GUIDE TO INVENTORY AND MONITORING OF AMPHIBIANS ON FORT A.P. HILL, FORT BELVOIR, MARINE CORPS BASE QUANTICO, AND PRINCE WILLIAM FOREST PARK, VIRGINIA

Supplement Number 1 to

Amphibian Decline in the Mid-Atlantic Region:

Monitoring and Management of a Sensitive Resource

Final Report to the Legacy Resource Management Program US Department of Defense

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Introduction

Amphibians in the mid-Atlantic region have not yet experienced the dramatic declines documented for other parts of the world (e.g., Phillips, 1990, 1994; Livermore, 1992; Drost and Fellers, 1996; Laurance et al., 1996; Lips, 1998). However, amphibians in this region have suffered population declines from acid precipitation and from habitat loss and alteration (Freda and Dunson, 1985, 1986; Tiner, 1987). Lowering the acidity of soil and water in which amphibians breed has reduced the amount of habitat available for one terrestrial salamander and the shifting of the genetic make-up of a pond-breeding salamander (Wyman, 1988; Wyman and Hawksley-Lescault, 1987; Bogart and Klemens, 1997). In Virginia, habitat loss and modification from urbanization (roads, home construction, shopping malls, office complexes, etc.) has caused the complete demise of many local amphibian populations (e.g., Mitchell, 1996), leaving what remains in smaller and smaller fragments increasingly isolated from one another. Declines and losses are local and the causes are usually obvious.

The problem for scientists and for people concerned about these animals is that we lack the long-term data sets necessary for realistic evaluations of trends. Are populations in a given area declining, stable, or increasing? Are populations declining in some areas and not others? Answers to such questions cannot be obtained without information from numerous places over many years using the same methodologies. Standardization of methods used to obtain population information is critical to future evaluations of how the amphibians are doing.

This guide is designed to assist resource managers on Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park with their inventory and monitoring programs on amphibians on their installations. It provides information on identification of larval and adult life history stages of the species most likely encountered during such programs, and it describes several methodologies that should allow the accumulation of data that can be used in the future to examine trends. This guide supplements the report to the Legacy Resource Management Program by Mitchell (1998).

Identification Guide

Identification of frogs, toads, and salamanders requires some basic knowledge of amphibian anatomy and understanding of key terms. This guide lacks dichotomous keys and assumes that a species in hand or one observed will be identified by comparing it with the illustrations and descriptions. Adult frogs and salamanders of different species differ in body form, certain key anatomical features, color, and pattern. Juveniles of the species included in this guide should not be difficult to identify but some individuals may exhibit variations that may be problematic. The most difficult amphibians to identify are the larval forms: tadpoles and salamander larvae. The descriptions and illustrations will allow most individuals to be identified correctly. However, the youngest larvae may be difficult because some features used in descriptions may not be fully developed.

The following species accounts provide a means to identify the 15 frogs and toads and 8 salamanders one may encounter during inventory and monitoring projects on Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico and Prince William Forest Park (Quantico MCB/PWFP). These descriptions may not work on every individual encountered because of the wide range of variation exhibited by some species. Other sources should be consulted when you are unsure of your identification. These include Martof et al. (1980), Pfingston and Downs (1989), Conant and Collins (1998), Altig and McDiarmid (1998), and Petranka (1998). Information in the following accounts were derived from Bishop (1943), Wright and Wright (1949), Pfingston and Downs (1989), Conant and Collins (1991), Petranka (1998), and my own experience on these installations.

Frogs

Northern Cricket Frog (Acris crepitans crepitans) (Figure 1A)

Adults: These small frogs (to 1 3/8 inches [35 mm] body length) have a blunt snout, a dark, ragged-edged stripe along the inside of the thigh, and legs that are not much longer than the body; the heel does not extend beyond the snout when the leg is extended along the side of the body. A dark stripe usually occurs along the side of the body and a dark, triangular patch occurs between the eyes on the dorsum of the head. Several raised, slightly elongated, bumps resembling warts occur on the body. Body color is highly variable within populations: gray,

green, and brown. Various combinations of red, yellow, orange, brown, green, and gray occur on the dorsum as a distinct stripe or sometimes as patches. The venter is white. Males have orange-brown skin under the chin (the vocal pouch) during the breeding season, whereas females have white chins.

Juveniles: Colored and patterned as adults.

Advertisement calls: Male vocalizations sound like pebbles being clicked together - *gick-gick-gick-gick*, etc. - that starts slowly and picks up speed during the 15-30 second call period. Males will call day and night.

Eggs: About 150-300 small, cream-colored eggs are laid singly in vegetation in shallow water.

Larvae (Figure 5): The most distinguishing feature of cricket frog tadpoles is usually black tail tip. On some tadpoles it looks as if the tip of the tail had been dipped in India ink. Body color is olive to yellowish brown with varying intensities of darker pigment. The venter is pinkish. The dorsal fin on the tail is higher than the ventral fin and its most anterior point is about mid-body. Both upper and lower fins have black pigment.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: Males start calling in mid- to late-April, depending on the weather, and can be heard well into September. Tadpoles may be found in wetlands throughout the summer. Metamorphosis occurs in August and September.

Habitat: These frogs are most often found in grassy areas along the margins of ponds and lakes where they breed in shallow water. They also occur in shallow pools in dirt roads, depressions in grasslands, and riparian corridors along creeks and streams. Cricket frogs are seldom encountered far away from water.

Identification notes: The triangular head patch, dark stripe on the thigh, and the various colors will distinguish this small frog from others of its size.

American Toad (Bufo americanus americanus) (Figure 1B)

Adults: American toads (to 4 inches [100 mm] body length) have numerous large warts (glands) on the back, including a large one (the parotoid) behind the eye, and a broad, squat body. American toads usually have one wart per dark spot or blotch on the back. The warts are brown to yellowish in color on the dark brown to black spots. Warts on the thighs are usually capped with a spine. A light line usually occurs down the center of the back. Body color is brown to nearly brick red. The venter usually has black spots on or near the chin and anterior abdomen. Males are usually smaller than females and the skin on the chin is dark brown to almost black in color during the breeding season.

Juveniles: Smaller versions of adults; the raised warts on the thighs and the single wart per dark blotch on the back will usually distinguish these juveniles from those of Fowler's toads.

Advertisement calls: A long, musical trill, lasting 15-30 seconds. Usually heard at night but males may call occasionally during the day.

Eggs: The 2,500-8,000 black eggs are laid in two long, gelatinous strings in shallow water usually unattached to vegetation.

Larvae (Figure 6): Tadpoles are dark brown to black at all developmental stages with fine gold-colored dots in some individuals. The body is ovoid in shape, broader posteriorly than anteriorly. The eyes are located more on top of the head than in tadpoles of other frogs. The anal opening lies along the midline, not curved to the right as in frogs. The upper half or more of the muscular portion of the tail is dark and lower half is light. The fins are about the same size above and below the muscular portion and somewhat opaque. Toad tadpoles often aggregate and occur in large numbers.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: American toads call during warm spells in late-winter and early spring. They are usually heard March to April, depending on the weather. Eggs are laid during this period. Sporadic calls may be heard

in February and May. The larvae are present for up to 2 months but may metamorphose earlier if the pool dries.

Habitat: Adults are terrestrial and usually underground outside of the breeding season. They are found in shallow water (road ruts, shallow depressions in fields, marshes, pond margins) in the open when calling and laying eggs. They may be found in back yards, gardens, and school grounds in suburban areas, agricultural fields, hardwood forests, and mixed hardwood/pine forest patches.

Identification notes: The combination of the time of year (late-winter and early-spring) for calling males, eggs, and young tadpoles will help to distinguish this toad from the Fowler's toad. Rely on the raised warts on the thighs for a positive identification for all postmetamorphic stages.

Fowler's Toad (Bufo fowleri) (Figure 1C)

Adults: Fowler's toads (to 3 inches [76 mm] body length) usually have more than one wart, usually 2-4, per dark spot or blotch on the back. The warts are yellowish in color on the brown to nearly black spots. Warts on the thighs are not capped with a spine; they are small and flattened. A light line occurs down the center of the back. Body color is brown to grayish. A large parotid gland occurs behind each eye. The venter usually lacks spots or other distinct dark markings. Males are usually smaller than females and the skin under the chin is dark in color during the breeding season.

Juveniles: Recently metamorphosed Fowler's toads resemble adults with the 2-4 warts per blotch on the back and the flattened warts without spines on the thighs. A hand lens may be necessary to examine these features.

Advertisement calls: A short (less than 5-10 seconds), nasal call that sounds something like a bleating of a sheep - something like w-a-a-a-a-h (as described in Conant and Collins, 1998).

Eggs: The round eggs are black, numbering 2,000-8,000; laid in long, gelatinous strings in shallow water usually unattached to vegetation.

Larvae (Figure 7): Fowler's toad tadpoles are black at all developmental stages and are similar in shape and eye position to American toads. The anal opening lies along the ventral midline. Most of the muscular portion of the tail is dark and only the extreme lower side is light in color, not distinctly bi-colored as in American toads.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: Males call from late-April through August and egg strings may be found at any time during this period. Male Fowler's toads usually start calling 1-2 weeks later than American toads, although in some years they may overlap in mid-April. Length of larval period is about one month.

Habitat: Fowler's toads can be found in many different terrestrial habitat types when they are not at shallow breeding pools. Such places include back yards, gardens, and school grounds in suburban areas, agricultural fields, hardwood and mixed hardwood/pine forest patches, and old fields. Breeding locations are usually shallow pools in dirt roads and wet depressions in grassy fields, ditches along roadsides, and the margins of ponds.

