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Published

2009

Journal Title

Ecological Management & Restoration

DOI

10.1111/j.1442-8903.2009.00498.x

Floodplain degradation and restoration in Northern Queensland: The response of the Alien Fish Pest

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Background

The Burdekin River basin is one of Queensland's most important areas in terms of primary production, with sugar cane production dominating the delta region. Extensive clearing – as well as extensive irrigation which has altered the hydrology from naturally intermittent to artificially perennial – has greatly changed fish habitats on the delta (Perna 2003). Changes in hydrology have greatly benefited aquatic weeds, which in turn has greatly reduced dissolved oxygen content in the waterbodies (Perna 2003; Perna & Burrows 2005). Large-scale physical removal of aquatic weed infestations by floating harvester and excavator has been shown to greatly improve water quality, fish habitat and the diversity and abundance of native fishes in two lagoons and a 15 km reach of Sheep Station Creek, a typical floodplain creek system on the delta (Perna 2003, 2004; Perna & Burrows 2005).

The alien Plague Minnow (Gambusia holbrooki (Girard, 1859)), a small fish within the Poeciliidae or top minnows, is abundant in many locations in the lower Burdekin River, frequently dominating fish communities in highly degraded locations (Perna 2003, 2004; Perna et al. in review). Many studies report that reductions in habitat condition can create the circumstances in which this species and other alien species are able to colonise and thrive (Kennard et al. 2005; Habit et al. 2006; King & Warburton 2007). We investigated the relationship between habitat condition (i.e. deviation away from natural) and the abundance and distribution of Plague Minnow on the Burdekin River floodplain. We also investigated whether removal of aquatic weed infestations affects the abundance of Plague Minnow in a large lagoon on Sheep Station Creek., degraded by proliferation of Water Hyacinth (Eichornia crassipes (Mart.) Solms) and Para Grass (Urochloa mutica (Forssk.) Nguyen). This paper describes the variation in the abundance of Plague Minnow associated with habitat degradation and trials of mechanical weed removal. A full description of the weed removal process is available in Perna (2003); while a full description of the response of native fishes to these factors will appear elsewhere (e.g. Perna et al. in review).

Methods

Assessment of habitat conditions

The habitat condition at each of 25 separate sites was classified according to evident changes in hydrology, riparian vegetation, water quality and the presence of alien aquatic weeds such as Water Hyacinth and Para Grass. The locations examined included 10 sites sampled over time (2.5 years) and 15 sites examined once to assess habitat conditions across the greater floodplain. For the present analysis, only samples from the same period (mid-2000) were used. Sites were assigned to one of three categories based on habitat condition. Condition 1 sites (highly degraded) were characterised by modified flows (e.g. artificially supplemented by water pumped from the Burdekin River), very high cover of aquatic weeds, low riparian continuity and integrity and poor water quality. Condition 2 sites (moderately degraded) were characterised by modified flows but low to moderate abundance of aquatic weeds, moderate riparian continuity and integrity and moderate water quality. Condition 3 sites (natural) were characterised by a natural or only partially modified flow regimes with little impact on water quality or habitat condition, no invasive weeds, high riparian continuity and integrity and good water quality. Full description of the classification process can be found in Perna (2003).

Aquatic weed removal at Payard's Lagoon

Changes in the same suite of variables in response to weed removal was assessed in one lagoon (Payard's) in Sheep Station Creek, the site chosen for the aquatic weed removal trial. This lagoon was sampled on three occasions prior (over a three month period) and a further six times (over 2 years) after weed removal.

Determination of plague minnow abundance

The abundance of Plague Minnow and native fish was determined at each site. A 1 m ・ 0.75 mm push net with knotless 15mm stretch mesh was lowered into the water from the bow of an aluminium punt and pushed for 1 m into specific habitat types (e.g. submerged macrophytes, emergent vegetation, Water Hyacinth clumps, Para Grass edges), lifted out and the catch collected and later sorted. Nine push net shots were taken at each site.

Data analysis

Between group (condition states) differences in total fish abundance (native and alien species combined), abundance of Plague Minnow and the proportional contribution of Plague Minnow to total abundance were assessed by one-way Analysis of Variance (ANOVA). Abundance estimates were log (x + 1) transformed and the proportional estimates were arcsine transformed prior to analysis to satisfy concerns about parameter heteroscedasticity. Analyses were preformed in SPSS version 14 (SPSS Inc, Chicago Illinois, USA).

Results and Discussion

Plague Minnow was the most abundant species ($F_{2,22} = 4.194$, $P < 0.05$, Fig. 1a) and dominated the fish community in the most degraded wetlands (condition 1) ($F_{2,22} = 4.30$, $P < 0.05$, Fig. 1b). In both cases, significant differences were limited to comparisons between condition 1 and 2 and 1 and 3, not 2 and 3. In the weed removal trial (Payard’s lagoon), a rapid reduction ($t = 6.781$, $P < 0.01$) in the proportional abundance of Plague Minnow from a pre-treatment mean of 89% to a post-treatment mean of 23% was detected (Fig. 2). These results suggest that habitat conditions influence the abundance of Plague Minnow within wetlands of the Burdekin River floodplain.

