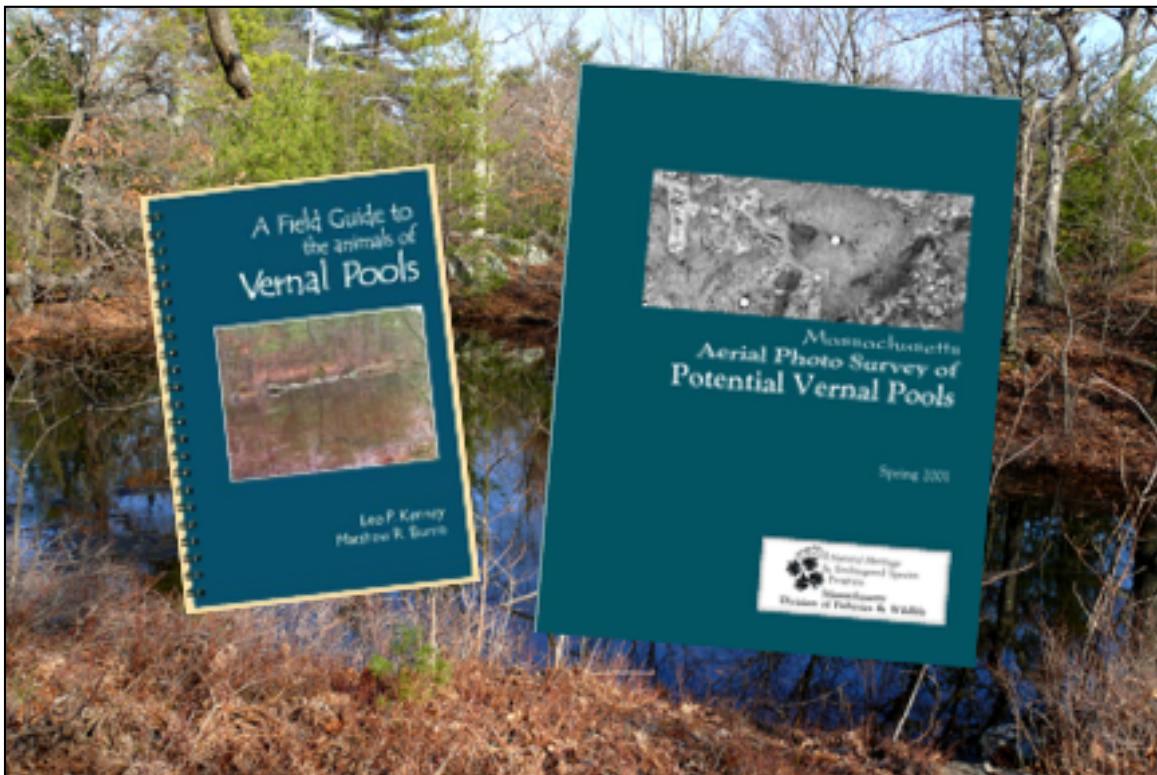




This is the perfect time of year to be thinking about vernal pools and to go out to see these wicked awesome puddles. This presentation will not get very deep into most of the topics we touch on, but hopefully whet your appetite for more about vernal pools!

Matt Burne is the Director of Conservation with the Walden Woods Project and was formerly employed by the MA Division of Fish & Wildlife's Natural Heritage & Endangered Species Program as the Vernal Pool Ecologist. Matt is the Vice-President of the non-profit Vernal Pool Association which works to promote the study, appreciation, and protection of vernal pools. He provides vernal pool outreach and education to the public, conservation commissioners and the regulated community, natural resource agency personnel, and the scientific community.



While at the Natural Heritage & Endangered Species Program, Matt co-authored *A Field Guide to the Animals of Vernal Pools* and created the state-wide survey of potential vernal pools using aerial photogrammetry which is available as a datalayer in the MassGIS. Access to those data is available at http://maps.massgis.state.ma.us/map_ol/oliver.php



The Vernal Pool Association was founded to promote the study, appreciation, and protection of vernal pools. A major aspect of our work is to provide access to high quality images for use in educational outreach and natural history interpretation. Contact the Vernal Pool Association at www.vernalpool.org for information and assistance.

To put it simply, vernal pools are basically small forest ponds that are free of fish and that hold water for a minimum of two months starting in the spring.

Vernal pools are wicked cool, and are extremely important wildlife habitat resources.



Most of our vernal pools in Massachusetts fill in the fall and hold water through the winter. A good way to identify vernal pools to check out in the spring is to walk the woods in winter searching for perfect little skating ponds. These will often be vernal pools.



In the early spring, as soon as ice is out, vernal pools come to life. In spring, vernal pools tend to be at their fullest. In this photograph, notice that the water level is rather lower than the previous winter picture. This was taken in a year where water levels were quite low. This variation, which can be quite dramatic year-to-year, is typical of vernal pools.



By mid- to late-summer, vernal pools typically dry out. Variation a key concept to bear in mind, though. Not all vernal pools dry completely every year, and some will hold water most years, drying only occasionally. However, to be a vernal pool, the basin needs to be free of fish.

Vernal pools are therefore aquatic ecosystems that do not support fish.



Vernal pools are important for a wide variety of wildlife, but most notably for several species that have evolved life styles that are entirely dependent upon them. The mole salamanders that occur in Massachusetts, the wood frog, and a variety of invertebrates, most notably the fairy shrimp, are all considered vernal pool obligate species.



The animals that use vernal pools are in a race against drying. They have adapted to breeding as early as possible in the spring to maximize the time their larvae have in the pool before the water dries up. The animals that migrate to vernal pools very early in the spring often arrive to a scene like this, with just the barest mote of access through the ice.



Wood frogs mate very early in the year and are among the first voices we hear in the spring.



Wood frog populations have a tendency to lay their eggs in communal rafts. A robust population of frogs may produce hundreds, and even thousands of egg masses each year. Eggs are laid at the water surface attached to vegetation to keep them in a particular location. They warm up quickly to aid in development, but a strong cold snap can kill embryos that are right at the water surface. This is one of the many trade-offs made by the frogs in trying to get the advantage of greater warmth.



Depending on many variables, larvae hatch in about three to four weeks.

