Conservation and Management of Vernal Pools/Temporary Wetlands

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Ephemeral Pool Jargon

- Temporary ponds
- Ephemeral pools
- Springs pools
- Woodland pools
- Semi-permanent ponds
- Fishless ponds
- Salamander ponds
- Intermittent woodland pools
- Seasonal forest ponds
- Seasonally astatic waters
- Geographically isolated wetlands
- Vernal pools
- Specifics- Carolina Bays, Karst ponds, Citronelle, prairie potholes, playa lakes, etc.

Ephemeral Pools Defined

- Confined basins with no continuously flowing inlet or outlet, and no surface-water connection with permanently flooded water bodies
- Typically small and shallow
- Fill seasonally; dry annually or every few years
- Typically lack established fish populations

Pool Origins

- Formation of pools is largely attributed to glaciation (kettle holes)
- Flood scour (former stream channels)
- Perched basins on impermeable substrate
- Human excavation over time (quarries, farm ponds, detention basins)

Woodland Context

- Occur in or next to forests or other wooded areas
- Most pools are heterotrophic- energy comes from detritus and not direct photosynthetic production
- Trees contribute to nutrient cycling, temperature regulation, and flood duration.
  - Canopy cover – shading moderates water temperature and provides annual input of leaves
  - Can limit evaporation
  - Contribute to drawdown during the growing season

Isolation

- Degree of physical isolation varies
  - completely surrounded by upland forests
  - fed and drained by intermittent streams
  - spillover flooding from adjacent water bodies
  - hydrologically connected by groundwater
  - BUT pools **DO NOT** have continuous surface water connections to other waters during most of their biologically active season

No permanent connections!

Pool Size and Depth

- Span a range of surface area and depth but generally small and shallow compared to permanently flooded ponds and lakes
- Large range of sizes from small rock basins to large vernal lakes covering hectares
- Because they are shallow, water temperatures increase rapidly between spring and summer stimulating growth rates of animals in pools

Pool Size and Depth

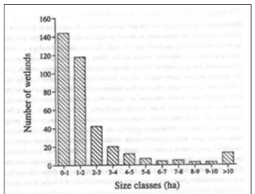


Figure 1. Distribution of natural depression wetland sizes (n = 371) from the Savannah River Site on the upper coastal plain of South Carolina. The lower limit of detection from geographic information system data was 0.2 ha.

Semlitsch and Bodie (1998)

Vernal Pools in the Landscape

Table 8. Maximum Size and Depth Data for Sixty-Four Vernal Pools in Massachusetts

	Surface Area (m^2)	Depth (cm)
	All Pools (N = 64)	All Pools (N = 50)
Range:	10–22,500	20–200
Mean:	1,433	69
Median:	315	60
	Semi-Permanent Pools (N = 10)	Semi-Permanent Pools (N = 8)
Range:	177–22,500	70–200
Mean:	5,590	110
Median:	1,898	93
	Annually Drying Pools (N = 40)	Annually Drying Pools (N = 32)
Range:	10–3,600	20–150
Mean:	584	62
Median:	300	55

Data from Colburn, unpublished data

Colburn (2004)

Hydrology

Vernal Pools

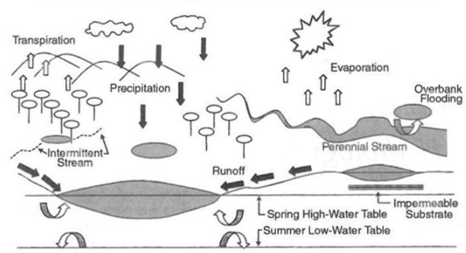


Figure 3. Water enters vernal pools from precipitation, surface runoff, intermittent streamflows, groundwater, and, in some cases, overbank flooding from rivers and other water bodies. Water leaves pools through evapotranspiration, intermittent streamflows, and groundwater recharge.

