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Prescribed Fire Management of Ephemeral Wetlands of Southern Pine Communities for Amphibian Conservation

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Habitat Requirements

Ephemeral wetlands are home to endemic and imperiled amphibians, including salamanders, newts, frogs, and toads, in the southeastern U.S. [1]. While there are several types of ephemeral wetlands in the region, this fact sheet focuses on those embedded in frequent fire-dependent sandhill, upland (clayhill), and flatwoods pine communities of the Coastal Plain from eastern Texas to North Carolina [2]. These wetlands are isolated from through-flowing water and include sinkhole depressions, cypress domes, and Carolina bays [3]. Ephemeral wetlands are small, often less than one acre, and yet they may support large amphibian populations. It is not uncommon to find more than ten amphibian species in a single ephemeral wetland and more than 15 species on a local property containing such wetlands [4].



Striped Newt Larva (Notophthalmus perstriatus); Jefferson County, FL. Image courtesy of Kim Sash.

Many amphibians depend on ephemeral wetlands because they periodically dry out and exclude fish which otherwise are important predators of amphibian larvae [5]. Patterns of surface water levels are tied to winter cold fronts that bring precipitation. Ephemeral wetlands typically dry out during late spring to early fall and are inundated from late fall to early spring [6]. However, wetlands supporting amphibians can be semi-permanent and hold standing water for one to several years in between dry periods [7]. Standing water is required for eggs to hatch and larvae to survive until going through metamorphosis to the adult terrestrial stage, such that hydroperiod (duration of inundation) is limiting to amphibian reproduction. For example, the reticulated salamander requires 3-4.5 months to grow and develop into adults before wetlands become dry [8]. Adults typically occupy the uplands surrounding ephemeral wetlands and then return to the wetlands to breed and lay eggs [9].



Amphibian species are diverse in their seasonal timing of breeding and migration, requirements for hydroperiod, and sensitivity to habitat vegetation structure.[10] However, most pond-breeding amphibians, including the most imperiled species, have the highest survival in ephemeral wetlands with little or no tree canopy cover, continuous groundcover of herbaceous plants, and a relatively long hydroperiod.[11] Lower tree canopy cover and shrub cover results in higher water temperatures that promote growth of amphibian larvae.[12] Less transpiration with less woody vegetation lengthens the hydroperiod and increases chances for larvae to metamorphose into adults.[13] Also, excessive leaf litter decreases pH and dissolved oxygen, creating a more stressful larval environment.[14]



Pickerel Weed (Pontederia cordata); Jefferson County, FL. Image courtesy of Kim Sash.



A prescribed burn of an ephemeral wetland in July; Jefferson County, FL. Image courtesy of Kim Sash.

Herbaceous vegetation is composed of some combination of wetland grasses, sedges, and forbs which vary in cover with soil type, sunlight, and hydroperiod.[15] Herbaceous vegetation is thought to provide substrates for algae, cyanobacteria, and other microbes that support invertebrates, which in turn provide food for amphibian larvae.[16] It provides habitat for prey and refuge from predators.[17] It is also important for providing amphibians with a location to anchor egg masses.[18] When ephemeral wetlands become unsuitable habitat for amphibian breeding and egg disposition, their bodies can reabsorb their eggs, or they may decline to breed entirely, resulting in decreased populations.

The Role of Fire in Maintaining Amphibian Habitat

Frequent fire (1-2 year fire return intervals) is critical for the maintenance of amphibian habitat in sandhill, upland, and flatwoods ecosystems. Fire is important both within ephemeral wetlands and in the surrounding uplands, especially for species of greatest conservation concern.[19] Ephemeral wetlands must be burned through periodically during dry periods to prevent woody plant encroachment, release herbaceous plants from competition with woody plants, reduce accumulation of plant litter and organic soil (peat or muck), and promote flowering and reproduction of herbaceous plants.[20] Reduction of organic soil is important for preventing shallow ephemeral wetlands from increasing in elevation, developing a shorter hydroperiod, and changing to a different vegetation type.[21] For flatwoods salamanders, reducing organic soil is necessary to provide bare soil where eggs are deposited.[22] Wetland fires can help buffer low pH caused by tannic and humic acids by releasing alkaline cations as a product of combustion.[23]

