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Managing pond-breeding anurans in the selectively harvested forests of coastal New South Wales, Australia

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ABSTRACT

Protective prescriptions are used to protect populations of anurans from the impacts of logging present in areas of eucalypt forestry operations in coastal New South Wales, retaining areas of undisturbed habitat known or perceived to be of importance to their survival. Current evidence indicates that the protective buffer zones applied around bodies of water are likely to provide significant protection to breeding individuals and the aquatic breeding environments. Studies of the activity patterns of anurans, however, suggest that non-breeding individuals often use forest areas falling outside of these buffers. The habitats used when not breeding are afforded some protection through the retention of habitat trees, identified suitable habitat areas and movement corridors, but significant areas can still be disturbed, and often severely, by logging machinery. Australian anuran populations appear to generally be robust to the effects of logging, with only habitat specialists showing obvious declines. I postulate that anurans in this region are pre-adapted to coping with the changes produced by selective logging because they have evolved in a highly changeable environment. Current forestry practices are unlikely to have significant long-term negative effects if current protective measures are retained to protect identified sensitive habitats. If more intensive logging is adopted, it should be the subject of a well planned adaptive monitoring program.

1. Introduction

Managing the impacts of forestry on anuran populations has become of considerable importance in recent years given the worldwide declines of amphibians (e.g., McCallum, 2007; Wake and Vredenburg, 2008). Whilst, in Australia, the dramatic declines of the 1980s and early 1990s were likely largely related to the arrival of the chytrid fungus (Berger et al., 1998), the remaining populations are smaller and more scattered and so may now be less robust to disturbances. Hence, the protection of anurans from threatening processes that are human-produced may be more critical than was previously the case. This is an area of particular importance in Australia as a relatively high proportion of its anuran species have declined and are listed as under threat of extinction (Hero et al., 2006).

Over one million ha of temperate, coastal eucalypt forest is available for selective harvesting of timber in eastern New South Wales and are divided into two classes: non-regrowth forest and regrowth forest. Forested areas are divided into compartments that are managed as separate units using approved harvest plans. Harvesting is undertaken using heavy machinery and typically covers one to two thinning cycles and a final saw-log cut of the retained larger trees at 40–60 years of age. Logging of the compartments is designed to leave a mosaic of logged and unlogged forest as recognized in Ecologically Sustainable Forest Management (ESFM) Plans (see http://www.dpi.nsw.gov.au/forests/management/esfm).

Concerns have been raised over the impacts of forestry on Australian species over a long period of time (e.g., Tyler, 1976; Scotts, 1991; Ehmann, 1997; Lunney, 2004). This has resulted in the protection of rainforest and identified high-conservation value old-growth forest. Where harvesting can occur, both general and anuran specific "prescriptions" have been designed to protect populations from being significantly impacted by harvesting. Research over the past 20 years has resulted in a better understanding of the habitat requirements of the anurans in the forests of coastal NSW and also provided more information of their responses to anthropogenic disturbances. The aim has been to provide scientifically based evidence as to whether it is possible to sustainably manage the anurans in these forests whilst being able to undertake harvesting of timber. The objective of this paper is to review and

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assess approaches being used to protect anurans from harvesting of timber, consider how they are employed and if they can be refined to be more effective.

2. Protective measures

The types and levels of protections afforded to threatened species in coastal forests managed for timber production are provided in Tables 1 and 2. They were determined after consultation with researchers and managers and form part of the Threatened Species License (TSL) issued by the NSW National Parks and Wildlife Service allowing forestry to be undertaken in areas with known threatened species.

2.1. Pond buffers

The most widely used method of protecting anurans in forested areas is the retention of riparian buffer zones, which are undisturbed strips of vegetation immediately adjacent to the breeding sites. Prior to logging, buffer zones of varying sizes are required to be placed around any identifiable pond or pool located within the harvest area, including sites where temporary pools will form. The size of the buffer zone depends on the size of the temporary or permanent pond and factors such as slope and soil type (CaLM, 1995), and all disturbances are to be excluded from these zones as far as it is practical to do so. Where threatened species considered to be more sensitive to disturbance are known or are likely to use a water body, this buffer zone is required to be of an increased minimum size and can vary between northern and southern coastal forests (Tables 1 and 2).

