TASMANIAN BIRD REPORT 34

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TASMANIAN BIRD REPORT 34

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EDITORIAL – TASMANIAN BIRD REPORT 34

The Tasmanian Bird Report continues to be an important source of knowledge for scientists and those who are concerned about Tasmanian avifauna. Thanks are extended to those who submitted articles for this Report. We encourage all those who are preparing reports on their work to continue to provide their documents to Birds Tasmania for publication. The published records over the years form the basis of solid evidence of the status of, and trends in Tasmania's avian populations.

Sightings and counts of specific species have continued regularly throughout the year, both for the Atlas and the Important Bird Areas projects. Birds Tasmania also has its own data set, which is now being used increasingly by Local Governments, NRM bodies and other community organisations. Birds Tasmania now also has a collection of photographs, thanks to the work of Robert Fletcher. These photographs, in addition to the observation data, are now increasingly available to scientists and other groups.

Another significant innovation has been the extensive digital collection of bird vocalisations, initiated by Sarah Lloyd. There are now recordings from more than 100 locations throughout the state, with repeat surveys at some sites. This is providing a valuable source of information on several species and in areas hitherto unrecorded.

In closing, we note with deep regret the loss of several members of Birds Tasmania, in particular Peter Britton, who was Editor of the Tasmanian Bird Report for several years.

Malcolm Grant
Editor

CONSERVATION OVERVIEW OF THE AZURE KINGFISHER *CEYX AZUREUS* SUBSP. *DIEMENENSIS* IN TASMANIA

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"I have seen and have records of this scarce Kingfisher from various parts of the island. Owing to its habits it is but seldom seen by the casual observer, even about the rivers it haunts" *A Handbook of the Birds of Tasmania and its Dependencies* (Littler 1910, p. 80).

Introduction

The Azure Kingfisher is listed as endangered (Schedule 3) on the Tasmanian *Threatened Species Protection Act 1995*. During 2008, we compiled a profile of the species as part of a joint State-Commonwealth initiative to consider the conservation status of State-listed species not presently listed on the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. It became clear to us that the database information available for the Azure Kingfisher was limited, especially in terms of the historical aspects of the species' distribution. In addition, there are few published accounts of the species in Tasmania, except for anecdotal reports.

The purpose of this paper is to present the available information on the Azure Kingfisher in Tasmania to the broader scientific, ornithological and naturalist community, with the hope of generating further interest and observations of the species.

Taxonomy and nomenclature

The Azure Kingfisher belongs to the kingfisher family (Coraciiformes, Alcedinidae). Christidis & Boles (2008) discuss the taxonomic position of the two Australian species of kingfisher most recently included in the genus *Alcedo*. They noted that the inclusion of both species (including *Alcedo azurea*) received general acceptance. However, Christidis & Boles (2008) further noted that recent detailed examination (Moyle 2006) of the alcedinine kingfishers using the mitochondrial ND2 gene and the second intron of the nuclear myoglobin gene suggested that the species commonly placed in *Alcedo* did not form a monophyletic group relative to other members of the family, and that the Azure Kingfisher should be included in the genus *Ceyx*. This recent taxonomic change has been accepted by the Tasmanian Department of Primary Industries, Parks, Water & Environment in their *Natural Values Atlas* database and by Birds Australia (see http://www.birdsaustralia.com.au/birds/checklist.html).

There are eight subspecies of *Ceyx azureus*, three of which occur within Australia (Higgins 1999): *C. a. azureus* (Queensland to Victoria); *C. a. ruficollaris* (northern Australia from the Kimberleys to Cape York Peninsula) and *C. a. diemenensis* (endemic to Tasmania). The subspecies differ only in minor details: subspecies *ruficollaris* is smaller, brighter, and has more blue on the flanks; subspecies *diemenensis* is consistently larger, shorter billed, and has a distinctly darker violet-blue crown. There is a north-south cline of increasing size but subspecies *diemenensis* is discontinuously larger in body proportions than mainland Australian subspecies (Schodde & Mason 1976), and has larger eggs (Campbell 1901 cited in Schodde & Mason 1976). The species is widely known as the Azure Kingfisher throughout its entire range (Higgins 1999) with some other common names listed such as blue, creek, purple, Victorian blue, river or water kingfisher, essentially reflecting the distribution, habitat or appearance of the species.

Methods

Record sources

Existing database sources were interrogated for records of the Azure Kingfisher in Tasmania. The primary database used by State government agencies in the administration of the Tasmanian *Threatened Species Protection Act 1995* is the *Natural Values Atlas*, managed by the Department of Primary Industries, Parks, Water & Environment.

Ornithological and naturalist literature sources were examined for records of the Azure Kingfisher in Tasmania. A volume by volume perusal of the following journals was undertaken: *Papers and Proceedings of the Royal Society of Tasmania*, *The Tasmanian Naturalist*, *Victorian Naturalist*, *Emu*, *Australian Bird Watcher*, *Records of the Queen Victoria Museum*, and the *Tasmanian Bird Report*. This latter journal includes an annual systematic list of interesting and unusual sightings, spans the years 1971 to the present, and mentions the kingfisher species in virtually all years.

Less formal information on the Azure Kingfisher in Tasmania was sought from literature

such as field guides, including ones specifically on Tasmanian birds such as the *Tasmanian Bird Atlas* (Thomas 1979). Additionally, information on sightings was sought from the following parties:

- Birds Tasmania (email to members and notice in bi-monthly newsletter, *Yellow Throat*, and discussion with individual members with personal knowledge of the species and/or access to historical records of bird sightings);
- Department of Primary Industries and Water (now the Department of Primary Industries, Parks, Water & Environment), including the Water Assessment Section, Wildlife Management Branch, Threatened Species Section and broader Biodiversity Conservation Branch (via email to staff and follow-up phone or emails with specific people);
- Department of Environment, Parks, Heritage and the Arts, specifically the Parks and Wildlife Service that includes regional rangers and field staff (email to staff);
- Inland Fisheries Service (email to staff and notice in monthly newsletter);
- Forest Practices Authority (email to staff, follow-up with specific people and email to a network of 180+ Forest Practices Officers, who are essentially regionally based field officers);
- University of Tasmania, including the schools of Zoology, Plant Science, and Geography and Environmental Studies (email to staff);
- Tasmanian Museum and Art Gallery (collection information);
- Queen Victoria Museum and Art Gallery (collection information);
- Tourism operators, especially those undertaking outdoor adventure types of activities such as river cruises, rafting, kayaking, jet boating, nature tours, etc.;
- Tasmanian Field Naturalists Club (notice in bi-monthly bulletin to members and discussion at meetings);
- Other regional field naturalists clubs (email and notice in newsletters);
- Scientists, naturalists and ornithologists considered by the authors to have previously unreported information on the Azure Kingfisher (this included both Tasmanian and ex-Tasmanian field workers known to the authors);
- Residents of King Island and Flinders Island (emails, phone calls, and notice in *Island News* in the case of Flinders Island);
- Recreational freshwater angling community (through a thread on the forum on the Sports Fish Tasmania web site and information requests in regional fly-fishing newsletters);
- Scouts Tasmania, who manage river bank camps on the Mersey, Leven and Blythe rivers.

The information request sent via email or inserted in newsletters and similar media took the form of the following (modified slightly to suit the particular audience):

INFORMATION REQUEST ON THE AZURE KINGFISHER

Mark Wapstra is currently writing a species profile for the Azure Kingfisher as part of a review of the conservation status of several threatened species. Mark is seeking any observations of the Azure Kingfisher from anywhere in Tasmania from anytime (because any observations, no matter how imprecise, will provide important information about changes to the distribution of the species). Much of the existing database information is imprecise with respect to location and date so even old observations will help clarify database information. The specific information being sought is:

LOCATION (ideally a precise easting/northing stating datum and precision or lat/long but even a river name would be great):

DATE (again, as precise as possible, but even a month and/or year is good information to have):

OBSERVER (personal, second-hand, etc.):

ABUNDANCE and EXTENT (single, pairs, many, several at different points on river, etc.):

BEHAVIOUR (especially interested in obvious breeding activity such as nest holes, birds carrying nesting material, feeding young, but also observations of perching and feeding activity is good):

HABITAT (general description such as riparian forest, willows, bridge crossing, etc.):

COMMENTS (e.g. threats to site, year last seen at site, etc.):

Information received will be used to inform the species profile and assess the conservation status of the species. All records will be compiled and entered into DPIW's Natural Values Atlas database at the completion of the project. The above fields can be directly filled in via email (just forward this email back to Mark's email address shown below) or Mark is happy to receive observation information in any format that suits you. Feel free to pass this email to anyone else you think might be able to help with this request.

