Surveys of waterbirds in selected wetlands of south-western Australia in spring-summer 2010-11

with further assessment of changes in habitat and waterbird usage over 2-3 decades

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Cover image captions

Top: Yarnup Lagoon, Dec 2009. The lagoon at this time had extensive areas of Jointed Rush *Baumea articulata*. (© AC, 08Dec2009).

Centre: Yarnup Lagoon, Jan 2009. The reddish-brown coloration may have been due to local acid sulphate soil processes which result in the precipitation of iron-oxyhydroxide and sulphate minerals. (© AC, 08Jan2009).

Bottom: Yarnup Lagoon, Nov 2015. Large areas of *Baumea articulata* have died, creating extensive areas of open water. (© AC, 13Nov2015).

CONTENTS

FIGURES

TABLES

APPENDICES

Summary

In 2008, the Western Australian Department of Environment and Conservation (now the Department of Parks and Wildlife; DPaW) commissioned a survey of a small group of wetlands in the south-west of the State, with the aim of documenting any long-term changes in waterbird habitats and their use by waterbirds. The survey, which was supported by DPaW scientific staff, was led by Wetland International – Oceania's waterbird specialist Roger Jaensch, who had surveyed the same wetlands in the 1980s and 1990s, and was therefore well-qualified to both repeat the waterbird surveys and subjectively assess any substantial changes, or lack thereof, in habitats.

The selected wetlands were: Nine Mile Lake (DPaW Swan Region); Lake Davies (South West Region); Yarnup Lagoon and Boat Harbour Lake 1 (Warren Region); and Lake Pleasant View, Mettler Swamp, Yellilup Lake, Esperance reserve 26410 and Shark Lake (South Coast Region). The survey was focussed on waterbird species that depend upon the presence of fringing and emergent wetland vegetation (live trees, shrubs, rushes and sedges) for cover, especially for nest sites. These 'sensitive' species were bitterns, crakes, small rails, Blue-billed and Freckled Ducks, and tree-nesting colonial herons, egrets, ibises, spoonbills and cormorants.

The surveys were conducted in November–December 2008 and January 2009, matching dates of previous surveys and records of nesting by bitterns, crakes and small rails. Searching by wading or from a boat, the observers employed methods for finding secretive birds and concealed nests modelled on methods used in previous decades. Nest searching at all wetlands was at least as comprehensive as in the past and more so at some. The surveys typically took 3-7 hours to complete and, where habitat was judged appropriate, included periods of listening at night for calling bitterns. The location of each nest was geo-referenced by GPS and other information that would benefit future surveys, such as listening positions and routes walked, was documented or mapped.

The January 2009 surveys at four of the nine wetlands were to compensate for probable dispersal of birds and delay or disruption of nesting caused by exceptional rainfall and increases of up to 0.5 metres in wetland water levels during the weeks of the November–December 2008 surveys.

The 2008-09 surveys were only snapshots in time, nevertheless some marked changes were apparent at several wetlands, particularly Nine Nile Lake (principally declining water levels and invasion by Bulrush), Yarnup Lagoon (increasing salinity, pH declines and death of vegetation) and Yellilup Lake (salinization and death of emergent eucalypt woodland). These habitat changes were accompanied by apparent changes in use by waterbirds.

Some wetlands appeared little changed. Three of these (Boat Harbour Lake 1, Lake Pleasant View and Mettler Swamp) were identified as potential candidates for listing as internationally important under the Ramsar Convention on Wetlands because they have supported the globally-threatened Australasian Bittern in the past 2-3 decades and continued to do so in 2008-09. Further surveys were recommended to confirm their current status. Other recommendations concerning management of wetlands, survey of waterbirds, hydrological investigations, colonial-nesting waterbirds and Australasian Bitterns were also made.

In 2009-10, further waterbird surveys were undertaken, this time led by DPaW Senior Technical Officer Alan Clarke, who had assisted Roger Jaensch in the 2008-09 surveys and previously.

Two wetlands, Owingup Swamp (DPaW Warren Region) and Albany 27157 (Cheyne Road Nature Reserve in DPaW South Coast Region), were added to the project, increasing the total number of wetlands in the project to eleven. Both were included on the basis of their documented past use by sensitive species, particularly bitterns, their history of hydrological monitoring and the potential for changes to have occurred.

The 'sensitive breeding species' category was also expanded in 2009-10, and retrospectively to the 2008-09 data set, to include Swamp Harriers, as nesting by this species is mainly within wetland rushbeds in south-western Australia and there are very few nest records from this region. In 2009-10, breeding by this species was recorded for the first time in Nine Mile Lake and Yarnup Lagoon.

The 2009-10 surveys revealed further changes in habitat condition for waterbirds at several wetlands. At Yarnup Lagoon some regeneration of fine sedge and melaleuca shrub thicket had occurred and breeding by two sensitive species had resumed. At Owingup there was some

expansion of Bulrush stands, with short and possibly long-term implications for use by waterbirds. At Esperance 26410 there was further deterioration in the health of eucalypts and melaleucas and some were dying. At Shark Lake, melaleucas had died and fallen. This change at Shark would be of concern if it continued and regeneration did not occur.

In 2010-11, the third and final year of this project, further waterbird surveys were undertaken by Alan Clarke. At Yarnup, the partial regeneration of melaleuca thicket and fine sedge beneath was continuing, however there was also substantial further death and loss of tall sedge across the lake bed. These changes were to the net detriment of waterbirds. While at Owingup there was no discernible change in the extent of *Typha* beds, there remains a medium to long-term threat of other habitat types more-favoured by waterbirds being overtaken. At Esperance 26410 and Shark, the death and fall of yate and melaleuca trees was continuing, with mixed consequences for waterbirds.

Overall, the following changes and realised and potential consequences for waterbirds have been observed during this project.

Since the 1980s / early 1990s, substantial changes have occurred in the suitability for waterbirds of some of the studied south-western Australian wetlands, but not others.

The major types of change that have been observed are reduced depth, areal extent and duration of surface water; altered and reduced food availability; loss of live trees, shrubs and sedges over water; substitution of higher value by lower value habitats, and weed invasion.

Principal causes of these major changes have been a long-term decline in rainfall over much of the south-west; secondary salinization; acidification; excessive inundation due to exceptional, localised, rainfall events; expansion of *Typha* beds, and limited weed control.

In some cases, remedial management actions are possible and should be affordable (e.g. weed control and *Typha* management). In other cases, while effective remedial technologies might exist, the financial costs could be prohibitive (e.g. water supplementation; water diversion or removal, salt removal). At one of the project wetlands, efforts have been made to halt and reverse salinization and acidification however, to date, these have been unsuccessful. At another wetland, hydrological investigation might show the recent high levels of inundation to be due primarily to natural, though infrequent, high rainfall events, in which case remedial action might be unwarranted.

These changes in habitats have had a variety of consequences for waterbirds. Species that are largely dependent upon fringing and emergent vegetation (live trees, shrubs, sedges) for nesting and or feeding (i.e. the 'sensitive' species on which this project has focussed) — and, of course, adequate water — have, from the 1980s / early 1990s to 2008-2011, lost suitable habitat at several of the eleven project wetlands. Species that have obtained some marginal benefit from habitat changes at project wetlands have been non-sensitive species, with less or no dependence on live fringing and emergent vegetation and a greater tolerance of salinity.

None of the studied wetlands is a unique representative of its type, at least in terms of hydrology and vegetation. The causes of observed changes are also not confined to these particular wetlands. Long-term rainfall decline and secondary salinization, for example, have occurred across much of the south-west. It can therefore be concluded that the observed changes have not been restricted to the few studied wetlands, but have also occurred at many others. However, in the absence of comprehensive mapping of wetland type and condition across the south-west, it is not possible to estimate the overall extent of change that has occurred, or the cumulative impact on waterbirds.

The results of this project (and of other projects such as *The New Atlas of Australia Birds* and BirdLife Australia's *Australasian Bittern in Southwest Australia* project) have raised our collective level of concern about the future of Australasian Bittern, in particular, in south-western Australia. Consequently, our work is now focussed on this species, in collaboration with DPaW South Coast Region and with funding support from South Coast NRM. Since 2011, further surveys have been undertaken to locate key Australasian Bittern wetlands and identify principal feeding and nesting habitats, sites and requirements. Simultaneously, wetland water levels and on-site rainfalls have been continuously monitored, both to better understand their influence on bittern presence and breeding activity, and to enable modelling and prediction of likely hydrological futures for bittern wetlands in a region of declining rainfall.

The Surveyed Wetlands

Nine Mile Lake (19May2008)

Lake Davies (19May2008)

Yarnup Lagoon (24May08)

Boat Harbour Lake 1 (26May2008)

Owingup Swamp (20May2008)

Lake Pleasant View (21May2008)

Albany 27157 (21May2008)

Mettler Swamp (21May2008)

Yellilup Lake (21May2008)

Esperance 26410 (16May2009)

Shark Lake (16May2009)

Introduction

The study area

This report presents further results from a wetland and waterbird survey project commenced in south-western Australia in 2008-09 and continued in 2009-10 and 2010-11. The study area extended from north of Bunbury to Albany and Esperance (Fig. 1). Hence it included parts of the Swan, South West, Warren and South Coast regions of the WA Department of Parks and Wildlife ((DPaW; formerly the Department of Environment and Conservation (DEC)), and parts of the Swan Coastal Plain, Jarrah Forest, Warren and Esperance Plains bioregions[1]. The study area experiences cool wet winters and hot dry summers with mean annual rainfall between about 500 and 1200 mm.

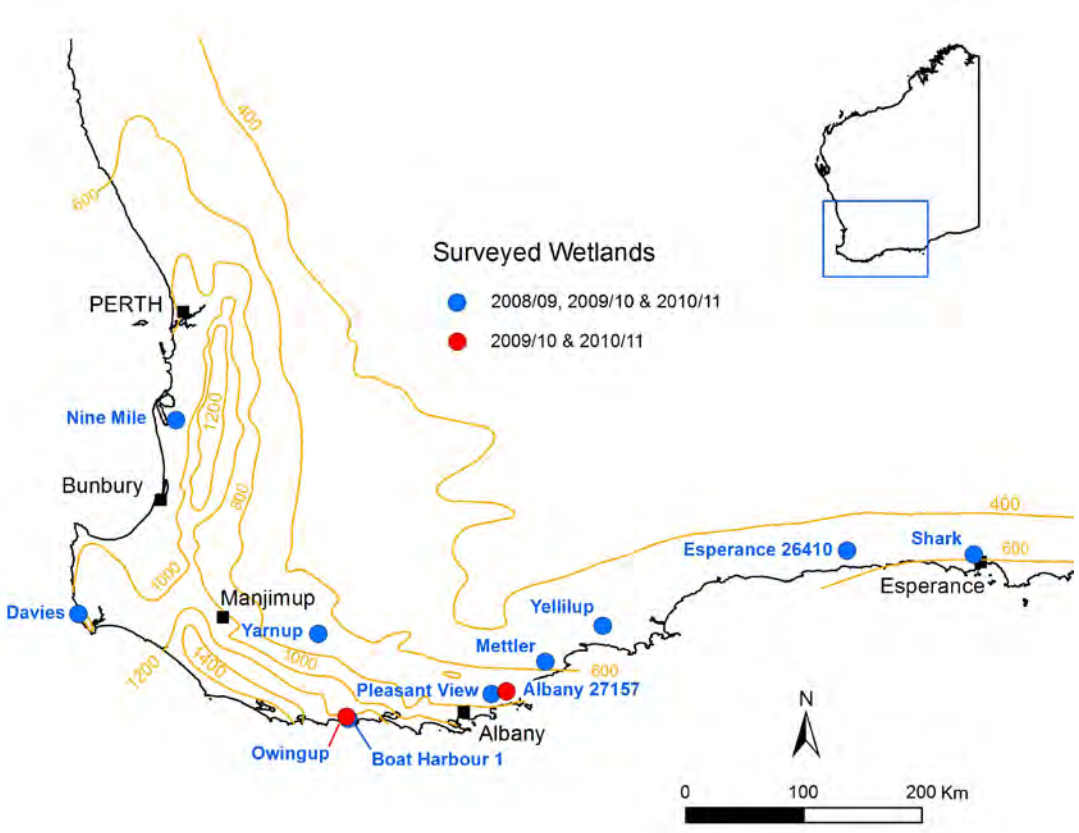


Figure 1. Location of eleven wetlands surveyed during 2008–2011.

Origins of the project

The origins of this project have been described in detail in a previous report (Jaensch *et al.* 2009).

The project stemmed from an awareness that, since the comprehensive surveys of waterbird use of wetlands in south-western Australia in the 1980s (e.g. Jaensch *et al.* 1988) and early

[1] https://florabase.dpaw.wa.gov.au/help/ibra/

1990s (e.g. Storey *et al.* 1993, Halse *et al*. 1994), some of these wetlands have undergone significant changes in water levels and salinities (Lane *et al.* 2009, 2015a) and, in some cases, undocumented changes in fringing and emergent vegetation (J. Lane, pers. obs.). These changes were thought likely to have impacted on use by waterbirds, in most cases negatively. Because of the previously established, high level of importance of some of these sites for waterbirds (ANCA 1996), the possibility that some adverse changes could be at least partially remedied through management, and the widespread and substantial threat posed to south-west wetlands by secondary salinization (Government of Western Australia 2002) and declining rainfall (Hope & Foster 2005, IOCI 2010), we considered it important to re-survey a sample of these wetlands in order to identify and document changes in waterbird use and vegetation that have occurred in the past several decades.

While the project was concerned about changes in use by waterbirds of all species, a particular focus was changes in use by species that are highly dependent on the existence of healthy emergent or fringing vegetation for all of, or at least critical stages of, their life cycles. Two species within this category, the Australasian Bittern and Australian Little Bittern, were given particular attention, due to an apparent decline in reporting and, it was inferred, their numbers.

In 2008, DPaW contracted Wetlands International – Oceania (WIO) to undertake a two-week field survey program (in November-December) to address the abovementioned issues. WIO specialises in wetland and waterbird surveys and staff (Roger Jaensch) have had considerable first-hand experience with wetlands and waterbirds of the study area, specialising in secretive species and nest surveys. This work (Nov-Dec 2008) was undertaken jointly with DPaW, who contributed a senior technical officer (Alan Clarke), 4WD vehicle, boat, other field equipment and water chemistry analyses. DPaW (Alan Clarke plus volunteers) also conducted a follow-up survey at a subset (4) of the wetlands in January 2009.

In our first report on this project (Jaensch *et al.* 2009), we made the point that the 2008-09 surveys were only 'snapshots' for comparison with previous studies and recommended that further surveys be undertaken to more-conclusively establish changes and current values.

In 2009-10 and 2010-11, additional surveys were undertaken, by Alan Clarke of DPaW, with assistance from other DPaW staff and volunteers. The 2010-11 work is the subject of this report. The 2009-10 work has previously been reported (Clarke *et al.* 2011).

Project objectives

The objectives of the 'changing wetlands' project were:

1. to identify and describe any **significant long-term changes** (or clear indicators of change) in waterbird usage and habitat availability at a small number of carefully selected wetlands of south-western Australia 2-3 decades after substantial, previous, waterbird survey effort.
2. to obtain information on **present usage by sensitive waterbird species** (see below for definition) especially those that are threatened, that are secretive and thus difficult to find, and/or that breed on-site, with an emphasis on bitterns (this work was to be primarily for the purpose of achieving objective 1).
3. to **facilitate future monitoring** of waterbirds through establishing well-documented survey procedures at each wetland, and by building the survey capabilities of local people, initially near Albany.

In 2009-10 and 2010-11, the emphasis was on further assessment of present usage of the same set of wetlands by waterbirds, particularly sensitive species, with a focus on bitterns. Two 'new' wetlands were added to the project in 2009-10 because they also met the target wetland selection criteria and could be accommodated within 2009-10 and 2010-11 resource and time constraints.

Target wetlands and waterbird species

The context for selection of target wetlands for the project is described in the corresponding section of Jaensch *et al.* (2009). The wetlands surveyed in 2009-10 and 2010-11 were the same nine, plus Owingup Swamp and 'Albany 27157'. All except one (Nine Mile Swamp) of these eleven wetlands are located on or near the south coast of Western Australia, between Cape Leeuwin and Esperance. Nine Mile is on the west coast, north of Bunbury and south-west of Pinjarra.

For this project, as in the projects of the 1980s and 1990s, the common definition of waterbirds as being birds that depend on wetlands for at least a part of their life cycle was adopted. A list of the species mentioned in this and the preceding two reports (Jaensch *et al.* 2009; Clarke *et al.* 2011) is provided in Appendix 1.

All waterbirds seen or heard were recorded in the field and details are in the report Appendices (see Methods below), but analysis of results focuses on certain 'sensitive' species.

Sensitive species

In Jaensch *et al.* (2009), Clarke *et al.* (2011) and this report the term **sensitive** species refers to waterbird species that:

- typically depend on inundated, dense live vegetation (sedge beds/tussocks, shrub thickets) or live trees for shelter and/or breeding, *and*
- that are, or may become, of conservation concern because:
    - they have numerically small populations in the study area (Australasian Bittern, Blue-billed Duck, Freckled Duck: Wetlands International 2006), *or*
    - they are rarely recorded in large numbers (bitterns, crakes and small rails: Jaensch *et al.* 1993) because they are highly secretive *or*
    - they are known to occur in relatively few wetlands (bitterns, Blue-billed Duck, Freckled Duck: Jaensch *et al.* 1988; Halse *et al.* 1990) *or*
    - they breed in relatively few wetlands (bitterns, Freckled Duck, Swamp Harrier[1] and colonial herons, egrets, ibises, spoonbills, cormorants: Jaensch *et al.* 1988, Blakers *et al.* 1984).

Several species met the first but not second criterion above and so were excluded from the category 'sensitive'. Thus, Purple Swamphen and Dusky Moorhen were excluded because they occur in many wetlands and sometimes occur in large numbers (hundreds: Jaensch *et al.* 1988, pp. 87, 257; Jaensch *et al.* 1993) and so are not presently of conservation concern. Australian Reed-Warbler and Little Grassbird were excluded because they occur in many wetlands, probably in all wetlands of the study area that have tall sedge beds or *Typha* (based on RJ pers.

[1] Swamp Harrier was not considered a sensitive species in Jaensch *et al.* (2009), but following further consideration of its breeding habits in south-western Australia (where nesting is largely confined to wetland rushbeds and has been recorded at very few locations), it was added to the list (Clarke *et al.* 2011).

obs.), and so are not presently of conservation concern. Musk Duck were excluded because, while not as abundant as many other duck species, it met none of the four conditions under the second criterion above.

The importance of trees, both dead and alive, for nesting by various species of waterbirds in Australia was discussed in the corresponding section of Jaensch *et al.* (2009). Relevant findings of several related studies (Halse 1987, Halse *et al.* 1993a, Briggs & Thornton 1995, Briggs *et al.* 1997) were also presented and so are not reported here.

In summary, the species and species groups regarded as 'sensitive waterbirds' for the purposes of this project were: bitterns, crakes, small rails, Blue-billed Duck, Freckled Duck, Swamp Harrier and colonially breeding herons, egrets, ibises, spoonbills and cormorants.

During 2008-2011, the following 'Sensitive on the basis of Numbers or Breeding' species were recorded[1]:

- Australasian Bittern, Australian Little Bittern, Spotless Crake, Blue-billed Duck and Freckled Duck.

  (Australian Spotted Crake, Baillon's Crake and Buff-banded Rail were recorded pre-2008, but *not* during 2008-2011).

During 2008-2011, the following 'Sensitive only on the basis of Breeding' species *were recorded breeding:*

- Swamp Harrier, Yellow-billed Spoonbill, Little Pied Cormorant, and Nankeen Night-Heron.

  (Australasian Darter, Little Black Cormorant and White-necked Heron were recorded breeding pre-2008, but *not* during 2008-2011).

Methods

Selection of target wetlands

Target wetlands for survey in 2008-09 were selected after close consideration of the project objectives, trends in depth and salinity, known changes in vegetation, prior use by waterbirds, survey logistics and budgetary constraints. These nine wetlands are listed in Table 1, together with the two wetlands (Owingup and Albany 27157) that were added to the project in 2009-10. Graphs of depths and salinities of the eleven selected wetlands over their entire periods of monitoring (currently to 2015) by DPaW are in Appendix 2.

Selection criteria variously met by these wetlands (Table 1) were as follows:

1. located on or near the south coast.
2. vegetated at present or in the past.
3. depth and salinity have been monitored by DPaW over a long period. All but one of the selected wetlands have been monitored at least 16 years (to 2007) and most for more than 25 years; ALB2 was monitored 1980-84 and 2008 onwards. All continue to be monitored.

[1] See Table 6 for details concerning these two dot points.

4. monitoring has shown a definite long-term change in depth and/or salinity.
5. there are early indications of possible long-term change in depth and/or salinity.
6. a substantial change in vegetation structure and/or arrangement has occurred.
7. vegetation structure and/or arrangement will be substantially affected if long term change in depth and/or salinity occurs.
8. early in the depth/salinity monitoring period the wetland was important for waterbirds that were highly dependent on emergent/fringing vegetation.
9. known to support sensitive waterbirds (see definition above).
10. in the DPaW South Coast or Warren Regions and suitable for training in survey of secretive waterbirds.

Table 1. Wetlands surveyed during 2008-09, 2009-10 and 2010-2011.

wetland name	*code*	*selection criteria met*	*surveys 2008-09*	*surveys 2009-10*	*surveys 2010-11*
Nine Mile Lake	NINE	2, 3, 4, 6, 8, 9.	1	1	1 (D)
Lake Davies	DAVI	1, 2, 3, 4, 7, 9.	1	1	1 (D)
Yarnup Lagoon	YARN	2, 3, 4, 6, 8, 9.	2	2	1 (N)
Boat Harbour Lake 1	BOA1	1, 2, 3, 5, 7, 8, 9, 10	2	2	2 (O N)
Owingup Swamp	OWIN	1, 2, 3, 7, 8, 9, 10	–	2	1 (O)
Lake Pleasant View	PLEA	1, 2, 3, 5, 7, 8, 9, 10.	2	1	4 (Au O N Ja)
Albany 27157 (Cheyne)	ALB2	1, 2, 7, 8, 9, 10	–	2	5 (Au O N Ja Ja)
Mettler Swamp	METT	1, 2, 3, 4, 5, 7, 8, 9.	2	2	3 (Au N N)
Yellilup Lake	YELL	1, 2, 3, 4, 6, 8, 9.	1	1	1 (N)
Esperance Res. 26410	ESP1	1, 2, 3, 4, 5, 7, 9.	1	2	2 (N N)
Shark Lake	SHAR	1, 2, 3, 5, 7, 8, 9, 10.	1	2	1 (N)

See Appendix 3 for details of single survey of Lake Maringup in November 2010.

There were three broad groups within this set of wetlands in terms of dominant vegetation: those where the vegetated areas were (as at 2008) dominated by trees (paperbarks such as Saltwater Paperbark *Melaleuca cuticularis* or Flat-topped Yate *Eucalyptus occidentalis*) but with tall sedges absent (YELL, ESP1); those dominated by sedges such as *Baumea* spp. (DAVI, PLEA, ALB2, SHAR); and those with substantial areas of both trees and sedges (NINE, YARN, BOA1, OWIN, METT). Survey methods suitable for each situation were adopted for the project.

It is important to note that only one (PLEA) of the eleven selected wetlands is also included in the set of 25 south-western Australian (mainly Wheatbelt) wetlands that were intensively monitored by DPaW under the State Salinity Strategy from 1997 until recently (Cale *et al.* 2004, Cale & Halse 2006a-u, Gibson *et al.* 2004, Lyons *et al.* 2007). This is because the objectives, criteria, geographic extent and time scales of the two projects were different.

Field survey methods

Survey methods employed in 2008-09 were described in detail in the corresponding section of Jaensch *et al.* (2009). A very similar approach, building on the previous years' experience, was taken by the authors in 2009-10 and 2010-11.

Field datasheets and project reports from surveys in the 1980s and 1990s were reviewed during preparation for field surveys of the two additional wetlands, OWIN and ALB2. This enabled AC to understand, wetland by wetland, the routes and coverage of previous surveys and the waterbird species recorded, both breeding and not breeding. Recent vertical (Landgate) and oblique (DPaW; see Lane *et al.* 2015a, Table 8) aerial photographs of these wetlands were also used to assist in this process.

The following procedures were then adopted for the 2010-11 surveys:

- All surveys were conducted or, when others assisted, conducted and led by the one experienced observer (AC), who could draw upon knowledge gained from his substantial involvement in the 1991-1992 and 2008-09 surveys, from additional advice and guidance provided by RJ in 2009-10 and 2010-11 and from a general familiarity with all of the surveyed wetlands arising from his ongoing involvement in DPaW's multi-decadal South West Wetlands Monitoring Program.
- Most surveys were conducted in spring and summer, as in 2008-09 and 2009-10, and as was most common in the projects of the 1980s and 1990s. Based on previous survey results and the general experience of the authors, spring-summer is the main breeding season of sensitive species (particularly bitterns) in south-western Australia, with a tendency on the south coast for breeding to be in late spring and early summer. Australian Little Bittern and Spotless Crake are considered summer breeding species (Halse & Jaensch 1989).
- Three wetlands (PLEA, ALB2, METT) were also surveyed in late winter, to assess potential breeding habitat for Australasian Bittern (AusB) in relation to water levels at the time, and to assess numbers of AusB and their locations, to enable targeted searching for nests in Nov 2010.
- The same wetlands as in 2009-10 were surveyed, plus one (Lake Maringup) due to low water levels in the usual AusB sites in the Muir-Unicup area. In several cases (NINE, DAVI, ESP1) the same areas (whole or part) of each wetland as in 2009-10 were surveyed. In other cases (YARN, PLEA, ALB2, METT), some additional areas were surveyed. Results of the single, exploratory, 3½ hr survey of Lake Maringup in November 2010 are presented in Appendix 3, but not elsewhere in this report.
- Knowledge gained from reviewing vertical and oblique aerial photos in previous surveys and known suitable habitat found during previous wading surveys assisted in targeting areas of interest for the 2010-11 surveys.
- Wherever possible, the entire wetland (DAVI, YELL, SHAR) or almost the entire wetland (NINE, PLEA, ALB2,) was surveyed (including, in some cases, by boat) as this is normally necessary to ensure that survey results truly reflect the diversity and numbers of waterbirds present (because individuals and species are often patchily distributed within wetlands). It was found to be impractical to survey all areas of the other wetlands due to their large size, impenetrable vegetation and, in some parts, overly penetrable sediments!
- Where habitat potentially suitable for bitterns was present at the wetlands, the observer(s) listened from one or more vantage points for calling bitterns for

approximately ½ - 1 ¾ hours around dusk or later in the evening. No listening was done at YARN because the water level was too low in November to expect any bitterns. No listening was done at OWIN due to strong wind and rain.

