Waterbirds and wetlands across eastern Australia

Author:

R.T. Kingsford, School of Biological, Earth and Environmental Science, University of New South Wales, NSW.

J.L. Porter, New South Wales Department of Environment and Conservation, Hurstville, NSW.

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Background

The project aims to estimate the abundance of waterbirds within 10 aerial survey bands across eastern Australia (Braithwaite et al 1985, 1986a and Kingsford et al 1999a Fig. 1), for the time period 1983-2004. The aerial survey provides information on up to 50 waterbird species, including several threatened species.

Many of Australia’s major river systems flow into large estuaries or floodplains. These floodplain areas provide habitat for many species of waterbirds and other dependent aquatic organisms. For this reason, aerial surveys of waterbirds across eastern Australia provide a long-term data set on the health and biodiversity of river and wetland environments. Such data have shown some waterbird populations are in decline (e.g Macquarie Marshes and Lowbidgee wetlands). Such analysis can be combined with detailed long-term data on river flows and climate to determine long term impacts of river regulation (dams, diversions, floodplain levees) on some wetland sites (see case studies in this paper). Aerial survey data of waterbirds are also used for the management of duck shooting seasons in Queensland, South Australia and Victoria.

With the number of different waterbird species surveyed, different functional waterbird groups can be identified (Kingsford and Porter 1994). These provide an opportunity to indirectly explore potential effects of river management and degradation on entire ecosystems. Different waterbird species feed on a wide range of aquatic fauna and flora that form part of the food web of an aquatic system. There are the ducks (e.g. blue-billed duck *Oxyura australis*, grey teal *Anas gracilis*) that feed predominantly on small invertebrates, herbivores (e.g. black swans *Cygnus atratus*, Eurasian coot *Fulica atra*), piscivores (e.g. Australian pelican *Pelecanus conspicillatus* and cormorants *Phalacrocorax* sp.), small wading birds (Charadriformes) and large wading birds (Ciconiiformes). These functional groups can provide some indication of potential changes to other aquatic biodiversity and the aquatic food web.

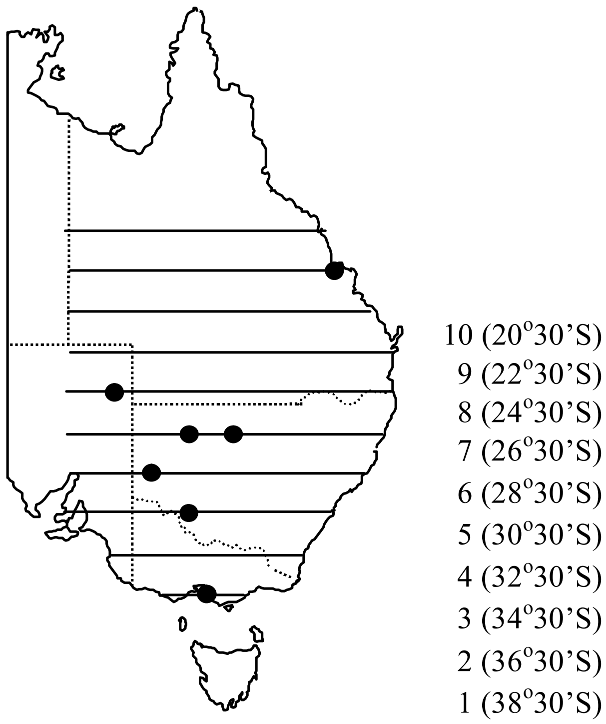

Figure 1. Ten aerial survey bands (each 30 km in width), every two degrees of latitude, crossing eastern Australia and providing estimates for up to 50 species of waterbirds in October each year (1983-2004).

Note: Letters identify seven particular wetlands: Styx River wetlands (A), Lake Hope (B), Paroo River overflow lakes (C), Macquarie Marshes (D), Menindee Lakes (E), Lowbidgee floodplain (F) and Curdies Inlet (G).

