Insectivorous bat activity in timber production forests in the headwaters of the South Esk River, North East Tasmania

Lisa Cawthen[1, 2, 3, 5], Markus Utesch[4], Nina Koch[4] and Sarah Munks [1, 2, 3]

[1] University of Tasmania, School of Zoology, Private Bag 05, Hobart, TAS 7001 Australia.

[2] Tasmanian Forest Practices Authority, 30 Patrick Street, Hobart, TAS 7001, Australia

[3] Cooperative Research Centre for Forestry, Private Bag 12, Hobart, TAS 7001, Australia

[4] DELATTINIA, AM Burenweg 12,66780 Siersburg, Germany

[5] Corresponding author. Email: lcawthen@utas.edu.au

ABSTRACT

Riparian zones are an important habitat for a range of bat species and, as a consequence, understanding whether land use practices such as timber harvesting influence their use is important for conservation and management. This small-scale study used bat activity as a measure of the use of riparian and up-slope zones along headwater streams by bats, and to determine whether past timber harvesting influenced the use of these areas by bats by comparing regrowth with no retained riparian buffers and mature forest. This study found no significant differences in bat activity between treatments, but did find a trend of higher bat activity in riparian zones compared to up-slope zones, particularly in regrowth forest. However, many sites had little to no bat activity indicating activity was influenced by factors not measured in this study. Despite limited data, this study highlights the potential value of retaining riparian habitat in harvested forests for bats, as is practised elsewhere in Australia, and the need for future research into the effectiveness of forest retention measures for wildlife.

Key words: insectivorous bat, bat activity, riparian, upslope, timber harvesting, threats and conservation, Tasmania.

Introduction

Riparian zones are important habitat for a range of bat species (Law and Chidel 2002; Russo and Jones 2002; Law and Chidel 2004). For insectivorous bats, such areas represent important foraging, drinking, roosting and commuting areas (Law 2001; Law and Chidel 2002; Fukui et al. 2006; Lloyd et al. 2006). Land use practices such as timber harvesting can alter the characteristics of riparian habitat by removing roost and foraging habitat and changing the structural characteristics of vegetation (i.e. increasing degree of clutter as forest regenerates), which may alter bat mobility and accessibility to foraging and roosting resources (Lunney *et al.* 1988; Taylor and Savva 1988; Law 1996) and as a result buffers are typically retained in Australian timber production forests to protect stream features (Lloyd *et al.* 2006). With more than one quarter of the world's bat species listed as threatened and forest habitat being cleared and altered through timber harvesting, understanding the effects of timber harvesting on the use of riparian zones by bats is important for the conservation of bats and associated habitat (Mickleburgh *et al.* 2002).

In Tasmania, an off-shore island to the south-east of Australia, riparian zones may be important habitat for bats as all eight species are insectivorous and forest-dwelling – relying on insects for prey and tree hollows for roost sites (Taylor *et al.* 1987). Previous baseline sampling has shown that overall bat activity is negatively affected by clear-fell harvesting (Duncan 1995; Rhodes 1996; Law and Law 2010), with some species more sensitive than others (Rhodes 1996; Law and Law 2010). However, no studies have investigated the use of riparian areas in timber production forests by Tasmanian bats. The aim of this study was to assess the use of riparian and up-slope areas along headwater streams by bats, and to determine whether past timber harvesting influences the use of these areas by bats. This study was part of a broader study of the impact of forest harvesting on the geomorphology, and biota of headwater streams (Bunce *et al.* 2001; Davies *et al.* 2005a; Davies *et al.* 2005b; Koch *et al.* 2006).

Methods

Bat activity (number of bat calls per night) was sampled between 13th March and the 5th April 2001 at 10 sites in the headwaters of the South Esk River in north east Tasmania by Markus Utesch and Nina Koch. Five of the sites were in headwater stream catchments (mean area of 23 ha) that had been clearfelled and regenerated in 1985. No riparian buffers were retained to protect stream features in the operations. The other five sites were in headwater stream catchments (mean area of 16 ha) that had been minimally disturbed in the past and had not been clearfelled. Within each site, bat activity was recorded at two recording locations – riparian and up-slope (20 recording locations in total). All sites had similar slopes

