Natural Heritage & Endangered Species Program

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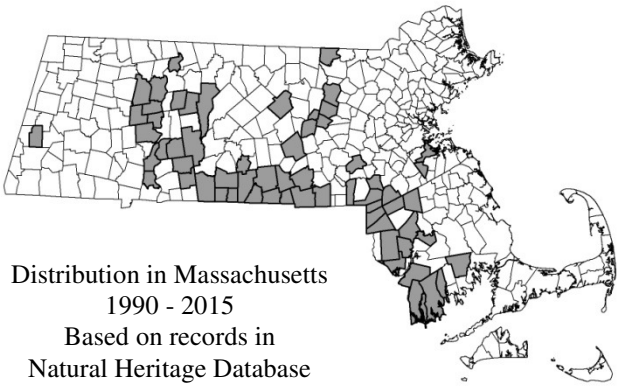
Massachusetts Division of Fisheries & Wildlife

Marbled Salamander
Ambystoma opacum

State Status: **Threatened**
Federal Status: **None**

DESCRIPTION: The Marbled Salamander is a stout, medium-sized salamander with a stocky body, short limbs, and a broad, rounded snout. Dorsal coloration is black, marked with bold, variably-shaped grayish to whitish crossbands that create a "marbled" pattern from head to tail. Lateral and ventral coloration is uniformly dark gray to black. Banding on the mid- to upper dorsum tends to be bright white in mature males and dull gray in mature females. Banding on the tail can be white in both sexes, or gray in females. Total length is 3–5 inches.



Distribution in Massachusetts
1990 - 2015
Based on records in
Natural Heritage Database

Recently hatched larvae are dark brown to blackish in coloration and measure approximately half-an-inch in total length. Throughout development, they have bushy, external gills, a broad head, a long caudal fin that extends onto the back, and a row of bright-white spots leading from the "armpit" of the forelimb down the lower lateral part of the body toward the hind limb. As larvae age, they develop dark pigment on the chin and belly, as well as light yellowish to olive-colored rows of spots or blotches along the upper lateral part of the body and tail. Mottling of the body and tail increases with age of the larva, and total length typically reaches 2–2.5 inches prior to metamorphosis. Base coloration can vary depending on environmental conditions, as dark-colored

Marbled Salamander
Photo by Lloyd Gamble

larvae collected from the wild will transform to a light-olive color when kept in a light-colored container. Albino/leucistic larvae have been documented in Massachusetts on at least two occasions.

Recently transformed juveniles (metamorphs) have a base color of brown to black and are marked with light, silvery flecks that become more pronounced and aggregated over the dorsum during the first several weeks post-metamorphosis. As the animal matures during the following 1–2 months, the markings elongate to form the characteristic marbled pattern of an adult.

SIMILAR SPECIES: Adult Marbled Salamanders cannot be confused with any other species in Massachusetts. Larvae can be distinguished from those of other *Ambystoma* salamanders in Massachusetts on the basis of the pigmented chin and the ventrolateral row of white spots. Metamorphs are somewhat similar to those of Spotted Salamander (*Ambystoma maculatum*), Blue-spotted Salamander (*A. laterale*), or Jefferson Salamander (*A. jeffersonianum*), but the latter three species are distinguished by yellowish (rather than silvery) dorsal flecking and tend not to occur until July or August, when most young-of-the-year Marbled

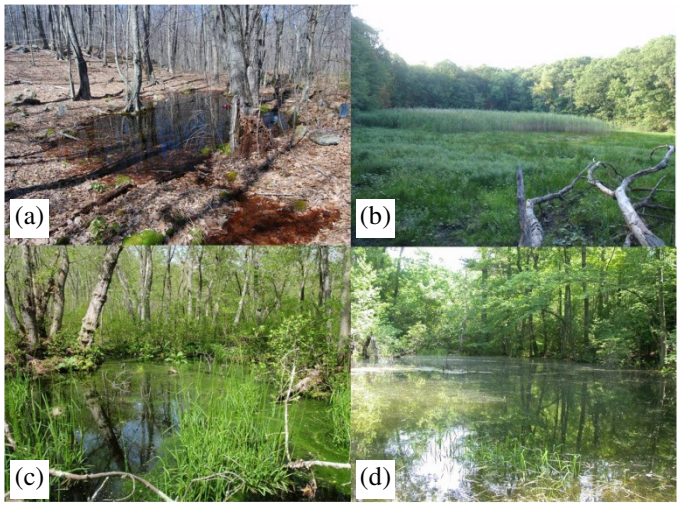
Salamanders have already attained the adult color pattern. Juvenile Blue-spotted and Jefferson salamanders have light-blue flecking that might be mistaken for the silvery-gray flecking of juvenile Marbled Salamanders, but the markings in Blue-spotted Salamander and Jefferson Salamander are concentrated much more heavily on the sides and legs (rather than on the head and dorsum).