Colburn (2004)

Hydrology

- During normal rainfall years in Southeast, pools contain water during winter (Nov-Feb) and spring (Mar-May)
- Variable hydroperiods; few days to months but usually 2 – 3 month minimum
- May have a single annual wet phase or fill and dry many times a year

Classification

- Seasonal palustrine wetlands

Colburn (2004)

Hydrology

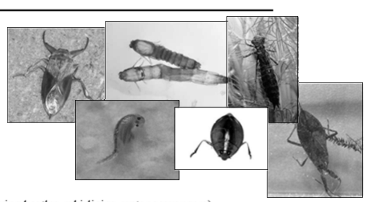
Table 2. Proposed Hydrologic Classes of Vernal Pools and Average Duration of Flooding

Hydrologic Class	Average Duration of Flooding (Months)
Short-cycle, spring-filling pools	3 – 4
Long-cycle, spring-filling pools	5 – 8
Short-cycle, fall-filling pools	7 – 9
Long-cycle, fall-filling pools	9 – 11
Semi-permanent pools	36 – 120

Animal Communities
Invertebrates

Common Invertebrates of Vernal Pools

Fairy shrimp
Clam shrimp
Tadpole shrimp
Ostracods
Copepods
Water fleas
Annelids (leeches)
Platyhelminthes (flatworms)
Nematodes (roundworms)
Oligochaetes
Snails
Fingernail clams
Caddisflies
Coleopterans (predaceous diving beetles, whirligigs, water scavengers)
Hemipteran (backswimmers, water boatmen, giant water bugs, waters scorpions)
Odonates (damselflies and dragonflies)
Dipterans (mosquitos, midges, craneflies, horseflies)



Animal Communities
Avifauna

- >85 avian species documented to use vernal pools (Silveira 1998)
- Greater abundance, richness and diversity near pond than in surrounding forested controls due to higher invertebrate abundance (Scheffers et al. 2006)
- Food source
  - Emerging aquatic insects from pond
  - Terrestrial and sub-terrestrial insects from moist soil and leaf litter surrounding ponds
  - Food from fruit-bearing trees
  - Insects from dead trees
  - Other aquatic organisms (salamander eggs, eaten by wood ducks)

Animal Communities
Amphibians

- Amphibians (salamanders, anurans (frogs and toads), caecilians)
  - Skin is moist and very permeable to water and gases; many breathe through their skin
  - Almost all are dependent on some form of aquatic system to complete their life cycle
  - Most lay unprotected eggs directly in water or need a very moist terrestrial microsite (e.g., decaying log)
  - Most do not do well in dry or hot conditions; toads (*Anaxyrus* spp.) may be the most well adapted for those conditions

Amphibian Declines

- Over the past several decades, amphibian populations have suffered global declines including the extinction of many species
- Reasons for decline:
  - HABITAT LOSS AND FRAGMENTATION
  - Introduced species (e.g., cane toad, bullfrog)
  - Contaminants, especially biocides
  - Acid precipitation
  - Disease (probably opportunistic on stressed populations)
  - Increased UV-B radiation

Benefits of Amphibian Populations

- Indication of environmental quality – when their populations start declining, we need to take notice
- Key role in energy flow and nutrient cycling as predators and prey.
- Pest control – have been used for control of insect pest species (marine toad and sugar cane beetle)
- Pharmaceutical uses - skin is loaded with chemicals for defense and other purposes (painkillers, antibiotics)

Temporary Wetlands for Pond-Breeding Amphibians

- Distinct species assemblages including many threatened and endangered species that only breed in temporary ponds, such as Flatwoods salamander (*Ambystoma cingulatum)* and Mississippi gopher frog (*Lithobates sevosus*)
- Some reside year-round and return to natal ponds each year to breed

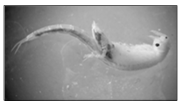
Aquatic and Terrestrial Habitat Needs

- Anuran and salamander breeding habitat
- Eggs, embryos, and larvae
- Juvenile and adult foraging sites
- Overwintering and estivation sites
- Dispersal and migration

Need Pool Proper + Terrestrial Habitat!

Obligate Species

- Vertebrate and invertebrate species that ***require*** vernal pools for all or a portion of their life cycle and are unable to successfully complete their life cycle without vernal pools (e.g., wood frog, spotted salamander, marbled salamander, mole salamander)




Ambystomatid Salamanders

(Pool-breeders collectively known as "mole salamanders")

- Habitat: Common in bottomland forests in or adjoining floodplains
  - Optimal habitat is considered to be mature deciduous forest with seasonal wetlands
  - Also occur in upland forests (hardwood, pine, or mixed forests) with suitable breeding sites
  - Breed in seasonal ponds lacking predaceous fish (larvae are palatable to fish and lack defense mechanisms)