Identification notes: Adult Fowler's and American toads are usually not difficult to distinguish in the mid-Atlantic region because they are not known to hybridize in this region, although they do elsewhere. Recently metamorphosed juveniles and tadpoles may be more difficult, but paying attention to the type of warts on the thighs of juveniles and when early stage tadpoles are present will help.

Cope's Gray Treefrog (Hyla chrysoscelis) (Figure 1D)

Adults: These are moderate-sized treefrogs (to 2 inches [61 mm] body length) with expanded toe tips used for climbing. The skin is not smooth but variously bumpy. Body color is usually gray but may be greenish during the breeding season. Temperature plays an important role and individuals may be dark when they are cold. Irregular dark brown to nearly black blotches, sometimes outlined in black, occur on the dorsum. A small, white patch occurs beneath each eye. The inside of the thighs and lower abdomen is bright yellow with dark mottling.

Juveniles: Colored and patterned as adults.

Advertisement calls: A fast, rasping trill that lasts about 3 to 10 seconds, depending on temperature.

Eggs: The dark-colored eggs are laid in multiple, small gelatinous egg masses on top of shallow water in ephemeral pools. Number per mass is about 20-200. Total number of eggs produced by individual females range from 1,000 to 2,500.

Larvae (Figure 8): Cope's gray treefrog tadpoles are dark gray to yellowish-brown to olive in color with high tail fins. The venter is white to light cream and may be iridescent. The dorsal fin is larger than the ventral fin and its anterior point on the dorsum of the head is at midbody. Both fins are variously mottled with patches of gray pigment. The fins of many gray treefrog tadpoles are red along the margins with black pigment along the edge. This results when these tadpoles are in the presence of an abundance of invertebrate predators, like dragonfly nymphs.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: Cope's gray treefrogs begin calling in mid- to late-April, depending on the weather, and continue well into August when conditions are moist or wet. Most egg laying occurs in May and June but also occasionally in July-August. Males may call from trees all summer, especially when it rains. Tadpoles can be found in pools throughout the summer but are most prominent May-July. Metamorphosis occurs June through August.

Habitat: Adults and juveniles use a wide variety of terrestrial habitats that contain shrub vegetation to hardwood trees. Many of these areas occur around wetland breeding sites. Riparian areas along streams are used extensively by juveniles. Adults may be found on various human constructions, like swimming pools, bath houses, and walls of one's home and in forested habitat outside of the breeding season. The primary breeding habitat is shallow, ephemeral pools and in small bodies of water in open places near woody vegetation. Such pools usually lack fish.

Identification notes: This species is identical in morphology, color, and pattern as the eastern gray treefrog (*Hyla versicolor*). See that species account for additional notes.

Green Treefrog (Hyla cinerea) (Figure 1E)

Adults: This is a bright green treefrog with toe pads. Body size is up to 2 ¼ inches (57 mm). A prominent, narrow white stripe may or may be present along each side of the body. If present, the stripe may extend completely from the snout to the rear legs or may terminate on the body. The venter is white. Body color will vary with temperature, from bright green to nearly yellowish to grayish brown. Small golden flecks may occur on the back. During the breeding season males possess a wrinkled pink-colored skin under the chin (location of the vocal sac).

Juveniles: Similar to adults in color and pattern.

Advertisement calls: A loud, nasal queenk-queenk-queenk repeated rapidly for several seconds.

Eggs: Females lay about 400-1,500 eggs in small egg masses on or near the surface attached to vegetation.

Larvae (Figure 9): The body of the tadpole is yellowish green above and pale cream to yellowish below. The tail musculature is similar in color but may have irregular dark patches. The heights of both fins are approximately equal and are clear with patches of dark pigment. The dorsal fin inserts about midway on the body.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: This is the late-spring and summer frog of the coastal mid-Atlantic region. Males call from May to August. Larvae occur from about June to August.

Habitat: Green treefrogs are most often found in vegetation along the margins of lakes, ponds, and marshes in coastal areas and wetlands associated with streams and rivers near the Chesapeake Bay. Adults often

utilize human shelters, such as bath houses, when they are not breeding and can be seen in water-saving postures (legs under the body) in corners, above doors, and in shower stalls.

Identification notes: This treefrog is more slender and has smooth skin compared to gray treefrogs that may occur in the same area.

Eastern Narrow-mouthed Toad (*Gastrophryne carolinensis*) (Figure 1F)

Adults: These small, stocky frogs have a pointed snout with a tiny mouth, smooth skin, and a unique fold across the back of the head. Body color is gray, brown, or reddish. A broad dark patch that extends from the eyes to the groin is present in some individuals but is obscured by irregular light and dark pigmentation in others. The venter is heavily mottled or speckled with light and dark pigment. Males have a dark patch under the chin.

Juveniles: Colored and patterned as adults.

Advertisement calls: Males produce an explosive, nasal *baaa* that lasts for less than 1 to 4 seconds and sounds like the bleating of a sheep.

Eggs: Packets of about 10 to 150 eggs are laid in small gelatinous masses on the water's surface in small, shallow pools.

Larvae (Figure 10): The tadpole of this species is unique because it lacks the normal grazing mouth parts typical of other frogs. The body is somewhat flattened and wide. Color of the body and tail musculature is black sometimes with fine light gray dots. A light line may be present from below the eye to the rear leg, and a light line occurs along the midline of the tail musculature. The venter is finely dotted with gray. The tail fins are about equal in height and bear a variable number of irregular black patches. The dorsal and ventral tail fins insert on the rear of the body. The spiracle is located along the midline of the venter.

Distribution: Limited to Fort A.P. Hill.

Seasonality: Males call in late spring and summer usually following thunderstorms and heavy rain. Females lay eggs during that time and tadpoles metamorphose in 3-5 weeks. Adults and juveniles are active in all warm months of the year in terrestrial habitats.

Habitat: Adults are active during the breeding season in open fields that have depressions that fill with summer rains. Outside of the breeding season adults and juveniles occur in hardwood and pine forest patches and in grasslands in agricultural areas.

Identification notes: These microhylids, often called toads, lack the large parotid glands, warty skin, and webbing between the toes present in true toads of the genus *Bufo*.

Northern Spring Peeper (Pseudacris crucifer crucifer) (Figure 2A)

Adults: This small frog (to 1 ½ inches [37 mm] body length) has a light brown to tan to grayish body with a distinct dark cross on its back in the form of an imperfect "X". A dark bar occurs between the eyes on the top of the head, but it be obscured in dark frogs. The venter is white to cream and may have small dark spots. The darker throat of males distinguish them from females during the breeding season.

Juveniles: Colored and patterned as adults.

Advertisement calls: This is the well-known harbinger of spring with its clear, high-pitched "peep-peep-peep" repeated several times at an interval of a second or less. Males call during the day and at night when choruses are most intense.

Eggs: Up to about 1,600 cream-colored eggs are laid singly by females among vegetation and on dead leaves on the bottom of shallow water wetlands.

Larvae (Figure 11): Spring peeper tadpoles are gray, brown, or nearly black depending on the type of substrate with patches of black pigment on the tail musculature and in the tail fins. Older tadpoles have more pigment than younger tadpoles. The venter is iridescent gold. Dorsal and ventral fins are nearly equal in size and the dorsal fin inserts on the posterior portion of the body.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: Males begin calling with the first warm days of late winter and continue, depending on the weather, well into April. Air temperatures in the 50s and 60s F (10-15° C) in January and February will stimulate these frogs to call. Choruses are most intense in this area in March and April. Females lay eggs during this time. Males can be heard calling from trees periodically in autumn (September-December) on cool days. Tadpoles can be found in shallow water breeding sites March through June.

Habitat: Spring peepers occur in forested habitats outside of the breeding season where they seek shelter in trees, shrubs, and beneath leaf litter. During the breeding season they occur in vegetation surrounding, and sometimes well away from, a wide variety of wetland types, including vernal pools in woodlands, road ruts, and grassland depressions, roadside ditches, freshwater marshes, and alongside small ponds that lack fish. Tadpoles can be abundant in these wetlands.

Identification notes: The call of this species is easily learned and distinguishes it from all others. Other frogs in this size range lack the "X" on the back.

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Upland Chorus Frog (*Pseudacris triseriata feriarum*) (Figure 2B)

Adults: This small frog (to 1 3/8 inches [35 mm] body length) has small toe pads and little to no webbing between the toes. Body color is brown to tan to slate gray usually with 3 narrow, dark stripes on its back. The stripes may or may not be complete and in some individuals may be broken into a series of elongated spots or lacking altogether. The upper lip is white. A dark line runs from the snout passing through the eye to groin. A dark triangular patch usually occurs between the eyes on the top of the head. The venter is white often with a variable amount of dark stippling in the upper abdomen.

Juveniles: Colored and patterned as adults.

Advertisement calls: Calls of males sound much like a fingernail running over the teeth of a stiff comb, like a loud *crreek* or *prreep* repeated regularly to intermittently depending on the temperature.

Eggs: About 30-150 eggs are laid in each of several clear egg masses attached to grass stems near the surface in shallow water. Total clutch size is up to about 700 eggs.

Larvae (not illustrated): Chorus frog tadpoles are dark brown to nearly black dorsally and bronze ventrally. Fine dots of greenish yellow occur on the upper body and tail musculature. The dorsal and ventral fins are about equal in height and the anterior insertion of the dorsal fin is on the posterior portion of the body. The dorsal fin has elongated dark markings.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: Males call early in the year, usually beginning when air temperatures are above freezing (40-50 F) for three or more days, sometimes when snow is still on the ground. Breeding occurs over a short, several day period in February or March but males will call from then into early-April. Tadpoles are seldom found after April to mid-May.

Habitat: Males call from grassy areas associated with shallow water in wetlands without fish. These include tire ruts, pools in dirt roads, roadside ditches, and pools in fields in the open. Outside of the breeding season adults and juveniles remain hidden in the leaf litter of hardwood forests and among shrubby and grassy vegetation not far from the vicinity of breeding sites. Riparian areas and saturated forested wetlands are utilized extensively for shelter.