Basal coloration of the Marbled Salamander larva can be relatively dark (top) or light (bottom), depending on developmental stage or pool environment. Both of the larvae shown above were collected on the same date from Dartmouth, Massachusetts, with the top animal from a vernal pool with tannic water, and the bottom animal from a forested swamp with heavy algal growth. Note that the ventrolateral row of white spots and the dark pigments on the chin and belly are much more prominent in the top animal.

Photos by Jacob E. Kubel

RANGE: Marbled Salamander ranges from southern New England south to northern Florida and west to eastern Texas and Oklahoma. Disjunct populations occur in southwestern Missouri, northern Indiana, southwestern Michigan, northern Ohio, and northwestern Pennsylvania. Within Massachusetts, Marbled Salamander is distributed primarily among parts of Bristol, Franklin, Hampden, Hampshire, Norfolk, and Worcester counties. Only several populations are known from Middlesex and Plymouth counties, and a disjunct population occurs in Berkshire County.

HABITAT: Adult and juvenile Marbled Salamanders inhabit relatively mature deciduous and mixed deciduous-coniferous forests and woodlands. Elevation and forest type vary greatly among local populations across Massachusetts, but dry sites seem to be preferred. Breeding/larval habitat is also variable, consisting of vernal pools, woodland ponds, shrub swamps, and forested swamps differing markedly in their surface areas, depths, bottom substrates, and/or densities and composition of vegetation. However, there are three consistent characteristics of those habitats – they almost always are fishless, occur within or adjacent to forests, and hold water continuously during a minimum period of January–May (often October–June). Most breeding wetlands dry completely or substantially during the summer, and many have variable microtopography (e.g., at least one relatively deep sub-basin adjacent to flat or gently-sloped "shelves" of intermediate depth).



Breeding wetlands of Marbled Salamanders in Massachusetts include (a) small vernal pools; (b) large, open, temporary ponds; (c) forested swamps; and even (d) abandoned farm ponds or borrow pits.

Photos by Lori Johnson (a) and Jacob E. Kubel (b–d)

In the terrestrial environment, trademarks of good-quality microhabitat for adult and juvenile Marbled Salamanders include well-developed leaf litter, abundant coarse woody debris, loose soils, predominantly closed-canopy tree cover, and abundant rodent tunnels. Most adult individuals reside within several hundred meters of their breeding wetland. Research suggests that local salamander distribution around a breeding site may be influenced by habitat integrity, with salamanders residing closer to a wetland (on average) in intact forest, but occupying areas farther from the wetland when a forest patch is fragmented (e.g., by development). Of course, variability in the distribution of high-quality microhabitat around a breeding site is also likely to influence the distribution of individual salamanders

around the wetland, as is the availability of other suitable wetlands within the patch of upland habitat.

LIFE CYCLE / BEHAVIOR: As the family name "mole salamander" implies, adult and juvenile Marbled Salamanders spend the majority of their time underground or hidden beneath rocks, logs, leaf litter, or other debris. During rainy or otherwise humid nights in the warmer months of the year, individuals may occur on the ground surface for purposes of foraging, dispersal, or migration to breeding sites. However, most hours of the year are spent under leaf litter, in rodent tunnels, or in other subsurface cavities. Winters are spent below the frost line, presumably in vertical rodent tunnels or root channels, as has been observed in other mole salamanders.

Unlike most Ambystomatid salamanders in Massachusetts that breed during early spring and deposit gelatinous egg masses in water, Marbled Salamanders breed during late summer and deposit clutches of loose eggs in dried wetland basins. In late August or early September (depending on the timing of rain or other high-humidity events), adult Marbled Salamanders emerge from their underground retreats and migrate to their breeding pools. Migrations occur at night, usually during or shortly following rain, or during foggy or misty conditions. Males generally arrive at the breeding sites several days to a couple of weeks prior to females.