Trends in abundance and distribution of waterbirds

Total numbers of waterbirds in eastern Australia

Waterbird numbers across eastern Australia have exhibited a decline since 1983 (Fig. 2a). The most significant decline occurred between 1984 to1986, with further declines after 1991 (see Fig. 2a). The annual average number of birds during the first three years of the survey was about 1 100 000; from 1986 to 1995 about 405 000 and from 1996 to 2004 about 238 000. The distribution of this decline varied between different parts of the continent (Fig. 2). Estimates of waterbirds in the northern four survey bands (bands 7-10, see Fig. 1) were highest in 1983 and 1984 but subsequently there has been little trend in the numbers of waterbirds between 1985 and 2004 (Fig. 2b). In contrast, estimates of waterbirds in the central survey bands (bands 4-6) and southern survey bands (bands 1-3) have shown downward trends (Fig. 2c, d), similar to the trend in total numbers of waterbirds.

Condition of wetland habitats – case studies

Floodplains comprise the most extensive wetland areas in Australia (see Roshier et al 2001), making up 89 per cent of wetlands in New South Wales (Kingsford et al 2004a). Flood frequencies and extent can be significantly reduced for wetlands downstream of major diversions, particularly on regulated rivers in the Murray-Darling Basin (Maheshwari et al 1995, Kingsford 2000). We identified six case studies from aerial survey data for which we analysed changes in abundance and numbers of waterbird species over time. These included: the Styx River wetlands, Lake Hope, the Paroo River overflow lakes, Macquarie Marshes, Lowbidgee wetlands and Curdies Inlet (Fig. 1). Two of the case studies show the effects of reduced river flows to major wetland systems on the Macquarie and Murrumbidgee Rivers. We have also considered potential impacts of river regulation on colonially breeding species in the Macquarie Marshes. In addition, we provide an analysis of the effects of using floodplain lakes (e.g. Lake Menindee, Euston Lakes, Cooper Lake and Lake Mokoan) as storages in southeastern Australia (Kingsford et al 2004b).

Styx River wetlands

The total numbers of waterbirds were highest in 1983, 1984, 1989 and 1990. Since 1990, numbers of waterbirds have remained low because the area has largely remained dry. Years where numbers were high reflected widespread flooding and creation of habitat for waterbirds. There is no clear trend in abundance or numbers of species (Fig. 3a).

Lake Hope

There was no indication of any trend in either abundance or numbers of species (Fig. 3b). Numbers of waterbirds and the composition of species reflect the presence of water which can depend on river flows in Cooper Creek or local rainfall (Kingsford et al 1999b). During flood periods a wide range of different species, often in large numbers and high densities, occur probably reflecting the abundance of food available (invertebrates and aquatic plants) (Kingsford et al 2004b).

Paroo River overflow lakes

There was no trend in numbers of waterbirds or numbers of species on the Paroo River wetlands (Fig. 3c). These lakes represent five freshwater lakes and floodplain areas. Mullawoolka Basin, the largest freshwater lake, retains water for the longest and was only dry in 2003 during the period of the survey. Waterbird density and composition was usually high during flood periods as the lakes go through their wetting and drying cycles (Kingsford et al 2004b).

Macquarie Marshes

The building of dams and subsequent diversion of water from the Macquarie River have significantly reduced flows and area inundated in the Macquarie Marshes by at least 40-50 per cent (Kingsford and Thomas 1995). Waterbird abundance and numbers of species estimated during aerial surveys have declined significantly over time (Fig. 4), despite the considerable variability. River flows are linearly related to area inundated (Kingsford and Thomas 1995, Kingsford and Auld 2005). There has been a significant long-term decline in river flows to the Macquarie Marshes as a result of river regulation and subsequent diversions upstream. Before river regulation, about 50 per cent of river flows reached the Macquarie Marshes but more recently this has declined to about 21 per cent (Kingsford and Thomas 1995).