and aspects ,but varied in their typical structure and composition of vegetation as illustated by a concurrent study at the same sites (Figure 2). The study catchments were on the same geology (adamellite-granite type) and had similar elevations and original forest communities. A full description of the catchments and sites is provided in Davies et al. (2005a and b). Bat activity was recorded using Anabat II detectors attached to delay switches and tape recorders set on the ground in waterproof containers with microphones at 45 degrees (Titley Electronics, Ballina, Australia). Within each site, bat activity was recorded all night for 1-3 consecutive nights along bat fly ways in both the riparian zone of the headwater stream (order 1 minor stream 1-2 m wide; ~40 cm deep) and the adjacent up-slope zone (100-200 m upslope) in mature and regrowth forest. Equipment malfunction resulted in three of the ten sites being sampled for one full night only. Sampling occurred irrespective of moon phase and did not occur when rainfall was forecast as weather was likely to influence bat activity (Mills et al. 1996). Each bat detector was placed at a minimum of 100 m away from forestry roads or forest stand edges. Bat calls were identified using Analook by Markus Utesch. Due to the high number of zeros in the data set, differences in bat activity between and within sites were analysed using the Wilcoxon rank-sum test in R (Version 2.10.1) (Quinn and Keough 2002).

Echolocation call surveys are potentially biased as detectability of bats can be influenced by forest structure (Lloyd *et al.* 2006). Hence it is possible that estimates of bat activity were under or overestimated in some sites due to unmeasured variation in forest structure. However, attempts were made to minimise this problem by placing bat call recorders in forest openings at all sites.

Results

In total 453 bat call sequences were recorded over 40 survey nights. No bat calls were recorded on 16 of the 40 nights (40% of nights), and at 5 of the 20 sites (25% of sites). A summary of bat activity at each site is presented in Table 1.

Overall, there were no significant differences in bat activity between riparian and up-slope sites in mature and regrowth forests. However, bat activity was consistently higher (but highly variable) in riparian zones compared to up-slope zones in regrowth forest (W=3.5, p=0.07). Furthermore, of all locations sampled in this study, the least amount of bat activity was recorded in up-slope zones of the regrowth in clear-felled catchments. In contrast, there was less variability between riparian and up-slope areas in mature forest (w=11.5, p = 0.92), with three of the five up-slope sites recording equal to or greater levels of bat activity compared to the riparian zones (Figure 1).

Table 1. Insectivorous bat activity (mean number of bat passes per night) in up-slope and riparian zones in mature and regrowth forest in the Ben Nevis region, Tasmania.

Mature	Riparian	Up-slope	Regrowth	Riparian	Up-slope
BC1	10.5	0.0	BR1	55.7	8.0
BC2	28.0	1.0	BR2	44.5	0.0
BC3	0.0	18.7	BR3	0.5	0.0
BC4	2.5	2.5	BR4	6.0	2.0
BC5	1.0	3.0	BR5	8.0	0.0
Mean	8.3±15.4	7.2±18.3	Mean	27.7±33.3	2.5±7.1
Median	2.5	2.5	Median	8	0

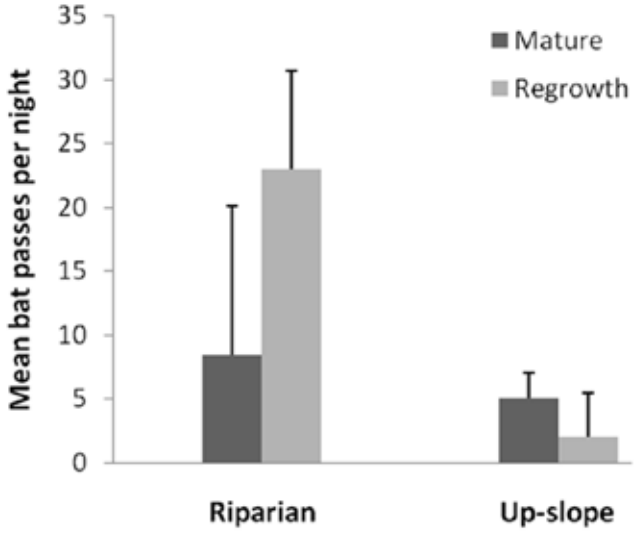

Figure 1. Comparison of bat activity (number of bat calls per night) at riparian and adjacent up-slope areas in mature and regrowth forest in the Ben Nevis Region, Tasmania

Discussion

The results of this study indicate that riparian zones of headwater streams may provide important habitat for insectivorous bats, particularly within regrowth forest after clear fell harvest. The importance of riparian habitat along larger rivers for bats is well recognised on mainland Australia (Law and Anderson 2000; Law and Chidel 2002; Lloyd *et al.* 2006) and overseas (Zahn *et al.* 1998; Holloway and Barclay 2000; Seidman and Zabel 2001; Fukui *et al.* 2006). Although no significant difference between treatments was found in this study, the trend of lower bat activity in up-slope areas within harvested areas suggests that the regenerating forest after clear fell may not provide suitable foraging and / or commuting habitat for bats in the short term, although it is likely that some species would be better-adapted to such areas than others (Law and Law 2010). It is unknown whether bats used other types of 'open' features within the regrowth forest such as man-made tracks. Such tracks are known to be important foraging habitat features for bats in regrowth and mature forest (Law and Chidel 2002; Lloyd *et al.* 2006).

