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Is forest close to lakes ecologically unique? Analysis of vegetation, small mammals, amphibians, and songbirds

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Abstract

We compared vegetation structure, flora, and fauna in forest stands at varying distances from small lakes in the boreal mixedwood zone of Alta., Canada, with that in the surrounding upland landscape. We tested the hypothesis that lakeside riparian forest is more structurally diverse, hosts different biotic communities, and has greater floral diversity and greater abundance and richness of other biota, as compared with similar forest in areas far from open water. Lakeside forest was characterized by greater canopy cover, and aspen height and diameter (breast height) than upland forest, but absolute differences were quite small and there was no evidence of greater structural diversity. Contrary to expectations, herb richness and diversity were lower in lakeside forests and the understory community there could not be differentiated from that of upland forests. Two species of anuran amphibians [wood frog (*Rana sylvatica*) and boreal toad (*Bufo boreas boreas*)] were more abundant in forest up to 100 m from lakes than in upland areas 400–1200 m away from open water. However, differences in abundance between trapping sites in the non-forested riparian zone and sites up to 100 m into the lakeside forest were small. Use of upland habitats by amphibians (juvenile wood frog in particular) was substantial during the latter part of their active season, possibly because they used upland areas for dispersal and overwintering. The two most abundant species of small mammal [red-backed vole (*Clethrionomys gapperi*) and deer mouse (*Peromyscus maniculatus*)] were trapped less often in the non-forested riparian zone, while the meadow vole (*Microtus pennsylvanicus*), meadow jumping mouse (*Zapus hudsonicus*), and shrews (*Sorex* spp.) were more abundant in those areas. Abundance did not differ significantly among trap lines located in forest from 50 m to >600 m from open water. Songbird abundance and richness were higher near lakes, possibly because of the additional niches available at the forest/lake interface and increased food supply for insectivorous birds. Overall, our results did not strongly support our hypotheses concerning the ecological attributes of lakeside riparian forest. If any part of these lakeside riparian areas can be considered ecologically unique or species-rich it appears to be the non-forested riparian zone and, for birds, the natural lakeshore ecotone (~50 m into the forest). We encourage those responsible for forest management to re-think prescriptive placement of fixed-width forested buffers around all lakes, and instead consider a landscape-scale planning approach that determines the appropriate placement of uncut forest on the landscape to meet broad conservation objectives.

Keywords: Riparian; Lake; Forest; Forest structure; Understory vegetation; Amphibians; Small mammals; Songbirds; Biodiversity; Community composition; Boreal

1. Introduction

The composition and structure of vegetation communities adjacent to open water (riparian communities) are a reflection of an unusually complex array of edaphic influences and natural disturbances (Gregory et al., 1991; Naiman and Décamps, 1997; Pollock et al., 1998). Many factors appear to contribute to the structural complexity of riparian vegetation: soils, topography, and microclimate; high productivity as a result of water and nutrient accumulation in low-lying areas; edaphic gradients; the unique nature of the natural disturbance regime (channel migration, flooding, ice scouring, fire, wind, and animal activity); biotic interactions (Rowe and Scotter, 1973; Suffling et al., 1982; Chandler et al., 1983; Swanson et al., 1988; Bergeron and Dubuc, 1989; Baker, 1990; Bergeron, 1991; Naiman et al., 1993; Andison, 1997; Denneler et al., 1999; Pollock et al., 1998; Donkor and Fryxell, 1999; Devito

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et al., 2000b; Nierenberg and Hibbs, 2000). As interfaces between terrestrial and aquatic ecosystems, riparian communities are considered key landscape features (Gregory et al., 1991; Naiman et al., 1993).

All riparian zones are ecotonal by nature, and are thus expected to exhibit high species and ecological diversity (Naiman and Décamps, 1997). Many studies have found greater species richness of both flora and fauna in riparian areas and differences in species composition between riparian and upland forests. Riparian communities have been found to high levels of plant species diversity and different patterns of species' associations than adjacent upland areas (Ericsson and Schimpf, 1986; Naiman and Décamps, 1990; Gregory et al., 1991; Jonsson, 1997; Pabst and Spies, 1998, 1999). It has also been shown that they support greater abundance and diversity of songbirds than upland forest (Henke and Stone, 1979; Stauffer and Best, 1980; Décamps et al., 1987; Knopf et al., 1988; Doyle, 1990; Johnson and Brown, 1990; Gates and Giffen, 1991; LaRue et al., 1995). Other studies, however, showed riparian areas to have similar or even lower abundance and richness of biota than upland forest (Murray and Stauffer, 1995; McGarigal and McComb, 1992; Whitaker and Montevecchi, 1997).