High river flows are also an important trigger for the breeding of colonial waterbirds in the Macquarie Marshes. Annual flows (1978, 1986-1996), measured at the Oxley gauge on the Macquarie River where the Macquarie Marshes begin, were significantly related to total colony size (number of nests) and sizes of six nesting Ciconiidae (Intermediate Egret *Ardea intermedia*, Rufous Night Heron *Nycticorax caledonicus*, Glossy Ibis *Plegadis falcinellus*, Straw-necked Ibis *Threskiornis spinicollis*, Australian White Ibis *Threskiornis mollucca* and Royal Spoonbill *Platalea regia*) colonies. Breeding of most colonial waterbirds in the Macquarie Marshes was positively related to flow in the three months before breeding and triggered when flows were usually above 200,000 ML. Generally colony sizes were significantly less (100 000 over 11 years) than would be expected without diversions of water upstream. Numbers of annual breeding events also declined with water diversions from natural to current development estimates: ten to seven (1963-1973); eight to seven (1974-1984), eight to five (1985-1995). Between 1996 and 2004, there were only four breeding events, including none between 2001 and 2004, the longest period known without breeding. The size of a waterbird breeding event and flooding extent were still primarily affected by river flooding and diversions upstream, despite the amount of environmental flow and the predicted ecological differences among the environmental flow options.

The Lowbidgee floodplain

Numbers of waterbirds and numbers of species have declined significantly on the Lowbidgee floodplain (Fig. 4b). The Lowbidgee floodplain is the Murrumbidgee River's major wetland in southeastern Australia. From more than 300 000 hectares in the early 1900s, at least 76.5 per cent was destroyed (58%) or degraded (18%) by dams (26 major storages), subsequent diversions and floodplain development (Kingsford and Thomas 2004). Diversions of about 2 144 000 ML year per year from the Murrumbidgee River provide water for Canberra, hydro-electricity and 273 000 hectares of irrigation. Diversions have reduced the amount of water reaching the Lowbidgee floodplain by at least 60 per cent between 1888 and 1998. About 97 000 hectares of Lowbidgee wetland was destroyed by development of the floodplain for an irrigation area (1975-1998), including building of 394 kilometres of channels and 2 145 kilometres of levee banks. Over 19 years (1983-2001), waterbird numbers estimated during annual aerial surveys collapsed by 90 per cent, from an average of 139 939 (1983-1986) to 14 170 (1998-2001) (Kingsford and Thomas 2004). Similar declines occurred across all functional groups: piscivores (82%), herbivores (87%), ducks and small grebe species (90%), large wading birds (91%) and small wading birds (95%), indicating a similar decline in the aquatic biota that formed their food base. Numbers of species also declined significantly by 21 per cent. The Lowbidgee floodplain is an example of the ecological consequences of major water resource development. Yanga Nature Reserve, within the Lowbidgee floodplain, conserved for its floodplain vegetation communities, will lose these communities because of insufficient water.

Curdies Inlet

There were no trends in numbers of waterbirds or numbers of species on Curdies Inlet in southeastern Australia (Fig. 4c). Both indices exhibited high variability over time, particularly abundances.

Effects of permanent flooding on floodplain lakes

The aerial survey data were used to compare waterbird communities on 12 floodplain lakes scattered across eastern Australia (Kingsford et al 2004b). Half of these lakes were regulated by turning them into lowland river storages for the management of river flows. These include the Menindee Lakes, Euston Lakes and two tributary lakes of the Murray, Lake Mokoan and Cooper Lake. The other six floodplain lakes still have largely intact flow regimes (Kingsford et al 2004b). Overall, mean density of waterbirds on unregulated floodplain lakes was significantly higher

(6.04 ± 1.64 SE waterbirds per hectare), compared with regulated floodplain lakes (0.66 ± 0.22 SE waterbirds per hectare) (Kingsford et al 2004b). Mean numbers of species on floodplain lakes was also significantly higher on unregulated lakes (17.21 ± 0.95 SE, n=19), compared with regulated floodplain lakes (9.32 ± 0.56 SE, n=19). Three of the five functional feeding groups, (ducks and small grebes, herbivores and small wading birds) reflected this pattern, possibly indicating that invertebrate populations and aquatic vegetation were similarly affected (Kingsford et al 2004b). Numbers of piscivores and large wading species and their densities were similar between regulated and unregulated lakes, possibly because exotic fish species thrived in regulated lakes. Reduction of hydrological variability, particularly removal of natural drying periods affected the ecology of regulated floodplain. Waterbird biodiversity requires flooding and drying disturbance on lowland rivers, where extensive floods are punctuated by drying periods.