Data examination

All sighting information was entered in a spreadsheet suitable for later input into the Department of Primary Industries, Parks, Water & Environment's *Natural Values Atlas* database. Records were allocated to a year (to allow decade by decade categorisation), month (to allow a seasonal frequency of observations analysis), and record type including source (1. existing database i.e. *Natural Values Atlas*; 2.

literature, principally the *Tasmanian Bird Report*; 3. museum; 4. report from other sources) and type (1. sighting only; 2. breeding evidence; 3. other evidence such as skin, egg or carcass).

Results and discussion

Veracity of sighting information

The information presented below on the distribution of the Azure Kingfisher in Tasmania is based largely on unverified sightings collated by the authors. Even more formal database information is largely unverified. Caution in drawing too many firm conclusions on changes to the distribution and abundance of the species is warranted.

Several people who reported sightings of the Azure Kingfisher also commented on the distribution of the species. It appears that many people have opinions based on their own observations (e.g. species restricted to west coast; species absent from certain areas due to lack of personal sightings or more formal reports) or older published maps of the distribution (e.g. *Tasmanian Bird Atlas*, *Atlas of Australian Birds*) and cast doubt on reports from sites outside the widely recognised "core" west coast distribution.

Distribution

The Tasmanian Azure Kingfisher is restricted to Tasmania, presently occurring along several river systems on the south, west and northwest coast with outlying occurrences in the northeast, east, centre and Bass Strait islands. Sightings of birds from outside the seemingly "core" range of the west and northwest coasts are also reported. For example, there is a record of a bird from Bass Pyramid (Brothers *et al.* 2001), several kilometres off the northwest tip of Flinders Island, which may represent a mainland vagrant rather than a major range extension of the Tasmanian subspecies (although the observations of the species on Flinders Island in the 1960s means that the tantalising possibility of individuals of subsp. *azurea* and/or subsp. *diemenensis* being present on offshore islands arises, with little opportunity for confirmation). Relatively recent sightings from the Cressy area in the northern Midlands, the Bridport area in the northeast and the anecdotal reports of the species from Flinders Island suggest a wide distribution beyond the "core" range, but whether these locations represent resident breeding individuals or dispersing or vagrant individuals is not known. There are several sightings of the Azure Kingfisher from the wider Central Plateau area (e.g. Dee Lagoon, Woods Lake area, Junction Lake, etc.), including sightings of pairs, perhaps suggesting resident breeding populations. Sightings of the species on King Island in the 1980s and late 2008 are likely to be either vagrant birds from Tasmania or Victoria (either equally possible) because a resident breeding population would probably have been long known about, although the tantalising possibility of breeding activity along the Sea Elephant River or the Grassy River (two of the larger river systems on the island) cannot be wholly discounted.

The overall distribution (historical and contemporary) appears to be a reflection of the distribution of suitable habitat along river systems – the consistently higher rainfall of the west to northwest region with significantly greater density of larger rivers compared to the usually drier east and northeast region.

Evidence of migration between Tasmania and mainland Australia is unclear but unlikely. Historical sightings of the Azure Kingfisher on Flinders Island (1960s) in two of the larger river systems may have represented a breeding population but this cannot be confirmed. A single bird was sighted on the barren Bass Pyramid (northwest of Flinders Island) in 1986. The species has also been sighted in the mid 1980s and in late 2008 in Currie on King Island. Whether these Bass Strait sightings represent birds dispersing from mainland Tasmania or mainland Australia is not known.

Examination of different database sources reveals very different pictures of the distribution of the Azure Kingfisher in Tasmania. For many years, the maps provided in Thomas (1979), and the *Tasmanian Bird Atlas*, served as a guide to the distribution of many species (Figure 1).

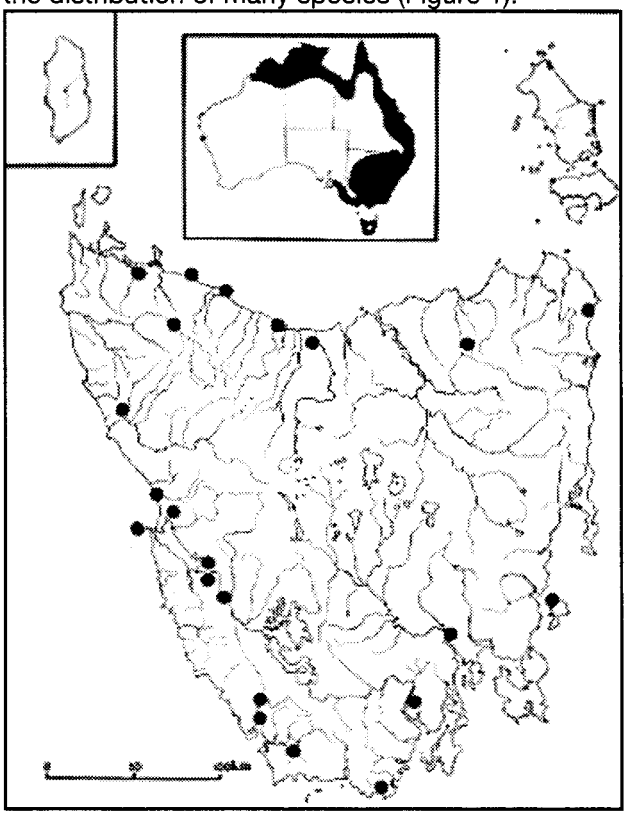

Figure 1. Distribution of the Azure Kingfisher according to the *Tasmanian Bird Atlas* (Thomas 1979).

More recently, DPIPWE's *Natural Values Atlas* database is recognised as the formal database for use by land managers and decision-makers for taking account of threatened species (Figure 2). Note the difference between Figures 1 and 2, with many of the older records collated by Thomas (1979) not included in the *Natural Values Atlas*.

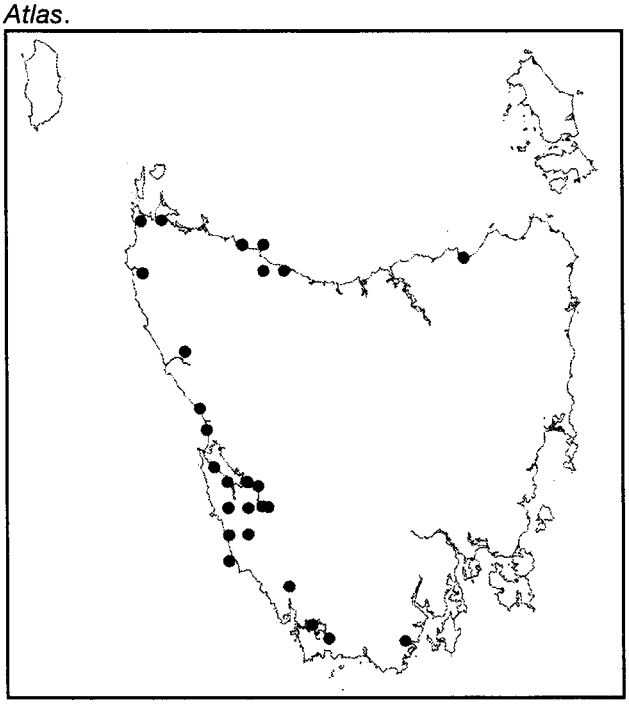

Figure 2. Distribution of the Azure Kingfisher according to DPIPWE's *Natural Values Atlas* (current as at January 2009).

The Birds Australia *New Atlas of Australian Birds* (Barrett *et al.* 2003) provides a much simpler view of the distribution of the Azure Kingfisher in Tasmania (Figure 3). The original Atlas *of Australian Birds* (Blakers *et al*. 1984) provided a similar map of the distribution of the species in Tasmania, with only eight 1° blocks with reports (all at a rate of less than 11%) and one 1° block with breeding reported (from far northwest Tasmania). Note the significant difference between the indicated distribution of the Azure Kingfisher in Tasmania based on Figures 1, 2 and 3.

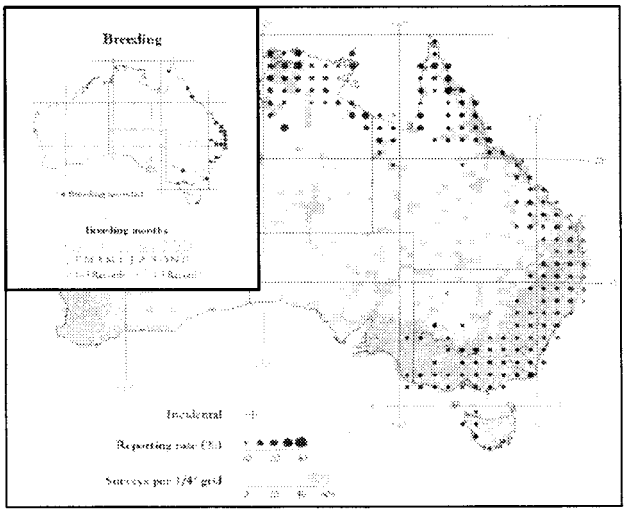

Figure 3. Distribution of the Azure Kingfisher according to the *Atlas of Australian Birds* (Barrett *et al.* 2003). Note the inset that shows the apparent absence of breeding records in Tasmania.

