# VERNAL POND BREEDERS

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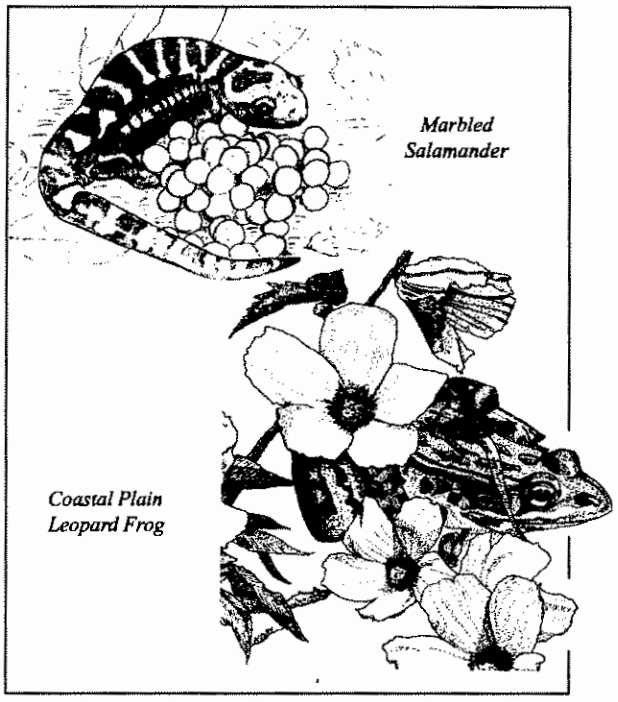


## ABSTRACT

**Six species of amphibians are chosen to illustrate the use of freshwater vernal pools along the estuary's upland shores. These small temporary areas of standing surface water that form in spring after ice or snow thaw or rain are exploited by specialized organisms for feeding, resting, or reproduction. The salamanders, frogs, and toads discussed here are part of the estuary food chain, and are sensitive indicators of the state of the ecosystem. Several are common wherever suitable vernal ponds or freshwater wetlands are available (e.g., wood frog, coastal plain leopard frog). Others select more forested habitats except during reproduction (e.g., spadefoot toads). The marbled salamander breeds in autumn vernal pools. The eastern tiger salamander is seriously endangered, and demonstrates the need to protect further loss of habitat for these types of animals. Chemical pollution and road mortality during migration are other significant causes of the general decline of amphibians.**

## INTRODUCTION

Vernal pools are important freshwater habitats along the Delaware Estuary's upland shores. By definition, a vernal pool or pond is a small body of standing surface water that forms in spring from thawed ice or snow or fresh rains that elevate ground water level in low areas (Colburn 1993). (The term "vernal" comes from the Latin word for spring.) Vernal pools are isolated wetlands that are biologically unique systems, which support a diverse assemblage of species often quite different from those found in larger, more permanent bodies of water (Moler and Franz 1987). These ephemeral pools often hold water long enough to allow a variety of specialized aquatic creatures such as insects, crustaceans, and amphibians to exploit these unique wetland conditions. Such activities as feeding, resting, and reproduction are usually carried out on an annual basis. Since these are temporary aquatic habitats, they are usually free of fish, an important factor for some invertebrates and small amphibians who would otherwise be preyed upon. Vernal pools are transitional and serve as links between permanent aquatic ponds, and dry terrestrial upland areas (Hulmes, Hulmes, and Zappalorti 1981; Colburn 1993).

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## Geographic Range

Six northeastern species of frogs, toads, and salamanders are included as priority species on the Delaware Estuary Program's list, and will be the focus of this chapter. All of these amphibians are native to the portions of Delaware, New Jersey, and Pennsylvania that are in the estuary. Most of these priority species also occur in other states along the coastal plain and Appalachian Mountains of the eastern United States (Conant and Collins 1991).

