Northern Leopard Frog

Rana pipiens

DESCRIPTION

The northern leopard frog is a slender, medium-sized ranid, sometimes referred to as the "meadow frog" because of its preference for grassy habitats (Hunter *et al*. 1999). It is one of about 20 sibling species making up the *Rana pipiens* complex that ranges over much of North and Central America. Members of the complex, including the northern leopard frog, are commercially collected and shipped worldwide for laboratory use.

The northern leopard frog is not considered an obligate vernal pool species in New England (Colburn 1995, Kenny 1995), primarily because it prefers lakes, ponds, and slow-moving streams for breeding (Hunter *et al*. 1999, Klemens 1993). Its life cycle includes an aquatic larval stage and semi-terrestrial juvenile and adult stages.

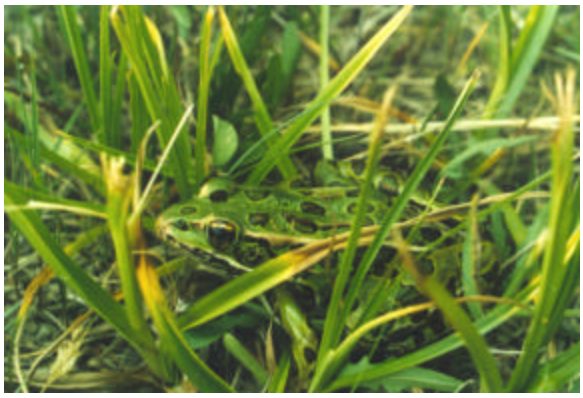
BODY SIZE

Klemens (1993) reported body lengths (snout-vent) of northern leopard frogs from a Connecticut sample (n=23) to be 51 – 65 mm for males (average 57.2 mm) and 53- 65 mm for females (average 57 mm). Hunter *et al*. (1999) reported slightly larger sizes (data possibly from a more northerly population), with male and female snout-vent lengths ranging from 52 – 82 mm and 54 – 95 mm, respectively.

In The Primary Study Area: Body size data from the Housatonic vernal pool surveys are presented in Table 1.

DISTRIBUTION

The northern leopard frog's range extends from the Canadian Maritimes and New England westward to the Rocky Mountains and beyond (Figure 1). The range of the northern leopard frog in southern New England overlaps somewhat with that of the southern leopard frog, (*Rana utricularia*), a sibling species that can be very similar in appearance (Klemens 1993).



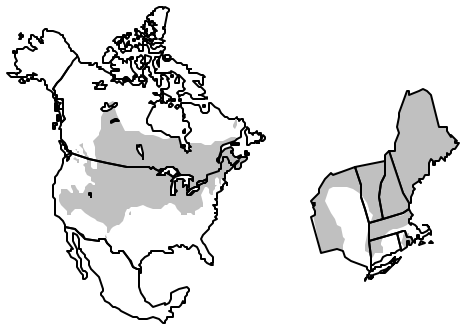


Figure 1. Range of the northern leopard frog

Table 1. Body size data for adult and yearling leopard frogs from 1999 live trapping surveys at vernal pools in the primary study area

Parameter	Males	Females
Weights (g)		
Mean	38.0	38.1
Range	16.5–76.3	3.9–79.4
Std. Dev.	13.3	21.7
n =	31	46
Lengths (mm)		
Mean	67.5	68.5
Range	52.8–79.2	41.7–87.7
Std. Dev.	5.9	14.4
n =	18	34

This overlap, however, does not appear to occur in the Housatonic River study area in Pittsfield, Massachusetts (Klemens *et al.* 1987). All leopard frogs observed there were assumed to be the northern species.

In Massachusetts, the range of the northern leopard frog is largely limited to northcentral and northeastern regions of the state, with localized populations also found in the Connecticut and Housatonic drainage basins. It is considered a relatively uncommon frog here, restricted to grassy riparian and floodplain habitats.

