

The Pine Barrens Treefrog: Fire, Seepage Bogs, and Management Implications

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Abstract: -- We report 28 new sites in panhandle Florida where one or more calling males verified the local presence of the Pine Barrens treefrog (Hyla andersonii). This extends the known geographic distribution in Florida by tenfold. The size of local breeding choruses seems to correspond with the amount and quality of larval, seepage habitat (grass-sedge-herb bog) present at a site. Both the temporal persistence and suitability as larval habitat diminish as seepage bogs undergo plant succession involving more and more woody growth. We believe periodic natural fires are important in maintaining bogs by killing back encroaching woody vegetation. Timber cutting seems not to affect populations adversely at first, but long term site occupancy by planted pine stands may. We suggest that successful and inexpensive habitat management for the Pine Barrens treefrog will involve the proper use of prescribed burning to maintain the aquatic seepage bogs larvae need. The presence of H. andersonii at a site and the size of the local population are not easy to deduce from the number of calling males heard or not heard there. Proper assessment of the endangered or threatened status of this species will depend upon better censusing techniques and more intensive study in the future.

INTRODUCTION

For biologists interested in its geographic distribution, the Pine Barrens treefrog (Hyla andersonii Baird, 1854) has been an enigma. The species occurs in Florida, the Carolinas, and New Jersey, but is not substantiated to occur in the intervening states of Georgia and Virginia. An old record for Georgia (Neill, 1948) needs confirmation and apparently no intensive search has been made for this species in Virginia's Coastal Plain.

Throughout its range, populations of the Pine Barrens treefrog are considered threatened or endangered. These determinations were made partly because the number of known breeding choruses is small and, at least for the Carolinas and Florida, the number of individuals per chorus also is small (rarely more than 10-15 calling males). Published information on the ecology of the species is limited to

occasional observations on the phenology of the breeding cycle or to a single season's field work done in only one of the 3 geographically disjunct enclaves (Noble and Noble, 1923; Means and Longden, 1976).

We report here new information on the Florida distribution of the Pine Barrens treefrog, and we discuss two aspects of the biology of this species which we feel have important bearing on the threatened status of regional populations. These aspects are the erratic calling behavior of males and the effect we think plant succession has on the quality of the larval habitat.

DISTRIBUTION

Figure 1 illustrates the presently known distribution of the endangered Florida

populations of H. andersonii. At the time of the final rulemaking (11/11/77), only 11 Florida sites were known for the species. We have since increased the total number to 37 sites during the summers of 1977 and 1978.

Two methods were employed for finding new populations. The first method was to drive over the public roads of Okaloosa and Walton counties at night, stopping wherever these crossed streams and other low areas having wetland vegetation. At each stop we would listen for calling males of the Pine Barrens treefrog; if none were heard we would try to elicit calls by giving our own vocal imitations or by playing a tape recording of a chorus. By this method, a total of 13 sites was located in 3 summers of modest effort (1970, 1971, 1977).

The second method employed was more successful. One of us (PEM) located 24 populations in 12 nights of searching in 1978 by identifying likely looking terrain on USGS 7½' topographic quadrangles, then travelling to the vicinity and listening for calls of adult males. The criteria used for selecting sites from topo maps were rather subjective, but consisted of identifying roads that crossed small stream tributaries or provided access to these. During daylight hours these sites would be reconnoitered to determine whether suitable bog habitat was present. Nighttime searching then was limited to only those sites which appeared as good prospects from daytime inspection.

LOCAL ABUNDANCE

During the course of conducting field work with the Pine Barrens treefrog over a period of 9 years, one aspect of the behavior of the species emerges from our observations which may have a significant bearing on judgments made about the apparent rarity of local populations, and ultimately on the threatened or endangered status of H. andersonii wherever it occurs. We observed that the low number of calling males often heard in choruses may be the result of erratic temporal distribution of calling behavior in known populations.

Means and Longden (1976) commented that local populations of the Pine Barrens treefrog in Florida seemed small because the number of calling males heard in breeding choruses usually was less than 10 individuals. Only about 9 of the 28 new populations reported here were judged by us to have breeding choruses consisting of more than 10 males. Fourteen of the new populations were confirmed on the basis of only 1 or 2 calling males. Field work on this species in North Carolina

conducted by one of us (DBM) in 1978 resulted in a similar observation that many local choruses were small.