- AC was familiar with the advertising calls of Australasian Bittern and Australian Little Bittern and attempted to elicit response calls from the latter species by imitating their vocalisations. If Australasian Bitterns were not heard during the initial listening period, AC attempted to elicit calls from that species by briefly playing amplified recordings of their calls.
- A substantial portion of any inundated, dense, wetland vegetation (emergent or fringing), which could potentially harbour nests of ducks, bitterns, crakes, small rails, waterhens and swamp warblers, was searched intensively. Hence, wading in the wetlands was essential.
- Inundated and recently-inundated (previous 12-24 months or so) trees were examined for indications of nesting by sensitive colonial species such as spoonbills and cormorants.
- **Depth** (wetland water level) was recorded by AC at each of the wetlands during the surveys, and by YW or AC during the routine September and November SWWMP monitoring visits, consistent with SWWMP monitoring protocols. **Salinity** was measured during the SWWMP visits and during the surveys at PLEA and ALB2 in January 2011.
- **Safety** of observers when wading was addressed by working closely in pairs, using hand-held UHF radios to communicate between survey participants, carrying recovery devices such as a boat oar when in boggy or 'floating' substrate, and wearing leg protection and carrying a compression bandage in snake habitat.

AC led the surveys at each wetland and was assisted by one or more additional observers[1] at YARN, BOA1, OWIN, PLEA, ALB2, METT and MARI. During these surveys, he provided training in methods of survey and searching for bitterns and other secretive waterbirds and their nests to volunteers and DPaW District staff.

Waterbirds were found, identified and counted using standard methods as described for previous surveys (Jaensch *et al.* 1988, 2009; Jaensch 1992). Total counts of all waterbirds present at the wetlands were attempted on most occasions.

At OWIN, in October 2010, survey effort was concentrated on areas that previously held AusBs. Low water levels restricted access by punt to western areas and greatly reduced the availability of nesting habitat for secretive species. In November 2010, YARN was too shallow to use a punt and deep mud prevented access on foot to large areas of the wetlands. At ESP1, in November 2010, access to flooded tree habitat to search for nests was restricted by deep water when on foot and by fallen timbers when in boat.

Secretive species perhaps were missed and undoubtedly were undercounted in some cases, particularly at large water bodies with extensive dense sedgeland such as at MARI, BOA1, PLEA and ALB2. A tripod-mounted telescope was used to identify birds that were far from the observers.

In densely vegetated wetlands some nests were found simply by thorough searching of all inundated dense sedge/shrub habitat. Where habitat was extensive and time or energy limited,

[1] See the Acknowledgements section for the names of these additional observers.

some prioritisation or focus of effort on most-suitable areas was needed. This depended heavily on the experience of AC (with some prior guidance by RJ), who could draw on 2009-10, 2008-09 and 1991-1992 experience of nest searching.

Figure 2 of Jaensch *et al.* (2009) illustrates typical nest sites of six waterbird species occurring in the study area.

Data recording and management

To ensure adequate capture of information and provision of a record that could be used in planning the conduct of future surveys at the same wetlands, the following procedures were followed for data capture and management:

- Counts of waterbirds and descriptions of nests and vegetation were entered into a pocket **notebook.**
- The **route** taken at each wetland was captured and saved on a Garmin GPS unit, to be later downloaded into a GIS mapping program and imported onto digital orthophoto-based maps of each wetland.
- The positions of all active **nests** and old nests additional to those found in 2008-09 or 2009-10 were recorded by GPS and later downloaded into a GIS mapping program.
- Digital **photographs** were taken of active nests and some old nests (especially where identity of bird species was unknown), habitat at nests, vegetation change (e.g. recently dead shrubs or trees at ESP1 and SHAR) and of other relevant subjects. Photographs were also taken of some non-nests (e.g. feeding platforms, which, in some instances, resemble nests).
- The digital photographs were subsequently stored on computer and named by wetland name and general location within the wetland. **Keywords**/tags to describe the subject(s) were added to the file properties to aid interpretation and file searches.
- All field data were transcribed from pocket notebook to hardcopy data sheets within days to weeks of each survey, and subsequently to the digital data sheets (Appendix 3) of this report.
- Datasheets, maps and photographs (digital or scanned) have been backed up on the DPaW computer **network**. The pocket notebooks of AC have been retained by AC at the DPaW Busselton office.

Summary datasheets and route maps for each of the eleven wetlands (and Lake Maringup) are in Appendix 3.

Coverage achieved

The eleven wetlands that are the focus of this report were surveyed on one (NINE, DAVI, YARN, OWIN, YELL, SHAR), two (BOA1, ESP1), three (METT), four (PLEA) or five (ALB2) occasions (Table 1). Three surveys were conducted in August 2010, four in October, ten in November, two in December and three in January 2011. Most attention was focussed on the three wetlands (METT, PLEA, ALB2) closest to the townsite of Albany, because these are large and/or complex wetlands. PLEA and ALB2 were targeted for additional surveys to assist in assessing the timing of breeding for AusBs and trying to find their nests. These surveys attempted to determine habitat preferences for feeding and nesting through the breeding cycle of AusBs. The October surveys were primarily to assess numbers and positions of calling bitterns. November and January surveys were aimed at finding nests. In summary, multiple surveys were required to help determine the timing of breeding, with additional time allocated to finding nests.

Table 2. Dates of surveys, hours of survey effort, approximate area of water, and percentage of inundated area surveyed, August 2010 – January 2011.

wetland	*survey date/s*	*hours of survey effort*	*approx. area * of water (ha)*	*% of inundated area surveyed*	*boat used?*
NINE	09 Dec 2010	2h 00m	1.2	100	No
DAVI	01 Dec 2010	0h 55m	1.3	≈ 100	No
YARN	26 Nov 2010	2h 15m	9.0	30	No
BOA1	14 Oct 2010	4h 25m	70	20	Yes
	25 & 26 Nov 2010	5h 00m	60	≈ 60	Yes
OWIN	13 Oct 2010	3h 15m	365	20	No
	15 Oct 2010	1h 00m	365	10	No
PLEA	10 & 12 Aug 2010	3h 00m	126	20	No
	19 & 20 Oct 2010	6h 55m	115	≈ 20	No
	27 & 28 Nov 2010	2h 20m	97	≈ 10	No
	12 Jan 2011	3h 40m	62	≈ 20	No
ALB2	11 Aug 2010	2h 20m	49	40	No
	21 Oct 2010	4h 05m	45	50	No
	26 & 27 Nov 2010	4h 00m	39	80	No
	10 & 11 Jan 2011	7h 05m	33	90	No
	13 Jan 2011	2h 20m	33	40	No
METT	11 Aug 2010	1h 45m	11	≈ 20	No
	08 Nov 2010	1h 30m	7.3	50	No
	28 Nov 2010	1h 00m	7.4	50	No
YELL	28 Nov 2010	1h 15m	64	100	No
ESP1	10 Nov 2010	1h 15m	50	30	No
	29 Nov 2010	1h 20m	48	80	Yes
SHAR	29 Nov 2010	2h 10m	6.8	>80	No

* Measured from Google Earth satellite image, guided by field survey maps. This is also the inundated area. See Appendix 3 for details of single survey of Lake Maringup in November 2010.

The typical daily routine for wetlands with dense sedgeland was as follows:

- morning to early afternoon: count waterbirds, conduct wading surveys and search for nests (4-6 hours).
- later in the afternoon: travel to next wetland to conduct a listening survey for calling bitterns (up to 1 ¾ hours) in the evening.

This was considered the most effective use of time and effort because past experience (RJ) indicated more records of bitterns calling in the evening than before sunrise, though this may have been partly an artefact of observer effort. Furthermore, the need for adequate sleep following evening surveys precluded early morning surveys, particularly in summer when nights were shortest.

At wetlands without dense low cover or that were relatively small, surveys could be completed more easily and survey duration was shorter (1-3 hours); also the time of day was less important, because listening for bitterns was not warranted.

Coverage of the water area ranged from nearly 100% at small wetlands (and YELL) to 70% or less (minimum 30%) at some larger wetlands and wetlands with extensive, dense low vegetation.

Training delivered

Acting on an offer (by JL) to DPaW's South Coast Region, RJ arranged training for DPaW ecologists and community volunteers in survey of secretive waterbirds at Lake Pleasant View, near the Region's headquarters in Albany, during 2008-09. This training took place at 0830–1230 on Saturday 28 November 2008 and comprised instruction, listening to call recordings and discussion/questions followed by illustration of points made by all wading through bittern habitat at the south end of the lake. It was reinforced by involvement of some of the same staff in the follow-up survey led by AC in January 2009.

In 2009-10, the surveys were conducted and led by AC with the involvement and assistance of DPaW staff based in Manjimup, Walpole, Albany and Esperance and experienced volunteers from Birds Australia in Perth and Albany.

In 2010-11, the surveys were conducted and led by AC with the involvement and assistance of DPaW staff based in Manjimup (Ian Wheeler), Walpole (Janine Liddelow and Carol Ebbett) and Albany (Saul Cowen) and experienced volunteers from Perth (John Graff, Susan Abbotts) and Albany (Tony Bush, Anne Bondin, Renee …).

In both 2009-10 and 2010-11, AC provided training to the participants in waterbird survey techniques, particularly the finding and identification, both visually and aurally, of secretive species and their nests. He also imparted his knowledge and experience in safe survey of wetlands that are, in parts, thickly vegetated, deep, boggy and populated by tiger snakes *Notechis scutatus.* Survey participation also provided AC with opportunities to inform Regional and District DPaW staff about the project, its background, objectives and findings to date

Wetland conditions

Wetland water levels and salinities in spring and summer of 2010-11 reflected the varied occurrence of rainfall and were also influenced by conditions in previous years with some showing long-term trends.

Long-term depth (water level) and salinity records from the selected wetlands are presented in graphical form in Appendix 2. These data are collected routinely by DPaW in mid-September and early November each year (Lane *et al.* 2015a) and indicate wetland conditions following the wetter months of winter and spring. The routinely-collected DPaW data of September and early November 2010, together with depths and salinities recorded on the days of wetland survey during this project (i.e. from August 2010 to January 2011), are shown in Tables 3a and 3b and in the graphs of Appendix 2.

Table 3a. Depths (m) of eleven surveyed wetlands, Aug 2010 – Jan 2011. Measurements taken at the time of bird surveys are shown in bold.

wetland	*Aug 2010*	*Sep 2010*	*Oct 2010*	*Early Nov 2010*	*Late Nov 2010*	*Dec 2010*	*Jan 2011*
NINE	-	0.32	-	0.28	-	**0.02**	-
DAVI	-	4.60	-	4.39	-	**4.32**	-
YARN	-	0.42	-	0.30	**0.23**	-	-
BOA1	-	0.89	**0.82**	0.77	**0.72**	-	-
OWIN	-	1.29	**≈ 1.1**	1.11	-	-	-
PLEA	**0.8**	0.83	**0.76**	0.74	**0.69**	-	**0.56**
ALB2	**1.00**	1.05	**0.99**	0.96	**0.92**	-	**0.82, 0.81**
METT	**0.48**	0.54	-	**0.40**	**0.38**	-	-
YELL	-	0.77	-	0.58	**≈ 0.4**	-	-
ESP1	-	2.10	-	**1.85**	**1.78**	-	-
SHAR	-	2.13	-	2.17	**2.00**	-	-

See Appendix 3 for depths and salinities of Lake Maringup in November 2010.

Table 3b. Salinities (ppt) of eleven surveyed wetlands, Aug 2010 – Jan 2011. Measurements taken at the time of bird surveys are shown in bold.

wetland	*Aug 2010*	*Sep 2010*	*Oct 2010*	*Early Nov 2010*	*Late Nov 2010*	*Dec 2010*	*Jan 2011*
NINE	-	0.33	-	1.09	-	**-**	-
DAVI	-	2.62	-	2.73	-	**-**	-
YARN	-	8.63	-	13	**-**	-	-
BOA1	-	0.91	**-**	1.18	**-**	-	-
OWIN	-	0.36	**-**	1.05	-	-	-
PLEA	**-**	0.43	**-**	0.55	**-**	-	**0.98**
ALB2	**-**	0.20	**-**	0.21	**-**	-	**-, 0.68**
METT	**-**	0.51	-	**0.84**	**-**	-	-
YELL	-	109	-	167	**-**	-	-
ESP1	-	2.7	-	**3.08**	**-**	-	-
SHAR	-	1.63	-	1.81	**-**	-	-

See Appendix 3 for depths and salinities of Lake Maringup in November 2010.

Limitations

A number of limitations were recognised in presenting the results and conclusions of the 2008-09 and 2009-10 reports. They are repeated in reduced and updated form below as they are also applicable to the present report and readers should bear them in mind:

- The 2008-2011 surveys are **temporal snapshots** of wetland habitat and waterbird usage of the surveyed wetlands and therefore did not capture all of the considerable natural variability that may occur on-site over one year let alone several or more years. However, the surveys were timed to coincide with what was considered to be the optimal time of year for detecting the priority waterbird species and their nesting activity.

- Waterbirds, including sensitive species, are highly mobile and variability in patterns of usage are driven both by on-site factors and by availability of **habitat elsewhere** in the region and even farther afield. Therefore, in the absence of a concurrent survey of all similar habitat in the study area and beyond, it is not possible to be entirely definitive about reasons for presence or absence of species and/or breeding at the local wetland.
- **Limitations of time** available for survey precluded 100% coverage being achieved at most of the wetlands. Less than a full day was usually available per wetland, due to large distances to travel between wetlands. Hence, some species and nests may have been missed.
- Information from **previous surveys** (1980s-1990s) of waterbirds at the selected wetlands varied greatly in detail and scope, hence accuracy in replicating these previous surveys during 2008-2011 was inconsistent, wetland-to-wetland. In some cases (e.g. METT), RJ (2008-09) and AC (2008-09, 2009-10, 2010-11) conducted more intensive nest searching than was done in the past. Nonetheless, we consider that the methods of our 2008-2011 surveys were appropriate and sufficient to address the primary objective in terms of whether or not certain sensitive species still occurred or could occur at these wetlands.
- Finding **secretive waterbirds** and their nests are inherently difficult tasks even for experts. Thus it is likely that we missed some secretive species and their nests at some of the eleven surveyed wetlands. However, we consider that our collective experience in understanding the habitat and nesting requirements of most of the waterbird species surveyed enables us to draw meaningful conclusions about the continued suitability of the subject wetlands for supporting secretive (and other sensitive) species.
- Some **old nests** cannot be identified as to the waterbird species that used them and the year when the nest was last active can, in some instances, be impossible to discern, especially if no eggshells or feathers remain in the nest. However, although some valuable knowledge remained unattainable, this loss generally was not significant with respect to our project objectives.

Results

Habitats and changes over 2-3 decades

Assessments of habitats and changes in habitats from the 1980s and early 1990s to 2008-09 and 2009-10 were presented in our previous reports (Jaensch *et al.* 2009; Clarke *et al.* 2011). Those assessments have been updated to include 2010-11 observations and are re-presented below in Table 4.

As in the previous report, the following classes of inundated habitat have been adopted:

- **TS** = Tall sedgeland: tall (1-3 m high) beds and/or clumps of sedge, principally *Baumea articulata.* Often including low thin rush and occasional shrubs. Shelter and nest sites for bitterns, crakes and small rails, and nest sites for ducks.
- **TY** = *Typha* beds: tall (1-3 m high) beds and/or clumps of *Typha* (probably *T. orientalis*) typically as mono-specific stands. Shelter and nest sites for bitterns, crakes and small rails, and nest sites for ducks.
- **GA** = *Gahnia* tussocks: low (up to 1.5 m high) tussocks and beds of saw-sedge *Gahnia trifida*. Shelter for Australasian Bittern, crakes and small rails, and when deeply inundated may support duck nests.

- **LS** = Low sedgeland: low (up to 1.5 m high) beds of dense sedge dominated by *Baumea juncea*, *B. vaginalis, Leptocarpus* sp., *Lepyrodia* sp. and/or similar sedge/rush species. Feeding habitat for Australasian Bittern, but on its own generally not structurally adequate to support bittern, crake, small rail or duck nests.
- **SH** = Shrub thicket: relatively low (up to 3 m high) dense thickets and clumps of *Melaleuca lateritia*, *M. teretifolia*, *M. cuticularis* and *Agonis* spp. Shelter and nest sites for Australian Little Bittern, crakes, small rails, and ducks if plenty of sedge is included.
- **WO** = Wooded swamp: tall (3-15 m high) woodland and/or clumps of trees in the zone of inundation, mainly Saltwater Paperbark *Melaleuca cuticularis*, Warren River Cedar *Agonis juniperina* and Flat-topped Yate *Eucalyptus occidentalis*. Substantial trees provide nest sites for colonial-breeding cormorants, herons, egrets, ibis and spoonbills, and Freckled Ducks may nest in trunk junctions near water level.

Major Classes of Inundated Habitat

TS = Tall sedgeland (AC, 8Dec09, YARN)

TY = *Typha* beds (AC, 10Dec09, NINE)

GA = *Gahnia* tussock (RJ-WI, 28Nov08, METT)

LS = Low sedge (AC, 13Dec09, PLEA)

SH = Shrub thicket (AC, 8Dec09, YARN)

WO = Wooded swamp (AC, 4Dec09, METT)

Combinations of Inundated Habitats

Mixed Tall & Low Sedge (AC, 4Dec09, PLEA)

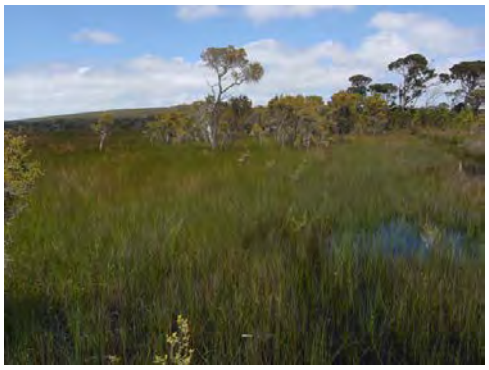
Tall sedge with Low Sedge (AC, 3Dec09)

Mixed *Gahnia* & Low Sedge (AC, 16Feb10, BOA1)

Gahnia with *Baumea* (AC, 2Dec09, BOA1)

Shrubs, *Typha* & Sedge (RJ-WI, 26Nov08, NINE)

Mixed sedge, shrubs, trees (AC, 4Dec09, PLEA)



Mixed Trees and Low Sedge (AC, 5Dec09, ALB2)

Fallen Timber (AC, 15Sep09, ESP1)

Table 4. Change in habitat for sensitive waterbird species at the surveyed wetlands, 1980s-90s to 2008-2011.

wetland	*habitat present in 1980s and/or early 1990s*	*habitat present in 2008-09*	*summary of change to 2008-09*	*summary of change to 2009-10*	*summary of change to 2010-11*
NINE	Mainly open water in main lake, small variable areas of TS[1], small areas of SH; satellite swamps occupied by SH and WO.	Mostly (over 95%) TY in main lake with fringing patchy TS and SH; satellites' vegetation unchanged.	**Major loss** of open water; **major gain** of dense cover (open lake has been invaded by *Typha* up to 2.5m tall; less water depth than 1980s. Satellite swamps apparently dry for many years).	No discernible further change.	No discernible further change.
DAVI	Mainly open water with narrow fringe of semi-continuous LS; some LS clumps. This is suggested also by Photo 1 of Robinson (1992).	Similar but LS with no clumps and possibly more-dense.	Possible loss of varied structure; otherwise unchanged (low sedge was more continuous and seemed denser, lacking the separated tussock clumps noted at eastern end in Dec 91).	No discernible further change.	No discernible further change.
YARN	Mainly TS with some open water (depth dependent); most of margin with SH and WO narrow zone. No definite signs of salinity increase in swamp in 1987-88 (Halse *et al.* 1993a)[2]	Area of TS markedly reduced, especially in south, and open water increased; TS no longer the dominant habitat. In SH zone, the prominent *Melaleuca lateritia* element dead or nearly so and the formerly common, tall, thin sedge element mostly lost.	**Major loss** of dense cover in broad basin and margins ((*Melaleuca lateritia* thickets now dead or nearly leafless, throughout site but worst on south side. *Baumea articulata* beds now greatly reduced (>50%) in area. Some dead eucalypts in wetland at edge)).	Some regeneration of *Melaleuca lateritia* and fine sedge.	Partial regeneration of *Melaleuca lateritia* and fine sedge continuing. Significant further deterioration in *Baumea* across bed of lagoon.
BOA1	Large area of open water; also large areas of LS with complex mosaic of GA, TS and SH; broad to narrow areas of WO, SH and TS at some margins and in back-swamps; small areas of TY at NE margins.	Unchanged.	No discernible loss or gain ((*Typha* not noticeably more extensive. Areas of burnt (dead?) *Agonis* trees in far NE and SE corners of wetland)).	No discernible change.	No discernible change.
OWIN	Large areas of open water. Areas of narrow fringe semi-continuous TS and LS. Continuous broad areas of TS and LS mixed with patches of GA.	Not assessed in 2008-09.	Not assessed in 2008-09	No discernible change since 1980s and/or early 90s, except **expansion** of *Typha* – large areas now exist in the southern sedge areas.	No discernible further change.

[1] Halse *et al.* (1993a) suggested that NINE had only 3% open water some time between 1969 and 1978, but the present authors have been unable to find evidence to support this. 1965 and 1980 aerial photography indicate >95% open water.

[2] Halse *et al.* (1993a) described YARN as being at an early stage of change in 1987-88. Salt scalds were reported to have appeared in the YARN nature reserve ≈200m south of the wetland in 1983 or 1984.

Table 4 continued.

wetland	*habitat present in 1980s and/or early 1990s*	*habitat present in 2008-09*	*summary of change to 2008-09*	*summary of change to 2009-10*	*summary of change to 2010-11*
PLEA	Some open water (depth dependent) but dominated by LS with patches of TS especially at some margins; small patches of SH and GA in margins[1]. In 1987-88 GA was the main sedge in the lake (Halse *et al.* 1993a).	Unchanged except for probable increase in occurrence and extent of SH, notably in the north. Cale *et al.* (2004) estimated open water comprised only 5% of PLEA's 'wetted area' in 1999-00[2].	No net loss or gain of dense cover; probably some LS & TS replaced by SH. Possible increase in extent of melaleuca shrubs on outer N side. Some pampas (weed) clumps in SW corner.	No discernible further change.	No discernible further change.
ALB2	Some open water in centre. Extensive areas of continuous LS and patches of TS.	Not assessed in 2008-09.	Not assessed in 2008-09.	No discernible change since 1980s and/or early 1990s.	No discernible change.
METT	Extensive live WO and broad area of TS; mixed WO, SH and TS in eastern margins and interior; GA scattered under western WO; some open water.	Unchanged; incidence of (the few) dead trees in deepest areas seemed 'natural' though some melaleucas had thin canopies.	No discernible loss or gain.	No discernible change.	No discernible change.
YELL	Extensive live WO and broad eastern area of open water; low shrubs in open water zone exposed at low water levels.	All trees below 2.5m gauge depth dead; some live seedlings and a few live paperbarks in 2.5-2.8m zone; samphire common on outer bed.	**Total loss** of dense live tree cover in lake interior. Former live woodland of yate and melaleuca trees occupying extensive outer zone of lake bed, **now all dead**; live trees now only near high water mark (depth > ~2.5m) apart from a few live melaleuca on E side just below ~2.5m; melaleuca seedlings 2m high, above depth=2.5m. Now samphire occurs on outer lake bed.	No discernible further change.	No discernible further change.

[1] Note that Cale *et al.* (2004) suggested the amount of open water in PLEA is variable, on the basis that Halse *et al.* (1993a) reported <1% of PLEA's area being open water (at time of field investigation between Dec 1987 and Feb 1998 or from aerial photography between 1969 and 1978?), whereas Cale's estimate (based on personal observation) of area of open water in 1985-86 was 75%. Note also that the map on p.92 of Halse *et al.* (1993a) indicates a much larger area (≈30%) of open water than stated in the text (0.04%).

[2] See previous footnote.

Table 4 continued.

wetland	habitat present in 1980s and/or early 1990s	habitat present in 2008-09	summary of change to 2008-09	summary of change to 2009-10	summary of change to 2010-11
ESP1	Extensive live WO and interior area of open water; GA scattered under some WO.[1]	Similar, but zone up to 50m wide of dead Yates around W to N sides of open water; some regrowth (seedlings 0.3–2.0m) above 0.8m depth.	**Some loss** of dense live tree cover. Zone of dead yate trees now around edge of open water in NW to NE side of wetland, some still with fine twigs. Some yate seedlings (to 2m) in NNE just above present water line; very small yate seedlings under large live Yate trees near boat launch site on west side.	More dead, fallen and storm-damaged Yates. Some melaleucas dying and damaged by falling Yates.	Changes occurring in 2009-10 continued in 2010-11.
SHAR	Mainly open water but with semi-continuous narrow zone of TS and some SH.	Unchanged.	No discernible loss or gain.	Many of the well-established melaleuca trees at the western end had **died** and many of these have fallen over.	Changes occurring in 2009-10 continued in 2010-11.

In summary, by 2008-09 major loss of habitat for sensitive waterbirds had occurred at two wetlands (YELL, YARN), minor loss or possible loss had occurred at two wetlands (ESP1, DAVI?), and no significant net loss had occurred at four wetlands (BOA1, PLEA, METT and SHAR). Major gain of habitat for some sensitive waterbirds (crakes, small rails, bitterns) had occurred at one wetland (NINE).

Habitat gains and losses to 2008-09 for other (i.e. non-sensitive) waterbirds were not thoroughly examined. However, notable changes were:

- loss of open (and deeper) water at NINE, which greatly reduced suitability for several waterbird species including diving species such as Great Cormorant and for shorebirds such as dotterels.
- loss of sedgeland at YARN, which reduced the area of habitat for non-sensitive waterbirds such as grassbirds and reed-warblers.

During the 2009-10 surveys, AC noted some improvement in habitat for sensitive species at YARN and some deterioration at ESP1 and SHAR. The changes at ESP1 and SHAR may be of some small benefit to non-sensitive waterbirds, by providing roosting and nesting habitat for several species such as some ducks.

[1] Extensive shrub *Acacia glaucoptera, Melaleuca glaberrima* understorey flooded in 1986 was dead by Jan 1988 (Halse *et al.* 1993a). These shrubs may have invaded during the extended dry period before 1986 (see graph in Appendix 2).

OWIN and ALB2 (Cheyne Rd Nature Reserve) were added to the project in 2009-10. No change in habitat was apparent at ALB2, and at OWIN change appeared to be limited to the expansion of *Typha* at the southern end.

During the 2010-11 surveys, AC noted that, while the partial regeneration of *Melaleuca lateritia* and fine sedge at YARN was continuing, there had been significant further deterioration of *Baumea articulata* across the lagoon. More Flat-topped Yate *Eucalyptus occidentalis* trees had died and fallen at ESP1, damaging melaleucas in the process. At SHAR many melaleuca trees had died and fallen over. There were no discernible changes or further changes at the other surveyed wetlands.

Changes in Habitats

NINE, *Typha* dominating the lake bed
(RJ-WI, 25Nov08)

YARN, Increased extent of open water
(AC, 8Jan09)

YARN, Dead thicket of *Melaleuca lateritia*
(RJ-WI, 26Nov08)

YARN, Some regeneration of *M. lateritia*
(AC, 8Dec09)

Changes in Habitats — Continued

OWIN, Expansion of *Typha* (AC, 16Feb10)

YARN, Some regeneration of thin sedge
(AC, 8Dec09)

PLEA, Probable increase in SH in north
(AC, 4Dec09)

YELL, Death of all live trees on lake bed
(RJ-WI, 29Nov08)

YELL, Dead paperbarks (RJ-WI, 29Nov08)

ESP1, Dead Yate trees (RJ-WI, 1Dec08)

Changes in Habitats — Continued

ESP1, Yates have fallen on melaleucas
(AC, 15Sep09)

SHAR, Melaleucas at W end have died
(AC, 6Dec09)

Numbers of waterbird species recorded, and species recorded breeding

Table 5 compares survey 'effort' (number of surveys), number of species and number of breeding species recorded at each wetland, before ('pre-08') and during the 2008-09, 2009-10 and 2010-11 surveys. All waterbird species, not just sensitive species, are considered.

