EMEND





ECOSYSTEM-BASED MANAGEMENT EMULATING NATURAL DISTURBANCE

EMEND Insights #15

Ecological Messages:

- The presence of breeding pools is an important determinant of local wood frog abundance, including within harvested blocks.
- Coniferous stands at EMEND supported as many wood frogs as the deciduous stands 17 years post-harvest, possibly due in part to extensive natural aspen regeneration.
- Relatively deep ephemeral wetlands under low canopy cover provided optimal conditions for tadpoles to complete growth and metamorphosis before the wetlands dried.

Management Implications:

- Variable retention levels had no apparent effect after 17 years of regeneration, suggesting either little initial effect or rapid recovery.
- Voluntary protection of deeper ephemeral wetlands (e.g., >50 cm) would most benefit wood frogs and other boreal amphibians.
- Intermediate retention or buffers around small wetlands and surrounding areas may improve tadpole survival and maintain suitable habitat for adult and juvenile amphibians.

Identifying high-quality wood frog breeding wetlands for protection during harvest

Research led by Matt Robinson, Brian Eaton and Scott Nielsen

With the ability to freeze solid during winter, it's fair to say that wood frogs are a hardy species. Yet like many amphibians, they are highly sensitive to environmental changes. For many amphibian species, adults live in terrestrial habitats, but aquatic habitats such as lakes, beaver ponds, and other wetlands are necessary for successful breeding and development. Since they require multiple habitats to complete their life cycle, even small changes to just one of these can have serious consequences for their survival.

Forestry has the potential to affect wood frogs in a range of ways. Most amphibians need to stay moist and cool to survive, and increased light, wind, and heat following clear-cutting may increase their risk of drying out. Harvesting around water features may also reduce habitat quality by increasing light levels and water temperature, and potentially by causing erosion and sedimentation.

In the light of these factors, can harvesting be planned in a way that minimizes the impacts to wood frogs at all stages of their life cycle?

This study looks at both sides of the coin by surveying adult frogs in harvested stands and tadpoles in ephemeral wetlands within the harvested area. We surveyed frogs in and around EMEND to test whether wood frog abundance was affected by retention levels nearly two decades after harvest. Overall, we found that on these older, naturally-regenerating sites, retention level at harvest was not nearly as important as expected. Instead, the distribution and characteristics of breeding ponds most affected wood frog abundance. Our study suggests that ***voluntary protection of breeding ponds, particularly deep ephemeral wetlands (e.g., >50 cm), can improve overall habitat quality for wood frogs*** and other amphibians within harvest areas.

Adult wood frog. Photo by Matt Robinson.

A life in two phases

Amphibians present an interesting conservation challenge, as they require both terrestrial habitat and breeding ponds to support their full life cycle (Fig. 1). It should come as no surprise, then, that they are one of the most threatened groups in the world. Not only are they highly sensitive to changes in their environment, but their dependence on multiple habitats also makes their responses to disturbance difficult to predict.

Scientific studies are therefore needed to improve our understanding of how human disturbances like forestry affect this sensitive group. In upland habitats, harvesting increases the risk of frogs drying out and reduces important habitat features like leaf litter and coarse woody debris. In aquatic habitats, harvesting of nearby forest increases temperature and light, and increases the risk of erosion and sedimentation. Exposed ephemeral wetlands may also dry out earlier in the season, killing all the tadpoles in their waters.

This project asks how we might mitigate the impacts of harvesting on amphibians in Alberta's boreal mixedwood forest. Our study species was the wood frog (*Lithobates sylvaticus*): this species is common throughout the boreal region, breeding in both permanent and temporary water bodies (e.g., beaver ponds and ephemeral wetlands, respectively).

We asked whether increased retention within harvests supported more wood frog adults. We also assessed whether characteristics of ephemeral wetlands (e.g., water depth, overhead canopy closure) in these stands affected how quickly wetlands dried up and how quickly tadpoles grew (see Box 1).