Data sources and limitations

In October of each year, waterbirds in eastern Australia are counted from the air on about 2 000 wetlands (100 hours flying). Abundance indices for all waterbird species were collected during aerial surveys of eastern Australia in October of each year, for ten years, 1983-2004. An area of 2 697 000 km^2 was systematically sampled with ten survey bands 30 kilometres in width, spaced every 2° of latitude from 38°30'S to 20°30'S (Kingsford et al 1999a, see Braithwaite et al 1985 for methodology; Fig. 1). More than 50 taxa of waterbirds are counted on all water bodies larger than 1 hectare. All lakes were surveyed during October each year from a high-winged aircraft (Cessna 206) with two observers, one each side of the plane, estimating numbers of waterbirds of each species onto mini-cassettes. The aircraft was flown at a height of 30 – 46 metres and a speed of 167 km/hr (90 knots), within 150 metres of the shoreline, where waterbirds usually congregate (Kingsford and Porter 1994). Most waterbirds were identified to species, although species in four groups could not be separated: small egrets (3 species), small grebes (2 species), small (>20 species) and large (>5 species) migratory waders (Kingsford and Porter 1994). Either the whole wetland was circumnavigated or a proportion of the wetland (> 50 %) counted. Counts for each species were totalled for each observer to give either a total count for a wetland or a proportional count for the wetland. Aerial surveys of waterbirds are imprecise but this does not affect their use in detecting temporal and spatial changes in abundance or species richness (Kingsford 1999). Large effect sizes allow for long term analyses of changes in waterbird numbers and species over time (Kingsford and Thomas 1995, 2004, Kingsford et al 2004b).

References

Braithwaite LW, Maher MT, Briggs SV and Parker BS 1985, An aerial survey of wetland bird fauna in eastern Australia. October 1983. *CSIRO Division of Wildlife and Rangelands. Res. Tech. Memo.* 21, 89pp

Braithwaite LW, Maher M, Briggs SV and Parker BS 1986a, An aerial survey of three game species of waterfowl (Family Anatidae) in eastern Australia. *Australian Wildife. Research* 13, 213-23.

Kingsford RT and Porter JL 1994, Waterbirds on an adjacent freshwater and salt lake in arid Australia. *Biological Conservation* 69, 219-228.

Kingsford RT and Thomas RF 1995, The Macquarie Marshes and its waterbirds in arid Australia: A 50-year history of decline. *Environmental Management* 19: 867-878.

Kingsford RT and Johnson W 1998, Impact of water diversions on colonially nesting waterbirds in the Macquarie Marshes in arid Australia. *Colonial Waterbirds* 21: 159-170.

Kingsford RT 1999, Aerial surveys as a measure of river and landscape and floodplain health. *Freshwater Biology* 41: 425-438.

Kingsford RT, Wong PS, Braithwaite LW and Maher MT 1999a, Waterbird abundance in eastern Australia, 1983-1992. *Wildlife Research* 26: 351-366.

Kingsford RT, Curtin AL and Porter JL 1999b, Water flows on Cooper Creek determine 'boom' and 'bust' periods for waterbirds. *Biological Conservation* 88: 231-248.

Kingsford RT 2000, Review: Ecological impacts of dams, water diversions and river management on floodplain wetlands in Australia. *Australian Ecology* 25. 109-127

Kingsford RT and Thomas RF 2004, Destruction of wetlands and waterbird populations by dams and irrigation on the Murrumbidgee River in arid Australia. *Environmental Management* 34, 383-396

Kingsford RT, Brandis K, Thomas RF, Knowles E, Crighton P and Gale E 2004a, Classifying landform at broad landscape scales: the distribution and conservation of wetlands in New South Wales, Australia. *Marine and Freshwater Research* 55, 17-31.

Kingsford RT, Jenkins KM and Porter JL 2004b, Imposed hydrological stability on lakes in arid Australia and effect on waterbirds. *Ecology* 85, 2478-2492.

Kingsford RT and Auld KM 2005, Waterbird breeding and environmental flow management in the Macquarie Marshes, arid Australia. *Rivers Research and Applications* 21, 187-200.