This buffer zone is designed to protect the water quality within the water body and varies widely depending on factors such as slope and soil type and the size of the water body being protected. Most studies and reviews of research have indicated that a 15–30 m buffer zone of retained native forest will minimize the impacts of siltation on water quality, even in areas of intensive forestry (Newbold et al., 1980; Davies and Nelson, 1994; Broadmeadow and Nisbett, 2004; Lee et al., 2004; Webb and Haywood, 2005). However, the width required for a buffer zone to be effective depends on the environment and on the activity undertaken. In general, the overland transport of sediments or other materials is quickly reduced by the presence of forest vegetation that captures the material within the ground cover (e.g., Lacey, 2000). Smaller pools in flat areas with coarse soils are only required to be protected by buffers 10 m wide. Soils with fine materials such as clays represent a significant problem in managing erosion and require buffer zones of 50 m or larger to be effective (CaLM, 1995). The setting of adequately sized buffer zones should prevent significant negative impacts on the water quality in breeding habitats of the resident anurans. However, given the variable nature of the environment, the success of buffers in protecting water quality is always the subject of further investigation and should be subject to adaptive management programs.

Whilst the use of buffer zones is well established, there is always the potential for sediment and ionic influxes to occur under extreme or unexpected circumstances. Changes can have negative effects on tadpoles (Duellman and Trueb, 1986), but the sensitivity of Australian tadpoles to such changes is not yet well established. A study that introduced repeated sediment influxes into the tanks of tadpoles from two species of ground anurans, one of which will breed in ponds, found no indication of negative impacts of this treatment (Green et al., 2004). Research into the impacts of sediment influxes on stream-breeding anurans indicated that the smothering of algae by sediments was a likely negative effect as this could greatly decrease the extent and quality of the available food leading to reduced tadpole growth (Gillespie, 2002).

Pond buffers also protect the habitats used by anurans during the reproductive period. The males of pond-breeding anurans in NSW generally call from within the perimeter of the pond or from within 10 m of the edge of the water, often using vegetation or downed woody material as shelter (Barker et al., 1995; Cogger, 2000). Hence, the majority of calling sites are protected from disturbance by even small pond buffers. The daytime retreat sites of males or females attending the pond during periods of reproduction are not well known, but the available information suggests that frogs in this region remain in close proximity to the breeding ponds at this time. Radio-tracked males of *Heleioporus australiacus* (Penman et al., 2008b), *Litoria peronii* (Lemckert et al., in press) and *Litoria brevipalmata* (Lemckert and Slatyer, 2002) remained within 20 m of the breeding pond during reproductive activity as mostly did female *Litoria littlejohni* (Lemckert et al., in press). Thus, a small retained band of vegetation is likely to provide cover for anurans during the course of their calling and breeding activities and 20 m buffer zones would appear to provide protection for most individuals.

Table 2
Buffer zones and widths set in place to protect pond-breeding anurans located in areas of forestry for the south coast areas of New South Wales (see http://www.environment.nsw.gov.au/resources/forestagreements/SthnSCTSLAmend1.pdf and http://www.environment.nsw.gov.au/resources/forestagreements/tumuttsl.pdf).

Species	Protection
All anurans	10 m buffer around dams and wetlands <0.5 ha
	20 m buffer around dams and wetlands 0.5–2.0 ha
	40 m buffer around dams and wetlands >2 ha
Heleioporus australiacus	500 m radial buffer (78 ha) exclusion on records
Litoria aurea	50 m buffer around record/water body
Litoria littlejohni	Site specific measures to be agreed to
Litoria raniformis[*]	Site specific measures to be agreed to
Pseudophryne australis	Site specific measures to be agreed to
Pseudophryne pengilleyi[*]	30 m buffer around bogs, soaks and seepages

[*] species listed under Tumut License.

Table 1
Buffer zones and widths set in place to protect pond-breeding anurans located in areas of forestry for north eastern New South Wales (for details see http://www.environment.nsw.gov.au/resources/forestagreements/UNETSLamend15.pdf and http://www.environment.nsw.gov.au/resources/forestagreements/LNEappBTSLAmend13.pdf).

Species	Protection
All anurans	10 m buffer around dams and wetlands <0.5 ha
	20 m buffer around dams and wetlands 0.5–2.0 ha
	40 m buffer around dams and wetlands >2 ha
Heleioporus australiacus	Site specific measures to be agreed to
Litoria aurea	50 m buffer around record/water body
Litoria brevipalmata	30 m buffer around records and breeding sites within 100 m
Litoria littlejohni	Site specific measures to be agreed to
Philoria spp.	50 m buffer around records
Pseudophryne australis	Site specific measures to be agreed to