

Assessing waterbird susceptibility to disturbance by duck hunters in Victoria

P. W. Menkhorst

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Front cover photo: At the first sign of disturbance Australasian Bitterns 'freeze' and use their camouflage plumage pattern to avoid detection. If this fails, they will fly to another part of the wetland. (photo: P. Menkhorst).

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1 Summary

Context

In Victoria, the hunting of eight species of native duck (game species) is allowed during a defined open season. Hunting takes place on wetlands that are also habitat for numerous other animal species, including more than 130 other waterbird species, some of which may be unintentionally adversely affected by the activities of hunters. To help reduce these potential adverse impacts on Victorian waterbird species, the *Wildlife (Game) Regulations 2012* allow for targeted management of wetlands and hunters if a need is identified. However, a lack of clarity around the decision-making process and the trigger points for instigation of special management action has led to uncertainty about the scientific rigour of decision-making. This can, in turn, result in reactive or delayed decisions, risking confusion and frustration amongst hunters and staff of the regulatory agencies, and poor wildlife management outcomes.

Aims

This report improves the process for making decisions on waterbird management during duck hunting season by:

1. developing an explicit process to assess the susceptibility of waterbird species to the types of disturbance associated with duck hunting.
2. applying this process to all waterbird species that are listed as threatened or near threatened in Victoria and are not game species.
3. ranking threatened non-game waterbird species according to the potential population-level (i.e. south-eastern Australian) conservation implications of disturbance caused by duck hunting.
4. providing estimates of the south-eastern Australian population of each waterbird species and suggested trigger points for consideration of special management attention at the level of an individual wetland.

Methods

Assessments were made for 39 non-game species that are listed as threatened or near threatened in Victoria. They were each considered under four separate criteria:

1. Susceptibility to disturbance (based on scoring five separate factors)
2. Conservation status at state and national level
3. Do they breed colonially or flock at traditional sites outside the breeding season, and if so, might these behaviours overlap with duck shooting season?
4. Are they long-distance migrants?

Population estimates for south-eastern Australia were then used to derive recommended trigger points for consideration of further management action for each of the 39 species.

Results

Species that ranked highest for susceptibility encompassed a range of taxonomic groups and ecological niches. The top 20 species include four members of two families – Ardeidae (herons, egrets, bitterns) and Laridae (gulls and terns) – and five members of the Scolopacidae (sandpipers and relatives).

Conclusions and implications

This report provides a transparent process for determining bird species most likely to be negatively affected by disturbance from duck hunting activities. The species susceptibility ranking, combined with the recommendations of significant population numbers, provide a clearer and more defensible basis for decisions about the need for further management interventions at individual wetlands. However, for it to function well, it is critical to have an adequate workforce sufficiently skilled in waterbird identification and counting.

2 Introduction

In Victoria, the hunting of eight species of native duck (game species) is allowed during a defined open season. Hunting takes place on natural and constructed wetlands that are also habitat for numerous other animal species, some of which may be unintentionally adversely affected by the activities of hunters, especially when large numbers of hunters gather at a wetland. Potential adverse effects (excluding death or injury from shotgun pellets) include: abandonment of nests or young due to the close presence of hunters in areas not normally visited by people, reduced feeding and resting opportunities due to disturbance by noise and movement, increased energy expenditure as a consequence of having to spend longer periods in flight following disturbance and reduced habitat availability resulting from the temporary abandonment of a wetland due to disturbance.

To help reduce these potential adverse impacts on non-game waterbird species, the *Wildlife (Game) Regulations 2012* allow for targeted management of wetlands and hunters if a need is identified. Targeted management may involve a range of actions including:

- the prohibition of hunting on a wetland, or part thereof, for the entire open season or for a shorter period
- greater compliance effort at a wetland, and
- increased engagement with hunters to explain the risks.

However, a lack of clarity around the decision-making process and the trigger points for instigation of special management action has, at times, led to uncertainty about the scientific rigour of decision-making. This can, in turn, result in reactive or delayed decisions, risking confusion and frustration amongst hunters and staff of the regulatory agencies, and poor wildlife management outcomes.

Additionally, the values that may trigger targeted management have changed over time and are increasingly being scrutinised by the public, further complicating the situation. In the past, wetland closures were triggered by only two criteria – the presence of large numbers of threatened, non-game species of duck (Freckled Duck and Blue-billed Duck but not Musk Duck, also listed as a threatened species in Victoria) or active breeding by colony-nesting species. More recently, the presence of significant numbers of other threatened waterbirds (e.g. Australasian Bittern, Brolga, Curlew Sandpiper) has also triggered management action. The presence of such species of concern is determined by surveys conducted in the month or so before duck hunting season begins – the Summer Waterbird Count (e.g. Menkhorst *et al.* 2019a) and by follow-up surveys through the course of the hunting season.

This report aims to improve the process for making decisions on waterbird management during duck hunting season by:

1. developing an explicit process to assess the susceptibility of waterbird species to the types of disturbance associated with duck hunting.
2. applying this process to all non-game waterbird species that are listed as threatened or near threatened in Victoria.
3. ranking threatened and near threatened non-game waterbird species according to the potential population-level (i.e. south-eastern Australian) conservation implications of disturbance caused by duck hunting.
4. providing a prioritised list of species of concern to be targeted during the annual Summer Waterbird Counts, monitored throughout the duck hunting season, and considered for special management attention.

Note that this ranking does not consider the risks or impacts of direct hunting mortality on non-target species – that is a separate question that can only be properly addressed by gathering robust data on the rates of non-target species being killed or injured by hunters. Such data do not exist and would be extremely difficult to gather. Even if the data were to be obtained, they would then need to be interpreted via taxon-specific demographic models that could estimate a sustainable harvest rate.