Courtship occurs on land, either in the dried wetland basin or at some other location beyond the wetland (research suggests that males occasionally intercept females prior to their arrival at breeding sites). Courtship behavior involves circular "dancing" and snout-to-vent nudging. This activity induces the male to deposit a gelatinous spermatophore (a tiny packet of sperm) on the ground, which the female picks up with her cloaca and stores for internal fertilization of her eggs.

After mating, the female moves to a select portion of the dried wetland basin (usually at an intermediate depth) to construct a nest. She carves out a small, elliptical cavity in the soil or detritus just below the leaf litter or at the edge of or beneath a partially imbedded log, stone, or mat of dead vegetation. She then deposits a clutch of approximately 50–150 individual eggs in the depression and coils her body over them, waiting for autumnal rains to fill the pool with water and inundate the eggs. The eggs are spherical and approximately 2–5 mm in diameter, depending on their age and hydration. Each egg initially appears as a transparent capsule containing a whitish embryo in a clear, fluid matrix, but the outer membrane soon stains dark-brown to black as the female moves over or turns the eggs, and soil particles stick to them. By the time a nest is several days old, it resembles a pile of spherical mud pellets.

In Massachusetts, egg deposition peaks in mid-September. Unless disturbed by a predator or other large animal, the female typically remains with her eggs until they are inundated by water or, if filling of the pool is slow to materialize, for a period of several weeks. Nests are often abandoned if dryness persists into mid-October; females are seldom observed brooding eggs in November. Dehydration and/or the onset of cold temperatures are probable triggers for abandonment. Egg mortality likely increases as wetland basins remain dry into the winter, but abandoned eggs can remain viable for a considerable period of time. Successful hatching of abandoned nests in Massachusetts has been documented in December and even late January.

A Marbled Salamander found guarding her eggs beneath a log in a dried vernal pool in Sutton, Massachusetts on September 7, 2012. Larvae were observed the following spring, even though the pool had not filled with water until late January.

Photo by Jacob E. Kubel

When the pool basin does fill with water, the eggs hatch within hours to a couple of days. Hatchling larvae are active immediately and feed on zooplankton. If hatching occurs during September or October (when water temperatures are relatively warm), larvae are able to put on noticeable growth (≥50% of initial body size) before winter arrives, pools ice over, and feeding activity slows.

The larval salamanders remain in their natal wetlands throughout the winter and rapidly increase their feeding activity (and growth) once ice thaws in March and water temperatures rise in April and May. At this time, the larvae feed on zooplankton, aquatic invertebrates (including mosquito larvae), and even other amphibian larvae (e.g., Spotted Salamander). Metamorphosis peaks during late May through early June, with some individuals or sites experiencing earlier or later dates, depending on larval density, pool hydrology, and/or other factors.

During metamorphosis, the larvae develop lungs, resorb their gills, and seek cover beneath stones, woody debris, leaf litter, or other detritus in moist or saturated portions of the wetland basin. There, the juvenile salamanders will wait for an opportunity to leave the basin and disperse into the surrounding forest (typically during an evening rain). Following dispersal from natal wetlands, juvenile salamanders will reside in the forest, feeding on snails, earthworms, beetles, slugs, and other small invertebrates. Upon reaching sexual maturity (1–5 years), most individuals will return to their natal wetland to breed, starting the cycle anew. Others will have sought out new ground, joining another segment of the local breeding population, or pioneering a new one of their own. One study in Massachusetts documented a juvenile dispersal rate of approximately 9%, with some individuals eventually breeding in wetlands >3,000 feet from where they were born.

Maximum life expectancy of Marbled Salamander is unknown. Mark-recapture studies of mole salamanders, in general, indicate that adult survivorship is relatively high, and individuals may live for several years or more with regularity. Accounts of salamanders held in captivity suggest a possible lifespan greater than 10 years. One study in Massachusetts documented Marbled Salamanders surviving greater than 6 years in the wild, with average annual adult survivorship at the site approaching 65%. In comparison, modeling exercises suggested annual adult survival near 80% at a site in South Carolina.