Table 5. Number of surveys, number of waterbird species recorded, and number of species recorded breeding, at each wetland, pre-2008 and during 2008-2011.

	No. of surveys					*Species Recorded*					*Breeding Species*				
	pre-08	***08-09***	***09-10***	***10-11***	***08-11***	***pre-08***	***08-09***	***09-10***	***10-11***	***08-11***	***pre-08***	***08-09 ****	***09-10****	***10-11****	***08-11***
NINE	32	1	1	1	3	22	9	9	1	11	6	3	4	5	7
DAVI	2	1	1	1	3	5	3	2	3	4	4	1	0	0	1
YARN	23	2	2	1	5	14	12	10	2	14	4	6	8	4	8
BOA1	22	2	2	2	6	34	13	4	12	19	0	3	4	2	5
OWIN	18	-	2	2	4	39	-	5	2	6	9	-	4	1	5
PLEA	35	2	1	4	7	24	13	7	8	14	5	5	5	4	8
ALB2	9	-	2	5	7	8	-	8	6	9	1	-	4	7	7
METT	19	2	2	3	7	16	13	11	9	18	0	7	4	3	8
YELL	9	1	1	1	3	40	15	9	8	23	11 **	2	7	0	7
ESP1	5	1	2	2	5	12	15	14	15	25	3	3	3	3	7
SHAR	60	1	2	1	4	43	15	14	15	21	8	7	4	4	9

* Breeding data for 2008-09 include unidentified nests where the nest was of a species not otherwise recorded breeding at the time, and include old nests (up to about three years old). In this Table, breeding data for 2009-10 and 2010-11 do not include old (pre- 2009-10 or pre- 2010-11 respectively) nests.

** Includes 2 species (Night-Heron, Wood Duck) found breeding only in October 1979 (by J.Lane & G.Pearson).

Pre-2008 data are from the RAOU Waterbirds Database 1981-89 (partly reported in Jaensch *et al.* 1988), Jaensch 1992, Jaensch & Clarke 1993, Storey *et al.* 1993, Clarke & Lane 2003, and some 1979 DPaW datasheets (held by J.Lane). See also pages 38-42 of the 2008-09 report.

See Appendix 3 for results of single survey of Lake Maringup in November 2010.

The number of species recorded or recorded breeding tends to increase with number of surveys (Jaensch *et al.* 1988; Halse *et al.* 1993b); hence results for 2008-09, 2009-10 or 2010-11 alone could be expected to be poorer than suggested by previous (accumulated) knowledge, especially at wetlands with a large number of pre-2008 surveys (e.g. PLEA, SHAR). However, at one wetland (ESP1) the number of species recorded was higher in 2008-09, 2009-10 and 2010-11. Furthermore, the number of species recorded breeding was higher in 2008-09[1], 2009-10 and 2010-11 than pre-2008 at four wetlands: YARN, BOA1, ALB2 and METT. Some of these increases reflect a greater intensity of effort and/or expansion of survey methods applied; nest searching by experts probably had not occurred previously at ALB2 or METT. Others may reflect seasonal or inter-annual variability in wetland water levels and thus the area and type of habitat that is inundated.

Notwithstanding the above, some of the marked changes (Table 5) can be confidently attributed to changes in habitat extent or quality. At YELL, both the lower number of waterbird species and lower number of breeding species are surely due to loss of live tree habitat and changes to food resources with the rise in salinity. At NINE, the lower number of species may be partly due to the loss of open water habitat, but the lower number of breeding species probably reflects the lower number of 2008-09, 2009-10 and 2010-11 surveys. At DAVI, the lower number of breeding species in 2008-09, 2009-10 and 2010-11 is perhaps due to increased salinity.

The increase (from 2 to 7) in number of breeding species at YELL from 2008-09 to 2009-10 is thought to be entirely due to changes in survey technique, the type and area of habitat searched and the amount of time spent searching. In 2008-9 the search was by two observers in one boat and was limited to the open water area and the inner (deeper) margin of the dead tree zone. In 2009-10 the water level was too low to operate a boat and the searches were conducted on foot by two observers walking some distance apart through the dead tree zone. In 2010-11, the water level was even lower (not reaching the inner margin of the dead tree zone), salinities were at record highs and there were no signs of breeding activity.

The decrease in number of species recorded (from 39 to 6) and breeding species recorded (from 9 to 5) from pre-2008 to 2009-10 and 2010-11 at OWIN is thought to be due to differences in survey technique and area covered. The 2009-10 and 2010-11 the surveys were focussed on searching for bitterns and other sensitive breeding species and were confined to the eastern end of this swamp.

Sensitive species

Table 6 compares the number of individuals counted, and breeding activity recorded, in 2008-09, 2009-10, 2010-11 and previously ('pre-2008'), for each wetland, and is confined to sensitive species. The wetland sequence below follows that of our first report (Jaensch *et al.* 2009).

At Yarnup and Yellilup

In our first report, we concluded that: *'Marked differences between 2008-9 and pre-2008 occurrence of sensitive species occurred at two wetlands'.* Thus:

- *'At YARN (despite two 2008-9 surveys), there was loss of all previously-recorded sensitive species, both breeding [ALiB, SpCk] and non-breeding [AusB]. It is not yet apparent as to whether these losses, due at least partly to major changes in habitat on-*

[1] Except ALB2, which was not surveyed in 2008-09.

site, are reversible. One sensitive species was newly recorded at YARN: breeding by (presumed) Little Pied Cormorant in fringing live paperbark trees'.

- *'At YELL there was loss of all previously-recorded sensitive species, both breeding and non-breeding. This is likely to be an irreversible loss arising from major changes in habitat on-site'.*

Yarnup

In our second report we wrote:

'In 2009-10, two of YARN's 'lost' sensitive breeding species (ALiB, Crake) 'returned' and breeding by LPiC was confirmed. The ALiB and Crake nests of 2009-10 were in regenerating fine sedge within the regenerating *M. lateritia* thicket'.

'In 2008-9, ALiB were not heard calling on YARN and could not be induced to call (by vocalisations), suggesting that they were, in fact, not present. In 2009-10, ALiB were not, at first, heard calling, but were later induced to call by vocalisations by RJ. These observations, and the lack of any other evidence that ALiB's were present in 2008-9, support the conclusion that ALiB were not breeding and not present in YARN in 2008-9'.

'Crakes were not heard calling in YARN in 2008-9 or 2009-10, but were present and breeding in 2009-10. The absence of calling in 2008-9 is therefore not strong evidence that they were not present in 2008-9. They were perhaps present but undetected'.

'2009-10 produced the first known record of SwHa breeding in YARN. Searching of the tall, dense stand of *Baumea articulata* in which an active nest was found in 2009-10 was not as intensive in 2008-9 so it is possible that 2009-10 is not the first time that SwHa have bred in YARN'.

In 2010-11, ALiB nests (2) were again found, one in *M. lateritia* thicket, the other in dense *Baumea articulata.* No evidence of breeding by crakes was found in 2010-11 and crakes were not detected. Evidence of breeding by SwHa was not found in 2010-11. Priority was given to surveying the southern *M. lateritia* thicket for secretive species' nests. SwHa nests had previously been found in *B. articulata* near the wetland edge. Very low water levels in 2010-11 left these nesting areas dry and deep mud prevented searching of the swamp interior.

Yellilup

In our second report we wrote: 'Two sensitive breeding species also 'returned' to YELL in 2009-10. One YbSl nest with young and one unidentified heron nest that appeared to have been recently used were found in two tall dead trees within this lake's dead tree zone. These were the only active spoonbill and heron nests found, despite extensive searching'. No evidence of breeding by sensitive species – or other, non-sensitive species – was found at YELL in 2010-11, no doubt due to the water level not reaching the (dead) tree line and salinities being at record high levels.

At Davies

In our first report we wrote:

- *'At DAVI, there has been a possible loss of a sensitive species but more surveys would be needed to confirm this'.*

In our second report we wrote: 'In 2009-10 no crakes or crake nests were recorded, adding weight to the suggestion that these species have been lost from this wetland'. In 2010-11 no crake nests were found, however two birds (unidentified crake species) were recorded as present.

Table 6. Number counted and breeding activity of sensitive species at each wetland pre-2008 and in 2008-09, 2009-10 and 2010-11.

Sensitive species on basis of Numbers or Breeding: AusB = Australasian Bittern, ALiB = Australian Little Bittern, SpCk = Spotless Crake, BaCk = Baillon's Crake, ASCk = Australian Spotted Crake, BbaR = Buff-banded Rail, BbiD = Blue-billed Duck, and FreD = Freckled Duck.

Sensitive species only on basis of Breeding: SwHa = Swamp Harrier; YbSl = Yellow-billed Spoonbill; Dart = Australasian Darter; LPiC = Little Pied Cormorant; LiBC = Little Black Cormorant; WnHe = White-necked Heron; NaNH = Nankeen Night-Heron.

Br = breeding, one nest/brood unless otherwise indicated, and on only one occasion unless otherwise indicated.

wetland	*sensitive species pre-2008*	*sensitive species 2008-09*	*sensitive species 2009-10*	*sensitive species 2010-11*	*sensitive species 2008-2011 summary*
NINE	ALiB (1, **Br**); SpCk (8, **Br?**: several old crake nests).	ALiB (1); SpCk (10, **Br?**: 3 old crake nests).	SpCk (1); SwHa (**Br**: one nest used this year)	None.	ALib (1); SpCk (10, **Br**?); SwHa (**Br**).
DAVI	SpCk (1, **Br**).	No crakes or their nests recorded.	No crakes or their nests recorded.	Crake (2).	Crake (2).
YARN	AusB (2); ALiB (**Br**: in 4 years in 1980s, up to 19 nests, with 12 active nests in 1983-4 season); SpCk (18; **Br,** 3+ nests, mid 1980s).	LPiC (**Br**: 11 nests probably of this species). No bitterns or crakes recorded and no old nests found of these species.	SwHa (**Br**: one nest, large juvenile nearby); LPiC (**Br**: 7 nests used this year); crake (**Br**: 2 new nests); ALiB (2, **Br**: 2 new nests in *M. lateritia*)	ALiB (**Br**: 2 new nests).	LPiC (**Br**); SwHa (**Br**); crake (**Br**); ALiB (2, **Br**).
BOA1	AusB (3); SpCk (13).	AusB (up to 3); ALiB (3); SpCk (up to 6, a possible old nest); BbiD (6).	crake (**Br**: 2 new nests in fine sedge tussocks); SpCk (4)	SpCk (≈5); SwHa (**Br:** one nest with 2 chicks & l egg); crake? (**Br**: one new nest).	AusB (up to 3); SpCk (up to 6); BbiD (6); crake (**Br**); SwHa (**Br**).
OWIN	AusB (5), SpCk (19, **Br**: 1 active & 1 old nest); BbiD (6); LiBC (**Br**: 10 active nests); Dart (**Br**: 2 active nests).	Not surveyed.	BbiD (1); crake (2); AusB (1); ALiB (**Br?**)	SwHa (1, **Br**: 1 nest with 2 eggs); AusB (1).	BbiD (1); crake (2); AusB (1); ALiB (**Br?**); SwHa (1, **Br**).
PLEA	AusB (5, **Br**: a nest reported in Dec 1986 by Tony Bush); ALiB (1, **Br**); SpCk (4); SwHa (2, **Br**: young in nest.	AusB (2); ALiB (2, **Br**: an old nest and a probable new nest); SpCk (6).	AusB (4, **Br**); ALiB (1); SpCk (4)	AusB (1 on several occasions, 2 once, **Br**: 1); ALiB (1 on 2 occasions); SpCk (2).	AusB (4, **Br**); ALiB (2, **Br**); SpCk (6);
ALB2	AusB (5); SwHa (**Br**: 1 active nest in 1979 reported by JLane).	Not surveyed.	SpCk (2); AusB (1, **Br**: an old nest and two new nests)	AusB (1-2 on several occasions, 1 dead, **Br**: 1 new nest); SwHa (3, **Br**: nest with 1 near-fledged young); crake (**Br**: l nest); ALiB? (**Br?**: 1 platform).	SpCk (2); AusB (1-2, **Br**); SwHa (3, **Br**); crake (**Br**); ALiB (**Br?**).
METT	AusB (2); ALiB (1); SpCk (3).	AusB (1); ALiB (1, **Br**: old nest, new nest); LPiC (**Br**: 40 nests).	ALiB (2, **Br**); SpCk (4, **Br**)	ALiB (1, **Br**: 1 nest with 3 eggs); SpCk (2); crake (**Br**: 1 nest).	AusB (1); ALiB (2, **Br**); LPiC (**Br**); SpCk (4, **Br**).
YELL	BbiD (30); FreD (2); **Br**: by NaNH (20 nests), LPiC (17 nests), a few YbSl & WnHe.	No BbiD or FreD; no colonial nesting recorded (one very old heron nest was recorded).	Heron (**Br**); YbSl (**Br**)	None.	Heron (**Br**); YbSl (**Br**)
ESP1	BbiD (1). Potential for small breeding colonies in live trees.	BbiD (1); FreD (2). Potential for small breeding colonies in live trees.	No sensitive species of either category (numbers or breeding).	NaNH (6, **Br?**: 2 nests probably this species); FreD (1); BbiD (20).	BbiD (20); FreD (2); NaNH (6, **Br?**); FreD (1).
SHAR	AusB (1); SpCk (11, **Br**); BaCk (4); ASCk (6, **Br**); BbaR (1); BbiD (9).	ALiB (1, **Br**: a new nest); BbiD (13, **Br**: a nest with eggs); SpCk (1, **Br**: an old nest).	BbiD (1); SpCk (4); crake (1, **Br**)	Crake (4, **Br**: 2 new nests).	ALiB (1, **Br**); BbiD (13, **Br**); SpCk (4, **Br**).

Pre-2008 data are from the RAOU Waterbirds Database 1981-89 (partly reported in Jaensch *et al.* 1988), Jaensch 1992, Jaensch & Clarke 1993, Storey *et al.* 1993, Clarke & Lane 2003, and some 1979 DPaW datasheets (held by J.Lane). See also pages 38-42 of the 2008-09 report.

See datasheets in Appendix 3 for details of 2010-11 surveys, including single survey of Lake Maringup in November 2010.

At Nine Mile, Pleasant View and Shark

In our first report we concluded that *'At three wetlands, no real or net difference seems to have occurred'.* Thus:

- *'At NINE, usage by sensitive species seemed highly similar (the ALiB was calling so it may have been nesting) although areas of occupancy have shifted from the now-drier satellite swamps to the now-more-vegetated main basin (see Appendix 4)'.*
- *'At PLEA, results were similar but with fewer Australasian Bitterns despite two surveys in 2008-9 (but numbers have always been low: less than 10 birds)'.*
- *'At SHAR, one sensitive species (BbiD) persisted; four sensitive species not recorded in 2008-9 were only occasionally recorded in the past and/or are difficult to find; and one sensitive species was gained (ALiB: probably overlooked) despite 60 previous surveys'.*

Nine Mile

In our second report we wrote: '2009-10 also produced the first known record of SwHa breeding in NINE. This nest was in tall, dense, 'live' (green) *Typha* near the centre of the swamp. SwHa may thus have benefitted to some extent from the long-term decline in water levels and the consequent expansion of *Typha* into areas of NINE that were formerly open water'. No evidence of breeding by SwHa was found in 2010-11.

Pleasant View

In our second report we did not discuss PLEA in this section, as the 2009-10 survey results did not alter our first report assessment. In 2010-11 AusB were again found breeding and ALiB and SpCk were again present.

Shark

In our second report we did not discuss SHAR in this section, as the 2009-10 survey results did not alter our first report assessment. In 2010-11 crake were again found breeding. ALiB and BbiD (and AusB) were not recorded in 2010-11, however this is not thought to be due to recent habitat change (death and fall of melaleuca trees).

At Boat Harbour, Mettler and Esperance 26410.

In our first report we concluded that *'No real differences are believed to have occurred at the [following three] wetlands, even though there were some small gains in sensitive species recorded and/or recorded breeding'.* Thus:

- *'At BOA1, two sensitive species (ALiB, BbiD) were newly listed in 2008-9 but these changes probably reflect previous oversight and are not considered to indicate any change in wetland health'.*
- *'Similarly, at METT, two breeding sensitive species (ALiB, LPiC) were gained and SpCk was not recorded; these results also probably reflect oversight'.*
- *'And at ESP1, one sensitive species (FreD) was gained but this species probably has occurred in the past: this was the first comprehensive boat survey at ESP1'.*

Boat Harbour

In our second report we did not discuss BOA1 in this section, as the 2009-10 survey results did not alter our first report assessment, despite the first record of breeding by crake. In 2010-11, the first record of breeding by SwHa was achieved. Both records also probably reflect previous oversight rather than a change in wetland health.

Mettler

In our second report we did not discuss METT in this section, as the 2009-10 survey results did not alter our first report assessment. The 2010-11 survey results were similar to those of the preceding year and also do not alter our assessment.

ESP1

In our second report we did not discuss ESP1 in this section, as the 2009-10 survey results did not alter our first report assessment. Probable NaNH nests (2) were found in 2010-11. This is consistent with the pre-2008 assessment of 'potential for small breeding colonies in live trees' and not indicative of wetland change.

At Owingup and Albany 27157

The following two wetlands were not referred to in this section of our first report, as they were not surveyed in 2008-09.

Owingup

In our second report we wrote: 'Notable differences between pre-2008 and 2009-10 results for sensitive species at OWIN were the smaller number of AusB recorded in 2009-10 (from 5 to 1), the first record of possible breeding by ALiB in 2009-10, and the fact that no breeding by Dart or LiBC was recorded in 2009-10. All of these changes may be wholly or partly due to differences in the number, areal extent and intensity of surveys between the two periods, but it is noteworthy that the lower number of AusB recorded in OWIN in 2009-10 is consistent with the supposition (Wetlands International 2006) that this species has declined in numbers in the south-west, and elsewhere in Australia, in recent decades'. In 2010-11 only one AusB was again recorded, however breeding by SwHa (one nest with two eggs, in a tall dense clump of *Baumea articulata*) was recorded for the first time (at this wetland).

Albany 27157 (Cheyne Rd Nature Reserve)

In our second report we wrote: '2009-10 produced the first record of AusB breeding in ALB2 (Albany 27157). This wetland was not extensively searched for sensitive breeding species pre-2008, so it is not known if breeding by AusB is new to this wetland'. More-extensive and more-numerous searches in 2010-11 produced another record of nesting by AusB, the first records of nesting in this wetland by crake (unidentified) and SwHa, and a suggestion (rough platform) of possible nesting by ALiB (this would also be a first record for this wetland).

Waterbird breeding efforts

The numbers of waterbird nests (of any age) and broods found at each wetland during surveys in 2008-09, 2009-10 and 2010-11 are shown in Table 7. In those wetlands where more than one survey was made in one survey year it was possible to determine, from records of survey paths and GPS positions of nests, which nests were additional to those found earlier in the same survey year. In some cases, the older nests examined in 2009-10 or 2010-11 were known to be active (those found in the previous year) or were possible active (those *not* found in the previous year) in the previous year. In other cases, they were older. See Appendix 3 for detail.

Table 7. Number of waterbird nests/broods found at each wetland in 2008-09, 2009-10 & 2010-11.
(HhGb = Hoary-headed Grebe; MusD = Musk Duck; PuSn = Purple Swamphen; LPiC = Little Pied Cormorant; AReW = Australian Reed-Warbler; LiGd = Little Grassbird; PaBD = Pacific Black Duck; Hard = Hardhead; Coot = Eurasian Coot; ChTl = Chestnut Teal; Swan = Black Swan; ALiB = Australian Little Bittern; SpCk = Spotless Crake; BbiD = Blue-billed Duck; YbSl = Yellow-billed Spoonbill; SwHa = Swamp Harrier). All numbers are of nests, except broods where indicated.

	2008-09			*2009-10*			*2010-11*		
wetland	***number of active or recent (08-09) nests***	***number of older nests ****	***breeding species (number of nests of any age or broods)***	***number of active or recent (09-10) nests***	***number of older nests ****	***breeding species (number of nests of any age or broods)***	***number of active or recent (10-11) nests***	***number of older nests ****	***breeding species (number of nests of any age or broods)***
NINE	0	7	AReW (3), crake (3), duck (1).	7	0	Swan (2), AReW (3), SwHa (1), MusD (1)	9	2	Swan (2), PuSn (2), LiGd (2), AReW (2), AReW? (2), MusD? (1).
DAVI	3	0	HhGb (1), grebe (2).	0	0	0	0	0	
YARN[2a,b]	20	9	LPiC? (11), PuSn (7), HhGb (3), MusD (2), LiGd (2), AReW (1), duck (2), other (1).	41	4+	HhGb (4), LPiC (9), MusD (9), PuSn (4), AReW (8+), SwHa (1), crake (2), duck (4), other (2), ALiB (2)	7 (8?)	? LPiC, ? AReW	ALiB (2), MusD (1), LPiC (?), AReW (3+), LiGd (1), MusD? (1?).
BOA1[2a,b, c]	3	1	PuSn (2), Swan (1), crake? (1).	8	0	Swan (2), MusD (1), crake (2), duck (1), PuSn (1), other (1)	2	0	SwHa (1), crake? (1).
OWIN[2b]	-	-	-	9	0	MusD (2), LiGd (5), ALiB (1), PuSn (1)	1	0	SwHa (1).
PLEA[2a,4]	7	1	ALiB (2), Hard (2), MusD (2), PaBD (1), PuSn (1).	10	0	MusD (3), LiGd (1), PuSn (3), AReW (2), AusB (1)	5	1	AusB (1), MusD (2), LiGd (1), PuSn (2).
ALB2[2b,5]	-	-	-	16	3	MusD (8), PuSn (5), other (2), duck (1), AusB (3)	12	0	AusB (1), MusD (1), PuSn (3), crake (1), AReW (3), LiGd (1), SwHa (1), ALiB? (1).
METT[2a,b,3]	24	43	LPiC (40), MusD (8), AReW (5), PuSn (4), duck (3), crake? (3), ALiB (2), Coot? (1), PaBD (1); also other nests not counted.	5	0	AReW (1), SpCk (1), MusD (2), ALiB (1)	5	0	ALiB (1), MusD (3), crake (1).
YELL	1	1	ChTl (1 brood), heron? (1 old nest).	6	12+	Duck (1), heron (1), BwSt (1), Swan (10+), Coot (2), YbSl (1), GyTl (2),	0	0	
ESP1[2b,c]	2	1	HhGb? (1), PaBD? (1), Coot? (1).	8	0	ChTl (1), Swan (1), BwSt (6)	4	0	Coot (1), ChTl (1), NaNH? (2), GyTl (1 brood)
SHAR[2b]	6	8	AReW (7), PuSn (2), ALiB (1), BbiD (1), SpCk (1), HhGb (1), Coot? (1).	13	Numer-ous	AReW / LiGd (1 + numerous), AReW (numerous), MusD (3), crake (1), PuSn (8)	11	0	LiGd (2), MusD (2), PuSn (5, 1 brood), crake (2).

* Includes nests of unknown age (up to about 3 years old). See Appendix 3 for details. Data include unidentified nests.
[2a, 2b, 2c] Surveyed twice in 2008-09, 2009-10 or 2010-11 respectively. [3, 4, 5] Surveyed three, four or five times respectively in 2010-11.
See Appendix 3 for results of single survey of Lake Maringup in November 2010.

Similar data on numbers of nests pre-2008 are not available consistently for all wetlands so comparisons between recent and pre-2008 data are problematic. Also, nest searching during 2008-09, 2009-10 and 2010-11 was not exhaustive at all wetlands (see Limitations, above). However, we consider the following waterbird breeding observations from 2008-2011 to be noteworthy, bearing in mind that more nesting was undoubtedly occurring during 2008-2011 than was discovered:

- A substantial amount of breeding (at least 30 nests) has occurred in recent years at three wetlands ((YARN 77 (78?)[1] nests, METT 77[2] nests, SHAR 38 nests)).
- One wetland (DAVI 3 nests) currently seems to be of low importance for breeding with respect to number of nests.
- Wetlands with high numbers of nests (Table 7) and diversity of breeding species (Tables 5, 7), e.g. YARN, PLEA, METT and SHAR, have diverse habitats including areas of dense sedges and trees/shrubs.
- Wetland area is not a critical factor. Small wetlands, e.g. SHAR, can have significant breeding activity both in terms of number of nests and number of breeding species.
- c. 20 breeding species were identified across the surveyed wetlands.
- The most prolific waterbird breeding species were: Little Pied Cormorant (60[3] nests), Musk Duck (50), Purple Swamphen (50) and Australian Reed-Warbler (at least 38).
- Breeding by sensitive species comprised: Little Pied Cormorant (60 nests), Australian Little Bittern (12 nests), Australasian Bittern (6), Spotless Crake (2), unidentified crakes (17), Swamp Harrier (5), Blue-billed Duck (1), Yellow-billed Spoonbill (1) and unidentified heron (1).
- The globally threatened Australasian Bittern were recorded nesting at PLEA and ALB2 in both 2009-10 and 2010-11, but not at any other wetland,
- Swamp Harriers were recorded nesting on five occasions, at NINE, YARN, BOA1, OWIN and ALB2. Its active nests have previously been rarely found within the project area and are therefore of considerable interest.
- More nests and breeding species were found at Yellilup in 2009-10 than in 2008-09 due to differences in the way this survey was conducted.

Other compositional differences

A number of differences in species composition with respect to occurrence and/or breeding are evident in the results of the 2008-2011 surveys. Salient points not already revealed in the above sections are as follows:

- Australasian Grebe was recorded at DAVI pre-2008, but not during 2008-2011. Perhaps this is related to the increasing salinity of DAVI (Lane *et al.* 2015a; Davies 2010). This species commonly avoids saline waters.
- Small colonies of old cormorant nests, probably of Little Pied Cormorant, were recorded at YARN in 2008-09, possibly for the first time. Seven active Little Pied Cormorant nests were found in 2009-10, however none were active in 2010-11. There is no obvious explanation for the 2009-10 change in breeding status, unless perhaps a temporary abundance of freshwater crayfish had arisen locally, on-site or in nearby stocked farm dams. In 2010-11 water levels in YARN were so low that these cormorant nests were not over water.

[1] 77 (78?) = 20 + 9 + 41 + 7(8?).

[2] 77 = 24 + 43 + 5 + 5.

[3] 60 = 11 + 40 + 9.