3 Methods

3.1 Species for assessment

For the purposes of this project, a broad definition of waterbird was adopted to include all bird species occurring in Victoria that routinely utilise wetlands or aquatic plants. The 145 species considered to meet these criteria are listed in Appendix 1 and include members of 27 bird families:

- Accipitridae (hawks and eagles)
- Acrocephalidae (Australian Reed-warbler)
- Alcedinidae (Azure Kingfisher)
- Anatidae (swans, geese, ducks)
- Anhingidae (Australasian Darter)
- Anseranatidae (Magpie Goose)
- Ardeidae (herons, egrets, bitterns)
- Artamidae (White-breasted Woodswallow)
- Charadriidae (plovers, dotterels, lapwings)
- Ciconidae (Black-necked Stork)
- Cisticolidae (Golden-headed Cisticola)
- Glareolidae (pratincoles)
- Gruidae (Brolga)
- Hirundinidae (swallows and martins)
- Laridae (gulls, terns)
- Locustellidae (grassbirds)
- Monarchidae (Australian Magpie-lark)
- Pandionidae (Eastern Osprey)
- Pelecanidae (Australian Pelican)
- Phalacrocoracidae (cormorants)
- Podicipedidae (grebes)
- Psittacidae (Orange-bellied Parrot)
- Rallidae (crakes, rails, gallinules)
- Recurvirostridae (stilts, avocets)
- Rostratulidae (painted-snipes)
- Scolopacidae (snipe, godwits, curlews, sandpipers, stints, phalaropes)
- Threskiornithidae (ibis, spoonbills)

To keep the task to a manageable level, formal assessment of susceptibility to disturbance was restricted to those taxa of waterbirds recorded from Victoria (Appendix 1) that are listed as threatened or near threatened on the most recent version of the Advisory List of Threatened Vertebrate Fauna in Victoria (DSE 2013). This restriction assumes that, for non-listed taxa, any effects of disturbance resulting from the annual duck hunting season would not materially change their conservation status at the population level (in most cases this translates to the south-eastern Australian population as waterbirds tend to be highly mobile and routinely move across State borders). Including the near-threatened category (species that do not actually meet the IUCN criteria for threatened species but come close to qualifying) ensures that the list of species to be assessed is a conservative (inclusive) one. We also included one taxon (Bar-tailed Godwit (subspecies *baueri*) that is not listed by DSE (2013) but has been classified as Vulnerable at the national level under Commonwealth environment legislation (*Environment Protection and Biodiversity Conservation Act* 1999) (EPBC Act). Species of duck that are available to be hunted (i.e. game species) were also excluded because such a designation clearly makes redundant any concerns about disturbance.

The 50 taxa identified by this selection process (Table 1) were then assessed for their primary habitat to remove species that rarely, if ever, utilise wetlands open to hunting in Victoria. This led to the removal of 11 taxa from further consideration because they are specialised birds of the sea-shore (called 'marine only' in Table 1) and are unlikely to be affected by duck hunting which is not authorised on Victorian beaches. However, five primarily sea-shore species (Hooded Plover, Bar-tailed Godwit, Common Sandpiper, Fairy Tern, Little Tern) that also utilise coastal lakes or estuaries where hunting may be allowed, were retained, as were shorebirds that regularly utilise inland wetlands. This left 39 species (Table 1), labelled 'species for assessment', to be scored against criteria designed to estimate the potential impact of disturbance caused by duck hunting on the species, at a population level.

3.2 Criteria for assessing susceptibility to disturbance

The 39 species for assessment were considered under four separate criteria:

1. Susceptibility to disturbance (based on scoring five separate factors).
2. Conservation status at state and national level.
3. Do they breed colonially or flock at traditional sites outside the breeding season, and if so, might these behaviours overlap with duck shooting season?
4. Are they long-distance migrants?

These criteria were distilled from the literature (e.g. Sokos et al. 2013), the author's participation in planning of duck hunting seasons, discussions with waterbird ecologists and observations of waterbird behaviour over several decades, including observations at wetlands when duck hunting was taking place.

Criteria 2, 3 and 4 have simple binary answers and values were assigned by the author alone. Criterion 1 requires a series of subjective judgements, so four waterbird biologists (including the author) were each asked to independently score each species against the six factors and the mean value calculated (see below). The four criteria are described below:

1. Susceptibility to disturbance

A form of expert elicitation using a simplified IDEA protocol (Hanea et al. 2018) was used to score each species against five factors (see below). Four waterbird experts were asked to independently score each species-factor combination into a spreadsheet. Outlying scores were then brought to the attention of the expert concerned and discussed with the author. Experts were then given the opportunity to adjust individual scores. The mean score for each species-factor combination was calculated and the sum of the mean scores for each of the five factors became the susceptibility score for each species.

The five factors, based partly on those developed by Sokos *et al.* (2013), are given equal weighting in the scoring process. They are:

Nocturnal feeding

Duck hunting is only legal during daylight hours, therefore, species that are capable of feeding during darkness should be less affected by hunting disturbance than those that require daylight to feed. Hunting may force obligate daytime feeders to feed while the disturbance is present or to fly to a wetland where hunting is not occurring.

Scores for nocturnal feeding were: able to feed at any time = 0; obligate diurnal feeders = 1.

Group size

Species that habitually occur in large groups will potentially suffer greater disturbance than those that prefer to utilise an area as singles or family groups and are therefore more widely scattered across the landscape. The assumption here is that dispersed species should more readily find space in refuge habitat than a large flock for which refuge habitat may be more limiting.

Scores for group size were: small/singles = -1; intermediate = 0; large = 1.

