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# Investigating behaviour for conservation goals: Conspecific call playback can be used to alter amphibian distributions within ponds

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ABSTRACT

Conspecific attraction can prevent occupancy of restored or created habitats by limiting dispersal to unoccupied areas. This may cause problems for threatened taxa where habitat restoration and creation programmes are implemented as part of species recovery plans. Studies on birds have found that the introduction of artificial communication cues such as calling can increase occupancy of restored habitat. The endangered green and golden bell frog (*Litoria aurea*) has a number of behavioural traits which suggest conspecific attraction occurs via a vocal mechanism, including a loud conspicuous call and large chorusing aggregations. To date, attempts to repopulate restored and created habitat through natural immigration and active translocation of tadpoles and juveniles have been met with limited success for this species. We used *L. aurea* to determine if distribution could be manipulated via conspecific attraction using artificial communication cues. We placed speaker systems in uninhabited areas of five inhabited ponds across two locations and broadcast calls of *L. aurea* to see if we could manipulate distribution into previously unoccupied pond areas. Surveys undertaken before and after broadcast indicate that we successfully manipulated *L. aurea* distribution for adults increasing both occupancy and calling around the speaker locations. This occurred in four of five replicate ponds over three months of experimental treatment, but controls remained low in abundance. We suggest that manipulation of distribution via conspecific attraction mechanisms could be a useful conservation tool for endangered amphibian habitat restoration and creation programmes, resulting in increased occupancy and programme success.



## 1. Introduction

Understanding the drivers of species dispersal, settlement and site occupation is of vital importance to conservation efforts. Conservation programmes frequently employ the creation of habitat and translocation of animals in response to habitat loss. However, there has been limited success in attracting many species to restored or created habitat (Lehtinen and Galatowitsch, 2001; Pechmann et al., 2001), or in retaining individuals at reintroduction sites (Armstrong and Seddon, 2008; Germano and Bishop, 2009; Reinert, 1991). In the instance that a restoration and/or translocation fails, poor outcomes are often attributed to predation, disease or a lack of understanding about species specific habitat requirements (Griffith et al., 1989; Pyke et al., 2008; Stockwell et al., 2008; White and Pyke, 2008; Wolf et al., 1998). One factor rarely considered in such programmes is the effect of aggregation behaviour and communication in driving distribution (Campomizzi et al., 2008).

For some species, an increase in local population density may promote reproduction and survival making areas of high density more attractive to move toward. With increasing density, organisms may experience an increase in mate-finding, mating probability and mate choice, or higher densities may provide protection from predators, climate as well as increase feeding efficiency (Hamilton, 1971; Kanarek et al., 2013; Morgan and Godin, 1985; Schwartz and Wells, 1985; Waldman and Adler, 1979; Watson et al., 2006). This increase in density can be facilitated through directional cues, which an organism can locate and move toward, such as visual spotting, olfaction and auditory calling (Hamer et al., 2011; Narins et al., 2003; Rosenthal et al., 2004). In the instance an animal preferentially settles near conspecifics, conservation efforts that merely focus on creating habitat may find that a lack of settled conspecifics and their directional cues prevents colonisation and/or persistence (Smith, 1990).

Amphibians are currently one of the most threatened vertebrate taxa, with hundreds of species experiencing population declines and extinctions around the world (Bishop et al., 2012; Houlahan et al., 2000; Stuart et al., 2004; Wake, 1991). Many threatening processes have been implicated in these declines but there are few examples of behavioural consideration in translocation or habitat restoration programmes.

Many amphibians aggregate to breed which can indicate that conspecific attraction occurs in this taxa (Bee, 2007; Gerhardt and Huber,

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2002). As auditory calling is one of the most conspicuous communication cues, it has been suggested that chorusing is the major cue used to locate conspecifics, facilitating mate and habitat finding over long distances (Bee, 2007; Swanson et al., 2007). Considerable focus has been placed on the call properties of male frogs, their variability and resulting changes in female attraction and mate selection (Gerhardt and Huber, 2002). However, very little research has assessed this in the context of landscape movements and spatial distribution. Studies have reported that five amphibian species show phonotaxis to the sound of a male chorus aggregation; four instances for females (Christie et al., 2010; Gerhardt and Klump, 1988; Swanson et al., 2007) and one instance for males (Bee, 2007). Furthermore, Swanson et al. (2007) and Christie et al. (2010) reported that females of three species approach choruses up to a distance of 40 m and 100 m, respectively. As such, conspecific attraction may play a critical role in determining amphibian movement and distribution. Therefore, imitating the presence of conspecifics in created habitats could manipulate distribution and thus encourage colonisation and establishment.

Manipulation of spatial distribution in natural settings using social cues has been reported for a number of bird species. The introduction of mirrors, models of conspecifics and broadcast of conspecific calls affected distribution of colonial birds and re-established colonies on previously occupied sites (Kress, 1997). Similarly, a review found that 20 out of 24 studies attempting manipulation of bird distribution were successful (reviewed in Ahlering et al., 2010), some of which indicate that call broadcast without visual cueing is adequate to manipulate distribution (Hahn and Silverman, 2006, 2007). Similar to studies with birds, amphibian management programmes might be able to use such cues to encourage occupation of sites in new or rehabilitated habitat by facilitating movement, if proof of this concept can be established. This may also help move animals back to their original distribution after the cause of decline has been removed.