Egg masses are colonized by the green algae, *Oophila amblystomatis*. This symbiotic algae provides oxygen to the growing larva and consumes nitrogenous waste.



Larvae graze the algae in the mass for a couple of days, and then move off into the pool to continue development.



Within six weeks or so, larvae are looking quite frog-like and reaching development stages that prepare them for metamorphosis.



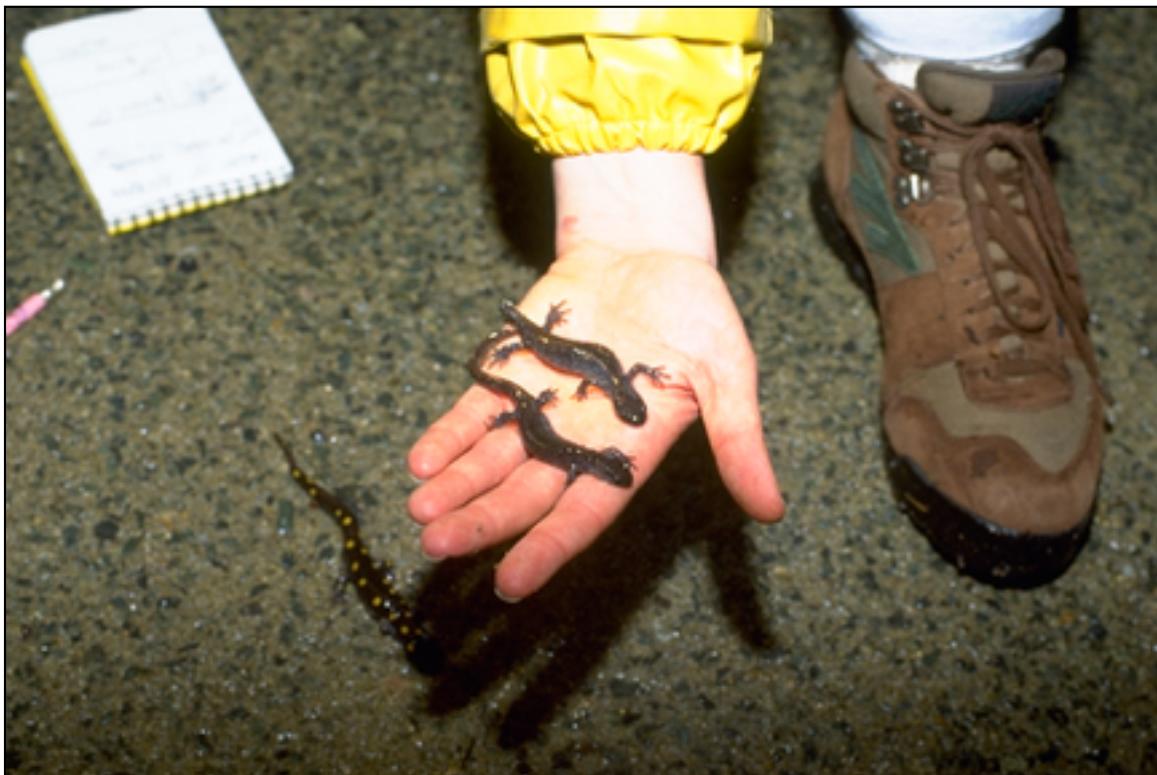
Wood frogs exchange the freedom from fish predation for the risk of the pool drying out before a cohort of frogs reaches metamorphosis.



Sometimes an entire cohort fails because the pool dries too rapidly, but if the pool holds water long enough more often than not, it will function as a vernal pool.



The Spotted Salamander, *Ambystoma maculatum*, is the Bald Eagle of vernal pools – our charismatic mega-fauna, so to speak. Let's look at their life history strategy.



The mole salamanders, like the Spotted and its cousin the Blue-spotted salamander pictured here, are terrestrial animals. They live in forests in small mammal burrows under ground. They migrate to their vernal pool for breeding starting with the first “warm” rains of spring, when night time air temperatures are about 40 degrees and we have a good rain going.

They migrate hundreds of meters, and will often need to cross roads to reach their breeding habitat. Road mortality is one of the most important factors affecting amphibian populations and has a negative impact on population dynamics.



Spotted salamanders engage in a ritualized mating activity known as congressing. It is an amazing phenomenon to witness, with dozens of salamanders cavorting late at night in the rain. They congress in shallow water, typically just a foot or so deep, and males produce small white mucous plugs capped with a mass of spermatozoa called a spermatophore. Females pick up sperm in their cloaca and within a day or so will deposit their fertilized eggs in the pool.



Spotted salamander eggs are distinctive and are relatively easy to see in a vernal pool. They are sometimes very clear, sometimes milky white, but these are not any different in their viability.



Within about six to eight weeks of deposition, larvae hatch out of the egg masses. Larvae have wide heads with prominent eyes, bushy external gills beside the head, and four limbs almost immediately after hatching. Salamander larvae are difficult to confuse with anything else you might find in a vernal pool in the early summer months.

Larvae are about a half-inch at hatching, and will grow to a length of two to three inches before metamorphosis.



Evaluating vernal pools typically means getting in the pool!

Equipment:

- Boots
- Net
- Polarized glasses
- Camera.

Surveying a vernal pool for evidence of indicator species often requires getting in the pool and some basic equipment.



By late-summer and early fall, salamanders begin their metamorphosis, and will leave the pool for the terrestrial environment. Salamanders become sexually mature in two to five years, and will return to their natal pool to breed most every year of their adult lives, which is 12 to 15 years in the wild.

Mole salamanders show high fidelity to their natal pool; the vast majority of a population of salamanders will return to the pool they came from to breed.



Blue-spotted and Jefferson Salamanders (the Jeffersonianum-complex salamanders) exhibit a life history strategy that is fairly similar to Spotted Salamanders with the exception of the group congressing.