Response to disturbance

The behavioural response of a species to disturbance from duck hunting activities is a significant determinant of the impact that hunting might have on that species. Species that can skulk into nearby dense cover and wait until the disturbance declines will presumably be less affected than those that take to the wing and circle the wetland, using more energy and exposing themselves to being shot.

Scores for response to disturbance were: run to cover or crypsis = -1; long flight to leave wetland = 0; short flight or swim within wetland = 0.5; circling flight over wetland = 1.

Dietary specialisation

Birds have relatively high metabolic rates and many waterbirds must forage fairly continuously to stay healthy. In general, dietary specialists such as high-order carnivores will have fewer choices for refuge habitat than generalists, such as herbivores and omnivores, and are therefore more susceptible to disturbance. Carnivores were divided into small and large based on the size of animals eaten, with small carnivores feeding primarily on macro-invertebrates and small fish (<5 cm in length).

Scores for food availability were: herbivorous = -1; omnivorous = 0; carnivorous small = 0.5; carnivorous large = 1.

Habitat breadth

Habitat specialists are less flexible than habitat generalists in the sorts of places they can use as refugia or as foraging sites until the disturbance has passed. Therefore, species that can utilise a range of wetland types (e.g. different salinities, depths, vegetation communities) should have a greater capacity to find refuge habitat.

Scores for habitat breadth were: broad = -1; intermediate = 0; narrow = 1.

2. Conservation status

Disturbance due to the activities of hunters will potentially be of greater significance to populations of species that are already under stress caused by other threatening processes. Hence, the conservation status of a species is an important component of this susceptibility assessment. Currently, four assessments of conservation status are available for Victorian bird taxa, two are formal lists maintained under legislation – Commonwealth (EPBC Act 1999) and State (*Flora and Fauna Guarantee Act 1988*) and two are advisory lists that use the IUCN threatened species categories and criteria (IUCN 2012). The advisory lists – the State-level assessment of DSE (2013) and the national assessments of Garnett *et al.* (2011) – are more complete and up-to-date than those maintained under legislation.

The state-level assessments, both legislative and advisory, create some outcomes that may seem anomalous because species that are common elsewhere, but rare in Victoria, may qualify for inclusion. On the other hand, a State-level assessment may provide a more nuanced and informed assessment of local conservation status and thus better reflect current understandings of conservation status in south-eastern Australia than does a national assessment. To overcome this dichotomy, the combined scores of the two advisory lists (DSE 2013, Garnett *et al.* 2011) have been used, so that species that are considered threatened at both state and national level score more highly than those that qualify at state level only.

Scores for conservation status were: Near Threatened – 1, Vulnerable – 2, Endangered – 3, Critically endangered – 4 at both state and national levels.

3. Colony-breeding species

Colony-breeding species are those which habitually aggregate to breed in a confined area with multiple nests built in close proximity. Because breeding colonies contain a high density of individuals, disturbance of breeding colonies can result in a magnified impact compared to species which nest as dispersed pairs. Colony-breeding species in Victoria include the Magpie Goose and Australasian Darter, herons and egrets (but not bitterns), cormorants, terns, ibis and spoonbills (Table 1). In acknowledgement that the Australian Painted-snipe will breed in aggregations when conditions are suitable, that species has also been classified as colony-breeding for this purpose, complying with the conservative stance adopted throughout.

Colony-breeding species received a score of 1.

One other species, the Brolga, also aggregates around the time of the duck hunting season, though not for breeding. In south-eastern Australia, Brolgas breed as isolated pairs mostly between July and December. Following breeding, and as the shallow freshwater marshes dry in late summer-autumn, Brolgas gather at a few traditional wetlands (Arnol *et al.* 1984; Marchant and Higgins 1993, Sheldon 2005) as part of their pair bonding and social learning behaviour. These gatherings, which, in Victoria, can involve up to 100 individuals, are thought to be important in the social life of a regional Brolga population and should not be unduly disturbed.

For this reason, Brolga received an additional score of 1.

4. Long-distance migrants

Migratory birds need to build up energy reserves in the lead up to their departure to give them the best chance of reaching their destination. Of particular concern here are the migratory shorebirds that spend their non-breeding period (the austral summer) in Victoria and breed more than 15 000 km away in the high Arctic. These species leave Victoria during autumn and fly non-stop for several thousand km to reach stopover feeding sites in south-east Asia where they can refuel before continuing their flight to the breeding grounds. In the weeks leading up to departure, it is critical that they can feed voraciously to reach a body weight and condition that will maximise their chances of successfully completing the migration and then breeding successfully (Zwarts *et al.* 1990, Battley and Rogers 2007). Disturbance during this critical period needs to be minimised. Note that first-year birds of most migratory shorebirds do not undertake a return (northward) migration, so remain in Victoria throughout their first southern winter, that is, through the duck hunting season. Therefore, disturbance of flocks of predominantly immature shorebirds late in the duck shooting season (May and June) is of less concern than disturbance of flocks containing adults prior to migration in March and April. With good views through binoculars or a spotting scope, first-year shorebirds can often be distinguished by plumage characters (see Menkhurst *et al.* 2019b page 120).

Long-distance migrants (i.e. trans-equatorial) received an additional score of 1.

Table 1. The initial list of Victorian waterbird species listed as threatened or near-threatened by DSE (2013) or Garnett *et al.* (2011) and their status within Victoria.

Shading indicates game species and species utilising only tidal marine habitats – their susceptibility to disturbance from duck hunting was not assessed. *species whose national (EPBC) conservation status has been changed since the assessments of Garnett *et al.* (2011). CR – critically endangered; EN – endangered; NT – near threatened; VU – vulnerable; y – yes.

