The Influence of Timber Harvest on Stream Associated Aquatic Amphibians

Introduction

Amphibians are important components of biological diversity in the humid, temperate, coniferous forests of the Pacific Northwest. In some streams and forested areas their biomass exceeds the cumulative biomass of deer, small mammals and birds (Leonard et al., 1993), they are also considered one of the most important predatory species within these areas (Leonard et al., 1993). Timber harvest affects aquatic amphibians in multiple ways; sediment yields and stream temperatures increase, microclimate conditions experience adverse changes, the loss of connectivity between riparian habitat increases the occurrence of isolated populations, and local extinctions can occur. This paper focuses on the consequences of sedimentation, altered riparian microclimate conditions, and general long-term affects on aquatic amphibian populations caused by clearcut harvesting near small, non-fish bearing headwater streams.

The geographic focus is within the three major low elevation physiographic regions in Western Oregon: the Oregon Coast Range province, the Klamath-Siskiyou province, and the Western Cascades province (Franklin and Dyrness, 1988). Although this paper focuses on western Oregon, I will be drawing on research conducted in similar areas of Washington and the redwoods, as well as western Oregon.

Aquatic Amphibian Species

In Oregon, several amphibian species are either riparian obligates or strongly associated with headwater streams: tailed frogs (*Ascaphus truei*), Columbia and southern torrent salamanders (*Rhyacotriton kezeri* and *R. variegatus*), Pacific giant salamanders and Cope's giant salamander, (*Dicamptodon tenebrosus* and *D. copei*), and Dunn's salamander (*Plethodon dunni*); several other amphibian species are found within the immediate splash zone of small streams (Leonard et al., 1993). Within Oregon the six species listed are recognized as sensitive, with A. *truei* and *R. variegatus* listed as federal species of concern (Oregon Department of Fish and Wildlife, 2003).

Headwater streams provide unique and important habitat. They are characterized by cool swift water, steep gradients, and an absence of sediment. Headwater streams may be perennial or intermittent, and include waterfall splash zones, seeps, and springs (Corkran and Thoms, 1996). These streams support the most abundant salamander populations (Bury and Corn, 1988), largely due to the presence of fewer predators of amphibian species (Hayes and Hagar, 2002).

This paper focuses on the most common stream associated species occurring in Western Oregon, *A. truei*, *R. variegatus*, and *D. tenebrosus* and the complex inter-relationships with each other and timber harvesting.

<u>Effects of Sedimentation</u>

Increased sedimentation created by timber harvest (Beschta, 1978) is a long-term factor in low gradient streams, leading to critical microhabitat losses for aquatic amphibian species (Bury and Corn 1988). The characteristic lower water velocities of these streams inhibit the ability of fine organic and inorganic material to be flushed from the system, causing higher sediment accumulations to occur, especially in pools (Murphy and Hall, 1981; Bury and Corn, 1988; Dupuis and Steventon, 1999). The accumulation of sediment creates a considerable impact on larval amphibians, whose primary microhabitat is within the crevices of rocks, areas easily filled with fine sediment (Murphy and Hall, 1981; Corn and Bury, 1989).

The primary factor of decline for *A. truei* populations has been attributed to increased sediment input following timber harvest (Hawkins, et al., 1983; Dupuis and Steventon, 1999). *A. truei* is disrupted by sediment on multiple levels; accumulation of fine sediment on coarse substrates inhibits the growth of microscopic algae and diatoms (Newcombe and MacDonald, 1991), which provide the primary food source for tadpoles (Bull and Carter, 1988; Leonard, et. al.

1993). In addition, sediment deposits on coarse substrates limit the ability of *A. truei* tadpoles to cling to the surface with their sucker mouths, increasing their likelihood of being swept downstream (Nussbaum et al., 1983; Leonard et al., 1993; Dupuis and Steventon, 1999).

Surface geology has a significant influence on the occurrence and distribution of aquatic amphibians after timber harvest. Welsh and Ollivier (1998) and Adams and Bury (2002), found aquatic amphibian species utilizing unconsolidated stream types within forested riparian areas. However, Wilkins and Peterson (2000) found a strong association with consolidated stream geologies and higher amphibian populations after harvest, and a strong negative correlation with unconsolidated stream types. Concomitantly, this supports Dupuis and Steventon's (1999) findings that the relationship between stream geology and amphibian association is intensified with timber harvesting.