Identification notes: This species is distinguished from other small frogs found in winter and early spring by the presence of the 3 stripes down the back, the white upper lip, and the dark stripe on the side of the body. The distinctive call will allow one to identify calling males.

Eastern Spadefoot (Scaphiopus holbrookii holbrookii) (Figure 2C)

Adults: Spadefoot toads (to 2 ¼ inches [57 mm] body size) are brown to blackish brown with two, wide, irregular yellowish lines extending down

the back to form a lyre-like pattern. Each line originates at the eye. An additional light yellowish line occurs on each side of the body. Body color depends on temperature; cooler spadefoots are darker. The pupil of the eye is vertical, not round, and the eyes protrude well above the head. There are no large glands on the back. The venter is white. A characteristic feature is the single black spade located on the inner border of each foot.

Juveniles: Colored and patterned as adults.

Advertisement calls: Male vocalizations are moderately short, explosive grunts described as a low-pitched *wank* repeated about every 2 or more seconds, depending on the temperature.

Eggs: Several thousand eggs are laid in irregular bands along grass stems or in the open in shallow water.

Larvae (not illustrated): The body color of this tadpole is very dark brown to black with a yellowish stripe along the body and the tail musculature. The body is somewhat flattened. The dorsal and ventral fins are not wider than the width of the tail musculature, and the dorsal fin barely extends onto the body. The fins are usually clear but may have some scattered dark pigment.

Distribution: Most known populations northern Virginia and Maryland occur east of the Blue Ridge Mountains. They also occur on Delmarva and in New Jersey. Scattered populations occur in the Shenandoah Valley and south-central Pennsylvania.

Seasonality: These frogs appear sporadically on the surface and are seldom seen except during or immediately after heavy rain storms. The few records known from the northern Virginia area occur within the period of April - September. Tadpoles have a very short developmental time; they reach metamorphosis in about three weeks following hatching.

Habitat: Most places known to harbor this species are sandy or of a soil type that allows spadefoots to burrow underground. Agricultural fields, grasslands, mixed hardwood and pine forest patches, and abandoned open areas may have these frogs. Breeding locations are shallow, ephemeral pools that form during rain storms or are depressions that hold water

for varying lengths of time. Most of these places are in the open or in sparse vegetation, and they all lack fish.

Identification notes: The pop eyes, vertical pupil, single spade, and yellowish lyre pattern will distinguish this frog from all others in the area. Toads have raised warts on the skin, black blotches on the back, a large gland behind each eye, and two spades on each foot.

Bullfrog (Rana catesbeiana) (Figure 2D)

Adults: This large, stout frog (to about 6 inches [152 mm] body length) has large eyes, long limbs with extensive webbing between the toes, and no dorsolateral ridge (raised line) along each side of the back. Body color varies from green to brown and may or may not have a netlike pattern of gray to dark brown, or a series of large obscure blotches. The venter is white with a highly variable mottling of gray. The snout and sides of the head are green. The diameter of the tympanum in males is larger than the diameter of the eye; they are about the same size in females. During the breeding season males have a yellow chin and throat and a dark, swollen patch on their thumbs (the pollex).

Juveniles: Similar to adults in color but there may be numerous small black dots on the back.

Advertisement calls: Males are well known for their deep, bass jug-o'rum calls.

Eggs: Females lay 10,000 to nearly 30,000 eggs in a large surface film among vegetation in ponds and lakes.

Larvae (Figure 12): The larvae of this species are the typical pollywog type of tadpole and can be large (up to 150 mm total length). Dorsal body color is uniformly greenish brown to olive with a clear yellowish venter. Distinct, small, black dots occur on the body, musculature of the tail, and at least the dorsal fin. The dorsal fin is not as wide as the width of the tail musculature.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: Bullfrogs begin calling and establishing territories in late-April to early May in the northern Virginia and mid-Atlantic region. Males call from that time throughout the summer. Egg laying occurs late-May to July. Tadpoles can be found in every month of the year, even under the ice, because they often take up to two years or more to reach metamorphosis.

Habitat: Adults inhabit permanent water, such as beaver ponds and manmade lakes, that may or may not have fish. Streams are also used by bullfrogs for shelter and breeding. Juveniles disperse widely from breeding sites and may found in ephemeral pools in roads and woods, roadside ditches, and other shallow wetlands long distances from permanent water. Tadpoles can be found in ponds, lakes, and streams.

Identification notes: This frog is distinguished from green frogs (*Rana clamitans*) by the lack of the raised dorsolateral ridge on each side of the back. Green frogs have similar coloration but are smaller and possess dorsolateral ridges.

Green Frog (Rana clamitans melanota) (Figure 2E)

Adults: Green frogs (to 3 ½ inches [89 mm] body length) are similar in shape to bullfrogs but are proportionally smaller. A dorsolateral ridge is present on each side of the back. Body color varies from greenish brown to nearly all brown, sometimes with small dark spots on the back, especially on young frogs. A green patch is present below the eye on the upper lip. The venter is white but may have dark markings on the upper chest and legs. The tympanum is larger than the diameter of the eye in males but similar in size in females. During the breeding season males have yellow throats and the dark pollex is enlarged.

Juveniles: Body color is usually brownish with numerous small dark spots on the back. Dorsolateral ridges are present.

Advertisement calls: Males emit several types of vocalizations, the most common of which is the one often described as a plucked and rather explosive loose banjo string. The call may be made once or several times with the notes becoming progressively less audible. This species emits a loud, high-pitched *squeenk* when startled as they jump from their resting sites along the bank of a pond.

Eggs: Between 1,000 and 4,000 dark eggs are laid by a female in a single, clear surface egg mass attached to vegetation in shallow water.

Larvae (Figure 13): Tadpoles are similar to bullfrog tadpoles but are olive green with a cream-colored, non iridescent venter. These tadpoles may be nearly all brown in color, resembling the clay of road rut pools or very dark with an abundance of dark blotches in pools filled with blackened leaves. The dark markings on the body, tail musculature, and tail fins are irregular in shape, often in the form of diffuse black spots. The dorsal fin is not as wide as the width of the tail musculature.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: Green frogs begin calling as early as late-April and will call throughout the summer into September. Eggs are laid May through September. Tadpoles may be found in every month of the year because they take a year or more to reach metamorphosis.

Habitat: Green frogs occupy a wide variety of freshwater wetland habitats, including margins of permanent beaver and manmade ponds and lakes, vernal pools in woodlands, road ruts, and grassland depressions, roadside ditches, streams, and rivers. Juveniles disperse long distances from breeding sites through terrestrial habitats to ephemeral pools and other shallow bodies of water. Tadpoles are found in all of these wetlands.

Identification notes: The dorsolateral ridge and green patch on the upper lip below the eye will distinguish this species from other ranid frogs in the area.

Pickerel Frog (Rana palustris) (Figure 2F)

Adults: These moderate sized frogs (to 3 inches [76 mm] body length) are brownish with two rows of dark, squarish spots between the two prominent and light-colored dorsolateral ridges. The spots on the back may be separate or joined together in some individuals to form wide, partial stripes. Squarish spots usually occur on the sides. The venter is white but the undersides of the legs are bright yellow. Males are similar to

females in color and pattern but have paired vocal pouches and darkened, swollen thumbs during the breeding season.

Juveniles: Patterned as adults but darker, often dark olive green.

Advertisement calls: Males emit a low-pitched snore lasting 1-3 seconds. These calls are seldom audible away from the breeding sites.

Eggs: Females lay up to 3,000 eggs in a single, globular egg mass deposited in shallow water attached to a twig or branch.

Larvae (Figure 14): These tadpoles are dark olive green to dark brown with blotches of white to yellowish pigment on the iridescent venter. There is a variable number of fine yellowish spots on the dorsum. The dark markings on the tail musculature and dorsal and ventral fins increase in density toward the tail tip, sometimes making the tail look nearly purplish black. Dorsal and ventral fins about equal in size and are not as wide as the tail musculature.

Distribution: Throughout northern Virginia and the mid-Atlantic region.

Seasonality: Males call in late winter and early spring, about February through early April in the northern Virginia area. Females usually lay eggs in March and early-April. Active, non-reproductive individuals may been seen at all times of the year except winter. Tadpoles can be found throughout the summer with metamorphosing occurring in late-May to July.

Habitat: Pickerel frogs occur in permanent ponds with abundant vegetation around the margin, beaver ponds, freshwater marshes and swamps in riparian zones, and along streams. Juveniles are found occasionally in vernal pools. Tadpoles also occur in these habitats.

Identification notes: The irregular, squarish spots, light-colored dorsolateral ridge, and yellow on the inside of the rear leg distinguish this frog from others in the area. Southern leopard frogs have distinctly round spots and lack the yellow legs.

Southern Leopard Frog (Rana sphenocephala) (Figure 3A)

Adults: Body coloration in this species varies from green to brown with a highly variable series of distinctly dark, round spots in the back between the light-colored dorsolateral ridges. There are few spots on the sides. Maximum body size reaches about 2 ½ inches (64 mm). The snout is distinctly pointed, there is a white spot in the center of the tympanum, and the venter is white. Males are similar to females but have paired vocal pouches and a pollex during the breeding season.

Juveniles: Similar to adults in color and pattern.

Advertisement calls: Males emit a series of short, chuckle-like calls that sound similar to that produced by rubbing an inflated balloon.

Eggs: A single, clear, globular egg mass of up to 3,500 eggs is laid in shallow water usually where live or dead grasses are present.