We have also noted that males are not predictably heard at known calling sites throughout the breeding season, or from year to year. Often it was easier to stimulate one or more males to call by mimicking their calls with our own voices than it was to hear males chorusing on their own, even on some nights with thundershower activity. We experienced the same difficulty in 1978 when we were unable to hear males in mid-August at sites we recorded them from earlier in the season. Many of the local sites where only a few males have been recorded calling are sites that on other nights have had considerably larger choruses. For instance, in mid-August 1977, robust choruses were heard along Poverty Creek in Okaloosa County that were silent in July 1972. Such erratic calling behavior also has been observed in populations in the Carolinas (A. J. Bullard, Jr.; J. H. Carter, III, pers. comm.).

We feel that estimates of local population size based on counts of calling males are unreliable if the estimates are made on one or only a few visits to a site. Also, the lack of calling males at likely looking sites does not necessarily mean the species is absent. Because judgments on the threatened or endangered status of the Pine Barrens treefrog rest on estimates of number of populations and number of individuals per population, it is imperative that such estimates reflect real rather than apparent population size. In the absence of better data of our own, we sound this cautionary note and hope others studying this species will examine calling behavior more closely.

HABITAT RELATIONS

The Florida habitat of the Pine Barrens treefrog was briefly described by Means and Longden (1976) as "acid hillside seepage bogs (shrub bogs)." Larvae were taken from tiny, clear-water seepage pools associated with these communities. Similar descriptions have been reported in the literature for New Jersey and Carolina populations (see Means and Longden, 1976). In their opinion, the presence of the delicate larval seepage pools is the most critical limiting factor in the local success of the treefrog. We wish to comment further upon important differences between larval and adult habitats and on the role of plant succession in relation to optimal larval seepage habitat.

We recognize 2 types of bogs: shrub bogs and herb bogs, both of which are important to the local success of the Pine Barrens treefrog. Shrub bogs contain dense evergreen shrubs, sometimes achieving small tree size upwards to 25

feet tall; these are the preferred habitat of the adults. We rarely have seen adult H. andersonii outside the dense woody vegetation of shrub bogs. Usually adjacent to, or interlaced with shrub bogs are herb bogs having little or no woody growth and lots of seepage. We have found larvae most often in seepage pools that occur in such herb bogs.

For both the Carolinas and Florida, we can characterize an environmental gradient containing these two bog communities as illustrated in Figure 2. Herb bogs are developed upslope from shrub bogs, usually along low gradient stream valleys paralleling the stream course. Herb bogs typically develop on sandy soils, are dominated by grasses, sedges, insectivorous plants and other forbs, and have more seepage water at ground surface than shrub bogs (Wells and Shunk, 1928; Wells, 1932; Garren, 1943; Penfound, 1952; Clewell, 1971; Wharton, et al., 1976). Downslope, the herb bog habitat grades into a shrub bog as the soil becomes more peaty, is less wet at ground surface, and supports a dense growth of evergreen woody vegetation with few herbaceous species present (Wells, 1932; Penfound, 1952; Wharton, et al., 1976).

The successional relationships between the 2 bog types depends upon fire. Frequent fires are obligatory in maintaining herb bogs; in the absence of fire, herb bogs succeed to shrub bogs (Wells and Shunk, 1928; Penfound, 1952; Eleuterius and Jones, 1969; Clewell, 1971). Wharton et al. (1976) stated that herb bogs burned on a frequency of 3-8 years and that a fire once in 10 years was sufficient to keep shrubs and pines out. In shrub bogs, burning intervals are longer, with fire occurring once every 20-50 years (Wharton et al., 1976).

Both herb bogs and shrub bogs are fire "subclimaxes." In the total absence of fire, bogs succeed to hardwood forest called mixed swamp or bayhead communities in Florida. Monk (1966) argued that these communities are climax types.

We have noticed generally that the Pine Barrens treefrog seems to do best where herb bogs are well developed alongside shrub bogs. We believe the reason this is true is because more potential larval habitat is available in early successional bog habitats. That is, the less woody vegetation occurring on a wetland site, the greater the tendency for seepage water to be present at ground surface. We argue that woody vegetation itself eliminates larval habitat or decreases the length of time water is present seasonally by depressing surface seepage through increased evapotranspiration.

Our observations support this hypothesis for Carolina as well as Florida habitats.