The present project has compiled a database of over 320 records for the Azure Kingfisher in Tasmania (Figure 4); data up to about December 2009. While many of these records represent duplication from a variety of sources, it is clear that the picture of the distribution of the Azure Kingfisher presented in Figure 4 is significantly different from that presented by other sources, as shown in Figures 1 to 3.

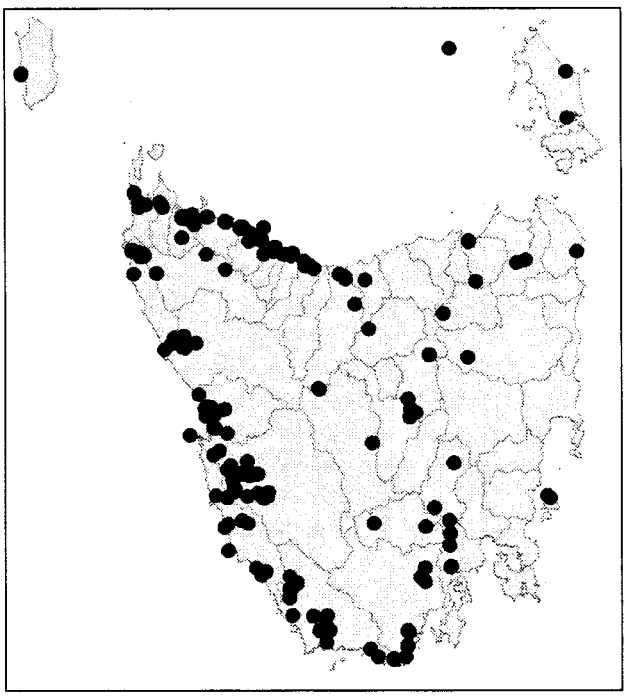

Figure 4. Summarised distribution of the Azure Kingfisher in Tasmania based on the records collated as part of the present project, which includes historical and contemporary records (polygons are catchments defined by the CFEV project).

Given the legislated threatened status of the Azure Kingfisher in Tasmania, a comparison

of the database information held by the State agency responsible for the State threatened species legislation (i.e. the *Natural Values Atlas* database) and the information available from other sources, is very revealing (Figure 5). Managing threatened species relies on sound base data. For example, the Department of Primary Industries, Parks, Water & Environment supplies the Forest Practices Authority with database information to allow the State's forest industry personnel to take account of threatened fauna during the preparation and implementation of forest practices plans. Similarly, environmental assessments (e.g. for development proposals) in Tasmania usually involve the interrogation of the *Natural Values Atlas* database (to obtain a formal report on known ecological values) before undertaking assessments. Such assessments are required for proposals such as dams on rivers. Our more recent information suggests that the *Natural Values Atlas* includes only limited observations of the species compared with our estimates of the actual and potential distribution of the Azure Kingfisher in Tasmania. This information (in the *Natural Values Atlas*) will need updating to ensure planning and land use decisions are made with the best available information.

It is important to consider the difference among record types held in databases because this affects the management of sites and potential habitat. The majority of records represent sightings of birds, usually individuals, but very few represent confirmed breeding activity. However, several locations are represented by sightings over many different years, sometimes spanning several decades, at several different locations. Such information, in the absence of confirmed breeding activity, probably indicates a resident breeding population. At present, databases holding records of the Azure Kingfisher rarely indicate critical information such as the type of record and we suggest that this should be addressed to facilitate the management of the species. It is noted that the *Natural Values Atlas* does differentiate the record type for species such as the Masked Owl (e.g. roost, nest or sighting), raptor species (e.g. nest sites included in the raptor nest database), Swift Parrot (nest site, forage area, sighting, etc.) and the Forty-Spotted Pardalote (e.g. nesting colony), where such information is critical to the appropriate management of the species. Additionally, it is important that databases include sightings from as many years as possible because temporal data may indicate how the Azure Kingfisher is utilising a site. For example, the *Natural Values Atlas* database contained one record of the Azure Kingfisher from the Lune River in 2006, which could easily be taken as a vagrant individual. However, the present project gathered records from 2005 and 2008, so now the Azure Kingfisher is known from several sightings over several years over several kilometres of the Lune River, which is highly suggestive of a resident population.

Table 1 provides a regionally based summary of the distribution of the Azure Kingfisher in Tasmania, separated by river system and catchment name, with notes on the type of observations associated with the location.

It is difficult to provide an indication of the absolute number of locations that the Azure Kingfisher occurs in because of the previously stated database veracity issues. The term 'location' is difficult to apply to a species such as the Azure Kingfisher based on the known information. Again, this relates to database and published information that does not record if an observation is a sighting, a breeding site or a resident population. If the populations on major river systems are assumed to represent locally resident populations (based on the fact that several such river systems are represented by several sightings over many years), then the Azure Kingfisher is known from at least 60 locations (Figure 4, Table 1).

However, this value is a somewhat artificial construct because some 'locations' are represented by a single record (e.g. one sighting on the Derby River) while other 'locations' are represented by numerous records (e.g. 10s of records over many decades from the mouth of the Arthur River and extending 10s of kilometres upstream). Other 'locations' are probably best regarded as composite sites (e.g. the records from Big Creek and the Inglis River are effectively one 'location' because Big Creek flows directly into the Inglis River at its mouth close to several sightings). Other 'locations' are imprecise (e.g. Mount Rugby) and may refer to a wider geographic area (e.g. Bathurst Harbour, Davey River, Melaleuca Lagoon).

Other methods of defining a 'location' may be more applicable to a species such as the Azure Kingfisher. For example, it is possible to state how many catchments the species has been sighted in. Using the latest catchment boundaries (as supplied by the Tasmanian Conservation of Freshwater Ecosystems Values program administered by DPIPWE – see Figure 4 for boundaries), the Azure Kingfisher occurs in 30-33 major catchments, and numerous additional sub-catchments (not shown on map). Of further relevance, but difficult to estimate (because of the previously stated database issues and the absence of river-length surveys), is the proportion of each catchment known to be utilised by, or potentially suitable for, the Azure Kingfisher.

Habitat

The Azure Kingfisher occurs mainly along the forested margins of the major river systems of the west and northwest coast of Tasmania, potentially within a relatively wide range of forest types but mainly wet sclerophyll eucalypt forest with broad-leaved and rainforest shrub understoreys (e.g. Harris & Kitchener 2005). It usually occurs in shady, and often overhanging, vegetation of riverine forests dominated by wet sclerophyll and mixed forest supporting mainly eucalypt species (e.g. Green 1995). Occasional sightings of individuals in other habitats have been reported but these are atypical (e.g. bare salt-sprayed rock of Bass Pyramid – Brothers *et al.* 2001; bare intertidal mudflat – *Tasmanian Bird Report, 10,* 1980).

The distribution and habitat of the Azure Kingfisher is intimately linked to its breeding and feeding biology. The Azure Kingfisher breeds in a hole drilled in a river bank (Green 1995; Higgins 1999) but in Tasmania very few sites have been documented in a formal sense. Table 1 indicates which locations have been associated with breeding activity.

Breeding has been confirmed and anecdotally reported from several river systems. Confirmed breeding behaviour has been reported from the following rivers: Blythe River, Sorell River/Birchs Inlet, Pieman River, Duck River, Deep Creek, South Esk River (historical), Arthur River, Black River, Henty River, Welcome River, Camp Creek, Condor River and Inglis River.

Frequent sightings on a river may be indicative of breeding birds but this can only be confirmed by observation of breeding behaviour. For example, it seems logical to conclude that the frequent sightings of individuals along the Inglis River is indicative of at least one breeding pair. However, there is only one report of birds carrying what appeared to be nesting material so breeding in this river remains unconfirmed. Oddly, some river systems anecdotally well known for supporting breeding birds are not represented in the literature or databases. For example, many people noted the Duck River as a breeding site but until the present project, breeding sites were undocumented in a formal sense. The precise location of many breeding sites remains poorly documented. This is in contrast to other threatened bird species in Tasmania for which management relies heavily on knowing where nests are (e.g. Wedge-Tailed Eagle, Masked Owl, Grey Goshawk), or at least where breeding colonies/clusters are (e.g. Swift Parrot, Forty-Spotted Pardalote). For example, the exact position of regularly used breeding holes for the Azure Kingfisher on the Arthur River and in the Birchs Inlet area are well known but not formally documented in an accessible source.