POPULATION STATUS IN MASSACHUSETTS:
Marbled Salamander is legally protected and listed as Threatened pursuant to the Massachusetts Endangered Species Act (M.G.L. c. 131A) and implementing regulations (321 CMR 10.00). As of January 2015, approximately 85 local populations had been documented among 61 towns since 1990. Massachusetts is near the northern limit of the geographic range of Marbled Salamander, and local populations in the state are relatively small. Adult survivorship appears critical to population persistence, especially at sites where reproductive output is low, or reproductive failures are common. Primary threats to Marbled Salamander in Massachusetts are habitat loss, habitat degradation, road mortality, and emerging infectious disease.

Clearing of forest for residential and other developments is an ongoing threat to Marbled Salamanders in Massachusetts.
Photo by Jacob E. Kubel

The most common types of habitat loss are the clearing of forests and the filling (or draining) of vernal pools during residential, commercial, industrial, mining, or agricultural development. Habitat degradation typically occurs when development fragments habitat (e.g., creates gaps between forest habitat and breeding wetlands), chemical applications (e.g., pesticides, deicing salts, fertilizers) pollute breeding wetlands, or commercial logging operations disrupt forest ecology (e.g., compact soils, reduce leaf litter, introduce or increase growth of non-native, invasive vegetation). High road densities and traffic volumes tend to result in increased levels of adult salamander mortality; in extreme cases, road mortality functions as a barrier between upland and breeding habitats. Known and potential impacts of several pathogens/emerging infectious diseases (e.g., ranavirus, *Batrachochytrium salamandrivorans*) are not completely understood, but outbreaks could result in severe and widespread salamander mortality.

MANAGEMENT RECOMMENDATIONS:
At a local scale, sites of known occurrence of Marbled Salamander should be managed to develop or maintain mature forest conditions within at least 1,000-ft radii around confirmed and potential breeding wetlands. Such management should aim to minimize forest loss/fragmentation, road traffic, soil compaction, and introduction/growth of invasive, non-native vegetation. Forest type should be maintained as deciduous or mixed deciduous-coniferous. Fallen trees, branches, leaves, and other detritus should be allowed to accumulate on the forest floor. Hydrology of breeding wetlands should not be altered in ways that might reduce hydroperiod within the October through June time period. Breeding wetlands should be protected from chemical pollution, and basin structure should not be altered without special permits from the Massachusetts Division of Fisheries and Wildlife and/or the Department of Environmental Protection. Breeding wetlands should not be filled or used for dumping of yard waste or refuse.

At the landscape scale, area of mature upland forest between local populations of Marbled Salamander should be maximized to maintain broad dispersal corridors and, therefore, genetic exchange between populations. Land acquisition/protection efforts for maintaining habitat connectivity should prioritize areas with low road densities and traffic volumes. A land-protection strategy may best serve long-term persistence of local populations where they occupy relatively large, connected areas containing abundant breeding habitats. However, lands supporting small, peripheral, or isolated populations are also worth protecting for maintenance of genetic diversity at the state level.

Stronger controls are necessary to guard against the introduction and spread of amphibian pathogens and infectious disease. For example, national policy and enforcement regarding importation of exotic wildlife in the global pet trade should be improved to reduce and minimize the volume of diseased animals entering the country. Within Massachusetts, field biologists, anglers, and other outdoor enthusiasts should adopt and promote appropriate equipment-sanitation procedures when outdoor activities span wide geographic areas. A statewide amphibian monitoring program that includes sampling for pathogens and disease outbreaks is needed.

Citizens are encouraged to assist with conservation of Marbled Salamanders in several ways. For example, observations of Marbled Salamander should be reported to the NHESP, as land-protection efforts for the species are dependent on knowing where local populations occur. Collection and submission of data for the certification of vernal pool habitat is another beneficial action, as it will afford certain legal protections to salamander habitats. Citizens may also provide important information by reporting incidents of mass amphibian mortality at vernal pools and other wetlands.

A gravid Marbled Salamander migrates to her breeding site during late August in Attleboro, Massachusetts.
Photo by Jacob E. Kubel

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Updated 2015

A Species of Greatest Conservation Need in the Massachusetts State Wildlife Action Plan

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