National Environmental Research Program

NORTHERN AUSTRALIA HUB

Improving biodiversity conservation in northern Australia

Freshwater fishes of Kakadu National Park and the impact of sea level rise

What is the issue?

Sixty two species of freshwater fish have been recorded from Kakadu National Park. For 11 of these species, between 15% and 40% of their total predicted distribution occurs within the Park. Many freshwater fish species in the Park are likely to be impacted by climate change, especially saltwater intrusion onto freshwater floodplains as a result of sea level rise and increased storm surge.

Sea level rise is predicted to cause rapid and substantial habitat changes. In particular, affected freshwater wetlands are predicted to change to open saline mudflats. Floodplain and mudflat habitats may also experience higher temperatures and faster evaporation rates and seasonal wetlands (both brackish and freshwater) may persist in the landscape for less time. While some estuarine species may potentially benefit from expanded tidal habitat, some lowland freshwater species, particularly those largely confined to this habitat type, would appear to be vulnerable. This study, funded under the Northern Australia Hub of the Australian Government's National Environmental Research Program, examined the direct effects of sea level rise on floodplain freshwater fish species.

The research was undertaken in the Alligator Rivers Region of Kakadu National Park - Photo by Michael Hammer.

What did the research do?

To predict the extent of impact of sea level rise on floodplain fishes the team developed a model incorporating topographic information for the lowland rivers, floodplains and estuaries of the Park and the predicted distribution data for 55 freshwater fish species. While climate change scientists are confident that sea levels will rise, due to the complexity of climate systems, the exact rate and amount of change is unknown. In the Kakadu region a rise of up to 100 cm over the next century is anticipated. To adequately identify species potentially at risk, this project adopted a sea level rise of 100 cm above the mean high water level, to generate the predicted extent of saline incursion on the existing floodplain environment. The areas predicted to be affected by sea level rise were then overlayed with distributional information for each fish species to identify the proportion of habitat that may become unsuitable due to sea level rise for each species.

The ancient osteoglossid or bonytongue *Scleropages jardinii* is an example of a fish species highly vulnerable to increases in salinity - Photo by Michael Hammer.

Which fish are at risk?

The most vulnerable fish species are those that have a low tolerance to increases in salinity and for which floodplains are their only habitat.

In this assessment, species were grouped according to levels of vulnerability to salinity changes (High and Moderate) and exposure (High and Moderate). Exposure is measured according to the proportion of their distribution within Kakadu National Park that will be affected by a sea level rise of 100 cm. Within Kakadu, floodplain-dependent fish distributions varied from 0-46% affected by a sea level rise of 100 cm. If more than 10% of a fish's distribution will be affected by a 100 cm sea level rise it was classed as high exposure, while having 1-10% of the distribution affected is classed as moderate exposure.

Within Kakadu the fishes assessed as most at risk, due to high vulnerability and high exposure were the gudgeon *Oxyeleotris nullipora*, the blue eyes *Pseudomugil tenellus* and *P. gertrudae*, the rainbowfish *Melanotaenia nigrans* and the pennyfish *Denariusa bandata*.

Table 1. Freshwater fish species of Kakadu National Park at risk of impacts associated with sea level rise. Species have been grouped according to levels of vulnerability to salinity (High and Moderate) and exposure (High and Moderate). Exposure is quantified according to the portion (%) of their distribution within Kakadu National Park that lies below a projected sea level rise of 100 cm. High = >10% of distribution, Moderate = 1-10% of distribution.

		Vulnerability	
		Moderate	**High**
Exposure	**Moderate**	*Neosilurus ater* *Oxyeleotris selheimi* *Leiopotherapon unicolor* *Melanotaenia splendida* *Anodontoglanis dahli* *Pingalla midgleyi* *Hephaestus fuliginosus* *Craterocephalus marianae*	*Craterocepahlus stercusmuscarum* *Glossamia aprion* *Porochilus rendahli* *Syncomistes butleri* *Ambassis macleayi*
	High	*Ambassis* sp. (northwest) *Ambassis agrammus* *Nematalosa erebi* *Toxotes chatareus* *Strongylura kreffti* *Oxyeleotris lineolate* *Amniataba percoides* *Toxotes lorentzi*	*Oxyeleotris nullipora* *Pseudomugil tenellus* *Melanotaenia nigrans* *Pseudomugil gertrudae* *Denariusa bandata* *Scleropages jardinii*

Moderately vulnerable species were not restricted to floodplain habitats and occurred widely within the riverine landscape. Risk for this group varied from 0% to 44% habitat conversion. The least vulnerable group of fishes included species with a higher tolerance to increased salinity. Risk for this group varied from 0 to 100% habitat conversion. This group included many species that use estuaries for breeding such as barramundi. Although not directly impacted by sea level rise, changes in primary production, food sources and food webs linked with the conversion of floodplain wetlands to saline mudflats may have substantial negative indirect effects.

As mentioned, the *Pseudomugil tenellus* or delicate blue eye was one of the fishes assessed as at most risk (pictured above). The species is restricted to floodplain wetlands in two isolated areas of northern Australia. One area is centred around the Kakadu region and the other is located on Cape York Peninsula. It is intolerant of elevated salinity unlike some other members of the genus and is most frequently found in association with aquatic vegetation which it uses for cover from predation and as an area for breeding. Aquatic vegetation species are typically intolerant of elevated salinity also. If they die off due to salt water intrusion, this vital habitat requirement will be lost for blue-eyes. *Oxyeleotris nullipora* has a similar distribution and macro and mesohabitat requirement as delicate blue eye. In addition it prefers water with a lower pH (i.e. slightly acidic).

