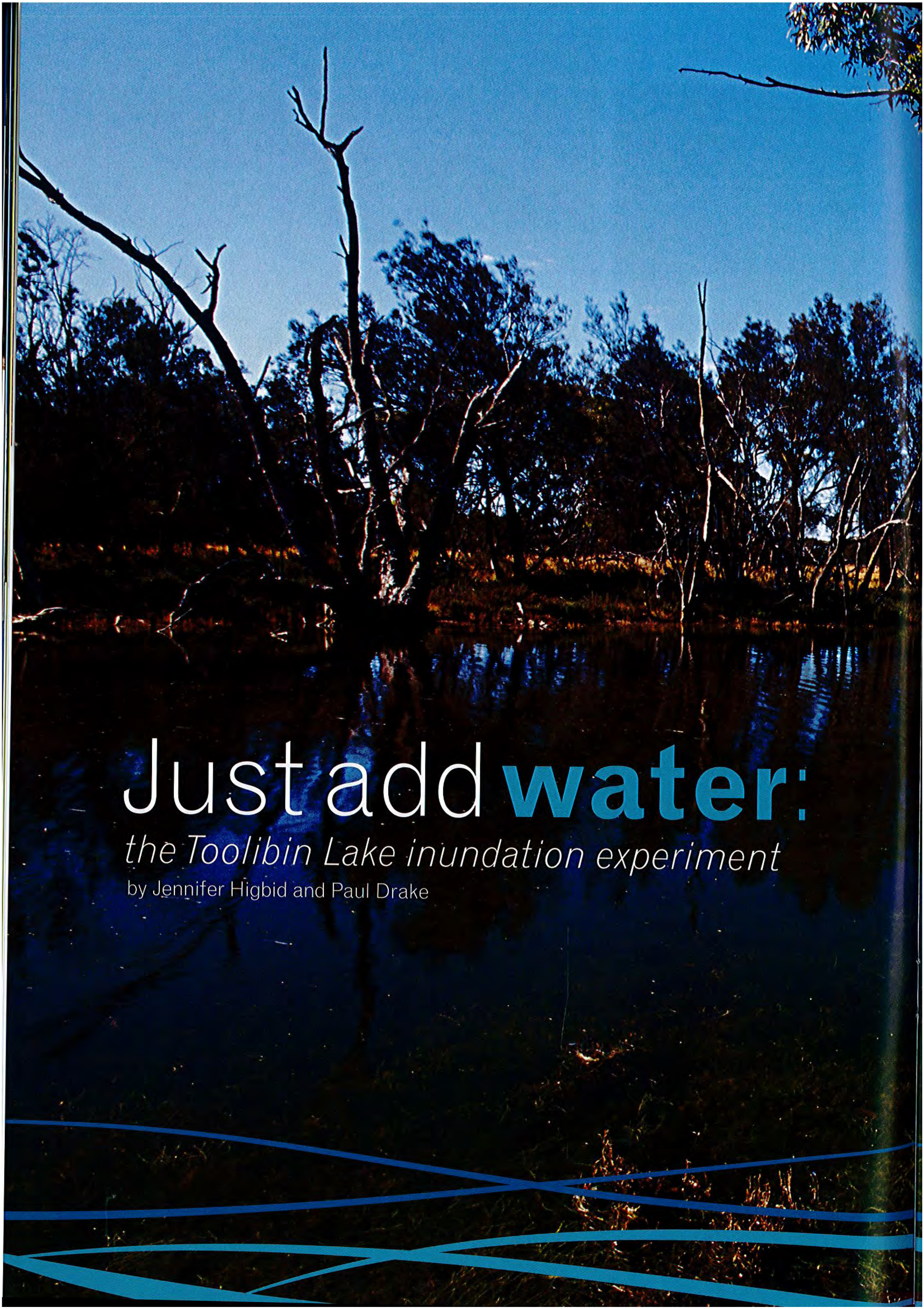


Just add **water**:

the Toolibin Lake inundation experiment

by Jennifer Higbid and Paul Drake

Surface water at Toolibin Lake has been a rare sight of late. Since 1997, the lake has only partially filled twice. So when a pool of water materialised on the lake bed during a sunny Tuesday morning in March it caused quite a stir.