Species (alphabetical order)	Victorian threatened status	National threatened status	Game species	Marine only	Long-distance migrant	Colony-breeding in Victoria
Australasian Bittern	EN	EN				
Australasian Shoveler	VU		y			
Australian Little Bittern	EN					
Australian Painted-snipe	CR	EN				
Baillon's Crake	VU					
Bar-tailed Godwit (ssp <i>blaueri</i>)		VU*			y	
Black Bittern	VU					
Black-tailed Godwit	VU				y	
Blue-billed Duck	EN					
Brolga	VU					
Caspian Tern	NT					y
Common Greenshank	VU				y	
Common Sandpiper	VU				y	
Curlew Sandpiper	EN	CR*			y	
Eastern Curlew	VU	CR*		y	y	
Fairy Tern	EN	VU				y
Freckled Duck	EN					
Glossy Ibis	NT					
Great Egret	VU					y
Great Knot	EN	CR*		y	y	
Greater Sand Plover	CR	VU		y	y	
Grey Plover	EN			y	y	
Grey-tailed Tattler	CR			y	y	
Gull-billed Tern	EN					y
Hardhead	VU		y			
Hooded Plover	VU	VU				
Intermediate Egret	EN					y
Latham's Snipe	NT				y	
Lesser Sand Plover	CR	EN		y	y	
Lewin's Rail	VU					
Little Egret	EN					y
Little Tern	VU					y
Long-toed Stint	NT				y	
Magpie Goose	NT					y
Marsh Sandpiper	VU				y	
Musk Duck	VU					
Nankeen Night Heron	NT					y
Orange-bellied Parrot	CR	CR				
Pacific Golden Plover	VU				y	
Pectoral Sandpiper	NT				y	
Pied Cormorant	NT					y
Red Knot	EN	EN*		y	y	
Royal Spoonbill	NT					y
Ruddy Turnstone	VU			y	y	
Sanderling	NT			y	y	
Sooty Oystercatcher	NT			y		
Terek Sandpiper	EN			y	y	
Whimbrel	VU			y	y	
Whiskered Tern	NT					y
White-bellied Sea-Eagle	VU					
White-winged Black Tern	NT				y	
Wood Sandpiper	VU				y	

4 Results

4.1 Susceptibility score

The results of the assessment of susceptibility to disturbance are provided in Table 2 and those for the final disturbance ranking (susceptibility plus conservation status, colony breeding and long-distance migrant assessments) in Table 3.

Table 2. Mean scores for each of the five factors that comprise the susceptibility to disturbance score for each species assessed.

Species for assessment (alphabetical order)	Nocturnal feeding	Group size	Response to disturbance	Dietary specialisation	Habitat breadth	Susceptibility score
Australasian Bittern	0.25	-0.75	-1	1	1	0.5
Australian Little Bittern	0.5	-1	-1	0.625	1	0.125
Australian Painted-snipe	0.25	-0.75	-0.625	0.5	1	0.375
Baillon's Crake	0.5	-1	-1	0.5	1	0
Bar-tailed Godwit	0	0	0.5	0.5	0.75	1.75
Black Bittern	0.5	-1	-1	0.875	0.75	0.125
Black-tailed Godwit	0	0	0.625	0.5	0.75	1.875
Blue-billed Duck	0.75	1	0.5	0.125	0.5	2.875
Brolga	1	0.25	0	-0.125	0.75	1.875
Caspian Tern	1	0	0.5	0.875	-0.25	2.125
Common Greenshank	0.75	-0.5	0.5	0.5	0.5	1.75
Common Sandpiper	0	-1	0.5	0.5	1	1.0
Curlew Sandpiper	0	1	0.625	0.5	0.5	2.625
Fairy Tern	1	0	0.75	0.75	0.75	3.25
Freckled Duck	0.25	0.5	0.875	0	0.25	1.875
Glossy Ibis	1	0.25	0.5	0.75	0.5	3.0
Great Egret	1	0.75	0.5	1	-0.25	3.0
Gull-billed Tern	1	0.25	0.5	0.75	0.5	3
Hooded Plover	1	-0.75	0.5	0.5	1	2.25
Intermediate Egret	1	-0.75	0.5	0.875	0.75	2.375
Latham's Snipe	0.25	0	0.625	0.5	0.75	2.125
Lewin's Rail	0.5	-1	-1	0.5	0.75	-0.25
Little Egret	1	-1	0.5	0.875	0.75	2.125
Little Tern	1	0	0.75	0.75	0.75	3.25
Long-toed Stint	0	-1	0.375	0.5	0.75	0.625
Magpie Goose	1	0.75	0.625	-1	0.5	1.875
Marsh Sandpiper	0.75	-0.25	0.5	0.5	0.75	2.25
Musk Duck	0.75	0.25	0.5	0.375	0.25	2.125
Nankeen Night Heron	0	-0.25	0.5	0.875	0	1.125
Orange-bellied Parrot	1	-1	0.75	-1	0.75	0.5
Pacific Golden Plover	0	-0.5	0.75	0.5	0.75	1.5
Pectoral Sandpiper	0	-1	0.625	0.5	1	1.125
Pied Cormorant	1	0	0.125	1	1	3.125
Royal Spoonbill	0.75	0.5	0.25	0.875	0.25	2.625
Ruddy Turnstone	0.75	-0.25	0.625	0.5	0.75	2.375
Whiskered Tern	1	0.75	0.375	0.625	0.75	3.5
White-bellied Sea-Eagle	1	-1	0.25	1	0.25	1.5
White-winged Black Tern	1	-0.75	0.375	0.625	0.75	2.0
Wood Sandpiper	0.75	-1	0.5	0.5	1	1.75

Scores: Nocturnal feeding – yes = 0, no = 1; Group size – small = -1, intermediate = 0, large = 1; Response to disturbance – run to cover/crypsis = -1, leave wetland = 0, short flight or swim within wetland = 0.5, circles over wetland = 1; Trophic level – herbivore = -1, omnivore = 0, small carnivore = 0.5, large carnivore = 1; Habitat breadth – broad = -1, intermediate = 0, restricted = 1

4.2 Combined disturbance score

Table 3 presents the 39 species assessed in rank order of their total score for disturbance susceptibility.