## Status and Trends

A select group of amphibians will be discussed that depends almost exclusively upon these temporary habitats. The six species and their status are the 1) eastern tiger salamander *(Ambystoma tigrinum tigrinum)*, endangered in Delaware and New Jersey, extirpated in Pennsylvania; 2) marbled salamander *(Ambystoma opacum)*, declining in all three states; 3) wood frog *(Rana sylvatica)*, common in all three states; 4) New Jersey chorus frog *(Pseudacris triseriata kalmi)*, common or stable in Delaware and New Jersey, but endangered in Pennsylvania; 5) coastal plain leopard frog *(Rana utricularia)*, also stable in Delaware and New Jersey, but endangered in Pennsylvania; and the 6) eastern spadefoot toad *(Scaphiopus holbrooki)*, listed as secure in Delaware and Pennsylvania, but declining in New Jersey.

These amphibians were selected because they are "indicator species" of a clean, healthy environment. More importantly, they play a role in maintaining the dynamic equilibrium of the food chain within the vernal pool ecosystem (Hulmes, Hulmes, and Zappalorti 1981; Moler and Franz 1987; Zappalorti, Dowdell, and Vargas 1991; Colburn 1993).

## Life History

The eastern tiger salamander (ranked S1, extremely rare) and the marbled salamander (S3, rare to uncommon) often share the same vernal ponds for courtship, breeding, and egg deposition, although they breed at quite different times of the year.

Marbled salamanders breed in autumn (October-November) on the dry floor of natural or human-made temporary ponds. Adults are short and stout and average 11 centimeters (4.3 inches) in length. Males arrive first and hide under leaf litter or in mole tunnels. Females arrive a few days later and courtship takes place (Noble and Brady 1933). Females deposit the eggs in low, moist depressions on the pond bottom, which will eventually fill with rain and groundwater in late fall or early winter. The eggs are unattached, but are laid together and resemble a cluster of small grapes. The adult female stays coiled around the eggs protecting them until they are covered with water. Once the eggs are submerged, they quickly develop and hatch and the larvae feed on plankton, small aquatic insects, and invertebrates that swim in the pond. The larvae spend the winter in the pond and metamorphose the following May or June (Noble and Brady 1933; Hassinger, Anderson, and Dalrymple 1970; Ashton and Ashton 1988).

The larger tiger salamander (15-20 centimeters [6-8 inches]) also uses natural or human-made vernal pools for breeding and egg laying. Tiger salamanders are winter breeders and typically begin congregating in the ponds in late November or December. A member of the family of mole

salamanders, *A. tigrinum* typically lives most of its life beneath the ground in mole tunnels; in burrows it digs; or under logs, emerging only for the short time required for courtship and egg laying in its breeding pond (Gehlbach 1967). Mild winter temperatures and rain are the chief stimuli for bringing about mating aggregations. Various investigators state the breeding season is December, January, February, or March (Hassinger, Anderson, and Dalrymple 1970; Anderson, Hassinger, and Dalrymple 1971; Anderson 1976; Anderson, Galandak, and Hawthorne 1978; Stine 1984; Arndt 1989). The adult males enter the pond first and remain secluded during the day, hidden under aquatic vegetation. When the females arrive, and temperature conditions become suitable, courtship begins. The egg masses are deposited in the water about 15-35 centimeters (6-14 inches) below the surface (Hassinger, Anderson, and Dalrymple 1970; Stine 1984).

Their secretive burrowing habits make it difficult to study adult tiger and marbled salamanders. Therefore, surveys are practical only during their fall or winter breeding seasons when the salamanders are entering their annual vernal pond. Although habitat use by terrestrial adult tiger and marbled salamanders is poorly understood, investigations of related species have confirmed the importance of surrounding wooded upland areas to adults and juveniles. Studies indicate that spotted salamanders *(A. maculatum)* have a home range of 100 to 300 meters (110 to 330 yards) from their breeding ponds (Sexton et al. 1986).