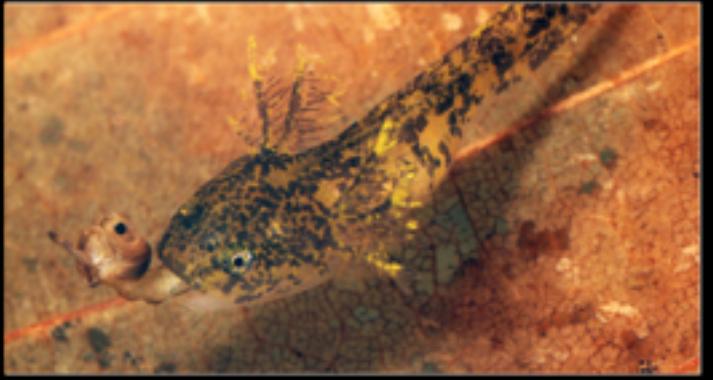
Marbled Salamanders (*Ambystoma opacum*), on the other hand, have a rather different strategy. They breed in the late-summer and fall. They arrive at a dry vernal pool and the female broods the nest until the water arrives. Eggs hatch and larvae over-winter, which gives them a competitive advantage over their spring-breeding cousins.



Marbled salamander larvae can be quite large by the time wood frogs and spotted salamanders are hatching, giving them a competitive advantage and putting them higher in the food web of a vernal pool.



All the salamanders feed upon insects, which they devour in great numbers, and hence their utility cannot be questioned."
- D.H. Storer, 1839



In healthy vernal pool ecosystems, mosquitoes tend to be a minor annoyance rather than a public health concern because of the amount of other animals that prey upon them.



Vernal pools are detrital systems; the energy that ultimately produces all of those salamanders and frogs starts as leaves falling into the pool from surrounding trees. Organisms such as this isopod, do the important work of shredding large leaves into smaller and smaller pieces, beginning the decomposition process and release of that stored energy into the pool.



Vernal pools have incredible diversity and richness of organisms. This caddisfly larva builds a case around its body that protects it from predators throughout its larval development.



After pupating, the caddisfly, which is moth-like when adult, leaves behind its case. Finding these in a dry pool can help indicate that an aquatic ecosystem exists.



Mollusks, such as fingernail clams and the spiral-shaped amphibious snail, are often found in vernal pools. When the pools dry and most of these individuals die, the shells are left behind and can be found in dry pool basins along with caddisfly cases.



There is amazing diversity of wee beasties in vernal pools, including daphnia, copepods, and ostracods...



Clam shrimp, including the exceptionally rare American Clam Shrimp (right)...



And hydra!



When is moss not moss?



When it's the Ghost Moss Animal, a colonial bryozoan that is very uncommon and very little-known.



While vernal pools are special because of their lack of fish predators, they are not safe places free of predation. Here, a Giant Water Bug sucks the juices (and life) from a frog tadpole it's caught with its large, raptorial fore-limbs.



Dragonfly larvae will often be found in vernal pools later in the summer, especially in pools that hold water longer.



Predaceous diving beetle larvae, and a host of other invertebrate predators make vernal pool life a little dangerous for amphibians.



Nonetheless, vernal pools can be amazingly productive ecosystems, where thousands of amphibians leave the pool to head out into the surrounding landscape. Vernal pools produce remarkable amounts of biomass that support animal populations at the landscape scale.



Amphibians feed birds, mammals,



Snakes, turtles. The ecological interactions of vernal pools extend well beyond the boundaries of the pool itself, making vernal pools an exceptionally important habitat for the protection of wildlife populations.



Vernal pools are quite diverse and have a wide range of physical characteristics. This small, isolated pool is a classic kettle hole depression pool.



Larger pools that hold more water will often support a variety of plants. Shrub such as buttonbush, highbush blueberry, and winterberry are very common in vernal pools.



Pools that hold water for very long periods will often support rich plant communities with grasses, floating leaved plants, and shrubs growing in them.



Under the right conditions, ringed plant zonation can develop in vernal pools, where plants that have different hydroperiod preferences grow in concentric rings within the basin.



Vernal pools can occur in the dune strand, where freshwater lenses pond in the dunes. These support a different fauna than forested vernal pools. This pool is in Truro, MA.



We often find vernal pools among the pit-and-mound topography of extensive swamps. As water levels recede in the late spring, depressions that hold water well into the summer resolve, and will be home to salamanders and frogs.



River oxbows and old meander scars quite often function as vernal pools after being separated from the river course. These may get a dose of fish every so often with flooding events, but they will dry out and kill off any fish that find their way in.



Not all vernal pools are natural basins, such as this CCC-built back-water pool on Spot Pond Brook in Stoneham. This is a popular spot to see a lot of salamander breeding activity in the early spring.

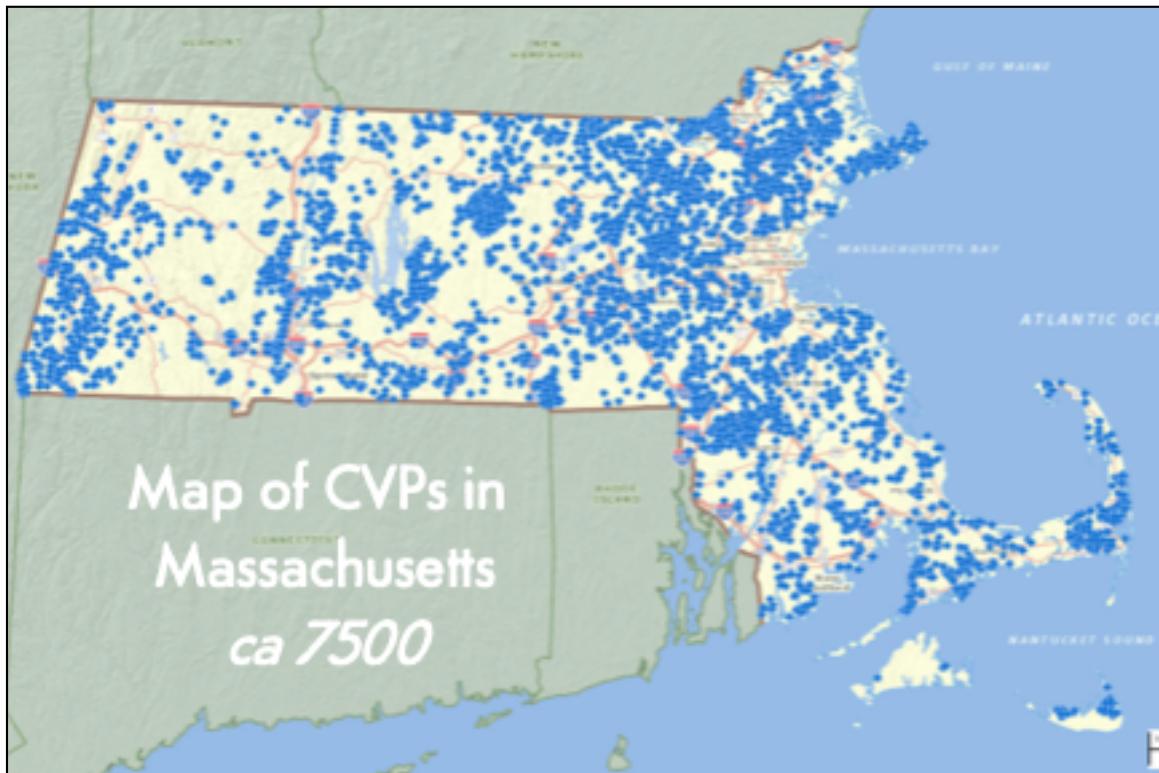
The very pools, now, soon after the ice has melted, so transparent and of glassy smoothness and full of animal and vegetable life, are interesting and beautiful objects.