Table 3. Disturbance ranking for Victorian waterbird species that may be disturbed by ducking hunting activity. Species sequence is highest to lowest combined score. Scores for conservation status were: Near Threatened – 1, Vulnerable – 2, Endangered – 3, Critically endangered – 4. For species listed at both state and national levels the two scores were summed.

Ranking	Species	Combined conservation status score	Susceptibility score	Colony-breeding/flocking site	Long-distance migrant	Total score
1	Curlew Sandpiper	7	2.625		1	10.62
2	Fairy Tern	5	3.25	1		9.25
3	Orange-bellied Parrot	8	0.5			8.50
4	Australian Painted-snipe	7	0.375			7.37
5	Gull-billed Tern	3	3	1		7.00
6	Blue-billed Duck	4	2.875			6.87
7	Bar-tailed Godwit	4	1.75		1	6.75
8	Australasian Bittern	6	0.5			6.50
9	Intermediate Egret	3	2.375	1		6.37
10	Hooded Plover	4	2.25			6.25
11	Little Tern	2	3.25	1		6.25
12	Little Egret	3	2.125	1		6.12
13	Great Egret	2	3	1		6.00
14	Whiskered Tern	1	3.5	1		5.50
15	Ruddy Turnstone	2	2.375		1	5.37
16	Marsh Sandpiper	2	2.25		1	5.25
17	Pied Cormorant	1	3.125	1		5.12
18	Glossy Ibis	1	3	1		5.00
19	Black-tailed Godwit	2	1.875		1	4.87
20	Brolga	2	1.875	1		4.87
21	Freckled Duck	3	1.875			4.87
22	Common Greenshank	2	1.75		1	4.75
23	Wood Sandpiper	2	1.75		1	4.75
24	Royal Spoonbill	1	2.625	1		4.62
25	Pacific Golden Plover	2	1.5		1	4.50
26	Caspian Tern	1	2.125	1		4.12
27	Latham's Snipe	1	2.125		1	4.12
28	Musk Duck	2	2.125			4.12
29	Common Sandpiper	2	1		1	4.00
30	White-winged Black Tern	1	2		1	4.00
31	Magpie Goose	1	1.875	1		3.87
32	White-bellied Sea-Eagle	2	1.5			3.50
33	Australian Little Bittern	3	0.125			3.12
34	Nankeen Night Heron	1	1.125	1		3.12
35	Pectoral Sandpiper	1	1.125		1	3.12
36	Long-toed Stint	1	0.625		1	2.62
37	Black Bittern	2	0.125			2.12
38	Baillon's Crake	2	0			2.00
39	Lewin's Rail	2	-0.25			1.75

5 Discussion

5.1 Inclusion of a score for colony-breeding species

Ideally, waterbird breeding colonies, and aggregations of Brolgas, would be identified in the Summer Waterbird Count that is held in the second half of February, roughly one month before the duck hunting season begins. This then allows consideration of the need for extra management intervention, e.g. wetland closure. Thus, one could argue that there is no need to include a specific score for colony-breeding species in this disturbance ranking system. However, coverage achieved during the Summer Waterbird Count varies annually depending on available departmental resources and the proportion of wetlands holding water in a given year, i.e. the magnitude of the task. Further, waterbird breeding is most likely in wet years when survey coverage will be most stretched. Therefore, a conservative approach has been taken here, however, I also encourage greater attention to colony-breeding species during the Summer Waterbird Count.

5.2 Threatened species rankings

The question of whether to apply conservation status rankings at the State or National level was given careful consideration. It is unlikely that distinct Victorian populations exist for most Victorian waterbird species, rather, most are part of larger, mobile populations that move widely across south-eastern Australia, according to climatic conditions (Orange-bellied parrot, Fairy Tern and Hooded Plover are likely exceptions to this). Therefore, it could be argued that the taxon level, rather than the State of Victoria, is the appropriate scale at which to assess conservation status for the current purpose. On the other hand, a State-level assessment (e.g. DSE 2013) provides a more nuanced and informed assessment of local conservation status and better reflects current understandings of conservation status in south-eastern Australia than do the existing national and global assessments. Adopting the State-level assessment is also more inclusive, allowing the assessment of 50 taxa compared to 12 taxa for the nationwide list (Table 1), thereby reducing the risk of failing to assess sensitive species. It also best accords with the *Flora and Fauna Guarantee Act* (1988) which requires conservation management to be focussed at the State level.

For these reasons, a combined score was used – the sum of scores for the rankings of DSE (2013) and Garnett *et al.* (2011). Both used the IUCN Red List criteria and categories, but applied them at the State and National levels respectively. Both assessments were applied specifically to the most relevant Australian taxon for each species, such as local subspecies and, in the case of migratory shorebirds, each used data from the East Asian-Australasian Flyway population. In a few cases, where a more recent (i.e. post 2010 when the Garnett *et al.* (2011) assessments were made) status assessment has been adopted by the Commonwealth under the EPBC Act (1999), we present the most current classification (indicated by an asterisk in Table 1).

5.3 Treatment of Blue-billed Duck and Freckled Duck

Two duck species, the Blue-billed Duck and Freckled Duck, that have long been listed as threatened species in Victoria (e.g. DSE 2013) and are known to be susceptible to non-target mortality during duck season, have well-established protocols for reducing the risk of mortality (rather than disturbance). These protocols are based on thresholds of flock size that trigger special management action to reduce the risk of mortality. These existing thresholds are equal to (Blue-billed Duck on large waters) or lower than (Freckled Duck and Blue-billed Duck on small waters) the numbers recommended here for reducing disturbance. In this case, the triggers designed to reduce the risk of mortality take precedence.