The Azure Kingfisher mostly catches prey by shallow plunging from perches 1-10 m overhanging the surface of water (Higgins 1999). It feeds on small fish, freshwater crayfish, aquatic insects and their larvae, occasionally amphibians, and occasionally forages on the ground taking beetles and other terrestrial insects and it may catch dragonflies in the air (Shields 1994; Higgins 1999; Hollands 1999). There is considerable anecdotal evidence that whitebait and trout fingerlings provide an important food source at many Tasmanian sites. Hollands (1999) noted that the Azure Kingfisher habitually uses favoured sites and perches for fishing, which may be for just a few days or weeks at an ephemeral pool or for up to five years on a permanent stream (on the same favoured perch). There is some anecdotal evidence from ferry operators on the Arthur River that the Azure Kingfisher is more prevalent in the lower reaches of the river during the time of the whitebait run but whether these factors are coincidental is not known. In addition, some anecdotal information suggests that the species was regularly seen near the weir on Bells Parade on the Mersey River, perhaps a suggestion it was feeding on schools of fish at this site. Similar observations of birds feeding on schools of small fish backed up against in-stream obstructions (including weirs and infestations of willow roots) come from the Mersey River and Deep Creek.

Population demographics

Garnett & Crowley (2000) stated that, "although it is ambitious to estimate numbers for this subspecies, records are few enough to suggest that the population contains fewer than 250 mature individuals and appears to be declining".

There are no published accounts of past or present population numbers, and no estimates of future changes to population numbers. Garnett & Crowley (2000) note that the subspecies is historically recorded throughout Tasmania, although it may never have been common in the east and north (Thomas 1979). Sharland (1945) reported the species as, uncommon," noting it is, "occasionally on the North-West Coast" and, "rare in the south". Later, Sharland (1958) reported that the species is, "uncommon and dispersed lightly along the rivers of northern Tasmania, and also occurs on the west coast, chiefly on the Gordon River...occasionally it is reported in the south and has been seen on the Derwent River at New Norfolk and on the Huon River near Franklin". Most sightings reported in journals such as the *Tasmanian Bird Report* are of single to few birds only, suggesting that the estimate of fewer than 250 mature individuals may be relatively reliable.

There is no published information of the species' home range/territory size in Tasmania. Higgins (1999) provides information of the

distribution of breeding pairs from mainland river systems, which may be applicable to the Tasmanian context but this aspect of the biology of the subspecies is unknown. Information presented in Higgins (1999) suggests that pairs are sedentary and resident, including in Tasmania (e.g. Green 1995), with unpublished information alluding to pairs of birds being found about every kilometre along major rivers (e.g. Shields 1994) with pairs maintaining permanent territories all year along watercourses of about 200-500 m of river bank but exact size depends on size of river and other factors. The tourist ferry proprietors on the Arthur River cruises report that there are probably only two pairs (but not more than three pairs) on the stretch of river covered by the cruises, which suggests a sparser density in Tasmania than the mainland because the cruise is at least 10 km long. The lower reaches of the Duck River appears to support about five breeding pairs (c. 10 years ago but may now be fewer than this) in about a 5 km stretch of river. Fluctuations in the number of breeding pairs along a stretch of river may not be unusual because in the early part of the 20th century, Littler (1910) had already noted that the, "Duck River was once a favourite resort, but now, so I am informed on good authority, the species is as rare there as elsewhere".

There is no reliable information to indicate a population trend for the entire species, including past decreases or future changes in size of populations but anecdotal information suggests decreases in several areas of the State.

Annual and seasonal variation in sightings

We analysed all records (eliminating obvious duplicates) with reliable dates of observation by decade, year and month, which indicates several trends. It should be noted that while the Azure Kingfisher is a highly distinctive species, many of the sighting records used in the analysis are formally unconfirmed. This statement is not intended to throw doubt on the veracity of the observation; rather to recognise the lack of precision of many records, meaning that detecting trends may be difficult.

Higgins (1999) suggests an apparent absence from Tasmania and parts of Victoria in July but the species' localised resident status in Tasmania (e.g. Green 1995) suggests that this is, at least in part, an artefact of when people are more likely to observe the species. A month by month analysis (Figure 6) clearly shows that the majority of sightings are made between October and February but that there are sightings in every month. We tend to use rivers for fishing, boating and even conservation management purposes (such as the orange-bellied parrot monitoring), during spring-summer, which coincides with the breeding season of the Azure Kingfisher (Higgins 1999), when the species may be more active (and hence obvious) due to foraging activities. It is possible (but entirely untested) that the species utilises more remote stretches of rivers during the autumn-winter months, which may relate to changes in food resources. Certainly many people suggested that the Azure Kingfisher is sighted in spring-summer because of the presence of whitebait.

Before 1970, there are few database records of the Azure Kingfisher in Tasmania, many of which are sightings with imprecise details (Figure 7). This paucity of records probably reflects the lack of formal documentation of sightings before the establishment of the Bird Observers' Association of Tasmania and the commencement of the compilation of the annual systematic list in the *Tasmanian Bird Report*. The 1970s, 1980s and 1990s saw a similar rate of observation but there is almost a doubling of the rate of observations for the present decade (Figure 7). This probably reflects the gathering of data for the present project combined with the formal listing of the species as endangered on the Tasmanian *Threatened Species Protection Act 1995* in 2002, which may have prompted observers to report sightings.

The first *Atlas of Australian Birds* (Blakers *et al.* 1984) noted that there were more numerous reports before 1950, especially on the east coast, noting only a single breeding record in the northwest and a reporting rate of less than 11%. The *Atlas* reported 22 locations (31 records) in the west, northwest and southeast. This compares to the *New Atlas of Australian Birds* (Barrett *et al.* 2003), which reported the species from 7 locations (26 records) mainly in the west and northwest. This apparent decrease in reporting rate is not mirrored in our more recent collation of records, suggesting that reporting frequency might not be a good indicator of trends in the population of the species. While a decrease in reporting rate is reported between the different *Atlas* versions, it is noted that the reporting rate is low even for areas such as the southwest coast, an area frequented by many people and a known stronghold for the Azure Kingfisher.

Reservation status

Due to the low precision of many database records, combined with the fact that many such records simply represent sightings and not necessarily resident breeding subpopulations, it is difficult to provide a clear indication of the reservation status of the Azure Kingfisher in Tasmania. However, as a general statement, many sightings are strongly associated with major river systems, which, if not already in national parks or other reserves, are invariably afforded some protection as Public Reserves

under the Tasmanian *Crown Lands Act 1998*.

Overlaying database records with the reserve system indicates that sightings (and probably therefore resident subpopulations because the sightings are from the "core" west coast distribution and strongly associated with the major river systems) are associated with the following reserves under the Tasmanian *Nature Conservation Act 2002*: Arthur-Pieman Conservation Area, Franklin-Gordon Wild Rivers National Park, Southwest Conservation Area, Mount Dundas Regional Reserve, Southwest National Park, Rocky Cape National Park, Donaldson River Nature Recreation Area, and, historically Maria Island National Park and Mount William National Park. None of these reserves are actively managed for the Azure Kingfisher, although as a general statement, all proposed activities within reserves are subject to the *Tasmanian Reserve Management Code of Practice* (PWS, FT & DPIWE 2003).

Several sightings are associated with major river systems located on State forest (public land managed by a government business enterprise, Forestry Tasmania), the majority of which are afforded management protection through Forestry Tasmania's Management Decision Classification (MDC) system (Orr & Gerrand 1998). Most such sites are surrounded by Wildlife Habitat Strips, which are classified as "informal reserves" providing security over and above areas of State forest designated as "Production Forest" (i.e. areas used for wood production), and requiring special consideration during forestry operations under the *Forest Practices Code 2000* (FPB 2000).

Threatening processes

While the Azure Kingfisher is listed as a threatened species, identifying specific threats, and the magnitude of the threats to the population, is somewhat complex because of the apparently disjunct distribution of the species, combined with its usually low population numbers and the infrequency of sightings. There are no long-term monitoring projects on the Azure Kingfisher (or other riverine birds) that can provide useful data on demographic and distributional changes to the species.

There are no published accounts of natural factors affecting the mortality and/or longevity of the Azure Kingfisher with no reports of disease or parasites in the species. Natural predators are presumed to be few, based on its protected foraging and breeding habitat, but snakes may be able to access nesting tunnels.