MIGRATION

Migration of northern leopard frogs is limited to movements between aquatic breeding and wintering habitats and nearby summer feeding areas. Summer movements of adult frogs include mostly short-distance (e.g., a few meters to 45 m) nocturnal travel on the home range. More extensive adult summer movements to areas outside the home area have been observed during nocturnal rains, in which travel distances exceeded 100 – 200 m (Dole 1965). Little is known about these large-scale movements. Fall migrations to the overwintering sites sometimes cover distances of up to 2 miles (Merrell 1970) as evidenced by adult captures far from any suitable waterbody.

HABITAT

Northern leopard frogs are considered semi-terrestrial amphibians. They breed and overwinter in water bodies, but the adults spend the entire post-breeding summer period (i.e., July, August, and early September) in grassy meadows, open shrub areas, or damp woods, often far from any water (Dole 1965, Hunter *et al*. 1999, Klemens *et al*. 1987, Merrell 1970). In southern New England, they appear to be restricted to floodplains along large streams and rivers, wetlands along lake margins, and meadows adjacent to freshwater and brackish tidal wetlands. They often inhabit cattle pastures and hay fields, but otherwise seem to avoid severely disturbed or polluted sites (Klemens 1993). In the spring, leopard frogs are attracted to vegetated shorelines by a greater abundance of food, moderated temperatures, and protective cover (Dole 1967a).

The preferred summer feeding habitat for adults is damp, grassy meadow with vegetation 6 inches to 1 foot high, though they have been shown to inhabit damp wooded areas as well (Hunter *et al*. 1999, Merrell 1970). In a Maine peatlands study, northern leopard frogs were found to be most abundant in streamside meadow habitats (Stockwell and Hunter 1989). Whitlock *et al*. (1994) indicate that the optimal summer habitat for northern leopard frogs includes pools of standing water surrounded by wet meadow with a broad transition to upland fields or pasture.

In fair weather, adults using grassy areas typically spend days sitting quietly in "forms," resting spots where the vegetation has been pushed aside so that the frog's underside is in contact with bare, moist soil. The soil moisture is absorbed through the frog's groin area, aiding hydration. Dew is also absorbed in this manner, and the frogs are known to move off the forms onto wet vegetation when sufficient soil moisture is not available (Dole 1967b).

During summer, northern leopard frogs do not use water to avoid predation as do other ranids (i.e., the green frog), but rather hop in a zig-zag fashion into thick vegetation (Klemens 1993). In fall and early spring, however, adult and juvenile leopard frogs more typically inhabit immediate shoreline areas and are known to take cover by diving into water and remaining temporarily submerged (Merrell 1970). Northern leopard frogs do not tolerate freezing conditions and must return to water to hibernate for the winter months (see Hibernation below).

The preferred breeding habitat of the northern leopard frog varies somewhat depending on geographic location (and possibly which species of the complex it belongs to). In New England, leopard frogs choose primarily shallow water bodies with emergent vegetation, including lake inlets and shallow, weedy shores, small ponds, slow-moving streams and backwaters (DeGraaf and Yamasaki 2001, Hunter 1999, Klemens 1993). In the Midwestern states, leopard frogs breed primarily in shallow ponds (with either temporary or permanent hydrology), though the juveniles leave the breeding ponds for the shores of larger waterbodies after metamorphosis (Merrel 1970).

In The Primary Study Area: Data on habitat use by northern leopard frogs from the Housatonic eco-characterization and vernal pool studies (1998 – 2000) are presented in Table 2.

HIBERNATION

Northern leopard frogs hibernate underwater from October or November to March or April (DeGraaf and Yamasaki 2001, Hunter *et al*. 1999). Emery *et al*. (1972) observed wintering leopard frogs on the bottom of an ice-covered pond in Ontario, Canada. These frogs were found hibernating in shallow excavated pits on the surface of the mud bottom at water depths of about 3 m. Though some frogs were covered with a thin layer of silt and others were completely uncovered, all maintained a clear space along their sides, presumably to facilitate sufficient respiration. Hibernating frogs exhibited some movement, albeit very slow. Cunjak (1986) observed a small number of leopard frogs overwintering in running water in a variety of stream types (e.g., riffles, pools, and runs) in southern Ontario. Both adult and juvenile frogs were found, typically in open crevices under rubble (rock diameter = 13 – 40 cm) in areas where there was only minimal silt deposition. Animals were found to be quite torpid but capable of swimming. Mean water depth in the hibernation areas was 85.5 cm, and mid-depth velocities averaged 22.5 cm/s. Cunjak (1986) speculates that the current provided aeration and prevented deoxygenation, which may be a cause of winter mortality in pond habitats. Northern leopard frogs also sometimes hibernate in caves (DeGraaf and Yamasaki 2001).