5.4 Characteristics of susceptible species

Species that ranked highest for susceptibility encompassed a range of taxonomic groups (13 Families) and ecological niches. The top 20 species in Table 3 include four members of each of two families: Ardeidae (herons, egrets, bitterns) and Laridae (gulls and terns) and five members of the Scolopacidae (sandpipers and relatives). The egrets and terns are listed threatened species, obligate diurnal feeders, high in the food chain and colony-breeders. Sandpipers that ranked in the top 20 are listed threatened species, occur in flocks, and are trans-continental migrants that need to dramatically increase body weight prior to departure in autumn.

5.5 Application of disturbance rankings

The end product of this scoring process is a list of waterbird species ranked for their potential to be adversely affected by disturbance caused by the activities of duck hunters. The purpose of this list is to identify species of most concern so that they can be prioritised for attention in the lead up to duck hunting season, for example, be carefully counted in the annual Summer Waterbird Count, and monitored through the course of the hunting season. Thus, it does not matter that some colony-breeding species are unlikely to be breeding during a hunting season, rather, their inclusion on the list is a prompt to ensure that surveys are undertaken to check that there is no breeding. This is necessary because many Australian waterbirds have the capacity to breed opportunistically, whenever conditions are suitable.

A ranking of species susceptibility highlights the species of greatest concern but does not indicate the circumstances under which extra management action is warranted. These need to be determined on a case by case basis, including consideration of the number of individuals at risk of disturbance at a given wetland and time. It is suggested that for each species in Table 3, a proportion of the estimated total south-eastern Australian population could be nominated as a trigger. A value of 1% of a population has often been used as an indication of a significant proportion of a population, for example, for defining sites of significance such as Ramsar sites (see criterion 6 at <https://www.environment.gov.au/water/wetlands/ramsar/criteria-identifying-wetlands>).

Population estimates for most species of waterbird in the Australian region are available (Wetlands International 2019) and could be used as the basis for an estimate of the south-eastern Australian population. For shorebirds, recent revised estimates of population number in the East Asian-Australasian Flyway (Hansen *et al.* 2016) form a solid basis for deriving defensible population estimates for south-eastern Australia. Population estimates for south-eastern Australia based on those two compilations are provided in Appendix 2, as are recommended trigger numbers for each species. It is anticipated that the presence of a single species at the trigger number would lead to consideration of targeted management action. If more than one species reached the trigger number at a given wetland and time then the case for targeted management action would be increased, depending on the rank (Table 3) of the species concerned. When a species reaches the trigger number simultaneously at more than one wetland, each wetland should be considered independently of the others to allow for local circumstances, such as hunting intensity and refuge options, to be considered.

The application of these disturbance rankings and population triggers is unlikely to significantly hinder duck hunting opportunities. Given that many of the species in Table 3 do not occur in large numbers in Victoria, they are unlikely to ever trigger a management response. Other species have large populations in south-eastern Australia and are also unlikely to reach the trigger proportion at any given wetland and time. Further, there will always be other factors to be considered in the application of this priority list to a particular situation, for example, the availability of refuge habitat close to a hunting wetland is an important local consideration that can only be handled on a case-by-case basis. Similarly, climatic conditions preceding a given hunting season can only be considered on a year-by-year basis.

5.6 Conclusions and implications

1. This report provides a transparent process for determining bird species most likely to be negatively affected by disturbance from duck hunting activities.
2. The species susceptibility ranking, combined with the recommendations of significant population numbers, provide a clearer and more defensible basis for decisions about the need for further management interventions at individual wetlands.
3. In the case of the Blue-billed Duck and the Freckled Duck, the existing triggers based on risk of mortality should continue to apply.
4. An important need for this process to function well is to have an adequate workforce sufficiently skilled in waterbird identification and counting, so that the community can have confidence that the process is being properly implemented.

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7 Appendices

Appendix 1. List of Victorian waterbird species.

* - fully marine species; # - very rare or vagrant species.

English name	Scientific name
	ANSERIFORMES
Magpie Goose	Anseranatidae
Magpie Goose	<i>Anseranas semipalmata</i>
Ducks, geese and swans	Anatidae
Plumed Whistling-Duck	<i>Dendrocygna eytoni</i>
Wandering Whistling-Duck#	<i>Dendrocygna arcuata</i>
Cape Barren Goose	<i>Cereopsis novaehollandiae</i>
Black Swan	<i>Cygnus atratus</i>
Freckled Duck	<i>Stictonetta naevosa</i>
Australian Shelduck	<i>Tadorna tadornoides</i>
Pink-eared Duck	<i>Malacorhynchus membranaceus</i>
Australian Wood Duck	<i>Chenonetta jubata</i>
Cotton Pygmy-goose#	<i>Nettapus coromandelianus</i>
Northern Mallard	<i>Anas platyrhynchos</i>
Pacific Black Duck	<i>Anas superciliosa</i>
Australasian Shoveler	<i>Anas rhynchos</i>
Northern Shoveler#	<i>Anas clypeata</i>
Grey Teal	<i>Anas gracilis</i>
Chestnut Teal	<i>Anas castanea</i>
Garganey#	<i>Anas querquedula</i>
Hardhead	<i>Aythya australis</i>
Blue-billed Duck	<i>Oxyura australis</i>
Musk Duck	<i>Biziura lobata</i>
	PODICIPEDIFORMES
Grebes	Podicipedidae
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>
Hoary-headed Grebe	<i>Poliocephalus poliocephalus</i>
Great Crested Grebe	<i>Podiceps cristatus</i>
	CICONIIFORMES
Storks	Ciconiidae
Black-necked Stork#	<i>Ephippiorhynchus asiaticus</i>
	PELECANIFORMES
Ibises and spoonbills	Threskiornithidae
Australian White Ibis	<i>Threskiornis moluccus</i>
Straw-necked Ibis	<i>Threskiornis spinicollis</i>
Glossy Ibis	<i>Plegadis falcinellus</i>
Royal Spoonbill	<i>Platalea regia</i>
Yellow-billed Spoonbill	<i>Platalea flavipes</i>
Hérons and bitterns	Ardeidae
Australasian Bittern	<i>Botaurus poiciloptilus</i>
Australian Little Bittern	<i>Ixobrychus dubius</i>