We present the following as the simplest model of the preferred habitat of the Pine Barrens treefrog. Periodic ground fires sweep downslope from longleaf pine-wiregrass communities (the native upland vegetation type in the Coastal Plain from North Carolina to Mississippi [Wahlenberg, 1946]) until they are retarded by wet soils, standing pools of seepage water, and less flammable fuels of the evergreen shrub bog communities (Figure 2). Because of varying hydroperiods and the vicissitudes of unpredictable drought, the intensity of fires and the extent to which they burn into the shrub bogs and further into hardwood creek swamps varies. Generally fires are much more frequent at the upslope end of the vegetation gradient, so much more in fact that even the longleaf pine-wiregrass community is a fire-maintained subclimax which will succeed to a mixed hardwood climax in the absence of periodic fires (Kurz, 1944; Quarterman and Keever, 1962; Delcourt and Delcourt, 1977).

Young woody plants of shrub bogs continually invade the herb bogs. Because they are fire tender, however, they are continually killed back by the periodic fires. Thus herb bogs (grass-sedge bogs, pitcher plant bogs, savannahs of some authors) form in the transition zone between xeric pinewoods slopes and the more mesic valley bottom communities beginning at the shrub bog zone. Ground water saps from the slope where the water table first reaches ground surface and is not depressed by evapotranspiration by woody plants. This occurs mostly in the herb bog community and to a lesser extent within the margins of the shrub bogs.

The juxtaposition of the shrub bog arboreal habitat utilized by adult Pine Barrens treefrogs next to herb bogs having lots of seepage habitat for developing larvae seems to be requisite for maintaining a treefrog population through time. In the complete absence of fire, shrubs and later hardwoods invade herb bogs, eliminating seepage breeding pools. Through plant succession, the habitat is grossly altered to a community type which H. andersonii is not adapted for.

MANAGEMENT IMPLICATIONS

In modern times, other disturbance factors seem to be suitable substitutes for fire in the establishment of herb bogs. Both in the Carolinas and in Florida we have noticed that clear-cutting of longleaf pine adjacent to shrub bogs has promoted increased ground water seepage upslope from the shrub bogs and to some extent inside the shrub bogs also. These observations have been made by others. Pessin and Smith (1938)

noted that logging longleaf pine resulted in a higher water table, and a herb bog often developed on these sites following logging. Wahlenberg (1946), Penfound (1952), and Clewell (1971) all expressed the same opinion that herb bogs could form following logging and that reduced evapotranspiration was responsible for increased seepage (Clewell, 1971). A necessary corollary to the benefit of increased seepage (i.e. increased breeding sites for H. andersonii) on sites after logging is that as dense stands of planted pines grow up on these sites, we predict that evapotranspiration will be greatly increased and then seepage will be lost or severely retarded. The newly formed herb bogs will literally dry up and succed to dense shrubby vegetation. Ultimately, silvicultural practices, good for Pine Barrens treefrog habitats at first, will be detrimental to them.

Herb bogs suitable for the Pine Barrens treefrog sometimes form as a result of actual mechanical disturbance of the soil such as where we noted earth was scraped away down to the water table during and adjacent to road construction. In other places, ruts formed by bulldozers and other machinery have caused seepage pools to form, and at one location, we noted that seepage along the base of an impoundment dike formed suitable seepage pools for this frog.

At first it seems incongruous that an endangered species should fare well at sites disturbed by such activities of man as clear-cutting and rutting the ground surface. If a species can accommodate to human caused disturbance, why then should it be reduced to a few small populations distributed patchily between 3 widely disjunct enclaves?

This paradox is resolved if one recognizes that the Pine Barrens treefrog inhabits a normally ephemeral environment. Herb bogs are transitional ecotones between longleaf pine-wiregrass communities upslope and shrub bog habitats downslope. Both of these latter communities, however, are successional subclimaxes themselves, and also dependent on periodic fires for their own perpetuation. Organisms inhabiting temporally or spatially transient environments are weedy species in the true sense of the word, capable of capitalizing on the fugitive occurrence of their habitat. In the case of H. andersonii, its local success is more a question of whether larval habitat is available from one breeding season to another. Under normal conditions the presence of seepage pools is highly dependent upon the annual distribution of rainfall locally, the occurrence of unusual drought, and time since the last fire. It is

not then surprising that we find H. andersonii utilizing seepage pools formed in vehicle ruts, borrow pits with seepage, or other human disturbed sites since these too are early successional, fugitive habitats. The erratic calling behavior of males mentioned earlier in this paper also fits this model. H. andersonii may only chorus vigorously when local conditions have produced adequate larval habitat. These conditions are not necessarily congruent from locality to locality.