In the *Action Plant for Australian Birds* (Garnett & Crowley 2000), it is stated that, "the most likely reason for the decrease in range of the Azure Kingfisher in Tasmania is competition with Brown Trout *Trutta trutta*, which are now present in all streams and probably reduce the availability of galaxids [sic] and the other small fish which are presumed to be the kingfisher's natural prey." Other suggested reasons for decrease are acidic run-off from mining tailings dams, clearing along stream banks and logging, which could all affect stream health, and the poaching of whitebait from western rivers". We investigated the possible magnitude of these, and other potentially threatening processes, and provide commentary on each of these below.

Competition with brown trout

Brown trout are widespread in Tasmania, and abundant down to sea level in all major drainages except in the south-west (IFS 2008; P. Davies pers. comm. 2009). Relating the historical distribution of brown trout to a decrease in the distribution and/or abundance of the Azure Kingfisher in Tasmania is difficult due to the lack of baseline population data for different river systems. It is possible to state that the Azure Kingfisher currently occurs in river systems with and without brown trout but it is not possible to relate this distribution to a threat to the Azure Kingfisher. Significant anecdotal evidence suggests that trout fingerlings may actually comprise an important part of the diet of the Azure Kingfisher in Tasmania, at least in combination with small native fish. Interestingly, Shields (1994) notes that the Azure Kingfisher (on mainland Australia) is most abundant along streams that are well protected by buffer strips of native eucalypt forest that provide shade and protection for trout (*Salmo* spp.), the fry of which constitute most of the kingfisher's diet in some parts of the species' range. We conclude that the presence of introduced fish species *per se* is unlikely to be a significant threat to the Azure Kingfisher in Tasmania.

Whitebait fishery

A whitebait fishery has operated in Tasmania for over a century (e.g. IFS 2006), with a commercial fishery operating since the early 1940s (Blackburn 1950). The term 'whitebait' is a collective name for small transparent native fish that migrate from the sea into rivers and streams during spring and summer. There is a *Whitebait Fishery Management Plan* produced by the Inland Fisheries Service (IFS (2006) that controls the recreational licensing of the whitebait catch. Upstream-moving schools or runs of whitebait occur in coastal streams around Tasmania.

A commercial fishery for whitebait existed from at least the 1930s until 1974 when the fishery was closed. The commercial fishery was based mainly on *Lovettia* (Blackburn 1950), and the demand for a supply of fish for the canning industry stimulated the rapid expansion of the fishery in the early 1940s (Lynch 1965 cited in IFS

2006). Canning ceased in the 1950s and commercial interest subsided markedly (Lynch 1965 cited in IFS 2006). There was rapid decrease of the fishery after the peak catch of 480 tonnes in 1947. Fulton (1984 cited in IFS 2006) considered that the extent of this decrease was caused by overfishing. Blackburn (1950) conducted research on whitebait stocks and recommended closure of the northern fishery for a year in 1949 to allow recovery of the fishery, and the establishment of quotas for subsequent seasons. The fishery was re-opened in 1950 but continued to remain in decline, dropping to 1,010 kg in 1972, with the fishery finally closed after the 1974 season. No legal commercial fishery has operated since 1974, and in view of the past situation with commercial over-exploitation of stocks, and in the absence of evidence that stocks could now support a commercial fishery, the Service considers that a commercial whitebait fishery based on the harvest of wild fish is not sustainable or desirable (IFS 2006).

A limited licensed recreational fishery for whitebait has operated in Tasmania since 1990 under the jurisdiction of the Inland Fisheries Service (*Inland Fisheries Act 1995*). Participation in the fishery over the past four years has slowly increased with the 2005 season having the highest number of licence holders since 1990. Whitebait are caught for personal consumption and are considered a seasonal delicacy, especially across the north of the State. Management of the fishery has been aimed to protect populations of whitebait species and avoid indirect impact on anglers targeting other species, while enabling a small legal catch of whitebait for personal consumption. Poaching and illegal sales are ongoing problems associated with the whitebait fishery (IFS 2006).

The recreational fishery is open in specified rivers in the southeast, northeast and northwest of Tasmania. Participation in the fishery is highest in the northwest, with this region generally having double the number of licence holders than in the southeast, with the southeast generally having double the number of licence holders than in the northeast (IFS 2006). In this respect, if recreational whitebait fishing is a threat to the Azure Kingfisher, the threat is current in the presently recognised stronghold for the species i.e. the northwestern river systems.

Blackburn (1950) noted that the main areas for whitebait fishing were (a) the region extending almost the full length of the north coast from the Duck River in the west to the Great Forester River in the east (virtually all the major rivers on the north coast), and (b) from a region in the south-east extending from the Esperance River north to Blackman Bay at Dunalley (on the Esperance, Huon and Derwent rivers). The distribution of historical whitebait fishing overlaps substantially with the reported historical and present distribution of the Azure Kingfisher (Thomas 1979). Blackburn (1950) also noted that fishing usually occurred between August and October. Interestingly, this coincides with the reported breeding season of the Azure Kingfisher (e.g. Higgins 1999).

There is very little evidence to suggest that the Azure Kingfisher is affected by fluctuations in whitebait numbers (and therefore illegal or legal fishing) because many sightings are strongly associated with known sites for whitebait accumulations such as at weirs on many river systems including Deep Creek, Rubicon River, Gawler River and others.

Habitat clearing and disturbance

Garnett & Crowley (2000) state that activities such as, "clearing along stream banks and logging, which could all affect stream health" may be a reason for the decrease in the Azure Kingfisher in Tasmania. Shields (1994) notes that the Azure Kingfisher (on mainland Australia) is most abundant on streams that are well protected by buffer strips of native eucalypt forest that provide shade and protection for trout (*Salmo*. spp.). In Tasmania, historically, many major river systems (e.g. South Esk, Macquarie, Elizabeth, Derwent rivers) that may have supported the Azure Kingfisher have had extensive clearing of the riparian vegetation, and this may have contributed to the localised extinctions of the species from several reported locations.

However, many river systems in eastern and northeastern Tasmania (e.g. Pipers, Little Forester, Great Forester, Brid, Boobyalla, Tomahawk, Ringarooma, Great Musselroe, Ansons, Scamander, Douglas and Apsley rivers) have extensive sections in very good condition with respect to natural riparian vegetation and water quality. Some sections of northwestern river systems have been historically extensively cleared to their banks for primary production (e.g. large sections of the Welcome, Montagu and Duck rivers) but broadscale clearing of forest from streamside reserves is no longer permitted under State legislation (e.g. *Forest Practices Act 1985).* An examination of recent GoogleEarth imagery of Tasmanian rivers associated with the Azure Kingfisher clearly shows almost wholescale retention of riparian buffers (e.g. the Arthur River and tributaries, most rivers flowing into Bass Strait) indicating that contemporary clearing related to forestry and primary production is probably a very low threat. However, at a finer scale several rivers known to support the Azure Kingfisher have localised disturbance factors operating (e.g. installation of private jetties where private property extends to the river bank): it is difficult to ascertain the degree of threat such

activities pose without further data.

Acid mine drainage (AMD) from tailings dams

Higgins (1999) stated that, "acidic runoff from tailings dams in Tas. may adversely affect local populations" (citing a personal communication but no published literature). There is no published information available on the degree of threat presented by AMD to the Azure Kingfisher, past, present or future. Mineral Resources Tasmania undertook a major review of the distribution of AMD affected drainage systems and soils throughout Tasmania (Gurang 2001). AMD is certainly present in many river systems inhabited by the Azure Kingfisher but seemingly affects only relatively limited portions of each catchment. Some of the worst-affected river systems (e.g. King and Queen rivers on the west coast) are apparently not inhabited by the Azure Kingfisher (although there is a single record from the King River from an unknown date), so it is possible to speculate that AMD makes some river systems unsuitable for the Azure Kingfisher. However, the Azure Kingfisher is present in the Macquarie Harbour catchment (e.g. sightings on the Gordon River, stream behind Strahan and several sightings in recent years around Macquarie Harbour and Strahan) so the effect of AMD (if real for the Azure Kingfisher) is probably localised to affected stream sections and not the entire catchment. Quantifying the past, present and future threat to the Azure Kingfisher from AMD is very difficult due to the lack of baseline population monitoring. Fielding (1976), in a general list of birds observed on Tasmania's west coast, noted that the Azure Kingfisher was, "reported along the Donaldson River but was not seen in the polluted Savage and Pieman Rivers" but provides no indication of the level of survey or the type of pollution.

Bridge construction

Bridges constructed across river sections supporting breeding colonies of the Azure Kingfisher are likely to locally disturb the breeding of the species. The extent to which this has affected the species is unknown but there are accounts of at least one colony being locally eliminated due to bridge construction associated with dairy production in the northwest. There is a report that Azure Kingfishers used to nest below the railway line bridge over Camp Creek near Wynyard indicating that bridge presence is not a threat *per se*.