Larvae (Figure 15): The body of leopard frog tadpoles is dark olive green with large, diffuse black spots on the tail musculature and both fins. The coiled intestines are clearly visible through the body wall. The venter is pinkish. The dorsal tail fin is about equal in height as the tail musculature and inserts on the head at about mid-body. Populations of larvae in wetlands with high densities of predators, like dragonfly nymphs, exhibit a black tail tip.

Distribution: Scattered populations of this frog occur in eastern portions of northern Virginia, eastern Maryland, and throughout the Delmarva peninsula.

Seasonality: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Habitat: These frogs may be found in lowland riparian corridors along stream courses, freshwater marshes, beaver ponds, and in shallow pools in grassy fields. Adults may be found along the margins of wetlands during spring and summer. Juveniles disperse widely and may be found well away from water as well as in isolated ephemeral pools, small ponds, and riparian areas. Tadpoles occur in pond margins, marshes, and ephemeral pools.

Identification notes: Southern leopard frogs have distinctly round spots and lack the yellow legs seen in pickerel frogs.

Wood frog (Rana sylvatica) (Figure 3B)

Adults: Wood frogs exhibit a wide range of body colors, from pink to reddish to brown to nearly black. There is almost no pattern on the back but there are two dark spots on each side of the chest. The one feature that will identify this frog is the dark, somewhat triangular patch that lies behind the eye on each side of the head. The patch or "mask" extends to behind the tympanum and down to the insertion of the forelimb. Dorsolateral ridges are present. Maximum body size reaches about 3 inches (76 mm). During the mating season, males are dark and the females are light in color, and males possess a pollex on each thumb.

Juveniles: Similar to adults in color and pattern but usually darker. They also show the dark "mask."

Advertisement calls: Males have a low powered call described as a "hoarse crackling sound that suggests the quack of a duck " (Conant and Collins, 1998) and a rasping "craw-aw-auk" (Martof et al., 1980).

Eggs: Females lay up to about 950 dark eggs in a loose globular mass in shallow water. They often aggregate to lay their eggs in the same portion of the pool, resulting in a large mat of numerous egg masses. Once the jelly around the eggs has been in the water for several days the mass takes on the appearance of a bunch of grapes.

Larvae (Figure 16): Tadpoles are uniform light to dark gray in color on the body and tail musculature with fine gold-colored spots. The venter is uniform cream in color. A cream-colored line extends along the snout above the mouth parts. The tail fins are clear and are larger than the width of the tail musculature. The dorsal fin inserts on the dorsum of the body less than halfway between the base of the tail and the eye.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: Wood frogs call earlier than most other species, usually in February or March in the mid-Atlantic. Adults remain at breeding sites only for 2-3 weeks at most. Juveniles disperse widely into the forest in summer and fall following metamorphosis in May and June.

Habitat: These frogs occur in hardwood forest habitats that contain or are near shallow, ephemeral pools in which they breed. Pools and ponds with fish are avoided (Hopey and Petranka, 1994). Juveniles disperse widely and may be found well away from water as well as in isolated ephemeral pools, small ponds, and riparian areas.

Identification notes: Southern leopard frogs and pickerel frogs have spots on the back and lack the dark mark on the side of the snout. Green frogs have a green snout and bullfrogs lack the dorsolateral ridges.

Carpenter Frog (Rana virgatipes) (Figure 3C)

Adults: Carpenter frogs are brown to olive dorsally with four light stripes. The venter is cream with black mottling. There is no dorsolateral ridge. Tympanum is larger in males than females and males have a swollen pollex during the breeding season.

Juveniles: Similar to adults in color and pattern.

Eggs: Egg masses containing up to about 600 eggs are attached below the surface of the water to vegetation.

Larvae (Figure 17): The color of the body and tail musculature is dark brown to olive brown to nearly black and may contain black spots. The upper half of the tail musculature is darker than the lower half. The venter is cream in color with some dark mottling. The dorsal and ventral tail fins are variously pigmented but the upper fin always has a series of dark pigment patches that forms a line that parallels the musculature.

Distribution: Fort A.P. Hill only.

Seasonality: Carpenter frogs begin activity in early to mid-April, depending on the weather. They call for an extended period of time, April to September. Tadpoles can be found in every month of the year as they overwinter before metamorphosis in late summer.

Habitat: Beaver ponds, marshy expanses of stream corridors, and sphagnum areas, all of which are acidic and heavily choked with vegetation. The water in these habitats is stained darkly. There is an abundance of dark organic material in the water in the preferred locations.

Identification notes: The four light stripes, the black mottling, and the lack of the dorsolateral ridge should distinguish this frog from all others in the area.

Salamanders

Spotted Salamander (Ambystoma maculatum) (Figure 3D)

Adults: The distinctly round cream, yellow, or orange spots on a black to bluish black, robust body characterize this species from other large salamanders in the area. Maximum total length is about 7 ¼ inches (200 mm). Most individuals have at least a few spots on the head, body, or tail. The venter is slate-gray without spots. Males possess enlarged cloacal lips during the breeding season.

Juveniles: Generally patterned as adults with distinct spots. Very recent metamorphs may lack distinct spots.

Eggs: Up to about 250 eggs are laid in one to several clear or opaque to white gelatinous masses attached to woody twigs or grass stems in shallow water. A symbiotic algae invades many egg masses soon after they are laid. Numbers of clear and white egg masses vary among ponds.

Larvae (Figure 18): Larval spotted salamanders are generally grayish above and cream below without a distinct pattern. Larvae in muddy pools are light tan. The broad tail fin has varying amounts of dark mottling. Older larvae may have a row of small white spots along each side of the body. The venter completely lacks pigmentation, especially on the throat.

Seasonality: Males in the mid-Atlantic region emerge from forest cover in February and March, rarely January, to lay spermatophores (short gelatinous stalks with a sperm packet on top) on the bottom of temporary pools and ponds. Females follow shortly thereafter and, after being courted by the males to pick up a spermatophore with the cloaca, lay one to several egg masses. Larvae hatch in 3-4 weeks and remain in the pool or pond until metamorphosis. Length of the larval period depends on pool

temperature and elevation. Most larvae metamorphose in July-September but only rarely will they overwinter and emerge the following spring.

Distribution: Throughout northern Virginia and the mid-Atlantic region.

Habitat: Adults live underground outside of the breeding season in hardwood forests. Individuals may be found under logs and rocks when the substrate is wet. They may migrate over a kilometer to breeding pools and ponds. Breeding sites include ephemeral pools in road ruts, grassland and woodland depressions without fish and in the shallows margins of ponds as long as there is abundant vegetation to allow shelter from fish predators.

Identification notes: The distinct round spots on the dark body will distinguish adults and juveniles of this species from others in the region. Marbled salamander larvae, with which this species is often found, has tiny black dots in the throat.

Marbled Salamander (Ambystoma opacum) (Figure 3E)

Adults: These are short (to 4 ¼ inches [108 mm] total length), stocky salamanders with several gray to white crossbars on a black to bluish black body. The crossbars may be broken in some individuals or run together to form parallel white stripes. Crossbars occur on head, body, and tail. The venter is black. Males have white crossbars and swollen cloacal lips during the breeding season. Females have gray crossbars and a flattened cloacal area.

Juveniles: Recently metamorphosed juveniles may lack the crossbars, instead having scattered light flecks to an irregular light mottling pattern on a brownish to blue black body.

Eggs: Eggs numbering from about 50 to 200 are laid singly by females under logs and rocks in moist shallow depressions where vernal pools will form with winter rains. The eggs are not encased in a gelatinous mass.

Larvae (Figure 19): Larvae are dark brown to grayish to tan in color without distinct markings on the dorsum. Venter is cream with tiny black peppering under the chin and around the fold of skin between the chin and abdomen. The peppering may be indistinct and best observed with a

hand lens. A line of distinct white dots is present along each side in older larvae. The broad tail fin may be heavily mottled with dark pigment.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: Males and females mate on the forest floor in September and October when forest conditions are wet. Females then deposit eggs under moist logs in and along the margins of woodland pools and other ephemeral pools and remain with them until winter rains fill the depressions. Embryos hatch upon contact with water and the female then leaves the pool for her underground retreat in the forest. Larvae overwinter in the pool and metamorphose about May-June the following year. Adults and juveniles live underground in the forest outside of the breeding period but may found occasionally under logs when the forest floor is wet.

Habitat: Adults prefer the floor of hardwood forests in the mid-Atlantic area where they live in rodent burrows, decayed root channels, and other pockets beneath the surface. They breed during September and October rains on the edge of and in depressions in the forest and other low areas that will accumulate water. Agricultural areas and some suburban areas with patches of forest and wetland pools remaining may support this species.

Identification notes: The adults are unique with their stocky bodies and light-colored crossbars. Larvae are more difficult to identify but the combination of the light stippling under the chin and their much larger size during the time when spotted and Jefferson salamander larvae are small (e.g., March - May) should allow correct identification in the field.

Northern Two-lined Salamander (Eurycea bislineata) (Figure 3F)

Adults: This a slender yellow to greenish-yellow salamander (maximum total length to 4 inches [100 mm]) with two dark brown stripes that border a broad yellowish to brownish stripe on the back. The broad light stripe along the back is usually peppered with black dots of varying densities. In some individuals, there may be a dark line down the center

of the back and in others the back is dark. The venter is plain yellow to cream in color and translucent.

Juveniles: Similar to adult in color and pattern.

Eggs: Fewer than 100 eggs are deposited by females under rocks, among root masses and vegetation, and under leaves and other objects under water in flowing streams.

Larvae (Figure 20): Two-lined salamander larvae are elongated and streamlined. The anterior martin of the tail fin occurs behind the rear legs. Body color is gray to light brown with a variable mottling pattern, the venter is cream in color, and the tail fin is variously mottled.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: Although this salamander can be found in most months of the year, it is most commonly encountered in spring and fall. Females lay their eggs in April and May. Hatching occurs one to two months later and the larvae metamorphose in 1-2 years.