Black Bittern#	<i>Ixobrychus flavicollis</i>
Nankeen Night-Heron	<i>Nycticorax caledonicus</i>
Striated Heron#	<i>Butorides striata</i>
Eastern Cattle Egret	<i>Bubulcus coromandus</i>
White-necked Heron	<i>Ardea pacifica</i>
Great Egret	<i>Ardea alba</i>
Intermediate Egret	<i>Egretta intermedia</i>
Pied Heron#	<i>Egretta picata</i>
White-faced Heron	<i>Egretta novaehollandiae</i>
Little Egret	<i>Egretta garzetta</i>
Eastern Reef Egret	<i>Egretta sacra</i>
Pelicans	Pelecanidae
Australian Pelican	<i>Pelecanus conspicillatus</i>
	SULIFORMES
Cormorants and shags	Phalacrocoracidae
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>
Black-faced Cormorant*	<i>Phalacrocorax fuscescens</i>
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>
Pied Cormorant	<i>Phalacrocorax varius</i>
Great Cormorant	<i>Phalacrocorax carbo</i>
Darters	Anhingidae
Australasian Darter	<i>Anhinga novaehollandiae</i>
	ACCIPITRIFORMES
Ospreys	Pandionidae
Eastern Osprey#	<i>Pandion cristatus</i>
Kites, hawks and eagles	Accipitridae
Swamp Harrier	<i>Circus approximans</i>
Black Kite	<i>Milvus migrans</i>
Whistling Kite	<i>Haliastur spheurnus</i>
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>
	GRUIFORMES
Rails, crakes and coots	Rallidae
Buff-banded Rail	<i>Gallirallus philippensis</i>
Lewin's Rail	<i>Lewinia pectoralis</i>
Baillon's Crake	<i>Porzana pusilla</i>
Australian Spotted Crake	<i>Porzana fluminea</i>
Spotless Crake	<i>Porzana tabuensis</i>
Australasian Swampphen	<i>Porphyrio melanotus</i>
Dusky Moorhen	<i>Gallinula tenebrosa</i>
Black-tailed Native-hen	<i>Tribonyx ventralis</i>
Eurasian Coot	<i>Fulica atra</i>
Cranes	Gruidae
Brolga	<i>Grus rubicunda</i>
	CHARADRIIFORMES
Stilts and avocets	Recurvirostridae
White-headed Stilt	<i>Himantopus leucocephalus</i>
Banded Stilt	<i>Cladorhynchus leucocephalus</i>
Red-necked Avocet	<i>Recurvirostra novaehollandiae</i>

Plovers	Charadriidae
Banded Lapwing	<i>Vanellus tricolor</i>
Masked Lapwing	<i>Vanellus miles</i>
Red-kneed Dotterel	<i>Erythrogonys cinctus</i>
Pacific Golden Plover	<i>Pluvialis fulva</i>
American Golden Plover#	<i>Pluvialis dominica</i>
Grey Plover*	<i>Pluvialis squatarola</i>
Ringed Plover#	<i>Charadrius hiaticula</i>
Red-capped Plover	<i>Charadrius ruficapillus</i>
Double-banded Plover	<i>Charadrius bicinctus</i>
Lesser Sand Plover*#	<i>Charadrius mongolus</i>
Greater Sand Plover*#	<i>Charadrius leschenaultii</i>
Oriental Plover#	<i>Charadrius veredus</i>
Hooded Plover	<i>Thinornis cucullatus</i>
Black-fronted Dotterel	<i>Elseynornis melanops</i>
Painted-snipes	Rostratulidae
Australian Painted-snipe	<i>Rostratula australis</i>
Sandpipers and snipes	Scolopacidae
Latham's Snipe	<i>Gallinago hardwickii</i>
Short-billed Dowitcher#	<i>Limnodromus griseus</i>
Asian Dowitcher*#	<i>Limnodromus semipalmatus</i>
Black-tailed Godwit	<i>Limosa limosa</i>
Hudsonian Godwit*#	<i>Limosa haemastica</i>
Bar-tailed Godwit	<i>Limosa lapponica</i>
Little Curlew	<i>Numenius minutus</i>
Whimbrel*	<i>Numenius phaeopus</i>
Eastern Curlew*	<i>Numenius madagascariensis</i>
Spotted Redshank#	<i>Tringa erythropus</i>
Marsh Sandpiper	<i>Tringa stagnatilis</i>
Common Greenshank	<i>Tringa nebularia</i>
Lesser Yellowlegs#	<i>Tringa flavipes</i>
Wood Sandpiper	<i>Tringa glareola</i>
Grey-tailed Tattler*	<i>Tringa brevipes</i>
Wandering Tattler*#	<i>Tringa incana</i>
Terek Sandpiper*	<i>Xenus cinereus</i>
Common Sandpiper	<i>Actitis hypoleucos</i>
Ruddy Turnstone	<i>Arenaria interpres</i>
Great Knot*	<i>Calidris tenuirostris</i>
Red Knot	<i>Calidris canutus</i>
Sanderling*	<i>Calidris alba</i>
Red-necked Stint	<i>Calidris ruficollis</i>
Little Stint	<i>Calidris minuta</i>
Long-toed Stint	<i>Calidris subminuta</i>
White-rumped Sandpiper#	<i>Calidris fuscicollis</i>
Baird's Sandpiper#	<i>Calidris bairdii</i>
Pectoral Sandpiper	<i>Calidris melanotos</i>
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>
Curlew Sandpiper	<i>Calidris ferruginea</i>
Stilt Sandpiper#	<i>Calidris himantopus</i>