Previous research has shown that the structural characteristics of tracks, riparian zones and forest interiors influence their degree of use by bats (Seidman and Zabel 2001; Lloyd *et al.* 2006). In this study, riparian zones were considered to be a naturally 'less cluttered' habitat for bats to fly in compared to up-slope areas, particularly in regrowth forest (Figure 2). The dense nature of regrowth eucalypt forest results in a more cluttered environment for bats to fly through. Less-cluttered environments (*i.e.* riparian zones, tracks) are likely to be less energetically

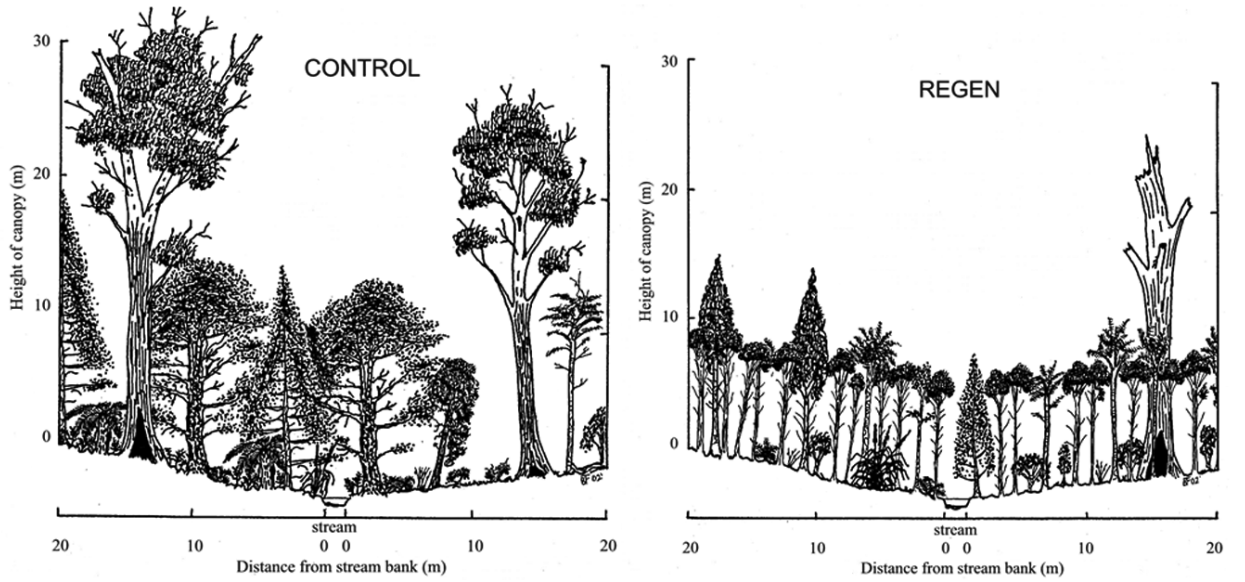

Figure 2. Typical structure and composition of the vegetation of the riparian zones in mature forest sites (Control) and sites regenerating after cleafelling (Regen) in the headwaters of the South Esk River, NE Tasmania (Davies ***et al.*** 2005b).

costly to manoeuvre through and forage in compared to cluttered environments (Kunz and Fenton 2005). Levels of clutter in the harvested and 'control' sites were not measured directly in this study, but have been illustrated in Davies *et al.* (2005b) at the same site (see Figure 2).

However, it is important to recognise that the data presented in this study is from a single area, over a short period, during autumn and did not account for variation in forest structure and other habitat variables which may influence the use of different types of forest habitat by bats. The number of bat calls recorded per night was also low in this study, suggesting that the sites or time of year may not have been optimal for undertaking this study. Despite its limitations and lack of significant results, the trends in bat activity across the sampled sites do suggest the value of riparian habitat for bats in logging coupes in the headwaters of river catchments in Tasmania could be enhanced by the retention of trees along headwater streams. In Tasmania, this currently only occurs for streams in highly erodible geologies (Davies *et al.* 2005b) and during other situations where tree retention is required under the Forest Practices Code planning tools for biodiversity reasons (e.g. threatened species habitat). Retention of habitat surrounding headwaters (minor order 1 streams) in timber harvested areas, as occurs elsewhere in Australia, could aid in the recolonisation and or maintenance of bats in harvested forests. This in turn could potentially enhance the health of the regenerating forest as bats are considered to be important for forest ecosystems as natural controllers of insect pests and potential nutrient dispersers (Cleveland *et al.* 2006; Duchamp *et al.* 2010).

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