In forest management planning, areas adjacent to lakes, streams, and rivers (riparian communities) are often left unharvested as riparian buffer strips. The main objective of this practice is to protect receiving waters from sediment, water, and nutrient flow originating in adjacent harvested areas. In addition, over time, buffers may hold the major portion of unmanaged mature commercial forest in a region. As such, they could serve as important reservoirs of biodiversity (Doyle, 1990; Darveau et al., 1995) and corridors for wildlife movement (Naiman et al., 1993; Machtans et al., 1996; Hannon and Schmiegelow, 2002; but see Robichaud et al., 2002). Therefore, it is critical to understand the ecological structure and composition of riparian forest in order to plan for conservation and ecological sustainability in harvested landscapes.

Upland (mesic) areas within the boreal mixedwood zone of western Canada are dominated by forest with varying proportions of deciduous [mainly aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*)] and coniferous [mainly white spruce (*Picea glauca*)] trees forming the canopy. The terrain is gently undulating and the landscape experiences relatively frequent and intense fires (Rowe and Scotter, 1973; Johnson, 1992). Working at the landscape scale in this region, Macdonald et al. (2004) failed to find substantial differences in forest composition or age in areas close to lakes versus areas farther away. They suggested that riparian buffer strips around lakes have no natural analog; therefore, creation of such buffers does not emulate natural disturbance. However, previous studies identifying greater biotic abundance and diversity in riparian areas were mostly conducted at a fine scale and we know that forest vegetation in natural lakeshore ecotones in the mixedwood boreal forest is different than in upland forest (Suffling et al., 1982; Harper and Macdonald, 2001), and could have important wildlife habitat value (Machtans et al., 1996). Further, the non-forested riparian zone may play an important role in determining biotic diversity adjacent to water bodies; this zone has received very little attention.

The purpose of this study was to compare the structure and biotic communities of forest adjacent to small lakes in the boreal mixedwood forest with that in upland areas away from open water in order to determine whether the former exhibits the distinctive structure and higher levels of biotic abundance and diversity often attributed to riparian areas. We examined forest structure, and the composition and diversity of understory vegetation, amphibians, small mammals, and songbirds. We predicted that forest near lakes would be more structurally diverse, has a different composition and greater diversity of understory vegetation, and greater abundance and richness for all three faunal groups than similar forest in the surrounding landscape.

2. Methods

We studied forest stands within the Mid Boreal Mixedwood Ecoregion of Alta., Canada (Strong and Legatt, 1992). In this region mean temperature is 13.5 °C in summer and −13.2 °C in winter. Annual precipitation is ∼400 mm with most falling in the summer (Strong and Legatt, 1992). Soils are primarily Gray Luvisols with some Eutric Brunisols and the terrain is largely undulating morainal plains (Rowe, 1972; Strong and Legatt, 1992). Mesic sites within this region support varying mixtures of deciduous and coniferous forests with trembling aspen, balsam poplar, and white spruce, normally dominating the canopy; *Abies balsamea* (balsam fir), *Pinus banksiana* (jack pine), *Betula papyrifera* (paper birch), and *Picea mariana* (black spruce) may also occur. Forests in wetter low-lying sites are dominated by black spruce and *Larix laricina* (tamarack).

We examined forest adjacent to small- to medium-sized lakes (20–172 ha surface area). In the study area, vegetation adjacent to water bodies often has only a very narrow unforested riparian community and is mostly comprised of mature forest located just above the high water mark but often quite close to the lakeshore. We focused our attention along a gradient from the interface (edge) between the non-forested riparian area and the adjacent forest away from the lake and into the surrounding forested upland.

2.1. Forest structure and vegetation

2.1.1. Study area and sampling design

Twenty stands were examined surrounding 10 lakes situated in three regions within east-central Alta., Canada (south Calling Lake, AB: 55°07′20″N, 113°43′30″W; Lac la Biche, AB: 55°08′30″N, 111°45′45″W; South Pelican Hills, AB: 55°23N, 113°38′W). All stands were selected with the help of 1:15,000 scale Alberta Phase III Forest Classification System maps and met the following criteria: (1) they adjoined small- to medium-sized lakes and continued at least 800 m upland away from the lakes; (2) they hosted mature (65–95 years of age) aspen-dominated mixedwood forest; (3) they were of fire-origin, unmanaged, and unaffected by any major recent disturbance.