— *Henry D. Thoreau, 16 April, 1855*

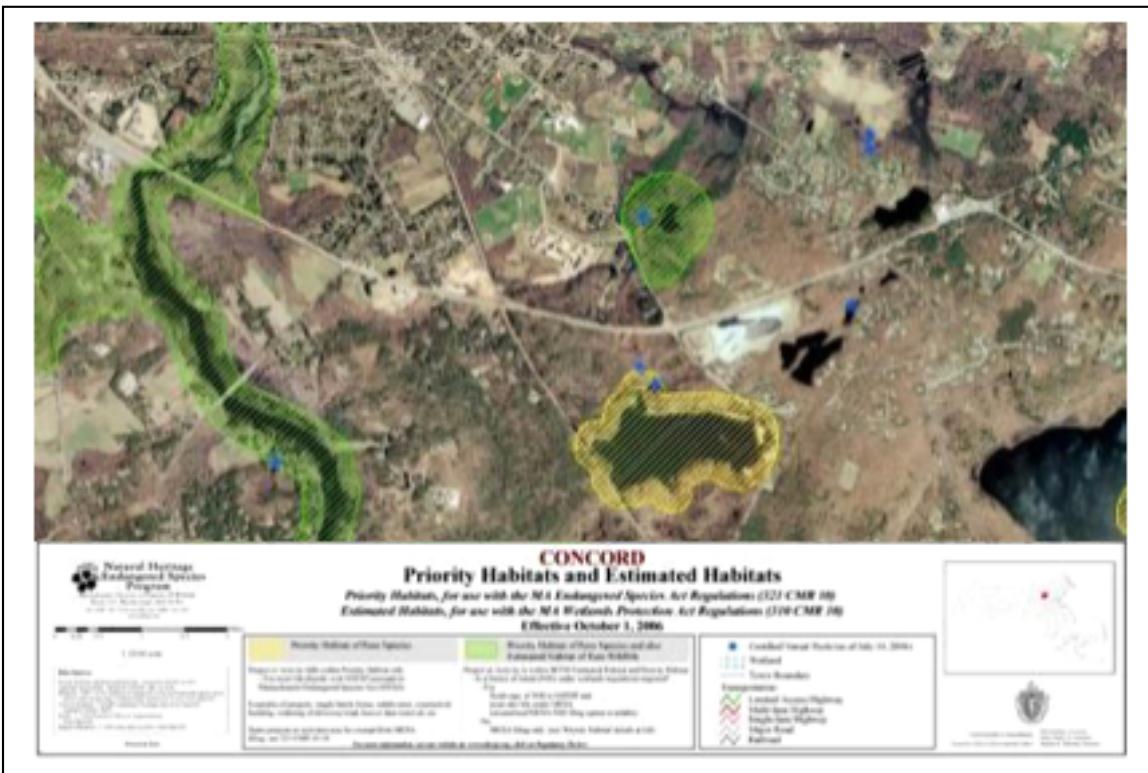
While vernal pools are highly variable year-to-year, the basins that function as vernal pools are quite predictable over time. This small pool is located adjacent to Henry Thoreau's house site at Walden Pond. He certainly would have listened to the wood frogs and peepers calling during his stay at Walden. Fort Ancient pools were dug by Hopewell culture circa 1000AD and remain functional vernal pools today.



Vernal pools are protected under the Massachusetts Wetlands Protection Act. Our first step is finding vernal pools. Vernal pools are not handled the way that other wetlands are; the proponent isn't required to identify vernal pools (if not certified prior to a project proposal). It's often up to the Commission to ask the question and evaluate whether vernal pools exist on a parcel.



First step, looking for CVPs. Certified pools are a great resource – they help you know when there are vernal pools on a project site. The number of CVPs is always growing, but it's an incomplete dataset. There are biases as well: concentrated where people have taken an interest; concentrated on public land; located on parcels that were undergoing development. CVPs are a good starting point for defining the universe of vernal pools, but only a starting point.



Any filing with the Conservation Commission must be checked against the NHESP map, which includes CVPs, to see if a copy must be filed with the state, so this is an obvious opportunity to see if there is a CVP.



Massachusetts has a process allowing citizens to document and officially certify vernal pools through Mass Wildlife. These steps can also be followed by Commissions that are trying to determine whether a wetland on a project site provides vernal pool habitat function.