Toolibin Lake, 200 kilometres south-east of Perth, is one of the last remaining fresh-to-brackish wetlands in the wheatbelt and has been recognised as a Wetland of International Importance under the Ramsar Convention for its flora and fauna. Toolibin Lake has recorded the highest number of breeding waterbird species of any inland wetland of the south-west and has historically been considered important for the freckled duck (*Stictonetta naevosa*), which is uncommon in the south-west. Toolibin Lake is also a natural diversity recovery catchment and the lake bed vegetation is listed under national legislation as a threatened ecological community.

The lake's catchment was mostly cleared by the 1950s and the first sign of secondary salinity at the lake was observed in the mid 1970s when trees began to die. Land clearing had caused salt stored in the soil to mobilise and this was entering the lake as saline surface water from the catchment and rising saline groundwater from beneath the lake. In response to these threats, the state government together with the local community began a process to protect the valuable wetland. In 1994, the *Toolibin Lake Recovery Plan* was released which outlined the activities and monitoring that were needed to manage and protect the lake.

Recovery plan

Under the guidance of the recovery plan, a variety of works, including revegetation and engineering interventions, have been implemented. The engineering works were designed to reduce the salinity of surface inflows and lower the saline groundwater beneath the lake. Works began in 1995 with the construction of a levee to divert saline surface water away from the lake, and in 1997 the first system of pumps was installed on the lake bed to lower the watertable (see 'Triple test: recovering natural biodiversity at Toolibin Lake and Lake Bryde', *LANDSCOPE*, Winter 2010).

More recently, infrastructure that controls the outflow of water has been upgraded with a sump and shallow channels constructed on the lake bed to enable surface water to drain before it becomes too saline from evaporation. Importantly, better outflow control also means that surface water can now be removed from the lake before it connects directly with

the groundwater. Other actions across the catchment area have also occurred, including revegetation of public and private lands. Without these actions the vegetation on the lake would have been lost.

Long-term biological and hydrological monitoring indicates that these management actions have largely halted the decline of vegetation since about 2006, with recovery of some smaller sections of lake bed vegetation during the past decade. However, there has not been large-scale recovery of the lake bed vegetation. This prompted an investigation into the tolerances and life history strategies of the dominant lake bed flora to help guide the future management of the lake.

BioRisk project

The Department of Environment and Conservation (DEC) is coordinating the BioRisk project, a partnership between DEC, Future Farm Industries Cooperative Research Centre and The University of Western Australia. The project is researching the water requirements and tolerances of the dominant trees on the lake bed—sheoak (*Casuarina obesa*) and paperbark (*Melaleuca strobophylla*), which are the most deep-rooted plants growing on

Previous page
Main Toolibin Lake.
Photo – Jiri Lochman
Inset Measuring surface water at Toolibin Lake.
Photo – Jennifer Higbid/DEC