Broad-billed Sandpiper*#	<i>Limicola falcinellus</i>
Buff-breasted Sandpiper#	<i>Tryngites subruficollis</i>
Ruff#	<i>Philomachus pugnax</i>
Wilson's Phalarope#	<i>Steganopus tricolor</i>
Red-necked Phalarope	<i>Phalaropus lobatus</i>
Grey Phalarope#	<i>Phalaropus fulicarius</i>
Pratincoles and coursers	Glareolidae
Australian Pratincole	<i>Stiltia isabella</i>
Oriental Pratincole#	<i>Glareola maldivarum</i>
Gulls, terns and skimmers	Laridae
Silver Gull	<i>Chroicocephalus novaehollandiae</i>
Franklin's Gull#	<i>Leucophaeus pipixcan</i>
Pacific Gull	<i>Larus pacificus</i>
Gull-billed Tern	<i>Gelochelidon nilotica</i>
Caspian Tern	<i>Hydroprogne caspia</i>
Crested Tern	<i>Thalasseus bergii</i>
Little Tern	<i>Sternula albifrons</i>
Fairy Tern	<i>Sternula nereis</i>
Common Tern	<i>Sterna hirundo</i>
Arctic Tern*	<i>Sterna paradisaea</i>
Whiskered Tern	<i>Chlidonias hybrida</i>
White-winged Black Tern	<i>Chlidonias leucopterus</i>
	CORACIIFORMES
Kingfishers	Alcedinidae
Sacred Kingfisher	<i>Todiramphus sanctus</i>
Azure Kingfisher	<i>Ceyx azureus</i>
	PSITTACIFORMES
Parrots	Psittacidae
Orange-bellied Parrot	<i>Neophema chrysogaster</i>
	PASSERIFORMES
Woodswallows, butcherbirds and allies	Artamidae
White-breasted Woodswallow	<i>Artamus leucorhynchus</i>
Monarchs	Monarchidae
Magpie-lark	<i>Grallina cyanoleuca</i>
Swallows and martins	Hirundinidae
Welcome Swallow	<i>Hirundo neoxena</i>
Fairy Martin	<i>Petrochelidon ariel</i>
Tree Martin	<i>Petrochelidon nigricans</i>
Reed-Warblers and allies	Acrocephalidae
Australian Reed-Warbler	<i>Acrocephalus australis</i>
Grassbirds and allies	Locustellidae
Tawny Grassbird	<i>Megalurus timoriensis</i>
Little Grassbird	<i>Megalurus gramineus</i>
Cisticolas and allies	Cisticolidae
Golden-headed Cisticola	<i>Cisticola exilis</i>

Appendix 2. Population estimates for the species assessed and recommended trigger points for consideration of further management action.

In cases where the estimate is in the form of a broad range, the 1st quartile is used. In cases where the estimate applies to the entire continent the 1st quartile is divided by three to give an estimate for south-eastern Australia. Estimates for shorebirds (Hansen et al. 2016) are for the entire East Asian-Australasian Flyway and were divided by 5 to give an estimate for south-eastern Australia before calculating the 1% trigger. *No estimate available, estimate for SE Australia by the author. **Estimate is for SE Asia plus Australia so 1st quartile is divided by 100 to give estimate for se Australia.

Common name	Estimate of flyway population (Wetlands International 2019)	Estimate of flyway population (Hansen <i>et al.</i> 2016)	Recommended trigger point (1% of adjusted flyway estimate)
Australasian Bittern	310-960		5
Australian Little Bittern	1-10,000		25
Australian Painted-snipe	1500-2250		17
Baillon's Crake	10,000-25,000*		138
Bar-tailed Godwit		325,000	650
Black Bittern	500*		5
Black-tailed Godwit		160,000	320
Blue-billed Duck	10,000		100
Brolga	25,000-100,000		146
Caspian Tern	10,000-100,000		325
Common Greenshank		110,000	220
Common Sandpiper		190,000	380
Curlew Sandpiper		90,000	180
Fairy Tern	1200-1980		14
Freckled Duck	10,000-25,000		137
Glossy Ibis	25,000-1,000,000**		2437
Great Egret	25,000-100,000		146
Gull-billed Tern	25,000-100,000		146
Hooded Plover	3750		37
Intermediate Egret	25,000-100,000**		187
Latham's Snipe		30,000	60
Lewin's Rail	1-25,000		21
Little Egret	25,000-100,000		146
Little Tern	10,000-100,000		108
Long-toed Stint		230,000	460
Magpie Goose	3000*		30
Marsh Sandpiper		130,000	260
Musk Duck	10,000-25,000		137
Nankeen Night-Heron	10,000-100,000		108
Orange-bellied Parrot	50*		1*
Pacific Golden Plover		120,000	240
Pectoral Sandpiper		1,220,000	2440
Pied Cormorant	10,000-25,000		137

Royal Spoonbill	20,000-80,000*		117
Ruddy Turnstone		30,000	60
Whiskered Tern	25,000-100,000		146
White-bellied Sea-Eagle	150*		2*
White-winged Black Tern	100,000-1,000,000**		3250
Wood Sandpiper		130,000	260