Habitat: The margins of rocky streams are utilized extensively by this salamander. Adults may venture far into the adjacent forest during wet periods where they can be found under logs and rocks. Two-lined salamanders appear to be more abundant in mountain streams than in Piedmont streams.

Identification notes: The yellow coloration distinguishes this species from all other streamside salamanders in this region. The larvae differ from other streamside species by the lack of a definable pattern on the body and tail. The gills on the larvae are longer than those in dusky and seal salamander larvae.

Three-lined Salamander (Eurycea guttolineata) (Figure 4A)

Adults: Three dark brown stripes on a yellowish brown to tan body (maximum total length to about 6 inches [150 mm]) characterize this species. The stripe along the center of the back is usually black and is bordered by the lighter stripes. The black stripe ends on the tail base,

whereas the yellowish stripes join to form the light stripe on the dorsum of the tail. The sides of the body and tail are dark brown with a pattern of vertical yellowish markings. The venter is tan with dark brown mottling.

Juveniles: Similar to adults in color and pattern.

Eggs: Little is known about egg deposition sites, but they are likely to be under water beneath rocks or other objects in streams. Egg number is not well known but clutches of between 8 and 15 have been found.

Larvae (Figure 21): The larvae of this species are elongated and streamlined with the tail fins starting behind the rear legs. Body color is brown to yellowish with a broad dark band along each side that extends onto the tail musculature. The venter is cream, and the mottling in the tail fin is variable. The pattern on the tail musculature of older larvae is herringbone like, with pigment spots forming vertical, bar-like shapes.

Distribution: East of the Blue Ridge Mountains in northern Virginia and vicinity.

Seasonality: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Habitat: Adults occupy Piedmont and Coastal Plain streams and seepage areas that usually run through forested habitat. Juveniles and adults can also be found under logs in terrestrial habitat near wetlands, especially forested riparian corridors during late-spring and summer.

Identification notes: The three dark lines on the dorsum of adults and juveniles will distinguish this species from others in the area. The pattern on the sides of the tail in juveniles and larvae should allow correct identification. Some populations east of the Blue Ridge Mountains, especially in some streams in Fairfax County, Virginia, have individuals that resemble long-tailed salamanders. The dark band on the sides of larvae will identify this species from larvae of the two-lined salamander.

Four-toed Salamander (Hemidactylium scutatum) (Figure 4B)

Adults: Four-toed salamanders are small bodied (reaching up to 3 ½ inches [89 mm] total length) with only four toes on each rear foot (most salamanders have 5) and a distinct constriction at the base of the tail. The constriction is associated with the tendency for the tail to break easily. Body color is brown with scattered small black dots on the back. The white venter is uniquely patterned individually with small black spots.

Juveniles: Colored and patterned as adults.

Eggs: Females lay about 29-80 eggs in sphagnum moss, decomposing moist stumps and logs, and leaf litter and usually remain with them until hatching.

Larvae (not illustrated): Gilled larvae resemble ambystomatids in body form. They are yellowish-brown in color with an upper tail fin that extends to the head and a lower tail fin that extends to the base of the tail. The heads of larvae can be colored yellow to orange with small dark spots that make a Y-shaped pattern on the back of the head.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: Adults migrate from overwintering sites in late-winter and early-spring and can be found until summer in association with wet areas and shallow wetlands. They may be found at other times of the year, except for the coldest months, under logs and other material in moist terrestrial habitats. Eggs are laid from late-March to mid-May and larvae metamorphose about a month later.

Habitat: This salamander is usually associated with seepage areas with sphagnum moss but may be found around small ponds without fish in intact hardwood forests and other moist areas. Hardwood forests and seepages seem to be required, although they will disperse into other habitats outside of the breeding season.

Identification notes: The four toes on the rear feet, the constriction around the base of the tail, and the black and white pattern on the venter will distinguish this salamander from all others.

Red-spotted Newt (*Notophthalmus viridescens viridescens*) (Figure 4C)

Adults: Mature adult newts are yellowish brown, olive green, or dark olive brown above with an individualistic, dorsal pattern of small red dots bordered by black. The venter is yellow with black flecks. Maximum total length is 5.5 inches (140 mm). A narrow dark line passes from the snout through the eye to the neck on each side of the head. The skin is rough, not smooth as in other salamanders. In males, the tail fin is substantially higher (wider) than that of females, and possess black toe tips and a line of raised black patches on the inside of the thighs. Females lack the black toe tips and black line inside the thighs. These sexually dimorphic features are more pronounced in the breeding season.

Juveniles: The immature stage of this salamander (eft) is fully terrestrial and brightly colored. Body color ranges from red to orange to yellowish. The spots are red to orange encircled or nearly so by black. The bright color signals a warning to potential predators that the glands in the skin produce a toxic mucous. Efts metamorphose into adults in three to seven years.

Eggs: Females lay about 200-300 eggs and wraps each one of them in a leaf or blade of aquatic vegetation.

Larvae (Figure 22): The larvae of this salamander are light brown to yellowish-green in color with a dark line from the snout through the eye to the neck on each side. The dorsal tail fin extends onto the back. The legs are longer than any of the other larval salamanders in the area. The larvae metamorphose into the eft stage.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: Adults remain in the aquatic habitat year round unless the pond dries up. If that happens, adult newts will seek shelter under debris in the dried pond or in the nearby forest. The extended breeding season lasts from about March through June. Larvae are present June through November.

Habitat: Many types of freshwater wetlands are used by adults and larvae this salamander, including beaver ponds, farm ponds, road rut puddles, woodland pools, water-filled depressions in old fields, and pools in riparian areas. Fish may or may not be present. Efts wander widely in the forest from their home pool or pond, and may disperse as far as a half mile. Mature hardwood forest is the optimal habitat for efts.

Identification notes: No other salamander in this region has the rough skin, green body color, and red spots on the back. Pay attention to the dark stripe on the side of the head of larvae that passes horizontally through the eye. Head stripes on other salamander larvae do not pass prominently through the eye.

Northern Red Salamander (Pseudotriton ruber ruber)

Adults: Adults are brightly colored red to reddish orange and reach a maximum total length of about 7 inches (178 mm). Numerous distinct black spots occur on the back but the pattern on the sides is black flecking. The venter is pale salmon in color with dark spots. Old adults may be purplish with obscure spotting on the back. Eye color is yellow. The margin of the chin may be lined with black flecks.

Juveniles: Colored and patterned as adults but brighter.

Eggs: Females lay about 30-130 eggs following courtship and mating in summer. Eggs are laid deep underground attached to rocks in seepage areas and springs.

Larvae (Figure 23): The larvae are robust but are elongated and have a paddle-like tail. They are dark brown to reddish brown in color with indistinct black spotting on the dorsum. The tail fins have a variable amount of mottling and the venter is pale white without a pattern.

Distribution: Fort A.P. Hill, Fort Belvoir, Marine Corps Base Quantico, and Prince William Forest Park.

Seasonality: Red salamanders spend winters deep underground in seepages and springs. They emerge about March or April and move to the forest floor. Females move back to springs and seepages in late summer and lay

eggs in the fall months. The larval stage lasts for 2-3 years, and metamorphosis occurs in summer.

Habitat: Adults may be found in early spring and fall in seepages, springs, and margins of mountain streams. In late spring, summer, and early fall adults may be found under logs and rocks in moist soil in hardwood forests. The combination of springs or seepages and hardwood forest is essential habitat for this species.

Identification notes: The longer snout, numerous distinct black spots on the back, and the yellow eyes will distinguish this species from mud salamanders. Spring salamanders have longer and broader snouts with a pale line bordered by black between the eye and nostril.

Lesser Siren (Siren intermedia) (Figure 4E)

Adults: This fully aquatic salamander similar to *S. lacertina* but smaller, reaching a maximum length of about 000 mm (00 inches). They are uniformly gray in color with large external gills and only one pair of legs, the forelegs. The rear legs are lacking completely. Number of costal grooves are 32-33, counting from the foreleg to the position of the cloaca.

Juveniles: Similar to adults in color and pattern.

Larvae (Figure 24): Larval lesser sirens have a conspicuous dorsal fin, a short tail, and large gills anterior to the small forelegs. Body color is gray to dark gray. A broad, dark band with a light streak down the middle occurs on each side. The venter and middorsal region are lighter in color. Small individuals have a reddish patch on the snout that sometimes extend to the gills.

Distribution: Fort A.P. Hill

Seasonality: Little is known about this species at the northeastern edge of its range in Virginia. The are probably active from about March through November and may be inactive when the water is cold in winter. Nothing is known about their reproductive behavior or life history.

Habitat: Lesser sirens inhabits streams and associated ponds that are choked with vegetation. Adults and larvae have been found in beaver ponds and marshy bottomlands of creeks.

Identification notes: Rely on costal groove counts to separate this species from greater sirens.

Greater Siren (Siren lacertina) (not illustrated)

Adults: This is a large, fully aquatic salamander reaching a maximum length of over 700 mm (28 inches). They are uniformly gray in color with large external gills and only one pair of legs, the forelegs. The rear legs are lacking completely. The sides of the body are lighter in color than the dorsum and usually has pale green flecking or blotches. Number of costal grooves are 37-38, counting from the foreleg to the position of the cloaca.

Juveniles: Similar to adults in color and pattern.

Larvae (not illustrated): Larval greater sirens have a gray head and dorsum, a dorsal fin, and a light stripe along each side from the gills to the tail. This species lacks the reddish patch on the side of the head.

Distribution: Fort A.P. Hill only.

Seasonality: Unknown in this area but probably active year round unless the water is near freezing.

Habitat: Greater sirens on Fort A.P. Hill are known to inhabit streams choked with vegetation.

Identification notes: This species is difficult to identify from lesser sirens, so costal groove counts are required to separate them.