Maheshwari BL, Walker KF and McMahon TA 1995, Effects of regulation on the flow regime of the River Murray, Australia. *Regulated Rivers - Research & Management* 10, 15-38.

Roshier DA, Whetton PH, Allan RJ and Robertson AI 2001, Distribution and persistence of temporary wetland habitats in arid Australia in relation to climate. *Australian Ecology* 26, 371-384.

Eastern Australia Aerial Survey Summaries

Braithwaite LW, Maher MT, Briggs SV and Parker BS 1985a, An aerial survey of wetland bird fauna in eastern Australia. October 1983. CSIRO Division of Wildlife and Rangelands Research Technical Memorandum No. 21.

Braithwaite LW, Maher MT, Briggs SV and Parker BS 1985b, An aerial survey of wetland bird fauna in eastern Australia. October 1984. CSIRO Division of Wildlife and Rangelands Research Technical Memorandum No. 23.

Braithwaite LW, Maher MT, Holmes J and Parker BS 1986b, An aerial survey of wetland bird fauna in eastern Australia. October 1985. CSIRO Division of Wildlife and Rangelands Research Technical Memorandum No. 24.

Braithwaite LW, Kingsford RT, Holmes J and Parker BS 1987, An aerial survey of wetland bird fauna in eastern Australia. October 1986. CSIRO Division of Wildlife and Rangelands Research Technical Memorandum No. 27.

Kingsford RT, Braithwaite LW, Dexter N and Lawler W 1988, An aerial survey of wetland birds in eastern Australia-October 1987. CSIRO Division of Wildlife and Rangelands Research Technical Memorandum No. 30.

Kingsford RT, Smith JDB and Lawler W 1989, An aerial survey of wetland birds in eastern Australia - October 1988. NSW, NPWS Occasional Paper No. 8.

Kingsford RT, Porter JL, Smith JDB and Lawler W 1990, An aerial survey of wetland birds in eastern Australia - October 1989. NSW. NPWS Occasional Paper No. 9.

Kingsford RT, Porter JL, Smith JDB and Holland P 1991, An aerial survey of wetland birds in eastern Australia - October 1990. NSW, NPWS Occasional Paper No. 10.

Kingsford RT, Porter JL and Ferster Levy R 1992, An aerial survey of wetland birds in eastern Australia - October 1991. NSW National PWS Occasional Paper No.12.

Kingsford RT, Porter JL and Ferster Levy R 1993, An aerial survey of wetland birds in eastern Australia - October 1992. NSW. NPWS Occasional Paper No.16.

Kingsford RT, Ferster Levy R and Porter JL1994, An aerial survey of wetland birds in eastern Australia - October 1993. NSW. NPWS Occasional Paper No.18.

Kingsford RT, Tully S and Davis ST 1997, Aerial Surveys of Wetland Birds in Eastern Australia - October 1994 and 1995. NSW. NPWS Occasional Paper No. 28.

Kingsford RT, Wong PS, Braithwaite LW and Maher MT 1999a, Waterbird abundance in eastern Australia, 1983-1992. Wildlife Research 26, 351-366.

Kingsford RT, Porter JL, Ahern A and Davis ST 2000, Aerial surveys of wetland birds in eastern Australia – October 1995-1999. NSW National Parks and Wildlife Service Occasional Paper No. 31.

Kingsford RT, Webb G and Fullagar P 2000, Scientific review of duck hunting seasons in New South Wales. NSW National Parks and Wildlife Service, 90pp.

Kingsford R.T, Porter JL and Ahern AD 2003, Aerial surveys of wetland birds in eastern Australia – October 2000-2002. NSW National Parks and Wildlife Service Occasional Paper No. 33.

Porter JL, Kingsford RT and Hunter SJ 2006, Aerial surveys of wetland birds in eastern Australia – October 2000-2002. NSW National Parks and Wildlife Service Occasional Paper No. 37.