HOME RANGE AND TERRITORIALITY

Adult northern leopard frogs show marked fidelity to home areas, with individuals remaining in a relatively confined area for most of the summer and returning to that area after nighttime excursions and the following year after hibernation and breeding (Dole 1968). They are especially active during rainy nights, when they will often move to warm road surfaces. It is thought that temperature (air and water) may play a major role in the timing of leopard frog movements between wintering and breeding areas and between summering and

Table 2. Habitat use by northern leopard frogs in the Housatonic study area from 1998-2000 survey data

Habitat Codes and Natural Community Classifications																				
Wetland Habitats													Terrestrial Habitats							
ROW	ROW & PAB	SHO		PFO				PSS	PEM		WM	VP	SW	MW	HW			OF	AGR	RES
Medium-gradient stream	Low-gradient stream	Riverine pointbar and beach	Mud flat	Red maple swamp	Black ash-red maple-tamarack calcareous seepage swamp	Transitional floodplain forest	High-terrace floodplain forest	Shrub swamp	Deep emergent marsh	Shallow emergent marsh	Wet meadow	Woodland vernal pool	Spruce-fir-northern hardwood forest	Northern hardwoods-hemlock-white pine forest	Successional northern hardwood forest	Red oak-sugar maple transitional forest	Rich mesic forest	Cultural grassland	Agricultural cropland	Residential development
Y	Y			B	B	B	B	B	Y	B	B	B			B	B	B	B	B	

ROW = Riverine Open Water
SHO = Shorelines
PFO = Palustrine Forested
PSS = Palustrine Scrub-Shrub
PEM = Palustrine Emergent
WM = Wet Meadow
PAB = Palustrine Aquatic Bed
VP = Vernal Pool
SW = Softwood Forests
MW = Mixed Forests
HW = Hardwood Forests
OF = Open Fields
AGR = Agricultural Croplands
RES = Residential

Season of Use
B = Breeding
M = Migration
W = Wintering
Y = Year-round
Shading = observed in study area

wintering areas (Merrell 1970). In one study, leopard frogs showed excellent homing ability when displaced moderate distances (i.e., <1 km) from their home area (Dole 1968).

BREEDING

Northern leopard frogs in southern New England begin their migration from hibernation sites to the breeding sites in early spring (mid- to late March), slightly later than the wood frog (Klemens 1993, Degraaf and Yamasaki 2001, Whitlock *et al*. 1994). The breeding period lasts 7 – 28 days, and by late April to early May, the egg masses have been deposited (Hunter *et al*. 1999, Klemens 1993). Timing of migration from the underwater hibernation sites may be most related to temperature gradient. Merrell (1970) reports that adult northern leopard frogs (presumably populations in the Midwest) leave the hibernation waters when the air temperature is about 50°F, and that the sexually-immature frogs tend to remain in the larger waterbodies while the mature individuals begin their migration to the breeding sites. Water temperature plays a role in the selection of a breeding pond, with the frogs avoiding large ponds that do not warm rapidly and very shallow ponds that experience pronounced diurnal temperature fluctuations. The frogs also seem to choose the warmest spots of the ponds for breeding and egg-laying, often in open areas without a canopy.

Male leopard frogs are presumably not territorial (Hunter *et al.* 1999). They gather together in dense groups in shallow water and actively seek the females. Coupling is by pectoral amplexus, which lasts for about 24 hours or less. The individual egg clutches, which contain 2,000 to 6,500 eggs, are laid in shallow water either singularly or in communal masses of 25 to 40 clutches. The eggs become attached to submerged twigs or vegetation, or sometimes rest on the pond bottom. After the breeding and egg-laying period, the adults leave the breeding pond for their summer habitats and home areas (DeGraaf and Yamasaki 2001, Hunter *et al*. 1999, Wright and Wright 1949).