Inventory and Monitoring Protocols

Wetland types included in Mitchell (1998) are man-made ponds and lakes, beaver ponds, ephemeral (vernal) pools, and freshwater marshes.

All sites are located on a map of each installation and have been assigned a numerical or place name. I review the three basic methodologies use to inventory and monitor amphibians in the 22 different sites in the three areas reported in Mitchell (1998).

Direct Observations

One relatively easy way to study amphibians is to simply observe them in their natural habitat by walking around the edge of a wetland or watching from a vantage point. Unfortunately, amphibians are not as easily observed as birds because they are often hiding beneath vegetation or in water, are camouflaged, and often remain still for long periods of time. Many species are active only at night. Daytime observations are useful, however, and should be used to supplement other methods, especially when the goal is to inventory the area for all amphibians present.

I recommend the use of binoculars to scan the shoreline of the wetland one is studying. Bullfrogs, green frogs, and other ranids sitting on the bank or vegetation out in the water may be observed and their microhabitats and behavior studied without disturbing them. Frogs may be encountered as one walks up to a wetland or even while hiking through the woods. This is especially true of toads. Records of these individuals provide insights into how the terrestrial habitat is used.

Some species of frogs call periodically during the daytime, especially during the height of the breeding season and sometimes for weeks afterwards. The recognition of a species by its calls is another form of direct observation. The difference is that the hearing sense is used instead of the visual sense. Records of frogs species based on calls may be the only way one can determine their presence during daytime searches.

On the initial approach to a vernal pool or pond, field personnel should first record the species of calling frogs on their data forms. Your presence may cause them to stop vocalizing. Scan the shoreline, low vegetation, and nearby riparian areas for frogs sitting on the ground or perched on low vegetation. Air and water temperatures and other environmental variables should be taken before disturbing the water by wading or dipping. Count each adult frog or salamander if possible, or catch a many as possible for measurement and marking. Water depth and the amount of vegetation along the edge may limit one's movement around the pond.

Egg Mass Surveys

Several species of amphibians in the mid-Atlantic region breed routinely in small ponds and vernal (ephemeral) pools. These include all species of ambystomatid salamanders, newts, and several frogs. Wood frogs (*Rana sylvatica*) breed exclusively in vernal pools devoid of fish predators. Some of these amphibians breed early in the year and leave conspicuous egg masses. Egg masses can be counted to obtain quantitative measures of relative abundance or indices indicative of population size. These aquatic habitats are often easily accessed and in many cases easily studied.

Field methods - Egg masses can often be identified to species. If a positive identification is not possible, then a full description may allow one to determine its identification later (photos are very useful here). Use terms like globular, firm jelly, loose jelly, surface film, attached to branch or grass, approximate depth, clumped, separated, etc. when describing the egg masses. Approximate counts of eggs in the egg masses and measurements of jelly mass length and width could help with identification. Unfortunately, there is no recent reference or guide to field identification of amphibian egg masses for Virginia or the mid-Atlantic region. Other sources are Bishop (1941), Wright and Wright (1949), Pfingsten and Downs (1989), and Petranka (1998). This technique may work best with spotted salamanders, wood frogs, gray treefrogs, and green frogs.

Each egg mass should be identified and counted throughout each wetland under study. If this is not possible, say due to deep water, then either find an innovative way to access the entire pond or pool or use a standard distance and count all the egg masses within this band around the margin. If the pool is shallow enough to allow wading, then a grid or transect marked off in meters could be laid out and the eggs counted within each grid cell or counted along the transect. If transects are used, then they should cover the entire pool to allow complete coverage. Counts for each species should be kept separate. Distance from the pool margin and depth are valuable data to take. If possible, count the number of eggs in a selected number (or all) of the egg masses, and determine how many, if any are not viable (dead). Record all data on the data forms, and repeat this procedure at each pond or pool. This method can be conducted during the day or at night. Night is best because of glare and other visual problems encountered during the day.

Frog Vocalizations

Frog vocalizations are an integral part of the reproductive and social biology of these animals. Only males advertise their presence to females and other males in the area by vocalizing. Females do not call. Each species has its own kind of call or types of vocalizations, and they can be identified by them. This important characteristic of frog biology allows us to study their activities. The frog call monitoring technique addresses the objective to document the dynamics of frog populations inhabiting wetlands in a specified area.

In the mid-Atlantic region, frog species are reproductively active at different times of the year. Generally, one group breeds in latewinter and early spring and the other in late-spring and summer (Lee, 1973; Mitchell, 1986). For some of these species, there is little to no overlap in calling times. Frogs also respond to variations in weather. Dates of initiation of calling change annually, the length of the male calling period varies within seasons, and the actual dates on which females breed are all weather-dependent. Rainfall events strongly influence when frog activities occur. Frogs in permanent wetlands exhibit different phenologies than frogs in vernal pools and puddles. Wetland hydrology is a major player in frog biology. Thus, spot-checking frogs by recording their vocalizations only once or twice a season will not provide information about the variation of frog breeding phenology. Knowledge of such variation is important if one wishes to understand the dynamics of frog populations and how to interpret how they are affected by changes in their habitats and changes in weather patterns.

The frog call methodology requires that it be repeated frequently throughout the season. It also allows the researcher to accumulate other observations on reproductive biology and habitat utilization. Several different methods can be employed to obtain information on the dynamics of local frog populations. These include direct day and night observations of frogs and other life history stages and the use of automated animal vocalization recorders (FrogLoggers).

There are several ways to conduct inventory and monitoring surveys of frog vocalizations. The following describes some of the methods I believe will work for teachers. It also notes some of the pitfalls one may encounter when seeking accurate identifications. I urge readers who will use these techniques to spend whatever time is necessary to learn local frog calls accurately.

Recording frog calls on cassette tape - An inexpensive but durable cassette tape recorder will allow one to tape the calls of male frogs at any time. Because of observer effects (some frogs will cease to call when the observer approaches), taping should be done before most other activities take place. Taping should be conducted by one person who directs the hand-held directional microphone toward calling males or the portion of the pond from which the calls are produced. Avoid making any sounds during the taping session. Recording time should be 5 minutes (minimum) to 10 minutes to help increase the chances of recording all species present. The following information should be recorded on the tape by the biologist BEFORE the recording session: **date**, **location**, **time**, **pond name and/or number**, **and teacher's and student's names**. See Heyer et al. (1994) for discussions on recording good frog calls.

Field notes on frog calls - In addition to recording calls on the cassette tape, all species identified by the observer from frog vocalizations must be written on the data sheet. The cassette is primarily a back-up system. It should not be viewed as the primary source of identification and data records.

Learning frog calls - It is possible to become familiar with frog calls by listening repeatedly to commercial tapes that include all the species in your area. However, calls may also be learned by combining training sessions based on tapes with field trips to locations to hear them in context. Calls will sound differently when coming out of a speaker or headset than they will when you hear them in the pond or other wetland. Practice, practice, practice.

Frequency of site visits - How many times during a season this methodology should be carried out depends on the goals of the study. If information on the phenology of the species in the study area is a primary goal, then this methodology should be carried out at least once per week from early March (or when frogs first become active in late winter and this may be January or February) through June. Because several species call into September in some areas (green frogs, cricket frogs), then the weekly methodology could extend from March through midto late-September, if personnel are available to continue the project into summer. Twice a month will provide less information on phenology but will allow assessments of habitat utilization and presence/absence and relative abundance of most frog species. Monthly observations will

cause you to miss some important events and perhaps even miss some species.

FrogLoggers - Automated animal vocalization recorders (FrogLoggers; Peterson and Dorcas, 1994) do most of the work for you. They record animal vocalizations during the period established by the researcher on the timers (e.g., 12 seconds per hour for about 7 days on one side of a 90 minute cassette tape). FrogLoggers are set outside in secure areas, locked, and chained to an immovable object. Microphones are placed within a cutoff plastic soda bottle and attached to a branch of a tree or shrub so that they point to the area to be recorded. Once operative, the field researcher or technician turns over or changes the cassette tape on a regular basis, the timing of which is determined by the recording time set on the timers and how long it takes to use up most of one side of a tape. Battery life may be affected by local conditions and the field person will need to replace them as needed. If FrogLoggers are to be used for extended periods of time, solar panels may be established to bypass the use of batteries (M. Dorcas, personal communication). A primary advantage of this methodology is the regular recording of animal vocalizations (it records birds, too) on a regular schedule over a 24 hour period. FroqLoggers also provide information on size of the froq chorus and on sensitive, secretive species. One quickly obtains information on the day/night patterns of animal behavior, especially frogs and birds.

An important aspect to keep in mind is that tapes from FrogLoggers accumulate rapidly. The project director should have someone available to record the data from the cassette tapes as soon as possible. In my experience, it takes a minimum of about 2 hours for a person well versed in frog call identification to record the data from one 90 minute tape.

FrogLoggers are not available commercially. You can make them following instructions in Peterson and Dorcas (1994). As this is only one possible type of assembly, creative persons may devise their own automated animal vocalization recorders.

Larval Surveys

Assessing amphibian larval (tadpoles and aquatic salamander larvae) presence and relative abundance can be an effective way to study and monitor amphibian populations. Such a program provides useful information on an often neglected aspect of frog population and community biology. This is especially important because studying tadpoles through metamorphosis provides information on reproductive

success and phenology of local populations. Several techniques may be used to obtain information on tadpole populations, and each is effective in different habitats.

The major advantages of these techniques is that they can be used day or night in a wide variety of wetland types and requires relatively inexpensive equipment. They also allow us to obtain quantitative estimates of relative abundance. The primary disadvantage is that some tadpoles and salamander larvae are often hard to identify. The same references listed for egg masses may illustrate and describe larvae.

