The Macquarie Marshes in Arid Australia and Their Waterbirds: A 50-Year History of Decline

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ABSTRACT / We investigated the relationship between total annual flow of water in the Macquarie River and the extent of flooding in the northern part of the Macquarie Marshes and trends in waterbird populations from 1983 to 1993. The amount of water in the Macquarie River measured each year within the Macquarie Marshes explained about 86% of the variation in area flooded in the northern part of this wetland. This allowed use of long-term data on flow at Oxley, a gauge within the Macquarie Marshes, as an index to flooding. Annual flows at Oxley have decreased significantly for high and medium rainfall events in the catchment, despite no trend in rainfall between 1944 and 1993. The area flooded by large floods has contracted by at least 40-50% during the last 50 years (1944-1993). Water use has progressively increased upstream in the period, depriving the Macquarie Marshes of water: 51% of all water passing Dubbo each year, a gauge 100 km upstream, reached the Macquarie Marshes in the period 1944-1953, but by 1984-1993 this had declined to 21%. Numbers of species and density of waterbirds on the northern part of the Macquarie Marshes declined between 1983 and 1993. Three other wetlands, not affected by water abstractions, showed no declines. We believe the decline was due to wetland degradation as a result of decreased flooding. We estimated more than 88,000 waterbirds in the Macquarie Marshes in October 1984, establishing the site as an important wetland site in Australia. The extent and viability of this wetland will depend on maintaining or increasing the water supply.

Dams and canals mostly supplying water for irrigated agriculture and for generating electricity regulate many of the world's rivers (Allan and Flecker 1993). Often this regulation has reduced the area of downstream wetlands (Turner 1991, Hollis and Jones 1991, Scott 1991), sometimes devastating their fauna (Scott 1991, Bildstein and others 1991). Wetlands in arid parts of the world are particularly vulnerable because water is so scarce (Hollis 1990). This process has seldom been reported in Australia, where the focus has been submergence of natural wetlands by dams (Finlayson 1991) and altered seasonality and frequencies of river flow (Walker 1985, Bren 1988, Lake and Marchant 1990).

The Macquarie River is a regulated river that supports a large irrigation industry and flows into arid Australia (see Stafford Smith and Morton 1990) to form the Macquarie Marshes (Figure 1A), an impressive wetland of waterways, aquatic vegetation, and flooded grassland. Except during large floods, the Macquarie River ends in the Macquarie Marshes (Paijmans and others 1985), which are renowned for their waterbirds (Cooper 1954, Hyem 1957, Braithwaite and others 1986, Brooker 1992). The Macquarie Marshes provide habitat for more than 60 species of waterbirds, including 42 species that breed in the area (Brooker 1992). These include significant breeding colonies of glossy ibis Plegadis falcinellus (800), Australian white ibis Threskiornis molucca (2000), straw-necked ibis Threskiornis spinicollis (>12,000), intermediate egrets Egretta intermedia (17,000), and Rufous Night Herons Nycticorax caledonicus (3000)(Carrick 1962, Jones 1983, Marchant and Higgins 1990, Magrath 1991, Brooker 1992, Johnson 1992, Johnson personal communication.) The conservation importance of the Macquarie Marshes was recognized early this century as a bird and animal sanctuary (Paijmans 1981). In 1955 they became a faunal reserve and 18,000 ha was dedicated as a nature reserve in 1971 (see Figure 1C). This area was recognized as a wetland of international importance in 1986 under the RAMSAR Convention (Michaelis and O'Brien 1988).

Despite the conservation importance of the Macquarie Marshes, development of the Macquarie River has undergone a long history of regulation, following construction of the first weir in 1896. There are now nine large dams with greater than 5000 Ml capacity (Ml = 10^6 liters), five major weirs (and several minor ones), a water-transfer scheme (14,000 Ml/yr), and an

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Changes in hydrology of the Macquarie River are reasonably well known (WRC 1979, TEC 1980, DWR 1991), but their impacts on the Macquarie Marshes and their fauna and flora are largely anecdotal (but see Brander 1987). We investigated the recent changes to the hydrology (1983–1993) on abundance, numbers of species, and density of waterbirds in part of the Macquarie Marshes over 11 years. Three wetlands were chosen as controls to separate induced variation from natural variation. We also investigated changes in the area flooded each year in relation to the amount of water supplied to the Macquarie Marshes. As long-term flow data were available, this allowed retrospective analysis of changes in water supply over a 50-year period (1944–1993) and their likely effects on the area flooded in the Macquarie Marshes.

Study Area

After the Macquarie River leaves the town of Warren, it forms an anastomosing channel pattern (Bora Channel, Buckinguy Creek, Bulgeraga Creek, Gum G oval, Marra Creek, Marthaguy Creek, Monkey Creek, Monkeygar Creek, Terrigal Creek, and the main channel of the Macquarie River) (Figure 1C). The complex habitat formed by these multiple creeks consists of scattered areas of open water, lignum *Muehlenbeckia florencia*, common reed *Phragmites australis*, cumbungi *Typha orientalis*, water couch *Paspalum paspalodes*, and floodplain eucalypts *Eucalyptus camaldulensis*, *E. microtheca*, and *E. largiflorens* (Paijmans 1981). To the west, tributaries of the Macquarie River (Crooked Creek, Duck Creek, Gunningbar Creek) join the Bogan River during extensive floods.

Median annual rainfall for the Macquarie Marshes is 300–400 mm and temperatures range from 4°C (average daily minimum temperatures) during winter months to 35°C (average daily maximum tempera-