- The 2008-09 surveys produced first records of Hoary-headed Grebe at PLEA, YARN, METT and ESP1 and first record of breeding by this species at YARN, ESP1 (?) and SHAR. In 2009-10, Hoary-headed Grebes were recorded only at DAVI and YARN and were recorded breeding only at YARN. In 2010-11, Hoary-headed Grebes were recorded at DAVI, BOA1, ESP1 and SHAR, but were not recorded breeding. These may be indicators of either a short term or long term influx of the species to the study area, perhaps due in part to increases in salinity of wetlands such as DAVI, YARN and ESP1. In south-western Australia, Hoary-headed Grebe often breed in brackish (Goodsell 1990) and even saline (D. Cale, unpublished data) wetlands. During 1981-85, this species was reported breeding at 17 of 197 surveyed wetlands, 11 of these being above 3 parts per thousand (i.e. brackish or saline), however it was not recorded breeding at any of the 20 surveyed wetlands in the south coast and Muir-Unicup districts (see Jaensch *et al.* 1988).
- In January 2009, Hardhead were recorded breeding (2 nests) for the first time at PLEA; this species is known to commonly exploit flood conditions (RJ pers. obs.), so the result may be due to the unusually heavy rain and local flooding in November-December 2008. No breeding by Hardhead was recorded during the 2009-10 or 2010-11 surveys.
- Notable among the breeding species recorded at METT in 2008-09, all being new records, were extensive use of partially-inundated *Gahnia* tussocks for duck nests (especially Musk Duck) and several small colonies of Little Pied Cormorant (of varied antiquity, some active) in inundated live Yate and paperbark trees. In 2009-10, no nesting by Little Pied Cormorants was found and Musk Duck were recorded nesting only in *B. articulata.* The *Gahnia* tussocks were dry in 2009-10. In 2010-11 water levels were even lower than in 2009-10, resulting in a greatly reduced area of water. Waterbird nesting was restricted to dense *Baumea* growing on old, elevated, potato-growing mounds, surrounded by water, in the centre of the wetland.
- At YELL in 2008-09, despite saline conditions (40ppt) there was a first record of nesting by Chestnut Teal (one brood) and noteworthy numbers of Australasian Shoveler (40). Many hundreds of several thousand Australian Shelduck were moulting. In 2009-10 Chestnut Teal and Shoveler were not recorded at YELL, however there were one thousand Shelduck, many flightless due to being in moult. In 2010-11 the water level was lower and the salinity even higher (167ppt three weeks prior to the bird survey) than in the preceding two years and the most abundant birds were c. 1000 Banded Stilt and c. 200 Red-necked Avocet, both species being highly tolerant of saline conditions.
- The first record of Great Crested Grebe at Shark Lake occurred in 2008-09. They were recorded here again in 2009-10 (two birds) and 2010-11 (one bird). These were the only records of this species at any surveyed wetland during this project.
- Migratory shorebirds were recorded at three of the eleven wetlands, Common Greenshank (≤ 15 birds) at METT (one year), YELL (3 years) and ESP1 (one year); Wood Sandpiper (1) at YELL (one year); and Sharp-tailed (23) and Curlew Sandpiper (1) at ESP1 (one year).

Numbers of waterbirds

Data on total numbers of all waterbird species were recorded during the 2008-2011 surveys but this was not a priority outcome because our focus was on the occurrence of sensitive species and their habitats. In 2010-11, as in the two preceding years, limited attention was paid to the abundance of species other than those regarded as 'sensitive' on the basis of *numbers or* breeding[1] (see p.4). Summary data are presented in Table 8.

[1] As opposed to species regarded as sensitive only on the basis of breeding, see pp.3-4.

Apart from the omission of perhaps tens or (at larger swamps) possibly a few hundreds of the smaller secretive waterbirds (total numbers of which are, in practice, impossible to determine in densely vegetated swamps), these totals are considered in most instances to reasonably reflect the actual total numbers present.

Table 8. Number of waterbirds counted in each survey in 2010-11 and the species that were most abundant.

(MusD = Musk Duck; BbiD = Blue-billed Duck; Hard = Hardhead; GyTl = Grey Teal; PaBD = Pacific Black Duck; Swan = Black Swan; HhGb = Hoary-headed Grebe; LiBC = Little Black Cormorant; YbSl = Yellow-billed Spoonbill; WfHn = White-faced Heron; PuSn = Purple Swamphen; Coot = Eurasian Coot; BaSt = Banded Stilt; RnAv = Red-necked Avocet).

The numbers in this table in almost all cases represent **partial counts**, and should be regarded as **minima** and **not indicative** of the total number of birds or species present on the wetlands at the time of survey, or the relative abundance of species. Thus the species with highest counts were not necessarily the most abundant species at the time of survey.

Wetland	***Number of waterbirds counted in each survey***	***The 3 species with highest counts in each survey (5 or more individuals counted)***
NINE	4 (Dec)	
DAVI	43 (Dec)	PaBD (29), HhGb (12).
YARN	25 (late Nov)	WfHn (17), PuSn (8).
BOA1	0 (Oct), 72 (late Nov)	PaBD (16), Black Swan (13), LiBC (8).
OWIN	2 (Oct)	
PLEA	1 (Aug), 5-7 (Oct), 9 (Nov), 2-4 (Jan)	
ALB2	1 (Aug), 2 (Oct), 7 (late Nov), 5 (Jan), 9 (Jan)	
METT	0 (Aug), 23 (early Nov), 15 (late Nov)	Early Nov: GyTl (12), YbSl (5). Late Nov: PaBD (6), WfHn (6).
YELL	1434 (late Nov)	BaSt (c.1000), RnAv (c.200), GyTl (c.100).
ESP1	44 (early Nov), c. 148 (late Nov),	Early Nov: (BbiD (20), GyTl (13). Late Nov: Hard (c.100), HhGb (9), BbiD (8).
SHAR	83 (late Nov)	PaBD (24), MusD (12), HhGb (10), Coot (10).

In 2010-11, the *highest total number*, by an order of magnitude, was again (as in 2008-09 and 2009-10) at the hyper-saline (and large) Yellilup Lake. Numbers counted at the other wetlands, five being predominantly very fresh (<1 ppt), four being predominantly fresh (1<3ppt), and one (YARN) being predominantly saline (10<50 ppt), ranged from a few, to a few tens, to 148 (at fresh SHAR). Of course, many factors besides salinity can influence waterbird numbers (Halse *et al.* 1993b), e.g. wetland area, bathymetry, nutrients, water clarity and pH, and factors external to the wetland, such as availability of food nearby (e.g. cereal grain in paddocks surrounding YELL may attract thousands of Shelduck to the area: Ian Peacock pers. comm., *circa* 1990).

In 2010-11, the *most abundant species* across the surveyed wetlands were (some of) those that tend to congregate in large numbers on open, shallow-margined lakes including saline lakes, for example the Banded Stilt (c. 1000), Red-necked Avocet (c. 200) and Grey Teal (c. 100) at YELL. Hardhead (a diving duck) were numerous at ESP1, where the lake depth at the time (late November) was ≈ 1.8m, the highest it had for more than 20 years (Appendix 2).

Conclusions

Changes by wetland and year

In our first report (Jaensch *et al.* 2009), we concluded that significant changes had occurred at five of the (then) nine surveyed wetlands in terms of habitat and/or waterbird use, from the early 1980s and/or early 1990s, to 2008-09. In our second report (Clarke *et al.* 2011) we reproduced our descriptions of those changes and followed each with a 2009-10 update. For the convenience of readers, those descriptions and updates are reproduced below, in the same order. Each is then followed by a 2010-11 update.

- ***'Yarnup Lagoon** was formerly a significant breeding locality for Australian Little Bittern (the largest breeding aggregation in south-western Australia) and Spotless Crake and supported Australasian Bittern, but appears to have lost all of these sensitive species, as a consequence of major loss of dense emergent vegetation (tall sedgeland) and fringing vegetation (sedge-infused, live shrub thicket). This loss of habitat is predicted (R. Hearn pers. comm.) to persist due to hydrological consequences of catchment clearing and it is not known if the changes can be reversed by intervention. Another possible indicator of change is the recent first recorded breeding by Hoary-headed Grebe, coinciding with increased salinity'.*

  In 2009-10, some regeneration of sedge-infused, live shrub thicket (*M. lateritia*) was apparent and some renewed nesting activity by Little Bitterns and crakes was discovered. These are positive developments but it remains to be seen whether they are persistent or short-lived. The cause(s) of these changes has not been determined but it is noteworthy that the pH of YARN's waters was closer to normal (pH ≈6.5) in spring of 2009 than in the two preceding years (pH ≈4; pH ≈4.5).

  In spring of 2010, pH was normal, however the water level was at a record low (0.23m in late Nov) and salinity at a record high value (13ppt in early Nov). Despite this, breeding by Little Bitterns, but not crakes, was again recorded.

  In 2010-11, the partial regeneration of melaleuca thicket and fine sedge beneath was continuing, however there was also substantial further deterioration of tall sedge (*Baumea*) across the lake bed. The regeneration of fine sedge will benefit nesting by a variety of sensitive and non-sensitive waterbird species by providing cover (e.g. for crakes), a base or support for nests (e.g. crakes, Little Bittern and Musk Duck), and material for nest construction (e.g. crakes, Little Bittern, Reed-Warbler). The regeneration of melaleuca thicket will benefit nesting by providing cover (e.g. for Little Bittern, grebes and ducks) and a base or support for nests (e.g. Little Bittern, ducks and Reed-Warblers). The substantial death and loss of *Baumea* is reducing the availability of feeding habitat for crakes, Little Bittern and Buff-banded Rail, and nesting habitat for Australasian Bittern, Little Bittern Swamp Harrier and ducks. There is no indication yet that any species has benefitted from the increase in open water that has resulted from the loss of *Baumea*.

- ***'Yellilup Lake** was formerly a fresh to brackish lake supporting herons, spoonbills, cormorants and ducks that breed in low salinity, periodically-inundated, live-wooded swamps, but has lost all live woodland habitat in its zone of seasonal inundation due to prolonged (multi-year) inundation and salinization. Consequently these sensitive species no longer breed there, a suite of other waterbird species no longer occurs and these changes are probably irreversible, at least in the short to medium term (decades)'.*

In 2009-10, very limited (two nests) breeding by two sensitive species and limited breeding by several other species was found, but this was due to changes in the way this lake was surveyed, rather than any improvement in habitat or conditions for breeding.

In 2010-11, the water level was at a record low (≈ 0.4m in late Nov) and not within the (dead) tree line, while salinity was at a record high (167ppt in early Nov). No evidence of breeding by any species was found.

- *'**Esperance 26410** has shown a recent minor loss of habitat for sensitive waterbirds and though this is not yet manifest in major changes to waterbird use, consistent with other live-wooded swamps in the surrounding catchments it is likely that further habitat loss may occur with perhaps eventual total loss (as at the similar Coomalbidgup Swamp, 45 km to the east). It is not known if the changes can be reversed by intervention'.*

  In 2009-10, further deterioration in the health of some Flat-topped Yates (*Eucalyptus occidentalis*) and melaleuca trees was observed; some of these appeared to be dying.

  In 2010-11, the death and fall of Yates and melaleucas was continuing. This may be of some small benefit to non-sensitive species, e.g. by providing roosting and nesting habitat for some ducks and nesting habitat for Black-winged Stilt. On the other hand, Freckled, Blue-billed and Pink-eared Ducks and Chestnut Teal favour the ESP1 live treed zone for loafing (and feeding?) and may be disadvantaged by opening and loss of the tree canopy.

- *'**Nine Mile Lake** has lost most of its open water but gained some dense vegetation that harbours sensitive species. Some waterbird species recorded in moderate numbers in the past probably do not use the wetland in its present condition, notably Great Cormorant (prefers deep open water; up to 29 counted in 1980s) and Red-capped Plover (occurs on beaches and drying open lake beds; up to 20 counted in 1980s). Changes are probably reversible by intervention, i.e. restoring former water depths, but impacts on sensitive species now using the main lake would need to be considered'.*

  In 2009-10, the habitat situation at NINE appeared unchanged. A sensitive breeding species, the Swamp Harrier, was recorded breeding for the first time, its nest located in dense vegetation near the centre of the lake, an area that was once open water.

  In 2010-11, the water level was very low, making waterbird breeding habitat less suitable and perhaps also impacting the *Typha*, which was declining in some areas. No sensitive species, nor evidence of breeding by sensitive species, was found.

- *'**Lake Davies** There are some indications of possible loss of habitat and loss of a sensitive species (Spotless Crake) and two breeding species (Spotless Crake, Australasian Grebe)'.*

  In 2009-10, the habitat situation at DAVI appeared unchanged and there was no significant change in use by waterbirds.

  In 2010-11, there was again no apparent change in habitat. Crakes (2, unidentified) were encountered for the first time since pre-2008, however no evidence of breeding by this sensitive was found. The number (12) of Hoary-headed Grebe (a relatively salt-tolerant species) was very similar to that of the two previous years.

- **Owingup Swamp** was surveyed for the first time in this project in 2009-10. Bulrush *Typha orientalis*, an introduced and invasive plant species, has expanded its occurrence at the southern end of the swamp since the early 1990s. This provides some additional nesting habitat, foraging habitat and shelter for both sensitive and non-sensitive species of waterbirds, though only non-sensitive species (Little Grassbird and Purple Swamphen) were found nesting in the *Typha* in 2009-10. Massive expansion of the *Typha* would have

severe negative impacts on biodiversity values of the swamp and its areal extent should therefore be monitored.

In 2010-11, little or no change in habitat had occurred since the previous year. Lower water levels made breeding habitat less suitable. The Swamp Harrier nest that was found (first record for this wetland) was in a tall dense clump of *Baumea articulata.*

While there was no discernible change in the extent of *Typha* beds in 2010-11, this remains a medium to long-term threat. The expanding beds have overtaken fine sedge feeding habitat of crakes, Australasian Bittern and Buff-banded Rail, and tall sedge (*Baumea*) nesting habitat for crakes, Australasian Bittern, Little Bittern, Swamp Harrier, Rail and Musk Duck. *Typha* may also overtake open water habitat, however at Owingup no bird species that depend upon large areas of open water are currently present. Species such as Reed-Warblers and Grassbirds could benefit if the *Typha* beds become denser, particularly if their edge to area ratio were high.

- **Shark Lake** underwent some changes in habitat availability in 2009-10. Many melaleuca trees at the western end of the lake had died and fallen since 2008-09. This may be of some small, short-term benefit to certain non-sensitive waterbirds such as some ducks, but will be of concern if continues and regeneration does not occur.

  In 2010-11, the decline of melaleuca trees was continuing, however there was no noticeable change to the *Baumea*. The death and fall of melaleucas may be of some small benefit to non-sensitive waterbird species, by providing roosting and nesting habitat e.g. for ducks. At Shark, no species seem to favour the treed zone, probably because of its small extent and narrow width.

In our 2008-09 report, we also concluded that: *'With respect to sensitive species, gains* [in 2008-09] *in terms of newly-listed species*[1] *at BOA1, METT, ESP1 and SHAR and newly-listed breeding species*[1] *at YARN, METT, and SHAR (Table 7) [Table 6 of this 2010-11 report] are considered to reflect survey methods and limitations rather than any real change over time'*. The same comment may be applied to the further (additional to the preceding year) gains in species at ALB2 (Spotless Crake) and in breeding species at YARN (Swamp Harrier), BOA1 (crake), OWIN (Australian Little Bittern?), ALB2 (Australasian Bittern) and METT (Spotless Crake) in 2009-10. The same comment may also be applied to the further gains in species at BOA1 (Swamp Harrier), OWIN (Swamp Harrier), ALB2 (Australian Little Bittern?) and ESP1 (Nankeen Night-Heron), and in breeding species at BOA1 (Swamp Harrier), OWIN (Swamp Harrier), ALB2 (crake, Australian Little Bittern?) and ESP1 (Nankeen Night-Heron?) in 2010-11.

Changes overall and consequences for waterbirds

In this third and final annual report on this project it is appropriate to make an overall assessment of the changes that have been observed and their consequences for waterbirds.

- Since the 1980s / early 1990s, substantial changes have occurred in the suitability for waterbirds of some of the studied south-western Australian wetlands, but not others.
- The major types of change that have been observed are reduced depth, areal extent and duration of surface water (NINE, YARN); altered and reduced food availability (YARN, YELL); loss of live trees, shrubs and sedges over water (e.g. live trees at YELL, ESP1;

[1] It is important to note that this paragraph refers to both newly-listed species and newly-listed breeding species *that are sensitive for whichever reason as defined on page 4 of this report*, not newly-listed sensitive species ('sensitive on the basis of numbers or breeding') or newly-listed sensitive breeding species ('sensitive only on the basis of breeding') as elsewhere in this report. This is a subtly different categorisation.

sedges at YARN); substitution of higher value by lower value habitats (NINE and potentially OWIN), and weed invasion (PLEA).

- Principal causes of these major changes have been a long-term decline in rainfall over much of the south-west (NINE, YARN); secondary salinization (YARN, YELL), acidification (YARN); excessive inundation due to unusual, localised, rainfall events (YELL, ESP1); expansion of *Typha* beds (NINE, OWIN), and limited weed control (PLEA).
- In some cases, remedial management actions are clearly possible and should be affordable (e.g. weed control at PLEA; *Typha* management at NINE, OWIN). In other cases, while effective remedial technologies might exist, the financial costs could be prohibitive (e.g. water supplementation at NINE; water diversion or removal at ESP1, salt removal at YELL). At one of the project wetlands (YARN), efforts have been made to halt and reverse salinization and acidification however, to date, these have been unsuccessful. At ESP1, hydrological investigation might show the recent high levels of inundation to be due primarily to natural, though infrequent, high rainfall events, in which case remedial action might be considered unwarranted.
- The changes in habitats referred to above have had a variety of consequences for waterbirds. Species that are largely dependent upon suitable water regimes and fringing and emergent vegetation (live trees, shrubs, sedges) for nesting and or feeding (i.e. the 'sensitive' species on which this project has focussed) — and, of course, adequate water — have, from the 1980s / early 1990s to 2008-2011, lost suitable habitat at several of the eleven project wetlands. Species that have obtained some marginal benefit from habitat changes at project wetlands have been non-sensitive species, with less or no dependence on live fringing and emergent vegetation and a greater tolerance of salinity.
- None of the studied wetlands is believed to be a unique representative of its type, at least in terms of hydrological regime and vegetation associations and structures. The causes of the observed changes are also not confined to these particular wetlands. Long-term rainfall decline and secondary salinization, for example, have occurred across much of south-western Australia. It can therefore be concluded that the changes that have been observed have not been restricted to the few studied wetlands, but have also occurred at many others. However, in the absence of comprehensive mapping of wetland type and condition across the south-west region, it is not possible to estimate the overall extent of change that has occurred, or the overall impact on use by waterbirds.
- The results of this project, and of other projects such as *The New Atlas of Australia Birds* (Barrett *et al.* 2003) and BirdLife Australia's *Australasian Bittern in Southwest Australia* project (Pickering 2013) to which we contributed, have raised our collective level of concern about the future of Australasian Bittern, in particular, in south-western Australia. Consequently, Alan Clarke's work is now focussed on this species, in collaboration with DPaW South Coast Regional Nature Conservation Leader Sarah Comer and with funding support from South Coast NRM. Since 2011, Alan has conducted numerous surveys to locate key Australasian Bittern wetlands and identify principal feeding and nesting habitats, sites and requirements (Pickering, Clarke, Comer *et al.* 2015). Simultaneously, he and DPaW colleague Yvonne Winchcombe have continuously monitored wetland water levels and on-site rainfalls, both to better understand their influence on bittern presence and breeding activity, and to enable modelling and prediction of likely hydrological futures for Australasian Bittern wetlands and habitats in a region of declining rainfall (Lane, Clarke & Winchcombe 2016).

Action to recognise the importance of specific wetlands

In our 2008-09 report (Jaensch *et al.* 2009), we concluded that, based on all survey data up to and including 2008-09, three (BOA1, PLEA and METT) of the (then) nine surveyed wetlands *might* (depending upon the results of further surveys) be considered internationally important under Criterion 2 (threatened species and communities) of the Ramsar *Convention on Wetlands* because during the preceding 2-3 decades and in 2008-09 they supported Australasian Bittern, a species listed as globally endangered.

The surveys of 2009-10 revealed continuing use and breeding by Australasian Bittern at PLEA (and ALB2), but not at BOA1 and METT (Clarke *et al.* 2011).

In 2010-11, Australasian Bitterns were recorded at OWIN and again recorded breeding at PLEA and ALB2. The past two years of work (2009-10 & 2010-11) have thus strengthened the case for considering PLEA to be internationally important under Criterion 2 of the Ramsar Convention. A case might also be developed for ALB2, however Australasian Bittern were not recorded breeding on this wetland pre-2008, so the basis for considering ALB2 under this criterion is not quite as strong (based on the data to the end of 2010-11) as for PLEA.

We also observed in our 2008-09 report that two of the surveyed wetlands (PLEA and SHAR) have supported at least 1% of the relevant (south-western Australian) populations of Australasian Bittern (1% = 5 birds) and Chestnut Teal (1% = 50 birds) on one or more occasions during the past 2-3 decades. We concluded that further surveys would be needed to establish continued and regular use at the ≥1% level and therefore did not propose nomination of either of these wetlands for listing under Criterion 6 of the Ramsar Convention at that time.

In 2009-10, four Australasian Bittern were recorded at PLEA and single individuals were found at OWIN and ALB2. No Chestnut Teal were recorded at SHAR; only 16 individuals were found at ESP1 and none were recorded at the other nine project wetlands.

In 2010-11, one Australasian Bittern was recorded at OWIN and 1-2 at PLEA and ALB2. Two Chestnut Teal were recorded at SHAR; three individuals were found at ESP1 and none (again) were recorded at the other nine project wetlands. The past two years of work have thus *not* strengthened the case for considering PLEA or SHAR to be internationally important under Criterion 6 of the Ramsar Convention.

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Ian Wheeler of DPaW Manjimup assisted with field surveys at Yarnup in Nov10. Saul Cowen of DPaW Albany assisted at ALB2 and Mettler in Aug10. Carol Ebbett and Janine Liddelow of DPaW Walpole received training and assisted at Owingup in Oct10. Volunteers Tony Bush (ALB2 Jan11), Renee ….. (BOA1 and Owingup Oct10), John Graff (BOA1 and Maringup Nov10, Pleasant View and ALB2 Jan11), Susan Abbotts (Pleasant View and ALB2 Jan11) and Anne Bondin (Mettler Nov10, ALB2 Jan11) also assisted. All of their efforts were much appreciated.

Yvonne Winchcombe (DPaW Busselton) assisted with data management and prepared the graphs of Appendix 2. Jasmine Rutherford (DPaW Kensington) advised concerning the probable cause of the unusual coloration evident in the January 2009 photograph of Yarnup Lagoon.

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APPENDICES

Appendix 1. Scientific and English names of waterbirds mentioned in this report.

Based on Christidis and Boles (2008).

FAMILY & SCIENTIFIC NAME	ENGLISH NAME
Anatidae	
Biziura lobata	Musk Duck
Stictonetta naevosa	Freckled Duck
Cygnus atratus	Black Swan
Tadorna tadornoides	Australian Shelduck
Chenonetta jubata	Australian Wood Duck
Malacorhynchus membranaceus	Pink-eared Duck
Anas rhynchotis	Australasian Shoveler
Anas gracilis	Grey Teal
Anas castanea	Chestnut Teal
Anas superciliosa	Pacific Black Duck
Aythya australis	Hardhead
Oxyura australis	Blue-billed Duck
Podicipedidae	
Tachybaptus novaehollandiae	Australasian Grebe
Poliocephalus poliocephalus	Hoary-headed Grebe
Podiceps cristatus	Great Crested Grebe
Anhingidae	
Anhinga novaehollandiae	Australasian Darter
Phalacrocoracidae	
Microcarbo melanoleucos	Little Pied Cormorant
Phalacrocorax carbo	Great Cormorant
Phalacrocorax sulcirostris	Little Black Cormorant
Pelecanidae	
Pelecanus conspicillatus	Australian Pelican
Ardeidae	
Botaurus poiciloptilus	Australasian Bittern
Ixobrychus dubius	Australian Little Bittern
Ardea pacifica	White-necked Heron
Ardea modesta	Eastern Great Egret
Egretta novaehollandiae	White-faced Heron
Nycticorax caledonicus	Nankeen Night-Heron
Threskiornithidae	
Threskiornis molucca	Australian White Ibis
Platalea flavipes	Yellow-billed Spoonbill
Accipitridae	
Circus approximans	Swamp Harrier

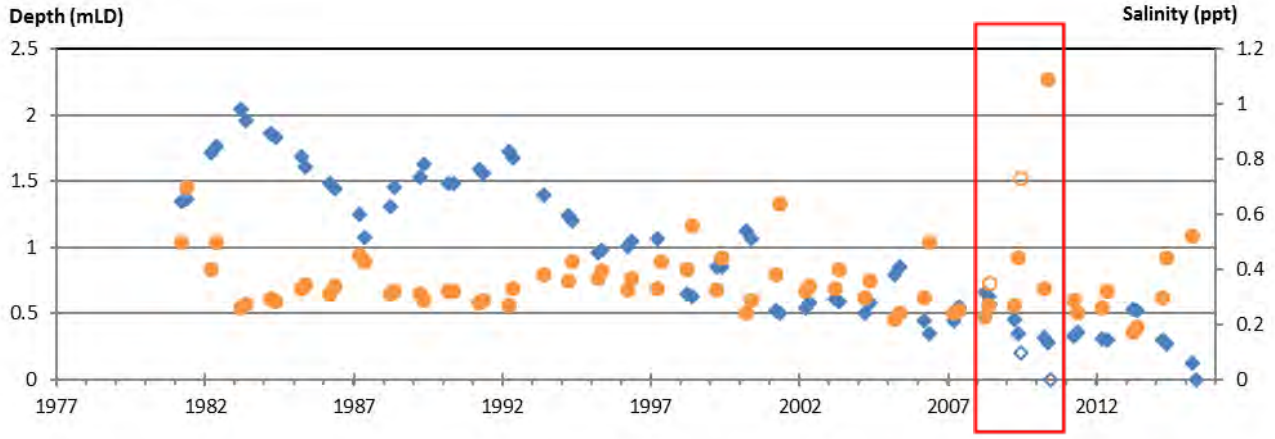
Appendix 1. Continued

FAMILY & SCIENTIFIC NAME	ENGLISH NAME
Rallidae	
Porphyrio porphyrio	Purple Swamphen
Gallirallus philippensis	Buff-banded Rail
Porzana pusilla	Baillon's Crake
Porzana fluminea	Australian Spotted Crake
Porzana tabuensis	Spotless Crake
Gallinula tenebrosa	Dusky Moorhen
Fulica atra	Eurasian Coot
Recurvirostridae	
Himantopus himantopus	Black-winged Stilt
Recurvirostra novaehollandiae	Red-necked Avocet
Cladorhynchus leucocephalus	Banded Stilt
Charadriidae	
Charadrius ruficapillus	Red-capped Plover
Elseyornis melanops	Black-fronted Dotterel
Erythrogonys cinctus	Red-kneed Dotterel
Vanellus miles	Masked Lapwing
Scolopacidae	
Tringa nebularia	Common Greenshank
Tringa glareola	Wood Sandpiper
Calidris acuminata	Sharp-tailed Sandpiper
Calidris ferruginea	Curlew Sandpiper
Laridae	
Sternula nereis	Fairy Tern
Gelochelidon nilotica	Gull-billed Tern
Chlidonias hybrida	Whiskered Tern
Chroicocephalus novaehollandiae	Silver Gull
Acrocephalidae	
Acrocephalus australis	Australian Reed-Warbler
Megaluridae	
Megalurus gramineus	Little Grassbird

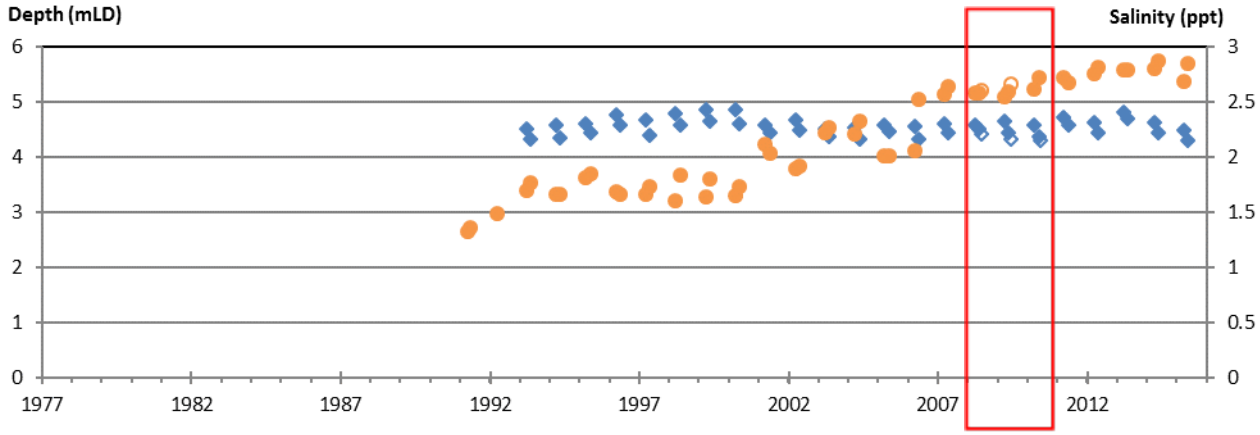
Appendix 2. Depths and salinities of the eleven selected wetlands over the entire period of monitoring by DPaW.

