Marine and Freshwater Research 67(6), 782-802
http://dx.doi.org/10.1071/MF14251_AC

Supplementary material

Wandering wetlands: spatial patterns of historical channel and floodplain change in the Ramsar-listed Macquarie Marshes, Australia

Timothy J. Ralph[A,C], *Paul P. Hesse*[A] *and Tsuyoshi Kobayashi*[B]

[A]Department of Environmental Sciences, Macquarie University, NSW 2109, Australia.

[B]Science Division, Office of Environment and Heritage NSW, Sydney South, NSW 1232 Australia.

[C]Corresponding author. Email: tim.ralph@mq.edu.au

Table. Summary of historical geomorphic changes in the southern Macquarie Marshes.

Location	Channel and floodplain change
Macquarie River and Terminus Marsh	Pre-1900: The sinuous meandering channel terminated in a large reed bed noted as ‘continual swamp’ (i.e. Terminus Marsh). Wetlands present along the margins of the Macquarie River upstream. 1900-1930: Channel entering Terminus Marsh had contracted slightly. 1949: Majority of Terminus Marsh degraded to ephemeral grassland. Possible cessation of flow due to installation of earth dam in 1930s/40s. 1963: Terminus Marsh desiccated. An anabranch had formed in the place where a small break channel and wetlands had been on the eastern side of the Macquarie River near Monkey Creek. Several other anabranches were evident around the divergence points of Grahway and Buckiinguy. 1970-1972: Terminus Marsh desiccated and not receiving flow. 1984-1985: No significant change. 1995-1998: No significant change.
Monkeygar Creek/Marsh	Pre-1900: Numerous break channels from the right bank of the Macquarie River. One channel extended a few kilometres downstream before terminating in small lagoons with ‘continual swamp’. Wetlands were not noted in the central part of the floodplain where a discontinuous section of Monkeygar Creek led to a large lagoon (at the upstream edge of Willancorah Swamp). 1900-1930: Monkeygar offtake was a single channel diverging from the Macquarie Terminus. Channel ran through a small

http://dx.doi.org/10.1071/MF14251_AC

	lagoon a few kilometres downstream. Monkeygar discontinuous and feeding a ‘continual swamp’ in middle reaches but apparently more continuous downstream near Willancorah. A lagoon noted in 1881 near the southeastern boundary of the Nature Reserve is absent. 1949: Channel almost continuous and interspersed with reeds/lagoons in middle reaches, fed a large reed bed (Willancorah Swamp) north of Gibson Way. 1963: Channel well-defined and continuous along most of its length, including though the lagoons in the middle reaches that were partially dissected by small channels. 1970-1972: Channel larger and the lagoons in the middle reaches almost entirely channelised. Large area of reed beds in Monkeygar Marsh which extended further to the north than in 1963 and included small lagoons. 1984-1985: Channel very clearly defined and reed beds smaller in size, perhaps due to channel incision. 1995-1998: Upper-middle reaches had incised and widened with channelisation of lagoons and decline of the reed beds on the western side of the channel. Knickpoints retreating up The Breakaway may have contributed to channel enlargement.
Little Monkeygar Creek	Pre-1900: Absent/not defined. 1900-1930: Absent/not defined. 1949: Several diffuse channels, including a relatively long distributary (i.e. Little Monkeygar) within the reed beds and lagoons. 1963: Slight expansion of wetlands to the east of Monkeygar Creek. 1970-1972: Slight expansion of wetlands in this area. 1984-1985: No significant changes. 1995-1998: Slight decline of wetlands in this area.
The Breakaway	Pre-1900: Absent/not defined. 1900-1930: Absent/not defined. 1949: Several discontinuous drainage lines near Monkeygar Creek. 1963: Several drainage lines in this area were more clearly defined. 1970-1972: Multiple drainage lines were connected, clearly defined and nearly continuous. The downstream reach drained into the Old Macquarie River to the north-west. 1984-1985: Channel more clearly defined and the lower reach was still draining into the Old Macquarie. Surrounding wetlands appear to have declined, perhaps related to incision. 1995-1998: Channel was continuous and incised (major channel connection and incision likely in 1990 floods). Channel diverting considerable flows from Monkeygar Creek and to the Old Macquarie River.

http://dx.doi.org/10.1071/MF14251_AC

Willancorah Swamp	Pre-1900: Lagoon fed by a discontinuous channel from Monkeygar Marsh. Multiple small channels noted in the area where a track (Gibson Way) traversed the wetlands. A small channel downstream of the lagoon rejoined the Macquarie River, which led north though several small channels to Bulgeraga Creek. 1900-1930: Lagoon was not connected to the Monkeygar Return in 1922. 1949: A large reed bed present north of Gibson Way. A small lagoon at the lower end may have become enclosed by reeds. 1963: A large reed bed. 1970-1972: Wetlands had expanded north of Gibson Way and had a larger reed bed and a central lagoon. Two overflow channels drained into Bulgeraga Creek from the northeastern margin. 1984-1985: No significant changes. 1995-1998: Large reed bed still fed by the continuous channel of Monkeygar Creek. The wetlands had expanded near Bulgeraga Creek in the northeast.
Old Macquarie River and Willie Marsh	Pre-1900: Meandering, discontinuous channel with two main reaches separated by an expanse of wetlands that extended onto the floodplain at Willie. Numerous Aboriginal earth mounds along its length and wetlands along the section of the Old Macquarie River near Gibson Way. 1900-1930: Southern channel of the Old Macquarie River had extended north and the wetlands appear to have contracted slightly, but still active wetlands around Willie. The section near Gibson Way was connected with the Monkeygar Return. 1949: Decline in wetland area. The section near Gibson Way was isolated from wetlands. 1963: Continued decline in wetland area and channel nearly continuous. 1970-1972: Discontinuous channel and wetlands in decline on Willie. Old Macquarie fed by the Buckiinguy Runner. 1984-1985: Continued decline in wetlands. 1995-1998: Receiving considerable flows from Monkeygar Creek via The Breakaway. Slight expansion of wetlands with reeds around the middle section of the Old Macquarie River downstream of The Breakaway.
Mole Marsh	Pre-1900: Wetlands noted in this area and near the end of the Old Macquarie River. 1900-1930: A long, possibly continuous channel diverged from the Old Macquarie River northwest towards Mole Marsh. 1949: A sinuous channel to the northwest had become the dominant arm of the river leading to Mole Marsh where two outlet channels drained back into the Macquarie River downstream of the Bulgeraga Creek junction. 1963: Wetlands upstream of Mole Marsh had declined, but the reed beds were still fed by sinuous channel. 1970-1972: Wetlands seemed to be expanding and several small channels present. The main channel joined the Macquarie River.