Figures

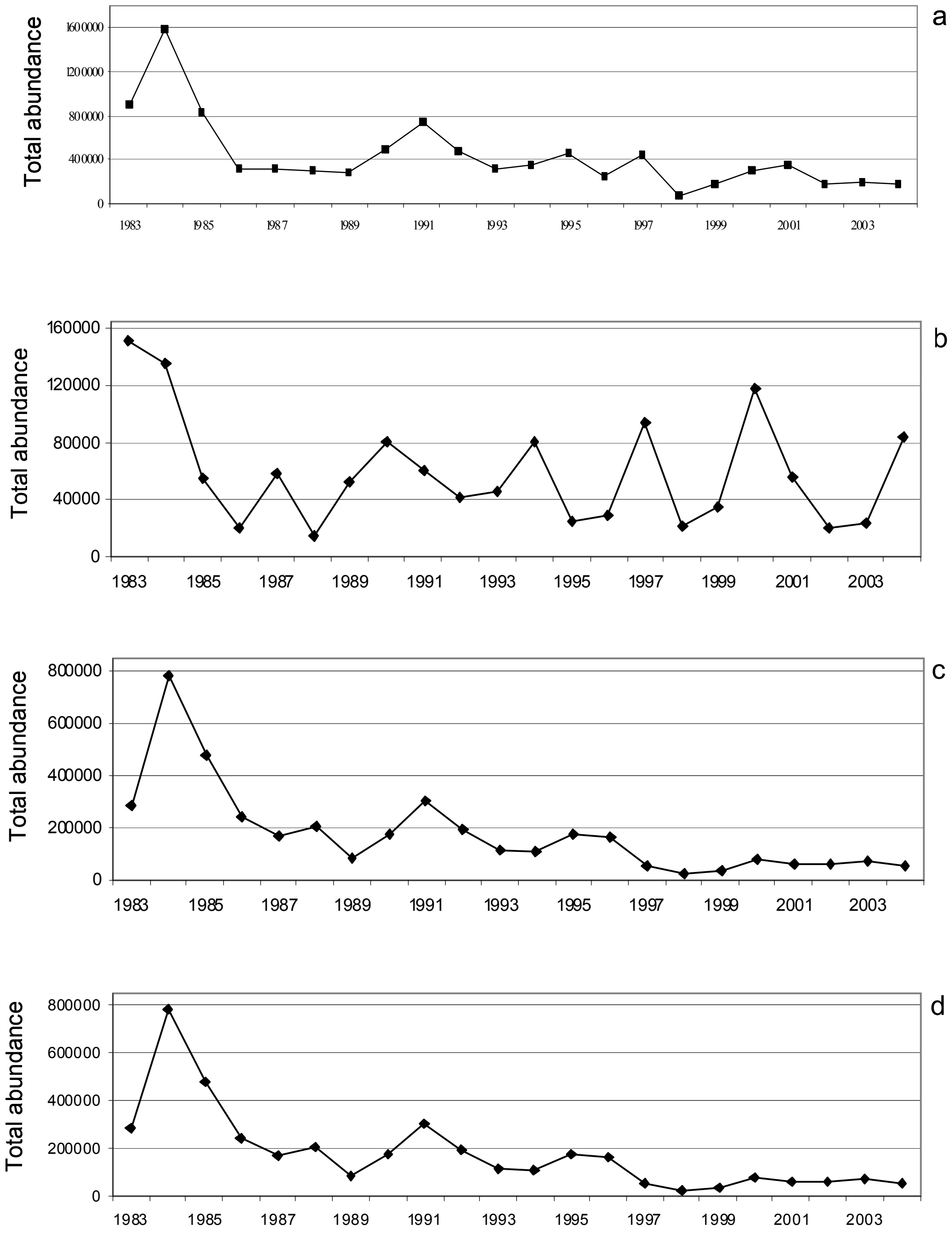

Fig. 2. Estimates of numbers of waterbirds of up to 50 different taxa counted during aerial surveys in October each year 1983-2004 along survey bands across eastern Australia (see Fig. 1): a) all ten survey bands; b) most southerly survey bands (1-3); c) middle survey bands (4-6) and; d) most northerly survey bands.