Blue diamonds = depth in metres, surveyed to deepest part of the wetland (mLD = metres Local Datum). Orange dots = salinity in parts per thousand (ppt). Filled symbols denote routinely-collected Sep & Nov data. Empty symbols denote additional data collected during 2008-2011 waterbird surveys of this project. Reb boxes contain the period 1st July 2008 – 30th June 2011, i.e. the (rounded) period of this 'Changing Wetlands' project.

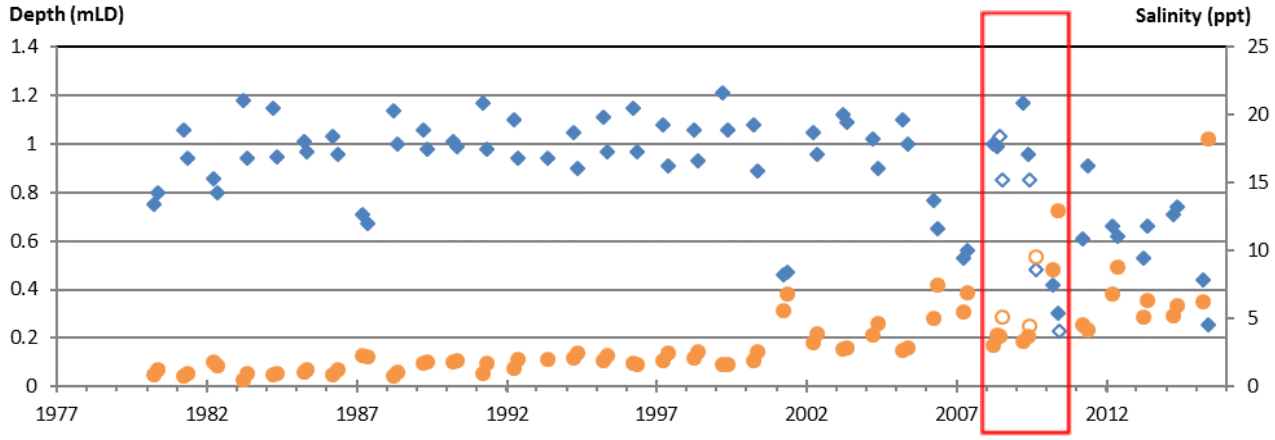
Nine Mile Lake (NINE)



Lake Davies (DAVI)

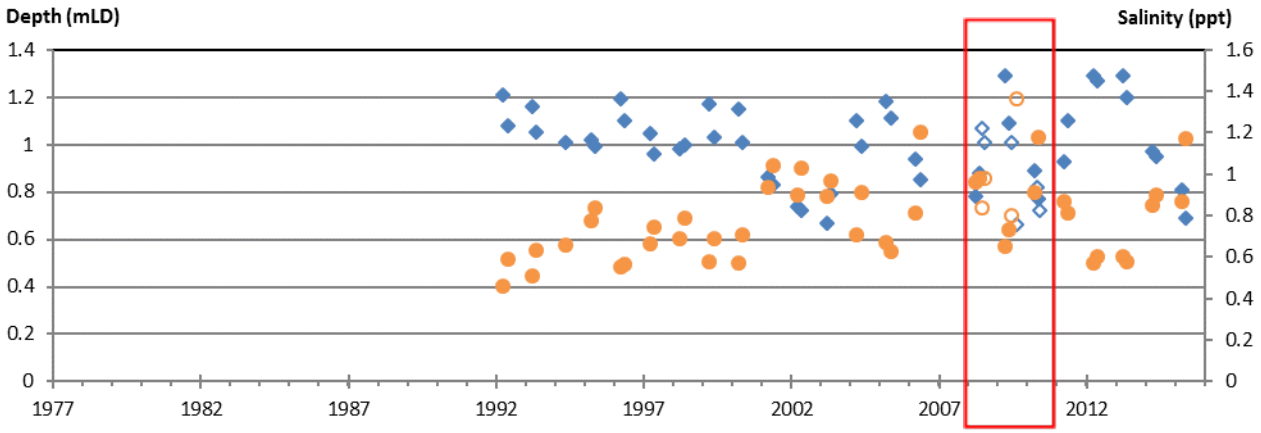


Yarnup Lagoon (YARN)

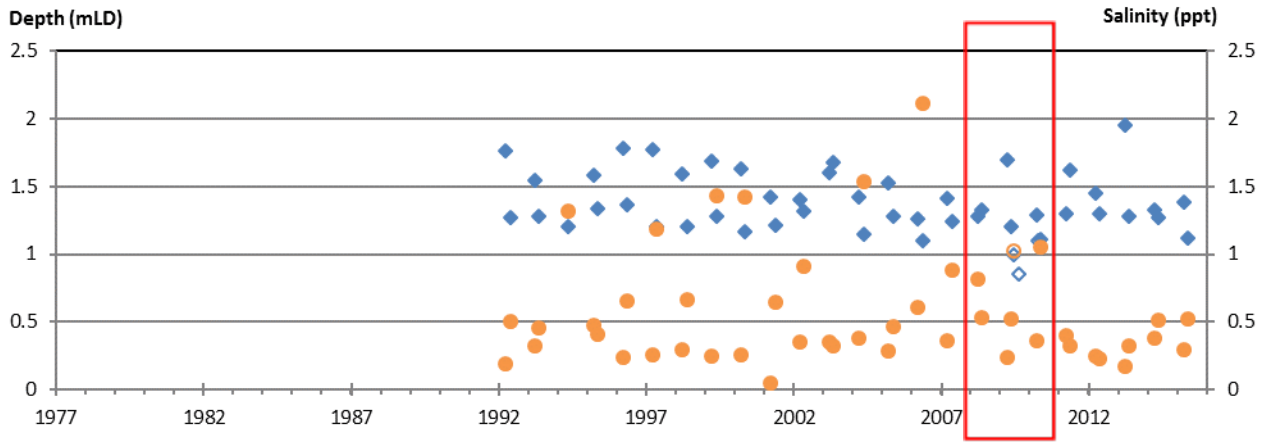


Appendix 2 continued

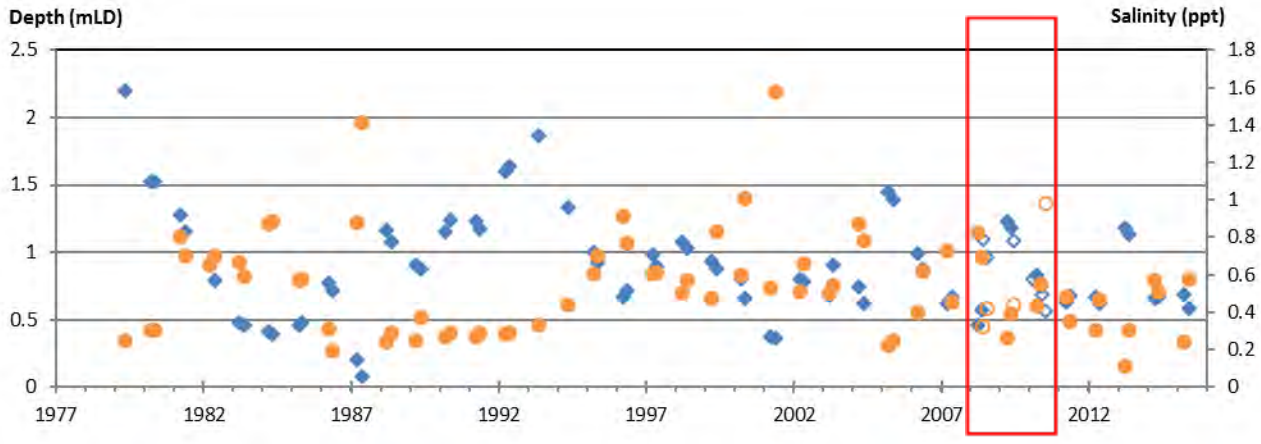
Boat Harbour Lake 1 (BOA1)



Owingup Swamp (OWIN)

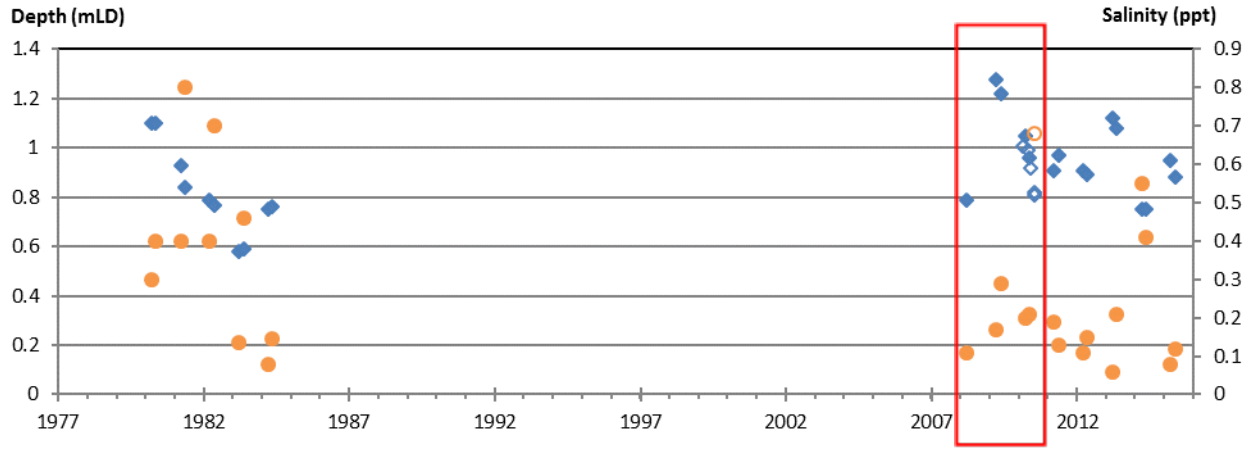


Lake Pleasant View (PLEA)

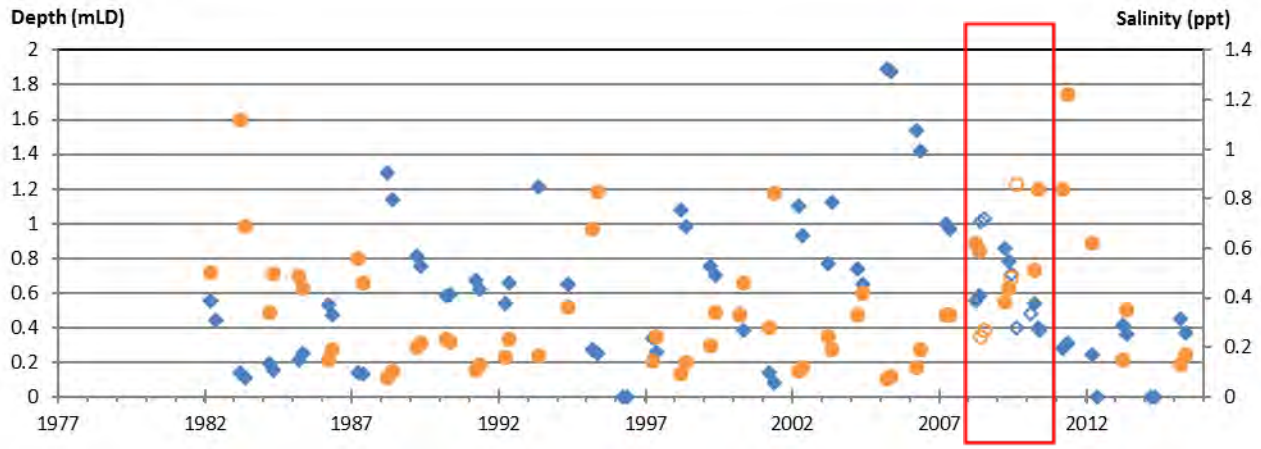


Appendix 2 continued

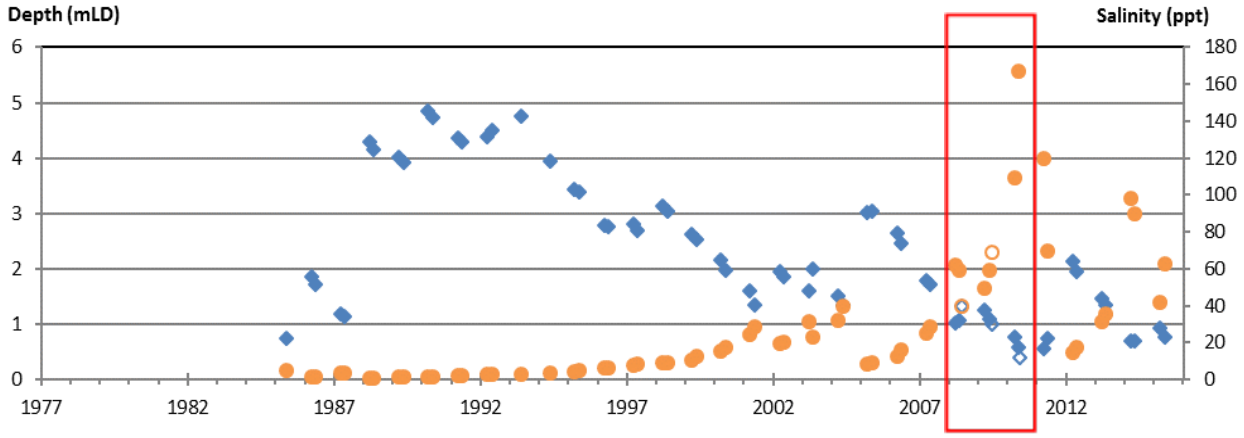
Albany 27157 (ALB2)



Mettler Swamp (METT)

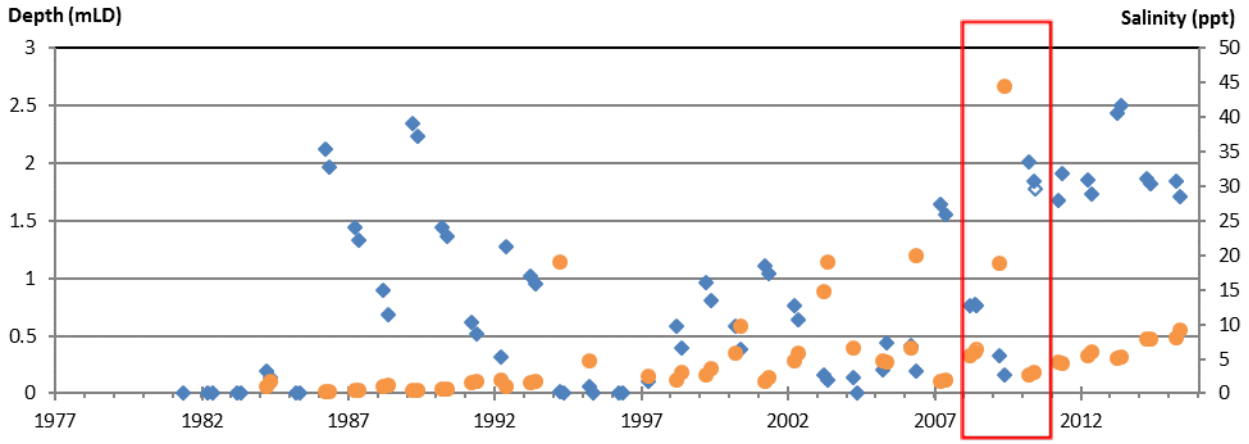


Yellilup Lake (YELL)

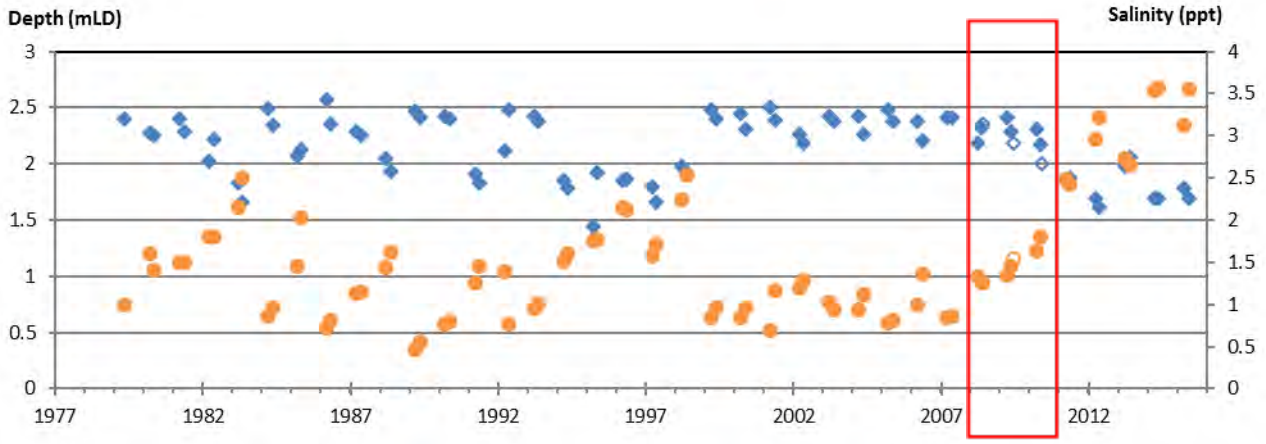


Appendix 2 continued

Esperance Reserve 26410 (ESP1)



Shark Lake (SHAR)



Appendix 3. Summary data sheets, maps and photographs of surveyed wetlands

Nine Mile Lake

Lake Davies

Yarnup Lagoon

Boat Harbour Lake 1

Owingup Swamp

Lake Pleasant View

Albany 27157

Mettler Swamp

Yellilup Lake

Esperance 26410

Shark Lake

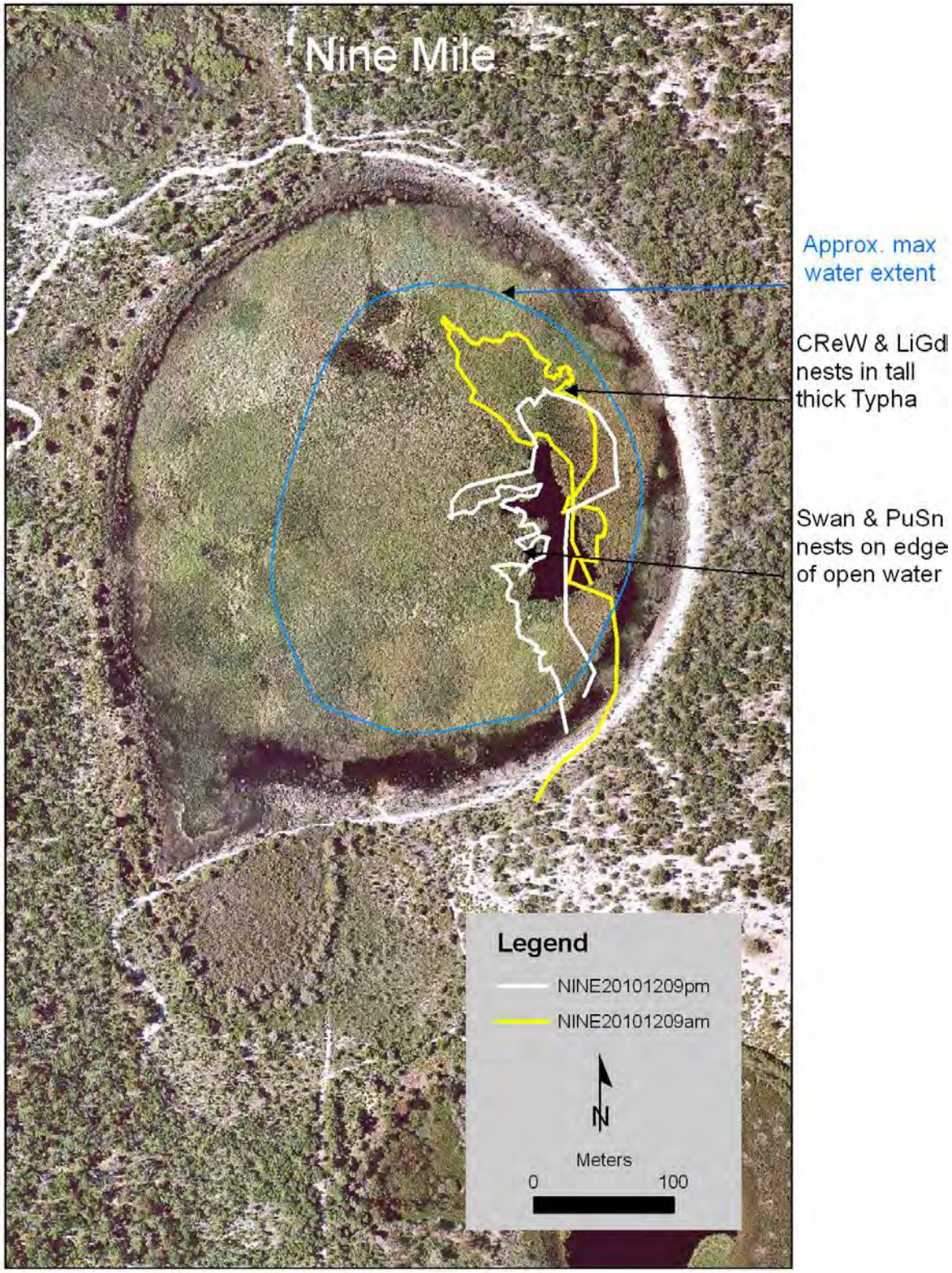
* Lake Maringup (additional to the project, in November 2010)

Nine Mile Lake – survey (09 December 2010) data

	DATA	COMMENTS
Wetland name	Nine Mile Lake (NINE)	Within a nature reserve.
Observers	A Clarke (DPaW).	
Date/s	9 December 2010	
Start & finish time/s	1045hrs – 1345hrs	One break of 1hr 00min
Total duration of survey	2hr 00min	
Weather	Fine, hot and calm.	
% of wetland inundated	1 % (of main basin).	Both satellite swamps were dry.
% of inundated area surveyed	100 %	
Water depth at gauge	Dry at Gauge B.	Only 2cm in open pool.
Survey methods used	Walked on dry mud and through dry *Typha*; intense nest searching.	
Habitats searched for nests	*Typha* beds.	
Change since 1980s/1990s?	Open lake invaded by *Typha* up to 2.5m tall; less water depth than 1980s. Satellite swamps apparently dry for many years.	
Other remarks	Search activities confined to small area near maximum extent of water. Once again lake has received a maximum of 30cm of water.	
Photos taken?	Yes: overview; habitat types; nests found.	
SPECIES	COUNT	COMMENTS
Purple Swamphen	4	
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Black Swan	On edge of open water pool, made of *Typha*.	
Black Swan	On edge of open water pool, made of *Typha* (WPT 172).	
Australian Reed-Warbler ?	2 nests of last year, in tallest thick *Typha*. Nest made of shredded *Typha* (WPT near 167).	
Purple Swamphen	2 nests near edge of pool in open *Typha*, this year (WPT 170, 171).	
Musk Duck/Duck?	This year, in thick, tall *Typha* (WPT 169).	
Australian Reed-Warbler	Two nests, this year in tall dense *Typha*. Made of shredded *Typha* near above (WPT 168).	
Little Grassbird	Two nests, this year, in tallest thick *Typha* (WPT 167 & 173).	

Note: 'WPT'= GPS WayPoint.

Nine Mile Lake – survey (09 December 2010: AM & PM) map



Nine Mile Lake

Swamphen feeding in open water area (AC, 09Dec2010).

Remnant of Black Swan nest (AC, 09Dec2010)

Little Grassbird nests (AC, 09Dec2010)

Australian Reed-Warbler nests (AC, 09Dec2010)

Black Swan nest (AC, 09Dec2010)

Lake Davies – survey (01 December 2010) data

	DATA	COMMENTS
Wetland name	Lake Davies (DAVI).	
Observers	A Clarke (DPaW).	
Date/s	1 December 2010.	
Start & finish time/s	1530hrs – 1624hrs	
Total duration of survey	0hr 54min	
Weather	Fine; mod. SW breeze.	
% of wetland inundated	90 %	
% of inundated area surveyed	Close to 100%	Missed very small areas of sedge.
Water depth at gauge	4.32m.	
Survey methods used	Scan from shore; wading (full circuit); intense nest searching.	
Habitats searched for nests	Low sedge, along inundated and dry edges.	
Change since 1980s/1990s?	Low sedge was more continuous and seemed denser, lacking the separated tussock clumps noted at eastern end in Dec 1991.	
Other remarks		
Photos taken?	Yes: overview; habitat types.	
SPECIES	COUNT	COMMENTS
Hoary-headed Grebe	12	
Pacific Black Duck	29	Black Duck were in wing moult. Any breeding had probably been finished for some time?
Unidentified Crake species	2	
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
None.	Evidence of breeding this season was not found.	