Obligate Species Method

Courting adults



Egg masses



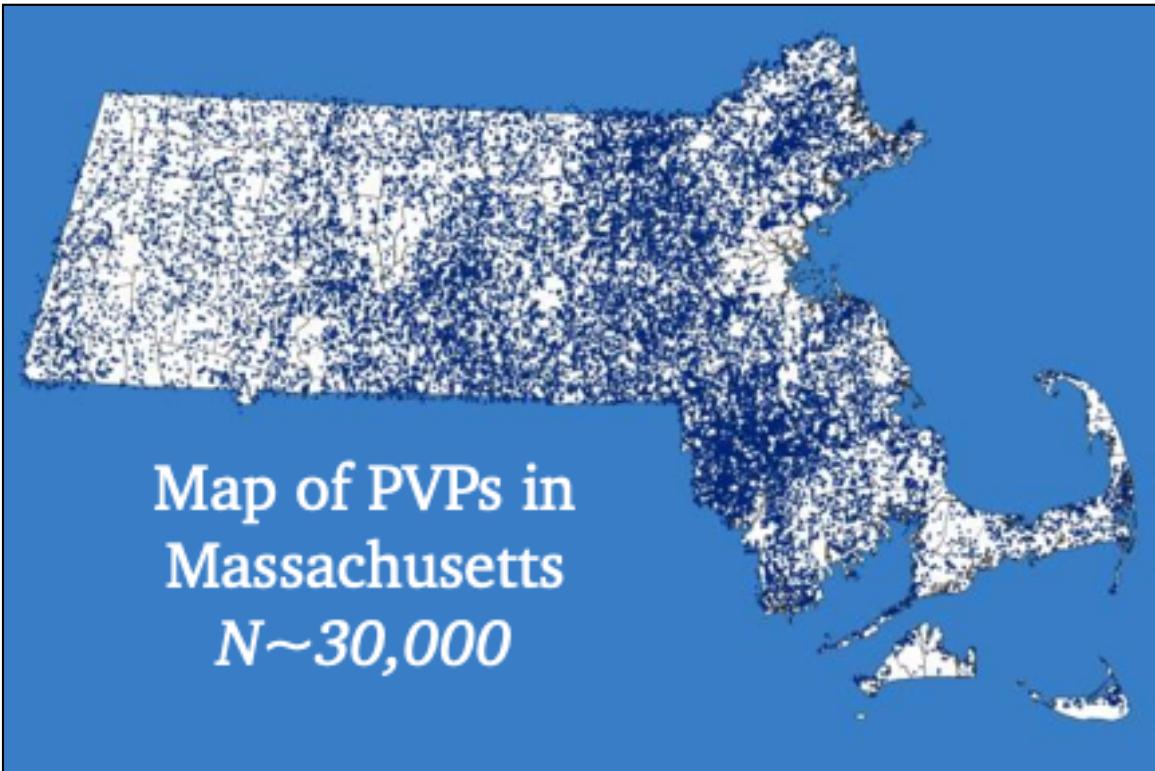
Larvae



A quick review of the obligate species method for vernal pool certification. More information is available at vernalpool.org.



The state Natural Heritage & Endangered Species Program has developed an online tool for reporting occurrences of vernal pools and rare species.



PVPs are a great dataset showing locations of vernal pools that could be identified from aerial photographs (MassGIS data). There are many more PVPs than CVPs, but this is still not the complete universe.

**Vernal pools may be
protected even if
they are not
certified.**

Important: certification is not necessary for protection of vernal pools under WPA and many local by-laws. The Issuing Authority has the discretion to protect function values present in a jurisdictional wetland for which there is no presumption of significance (310 CMR 10.53).

Commission's Discretionary Authority

10.53: General Provisions

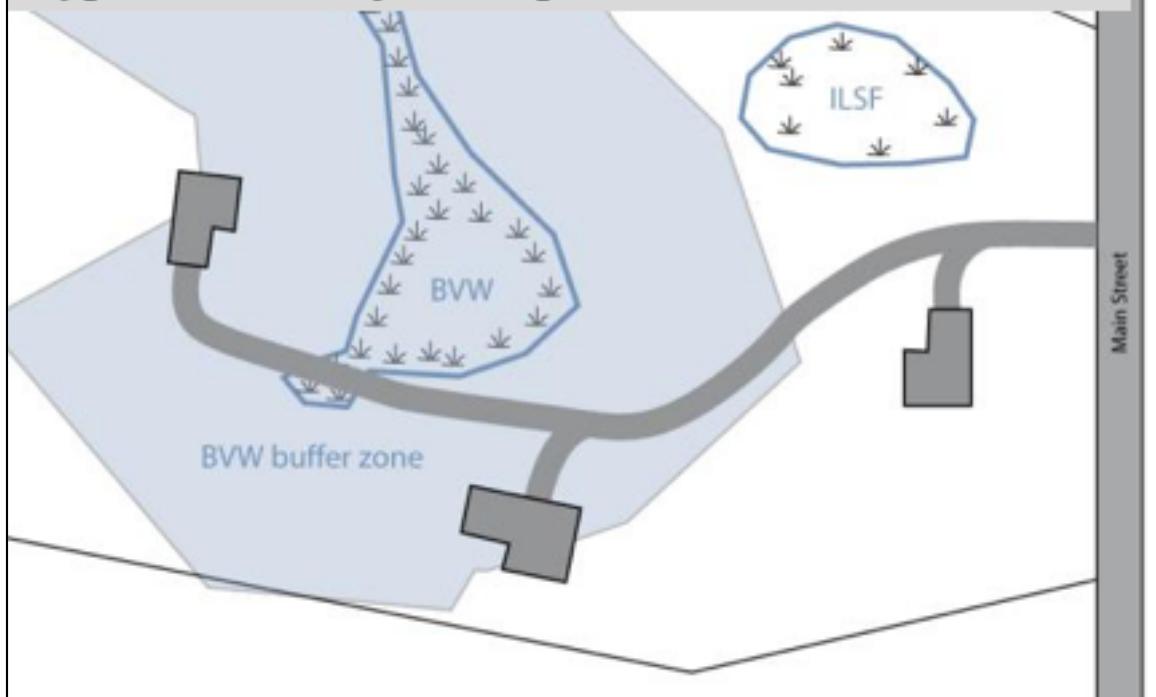
- (1) If the issuing authority determines that a resource area is significant to an interest (*ie, a functional value*) identified in [the Act] for which no presumption is stated ... the issuing authority shall impose such conditions as are necessary to contribute to the protection of such interests.

Discretionary authority at 10.53 gives the issuing authority the ability to protect a functional value that a wetland is providing even when there's no presumption for that value – the prime example here is land subject to flooding that is functioning as vernal pool habitat, where there is no certified vernal pool.