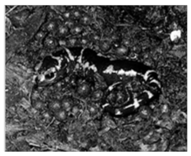


Marbled Salamander (*Ambystoma opacum*)

- One of only 2 *Ambystoma* spp. that oviposits on land
- Adults move to ponds in late summer through fall (September - November) during rainy weather
- Nest in dried beds of temporary ponds or along pond margins
- Burrow cavities in soil surface immediately below leaf litter
- Only *Ambystoma* that exhibits parental care→brood eggs – coil around clutch and turn eggs

Marbled Salamander

- Nest sites are eventually flooded as ponds fill
- Embryos develop to hatching stage 9 – 15 days after oviposition BUT do not hatch until flooded (hypoxia triggers hatching)
- Larvae metamorphose (transform) in March-April in south



Spotted Salamander (*Ambystoma maculatum*)

- Adults migrate to ponds during winter and early spring on rainy/foggy nights (December – March/April)
- Eggs deposited within the pond on twigs or aquatic plants
- Relatively long incubation period – 1 – 2 months
- Larvae hatch and transform within 2 – 4 months (mid-June)
- Slow growing larvae may overwinter and transform the following spring or summer

Mole Salamander (*Ambystoma talpoideum*)

- Adults migrate to ponds during fall- early spring (September – late March; peak in November – January)
- Eggs deposited within pool on twigs or submerged structures
- Larvae hatch and transform within 3 – 4 months
- Paedomorphism is common (alternative developmental pathway is which the organism becomes reproductively mature and maintains a purely aquatic existence, while retaining larval characteristics such as external gills and tail fins)
- Population may include both terrestrial and gilled adults

Eastern Tiger Salamander (*Ambystoma tigrinium*)

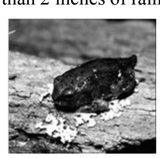
- Adults migrate to ponds during fall- spring (November through February/March in Southeast)
- Eggs deposited within pool on twigs, weed stems or submerged structures
- Larvae period of 2.5 – 5 months
- Hatch ~March/April and transform ~ June – August
- May overwinter

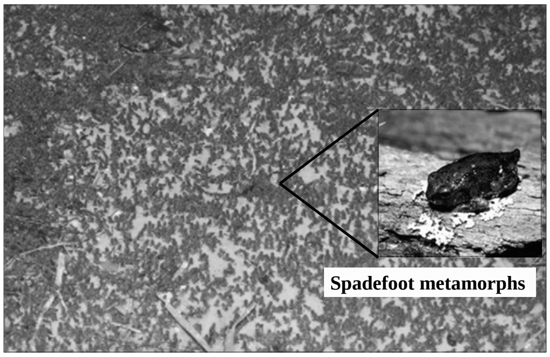
Eastern Spadefoot Toad (*Scaphiopus holbrookii holbrookii*)

- Habitat: Forested lowlands with sandy or loose soil preferred
- Behavior: Spadefoots may remain torpid underground for several weeks. They can survive enormous loss of water (over 40 percent of body weight). Can excrete a fluid that hardens the soil around them forming a compact chamber to retain moisture. Activity is stimulated by heavy rains.

Eastern Spadefoot Toad

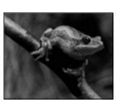
- Reproduction:
  - Spadefoot toads are "explosive breeders”
  - Breed in shallow, temporary pools formed after heavy rains
  - Hundreds of toads move to ponds within 1 – 2 nights following rain
  - There is no regular, annual migration to the breeding pools. Instead, the event is triggered by a quick drop in barometric pressure and more than 2 inches of rainfall
  - Tadpole stage: 16 – 20 days





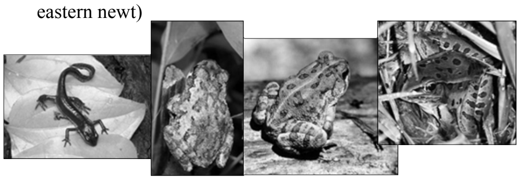
Wood Frog
(*Lithobates sylvatica*)

- Explosive breeders
- Arrive at ponds February/March
- Larval period ~145 days, transform June/July
- The majority of wood frog egg masses are deposited in a large communal aggregation
- Wood frog eggs are deposited near the edge of the pond on the water's surface where water temperature is highest
- Attached to submerged branches and herbaceous vegetation