Lake Davies – survey (01 December 2010) map

Lake Davies

Dense low sedge, southern shore, looking east (AC, 01Dec2010)

Southern shoreline, looking west (AC, 01Dec2010)

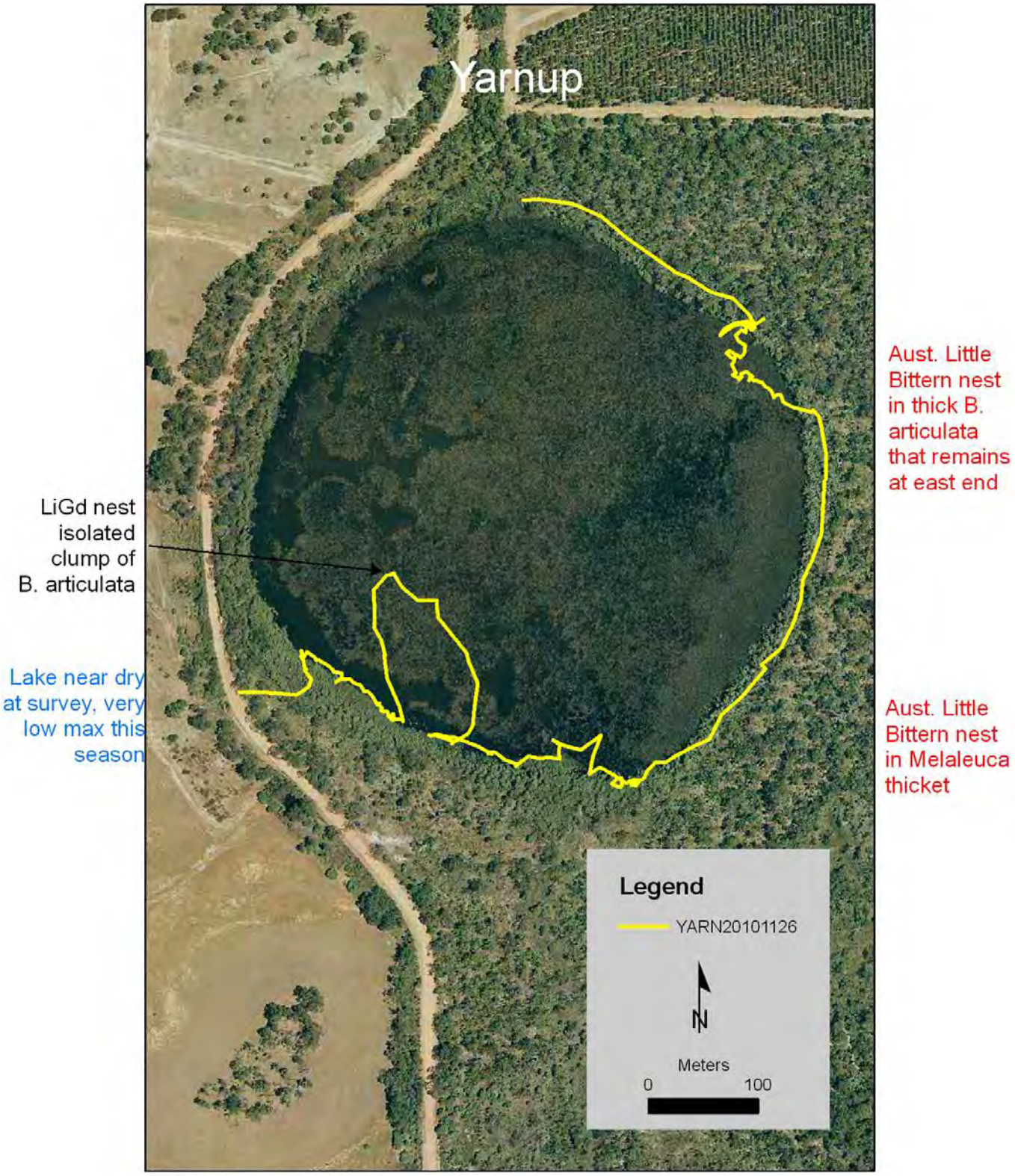
Open low sedge, northern shore, looking east (AC, 01Dec2010)

Yarnup Lagoon – survey (26 November 2010) data

	DATA	COMMENTS
Wetland name	Yarnup Lagoon (YARN).	Within a nature reserve.
Observers	A Clarke (DPaW), Ian Wheeler (DPaW).	
Date/s	26 November 2010	
Start & finish time/s	1445hrs – 1700hrs.	
Total duration of survey	2hr 15min.	
Weather	Fine, calm & warm.	
% of wetland inundated	50 %	
% of inundated area surveyed	30 %	Tall eastern sedge & thickets searched only.
Water depth at gauge	0.23m.	
Survey methods used	Scan from shore; wading; intense nest searching.	
Habitats searched for nests	Shrub thickets; tall sedge; mixed shrubs and sedge.	
Change since 1980s/1990s?	*Melaleuca lateritia* thickets now dead or nearly leafless, throughout site but worst on south side. *Baumea articulata* beds now greatly reduced (>50%) in area. Some dead eucalypts in wetland at edge. Some regeneration of *Melaleuca lateritia* and fine sedge this year.	
Other remarks	Search focused on secretive waterbird nests in *M. lateritia* thicket and tall dense *B. articulata* at east end of wetland.	
Photos taken?	Yes: overview; habitat types; habitat change; nests found.	
SPECIES	COUNT	COMMENTS
Purple Swamphen	8	Including 4 fledged juveniles.
White-faced Heron	17	
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Australian Little Bittern	This season nest made of fine sedge 400mm from lake base in *Melaleuca lateritia* thicket. WPT 143. Photos 381-383.	
Australian Little Bittern	This season nest made of fine *B. articulata* in dense *Ba* close to shore on NW side. YARN10NLB. Photos 384-388.	
[Little Pied Cormorant]	All nests from previous years not used this season.	
Musk Duck	1 nest finished with down & egg shell in very thick *Ba*. Nest was 20m into wetlands from YARN10NLB.	
[Purple Swamphen]	Nests possible in *B. articulata* clumps not searched in middle and western areas of the lake.	
Australian Reed-Warbler	3 nests from this season- finished. All nests in shrub thicket. YARN10N2. Photos 369-371. YARN10N4. WPT 142. Old nests adjacent to active nests.	
Little Grassbird	Finished nest this season in tall *Baumea* clump.	
Unidentified Duck (Musk?)	Large platform unfinished suspended in *Melaleuca lateritia* thicket made of sward sedge. YARN10N1. Photos 364-365	

Note: 'WPT 143', 'YARN10NLB', etc., are the names of GPS WayPoints.

Yarnup Lagoon – survey (26 November 2010) map



Yarnup Lagoon

Extent of water, southern shore (AC, 26Nov2010)

Loss of *B. articulata* density, south shore (AC, 26Nov2010)

Thinning *B. articulata* in southern area (AC, 26Nov2010)

Water extent and *B. articulata* from northern shore (AC, 26Nov2010)

Australian Reed-Warbler nest in *M. lateritia* near south shore (AC, 26Nov2010)

M. lateritia in poor condition, south shore (AC, 26Nov2010)

Yarnup Lagoon – Continued

Little Bittern nest platform (AC, 26Nov2010)

Little Bittern nest construction (AC, 26Nov2010)

An active Little Grassbird nest in tall dense
B. articulata clump near southern shore (AC, 26Nov2010)

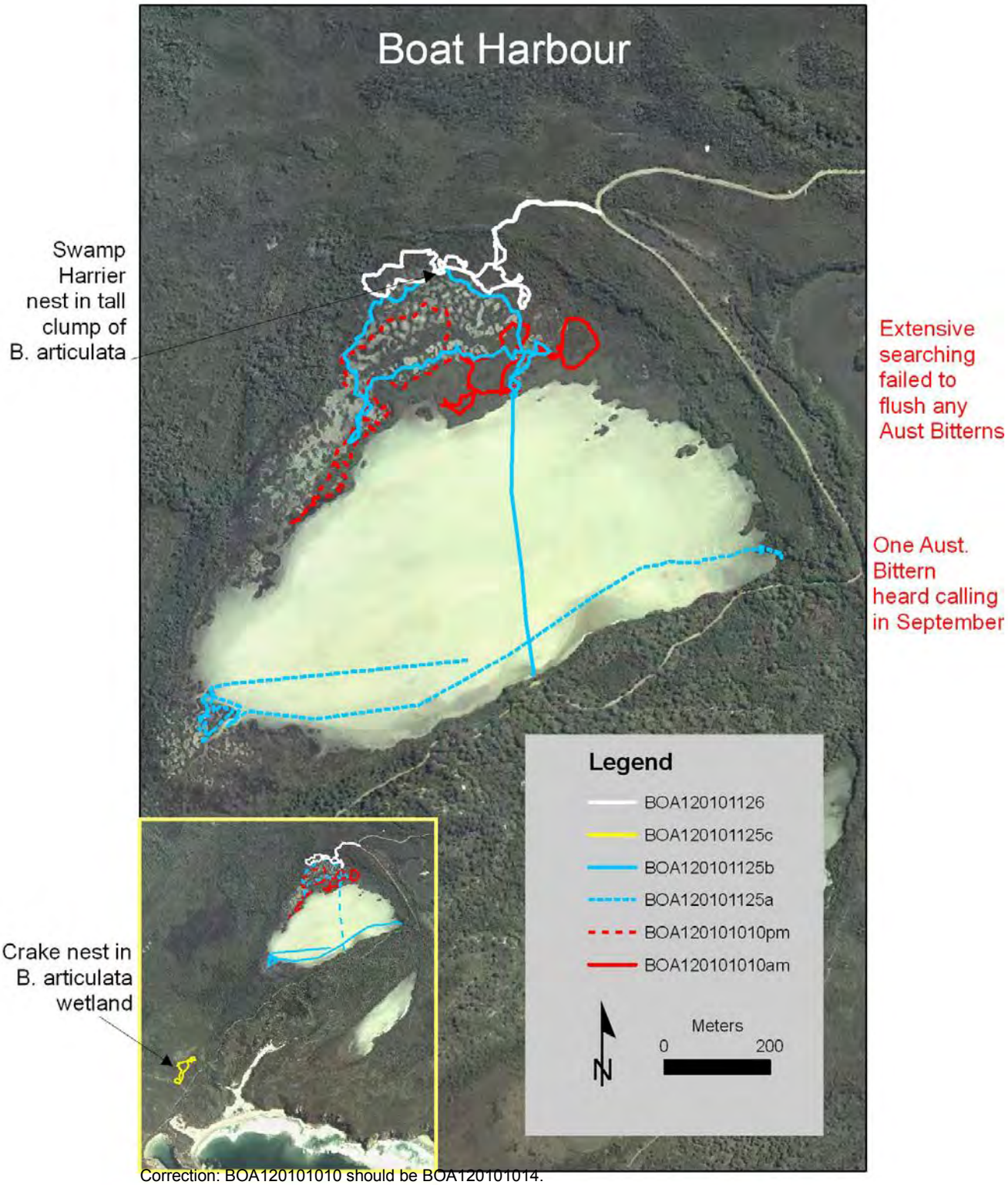
Boat Harbour Lake 1 – first survey (14 October 2010) data

	DATA	COMMENTS
Wetland name	Boat Harbour Lake 1 (BOA1)	Within a nature reserve.
Observers	A Clarke (DPaW), Renee … (DPaW).	
Date/s	14 October 2010.	
Start & finish time/s	11h05hrs – 1630hrs.	1hr 00min break taken.
Total duration of survey	4hr 25min.	
Weather	Overcast; strong south wind.	
% of wetland inundated	Probably close to 80 %.	
% of inundated area surveyed	North east area only.	Focus on searching for nests.
Water depth at gauge	0.82m.	
Survey methods used	Scan from shore; wading; intense nest searching; boating on lake to access north area; listening for calling Bitterns at night abandoned due to strong winds.	
Habitats searched for nests	Mixed tall sedge, low sedge and *Gahnia* tussocks; *Melaleuca* shrub/tree thickets.	
Change since 1980s/1990s?	No change evident. *Typha* not noticeably more extensive. Areas of burnt (dead?) *Agonis* trees in far NE and SE corners of wetland.	
Other remarks	Survey focused on secretive birds and their nests. Other waterbirds were not recorded.	
Photos taken?	Yes: overview; habitat types and possible Bittern activity.	
SPECIES	COUNT	COMMENTS
Bitterns and crakes not seen or heard.		
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
No secretive bird nests found.		

Boat Harbour Lake 1 – second survey (25-26 November 2010) data

	DATA	COMMENTS
Wetland name	Boat Harbour Lake 1 (BOA1)	Within a nature reserve.
Observers	A Clarke (DPaW), John Graff.	
Date/s	25 & 26 November 2010.	
Start & finish time (Day 1)	1100hrs – 1930hrs.	Two breaks taken. Survey duration is 3hr 30min.
Start & finish time (Day 2)	0950hrs – 1120hrs.	Survey duration is 1hr 30min.
Total duration of survey	5hr 00min.	Incl. 1h 30m listening at night.
Weather	Overcast; strong S wind.	Not ideal listening conditions.
% of wetland inundated	Presume 80 %.	Outer limits not surveyed.
% of inundated area surveyed	Approximately 60 %.	Whole of open lake, part of swamp.
Water depth at gauge	0.72m.	
Survey methods used	Scan from shore; wading; intense nest searching; boating to access sedgeland; listening for calling Bitterns at night.	
Habitats searched for nests	Mixed tall sedge, low sedge and *Gahnia* tussocks.	
Change since 1980s/1990s?	See previous report.	
Other remarks	Bittern calls were not heard, but conditions were poor. *Gambusia* present & lots of frogs.	
Photos taken?	Yes: Bittern habitat & possible activity; nests found.	
SPECIES	COUNT	COMMENTS
Fairy Tern	5	
Silver Gull	3	
Gull-billed Tern	1	
Pacific Black Duck	c. 16	Approximate numbers.
Australian Pelican	5	
Little Pied Cormorant	6	
Black Swan	13	
Hoary-headed Grebe	5	
Little Black Cormorant	8	
Purple Swamphen	2	
Australian Shelduck	3	
Spotless Crake	c. 5	Approximate numbers.
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Swamp Harrier	Active with two newly hatched chicks and one egg. Tall dense clump of *B. articulata* with fine sedge in NE area. Photos 357-362.	
Crake species?	This season's nest - finished. Made of fine sedge in dense *Baumea* located in southern detached wetland. WPT 126. Photos 340-344.	

Boat Harbour Lake 1 – surveys (14 October & 25-26 November 2010) map



Correction: BOA120101010 should be BOA120101014.

Boat Harbour Lake 1

Low fine sedge where AusBs were flushed in previous years, mostly dry (AC, 25Nov2010).

Aus. Bittern feeding habitat, dry this year (AC 25Nov2010

Aus. Bittern feeding habitat when shallow (AC, 26Nov2010)

Feeding platform with 'gilgie' claw (AC, 26Nov2010)

Unidentified crake nest in *B. articulata* clump with fine sedge (AC, 25Nov2010)

Boat Harbour Lake 1 – Continued

Swamp Harrier nest in dense *B. articulata* clump (AC, 26Nov2010)

Swamp Harrier nest in dense *B. articulata* clump (AC, 26Nov2010

Predated tortoise eggs (AC, 25Nov2010))

Owingup Swamp– first survey (13 October 2010) data

	DATA	COMMENTS
Wetland name	Owingup Swamp (OWIN)	Within a nature reserve.
Observers	A Clarke (DPaW) & Renee …	
Date/s	13 October 2010	
Start & finish time/s	1045hrs – 1400hrs.	
Total duration of survey	3hr 15min	
Weather	Strong southerly gale.	
% of wetland inundated	90 %	
% of inundated area surveyed	20%	
Water depth at gauge	Approx. 1.1m.	
Survey methods used	Flushing along shore north of gauge for 300m; wading; intense nest searching.	
Habitats searched for nests	Tall sedge; mixed shrubs/trees and sedge.	
Change since1980s/1990s?	*Typha* has been introduced & now large areas exist in the southern sedge areas.	
Other remarks	Survey concentrated on recording Bitterns and nesting species only.	
Photos taken?	No: Camera later stolen.	
SPECIES	COUNT	COMMENTS
Swamp Harrier	1 adult	
Australasian Bittern	1	Flushed from moderate density *B. articulata* north of gauge. OWINABOCT10.
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Swamp Harrier	Nest with two eggs in tall dense clump of *B. articulata.* OWINSWMPHR.	

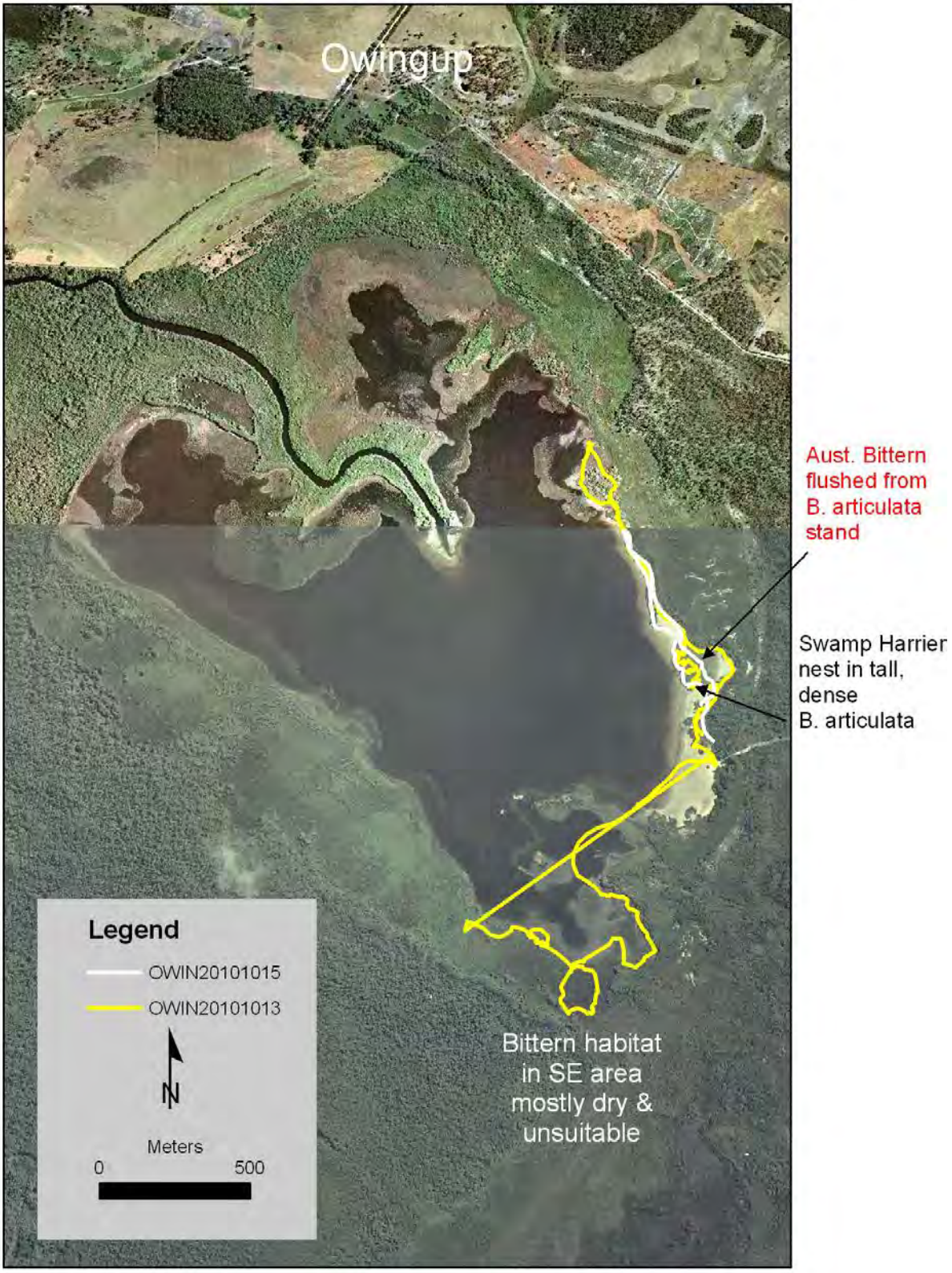
Note: 'OWINABOCT10' and 'OWINSWMPHR' are the names of GPS WayPoints.

Owingup Swamp– second survey (15 October 2010) data

	DATA	COMMENTS
Wetland name	Owingup Swamp (OWIN)	Within a nature reserve.
Observers	A Clarke (DPaW), Carol Ebbett (DPaW), Janine Liddelow (DPaW)	
Date/s	15 October 2010	
Start & finish time/s	1035hrs – 1135hrs.	
Total duration of survey	1hr 00min	
Weather	Fine. Low wind.	
% of wetland inundated	90 %	
% of inundated area surveyed	10%	
Water depth at gauge	Approx. 1.1m.	
Survey methods used	Brief searches (by wading) for nests at selected sites, including tall sedge. Boat not used.	
Habitats searched for nests	Tall sedge; mixed shrubs/trees and sedge.	
Change since1980s/1990s?	*Typha* has been introduced & now large areas exist in the southern sedge areas.	
Other remarks	Survey concentrated on recording Bitterns and nesting species only.	
Photos taken?	No: Camera later stolen.	
SPECIES	COUNT	COMMENTS
Swamp Harrier	1 adult	
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Swamp Harrier	Nest with three eggs in tall dense clump of *B. articulata*. OWINSWMPHR.	

Note: 'OWINSWMPHR' is the name of a GPS WayPoint.

Owingup Swamp – survey (13 October 2010) map



Lake Pleasant View – first survey (10 & 12 August 2010) data

	DATA	COMMENTS
Wetland name	Lake Pleasant View (PLEA)	Within a nature reserve.
Observers	A Clarke (DPaW)	
Date/s	10 & 12 August 2010	
Start & finish time/s (Day 1)	1100hrs – 1225hrs	Survey duration 1hr 25min.
Start & finish time/s (Day 2)	0900hrs – 1035hrs	Survey duration 1hr 35min.
Total duration of survey	3hr 00min	
Weather	Fine, cool; light wind.	
% of wetland inundated	80 %	
% of inundated area surveyed	20 %	East & West side wade only.
Water depth at gauge	0.80m (10th August).	
Survey methods used	Wading through low rush to flush Bitterns.	
Habitats searched for nests	Limited nest searching done due to time of year.	
Change since 1980s/1990s?	No change evident other than possible increase in extent of *Melaleuca* shrubs on outer N side. Some introduced Pampas Grass (*Cortaderia selloana*) clumps	
Other remarks	Survey focused on presence or absence of Australasian Bitterns by wading through shallow water along both east & west sides.	
Photos taken?	Yes: flushing site & habitat types.	
SPECIES	COUNT	COMMENTS
Australasian Bittern	1, 10 Aug.	Flushed from GPS location PLEAAB100810 in 28cm water, low rush, Photos 1-3.
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Limited nest searching done.		

Lake Pleasant View – second survey (19-20 October 2010) data

	DATA	COMMENTS
Wetland name	Lake Pleasant View (PLEA)	Within a nature reserve.
Observers	A Clarke (DPaW)	
Date/s	19 & 20 October 2010	
Start & finish time/s (Day 1)	1835hrs – 2045hrs	Listening only. Survey duration 2hr 10min.
Start & finish time/s (Day 2)	0940hrs – 1740hrs	Includes two breaks totalling 3hr 15min. Survey duration 4hr 45min.
Total duration of survey	6hr 55min	Includes 40 mins evening listening.
Weather	Stormy, variable winds.	Good listening conditions
% of wetland inundated	At least 80 %	
% of inundated area surveyed	Approximately 20 %	Confined to wading near shore.
Water depth at gauge	0.76m.	
Survey methods used	Scan from shore; wading; nest searching; listening for calling Bitterns at night.	
Habitats searched for nests	Mixed tall sedge and low sedge.	
Change since 1980s/1990s?	No change evident other than possible increase in extent of *Melaleuca* shrubs on outer N side. Some introduced Pampas Grass (*Cortaderia selloana*) clumps.	
Other remarks	Survey focused on flushing Bitterns and finding their nests.	
Photos taken?	Yes: overview; habitat types, nests.	
SPECIES	COUNT	COMMENTS
Australasian Bittern	One,19 Oct.	Heard calling from southern shore in tall *B. articulata*.
Australasian Bittern	One, 20 Oct.	Flushed from low rush surrounded by *B*. articulata, PLEAAB201010.
Australian Little Bittern	One, 19 Oct.	Heard calling from southern shore in tall *B. articulata* near edge.
Purple Swamphen	1	
Little Grassbird	1	Heard only.
Musk Duck	1	Heard only.
Australian Reed-Warbler	1	Heard only.
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Musk Duck	Old nest in tall *B. articulata* with fine sedge, WPT 101.	

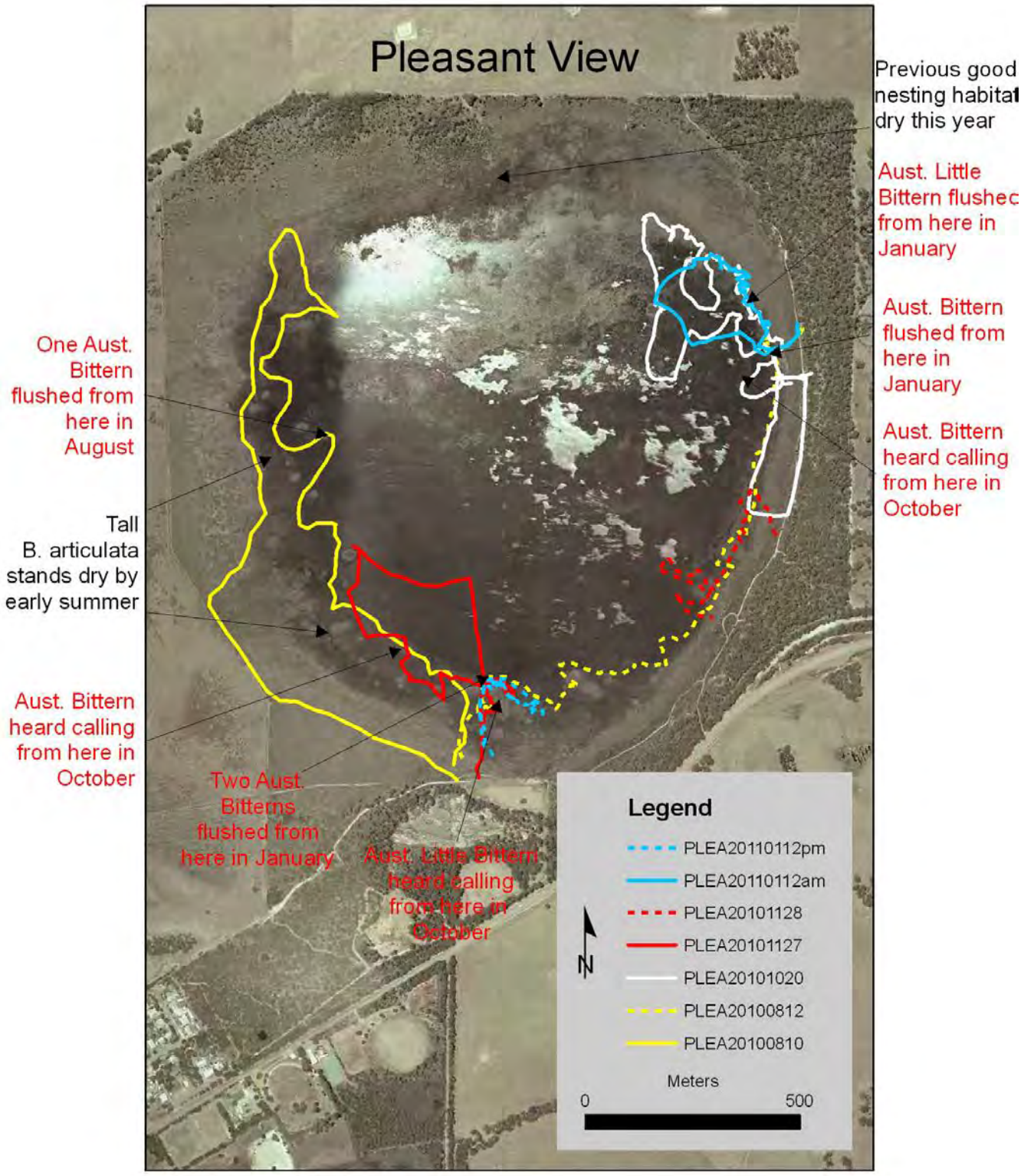
Lake Pleasant View – third survey (27-28 November 2010) data

	DATA	COMMENTS
Wetland name	Lake Pleasant View (PLEA).	Within a nature reserve.
Observers	A Clarke (DPaW).	
Date/s	27 & 28 November 2010.	
Start & finish time/s (Day 1)	1650hrs – 1930hrs.	1hr 15min break taken. Survey duration 1hr 25min.
Start & finish time/s (Day 2)	0950hrs – 1045hrs.	Survey duration 0hr 55min.
Total duration of survey	2hr 20min	Includes 45 mins evening listening.
Weather	Overcast; strong south wind.	Poor listening conditions.
% of wetland inundated	At least 80 %.	
% of inundated area surveyed	Approximately 10 %.	Shallow low sedge areas.
Water depth at gauge	0.69m..	
Survey methods used	Scan from shore; wading; intense nest searching; listening for calling Bitterns at night.	
Habitats searched for nests	Mixed tall sedge and low sedge.	
Change since 1980s/1990s?	No change evident other than possible increase in extent of *Melaleuca* shrubs on outer N side. Some introduced Pampas Grass (*Cortaderia selloana*) clumps.	
Other remarks	Low water seemed to have reduced waterbird numbers.	
Photos taken?	Yes: overview; habitat types, nests.	
SPECIES	COUNT	COMMENTS
Australasian Bittern	One, 28 Nov.	Heard once. Called from near logger.
Purple Swamphen	2	1 flushed, 1 heard.
Little Grassbird	2	Heard calling around lake.
Musk Duck	1	
Spotless Crake	2	Heard calling around lake.
Swamp Harrier	1	Flushed from sedge platform.
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Little Grassbird	Nest with 4 eggs in *Baumea articulata* clump in middle of lake. Used Aust. Bittern feather in nest. WPT 152, Photos 442-448.	