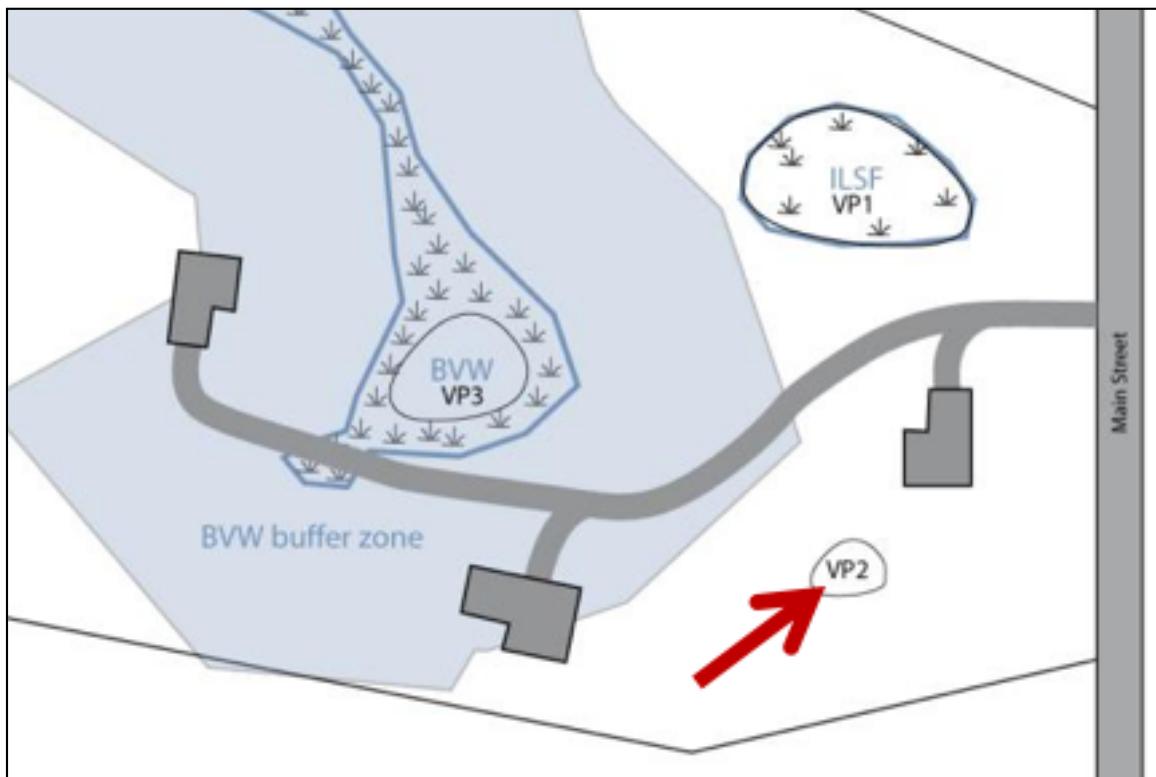


Cons coms are out on site reviewing whether or not all resource areas are correctly identified, same goes for vernal pools. The question that commissions need to be asking is: "among the jurisdictional wetland resources on this site, are there any that provide vernal pool habitat function?" After reviewing CVPs, PVPs, and a site visit, a fairly complete inventory of vernal pools should exist for a property.

Hypothetical Project Proposal

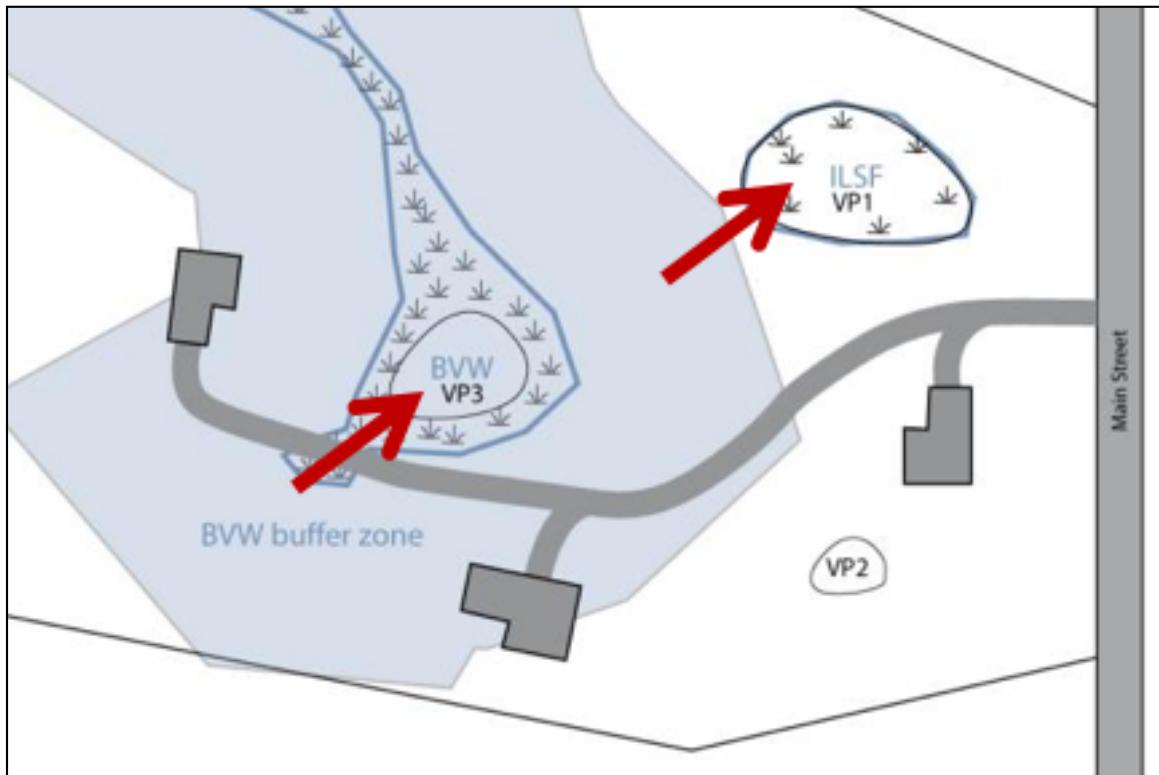


In this hypothetical project proposal, a modest subdivision plan comes in, showing two jurisdictional wetlands with a small proposed wetland impact and associated buffer zone work. The plan shows a Bordering Vegetated Wetland (BVW) and an Isolated Land Subject to Flooding (ILSF).