Tadpole and salamander color, shape, and sometimes pattern are influenced by the local environment. Larvae of the same species in muddy road rut pools will be the color of the mud, whereas those in woodland pools with dark organic substrate will be dark in color. Thus, this technique is best used by well-trained personnel who become experienced in recognizing the ranges of variation of both tadpoles and salamander larvae in each local species.

Dip nets - Sturdy dip nets can be used in a wide variety of wetlands, especially in small ones and those with vegetation. I recommend the Dshaped ring over the round-shaped ring because the flat portion of the dipnet can be dragged across the substrate much like a small-scale seine. Sweep lengths should be standardized to the extent possible (e.g., 1 meter). Sweeps in all but the smallest wetlands (small pools, road ruts) should be at least 5 meters apart to approximate independent sampling for statistical treatment (Shaffer et al., 1994). The numbers of each species in each sweep are recorded on the data form, along with all pertinent environmental data. This allows an assessment of relative abundance (based on the total sample) and, at least for some sites, statistical treatment of the data (using numbers of each species per sweep sample). If time allows, salamander larvae and tadpoles can be measured or staged using developmental staging schemes (e.g., Gosner, 1960) to provide important information on population structure.

The technique I have found useful with this method is to extend the dipnet approximately 1 meter or more away from the shoreline, dig all the way to the bottom, and then in a vigorous and rapid motion drag the dipnet toward the shore with all the debris and leaves. The rapid movement of the sweep reduces the chances that the larvae will escape and it helps the net pass through vegetation. Pull all this material up onto shore. Before dumping the contents on the ground, check the bag for any adult or juvenile amphibians that may escape once you have emptied

it. Catch, identify, and count them before checking the contents of the bag. Place them in a separate plastic bags for later measurement.

Once you have emptied the contents on the ground, on a plastic sheet, or in a shallow pan, poke carefully through the debris and leaves for salamander larvae and tadpoles (see below for notes on handling amphibians). A spoon is a very useful tool for this part and it also helps to scoop up larvae. These animals may be small, so it is advisable to take your time. Look at every leaf. All animals caught for observation can be placed into one or two plastic bags or a shallow pan containing a quantity of water. Do not combine small larvae with large larvae because the larger ones may eat the smaller ones.

The required number of sweeps of the dipnet depends on the size of the pond. Small ponds and wetlands (<15 m in diameter) may be sampled with as few as 10 sweeps. Larger ponds and wetlands should be sampled with 20 to 30 sweeps. Once the number of sweeps has been determined for each pond, the same number of sweeps should be taken each sampling session to facilitate season-to-season and year-to-year comparisons. All of the parts of the pond system should be sampled to increase the chances of encountering larvae. Remember that the species of larvae and the numbers of individuals of each species should be recorded for each sweep of the dipnet.

Handling Amphibians

Amphibians have sensitive skin and whatever is on your hand may easily transfer to the animal in your hand. Frogs and salamanders are also sensitive to drying conditions and the heat of the sun. The following is a list of precautions that will minimize the stress and potential death of an individual your have captured: (1) never use bug spray or other chemicals on your hand while working with amphibians. (2) Keep the frog or salamander out of the hot sun and do not let it overheat. (3) Keep the animal moist. (4) Do not keep tadpoles or salamander larvae out of water for more than a minute or so; return them to the water as soon as possible. (5) Do not squeeze frogs any tighter than is necessary to restrain them; holding them firmly around the waist is the best method. (6) Do not squeeze tadpoles; they are turgid with water and may pop open.

Health Issues

An important recent development in the scientific evaluation of the worldwide amphibian decline crisis is the realization that things we may do may harm the animals we are studying. The Declining Amphibian Populations Task Force (DAPTF), a network of concerned scientists based

in the United Kingdom, released a Fieldwork Code of Practice 1998. The seven points to the code are included here to make teachers and students aware of the issues involved.

1. Remove mud, snails, algae, and other debris from nets, traps, boots, vehicle tires and all other surfaces. Rinse cleaned items with sterilized (e.g., boiled or treated) water before leaving each study site.

2. Boots, nets, traps, etc. should then be scrubbed with 70% ethanol solution and rinsed clean with sterilized water between study sites. Avoid cleaning equipment in the immediate vicinity of a pond or wetland.
3. In remote locations, clean all equipment as described above (or with a bleach solution) upon return to the lab or "base camp". Elsewhere, when washing machine facilities are available, remove nets from poles and wash with bleach on a "delicate" cycle, contained in a protective mesh laundry bag.

4. When working at sites with known or suspected disease problems, or when sampling populations of rare or isolated species, wear disposable gloves and change them between handling each animal. Dedicate sets of nets, boots, traps, and other equipment to each site being visited. Clean and store them separately at the end of each field day.
5. When amphibians are collected, ensure the separation of animals from different sites and take great care to avoid indirect contact between them (e.g., via handling, reuse of containers) or with other captive animals. Isolation from unsterilized plants or soils which have been taken from other sites is also essential. Always use disinfected/disposable husbandry equipment.

6. Examine collected amphibians for the presence of diseases or parasites soon after capture. Prior to their release or the release of any progeny, amphibians should be quarantined for a period and thoroughly screened for the presence of any potential disease agents.7. Used cleaning materials (liquids, etc.) should be disposed of safely and if necessary taken back to the lab for proper disposal. Used disposable gloves should be retained for safe disposal in sealed bags.

Environmental Data

Taking accurate measurements of environmental variables may be difficult. The most important criterion is to take each measurement the same way each time. Water temperature varies in a wetland due to shading, depth, presence of vegetation, etc. The edges of wetlands may not be discrete, but may vary considerably due to the nature of the slope and vegetation along the margin. Such naturally-induced variation

makes it difficult to obtain accurate measurements. Thus, one must decide, for instance, whether to take several water temperature measurements and average them, or measure the length and width of a pond to the nearest 0.1 m or nearest 1 meter. Decisions on standardization of such measurements must be made in the planning stage of the project.

Temperature and water measurements - Physical parameters that need sampling at each wetland studied are (1) temperature (in Celsius) of the air and water, (2) an estimate of turbidity, (3) pH, and (4) dissolved oxygen (if you have a DO meter calibrated appropriately for elevation). Recording temperature is essential. Air temperature should be taken about 1 meter above the ground in shade while you are standing near the edge of the pond. Make sure that the thermometer is held away from you to avoid body temperature influence. Water temperature should be taken in about the same place in the pond where the water sample was obtained. Take several readings from several locations. Both of these samples should be taken before entering the pond to sample larvae.

Water samples for chemical analysis. - A number of chemical factors influence the presence and survival of amphibians. These include pH, alkalinity (or acid neutralizing capacity), dissolved oxygen, salts, and heavy metals. Most of these are obtained easily, either with field meters or by having them analyzed in a chemistry lab. Other chemicals, like pesticides and herbicides, can be evaluated but they are expensive. It may be possible to obtain data on many of the basic water chemical parameters by engaging the chemistry department in one's school. This approach has many advantages, including collaboration with colleagues and other students.

Water sample bottles require special preparation because the acidbase chemistry required for many chemical analyses can be altered by contaminated bottles. The usual procedure is to have bottles in hydrochloric acid, rinsed thoroughly, and stored with de-ionized water. Enough bottles should be made available to cover both sampling periods for all ponds BEFORE the field season starts. This will avoid having to obtain these specially-prepared bottles on short notice.

Take the water sample before entering the wetland to sample or monitor amphibians but after recording observations on species present and other environmental data like temperatures. This will minimize disturbance of the sediment on the bottom and lessen the changes of getting undesirable material in the bottle. The contents of the water bottle should be dumped out immediately before obtaining a water sample

from the pond. Plastic gloves are preferred protection against contamination by chemicals on one's hands but in practice this is not always done. One's hand should, however, never come in contact with the column of water being sampled or the uncovered mouth of the bottle. The bottle must be rinsed three (3) times with wetland water before taking the final sample. The final sample should be taken from an untouched portion of the wetland, avoiding plant material and bottom debris. Take the sample in a portion of the wetland that has at least 20 cm of water. Fill the bottle completely.

Once the sample has been taken and the bottle capped, the bottle should be wiped dry and placed into a separate plastic bag and labeled. The date, pond name or number (or both), and location must be provided on either a label inside the bag or written clearly on the outside of the plastic bag with a magic marker. Store the water bottles with their samples in the field in a cooler with frozen blue ice packs.

Work closely with the laboratory conducting the chemical analyses, as they may have their own set of rules for sample collection.

Checklist of Things to do Before and After Each Field Trip

This list includes points for a full species inventory. Parts not applicable to the specific methodology you have selected may be omitted.

1. Review procedures, species ID, and prep equipment in classroom for method to be used.

2. Review briefly and prep equipment in classroom or at vehicle at start of protocol execution.

3. Assign specific tasks to each student and review them.

4. Identify frog calls heard and adults observed upon approaching wetland.

5. Tape record frogs if night field trip.

6. Take water samples, and air and water temperatures.

7. Record habitat information as noted on data sheet.

8. Photograph sites and procedures as needed.

9. Record all observations (e.g., frogs calling, adults, egg masses) on data sheets.

10. Obtain dipnet samples & record results for <u>each</u> sweep; preserve examples of larvae if necessary.

11. Review data sheets for completeness.

12. Pack up all supplies in bucket or other waterproof container, and assemble all equipment and supplies.

13. Review tapes (make sure it worked), data sheets, and equipment at vehicle (to ensure against loss).

14. Repeat 2-11 for each site in the field.

- 15. Back in the classroom:
 - a. check labels of all samples
 - b. water samples in refrigerator
 - c. specimen jars in safe storage
 - d. copy data sheets
 - e. clean equipment and supplies, repack
 - f. all data sheets and tapes in files

Checklist of Things to do After Field Data have been Collected

1. Repeat the original questions or hypotheses (handout or on blackboard).

2. Enter data into computer spreadsheets following a simple format that will allow you to obtain statistics and graphs (individual students or groups can partition work load). This includes the species and site data and the environmental data.