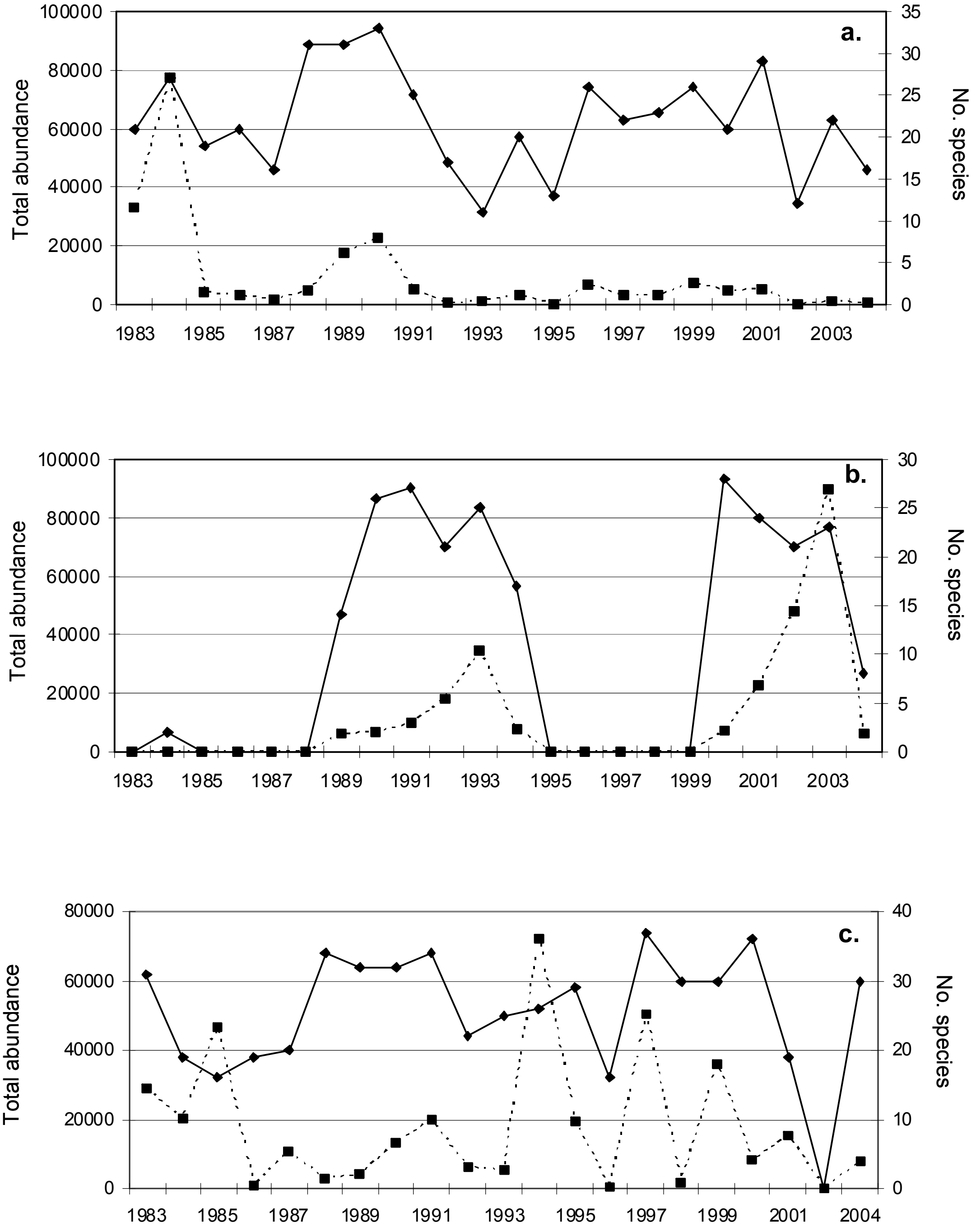

Fig. 3 Estimates of numbers of waterbirds (dashed line) and numbers of species (continuous line) of up to 50 different taxa counted during aerial surveys in October each year 1983-2004 on three wetlands in eastern Australia (see Fig. 1): a) Styx River wetlands; b) Lake Hope and; c) Paroo River overflow lakes.