Regardless of the overwhelming laboratory evidence that amphibians exhibit conspecific attraction, attempted manipulation of amphibian distribution has not been undertaken. The current study aimed to determine whether the introduction of artificial conspecific calls can influence the chorus locations of a pond breeding anuran (the green and golden bell frog, *Litoria aurea*).

## 2. Methods

### 2.1. Study species

The green and golden bell frog (*L. aurea*) is considered globally (IUCN, 2015) and nationally vulnerable (*Environment Protection and Biodiversity Conservation Act 1999*) and is considered endangered in N.S.W. Australia (*Threatened Species Conservation Act 1995*) having declined in distribution across the State. For *L. aurea*, habitat loss is a stressor affecting local populations which are small and isolated, following declines from global causes such as disease and climate change (Mahony et al., 2013). *L. aurea* breeds in ephemeral and permanent ponds of varying sizes and hydroperiod (Hamer et al., 2008; Mahony, 1999).

*L. aurea* exhibits behavioural traits consistent with conspecific attraction. Males display aggregatory behaviour in permanent ponds often within vegetation patches and appear in flooded sites immediately after rain. It has been hypothesised that this species has ‘boom and bust’ breeding events in ponds and thus high variability in frog abundance within ponds in a breeding season (Hamer, 2002; Hamer et al., 2008). In this sense, calling may facilitate aggregations away from permanent ponds.

Additionally, studies attempting to correlate habitat features with distribution have not identified a consistent set of habitat predictor variables, suggesting habitat structure and composition is not the driving factor in their occupancy patterns (Garnham, 2009; Hamer et al., 2002; Midson, 2009; Pollard, 2009; Pyke and White, 1996). Despite the apparent lack of selectivity, they do not occupy all available habitat ponds (Hamer and Mahony, 2009; Stockwell, 2009) indicating that other factors are responsible for the occupancy of habitat. Additionally, although this species often uses artificial habitat (Pyke and White, 2001), habitat creation and reintroduction programmes often fail to establish populations (Daly et al., 2008; Pyke et al., 2008; Stockwell et al., 2008; White and Pyke, 2008).

Taken together, these observations of chorus aggregation and occupation of a limited proportion of the available pond habitat, indicate that their site selection and occupation is driven by social cues. These cues have the potential to be manipulated to select and control the ponds that are occupied and redistribute this species within a landscape.

### 2.2. Study site

This study was undertaken on Ash Island (AI) (−32.862863 S, 151.728355 E), and Sydney Olympic Park (SOP) (−33.841014 S, 151.071789 E) N.S.W. Australia where two of the largest persisting populations of *L. aurea* occur. Five permanent ponds were chosen as replicates based on regular occupation by chorusing *L. aurea* and occupancy data from recent research and monitoring programmes (Bower et al., 2011; Stockwell, 2011); two on AI (AI1 and AI2) and three within SOP (SOP1, SOP2 and SOP3). Experimental manipulation and surveys of these ponds were undertaken from spring to autumn (September 2011 to March 2012). Each pond was divided into multiple survey sections based on vegetation patches, where the border between two patches was defined by separation of water, rocks or change in vegetation type.

### 2.3. Pre-broadcast surveys

Prior to the introduction of calls (broadcast), abundance surveys were undertaken for eleven nights at SOP and five nights on AI (September, October and November 2011). Each section of each pond was surveyed using auditory surveys (AS) and timed visual encounter surveys (VES) (Bower et al., 2014) to determine the relative abundance of adults and amount of calling. Surveys were undertaken within the fringing and emergent vegetation of each pond after dusk, commencing at approximately 2000 h Eastern Daylight Savings Time (EDST) and ceased between 0100 and 0500 h. Observers were trained to recognise adults from size over short distances (<5 m). However, if a frog was close to adult size (SVL of <45 mm), they were captured and measured using dial callipers. Due to difficulties in capture and determining sex from a distance, sex was not recorded unless there was direct observation of calling which indicate the frog was an adult male.

The location of each animal was recorded using a Global Positioning System (GPS) device (eTrex Vista HCx) and mapped using MapInfo (Pitney-Bowes-Software-Inc., 2010) to the nearest 4 m. Ponds were mapped on a geo-referenced satellite image and geographical polygons were applied around pond sections and numbered. The GPS coordinates for each *L. aurea* from pre-broadcast surveys were plotted onto the satellite image and the polygon number was transferred to the raw data sheet to indicate which pond section each animal was found.

Within ponds, *L. aurea* distribution is aggregated, thus causing some vegetation patches to have high abundance levels and some to have low abundance levels. As this experiment aimed to draw *L. aurea* to uninhabited areas within a pond, the section with the lowest abundance level was classified as a treatment location (where speakers would be placed). The remaining pond sections were then used as reference areas (controls). Reference areas were split into high abundance areas (with aggregations of *L. aurea*) and low abundance areas (without aggregations of *L. aurea*). The two reference group categories were selected by reference to the distribution of adults at each pond. There was a clear grouping of low abundance reference areas with densities below 1.5 adults counted per 30 min VES. This resulted in multiple pond sections; five treatment areas (one per pond), eleven low