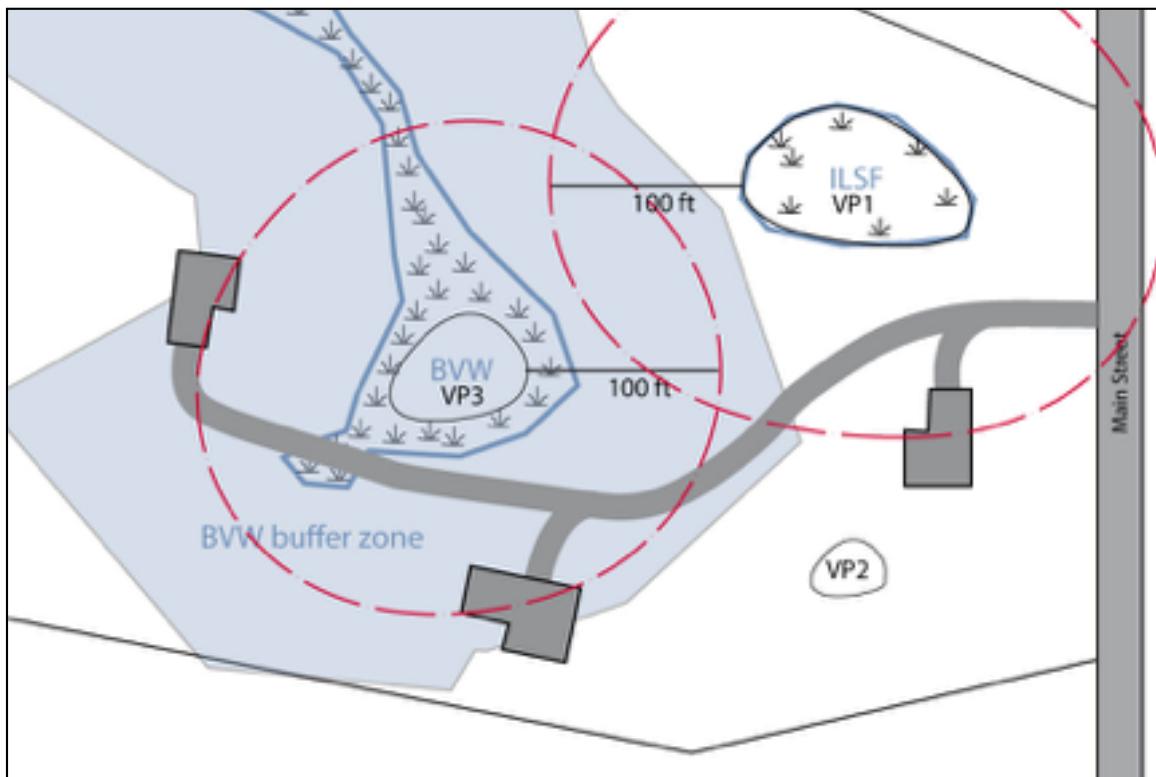


In an early review step, the Commission reviews the town's Natural Heritage map and discovers that there are three certified vernal pools on site. Two of the pools are in the jurisdictional wetlands, but a third is a small depression that does not meet minimum size requirements to qualify as an ILSF.

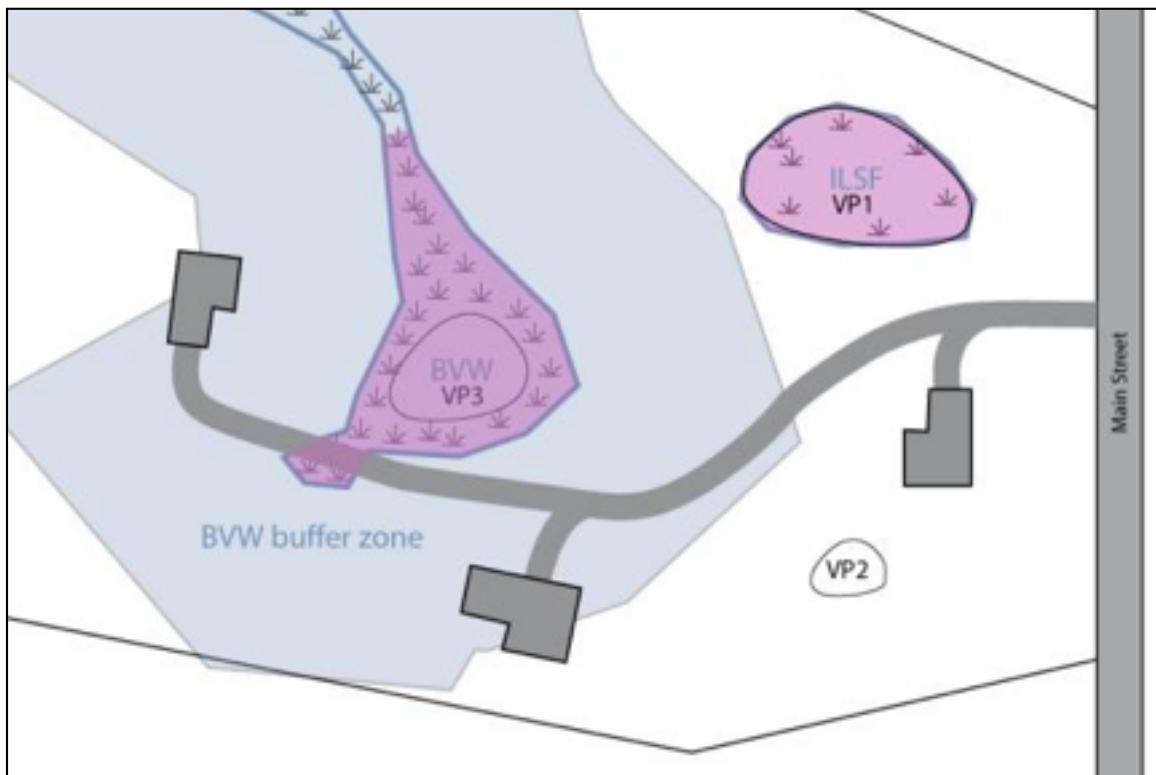
Vernal pool certification and wetland jurisdiction are two separate questions; the former does not confer the latter. VP2, a certified vernal pool, is not a jurisdictional wetland, so the Wetlands Protection Act does not provide protection for it. Title V, the Surface Water Quality Standards, and local by-laws may, but the state Act does not have anything to say about this pool.