Eastern spadefoot toads, listed as "common" or "stable" (S4) species, are stout-bodied amphibians that average 4.4 to 5.7 centimeters (1.5 to 2.5 inches) in size. They are usually some shade of brown with a curved yellow line extending backwards from their golden eyes (Bragg 1965, Conant and Collins 1991). The "spadefoot" is a secretive amphibian whose life history is not well known. It burrows into the ground and sleeps for days, weeks, or perhaps years at a time. The author has found them hibernating 2.7 meters (3 yards) below the surface of the ground, at a pine snake (*Pituophis melanoleucus*) den in the Pine Barrens of southern New Jersey. The "spadefoot" is seldom discovered in garden or orchard, but it is often seen crossing roads on rainy nights, especially during downpours of more than 2.5 centimeters (1 inch) of rain.

The one time when spadefoot toads are conspicuous is when they travel to the ponds to deposit their eggs. This is usually in the spring (although they may breed any time of the year) and is always coincident with a very heavy rainstorm or a long-continued, warm drizzling rain. They are likely to remain in the pond only one or two nights, but during this time the males call while stretched out floating on the water surface. They keep up a continual chorus of loud calls that resemble snorty grunts, like long, drawn-out "quonks." The call is repeated every 10 seconds and can be heard at a great distance (Conant and Collins 1991). After breeding, the eggs are laid in stringy gelatinous masses attached to underwater debris; the adults then migrate back to their underground retreats.

Eggs hatch rapidly, usually within two days. The tadpoles develop quickly in a race against the heat of the sun, which evaporates the water of the temporary pond. The young spadefoot toads select forested areas with loose, loamy soil where they can easily burrow and remain hidden during dry periods (Bragg 1965).

This amazing pioneering ability prevents certain amphibian populations from dying off when their breeding habitat is lost.

The New Jersey chorus frog is stable or common in Delaware and New Jersey, but is listed as an endangered species in Pennsylvania. Members of the species are small in size (2 to 3.5 centimeters [0.75 to 1.5 inches]), with three distinct dark brown stripes down the back. Upper portions of the body and head are light brown or gray, the ventral side is white (Whitaker 1971, Groves 1985).

New Jersey chorus frogs select their habitat in flooded fields, wet borrow pits, roadside ditches, and bogs. They also use stream floodplains with vernal ponds and river bottom swamps. Open, grassy wet fields are their favorite habitat and large groups will congregate in late March on rainy nights to begin breeding activities. These small frogs are difficult to find because as one approaches the breeding pond, the frogs become silent. Once the intruder leaves, they resume calling. They often call during the day when temperatures are warmer. Calling males produce a series of short trills that steadily rise in pitch, best imitated by running a thumb along the teeth of a large plastic comb. Eggs are produced in clutches ranging from 20 to 150 eggs. The loose cluster of eggs is always attached to sticks or other aquatic vegetation (Dickerson [1906] 1969). The tadpoles are nearly black in color when hatched and as they develop. Metamorphosis takes place from May to June when the tadpole is slightly over 2.5 centimeters (1 inch) long (Bragg 1948, Harper 1955, Whitaker 1971, Groves 1985).

Wood frogs are one of the smallest members of the family Ranidae, which range in size between 4 to 8.5 centimeters (2 to 3 inches). This handsome frog is found from as far north as Labrador and Alaska; to the southern Appalachians in the southeast; and with isolated colonies in the Central Highlands, east-central Alabama, northwest North Dakota, and western Newfoundland. This species ranges farther north than any other North American amphibian or reptile. There are also western subspecies (Conant and Collins 1991).