The reason the Pine Barrens treefrog is relatively rare over its geographic range is simply because its delicate seepage bog habitat (both herb and shrub bog) has been dramatically reduced in the Coastal Plain. Means and Longden (1976) argued that this is a result of post-Wisconsin climate change, but another hypothesis contends that the present day fragmented distribution and local rarity of populations has been brought about only in historic times by European man (Means, Karlin and Guttman, 1979).

If our contention that larval seepage habitat is a critical limiting factor in the local success of populations of the Pine Barrens treefrog, then management practices should be geared toward maintaining or restoring adequate seepage pools for breeding. Experimental application of prescribed burns are needed in bog sites that have not burned for some time. In Florida and the Carolinas, this applies to most bogs. No known H. andersonii bogs we have seen in either North Carolina, South Carolina, or Florida are being burned regularly. Since natural fires are either actively suppressed over large acreages in the Coastal Plain, or are impeded by roads, agricultural fields, silviculture, and other human alterations of the natural landscape, prescribed burning is the only way to approximate the Pre-Columbian fire frequency. Until biologists conduct careful ecological studies with experimental habitat manipulation, not much more can be recommended as possible management techniques.

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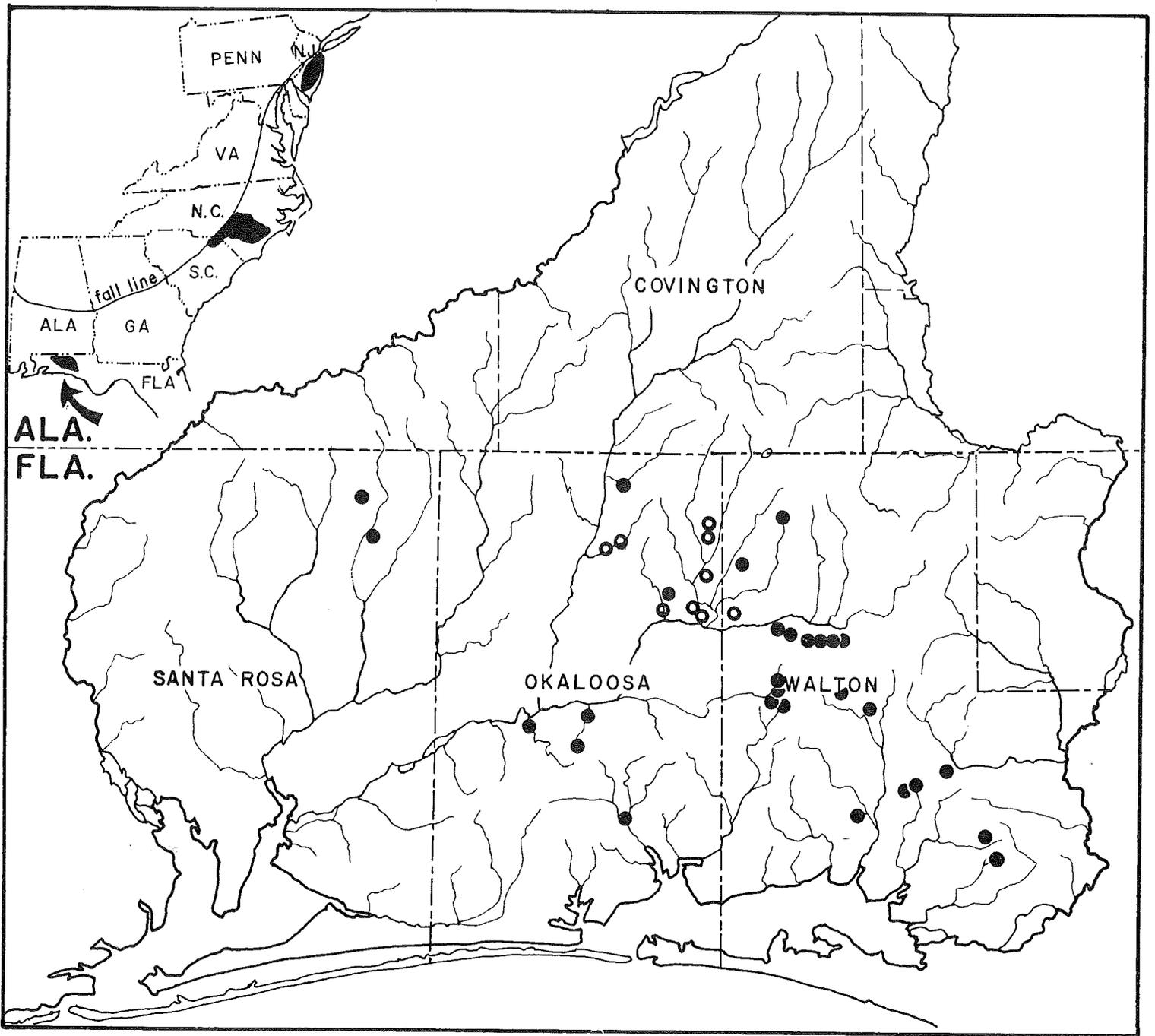