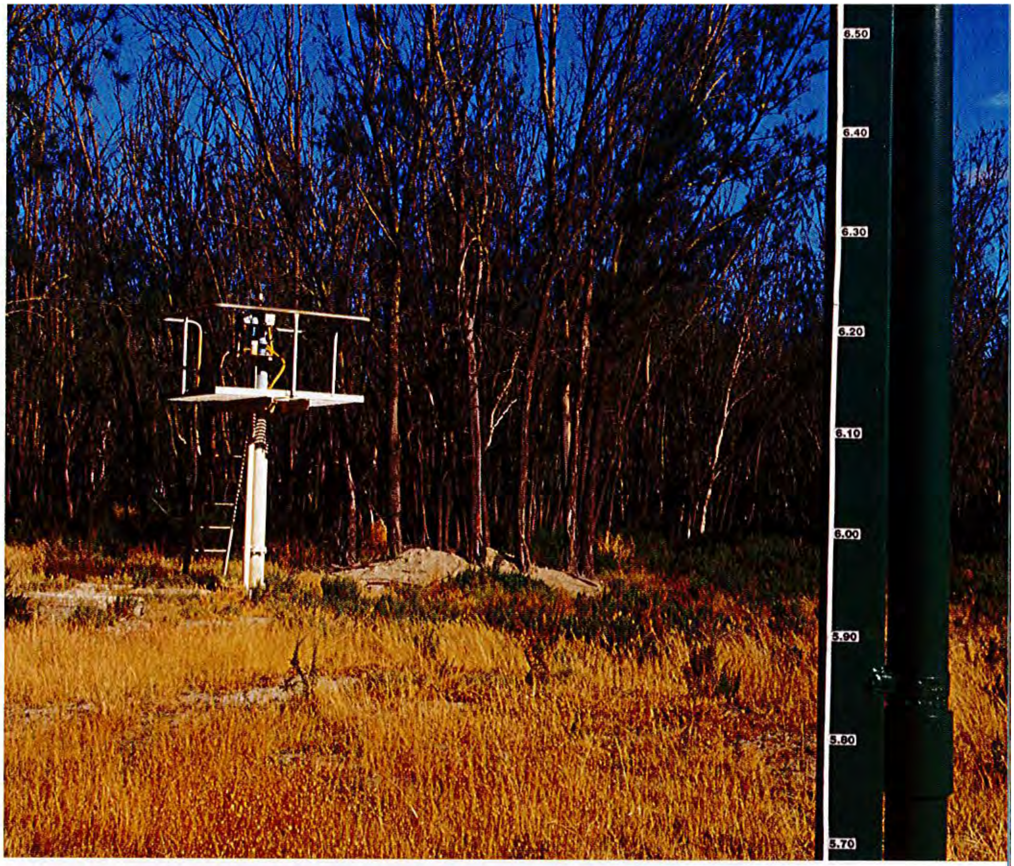
Above Maintaining equipment at Toolibin Lake.
Photo – Cliff Winfield

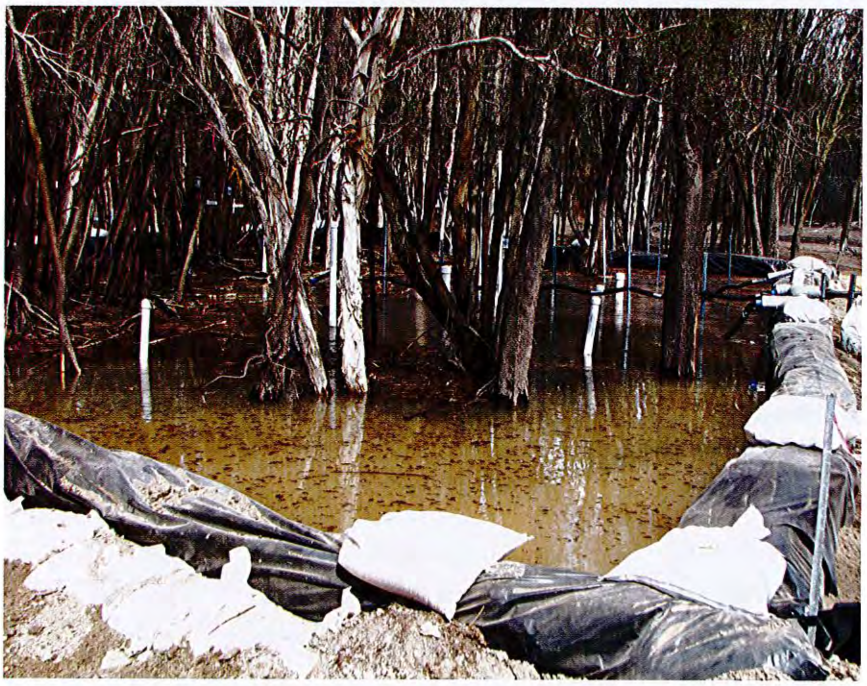
Left Freckled duck.
Photo – Jiri Lochman

Right Toolibin Lake pumping station.
Photo – Marie Lochman

Centre right The bund established for the flooding trial.
Photo – Jennifer Higbid/DEC

Below right Red-capped robin.
Photo – Jiri Lochman





the lake bed. These trees are good indicators of hydrological change in groundwater as they are sensitive to fluctuations in the quantity and quality of water in the unsaturated zone of the soil profile. The quantity and quality of water in the unsaturated zone, in turn, is influenced by surface water inflows and the depth to groundwater from the soil surface.