The Plague Minnow has been shown to thrive in highly degraded conditions within Australia (Arthington et al. 1983; Morgan et al. 2004; Kennard et al. 2005; Habit et al. 2006; King & Warburton 2007) and this was also shown to be the case in wetlands of the Burdekin River in the present study. Plague Minnow was absent from some

(a) **(b)**

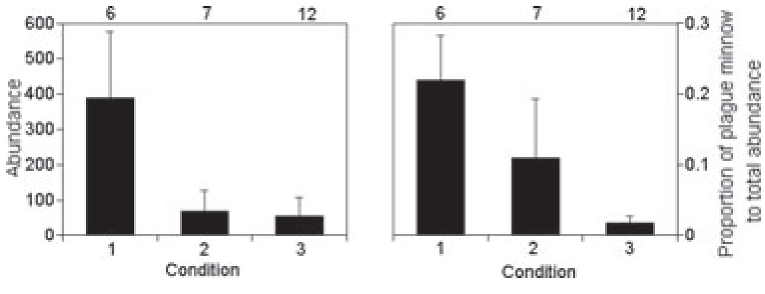

Figure 1. Changes in the total abundance (a) and proportional abundance (b) of Plague Minnow in floodplain lagoons of differing habitat condition (1 = highly degraded, 2 = moderately degraded and 3 = near neutral). Sample sizes are given for each treatment. Values shown are the mean and standard error.

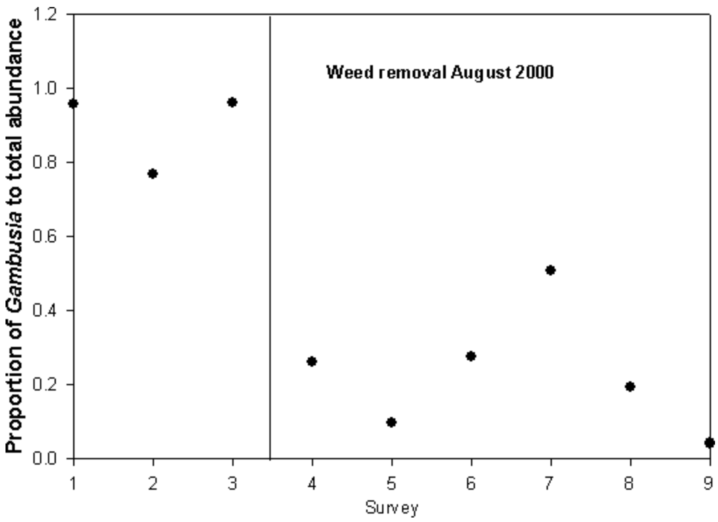

Figure 2. Comparison of proportion of Plaque Minnow to total abundance before and after weed removal at Payard's lagoon. Data shown are the mean abundance estimates from nine push net samples from each of nine surveys over the period 2000–2002.

highly degraded sites however, and was also found in high abundance at some sites of high condition, suggesting that the abundance of this alien fish may be due to several factors in addition to habitat disturbance (e.g. generalist habitat preference or colonisability of lagoon habitats). However, sites with intact aquatic and riparian habitat tended to contain a higher diversity and abundance of native fish and typically contained few or no Plague Minnow. (Perna 2003; C. Perna et al. 2010, unpublished data). The combined effects of reduced abundance of alien plague minnows and improved habitat suitability for native fish (Perna 2003; Perna et al. in review) suggests that a relatively simple remediation measure such as aquatic weed removal can result in significant improvements in fish community structure.

Given the association between habitat degradation and abundance of Plague Minnow and the negative impact it has on native fish species (Howe et al. 1997; Ivanstoff & Aarn 1999; Morgan et al. 2004; Becker et al. 2005), the preliminary results on the success of weed removal in one lagoon are encouraging. If restoring degraded wetland habitats through aquatic weed control can reduce the abundance of this alien species and allow for more natural communities of native fish to develop, then the negative impacts of Plague Minnow may be reduced. We here assume that negative impacts of Plague Minnow are correlated with its abundance, but we cannot, however, ascribe all changes to native fish communities (Perna 2004) to its presence. Habitat degradation, in and of itself, is more likely to be the major source of impact on native fish communities. Aquatic weed control in the Burdekin floodplain may allow native species previously excluded by poor condition to re-establish, which in turn, may subsequently aid in further reduction of Plague Minnow abundance. Webb (2003) found that reducing the extent of weed cover increased predation on Plague Minnow by native piscivorous fishes such as the Mouth Almighty (Glossamia aprion (Richardson)). Similarly the predation of Plague Minnow by Tarpon (Megalops cyprinoides (Broussonet, 1782)) was observed during and immediately after weed removal at Payard's (Arthur Darwen, landholder, pers comm., Perna 2003). Further investigation into the effects of habitat restoration and its effects on the presence and abundance of alien fishes is recommended.

Acknowledgements

We would like to thank the local landholders along Sheep Station Creek for their support, local knowledge and access; the Natural Heritage Trust for funding; and the Australian Institute for Marine Science Australian and Centre for Tropical Freshwater Research for operational support. Suggestion made by the anonymous reviewers were greatly appreciated.

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