Although research on the effects of season of fire on amphibians is still limited, the importance of growing season fire is recognized for its suitability to the evolutionary adaptations of amphibians of greatest conservation concern. Although fires often spread across the wetland during the growing season, adults are typically able to burrow, climb trees, retreat to moist or inundated areas, or find refuge in other fire-protected locations such

as stump holes, tree tip-up pits, burrows of other animals, and the underside of rotten logs [24]. Eggs of most species (but not flatwoods salamanders) are laid underwater, and larvae must live in the water, where they are protected from direct fire effects. Most migration, when adults would be susceptible to fire, occurs during rain events when risk from fire is minimal. However, there are exceptions. Dormant season fires that coincide with migration can have a negative effect [25]. For flatwoods salamanders, fires in January, when ponds have not yet been inundated and eggs are on the ground, could cause the loss of an entire year of reproduction. Additionally, there are accounts of high mortality of adult gopher frogs after dormant season prescribed fires immediately following frontal rains. However, if the wetland is dry in the fall or winter and there are no cold fronts in the near future, then fire is expected to have minimal negative effects (with the exception of wetlands with flatwoods salamanders). Early spring (March-April) fires can be potentially devastating for winter breeding species if occurring when amphibians are emerging from the soil after going through metamorphosis to juveniles.

Recommendations for Fire Management

Given that ephemeral wetlands tend to dry out in the late spring and summer months, prescribed fires are at least periodically necessary at that time in order to burn through and maintain amphibian habitat. However, the need to burn through wetlands at this time often must be balanced with overall management objectives. These often include the need to burn at varying times of the year to accomplish target annual acreages, burning under milder conditions such as those in the dormant season that minimize tree crown scorch and organic soil consumption, and remaining within fire prescriptions. An effective approach has been to burn the uplands under mild conditions, typically in the winter or early spring months, when wetlands are inundated or too moist to burn, then later burn isolated ephemeral wetlands and when they are dry enough and surrounded by upland vegetation that will not carry fire. However, protecting wetlands during severe drought when organic matter may be excessively combusted is an important consideration. Prescribed fires intended to spread through wetlands should be applied when the saturated zone is just below the soil surface. Burning within the recommended 1-2 year fire return intervals [26] will help protect ephemeral wetlands from the most severe fire effects of wildfires. Given the overarching importance of frequent fire for maintaining amphibian habitat, occasionally losing a year of successful breeding because of an ill-timed prescribed fire may be preferable to missing the opportunity to burn.

Firebreaks around ephemeral wetlands, typically installed using a tractor plow or disk harrow, are detrimental to these wetlands and amphibian habitat [27]. They typically result in distinct rings of trees and shrubs on the inside of the firebreak causing problems described above. They also disrupt the natural seepage of water into the wetland that supports its natural hydrology and the diverse native plant community that depends on it [28]. Additionally, soil disturbance promotes fire ants which can attack and kill amphibians, as documented for striped newts during migration away from wetlands [29].

Some intensive vegetation management approaches can be used to improve effectiveness of fire in ephemeral wetlands. Trees that grow around the edges of wetlands can be mechanically removed to reduce shading and litter deposition, release herbaceous vegetation, and allow fires to more easily spread into the wetlands [30]. Special care must be taken in choosing the weather conditions and water table level for harvesting trees in these sensitive wetlands to prevent rutting, siltation, and deposition of excessive coarse woody debris [31]. Restoration of natural hydrological regimes when possible is also important, such as filling in ditches that were installed to drain wetlands [32] or installing liners to retain water in the lowest areas of ponds [33]. In general, restoration efforts should be focused on the two main factors that have the greatest influence on amphibian habitat - fire regime and hydroperiod.



A semi-permanent wetland managed with fire; black gums are scattered among the bluestem grasses, maidens cane, and redroot; Jefferson County, FL. Image courtesy of Kim Sash.

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