The lake bed trees are also highly responsive to the hydroperiod (the timing and frequency of flooding), and the length of time that water remains in the lake. In particular, the regeneration and survival of seedlings depends on certain aspects of the lake's hydroperiod. For example, a flooding event is needed for seeds to germinate but the lake bed has to then remain relatively dry for some years after germination to enable the seedlings to become established.

To help understand how the trees of the lake bed interact with surface water and saline groundwater, the BioRisk project team has installed sensors to record changes in the soil's physical environment (soil moisture and salinity), the underlying hydrology (groundwater depth and salinity) and growth and water use in trees (tree girth and sap flow).

While the data obtained from these sensors have shown how the trees respond to seasonal cycles, there hasn't been enough rainfall in the past three years to cause new water to flow into the lake. This has meant that our understanding of the interaction of surface water inflows with the soil and plants has been largely derived from models. To confirm some of the assumptions of these models and to understand the dynamics of salt and water movement during lake inundation, a small flooding trial was conducted on the lake bed.

Pond within a lake

A bund was created with sandbags, forming a rectangular plot about 15 metres long by 10 metres wide by 0.5 metres high. The bags were covered with polymer film to limit leakage. The plot contained more than 100 trees, both sheoaks and paperbarks, and a small group of these was fitted with sensors to measure tree girth and sap flow. Sensors were also set up to record changes in the depth and salinity of groundwater and surface water, and moisture and salinity in the soil profile. This design was replicated in a plot adjacent to the bund and a control plot about 50 metres from the bund. The bunded area was made watertight and fenced to keep kangaroos out of the plot and away from the sensitive equipment. Now to add water.

On Tuesday 22 March 2011 the water truck rolled up to Toolibin Lake and fresh water was gravity fed into the bund from two 9,500-litre storage tanks. Very soon the glorious sound of trickling water could be heard among the whistling sheoaks. The water truck returned throughout the day and replenished the tanks to provide a near-continuous water flow into the bund.

The seal of the bund was closely monitored and leaks were quickly plugged with clay spoil. During the first day, 60,000 litres of water were fed into the bund and the water depth increased at a rate of nine centimetres an hour and peaked at 42 centimetres. Another 20,000 litres of water were delivered three days later and the following week an additional 20,000 litres were applied, bringing the total to 100,000 litres. While some surface seepage did occur, a water depth of more than 30 centimetres was maintained for seven days. When the input of water ceased, the standing water slowly declined at a rate of about 0.14 centimetres an hour.

Happy dragonflies

Some of the lake's resident fauna were soon to arrive to inspect the newly formed pond. Within a couple of hours of the plot flooding, Australian emperor dragonflies (*Hemianax papuensis*) were zooming along the water surface. They were quick to seize the opportunity—by the afternoon, mating had already occurred and couples were observed laying eggs in tandem. Three different species of dragonfly were seen at the pond during the first three days of inundation.

Some of the local birds were also curious about the unusual water activities. A family of white-eared honeyeaters (*Lichenostomus leucotis*) flew in and before long they were enjoying a rare swim on a warm autumn day. A red-capped robin (*Petroica goodenovii*) dropped in for a quick dip while a grey butcherbird (*Cracticus torquatus*) surveyed the scene from the surrounding fence.

Results

The sensors within the bund detected a rapid increase in soil moisture almost immediately after flooding started and the soil profile remained saturated for several weeks after the initial rise. Soon after inundation, groundwater beneath the bund was observed rising toward the surface. Groundwater also rose adjacent to the bund but the rise was less than that observed below the bunded area.

Left New paperbark growth.
Photo – Jennifer Higbid/DEC

Water in, water out

The management actions implemented from the *Toolibin Lake Recovery Plan* have succeeded in reducing saline surface water flowing into Toolibin Lake and have also increased the depth to groundwater beneath the lake. Unfortunately, there is still a lot of salt in the soil and this has slowed the recovery of sheoaks and paperbarks. To help flush salt through the soil profile, surface water inflows must be carefully managed and an adequate depth of groundwater has to be maintained. For example, if fresh water enters the lake and remains there for longer than a month when the saline groundwater is near the surface, there is a high risk of bringing saline groundwater into the root zone, which would be detrimental to tree health.