Lake Pleasant View – fourth survey (12 January 2011) data

	DATA	COMMENTS
Wetland name	Lake Pleasant View (PLEA)	Within a nature reserve.
Observers	A Clarke (DPaW); John Graff & Susan Abbotts.	
Date/s	12 January 2011	
Start & finish time/s	0950hrs – 1615hrs.	2hr 45min break taken.
Total duration of survey	3hr 40min	
Weather	Fine, strong SE wind.	
% of wetland inundated	At least 70 %.	
% of inundated area surveyed	Approximately 20 %.	Searched mixed sedge areas near shore.
Water depth at gauge	0.56m.	
Survey methods used	Scan from shore; wading; intense nest searching.	
Habitats searched for nests	Mixed tall sedge and low sedge.	
Change since 1980s/1990s?	No change evident other than possible increase in extent of *Melaleuca* shrubs on outer N side. Some introduced Pampas Grass (*Cortaderia selloana*) clumps.	
Other remarks	Concentrated nest searching for Bitterns in areas of previous calls.	
Photos taken?	Yes: overview; habitat types, nests.	
SPECIES	COUNT	COMMENTS
Australasian Bittern	1	Flushed from 20cm of water in low sedge, near shore on east side.
Australian Little Bittern	1	Flushed from tall dense *Baumea articulata* on east side.
Australasian Bittern	2, during afternoon wade.	Flushed from 20cm of water in low sedge against tall sedge, on south side. Adult and fledged young.
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Australasian Bittern	Robust nest of *Baumea articulata* & fine sedge in tall *B. articulata*. Nest was suspended, 30 x 35cm and 15cm thick in 15cm water. WPT 182 Photos 702-707. Second nest with similar dimensions. Photos 708-722.	
Purple Swamphen	This season nest, further out into wetland in open *B. articulata*. WPT 183. Photos 723-728.	
Musk Duck	Finished nest with egg shell & down in tall dense *B. articulata.* WPT 185. Photos 735-736.	
Purple Swamphen	This season nest in open *B. articulata* near Australasian Bittern flush site. Photos 737.	

Lake Pleasant View – surveys (10 & 12 Aug, 19-20 Oct, 27-28 Nov 2010, 12 Jan 2011) map

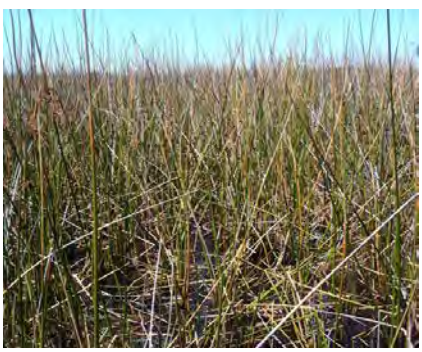


Lake Pleasant View


Southern shore, site of two flushed Australasian Bittern (adult & young) (AC, 12Jan2011)


Eastern shore, site of flushed Australasian Bittern (AC, 12Jan2011)


Western shore, site of flushed Australasian Bittern, and feeding platform (AC, 10Aug2010)



Aus. Bittern nest #1 site in *B. articulata*


Australasian Bittern nest #1 (AC, 12Jan2011)

Lake Pleasant View — Continued

Australasian Bittern nest #2 site in *B. articulata*

Australasian Bittern nest #2 (AC, 12Jan2011)

Swamphen nest in *B. articulata*

Purple Swamphen nest (AC, 12Jan2011)

Little Grassbird nest
(AC, 28Nov2010)

Musk Duck nest in *B. articulata* clump (AC, 12Jan2011)

Albany 27157 (Cheyne Road Nature Reserve) – first survey (11 August 2010) data

	DATA	COMMENTS
Wetland name	Cheyne Road (ALB2)	Within a nature reserve.
Observers	A Clarke (DPaW), Saul Cowen (DPaW Albany).	
Date/s	11 August 2010.	
Start & finish time/s	1340hrs – 1600hrs	
Total duration of survey	2hr 20min	
Weather	Fine; light breeze.	
% of wetland inundated	80 %	
% of inundated area surveyed	40%	
Water depth at gauge	1.005m (adjusted gauge 'A' reading after resurvey in April 2011).	
Survey methods used	Scan from shore; wading/flushing.	
Habitats searched	Low sedge.	
Change since 1980s/1990s?	Investigation of 1979 photos showed little change.	
Other remarks	Survey focused on flushing Bitterns in the low sedge shallows.	
Photos taken?	Yes: overview; habitat types.	
SPECIES	COUNT	COMMENTS
Australian White Ibis	1 (dead)	South shore in low sedge-30cm of water.
Australasian Bittern	1	Flushed from NE corner in 15cm of water sheltering in 1m tall sedge close to shore. CHEYAB110810.

NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF
Nesting habitat was not searched.	

Note: 'CHEYAB110810' is the name of a GPS WayPoint.

Albany 27157 (Cheyne Road NR) – second survey (21 October 2010) data

	DATA	COMMENTS
Wetland name	Cheyne Road (ALB2)	Within a nature reserve.
Observers	A Clarke (DPaW).	
Date/s	21 October 2010.	
Start & finish time/s	1115hrs – 1700hrs	1hr 40min break taken.
Total duration of survey	4hr 05min	
Weather	Fine; light breeze.	
% of wetland inundated	80 %	
% of inundated area surveyed	50%	
Water depth at gauge	1.03m.	
Survey methods used	Scan from shore; wading; intense nest searching.	
Habitats searched for nests	Tall sedge.	
Change since 1980s/1990s?	Investigation of 1979 photos showed little change.	
Other remarks	Concentrated on tall *Baumea articulata* near two calling Australasian Bitterns.	
Photos taken?	Photos lost in subsequently stolen camera.	
SPECIES	COUNT	COMMENTS
Australasian Bittern	2	Heard calling from southern *Baumea* near eventual nest and the other in northern tall *Baumea*.
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Australasian Bittern platform	Small robust platform found at calling Bittern site. Possible feeding platform, near eventual nest.	

Albany 27157 (Cheyne Road NR) – third survey (26-27 November 2010) data

	DATA	COMMENTS
Wetland name	Cheyne Road (ALB2)	Within a nature reserve.
Observers	A Clarke (DPaW)	
Date/s	26 & 27 November 2010.	
Start & finish time/s (Day 1)	1930hrs – 2000hrs	Evening listening only
Start & finish time/s (Day 2)	0930hrs – 1430hrs.	1hr 30min break taken
Total duration of survey	4hr 00min	
Weather	Fine; light breeze.	
% of wetland inundated	70 %	
% of inundated area surveyed	80%	
Water depth at gauge	0.96m.	
Survey methods used	Scan from shore; wading; intense nest searching.	
Habitats searched for nests	Tall sedge.	
Change since 1980s/1990s?	Investigation of 1979 photos showed little change.	
Other remarks	Comprehensive survey conducted.	
Photos taken?	Yes: overview; habitat types; nests found.	
SPECIES	COUNT	COMMENTS
Purple Swamphen	2	
Musk Duck	1	Heard only
Swamp Harrier	3	Inc. one near fledged young.
Australasian Bittern	1	1 boom heard @ 0952 hrs.
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Musk Duck	Finished nest with down & egg shell in tall clump of *B. articulata*, near WPT 147.	
Purple Swamphen	Finished nest in open *B. articulata.* Nest of fine sedge. WPT 144. Photos 394-396.	
Purple Swamphen	Finished nest with feathers in open *B. articulata.* Nest of fine sedge in oval shape. WPT 146. Photos 415-419	
Purple Swamphen	Finished nest in open *B. articulata.* Nest of fine sedge. Photos 430-431.	
Crake	Nest made of fine sedge under old Swamphen nest. Near WPT 144. Photos 397-399.	
Australian Reed-Warbler	Nest with four eggs in tall *B. articulata* clump. Photos 402-405.	
Little Grass Bird	Nest with one egg in tall *B. articulata* clump. Photos 408-410.	
Swamp Harrier	Nest with one near-fledged young in tall dense *B. articulata.* WPT 147. Photos 422-429.	
Australian Little Bittern?	Rough platform 15cm diameter in tall dense *B. articulata* clump. Most likely a nest of this species. WPT 145. Photos 411-414.	

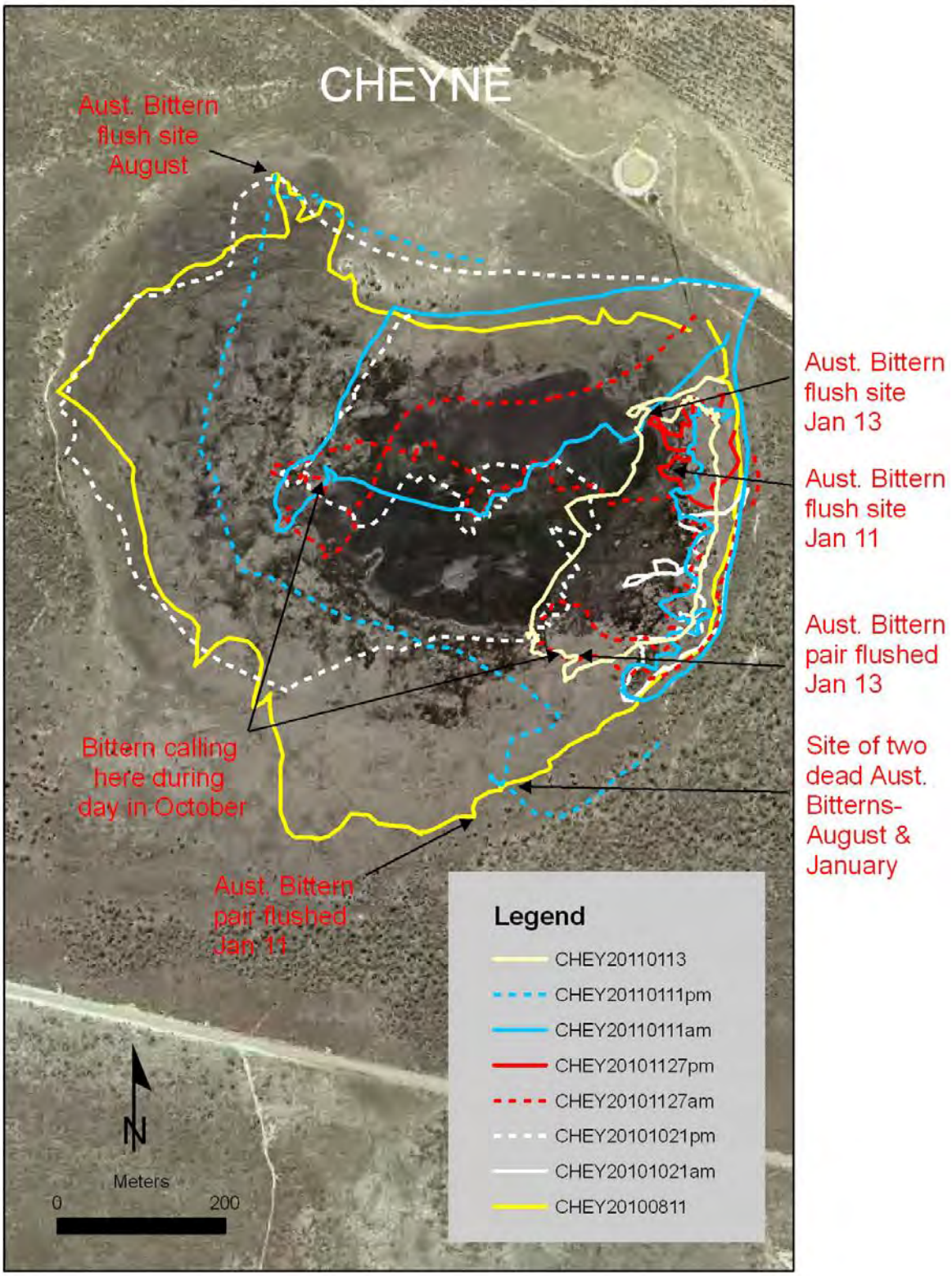
Albany 27157 (Cheyne Rd NR) – fourth survey (10-11 January 2011) data

	DATA	COMMENTS
Wetland name	Cheyne Road (ALB2)	Within a nature reserve.
Observers	A. Clarke (DPaW), John Graff, Susan Abbotts, Tony Bush & Anne Bondin	
Date/s	10 & 11 January 2011	
Start & finish time/s (Day 1)	2010hrs – 2130hrs	Listening only. Poor conditions. Survey duration 1hr 20min.
Start & finish time/s (Day 2)	0800hrs – 1445hrs	1hr break taken. Survey duration 5hr 45min.
Total duration of survey	7hr 05min	
Weather	Cloudy & strong wind.	
% of wetland inundated	60 %	
% of inundated area surveyed	90%	
Water depth at gauge	0.86m.	
Survey methods used	Scan from shore; wading; intense nest searching.	
Habitats searched for nests	Tall sedge.	
Change since 1980s/1990s?	Investigation of 1979 photos showed little change.	
Other remarks	The species counts are the minimum number present.	
Photos taken?	Yes: overview; habitat types; nests found.	
SPECIES	COUNT	COMMENTS
Purple Swamphen	1	Heard only
Dusky Moorhen	1	
Australasian Bittern	1	Flushed from tall *B. articulata*-east shore near open water. WPT 175
Australasian Bittern	2	Flushed from west shore in low sedge-10cm of water.
Australasian Bittern	1 (freshly dead)	Predated by Swamp Harrier. WPT 178. Photos 680-695.
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Australian Reed-Warbler	Nest with one egg in tall dense *B. articulata*. WPT 176.	
Australian Reed-Warbler	Nest with one egg in tall dense *B. articulata*. WPT 177.	

Albany 27157 (Cheyne Road NR) – fifth survey data (13 January 2011) data

	DATA	COMMENTS
Wetland name	Cheyne Road (ALB2)	Within a nature reserve.
Observers	A Clarke (DPaW)	
Date/s	13 January 2011.	
Start & finish time/s	0930hrs – 1155hrs.	
Total duration of survey	2hrs 25min.	
Weather	Fine, moderate SE wind.	
% of wetland inundated	60 %	
% of inundated area surveyed	40%	
Water depth at gauge	0.85m.	
Survey methods used	Scan from shore; wading; intense nest searching.	
Habitats searched for nests	Tall sedge.	
Change since 1980s/1990s?	Investigation of 1979 photos showed little change.	
Other remarks	Focus on finding Bittern nest in *Baumea articulata* of eastern area.	
Photos taken?	Yes: overview; habitat types; nests found.	
SPECIES	COUNT	COMMENTS
Purple Swamphen	4	
Swamp Harrier	2	
Australasian Bittern	2	Flushed from open tall *Baumea articulata* near nest. WPT 187. Photos 739-741.
Australasian Bittern	1	Probable Juvenile flushed from feeding platform in open *Baumea articulata* WPT 189. Photos 771-773.
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Australasian Bittern	This season's nest had fallen on itself. Constructed of short heavy pieces of *Baumea articulata* and fine sedge. Edge of nest still woven in place. WPT 188. Photos 766-768. Two small feeding platforms found near nest and an additional large feeding platform with a frog carcass.	
Australian Little Bittern	This season's nest. Roughly constructed platform (15x20cm and 10cm deep), located 0.7m from water at time of survey.	

Albany 27157 (Cheyne Road NR) – survey (11 Aug, 21 Oct, 26-27 Nov 2010 and 10-11 Jan, 13 Jan 2011) map



Albany 27157 (Cheyne Road NR)

Australasian Bittern flush site (AC, 11Aug2010)

Aus. Bittern feeding platform (AC, 13Jan2011)

Aus. Bittern nest site in *B. articulata* (AC, 13Jan2011)

Aus. Bittern feeding platform (WPT 189) (AC, 13Jan2011)

Bittern survey with volunteers (AC, 11Jan2011)

Australasian. Bittern nest (AC, 13Jan2011)

Collapsed Australasian Bittern nest (AC, 13Jan2011)

Aus. Bittern feeding platform and frog carcass (AC, 13Jan2011)

Aus. Bittern feeding platform and frog carcass (AC, 13Jan2011)

Albany 27157 (Cheyne Road NR) – Continued



Australasian Bittern carcass from which Swamp Harrier was flushed (AC, 11Jan2011)

Australian Little Bittern nest
(AC, 27Novn2010)


Australian Little Bittern nest
(AC, 13Jan2011)


Swamp Harrier chick on nest
(AC, 27Nov2010

Albany 27157 (Cheyne Road NR) – Continued

Purple Swamphen nest site
(AC, 27Nov2010)

Purple Swamphen nest
(AC, 27Nov2010)

Aus. Reed-Warbler nest #1
(AC, 27Nov2010)

Australian Reed-Warbler nest #1 with eggs
(AC, 27Nov2010)

Aus. Reed-Warbler nest #2
(AC, 11Jan2010)

Aus. Reed-Warbler nest #2
(AC, 11Jan2010)

Australian Reed-Warbler nest #2 with egg
(AC, 11Jan2010)

Little Grassbird nest
(AC, 27Nov2010)

Mettler Swamp – first survey (11 August 2010) data

	DATA	COMMENTS
Wetland name	Mettler Lake (METT)	Within a nature reserve.
Observers	A Clarke (DPaW), Saul Cowen (DPaW Albany).	
Date/s	11 August 2010	
Start & finish time/s	1000hrs – 1145hrs	
Total duration of survey	1hr 45mins	
Weather	Fine, light breeze	
% of wetland inundated	Approx. 70%	
% of inundated area surveyed	Approx. 20 %	All open water; part of dense vegetation.
Water depth at gauge	0.48m.	*Gahnia* tussock area was dry.
Survey methods used	Wading; only brief searches at selected areas to assess potential as AusB habitat.	
Habitats searched for nests	Tall sedge.	
Change since 1980s/1990s?	No change evident.	
Other remarks	Search focused on investigating previously unvisited habitat.	
Photos taken?	Yes: habitat types; nests found.	
SPECIES	COUNT	COMMENTS
No waterbirds were flushed		
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
No active nests found		

Note: **A listening survey only was conducted at Mettler on 21 October 2010** from 1845hrs to 1920hrs. One Australian Little Bittern was heard calling regularly.

Mettler Swamp – second survey (08 November 2010) data

	DATA	COMMENTS
Wetland name	Mettler Lake (METT)	Within a nature reserve.
Observers	A Clarke (DPaW)	
Date/s	8 November 2010	
Start & finish time/s	1000hrs – 1130hrs.	
Total duration of survey	1hr 30min.	Listening not conducted.
Weather	Windy.	
% of wetland inundated	40 %	
% of inundated area surveyed	50 %	
Water depth at gauge	0.40m.	Very little standing water.
Survey methods used	Wading; intense nest searching.	
Habitats searched for nests	Tall sedge.	
Change since 1980s/1990s?	See previous datasheet.	
Other remarks	The main focus was to check the 1st tall line of *Baumea articulata* for Little Bittern nests.	
Photos taken?	Yes: nests found.	

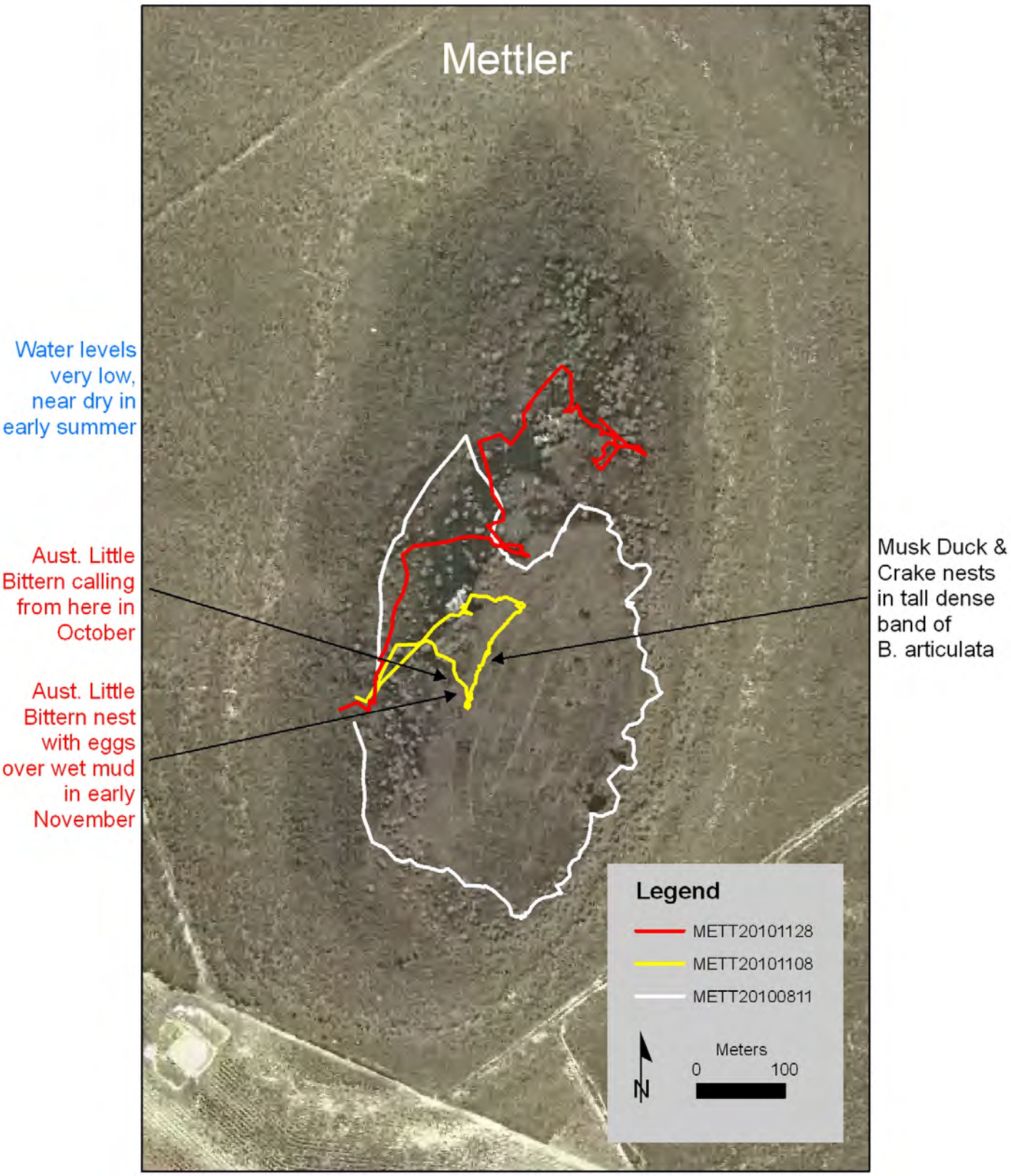
SPECIES	COUNT	COMMENTS
Purple Swamphen	2	
Common Greenshank	1	
Grey Teal	12	
Yellow-billed Spoonbill	5	
Spotless Crake	2	Heard only
Australian Little Bittern	1	Flushed from nest

NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF
Australian Little Bittern	Rough platform (15cm dia. 20cm deep) of fine *B. articulata* with three eggs in tall, dense *Ba*. Nest 1.2m above wet mud. WPT 117. Photos 118-137.
Musk Duck	Nest with down and egg shell near WPT 117 in tall, dense *Ba*.
Crake	Small palm size cup near WPT 117 in tall, dense *B. articulata.* Photos 112-116.
Musk Duck	Nest with down and egg shell in tall, dense *B. articulata*. WPT 118.

Mettler Swamp – third survey (28 November 2010) data

	DATA	COMMENTS
Wetland name	Mettler Lake (METT)	Within a nature reserve.
Observers	A Clarke (DPaW), Anne Bondin (volunteer).	
Date/s	28 November 2010	
Start & finish time/s	1305hrs – 1405hrs.	
Total duration of survey	1hr 00min.	Listening not conducted.
Weather	Hot.	
% of wetland inundated	20 %	
% of inundated area surveyed	50 %	
Water depth at gauge	0.38m.	Deepest water encountered - 10cm.
Survey methods used	Wading; intense nest searching.	
Habitats searched for nests	Tall sedge.	
Change since 1980s/1990s?	See previous datasheet.	
Other remarks	A complete survey was not conducted because of the increasing number of tiger snakes.	
Photos taken?	Yes: nests found.	
SPECIES	COUNT	COMMENTS
Pacific Black Duck	6	
Purple Swamphen	1	Heard only.
Black-fronted Dotterel	2	
White-faced Heron	6	
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Musk Duck	Nest with down and egg shell in tall, dense *Ba*. WPT 153.	