Figure 1. Geographical distribution of the Pine Barrens Treefrog, *Hyla andersonii*. Solid circles= new localities discovered 1977-1978. Open circles=localities known at time of final endangered species rulemaking (11/11/77).

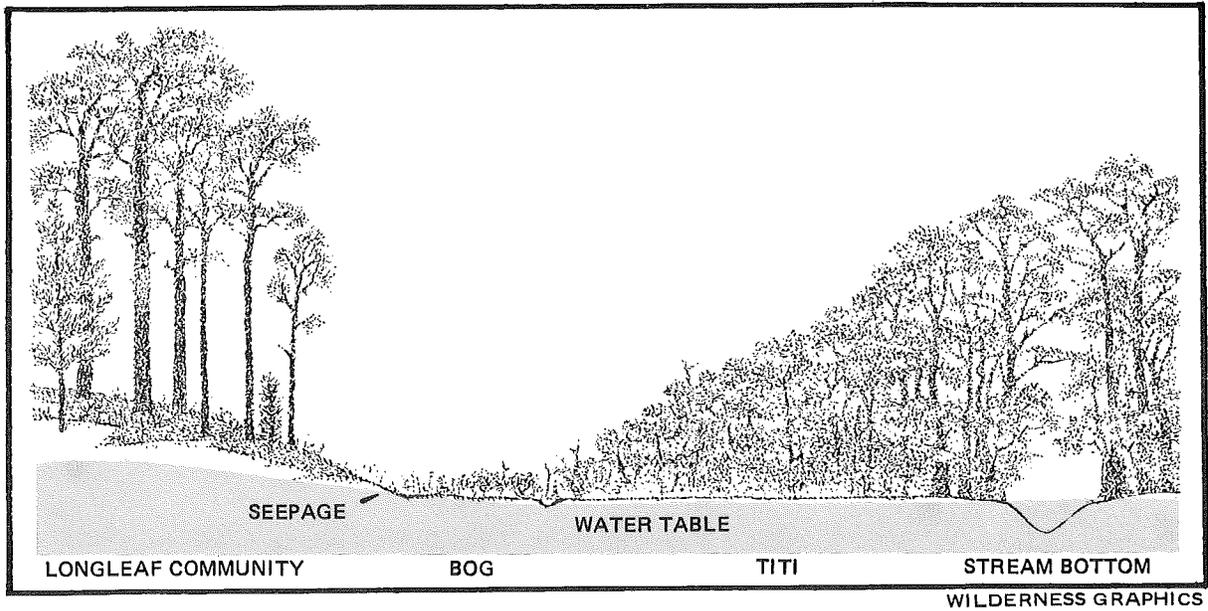


Figure 2. Florida habitat gradient maintained by fire. Frequent fires burn downslope from longleaf pine-wiregrass community forming herb bog (labelled "bog") with lots of seepage. Herb bogs grade into shrub bogs (titi community in Florida) that burn less frequently, have little herbaceous ground cover, and less seepage occurring in standing pools through time. Hardwood creek swamps burn very rarely and are the vegetational climax both herb bogs and shrub bogs would tend toward in long term absence of fire. Optimum Pine Barrens treefrog habitat occurs at interface between herb bogs (best larval habitat) and shrub bogs (adult habitat).