In evaluating what resources are on site, the Commission sees that there are two Certified Vernal Pools that fall within jurisdictional wetlands. But what about the 100 feet around these vernal pools?

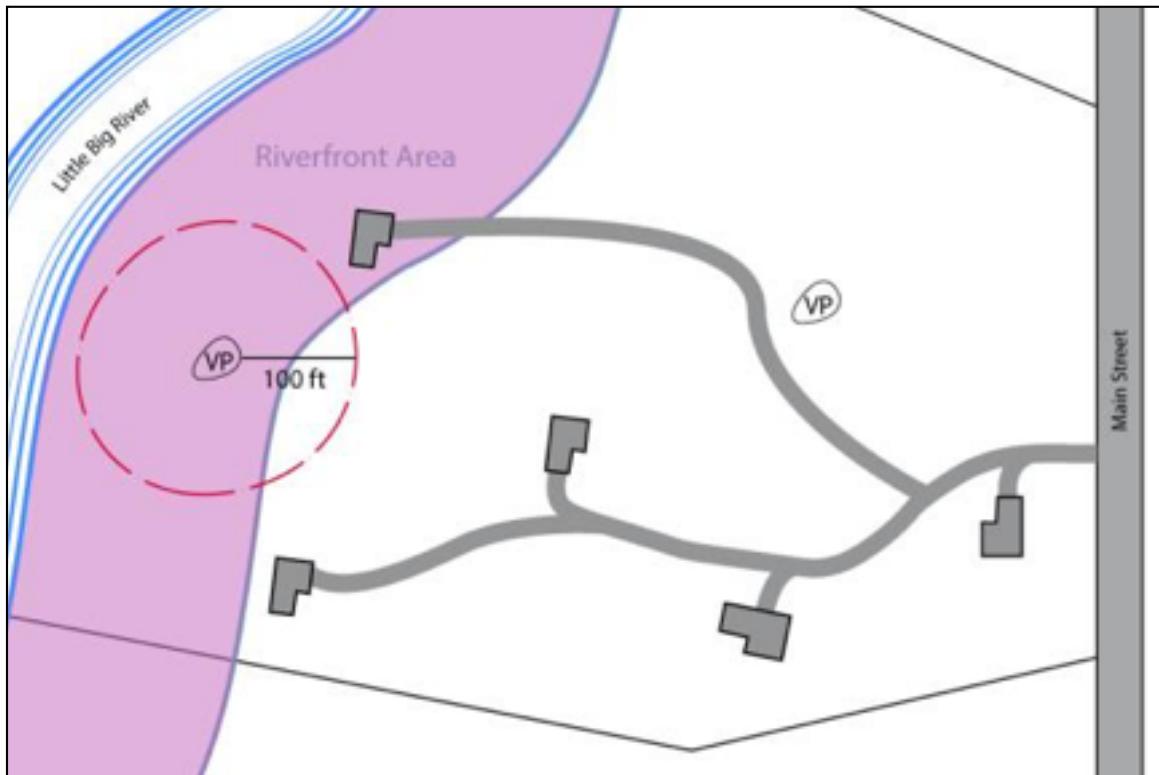


Vernal pools do not have a 100 foot buffer or no-touch zone associated with them. The definition at 10.04 says that a vernal pool is the confined basin plus up to 100 feet to the extent that such area is within the jurisdiction of the Act. So we can draw a 100-foot circle around the two vernal pools in jurisdictional wetland, but the area protected by the Act stops at the wetland flags.



On this project site, the vernal pools and their 100-foot “vernal pool habitat” is shown in pink. The performance standards addressing vernal pools only apply to this highlighted area.

It's important to note that performance standards are written only in the Land Subject to Flooding and Riverfront Area sections of the regulations. When vernal pools occur in other kinds of wetlands, as in this example where a pool occurs in BVW, the performance standards at Land Subject to Flooding can be applied to the pool in BVW. This was adjudicated in 1997 in JANCO v. Foxboro.



The only situation in which we can consider the terrestrial, non-breeding habitat needs of animals using a vernal pool is when Riverfront Area provides that habitat. The Rivers Protection Act (section 10.58 of the Regulations) defines all area, including terrestrial land, within 200 feet of a perennial stream as jurisdictional area.



We can do a lot in the immediate term to minimize impacts to vernal pools in wetlands permitting. Ensuring that invasive species do not become established following development is important. Purple loosestrife is a commonly occurring invasive exotic species that affects many wetlands, including vernal pools, following development. Long term monitoring, on the order of 3 to 5 years is necessary.



Preventing trash dumping and require clean up of existing trash as part of permits.



Silt fencing is important for protecting wetlands during construction, but it is very effective at stopping animals from moving about the landscape. After work is completed, silt fencing must be removed.



Roads take a heavy toll on wildlife, so reducing lane miles is a key step in minimizing development impacts. Road crossing structures, in some circumstances, are appropriate to consider.



Work with local boards to get away from the vertical granite curbing requirements. They are very effective at keeping animals in the road bed, leading to mortality. If curbing must be this variety, try to get wildlife curb cuts installed every 100 feet or so, just to give animals that are trapped in the road the chance of escaping.



There are wetlands, vernal pools, and forest.



Proposal initially came in with standard subdivision plan, which would have obliterated the entire site.



After working with the local commission, NHESP, and proponent arrived at a solution that had a much lower impact, higher number of units, half the roadway, etc.



Vernal pools are a fantastic way to engage with your community in the goals of appreciating and protecting our natural resources.



Road crossing sites where people can help amphibians get across roads on migration nights in early spring are exciting. Be cautious and manage risks around people out on roads at night!



As we have criss-crossed the land with roads, we have cut between vernal pools and non-breeding, upland habitats. This means that, as frogs and salamanders migrate to their breeding pools, they often must cross roads where tremendous mortality can occur. In some places, roads are temporarily closed during the early spring migrations on rainy nights.



Witnessing a salamander congress is rather incredible. It can hook people on the importance and wonder of these little jewels of the forest.



Thank you

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