Mettler Swamp – surveys (11 Aug, 08 Nov & 28 Nov 2010) map



Mettler Swamp

Baumea *articulata* stand
(AC, 08Nov2010)

Unidentified crake nest
(AC, 08Nov2010)

Australian Little Bittern nest with eggs
(AC, 08Nov2010)

Elevated Aus. Little Bittern nest
(AC, 08Nov2010)

Australian Little Bittern nest
(AC, 08Nov2010)

Mettler Swamp — Continued

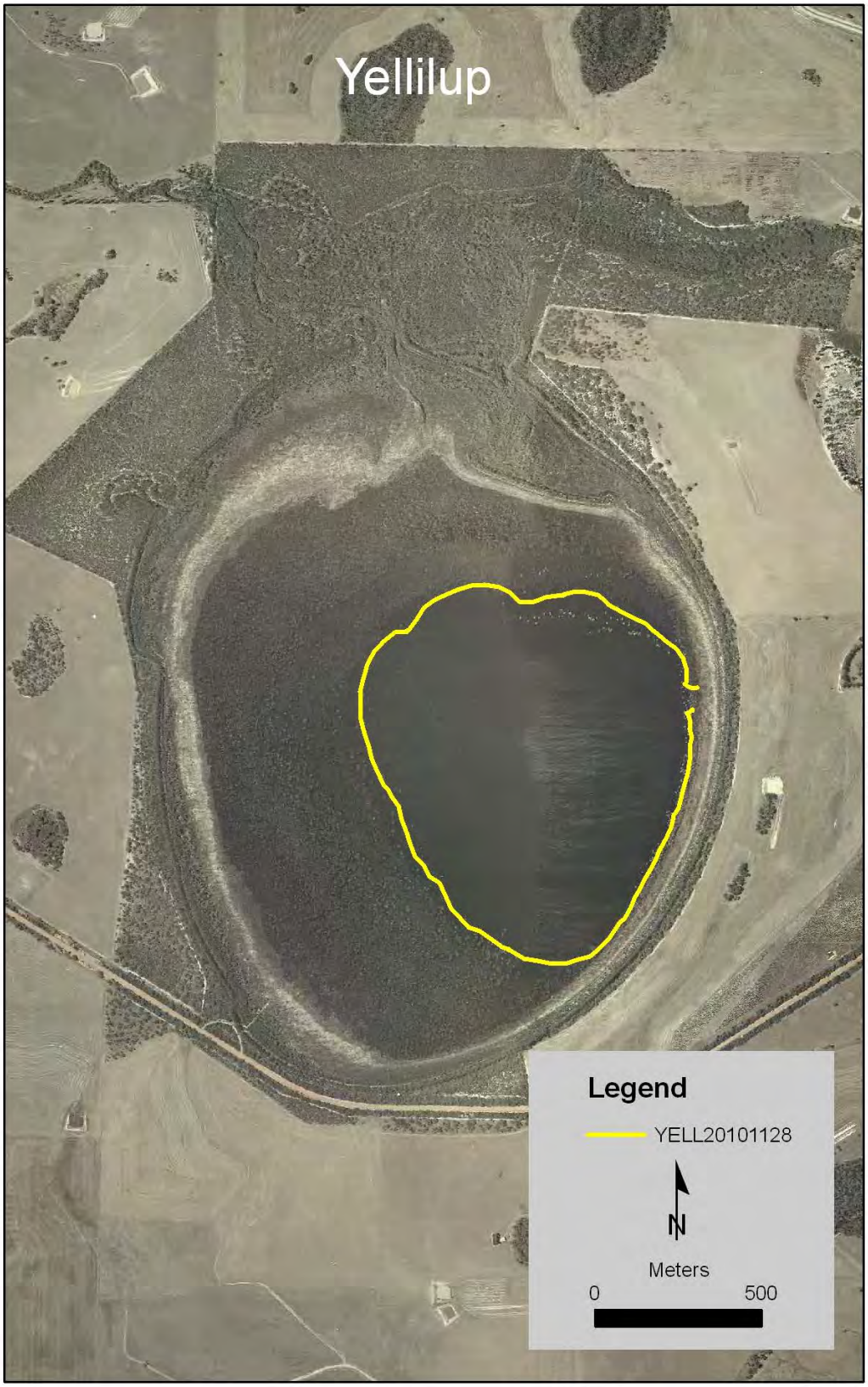
Mettler was nearly dry by late November 2010 (AC, 28Nov2010)

Mettler was nearly dry by late November 2010 (AC, 28Nov2010)

Yellilup Lake – survey (28 November 2010) data

	DATA	COMMENTS
Wetland name	Yellilup Lake (YELL)	On freehold land.
Observers	A Clarke (DPaW)	
Date/s	28 November 2010.	
Start & finish time/s	1540hrs – 1655hrs.	
Total duration of survey	1hr 15min.	
Weather	Fine; moderate S. wind.	
% of wetland inundated	Approx. 20 %	
% of inundated area surveyed	100 %	Open water viewed with telescope.
Water depth at gauge	Approx.0.4m.	
Survey methods used	Scan from shore and walking around entire shore.	
Habitats searched	Open water	
Change since 1980s/1990s?	Former live woodland of yate and *Melaleuca* trees occupying extensive outer zone of lake bed, now all dead; live trees now only near high water mark (Depth > ~2.5m) apart from a few live *Melaleuca* on E side just below ~2.5m; *Melaleuca* seedlings 2m high, above D=2.5m. Now samphire occurs on outer lake bed.	
Other remarks	The waterline was inside the zone of dead trees reducing nesting a loafing habitat.	
Photos taken?	Yes: overview; habitat types; nests.	
SPECIES	COUNT	COMMENTS
Grey Teal	c. 100	Number approximate.
Australian Shelduck	25	
Common Greenshank	15	
Banded Stilt	c. 1000	Number approximate.
Red-necked Avocet	c. 200	Number approximate.
Black-winged Stilt	90	
Silver Gull	3	
Whiskered Tern	1	
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
No nests were found		

Yellilup Lake – survey (28 November 2010) map



Extent of water was inside line of dead trees reducing nesting & loafing habitat

Wading birds feeding on Anostraca (Fairy shrimp)

Yellilup Lake

Large flock of Banded Stilt (AC, 28Nov2010)

(AC, 28Nov2010)

Esperance 26410 – first survey (10 November 2010) data

	DATA	COMMENTS
Wetland name	Esperance 26410 (ESP1)	Within a nature reserve.
Observers	A Clarke (DPaW).	
Date/s	10 November 2010.	
Start & finish time/s	1245hrs – 1400hrs	
Total duration of survey	1hr 15min.	
Weather	Fine, Moderate S breeze.	
% of wetland inundated	Approx. 80%.	
% of inundated area surveyed	30 %	Depth prevented comprehensive survey without a boat.
Water depth at gauge	1.85m.	
Survey methods used	Scan from shore; wading; nest searching.	
Habitats searched for nests	Wooded thickets; around fallen trees.	
Change since 1980s/1990s?	Zone of dead yate trees now around edge of open water in NW to NE side of wetland, some still with fine twigs. Some yate seedlings (to 2m) in NNE just above present water line; very small yate seedlings under large live yates near boat launch site on W side.	
Other remarks	Wading survey only. Depth prevented views to main water body.	
Photos taken?	Yes: overview; habitat types; habitat change.	
SPECIES	COUNT	COMMENTS
Blue-billed Duck	20	Males displaying to females.
Pacific Black Duck	1	Heard only
Grey Teal	13	Inc. brood of three stage 2.
Chestnut Teal	3	One pair
Australasian Shoveler	2	
Musk Duck	2	
White-faced Heron	1	
Australian Wood Duck	1	
Eurasian Coot	1	
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Grey Teal	Brood of three Stage 2 ducklings referred to above under 'Species'.	
Eurasian Coot	Bird flushed off nest near Gauge B, 10m inside tree line on fallen Yate. Deep water prevented access.	

Esperance 26410 – second survey (29 November 2010) data

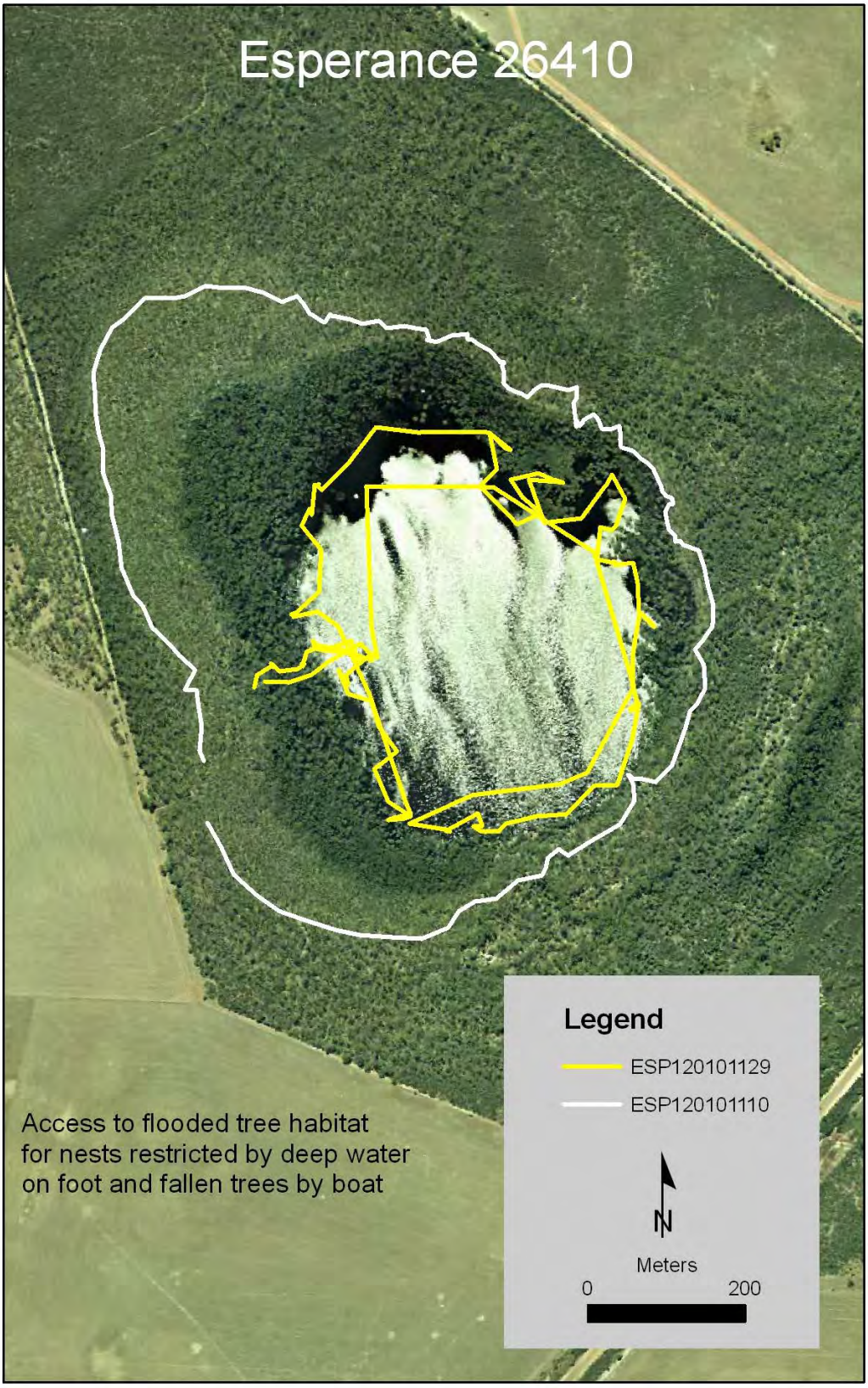
	DATA	COMMENTS
Wetland name	Esperance 26410 (ESP1)	Within a nature reserve.
Observers	A Clarke (DPaW).	
Date/s	29 November 2010	
Start & finish time/s	1330hrs – 1450hrs.	
Total duration of survey	1hr 20min.	
Weather	Fine, strong S wind.	
% of wetland inundated	Approx. 80%	
% of inundated area surveyed	80 %	
Water depth at gauge	1.78m.	
Survey methods used	Boating; nest searching.	
Habitats searched for nests	Flooded woodland. Access limited by fallen trees.	
Change since 1980s/1990s?	Zone of dead yate trees now around edge of open water in NW to NE side of wetland, some still with fine twigs. Some yate seedlings (to 2m) in NNE just above present water line; very small yate seedlings under large live Yate trees near boat launch site on west side.	
Other remarks	Yate trees continue to fall and damage *Melaleuca*. Waterbird counts are the minimum number.	
Photos taken?	Yes: overview; habitat types; habitat change; nests found.	
SPECIES	COUNT	COMMENTS
Eurasian Coot	1	
Hoary-headed Grebe	9	
Black Swan	2	
Chestnut Teal	3	One on nest & a pair on water.
Pacific Black Duck	5	
Blue-billed Duck	8	
Hardhead	100	
Nankeen Night-Heron	6	
Little Pied Cormorant	2	
White-faced Heron	3	
Grey Teal	6	
Musk Duck	2	
Freckled Duck	1	

Esperance 26410 second survey nesting species are on next page >>>

Esperance 26410 – second survey (29 November 2010) data— Continued

NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF
Eurasian Coot	Active two weeks earlier. Near gauge B, 10m inside tree line on fallen tree. Photos 477-478.
Chestnut Teal	Nest in Yate tree hollow. 10 eggs covered in down. WPT 154. Photos 479-481.
Nankeen Night-Heron?	Two robust nests of sticks with paper bark, larger than WnHe. Photos 503, 504, 486, 493, 496.

Esperance 26410 – surveys (10 & 29 November 2010) map



White track is approx. water line in November

Blue-billed Duck males displaying under tree cover

Esperance 26410

Falling Yate trees damaging melaleucas and opening canopy (AC, 10Nov2010)

Blue-billed Duck courtship (AC, 10Nov2010)

Healthy vegetation on southern side of lake (AC, 29Nov2010)

Dead and dying Yates on NE side of lake (AC, 29Nov2010)

Esperance 26410 – Continued

Dead and dying Yate trees on NE side of lake (AC, 29Nov2010)

Chestnut Teal nesting hollow, nest and eggs (AC, 29Nov2010)

Eurasian Coot nest (AC, 29Nov2010)

Shark Lake – survey (29 November 2010) data

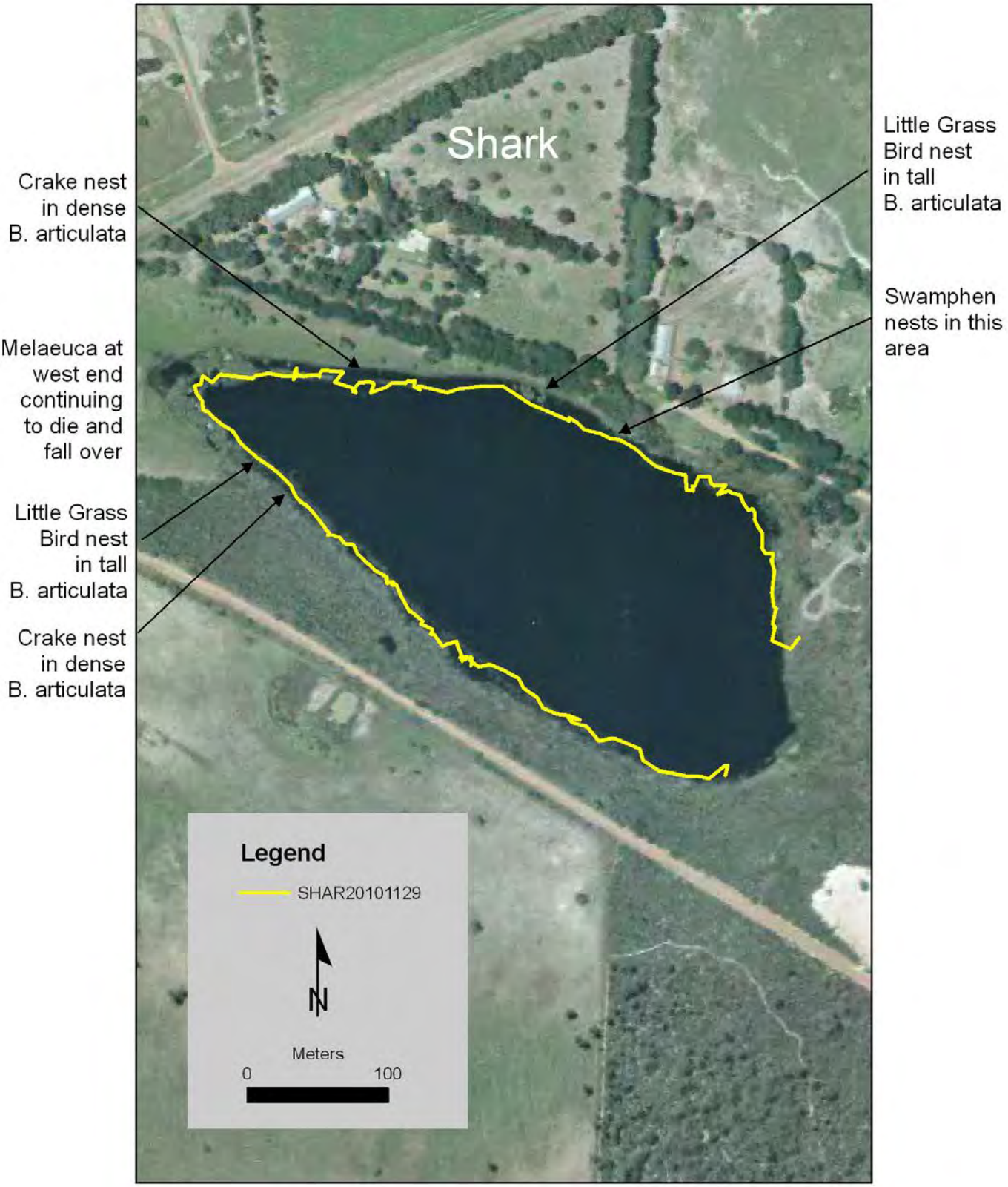
	DATA	COMMENTS
Wetland name	Shark Lake (SHAR)	Within a nature reserve.
Observers	A Clarke (DPaW)	
Date/s	29 November 2010	
Start & finish time/s	1635hrs – 1845hrs	
Total duration of survey	2hr 10min.	Includes 0hr 30min listening on dusk
Weather	Fine; Strong S wind.	
% of wetland inundated	80 %	
% of inundated area surveyed	Over 80%	Open water 100%; sedge 80%
Water depth at gauge	2.00m.	
Survey methods used	Scan from shore; wading; intense nest searching; listening for calling Bitterns at dusk.	
Habitats searched for nests	Tall sedge; mixed shrubs/trees and sedge.	
Change since 2008 survey	Many of the well-established *Melaleuca* trees at the western end had died and many of these have fallen over.	
Other remarks	Continued decline of *Melaleuca* at west end of lake.	
Photos taken?	Yes: overview; habitat types; nests found.	
SPECIES	COUNT	COMMENTS
Purple Swamphen	4	Inc. brood of two stage 1
Musk Duck	12	
Eurasian Coot	10	
Pacific Black Duck	24	
Australian Reed-Warbler	Approx. 4	Heard only
Black Swan	2	
Little Black Cormorant	1	
Chestnut Teal	2	A pair
Little Grassbird	1	Heard only, in tall sedge
Crake	4	Heard only, in tall sedge
Great Crested Grebe	1	
Nankeen Night-Heron	1	
Australian Shelduck	6	
Australasian Darter	1	
Hoary-headed Grebe	10	

Shark Lake nesting species are on next page >>>

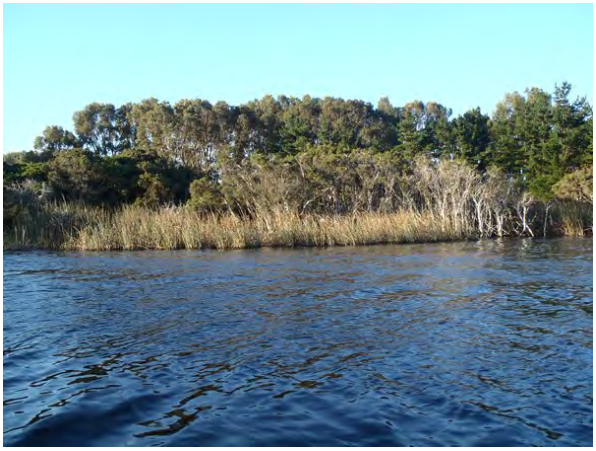
Shark Lake – survey (29 November 2010) data— Continued

NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF
Little Grassbird	Nest in tall thick *Baumea articulata*. WPT 156. Photos 513-517.
Little Grassbird	Nest in tall thick isolated *B. articulata* clump. WPT 161.
Musk Duck	Two nests in tall *B. articulata*, possibly both abandoned on south side near WPT 155. Photos 507-512.
Crake	This year's nest under old Musk Duck nest on south side. infused with fine grass. WPT 157. Photos 518-521.
Crake	This year, under construction in dense fallen over *B. articulata*, Crake calling nearby. WPT 158. Photos 531-534.
Purple Swamphen	Brood of two Stage 1 chicks referred to above under 'Species'.
Purple Swamphen	3 finished nests in open *B. articulata* near shore. WPT 159. Photos 535-537.
Purple Swamphen	Nest with 1 egg in open *B. articulata* near shore. WPT 160. Photos 539.
Purple Swamphen	Bird flushed off nest in open *B. articulata* near shore. WPT 162.

Shark Lake – survey (29 November 2010) map



Shark Lake



Melaleucas at western end of lake (AC, 29Nov2010)

Tall, dense *Baumea articulata* in SE area (AC, 29Nov2010)

Progressive death of melaleucas at western end of lake (AC, 29Nov2010)

Swamphen nest in open location (AC, 29Nov2010)

Swamphen nest with egg (AC, 29Nov2010)

Shark Lake – Continued

Crake nest (1st) at base of dense *Baumea articulata*
(AC, 29Nov2010)

Site of 2nd crake nest
(AC, 29Nov2010)

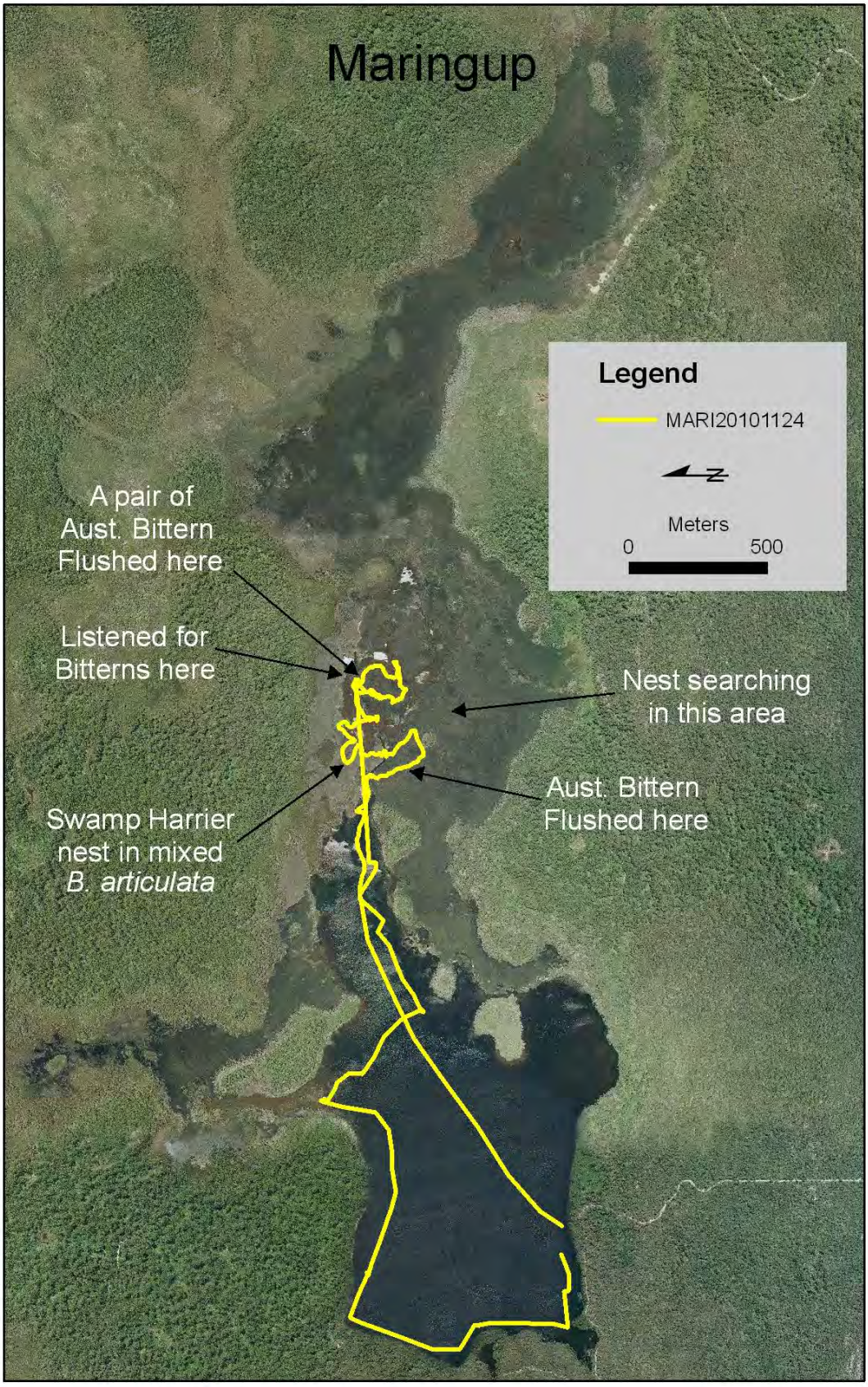
2nd crake nest (AC, 29Nov2010)

Little Grassbird nest (AC, 29Nov2010)

Lake Maringup – survey (24 November 2010) data

	DATA	COMMENTS
Wetland name	Lake Maringup (MARI)	Within a nature reserve.
Observers	A Clarke (DPaW) & John Graff	
Date/s	24 November 2010	
Start & finish time/s	1530hrs – 2000hrs.	
Total duration of survey	4hr 30min	
Weather	Strong S wind.	
% of wetland inundated	90 %.	
% of inundated area surveyed	80% open water, 5% sedge	
Water depth at gauge	Approx. 5.9m	Calculated from 5.99m on 09Nov10.
Survey methods used	Used boat to access vast sedge area at east end of the lake then wading & intense nest searching.	
Habitats searched for nests	Tall sedge; mixed sedge.	
Change since1980s/1990s?		
Other remarks	Species counts are a minimum. Native minnow fish abundant.	
Photos taken?	Yes: overview, habitats & nest.	
SPECIES	COUNT	COMMENTS
Swamp Harrier	3 adults	Plus two chicks.
Australasian Bittern	3	Flushed from fine, low sedge and mixed tall & low sedge. WPTs 123 &125
Little Pied Cormorant	2	
Pacific Black Duck	42	
Musk Duck	10	
Hardhead	2	
Australian White Ibis	1	
Black Swan	12	
Australian Wood Duck	4	
Spotless Crake	2	
Great Egret	1	
Australasian Darter	1	
Purple Swamphen	2	
Little Grassbird	numerous	
NESTING SPECIES	NESTS, AGE & CONTENTS; HABITAT; GPS REF	
Swamp Harrier	Nest with three eggs and two chicks in tall dense clump of *B. articulata.* WPT 124. Photos 292-299.	

Lake Maringup – survey (24 November 2010) map



Lake Maringup

Australasian Bittern flushing site (AC, 24Nov2010)

Australasian Bittern foraging habitat (AC, 24Nov2010)

Australasian Bittern foraging habitat (AC, 24Nov2010)

Mixed density *Baumea articulata*, low fine sedge and open water (AC, 24Nov2010)

Lake Maringup – Continued

Lake Maringup (AC, 24Nov2010)

Aus. Bittern roosting / feeding platform (AC, 24Nov2010)

Swamp Harrier nest with two chicks and three eggs (AC, 24Nov2010)

Rakali food remnants (AC, 24Nov2010)

Long-submerged tree stump (AC, 24Nov2010)

Appendix 4. GPS coordinates of nests located during the 2010-11 surveys

These GPS coordinates are retained by DPaW and are not for general distribution, at least in the short term (several years at least), in order to give current nest sites a level of protection from possible unlawful disturbance.