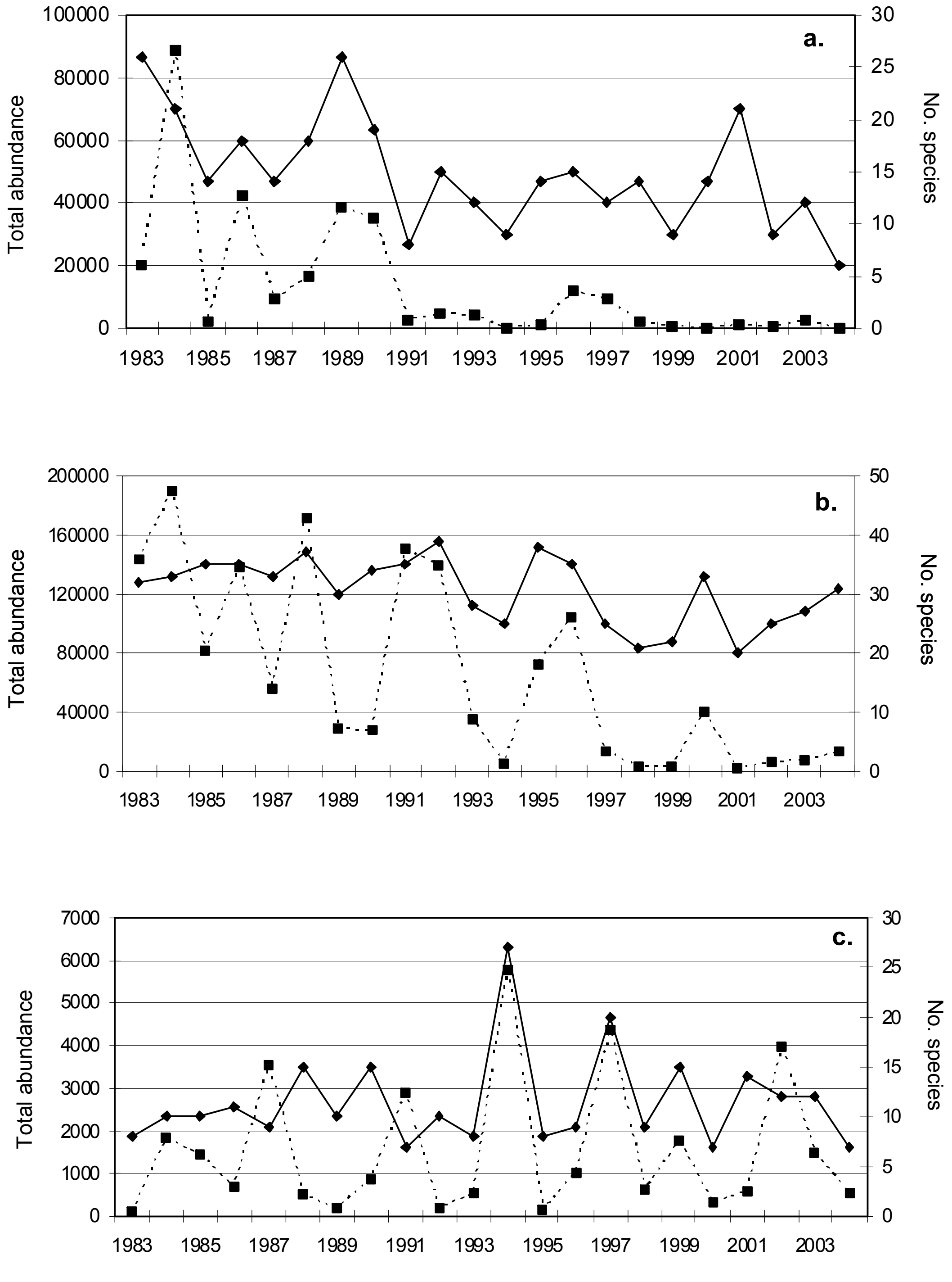

Fig. 4 Estimates of numbers of waterbirds (dashed line) and numbers of species (continuous line) of up to 50 different taxa counted during aerial surveys in October each year 1983-2004 on three wetlands in eastern Australia (see Fig. 1): a) Macquarie Marshes; b) Lowbidgee and; c) Curdies Inlet.