Riparian Microclimate Factors

The near-stream microclimate is essential for maintaining favorable conditions (cool temperatures and high humidity) required for aquatic amphibian species to migrate and forage within the splash zone of streams (Nussbaum et al., 1983; Dupuis et al., 1995).

Clearcut harvesting near headwater streams increases temperatures and decreases humidity levels (Brosofske et al., 1997). Clearcut edge effects are capable of influencing the microclimate of forested stream buffers as well; Brosofske and others (1997) found microclimate values altered with the removal of adjacent forest structure, with clearcut edges affecting up to 240 m into Douglas-fir forests (Chen et. al., 1995). Chen and colleagues (1999) reported that harvesting a minimum of 17 meters from a stream can increase the air temperature 2 to 4 ° C and decreased relative humidity 2.5 to 13.8%.

Biek and others (2002) also found a distinct difference in larval density in streams across the clearcut-forest interface; both *D. tenebrosus* and *A. truei* had significantly lower numbers of occurrence towards the clearcut area. Aspect is another influential factor on the presence of species after logging, suggesting areas with higher solar radiation have a significant affect on amphibian populations after near-stream harvests (Stoddard, 2001).

Habitat Loss and Long-term Population Consequences

Clearcut harvesting near small headwater streams has vital impacts on long-term population establishment. Adams and Bury (2002) found that timber harvesting forced *D. tenebrosus* into a constricted habitat range, pushing this species higher in the stream network. Additionally, *D. tenebrosus* were found to avoid areas with an understory composition of hardwoods and grass cover, plant species associated with disturbance and harvesting (Welsh and Lind, 2002). The contracted range of *D. tenebrosus* may have severe impacts on populations of *R. variegatus* and *A. truei* – as larval and adult *D. tenebrosus* prey on other amphibian species.

In addition to general population decline, Bury and Corn (1988) suggest *A. truei* populations may experience local extirpations caused from logging impacts. This consequence, however, is not just limited to *A. truei; R. variegatus* is also considered "poor" at recolonization (Corn and Bury, 1988). Bury and Pearl (1999) found stream species within the Oregon Coast Range province had not recovered within 35-50 years after clearcut harvesting occurred. The threat of local extinctions increases the probability for genetically independent populations to occur, since *A. truei* and *R. variegatus* occur in small isolated populations (Bury and Corn, 1988).

Harvesting consequences are further compounded for *A. truei* by their unique and specialized breeding practices. Female and male tailed frogs cannot produce vocalization (Leonard et al. 1993); it is believed they congregate in their natal streams for the purpose of locating mates (Corn and Bury, 1988). Kelsey (1995) observed that adult male frogs exhibiting secondary sexual features were frequently found closer to the stream's origin than tadpoles or larvae. This finding has severe implications for populations in areas where habitat alteration has occurred - the habitat most important to successful breeding has been destroyed.

Research Needs

There is a need for further investigation of the effects of *D. tenebrosus* moving higher in the stream network following harvest without buffers and the population and species diversity of other headwater associated species. Prey species of *D. tenebrosus*, specifically *R. variegatus* and *A. truei* (Leonard et al., 1993) could be extirpated following the migration of *D. tenebrosus* farther up the reach. In addition, there is also a chance that smaller habitat ranges will cause an increase in the rate of cannibalism among larval amphibians.

The effects of forest management with and without buffers needs to be continually studied, in order to enhance scientific knowledge of stream amphibians so that effective Oregon state forest practice rules, with respect to riparian buffers, can be implemented before total loss of headwater amphibians occurs. Currently, small, non-fish-bearing streams are not protected.

Interestingly, while the interaction between salmonid habitat, salmonid populations, and roads has been studied in great detail, such research is conspicuously lacking for amphibian species. Roads and culverts have been studied for their contribution to sediment delivery, alterations to the hydrologic regime, and as barriers to movement for fish species. A bulk of studies have examined clearcut and deforestation effects on stream amphibian species, however, quantifying sediment affects from roads is vital for establishing best management practices. Roads and poorly designed and installed culverts should also be studied with respect to their potential role as barriers to the movement of stream amphibians. Roads and culverts could increase population isolation and cause accelerated local extinctions, especially for populations of *A. truei* and *R. variegatus*.

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