Methods

This project was conducted in two parts. First, adult wood frogs were sampled using pitfall arrays in the coniferous- and deciduous-dominated stands within the clear-cut, 20% retention, 50% retention, and unharvested (control) treatments at EMEND. For each pitfall array, we measured the distance to the closest breeding site (permanent or temporary pond), since this was expected to affect how many frogs we would capture.

Second, we surveyed tadpoles in ephemeral wetlands located within and just outside of EMEND. We were not able to test the effect of retention directly because these wetlands were not consistently found in each EMEND treatment. At each selected wetland, we sampled the tadpoles every two weeks until they completed metamorphosis or the wetland dried, whichever happened first. We measured body size of tadpoles to assess growth and used larval period (days until tadpoles reached metamorphosis) to assess development (Box 1).

About EMEND:

The Ecosystem-based Management Emulating Natural Disturbance (EMEND) Project is a multi-partner, collaborative forest research program. The EMEND project documents the response of ecological processes to experimentally-delivered variable retention and fire treatments. The research site is located in the western boreal forest near Peace River, Alberta, Canada, with monitoring and research scheduled for an entire forest rotation (i.e. 80 years).

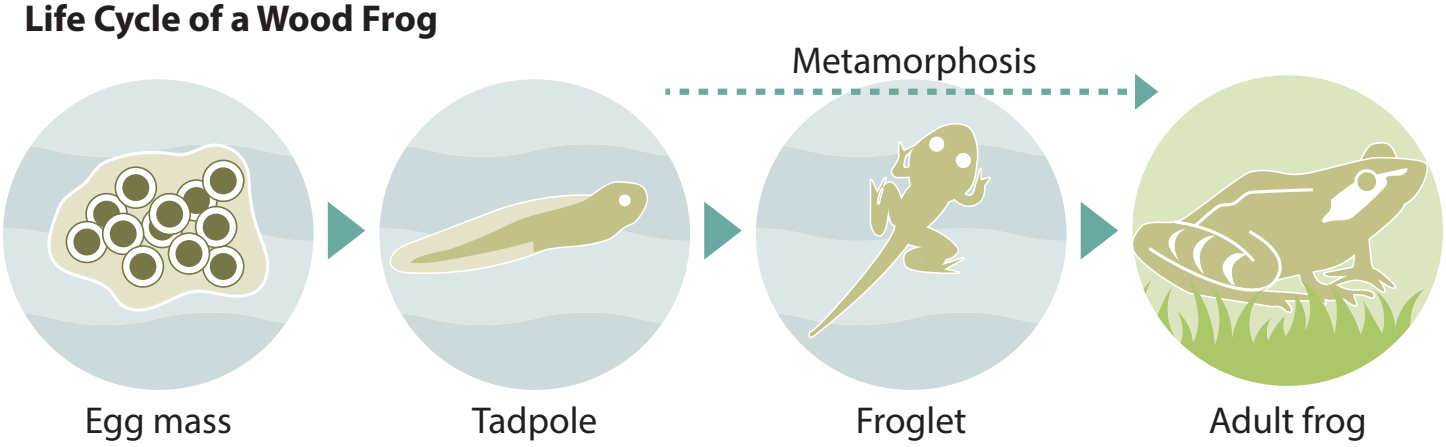

Figure 1. Life cycle of a wood frog.

Box 1. What can we learn from tadpole growth and development?

Tadpoles in temporary wetlands face a variety of challenges. There is often a trade-off between growth (increase in size and mass) and development (transition from tadpole to frog). This trade-off depends largely on a wetland's traits, including temperature, food availability, predators, and duration (how long before it dries up). If the wetland is not at immediate risk of drying and food is abundant, rapid growth may allow tadpoles to reach a larger body size before metamorphosing, increasing their survival as young frogs. Rapid development, in contrast, may allow a tadpole to "escape" a wetland before it dries, thus avoiding certain death, but at the cost of a smaller body. In this study, tadpoles in some wetlands reached adulthood, but in other pools they were still growing when the water dried up—in the latter case, we inferred 100% mortality of the tadpoles.