Shooting for skins

Higgins (1999) cites Dove (1907) stating that the Azure Kingfisher was formerly shot for skins in Tasmania. Dove (1907) states, "Why should Kingfishers be absent from Tasmania? I have frequently seen the beautiful little *Alcyone azurea* on retired streams, which are seldom visited, and do not doubt that it would be much more common were it not shot at sight for its skin – another argument for the speedy imposition of a gun tax". There is no evidence available on the extent and duration of this historical threat, with scant published accounts (e.g. McClymont (1906) reports on the skin of one bird shot near Broadmarsh in the State's south), and no evidence that the threat is current. Indeed, State museums hold very few specimens of the Azure Kingfisher suggesting that historical 'sampling' was also low. A preliminary search of records held in the State Archives Office indicated that limited information is likely to be available on the export of skins or feathers from the early days of the colony.

Miscellaneous Mortality

Higgins (1999) states that the mainland subspecies, "often collide with windows" (e.g. Binns 1954; Shields 1994). There are, however, few reports of this nature from Tasmania, where the species generally occurs along more remote forest rivers. However, incidents are recorded infrequently e.g. *Tasmanian Bird Report* (2006) reports of a bird striking a window and surviving at Gawler in 2005, and three individuals were killed through window-strike in Strahan post-2005. Higgins (1999) also states that on the mainland, the Azure Kingfisher is, "sometimes injured by cats" (citing Dowling *et al.* 1994). There are no published reports of this nature from Tasmania.

Collisions with vehicles is also apparently infrequent with anecdotal evidence suggesting that this has occurred at least twice on the coast near Burnie in the last 10 years, and some reports of individuals from the middle of towns (e.g. Margate, Rosetta, Dial Road at Penguin) may represent mortality from vehicle collisions (although mortality caused by cats or window strike is also possible because the cause of death is not recorded in any cases). A bird brought into the Tasmanian Museum and Art Gallery in 1979 from the centre of Huonville apparently died after colliding with power transmission lines. The cause of death of a bird found in the Wilderness Air hangar at Strahan in the 2000s is unknown.

Dams

Alterations to water quality and stream flow by the elaborate system of dams and weirs along major watercourses such as the Murray and Murrumbidgee rivers on mainland Australia are attributed to changes in the distribution and breeding status of the mainland subspecies of the Azure Kingfisher, perhaps because of muddy or discoloured water making detection of swimming prey difficult (e.g. Shields 1994). Fluctuating water levels may also flood out nest

tunnels drilled low in the banks of large streams (Shields 1994). While many Tasmanian river systems are affected by dams and weirs, including major hydro-electric impoundments on some of the west and southwest river systems, the degree of impact that this may have had on the distribution of the Azure Kingfisher is entirely unknown. It appears, however, that small in-stream barriers such as weirs may enhance localised feeding opportunities for the kingfisher taking advantage of backed up schools of small fish.

The *Whitebait Fishery Management Plan* (IFS 2006) identifies that in-stream barriers that prevent the movement upstream of juvenile fish into adult habitat are one of the major threats to galaxiid whitebait populations. Whitebait are likely to be a significant part of the diet of the Azure Kingfisher so factors that affect whitebait populations may also affect the Azure Kingfisher. Sites where whitebait accumulate are also a focus for large scale poaching (IFS 2006). During 2001-2002, the IFS conducted a Natural Heritage Trust funded project to improve fish passage by removing weirs in the lower reaches of rivers or in some cases, modified the existing structure to help facilitate fish passage over them (IFS 2006). Some of these rivers included ones known to support the Azure Kingfisher (e.g. Duck River). IFS (2006) reports that major fish barriers remain on many coastal rivers. In addition, many rivers have major hydro-electric dams, which alter the flow regimes in lowland reaches and potentially effect whitebait migrations (McDowall & Eldon 1980 cited in IFS 2006) and habitat availability. The Forth River (from which the Azure Kingfisher has been reported) has several major dams and flows are controlled by Hydro Tasmania according to power demands, resulting in variable river flows.

Climate change

The distribution of the Azure Kingfisher appears to be correlated with the distribution of major river systems with stretches of suitable foraging and nesting habitat i.e. more widespread in the southwest, west and northwest (higher rainfall region, larger rivers, higher densities of stream channels) compared to the southeast, east and northeast (generally lower rainfall, more flood-prone river systems, lower density of stream channels and lower length of potential habitat along any particular river system. Climate change (i.e. drier seasons) is more likely to affect the already lower flow drainage systems of the eastern part of the State compared to the permanent deep flows of the western part of the State. What the impact of the inevitable warmer climate will have on the Azure Kingfisher in Tasmania is unknown but it may be a suitable species to monitor the differential impacts of climate change on species in different parts of Tasmania.

River cruise and recreational boating alteration of river banks

At least four of the major river systems that support the Azure Kingfisher in Tasmania (i.e. the Arthur, Gordon, Pieman, Leven) have commercially-operated cruise boats operating on a virtually daily basis year-round. Historically, such cruise boats created severe river bank erosion (at least on the Gordon River) with significant changes to riparian vegetation but in the last decade (at least), controls have been imposed on the height of the wake that can be produced. Whether the small wash still created by cruise boats is sufficient to flood nesting burrows along these stretches of river is unknown and there have been no studies examining the distribution of breeding burrows. Discussion with operators of the cruises on the Arthur River indicated that breeding activity of the known pairs on the Arthur River frequented by the cruise route has been continuous in recent years suggesting that the birds are nesting above the level of wake wash. Natural and unpredictable flood events were suggested as being more detrimental than wake wash.

Several other river systems that support the Azure Kingfisher may also be subject to recreational boating activity and it is possible that even a one-off high wake from a power boat could flood an active burrow. Again, this aspect of the breeding ecology of the species has not been examined so this must be considered as a potential threat only.

Willow removal

There is some anecdotal evidence that the Azure Kingfisher may benefit locally by infestations of in-stream willows, which create slow-moving to still backwaters on some drainage systems and allow schools of small fish to back up at certain times of the year. Willow removal may remove both the opportunity for the fish to school and thus provide a food source, and also remove perching sites for fishing birds. There is some evidence that the Azure Kingfisher has not been seen at the Bells Parade weir on the Mersey River since the willows were removed. While we are not advocating the retention of willows, which are widely regarded as an ecological pest species, we are simply noting that well-intentioned riparian rehabilitation activities may have a possible, albeit localised spatially and probably temporary, adverse impact on the Azure Kingfisher.

Conservation status

The Tasmanian subspecies of the Azure Kingfisher is presently listed as Endangered (Schedule 3) on the Tasmanian *Threatened*

Species Protection Act 1995, a status we fully endorse. The species is listed (as *Alcedo azurea* with no subspecies noted) on Schedule 2 ("protected wildlife") of the Tasmanian *Wildlife Regulations 1999*. The Tasmanian-Commonwealth *Regional Forest Agreement* (CofA & SofT 1997) included the species (with no subspecies noted) as a category of "priority species", specifically as "Part B. Other identified species requiring further research to determine requirement for protection or listing". A review of the "priority species" list in 2002 (TasGov 2002) did not include the Tasmanian Azure Kingfisher as a listed species. The most recent review of the *Regional Forest Agreement* (TasGov 2008) does not make any formal alterations to the list of priority species but recommends alignment with State and Commonwealth threatened species legislation.

We also suggest that the Tasmanian Azure Kingfisher be considered for listing on the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* as Endangered, satisfying criterion 3 'The estimated total number of mature individuals is low', specifically subcriterion (b) 'the number is likely to continue to decrease and its geographic distribution is: precarious for its survival'. The corresponding IUCN 2000 guideline is C: 'Population size estimated to number fewer than 2500 mature individuals', specifically subcriterion 2(a) 'A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a-b): (a) Population structure in the form of one of the following: (i) no subpopulation estimated to contain more than 250 mature individuals'. While some authorities estimate the Statewide population to be fewer than 250 mature individuals (which could invoke criterion 4 of the Endangered category), this estimate is of low reliability and other criteria are more applicable i.e. there are almost certainly fewer than 2500 mature individuals, most of which occur in disjunct locations with apparently low populations numbers, with an inferred continued decrease in population numbers.

The future

There is currently no recovery plan for the Tasmanian subspecies of the Azure Kingfisher. Very little on-ground actions have been undertaken on any land tenures that have deliberately focused on increasing protection for the Azure Kingfisher in Tasmania. The recovery outline provided in the *Action Plan for Australian Birds* (Garnett & Crowley 2000) identifies the following actions:

- assess population size to establish a baseline;
- characterise occupied and unoccupied streams in terms of water quality, prey availability and likely threatening processes;
- surveys of streams in northwest, west and central Tasmania;
- assess possibility of establishing a captive population;
- remedial action based on habitat quality assessments.