In The Primary Study Area: Documented leopard frogs breeding sites within the Housatonic study area included river edges and relatively deep backwaters adjacent to grassy meadow floodplain areas. Although leopard frogs were trapped going into and out of the vernal pools, no breeding activity was observed in any of the isolated pools surveyed, and no groups of adults were seen in the primary study area. In general, male and female adult leopard frogs (n = 44) were observed entering the vernal pools the first week of April, but they were caught leaving the pools within a day or two of entering.

GROWTH AND DEVELOPMENT

Like many frog species, embryonic development of the northern leopard frog is temperature-dependent, and can be delayed by periods of cold weather. The eggs hatch in 13 – 20 days, and the tadpoles metamorphose 60 – 80 days after hatching (DeGraaf and Yamasaki 2001, Hunter *et al.* 1999). Northern leopard frog tadpoles are relatively large, up to 84 mm in length (Wright and Wright 1949). In southern New England, metamorphosis would likely occur from mid-July through mid-August. Newly-metamorphosed juvenile leopard frogs are 20 – 30 mm in length (snout to vent). Their growth rate is highest in the summer, slowing considerably in September (Hunter *et al*. 1999). These juvenile frogs leave the natal pond area and disperse (often during rains) into nearby grassy areas or towards the shoreline of larger bodies of water. At first, the young frogs stay close to open water, which they use for escape cover and thermoregulation, but they tend to range further and further from water as they grow (Merrell 1970).

FOOD HABITS AND DIET

Foods of adult and juvenile northern leopard frogs include almost any kind of insect, as well as spiders, snails, and frogs. Linzey (1967) suggests that availability rather than preference determines food types, and reports that beetles (Coleoptera) are a staple in the diet of adults and juveniles probably because they are available throughout the active season. Moth and butterfly (Lepidoptera) larvae, grasshoppers and crickets (Orthoptera), bees, wasps and ants (Hymenoptera), and bugs (Hemiptera) are also particularly common (DeGraaf and Yamasaki

2001, Knowlton 1944, Linzey 1967). Linzey (1967) found that vegetable matter can also make up a significant volume (10 – 20%) of adult and juvenile food, and that the diet of adults was more diverse than that of juveniles in his study. Knowlton (1944) reported finding recently-shed frog skins and juvenile frogs in the stomachs of leopard frogs.

Leopard frog tadpoles are primarily herbivorous, consuming algae, plankton, and small plant materials (detritus) from the substrate and the undersides of aquatic vegetation within the natal pond (Hunter *et al*. 1999).

POPULATIONS AND DEMOGRAPHY

Survivorship: No specific information was found on the survivorship of the northern leopard frog. Based on data from other ranids like the wood frog, it is expected that survivorship at each of the various life stages would be variable and affected by factors such as weather, predation, environmental stresses, competition for limited resources (i.e., density-dependent factors), and geographic location. As with other amphibians, predation pressure on eggs and larvae is likely high, and juvenile mortality varies more than adult mortality (Duellman and Trueb 1986). The percent survival from egg stage to adult stage is probably very low, which is typical for amphibian species with similar reproductive strategies.

Age at Maturity and Life Span: Little information is available regarding the age at first breeding for the northern leopard frog in the Northeast. In Michigan, leopard frogs (presumably both males and females) were reported to mature sexually at 3 years of age (Force 1933, as cited in DeGraaf and Yamasaki 2001). Other sources (Hunter *et al*. 1999) say that age of first breeding may occur 1 year after transformation, but more typically 2 years from the egg stage. No specific information was found regarding the average life span of the northern leopard frog in the wild.