Key Findings

Wood frogs were not sensitive to retention harvests after 17 years

Contrary to our expectations, wood frog abundances did not change with retention level. Seventeen years after harvest, natural regeneration may have increased the suitability of all harvested stands for wood frogs, thus masking any benefits overstory retention may have provided immediately after harvest. After nearly two decades, the harvested stands at EMEND now contain high densities of young aspen and shrubs, which provide shade, leaf litter, and improved habitat for wood frogs overall.

Even more unexpected was the high number of wood frogs in coniferous stands, with which they are not typically associated. Once again, aspen regeneration following harvest has likely altered these habitats in a way that provides wood frogs ample opportunities to forage and find shelter. These stands also had higher soil moisture as predicted using Wet Areas Mapping, which may help explain the high numbers of frogs.

Deep ephemeral wetlands have distinct value to wood frogs

Ephemeral wetlands are important breeding habitat for wood frogs and other boreal amphibians, but some dry out more quickly than others. How long a wetland lasts is a matter of life or death for the tadpoles growing in its waters.

The deepest wetlands in our study (>50 cm) took the most time to dry out, meaning tadpoles had a higher likelihood of completing metamorphosis and moving onto dry land. Shallower wetlands, in contrast, were more likely to dry out before tadpoles metamorphosed, resulting in their deaths. We expected canopy cover to affect wetland drying rate, but instead found no effect: wetland depth was far more important.

Canopy cover did, however, affect tadpole growth and development. Tadpoles grew larger and faster in wetlands with less canopy cover. Warmer water may have allowed tadpoles to grow more quickly, which is an important advantage in temporary habitats such as those studied here.

This result, however, should be interpreted with caution. Our low-canopy sites were not equivalent to a recent clear-cut, having up to 25% cover and more developed surrounding vegetation. Additionally, emerging adults require suitable habitat and shelter to survive, which is better preserved using buffers or retention.

Management Implications

Breeding pools were more important than harvest prescription after 17 years

Identifying and protecting breeding pools will be important for supporting wood frogs within harvested landscapes. Seventeen years after harvest, proximity to breeding sites (permanent and ephemeral wetlands) was an important predictor of wood frog abundance, while retention harvest level and forest type (coniferous vs deciduous) were not.

Results suggest the importance of protecting vernal pools. Photo by J. Witiw (DMI).

This finding runs contrary to the typical expectation of a strong negative effect of harvest on amphibians, but the time since harvest provides important context for this result—and also provides some insight into wood frog resilience. Many studies have found a negative response to clear-cutting, which we may also have observed had we surveyed wood frogs in the years immediately following harvest. The fact that treatment had no apparent effect after 17 years demonstrates that naturally regenerating cutblocks provide suitable wood frog habitat within a short time relative to a full harvest rotation of 80–100 years.

Ephemeral wetlands should be protected to improve breeding success

We recommend that forest planners and operators carefully look for ephemeral wetlands and ***prioritize deep (e.g., >50 cm) pools for protection during harvesting.*** Deep, longer-lived wetlands represent important breeding habitat for maintaining wood frog populations on the boreal landscape, particularly during dry years. A pond that attracts breeding adults does more harm than good if it dries up early, killing all their offspring.

While this study found some benefit of low canopy cover for tadpole growth and development, we recommend ***voluntarily protecting wetlands for which buffers are not legally required.*** This protection during harvest helps prevent physical damage, erosion, and sedimentation caused by equipment and activity close to the water.

Using intermediate retention levels close to wetlands may balance the advantages of warmer waters with habitat quality for emerging juveniles and adults. Regardless of the strategy, some degree of buffering or retention bordering wetlands would be more suitable than clear-cutting around them.

Further reading

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