3. Perform basic statistics (e.g., means, standard deviations, and minimum-maximum for number of observations per quadrant, transect, or dip net sweep) as needed.

4. Develop graphs (e.g., pie charts, histograms) that illustrate and summarize the results.

4. Organize non-numerical results and observations by habitat type and species in a meaningful way.

5. Assign writing tasks as appropriate (individual students or groups).6. Write the papers using scientific format.

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Frog call identification tapes

The Calls of Frogs and Toads, NorthWord Press, Inc., P.O. Box 1360, Minocqua, WI 54548 (800-336-5666)

Voices of the Night, Library of Natural Sounds, Cornell Laboratory of Ornithology, 159 Sapsucker Woods Rd., Ithaca, NY 14850)

Sounds of North American Frogs. C.M. Bogart. Smithsonian Institution, Folkways Cassette Series 06166. (Center for Folklife Programs and Cultural Studies, 955 L'Enfant Plaza, Washington, D.C. 20560)



Figure 1. A- upper left: Acris crepitans; B-upper right: Bufo americanus; C- middle left: Bufo fowleri; D-middle right: Hyla chrysoscelis; E-lower left: Hyla cinerea, F-lower right: Gastrophryne carolinensis. Photos A-E by Joseph C. Mitchell, F by C.A. Pague



Figure 2. A- upper left: Pseudacris crucifer; B-upper right: Pseudacris triseriata; C- middle left: Scaphiopus holbrookii; D-middle right: Rana catesbeiana; E-lower left: Rana clamitans; F-lower right: Rana palustris. Photos A & C-F by Joseph C. Mitchell; B by C.M. Craig.



Figure 3. A- upper left: Rana sphenocephala; B-upper right: Rana sylvatica; C- middle left: Rana virgatipes; D-middle right: Ambystoma maculatum; E-lower left: Ambystoma opacum, F-lower right: Eurycea bislineata. Photos A-E by Joseph C. Mitchell; F by R.W. Van Devender.



Figure 4. A- upper left: Eurycea guttolineata; B-upper right: Hemidactylium scutatum; C- lower left: Notophthalmus viridescens; Dlower right: Siren intermedia. Photos A-B & D by Joseph C. Mitchell; C by D. Liebman.

Figure 5. Acris crepitans tadpole.

Figure 6. Bufo americanus tadpole.

Figure 7. Bufo fowleri tadpole.

Figure 8. Hyla chrysoscelis tadpole.

Figure 9. Hyla cinerea tadpole.

Figure 10. Gastrophryne carolinensis tadpole.

Figure 11. Pseudacris crucifer tadpole.

Figure 12. Rana catesbeiana tadpole.

Figure 13. Rana clamitans tadpole.

Figure 14. Rana palustris tadpole.

Figure 15. Rana sphenocephala tadpole.

Figure 16. Rana sylvatica tadpole.

Figure 17. Rana virgatipes tadpole.

Figure 18. Ambystoma maculatum larva.

Figure 19. Ambystoma opacum larva.

Figure 20. Eurycea bislineata larva.

Figure 21. Eurycea guttolineata larva.

Figure 22. Notophthalmus viridescens larva.

Figure 23. Pseudotriton ruber larva.

Figure 24. Siren intermedia larva.

Standardized List of Data to be Collected on Each Inventory and Monitoring Field Trip

This list is derived from Fellers and Freel (1995) and is intended to help field personnel keep in mind the list of data fields used for most inventory and monitoring studies.

Site - state, county, installation, specific site. Date Begin and end time Total time Observers Locality - exact locations with map Elevation Topographic map name Weather Wind Air temperature Water temperature Site description (habitat type, size) Drainage (from topographic map; alterations) Substrate type Vegetation (description, canopy cover) Species found (adults, juveniles, eggs, larvae) Other species present (reptiles, fish, birds, mammals) Individual data (sex, body size, tail length, weight) If Aquatic habitat - maximum and average depth, water flow, turbidity, mid-day shade, emergent and floating vegetation, fish present?, fishing tackle present?) Photographs taken (roll and frame numbers)

The list of supplies and equipment listed for each of the major types of methods described above is not exhaustive. You may find other items that suit your needs. Abbreviations: FC = frog call surveys, EM = egg mass surveys (including direct observation), and LV = larval surveys.

Equipment checklist:	FC	EM	LV
Collecting permit	х	х	х
Data forms with clipboard and pencil/pen	х	х	х
Cassette recorder, with extra batteries	х		
Microphone with switch	х		
Blank cassettes (60 min non-metallic)	х		
Watch with second hand or stopwatch	х		
Metric tape measure (50 m)	х	х	х
Headlamp and extra batteries	х	х	
Binoculars		х	х
Pesola® scales	х	х	х
Waders	х	х	х
Rainsuit	х	х	х
Dipnets		х	х
Aquarium dipnets			х
Spoons			х
Plastic bags	х	х	х
Plastic metric rulers	х	x	х
Hand lens (10X)			х
Sling psychrometer	х	x	х
Thermometer (Celsius)	х	х	х
pH meter	х	х	х
DO meter	х	х	х
Minnow traps			х
FrogLoggers*	х		
Flagging tape		х	

Sources of Equipment and Supplies

Vendors:

Forestry Suppliers, Inc., P.O. Box 8397, Jackson, MS 39284-8397 (800-647-5386) (clipboard with cover; thermometers (Celsius); Justrite headlamp - FS 02155; extra bulbs for headlamp; Pesola scales; tape measures; Rite-in-the-Rain copy paper; pH and DO meters)

Ben Meadows Co., 3589 Broad St., Atlanta, GA 30341 (800-241-6401) (clipboard with cover; thermometers (Celsius); Justrite headlamp -BM 130594; extra bulbs for headlamp; Pesola scales; tape measures; Rite-in-the-Rain copy paper)

Carolina Biological Supply, 2700 York Rd., Burlington, NC 27215 (800-334-5551) (ethanol, chloretone, field supplies)

Wards Natural Science Establishment, Inc., 5100 West Henreitta Rd., P.O. Box 92192, Rochester, NY 14692-9012 (800-962-2660) (dipnet, D-frame - 10W0620; extra dipnet bags - 10W0625)

Diagger and Company, Inc., 199 Carpenter Ave., Wheeling, IL 60090 (800-621-7193; FAX 800-320-7200). (Nalgene™ water sample bottles)

University Products, Inc., PO Box 101, 517 Main St., Holyoke, MA 01041 (800-628-1912) (100% rag, 28 lb, 8.5x11 inch paper, 100 sheets)

Fisher, Inc. (formaldehyde, 37% stock solution)

Bass Pro Shops, 2500 East Kearney, Springfield, MO 65898-0123. (800-227-7776) (minnow traps, waders)

Local = local sources (plastic bags, quart size; spoons; pens/pencils; cassette recorder with external microphone on cord; cassette tapes; batteries for cassette player; batteries for headlamp; magic markers (black); Styrofoam boxes for shipping water bottles; shipping tape; box for specimen jars)

Example Field Data Forms

LEGACY 2000 - FROG CALL SURVEY FIELD DATA FORM

Location: VA:	Date:	Site:	
Observers:			
Begin time:End time:	Air Temp:	Water temp:	Rh
Cloud cover: (clear = drizzle =	1, partial cloud 5, showers = 6)	s = 2, overcast =	3, fog = 4,
Wind speed: $(0 = \text{smoke r:} smoke drift; 2 = wind felt on factors small branches moved; 5 = high wir$	ises vertically; ce; 3 = leaves i nd gusts)	<pre>1 = wind directi n constant motion;</pre>	on shown by 4 = dusty,
Water turbidity: clear to fully tu	urbid - 1 2 3	4 5 (circle one)	

Species	Chorus size ¹	Microhabitat ²	Life history obs ³
Spring peeper			
Upland chorus frog			
Pickerel frog			
Wood frog			
American toad			
S. leopard frog			
Green frog			
Bullfrog			
N. cricket frog			
Carpenter frog			
Fowler's toad			
Green treefrog			
E. gray treefrog-H.vers			
Cope's gray treefrog-H. chrysoscelis			
E. spadefoot toad			
E. narrowmouth toad			
Other			
Other			

¹Chorus: 1 = individuals can be counted; space between calls: 2 = indiv. calls distinguished; intermed. between 1&3: 3 = full chorus, continuous and overlapping

²Microhabitat: 1 = in open water; 2 = in veget. in water; 3 = on veget. (use all above open water; 4 = in open on bank; 5 = in or under low veget. on bank; 6 = in veget. above bank; 7 = in adj woods
³Life history = # egg clusters, # amplectant pairs; # obs but not calling. etc.
<u>Contact Joseph C. Mitchell, Dept. of Biology, Univ. Richmond, VA 23173</u>
(phone/FAX 804-740-7086) for questions/comments.

NOTE: ADD OBSERVATIONS OF OTHER SPECIES ON BACK OF THIS FROM

	LEGACY	2000 - A	MPHIBIAN	I LARVAL	SURVEY	FIELD	DATA	FORM	2
Location:	VA:			Date	:		Sit	ce:	
Observers:									
Time:	Air Tem	ıp:	Water t	emp:	Wate	r deptl	n:		
Weather:									

Numb	Species ¹	Microhabitat ²	Observations ³	Substrate⁴
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Species: use first letters of genus and species name

²Microhabitat: 1 = in open water; 2 = in thick veget.; 3 = in sparse veget. ³Observations: other species, interactions, developmental stage, eggs, etc. ⁴Substrate: 1 = decaying leaves/litter; 2 = clay; 3 = sand; 4 = gravel

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