http://dx.doi.org/10.1071/MF14251_AC

	1984-1985: No significant changes. 1995-1998: Wetland area expanded, probably due to the increased flows from Monkeygar and The Breakaway to the Old Macquarie River.
Monkey Creek/Marsh	Pre-1900: Perhaps present in a group of small break channels and splays on the east side of the Macquarie River. 1900-1930: An area of wetlands noted on the eastern side of the Macquarie River near several small break channels. A longer, discontinuous channel diverged from these small breaks to the northeast. 1949: Beyond the limit of available aerial photos, but two small return channels near Monkeygar Creek are present to the north of Monkeygar Marsh. 1963: A large area of wetlands fed by a nearly continuous narrow channel and several small distributaries. Some flow passed into Monkeygar via the Monkey West Arm Return and the small East Arm Return channel. Wetlands may have enlarged since 1949 due to channel excavations in the 1950s (see Paijmans 1981). 1970-1972: Distinct channel into a large area of wetlands with significant reeds. Minor changes in small channels. Monkey West Arm Return and the East Arm Return direct flows back into Monkeygar. 1984-1985: Slight contraction of wetlands and changes in the reed beds and shallow flow paths. Flows passed through to the Monkey West Arm Return and the East Arm Return towards Monkeygar Creek. 1995-1998: Channel was continuous through densely vegetated and expanding wetlands. The Monkey West Arm Return carried less flow towards Monkeygar, probably due to earthworks in the mid-1990s at the head of the channel which were designed to halt knickpoints retreating into Monkey Marsh. The Monkey East Arm Return channel still fed into Monkeygar Creek through a series of overflow lagoons at the northern margin of the wetland.
Buckiinguy Creek/Marsh	Pre-1900: Absent/not defined, but a couple of small channels and wetlands were noted in this area, including a distributary channel (Grahway) that fed an area of wetlands between the Milmiland Creek palaeochannel and the Macquarie River. 1900-1930: No significant change. 1949: Beyond the limit of available aerial photos, but a runner extending towards the Old Macquarie River is present. 1963: Defined distributary channel is present downstream of Grahway, as is a significant wetland with several small distributaries between Milmiland Creek and the Macquarie River. A lagoon and dense reeds were present in Buckiinguy Swamp which overflowed into the Buckiinguy Runner, an almost continuous channel that joined the Old Macquarie. 1970-1972: Small channels had begun to incise near the Buckiinguy Return, diverting flow back to the Macquarie River. Reeds had expanded into the buried palaeochannel (Horseshoe Lagoon) from which multiple arms of the Buckiinguy Runner drained north into the Old Macquarie. Diffuse drainage lines ran to the west. Grahway had reduced in size. 1984-1985: Slight contraction of wetland around Buckiinguy Swamp and upstream in the area between the Macquarie River

http://dx.doi.org/10.1071/MF14251_AC

	and Milmiland Creek. The Buckiinguy Return and Runner drained into the Macquarie and Old Macquarie, respectively. Grahway abandoned (possibly due to the effects of a small earth bank near its offtake point from the Macquarie River). 1995-1998: The wetland had enlarged and there was open water in Horseshoe Lagoon. Buckiinguy Return had cut back into the reed beds and the Buckiinguy Runner was distinct.
Little Milmiland Creek	Pre-1900: Absent/not defined, but the Milmiland Creek palaeochannel was swampy (probably due to overflows from Grahway channel). 1900-1930: No significant change. 1949: Beyond the limit of available aerial photos. 1963: Diffuse drainage lines in this area spread towards Milmiland Creek. 1970-1972: Drainage lines fed into Milmiland Creek and into a small area of reeds adjacent to Grahway. 1984-1985: The discontinuous drainage lines of Little Milmiland had begun to cut across the floodplain to join Milmiland Creek. 1995-1998: Channel had become continuous and slightly incised between Buckiinguy Creek and Milmiland Creek.
Bulgeraga Creek	Pre-1900: Meandering, discontinuous channel with a large meander loop downstream of present Gibson Way. No channel shown in the short reach upstream of present Gibson Way. 1900-1930: Continuous channel that bypassed the large meander. 1949: No significant change. 1963: Channel clearly defined and continuous. The area immediately upstream of the Monkeygar confluence had wetlands. 1970-1972: Slight increase in the area of wetlands near Monkeygar. 1984-1985: No significant change. 1995-1998: No significant change.