Within the estuary, wood frogs are found wherever suitable temporary, vernal ponds are available with sufficient hardwood swamps and forest floodplains. Their coloration is variable, changing from chocolate-brown to fawn color, through varying shades of red, yellow, or gray-brown. There is a black or dark-brown patch of color in the region of the ear, eye, and snout, which resembles a "robber's mask" (Dickerson [1906] 1969). Wood frogs appear very early in spring, and are often heard calling before ice is completely off the ponds. An explosive breeder, the eggs are laid in the course of a very few days, and the breeding season is likely to end before the first of May. After that time, wood-frog voices are not heard again until the following spring. Development of eggs and tadpoles is especially rapid in the warmer temperatures of shallow, temporary vernal pools. The young tadpoles are nearly black, and like other tadpoles, they act as scavengers by greedily devouring all dead animal and vegetable matter in the pond (Wilbur and Collins 1973).

The wood frog is listed as a "common" or "stable" species (S4) in Delaware, New Jersey, and Pennsylvania. It was chosen as a priority species because it is a classic vernal pool breeder and a good "indicator" of a healthy wetland complex (Wilbur 1972).

Coastal plain leopard frogs occur along the coastal plain from Long Island and Staten Island, New York, south to southern Florida; and west to the Mississippi Valley in Kansas, Missouri, Illinois, and Indiana, and in southern Ohio. The species is also known from eastern Texas. There are other

forms recognized in the *Rana pipiens* complex (Pace 1974, Conant and Collins 1991). The leopard frog is common wherever suitable freshwater wetlands are available. In Pennsylvania, this frog is recorded from only the southeastern portion of the state in Bucks, Delaware, and Philadelphia Counties (Groves 1985).

This is a mid-sized, slender, and elongated frog that averages 5-12 centimeters (2 to 3.5 inches) in length. Leopard frogs have a distinctive narrow head and pointed snout. The ground color is green, tan, or brown with numerous elongated or round dark spots, which are sometimes bordered in white or yellow. A light spot is usually present in the center of the tympanum (eardrum).

Coastal plain leopard frogs select all types of shallow, freshwater wetlands as habitat. Adults are sometimes found along the edges of brackish marshes in the Delaware Bay (Wright and Wright 1949). Leopard frogs forage away from water in wet meadows and grassy fields, where high weeds and successional vegetation offer shade and hiding places. This type of habitat is rich in crickets, grasshoppers, beetles, and other small insects that comprise their primary diet. Breeding begins after the first warm rains in early March and continues through April. Calling males produce a series of guttural croaks and clucks similar to the sound made by rubbing a finger across an inflated balloon. Males usually call from shallow water along the edges of ponds, lakes, or other waterbodies, but underwater vocal behavior has also been observed by the author. Eggs are usually laid in shallow water in gelatinous masses, each containing from 100 to 2,000 eggs. A single female may produce two to four masses of eggs during the breeding season. Egg masses are generally attached to aquatic vegetation at or near the water surface. Eggs require 15 to 20 days to hatch, depending on water temperature. Tadpoles metamorphose by late July and the juvenile frogs move into the grassy meadows that usually surround the breeding pond. Newly transformed frogs are 16 to 30 millimeters (0.75 to 1.3 inches) in length (Groves 1985, Ashton and Ashton 1988).

Populations of the coastal plain leopard frog are secure (S5) in the states of Delaware and New Jersey. Once abundant in Pennsylvania, the frog is presently listed as an endangered species. Much of its habitat has been lost or drastically altered by industrialization along the Delaware River.

Some species of amphibians have the ability to venture out or "pioneer" into other vernal pools that are nearby (Anderson 1976). They will exploit whatever type of water body is available, either natural or human-made, as long as it is within a 1.6-kilometer (1-mile) radius of the original breeding habitat (Sexton et al. 1986, Arndt 1994). This is especially true if their vernal pool has been polluted, altered, or destroyed by filling or draining. However, only the frogs, toads, or salamanders that selected temporary, fish-free vernal pools will be successful breeders. This amazing pioneering ability prevents certain amphibian populations from dying off when their breeding habitat is lost. This occurred with tiger salamanders and southern gray treefrogs when wet borrow pits were selected secondarily after their natural vernal pools were lost to various construction projects and sand and gravel mining activities throughout southern New Jersey (Anderson 1976; Zappalorti, Dowdell, and Vargas 1991; Zappalorti 1973-1993).