Facultative Species

- Vertebrate and invertebrate species that ***frequently use*** vernal pools for all or a portion of their life cycle, but are able to successfully complete their life cycle in other types of wetlands (e.g., spring peeper, gray treefrog, American toad, Fowler’s toad, green frog, southern leopard frog, eastern newt)



Threats - Isolation/Connectivity

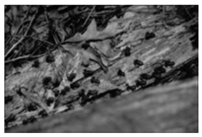
- Amphibian populations are structured as **metapopulations**.
- Populations centered on discrete breeding sites and require connectivity

(**Limited dispersal capability!**)

- Local populations persist by periodically producing large numbers of metamorphosing juveniles followed by years with little or no reproduction

("Boom or Bust" years)

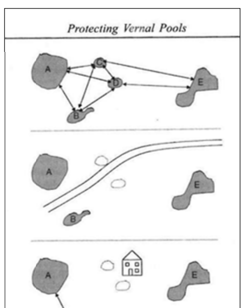
- Multiple successive years of reproductive failure due to natural conditions such as pond drying, fish predation, and drought can lead to decline and extinction of local populations.



Threats Isolation/Connectivity

Summary of terrestrial migration distances from aquatic breeding sites for amphibians. (Adapted from Semlitsch and Bodie 2003)

Species and Location	Distance in m (sample size)
Frogs	
Anaxyrus americanus, Ontario	range 23 – 480 (176)
Pseudacris triseriata, Indiana	mean = 75, maximum = 213 (9)
Acris crepitans, Illinois	range 8 – 22 (189)
Lithobates catesbianus, New York	mean = 406, mode = 1046 (22)
Lithobates clamitans, Ontario	mean = 137, maximum = 457
New York	mean = 121, maximum = 360
Missouri	mean = 485, range 321 – 570 (6)
Salamanders	
Ambystoma maculatum, Michigan	mean = 67, range 26 – 108 (2)
Michigan	mean = 103, range 15 – 200 (14)
Indiana	mean = 64, range 0 – 125 (7)
Kentucky	mean = 150, range 6 – 220 (8)
Michigan	mean = 192, range 157 – 249 (6)
New York	mean = 118, range 15 – 210 (8)
Ambystoma opacum, Indiana	mean = 194, range 0 – 450 (12)
Kentucky	mean = 30 (6)
Ambystoma talpoideum, South Carolina	mean = 178, range 13 – 287 (17)
Ambystoma tigrinum, South Carolina	162 (1)
South Carolina	mean = 215, range = 112 – 450 (4)
New York	mean = 60, range 0 – 286 (27)



Colburn (2004)

Maintain dispersal corridors!!!

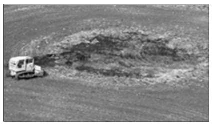
Amphibian Larval Periods
(Importance of <u>Hydroperiod</u>)

Common Name	Scientific Name	Breeding Season	Larval Period
Marbled Salamander	*Ambystoma opacum*	September - November	
Mole Salamander	*Ambystoma talpoideum*	September - March	90 – 120 d
Spotted Salamander	*Ambystoma maculatum*	December - April	60 – 120 d
Tiger Salamander	*Ambystoma tigrinum*	November - March	75 – 150 d
Wood Frog	*Lithobates sylvatica*	February	~145 d
Fowler's Toad	*Anaxyrus fowleri*	March - August	40 – 60 d
Green Frog	*Lithobates clamitans*	April - September	90 d
Southern Leopard Frog	*Rana sphenocephalus*	Throughout year	50 – 75 d
Green Treefrog	*Hyla cinerea*	March - October	24 – 45 d
Spring Peeper	*Pseudacris crucifer*	January - May	90 d
Eastern Narrowmouth Toad	*Gastrophryne carolinensis*	March - October	20 – 70 d
Eastern Spadefoot Toad	*Scaphiopus holbrookii holbrookii*		16 – 20 d

Not only do you need wetlands in close proximity but you also need a **diversity of hydroperiods** to support the amphibian community with wide ranges of larval periods!

Threats - Physical Destruction/ Hydrologic Alteration

Draining, Filling, Soil Compaction, Erosion, Development



Four-wheel drive roads and ATV trails can significantly damage bottomland habitats.

Limit mechanical site preparation and recreational vehicle use!