Water inflows from the catchment that are greater than 1,000 milligrams a litre of total dissolved salts are currently diverted away from Toolibin Lake. While this saline surface water is being kept out to protect the lake bed vegetation, it also means that less water has been going into the lake for waterbirds. A modelling study in 2008 proposed raising the current salinity threshold to increase the frequency and extent of inundation, which would then improve habitat for waterbird breeding. The recent upgrade to outflow infrastructure means that water can now be released from the lake when needed; for example, when salts start to concentrate due to evaporation. However, before the threshold is increased, a better understanding of the risks to the lake bed vegetation is needed. Data from the inundation experiment will be useful for refining the salinity threshold and also for understanding the benefits and risks to the lake's biota from surface water inflows.

Right A stand of sheoaks on the lake bed.
Photo – Cliff Winfield

Centre right Mating dragonflies.

Below right Measuring sap flow.
Photos – Jennifer Higbid/DEC

Two weeks after inundation, salt was recorded flushing down through the upper soil profile.

Tree sap flow rose in both species, but mainly in the sheoaks, within several hours of inundation, as the rate of tree water use increased. Tree girth also increased—the sheoaks responded immediately to the available water while the paperbarks showed a slower, steadier response. Two months after the flooding trial, new growth was observed on the paperbarks and sheoaks within the bunded area. One male sheoak had even begun to produce flowers.

Next step for Toolibin Lake

The experiment showed that the lake bed vegetation responds rapidly to inundation with fresh water. During the experiment, sensors also detected flushing of salt from the upper soil profile. These benefits were somewhat offset by a rapid rise in highly saline groundwater toward the root zone. So the duration of inundation events at Toolibin Lake must be carefully regulated to ensure that salt is removed from the soil profile without bringing saline groundwater into the root zone. Alternatively, pumping must be used to further lower groundwater to the point that it does not represent a risk during inundation events. This information will be incorporated into hydrological models to improve management of the lake for conservation. Information from the BioRisk project will be instrumental in guiding the revision of the recovery plan and setting new goals and targets.

The flooding trial at Toolibin Lake has been a great success and the results will contribute to an informed management process that aims to improve the health of the lake bed flora of this internationally important wetland. As a bonus, the dragonflies were happy!

Jennifer Higbid is a planning officer with the Department of Environment and Conservation's (DEC's) Natural Resources Branch based at Kensington. She can be contacted by email (jennifer.higbid@dec.wa.gov.au).

Paul Drake is a senior research scientist with DEC's Natural Resources Branch based at Kensington. He can be contacted by email (paul.drake@dec.wa.gov.au).

The BioRisk project is funded by the Future Farm Industries Cooperative Research Centre.

The authors would like to thank DEC staff from the Natural Resources Branch and Great Southern District for their assistance during this project.

For more information on the Natural Diversity Recovery Catchment Program visit the 'Salinity' section of DEC's website at www.dec.wa.gov.au.

Volume 27 Number 2 SUMMER 2011–12

contents

Regulars

Publishing credits
Executive editor Madeleine Clews.
Editors Joanna Moore, Samille Mitchell, Rhianna King.
Scientific/technical advice Kevin Thiele, Keith Morris, Adrian Pinder, Kelly Waples, Allan Burbidge, Lindsay Bourke.
Design and production Gooitzen van der Meer, Tiffany Taylor, Natalie Jolakoski, Lynne Whittle, Sonja Schott.
Illustration Gooitzen van der Meer.
Cartography Promaco Geodraft.
Marketing Cathy Birch.
Phone (08) 9334 0296 or *fax* (08) 9334 0432.
Subscription enquiries *Phone* (08) 9219 8000.
Prepress and printing GEON, Western Australia.

ISSN 0815-4465

Please do not send unsolicited material, but feel free to contact the editors.

Published by the Department of Environment and Conservation, 17 Dick Perry Avenue, Kensington, Western Australia.

Visit DEC online at www.dec.wa.gov.au to search the *LANDSCOPE* catalogue.

Department of Environment and Conservation