## Ecological/Economic Role

All these amphibians contribute to the dynamic equilibrium of the food chain in the estuary. They

serve as predators of various nuisance insects, including biting flies and mosquitoes, and are therefore beneficial to humankind.

None of the species covered in this chapter are collected for human consumption, and none have significant economic value. The occasional collector may take animals for pets; the tiger salamander is especially popular in this regard. They also serve as educational aids in biological laboratories and classrooms, particularly their tadpoles or larvae. Their most important role is as good "indicator species" of a clean and healthy environment.

## Habitat Requirements

In general, frogs, toads, and salamanders have various degrees of fidelity to the breeding pond from which they originally came. Site imprinting to the breeding pond may take place prior to, or during metamorphosis. Certain adult "pioneers" may later leave their vernal pool if it is destroyed or altered, and they can find more ideal conditions at a wetland less than a mile from their breeding pond (see life history). A general discussion of habitat requirements follows.

***Breeding Pools.*** The six indicator species of salamanders, frogs, and toads were found to use four distinct types of vernal-pond breeding habitats:

- Isolated Natural Vernal Pond
- Connected Pools within a Stream Floodplain
- Human-made Wet Borrow Pit or Roadside Ditch
- River Corridor - Hardwood Swamp Forest (Arndt 1989, Zappalorti 1973-1993)

Individually, these four wetlands types are quite different from one another (e.g., natural versus human-made; open canopy versus closed, shaded, woodland canopy). Nonetheless, they also have important similarities, the most obvious being that all eventually dry up by summer, sometimes very rapidly during a drought. Higher ambient air and surface temperatures will increase the rate of evaporation, preventing the survival of fishes that may have found their way into the pool during periods of flooding.

An investigation of 80 breeding sites of the southern gray treefrog *(Hyla chrysoscelis)* in Cape May and Cumberland Counties, New Jersey, revealed that various temporary ponds were the most commonly used habitat type for this species (Zappalorti, Dowdell, and Vargas 1991). Of the 80 wetlands surveyed, natural vernal ponds were used 28.7 percent of the time, connected pools in stream floodplains made up 27.5 percent of the sample, and human-made wet borrow pits comprised 32.5 percent of the breeding habitats studied. Combined, these vernal wetlands represented 88.7 percent of the total sample. Only 11.3 percent of the sites used by breeding amphibians were permanent ponds or lakes (Zappalorti, Dowdell, and Vargas 1991, 1992). Similarly, Arndt (1989), surveyed 173 ponds in three Delaware counties and found that 76 were vernal pools while the other 97 were considered permanent. Sixty-three of the ponds surveyed were thought to be natural while the other 110 were thought to be human-made. Tiger salamanders and some of the other target species were found in only 12 of the temporary, vernal ponds. Bullfrogs *(Rana catesbeiana)* and green frogs *(Rana clamitans melanota)* were present in most permanent bodies of water. The presence of fish in these permanent bodies of water, along with waterfowl and large aquatic turtles, was thought to be the

main reason for their having such limited use by certain amphibian species (Moler and Franz 1987; Arndt 1989; Zappalorti, Dowdell, and Vargas 1991, 1992; Colburn 1993).

***Diet and Food.*** The survival of tadpoles and salamander larvae is strongly dependent upon a consistent food supply. This ensures they will develop a reserve of stored body fat, which will provide the energy they need to change from a gilled, aquatic creature that absorbs dissolved oxygen from the water to a lunged, air-breathing terrestrial form. Stored energy enhances their ability to metamorphose quickly before the water evaporates. If the pond dries up before their metamorphosis is complete, they will perish in the mud, or, if the larvae are left in a low level of water, they are exposed to predation by waterfowl, wading birds, raccoons, turtles, or snakes (Zappalorti 1973-1993).