Mortality: Factors contributing to adult and juvenile leopard frog mortality are not well understood. Predation, road mortality, diseases and parasites, winter kill, and desiccation during periods of low rainfall all contribute to leopard frog mortality. Other factors, including environmental stresses and collection for commercial sale and human consumption have been identified (Hunter *et al*. 1999). The role of density-dependent factors in survivorship and overall population regulation is not well understood.

Enemies: Adult and juvenile northern leopard frogs have few defenses against predators, but they are often effective at avoiding capture by leaping into thick vegetative cover. In breeding habitats, adults fall prey to fish, water snakes, snapping turtles, herons, mink, raccoon, skunk, fox, and coyote. The eggs and juveniles are fed upon by leeches, caddisfly, mayfly, and dragonfly larvae, predaceous diving beetles, salamanders, adult frogs and toads, turtles, snakes (particularly eastern garter), herons, ducks, grebes, blackbirds, birds, and various carnivorous mammals (DeBenedictis 1974, Hunter *et al.* 1999, Whitlock *et al.* 1994).

STATUS

General: The northern leopard frog is considered to be an indicator of high quality, specialized wetlands. Though locally common in some floodplain areas, it is relatively rare in the Northeast region, and there is evidence that this species has been extirpated at many sites in southern New England as a result of flood control measures, impoundments, and other types of developments that have altered wetlands (Klemens 1993). Excessive collection for the scientific supply market has also contributed to the decline of northern leopard frog in Canada and the United States, and massive, continent-wide die-offs (not well understood) were reported in the 1970s and 1980s. Environmental stresses, including low pH and high concentrations of metals and chemicals from pesticides and fertilizers, have been shown to have detrimental effects on leopard frogs and tadpoles. Other possible factors contributing to declines include road mortality and increased ultraviolet-B radiation caused by the thinning ozone layer (Freda and McDonald 1990, Hunter 1999).

In The Primary Study Area: Leopard frogs were the second most common amphibian species observed

during the vernal pool surveys in 1999. Approximately 154 leopard frogs were caught in pitfall traps as they entered the four vernal pools in the study, as compared to 1,300 wood frogs, 87 green frogs, and 70 spotted salamanders.
Figure 2 illustrates the locations within the primary study area where leopard frogs were observed during the 1998, 1999, and 2000 field studies.

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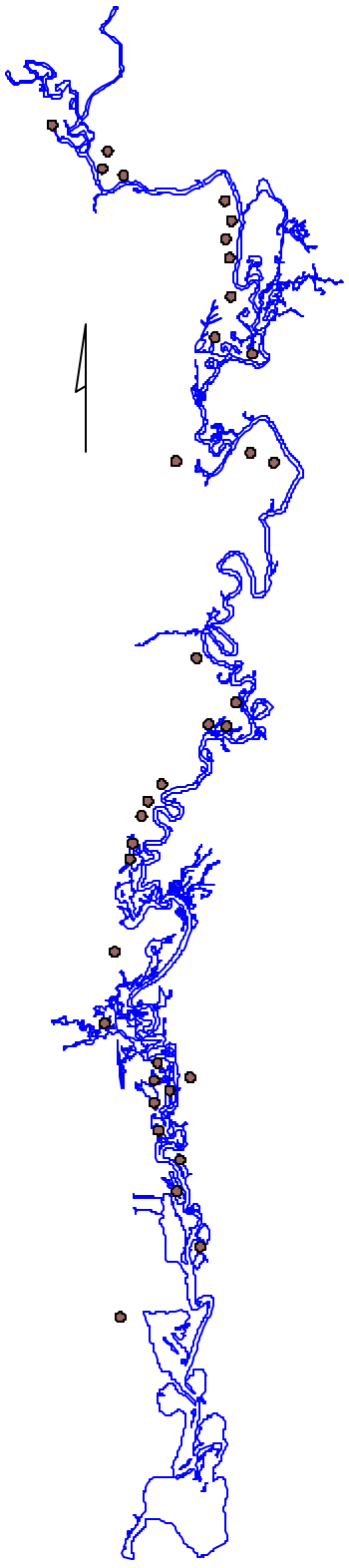

Figure 2. Northern leopard frog sightings in the primary study area in 1998, 1999, and 2000.

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