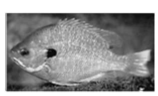
Threats – Incompatible Forestry

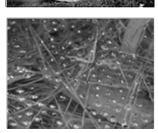
- Forestry practices have differential effects depending on species and proximity to critical breeding habitats
- Timber harvesting and site preparation removes forest canopy, increases light penetration that affects soil temperatures and soil moisture, and amounts of leaf litter, coarse woody debris, and understory vegetation
- Selective harvest generally recommended over clearcuts
- Limit mechanical site preparation following timber harvesting
- Skidder ruts and logging road pools – alter hydrology and damage habitat
  - Negatively correlated with *Ambystoma* spp.

Threats - Fish Predators

Fish species captured during sweepnet surveys in 10 ephemeral pools on Tombigbee National Forest and Noxubee National Wildlife Refuge, MS 2004-2006
(Edwards 2006).

Taxon	Common Name	Floodplain # Sites Detected	Upland # Sites Detected
Family Aphredoderidae	Pirate Perch		
Aphredoderus sayanus	Pirate Perch	1	0
Family Centrarchidae	Sunfishes		
Elassoma zonatum	Banded Pygmy Sunfish	2	2
Lepomis machrochirus	Bluegill Sunfish	1	2
Family Cyprinodontidae	Killifishes		
Fundulus olivaceus	Blackspotted Topminnow	1	0
Family Percidae	Perches		
Etheostoma nigrum	Johnny Darter	4	1
Family Poeciliidae	Livebearers		
Gambusia affinis	Mosquitofish	2	0





Amphibians breeding in temporary and semipermanent ponds are vulnerable to extirpation when fish are introduced. Public education can mean the difference between survival and extirpation of populations.

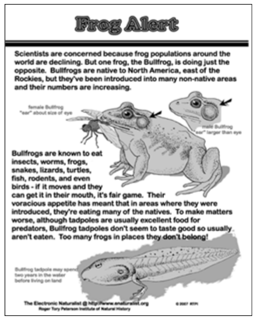
Prohibit the introduction of predatory fish into breeding ponds (e.g. bass, bluegill)!

Threats - Introduced Species

American bullfrog (*Lithobates catesbeianus*)

Large reproductive capability **>20,000 eggs/clutch!!!**

Effects on native species = predation, disease, reduced mass at metamorphosis + shortened larval periods (Boone et al. 2004)



Threats – Pollution and Pesticides

- Effects of commonly used pesticides on amphibians: delayed metamorphosis, immunosuppresion, hermaphroditism, sex reversal, and mortality
- Minimize agricultural chemicals, avoid flyovers
- Mosquito control - if absolutely necessary, use microbial larvicide- *Baccillus thuringiensis* var. *israeliensis* (Bti) is preferable to ditching, excavation, introduction of fish, or other pesticides

Isolated wetlands are NOT sinkholes for trash!!!

Threats - Roads

- Road effects
  - 2 – 18% direct mortality rates
  - Habitat fragmentation – deflect movement 51% of time
  - Petroleum runoff
  - Acoustic interference – calling rate decreases at wetlands near roads
- Possible solutions to minimize road effects
  - Drift fences
  - Culverts
  - Animal Crossing Signs
  - Roads should be > 60m from wetlands to prevent harmful edge effects

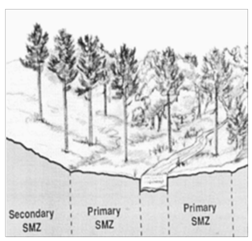
Key Policy Affecting Temporary Wetlands

- Clean Water Act - Section 404 – Permitting to regulate dredging and filling of jurisdictional wetlands
- SWANCC Decision
- Rapanos vs. United States

Isolated wetlands are not considered "Waters of the United States" (i.e. jurisdictional wetlands) and not protected under CWA unless a "significant nexus" to navigable waters exist.

Wetland Protection

- Floodplain pools – (river or stream-connected pools) may be afforded protection due to Streamside Management Zones (SMZs) on public and private lands and also from Clean Water Act Section 404
- Retention is voluntary on private lands and defined by management plans on public lands



Wetland Protection

- Tennessee Forestry Best Management Practices (BMPs) – SMZ width a minimum of 25 feet (7.6m) from the disturbed area to the stream bank for zero percent slope and 20 additional feet for each additional 10 percent of slope. This applies to both sides of the stream for a total minimum width of 50 feet (15.2m).
- This may be adequate to control water quality, but it has been shown by numerous studies that wider SMZs are required to protect much of the biological diversity on riparian areas.