Adult frogs, toads, and salamanders are aggressive predators that eat a variety of invertebrates they encounter in their environment: small worms, spiders, beetles, dragonflies, damselflies, moths, butterflies, and other insects. Motion of the food item triggers a feeding response by the frog, toad, or salamander and they will "snap up" whatever moves in front of them (that fits in their mouths).

## Special Problems/Management Considerations

Unfortunately, many frog, toad, and salamander populations have been lost throughout the Delaware Estuary due to the filling, draining, or polluting of their breeding ponds. Highways and roads that cross wetlands may be de-iced in winter with rock salt (sodium chloride and calcium chloride); these chemicals eventually find their way into breeding ponds. Indiscriminate spraying of insecticides for the control of mosquitoes or other nuisance insects may have also decimated amphibian populations. Currently, state agencies responsible for mosquito control are not informed of sensitive "endangered" amphibian areas. Many ponds, marshes, swamps, and other wetlands are periodically treated with "Abate" or other types of chemicals used to control insects. Salamander larvae and frog or toad tadpoles are also affected by these chemicals, and often die following exposure to them. Along with land development and alteration, these pressures may have caused the drastic decline of amphibian populations in the Delaware Estuary.

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Road mortality is another major problem that affects amphibian populations negatively, especially during ingress and egress migrations associated with breeding sites. There is an increase in vehicular traffic on older roads, and new roads are often constructed across sensitive wetlands. As a result, thousands of frogs, toads, and salamanders are crushed on the pavement each spring during their breeding migrations (Wyman 1992).

## Recommendations

There are certain poorly understood environmental factors, either natural or human-caused, that contribute to declines in amphibian populations. Factors identified in the Delaware Estuary have been sorted into three general categories: habitat loss, chemical pollution, and vehicular collisions. Recommendations will be suggested in each category to help decrease potential losses.

***Habitat Loss.*** In the past, various types of development (housing projects, industrial parks, commercial buildings) have inadvertently caused some loss of sensitive vernal-pool breeding sites.

These losses can be prevented in the future if local planning boards and environmental commissions request that developers conduct site-specific surveys of wetlands systems for the presence of state-listed endangered or threatened species. These surveys should be done prior to site disturbance. State natural heritage programs should also be contacted by the developer for a database printout of local species, including the location of any endangered species on or near the project site. These steps will help planners and developers make the correct decisions concerning the width of buffers that should be left to protect sensitive amphibians and their breeding habitat.

***Chemical Pollution.*** During winter storms, highway and transportation departments should limit the use of sodium chloride and calcium chloride on roads that cross over or pass near wetlands, particularly those that are important amphibian habitats. Alternative methods for removing snow and ice should be encouraged, including mechanical scraping and sand spreading. Water retention and detention basins should be used on all construction sites to collect surface runoff. Various fertilizers and other agricultural chemicals should be used sparingly near wetlands, especially on large farms and golf courses. Pesticides, herbicides, petroleum hydrocarbons, and heavy metals should not be allowed to enter wetlands of any type. Over time, these chemical substances become toxic to amphibians, causing the death of both larvae and adults and the rapid decline of most animal species that depend upon the wetlands for some important life-history stage.

***Vehicular Collisions.*** During spring breeding migrations, many amphibians must cross paved roads to get to their annual breeding pools. With an increase in road construction and traffic, amphibians suffer high rates of mortality on rainy spring nights. This problem can be greatly reduced or eliminated by providing culverts or tunnels under the roadways. However, drift fences or walls must be used in conjunction with the tunnels to prevent the frogs, toads, or salamanders from entering the surface of the roadway. The fence or wall will herd the amphibians into culverts where they can travel under the road and come out safely on the other side. This method has been used successfully in Europe and portions of the United States (Langton 1989).

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