We strongly endorse these suggested actions and note that none of these actions have been pursued systematically by State authorities. A more formal data exchange system among agencies and parties with information on species such as the Azure Kingfisher is suggested to ensure that land managers and decision-makers can have access to the most up-to-date data. We encourage funding of innovative research projects on the Azure Kingfisher in Tasmania that utilise a cooperative approach among land managers across catchments supported by government and the private sector. Some aspects of the research would be ideally suited to longer term postgraduate study. The preparation of a formal Listing Statement under the provisions of the Tasmanian *Threatened Species Protection Act 1995* should also be regarded as a high priority.

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References

Barrett, G., Silcocks, A, Barry, S., Cunningham, R. & Poulter, R. (2003). *The New Atlas of Australian Birds*. Royal Australasian Ornithologists' Union, Hawthorn East, Victoria.

Binns, G. (1954). The camp-out at Lake Barrine, Atherton Tableland, North Queensland. *Emu* 54(1): 29-46.

Blackburn, M. (1950). The Tasmanian whitebait, *Lovettia seali* (Johnston), and the whitebait fishery. *Australian Journal of Marine and Freshwater Research* 1(2): 155-198.

Blakers, M., Davies, S.J.J.F. & Reilly, P.N. (1984). *The Atlas of Australian Birds*. Melbourne University Press, Brunswick.

Boskell, T. (2006). A bird list compiled from aboriginal sources. *Tasmanian Bird Report* 32: 5-7.

Brothers, N., Pemberton, D., Pryor, H. & Halley, V. (2001). *Tasmania's Offshore Islands: Seabirds and Other Natural Features*. Tasmanian Museum and Art Gallery, Hobart.

Butler, A.L. (1907). *Halcyon sanctus* and *Alcyone azurea*. *Emu* 7(2): 89.

Christidis, L. & Boles, W.E. (2008). *Systematics and Taxonomy of Australian Birds*. CSIRO Publishing, Collingwood.

Dove, H.S. (1907). Some Tasmanian birds. *Emu* 7(1): 39-40.

Fielding, P. (1976). Birds of the far west coast of Tasmania. *The Tasmanian Naturalist* 45: 12-16.

Fletcher, J.A. (1915). Nesting of the black cormorant (*Phalacrocorax carbo*) in Tasmania. *Emu* 15(2): 114-118.

Forest Practices Authority (FPA) (2008). *Online version of the Threatened Fauna Manual*. http://www.fpa.tas.gov.au/index.php?id=82.

Garnett, S.T. & Crowley, G.M. (2000). *Action Plan for Australian Birds 2000*. Environment Australia, Canberra.

Green, R.H. & Mollison, B.C. (1961). Birds of Port Davey and south coast of Tasmania. *The Emu* 61: 223-236.

Green, R.H. (1995). *Birds of Tasmania: An Annotated Checklist with Illustrations*. Potoroo Publishing, Launceston.

Higgins, P.J. (ed). (1999). *Handbook of Australian, New Zealand and Antarctic Birds. Vol. 4. Parrots to Dollarbird.* Oxford University Press, Melbourne.

Hollands, D. (1999). *Kingfishers & Kookaburras*. Reed New Holland, Sydney.

Inland Fisheries Service (IFS) (2006). *Whitebait Fishery Management Plan* (September 2006).

Inland Fisheries Service (IFS) (2008). *Fact Sheet for Brown Trout*. Web-based resource (http://www.ifs.tas.gov.au/ifs/IFSDatabaseManager/SpeciesDatabase/brown-trout accessed 28/07/08).

Littler, F.M. (1910). *A Handbook of the Birds of Tasmania and its Dependencies*. Self-published, Launceston, Tasmania.

McClymont, J.R. (1906). Birds observed and bird-skins examined in 1905. *Emu* 5(3): 161-162.

Morcombe, M. (2003). *Field Guide to Australian Birds*. Steve Parish Publishing, Archerfield, Queensland.

Moyle, R.G. (2006). A molecular phylogeny of kingfishers (Alcedinidae) with insights into early biogeographic history. *The Auk* 123(2): 487-499.

Orr, S. & Gerrand, A.M. (1998). Management Decision Classification: a system for zoning land managed by Forestry Tasmania. *Tasforests* 10: 1-14.

Parks and Wildlife Service, Forestry Tasmania and Department of Primary Industries, Water and Environment (PWS, FT & DPIWE) (2003). *Tasmanian Reserve Management Code of Practice*. Department of Tourism, Parks, Heritage and the Arts, Hobart.

Schodde, R. & Mason, I.J. (1976). Infra-specific variation in *Alcedo azurea* Latham (Alcedinidae). *Emu* 76(4): 161-166.

Schodde, R. & Mason, I.J. (1997). Aves (Columbidae to Coraciidae). *Zoological Catalogue of Australia. Vol. 37.2.* (Eds. W.W.K. Houston & A. Wells). CSIRO Publishing, Melbourne.

Schulz, M. & Kristensen, K. (1994). Notes on selected bird species on the south-western coast of Tasmania, between Port Davey and Cape Sorell. *Aust Bird Watcher* 15: 265-272.

Sharland, M. (1945). *Tasmanian Birds*. Oldham, Beddome, and Meredith Pty Ltd., Hobart.

Sharland, M. (1958). *Tasmanian Birds*. Angus & Robertson Ltd, Sydney.

Shields, J. (1994). *Azure Kingfisher*. In: *Cuckoos, Nightbirds & Kingfishers of Australia*. (Ed. R. Strahan). The National Photographic Index of Australian Wildlife, Angus & Robertson, Sydney.

Tasmanian Bird Report produced by Birds Tasmania (and preceding organisation names) from 1971 (volume 1) to 2006 (volume 32), principally the annually produced systematic list for the preceding year of observations.

Thomas, D. (1979). *Tasmanian Bird Atlas. Fauna of Tasmania Handbook No. 2*. University of Tasmania, Hobart.

Watts, D. (2002). *Field Guide to Tasmanian Birds*. New Holland Publishers (Australia), Sydney.

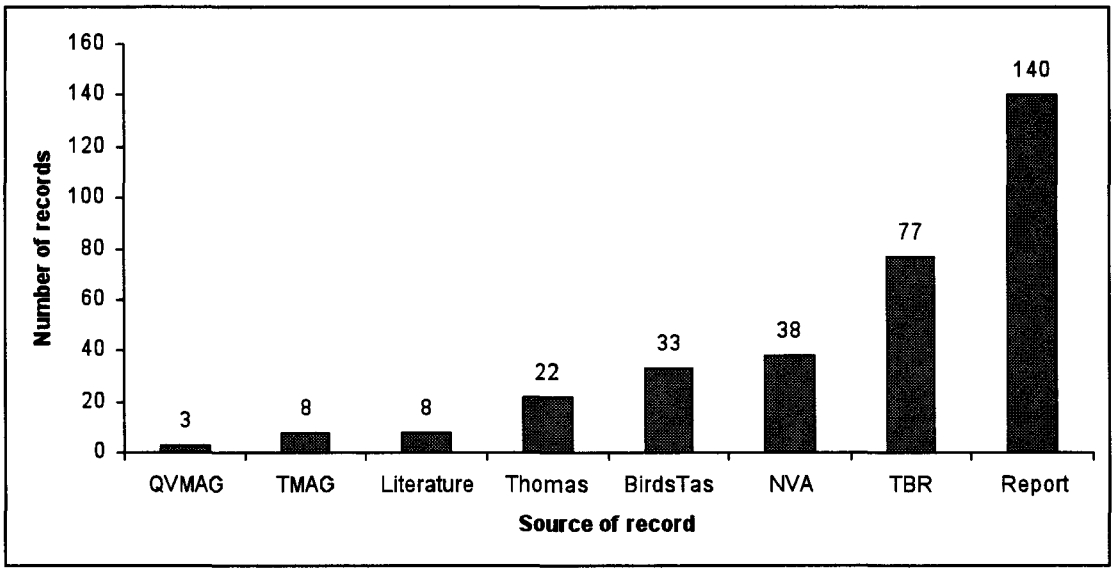

Figure 5. Source of records used in the present project. Note that there is some overlap among some sources – this graph is to illustrate the major differences among sources. Total records used = 329.

