Population dynamics of the invasive fish, *Gambusia affinis*, in irrigation impoundments in the Sundays River Valley, Eastern Cape, South Africa

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ABSTRACT

The alien invasive *Gambusia affinis* is one of the most widely introduced fish species on the planet, and has established in freshwater ecosystems across South Africa. The invasion ecology and, in particular, the population dynamics of the species in this country are, however, poorly understood. In this study the relative abundance and population dynamics of *G. affinis* were quantified in 5 interconnected irrigation impoundments within the Sundays River Valley, Eastern Cape. Four fish surveys were conducted from early summer (February 2012) to early winter (June 2012). Repeated-measures ANOVA analyses on the catch per unit effort (CPUE) of *G. affinis* between sampling events and dams revealed significant differences in population dynamics among dams, although an overall trend of rapid increase followed by plateau in summer, with a rapid decline in winter was seen in most dams. A general linear model assessing the role of biotic and abiotic factors on *G. affinis* CPUE found that water temperature and the presence of the native fish *Glossogobius callidus* had significant effects on the CPUE of *G. affinis*. While winter drops in temperature are likely to have caused mortality in *G. affinis* populations, and may act as the primary regulator of *G. affinis* establishment success in South African impoundments, the negative effect of *G. callidus* densities on *G. affinis* suggests competitive or predator-prey interactions with the native species.

Keywords: Mosquitofish, population growth rate, invasive success, establishment

INTRODUCTION

Species invasions are a principle driver of biodiversity losses (Lowe et al., 2000), and identification of what determines successful invasions is a prerequisite for adopting sound conservation policies (Leprieur et al., 2008). Freshwater ecosystems are at the forefront of the global biodiversity crisis, with more species facing local extinction than in marine and terrestrial environments (Johnson et al., 2008). Hydrological alterations and biological invasions represent two of the greatest threats to freshwater biota (Johnson et al., 2008). Invasive fishes in particular have had dramatic impacts on the native biota in aquatic ecosystems and are largely responsible for habitat degradation and species loss (Mack et al., 2000).

South Africa is an alien invasive fish hotspot (Van Rensburg et al., 2011). Sixteen of the thirty IUCN red-listed fish species native to South Africa are threatened primarily by predatory non-native fish species (Richardson et al., 2010). As a result, a number of native fishes, amphibians and invertebrates have become locally extinct (Van Rensburg et al., 2011). In addition to their direct impacts on native species, invasive fish also negatively affect aquatic macro-invertebrates and can alter habitats (Richardson et al., 2010).

The mosquitofish, *Gambusia affinis,* is listed as one of the world's worst invasive species (Lowe et al., 2000) and, together with the closely-related *G. holbrooki*, is the most widely distributed freshwater fish in the world (Pyke, 2005). Since its introduction into South Africa in 1936 for mosquito control, *G. affinis* has spread across southern Africa (De Moor and Bruton, 1988). The main vector responsible for the expansion of invasive fish is human-mediated relocation (Van Rensburg et al., 2011), although they are also spread through interconnected waterways (Rauchenberger, 1989). Currently, *G. affinis* is present in more than 50% of South Africa's river systems and will continue to colonise new waters where the environmental conditions permit (Van Rensburg et al. 2011).

Although *G. affinis* is a relatively well-studied fish, its invasive characteristics and impacts on biodiversity are controversial, with research supporting conflicting perceptions that the species is either relatively benign or a significant threat to native species (Pyke, 2008). While humans have regarded *G. affinis* as beneficial because of their control of mosquitoes, *G. affinis* is considered likely to have deleterious impacts on the native fish, frogs and aquatic invertebrates with which they interact (Pyke and White, 2000). Few quantitative studies, however, exist that describe the population dynamics of *G. affinis* in systems where it is introduced, or the direct impacts they have on native species in these habitats (Pyke, 2008). For example, reduced densities of *G. affinis* are often recorded during winter months relative to summer, although the reasons for this pattern are still not well understood (Pyke, 2005). The lack of information on this species is particularly acute in South Africa, where most existing studies on *G. affinis* biology are unpublished (De Moor and Bruton, 1988).

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