of the coastal topography from land to the intertidal zone and into the permanently submerged area (useful return signals were recorded up to about 7.5 m water depth)

A similar overlay of data from the Murray mouth (Figure 20) clearly shows the submerged scars of recent dredging and also illustrates loss-of-signal situations caused by foam, spray, etc., which would require multiple overpasses and mosaicking/ stacking in order to recover sufficient data in disturbed areas.

Managing and adapting to secondary salinity and altered hydrology in a Ramsar listed lake suite – Lake Warden wetland system case study

Lizamore, J.[1], Pinder, A.[2] and Vogwill, R.[3]

[1] Environmental Impact Assessment, Department of Parks & Wildlife, Kalgoorlie, W.A.

[2] Science Division, Department of Parks & Wildlife, Perth, W.A.

[3] School of Earth & Environment, University of Western Australia, Perth, W.A.

john.lizamore@dpaw.wa.gov.au

Presenter: John Lizamore

Sections of the Lake Warden Wetland System were listed as a wetland of international importance under the Ramsar treaty on 7 January 1990. The system, which consists of 8 major lakes and more than 90 satellite lakes, are fed by a catchment of around 212 000 ha. Of this catchment, more than 80% has been cleared for agriculture and less than 15% remnant vegetation remains. In November 1996, the Lake Warden catchment was included under the State Salinity Action Plan as a Recovery Catchment to manage the threat of secondary salinity. Management authorities need to test and set hydrological management objectives, within the uncertainty of climate change, covering salinity and other water quality parameters, not just lake levels, to ensure this and similar sites can remain valuable bird habitats into the future.

Over a period of a decade, several research initiatives identified and confirmed altered hydrology, including secondary salinity, as the biggest threat to the ecological character of the Lake Warden Wetland System. As a result, several engineering and management interventions were assessed, recommended and implemented. These include revegetation of priority areas identified .within the catchment, drainage works to reduce excessive high water levels and the removal of various anthropogenic hydrological flow constraints within the catchment. This led to the successful achievement of management objectives with regard to target water levels within the system and some recovery of vegetation and waterbird composition and abundance, especially at Lake Warden. As the system started to recover, a review of the historic monitoring data in 2012 revealed a number of potential issues, which included the potential inaccuracy of the previous data (specifically the water balance model); the possibility of incorrect surrogates used as environmental indicators (e.g. lake depth); and the possibility of a more rapid decline of the system health than what was previously envisaged as a result of secondary salinity (mainly experienced in one of the major lakes of the system, Lake Warden).

In 2013 it was confirmed that further recovery of waterbird assemblage was being limited by the increased salinity due to additional salt loading which affected shorebird food resources (aquatic invertebrates). As a result, further research and monitoring was conducted, aimed at informing future management interventions. This included evaporation monitoring of various saline lakes; improving the understanding of the groundwater and surface water interaction within the system; research into why pink lakes are pink; and how pink lakes could possibly be recovered if altered (e.g. Pink Lake, which has not been pink for more than a decade).

In August 2014, the Recovery Program entered a care and maintenance phase and all research ceased. However, continued financial support from South Coast Natural Resource Management and University of Western Australia ensured the *Pink Lakes Project* ran to fruition in May 2015. Currently, the results of the research is in process of being written up, but conclusions include the confirmation that Pink Lake's iconic pink colour can be recovered

if the salinity level in the lake were to be restored; Lake Warden's shorebird assemblage recovery can be ensured through more active management of the surface water level and/or salinity levels; and Electrical Conductivity as a surrogate measurement for salinity levels within hyper saline systems are inaccurate and measurement procedures must be adapted to reflect and/or correct this aspect