While this study didn't examine the potential impacts of sea level rise to the energy transfer from wetlands to the estuary due to the change of wetlands to saline mudflats, it's reasonable to assume they may be extreme. Other Hub research has documented that wet season flows transport large amounts of nutrients and energy from Kakadu's freshwater floodplain wetlands to downstream estuaries. This pulse drives a surge in primary productivity within the estuary and sustains the estuary for the remainder of the year. If the productivity of the floodplain wetlands is reduced due to conversion to mud flats, it is logical to assume that this will reduce the supply of nutrients and energy to downstream estuaries which will reduce the productive capacity of the estuary and impact recreationally important species such as barramundi and jewfish.

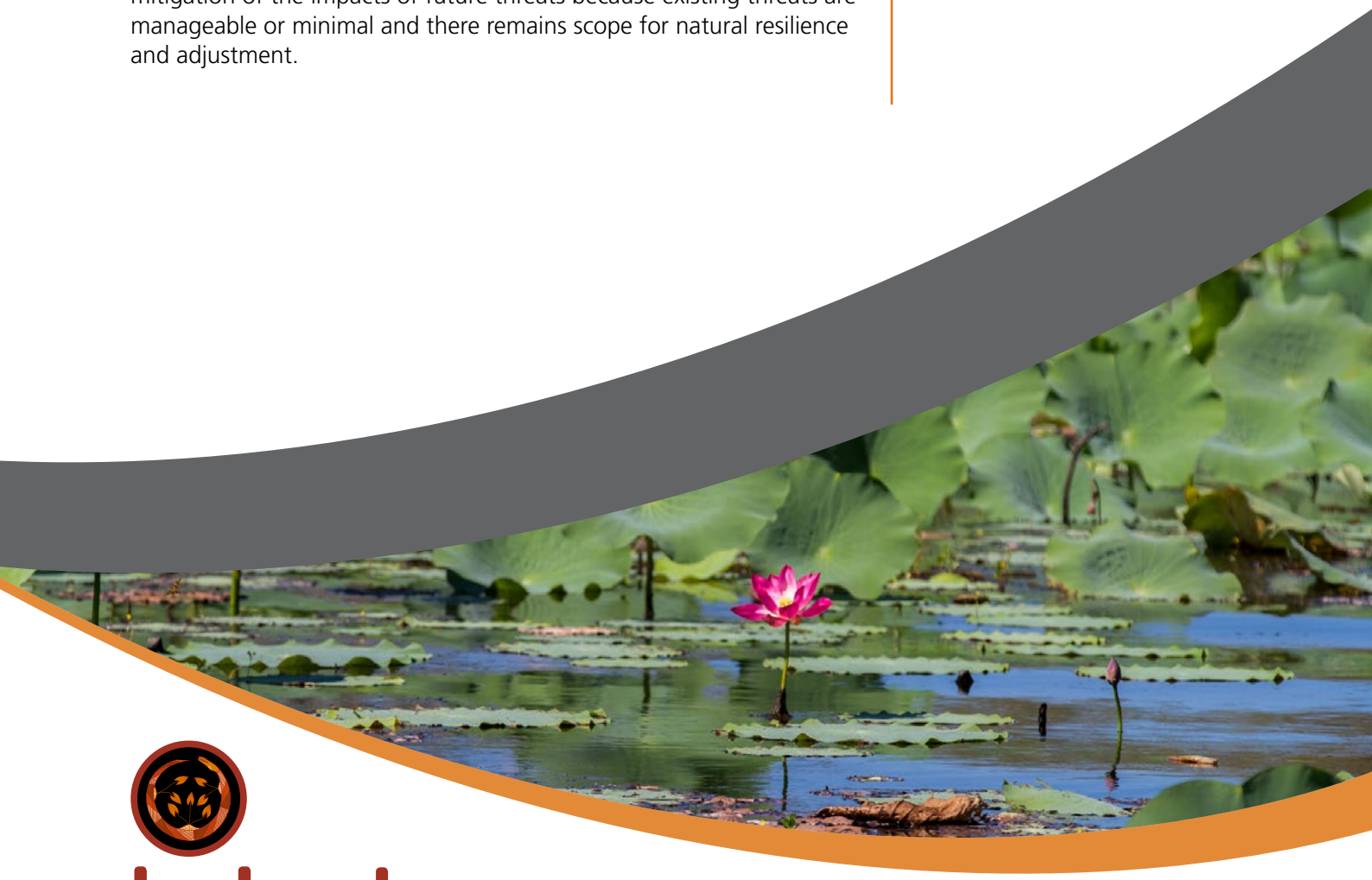
How can we use this research?

Wetlands of the Kakadu region and of northern Australia in general are high value repositories of fish biodiversity. Climate change and sea level rise are potential threats to estuarine and floodplain condition in addition to the existing threats imposed by weeds, feral animals and inappropriate fire regimes. Kakadu National Park offers the best opportunity for sustainable management of its aquatic ecosystems and mitigation of the impacts of future threats because existing threats are manageable or minimal and there remains scope for natural resilience and adjustment.

Further information

Contact Brad Pusey at bpusey@westnet.com.au

You can also visit http://www.nerpnorthern.edu.au/research/projects/33



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