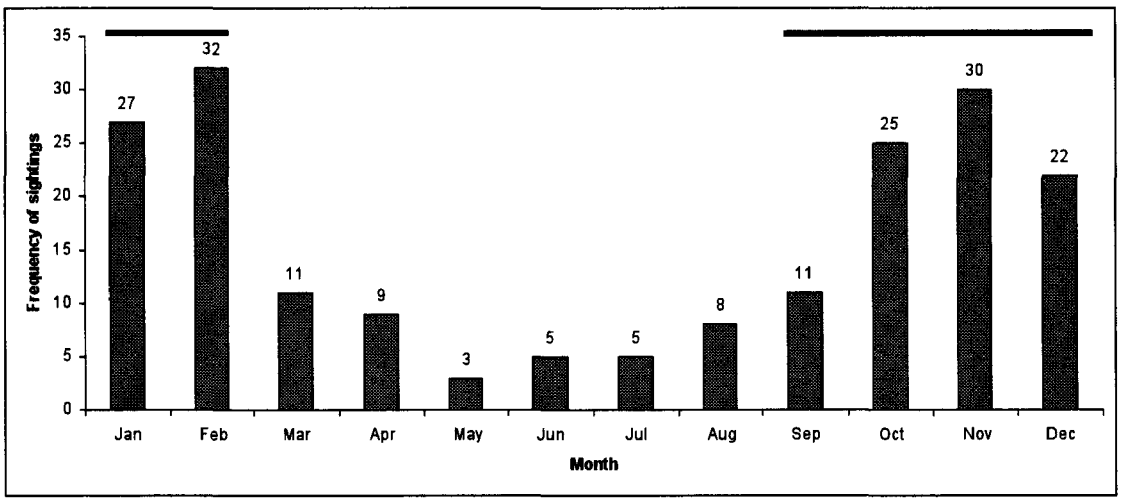

Figure 6. Frequency of sightings by month. The solid bars indicate the published accounts of the breeding season. Total records used = 188.

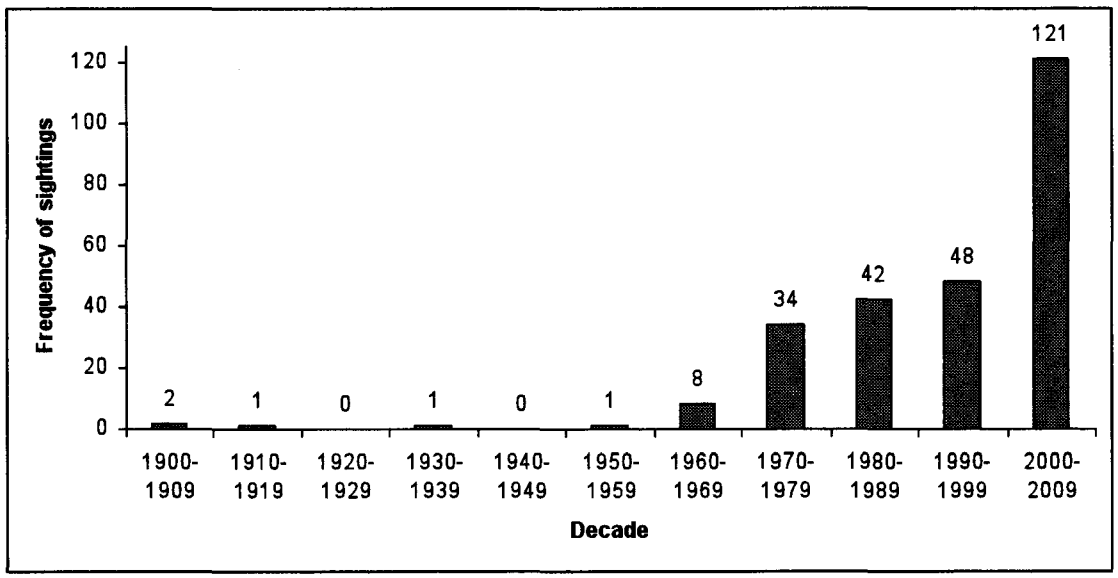

Figure 7. Frequency of sightings by decade. Total records used = 258.

Table 1. Annotated listing of distribution of Azure Kingfisher by catchments used by the Conservation of Freshwater Ecosystems Values project.

Catchment	Comments	Breeding?
Northeast, East		
Musselroe-Ansons	Pre-1980 observations from Ansons River	
Furneaux	Possible observations from Patriarch River and Samphire River (pre-1980s)	
Ringarooma	1960s record from Moorina area; 1990s record from Derby area	
Great Forester-Brid	Records pre-1980s from upper Brid River area; mid 1990s sightings from Brid estuary at Bridport	
Prosser	Two sightings from Maria Island (one pre-1980; one early 1980s)	
Midlands, Derwent, Central Plateau		
South Esk	1950s sightings near Epping Forest	Breeding reported
Brumbys-Lake	1990s-2000s sightings in Lake River near Cressy; 1970s sightings from upper catchment in Upper Lake River	
Ouse	1970s sightings from Lagoon of Islands	
Upper Derwent	2002 sighting from Dee Lagoon	
Lower Derwent	1980s sighting from Maydena area and New Norfolk (unknown date, probably c. 1950s).	
Jordan	Two records (2000s – dead bird in trap; pre-1980s from lower reaches near Derwent)	
Southeast, South		
Derwent Estuary-Bruny	1960s dead bird at Rosetta; possible sighting on Mount Wellington in 2000s; dead bird and live sighting in/near Margate in 1970s;	
Huon	Dead bird in Huonville in 1979; several sightings in 2000s in Lune River and d'Entrecasteaux Rivers; Cockle Creek pre-1980s	
South, Southwest, West		
Port Davey	Several sightings over several decades including in 2000s from south coast rivers including South Cape Rivulet, Surprise Bay, New River Lagoon and Cox Bight; numerous sightings from Port Davey area including Moth Creek, Davey River, Melaleuca area, Bathurst Harbour, Ray River, Old River,	
Wanderer-Giblin	Sightings from Giblin River, Unmarrah Creek, Condor River, High Rocky Point	Possible breeding behaviour observed at Condor River crossing in 1966
Gordon-Franklin	Numerous records from Gordon River but very few from Franklin River; numerous observations from Macquarie Harbour and the Sorell River/Birchs Inlet area	Breeding well known from the Birchs Inlet-Sorell River system but number of pairs present is unreported
King-Henty	Undated record (museum) from King River; several sightings around Strahan; record from Tully River; numerous records from Henty River from mouth to 10s of kilometres upstream	Breeding reported from Henty River but number of pairs is unknown
Pieman	Numerous records from Pieman River and feeder rivers include Whyte River	Breeding reported from Pieman River but number of pairs is unknown; one pair reported from bank near barge jetty at Corinna in 2005
Nelson Bay	Pre-1980s sightings from Donaldson River; 1990s sighting from Rebecca Creek near Temma	
Arthur	Numerous records over several decades from Arthur River mouth to 10s of kilometres upstream and into Frankland River and Keith River, including along some minor tributaries such as Sawards	Breeding reported from Arthur River (2 pairs along length of main

Catchment	Comments	Breeding?
	Creek and at the base of Elvers Falls	cruise)
Welcome	Several records on Welcome River system over several decades	Breeding reported from Welcome River
Northwest, North		
Montagu	Several records on Montagu River system over several decades including late 2000s	
King Island	Single birds observed in Currie in 1985 and 2008	
Duck	Numerous sightings along the Duck River, around Lake Mikany and Deep Creek	Breeding (up to 5 pairs) reported from Duck River near Smithton; older records (pre-2000s) of breeding in Deep Creek system north of Bass Highway
Black-Detention	Reports from Black River and Detention River	Breeding reported on Black River in 1960s
Inglis	Several records from the Sisters Creek-Sisters Beach area over recent decades; numerous sightings in Inglis River (and associated Big Creek and Camp Creek)	Possible breeding behaviour observed in birds along Inglis River; breeding reported from Camp Creek below old railway bridge for long period until mid 2000s
Cam	Several sightings from river mouth to several kilometres upstream	
Emu	Sightings from the Fern Glade south of Burnie, and Romaine Reserve (Romaine Creek)	
Blythe	Several sightings from mouth to several kilometres upstream	Breeding reported (one pair) from c. 3 km upstream of mouth in recent years
Leven	Several sightings from the lower reaches of the River Leven (downstream of Lobster Creek) and from lowest reaches of the Gawler River inflow into the River Leven's estuary; recent reports from as far upstream as 8 km	
Mersey	Several sightings over several decades from Latrobe area including Bells Parade; recent (2007) sighting at Kimberley; unconfirmed sightings from the Don River; recent (2009) sightings of pairs from Junction Lake and Clarke Falls at the headwaters of the Mersey River on the Central Plateau	
Rubicon	Single sighting at weir on Rubicon River in mid 2000s	
Meander	1950s sighting from Western Creek area	