State Wetland Protection Acts (WPA) and Natural Heritage Programs

- Certification of vernal pool habitat to provide essential breeding habitat for rare species
- Massachusetts – WPA regulations protect vernal pools and up to 100 feet beyond pool boundary
- Certified vernal pools must occur within a jurisdictional wetland ‘Resource Area”
- Pools that are not certified may still receive protection by local conservation commissions or the DEP
- Certification based on obligate species, facultative species, and depth, size, and vegetation

Vernal Pool Certification Obligate Species

- Breeding evidence of obligate amphibians species OR presence of fairy shrimp
- Evidence of a pool with no permanently flowing outlet
- Presence of adults
  - Full chorus for anurans or 5 + mated pairs
  - Congressing adults salamanders or spermatophores or salamanders attending nest
- Presence of egg masses
  - Total of 5 egg masses or 1 egg mass of MESA-listed salamander or nest and eggs of marbled salamander
- Presence of larvae
- Transforming juveniles

Massachusetts Vernal Pool Certification

Management Considerations

- Designation of “core terrestrial habitat” (Semlitsch and Bodie 2003)
- Protects pool proper AND terrestrial habitat
- Width of core habitat is determined by dispersal distances to summer or winter sites

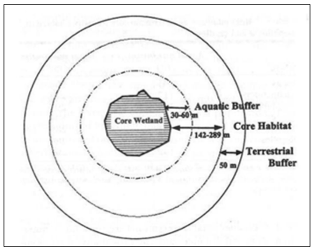
Table 1. Mean minimum and maximum core terrestrial habitat for amphibians and reptiles.*

Group	*Mean minimum (m)*	*Mean maximum (m)*
Frogs	205	368
Salamanders	117	218
Amphibians	159	290
Snakes	168	304
Turtles	123	287
Reptiles	127	289
Herpetofauna	142	289

**Values represent mean linear radii extending outward from the edge of aquatic habitats compiled from summary data in Appendices 1 and 2.*

Management Considerations

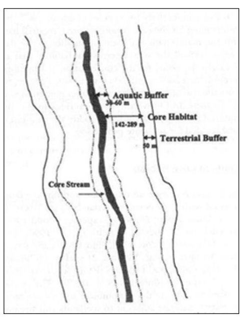
Terrestrial Zones of Protection (Semlitsch and Bodie 2003)



Aquatic buffer - Protects water resources and aquatic breeding habitat.
Core habitat - Protects life history functions of individuals in the local population.
Terrestrial buffer - Protects core habitats from edge effects due to surrounding land- use practices.

Management Considerations

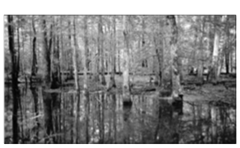
Terrestrial Zones of Protection (Semlitsch and Bodie 2003)



- Most studies recommend 25 m (80 ft.) to >100 m for different groups (small mammals, amphibians, birds)
  - Many woodland salamanders spend the majority of their life on land near streams and only return to water to breed or in drought years
  - Most salamanders remain within 30 m of streams, but 25 ft. (7.6 m) SMZs (as recommended by Forestry BMPs) do not cover this area)

Management Considerations

- Limit disturbance to ground cover, stumps, and old logs
- Retain slash and decomposing logs
- Promote insects



- Use prescribed burning in areas of longleaf pine habitat occupied by adult amphibians to preserve habitat
- Burns should be extended into the pond basins when dry in order to reduce predator build-up and maintain a high pH need by larvae (should not be conducted during the breeding season)

Management Considerations
Creation of Artificial Wetlands

- Stratman (2000) recommends the creation of artificial wetlands that are small (0.2-1.0 ha), multi-shaped, and have shallow basins (0.5-1.0 m deep).
- A diversity of hydroperiods lasting from 30 days to 1-2 years.
- Constructed ponds should occur at 100-200 m intervals.
- Gradual slope
- Shoreline vegetated with native plants
- Naturally occurring seasonal wetlands should not be disturbed in lieu of artificial ponds.

Bad example of constructed pond

EPA Vernal Pool Construction Workshop




EPA Vernal Pool Construction Workshop

Final product - Better example of a constructed wetland!