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Use of an Artificial Pond and Marshes by Amphibians and Reptiles in West Virginia

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USE OF AN ARTIFICIAL POND AND MARSHES BY AMPHIBIANS AND REPTILES IN WEST VIRGINIA

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ABSTRACT

A farm pond approximately 40 years old located in Wayne County, West Virginia was studied to determine the ingress and egress of amphibians and reptiles. In addition to the pond, 2 small marshes were also examined. The study extended from February 2003 to November 2003. The pond is approximately 36 m long and 38 m wide and is located on a south-facing hillside at 202 m in elevation. A drift fence composed of landscaping cloth was constructed to completely encircle the site. At every 5.15 m, funnel traps were positioned on both sides of the fence. Traps were checked daily during the study period.

The most common species found entering and exiting the pond were (in order of frequency) *Rana clamitans melanota*, *Notophthalmus v. viridescens*, and *Pseudacris c. crucifer*. Other species less frequently observed included *R. palustris*, *R. catesbeiana*, *P. brachyphona*, *Ambystoma maculatum*, *Terrapene c. carolina*, and *Scincella lateralis*. Ten other species were trapped while entering or exiting the pond. The most common species trapped within the marshes were *P. brachyphona*, *Pseudacris c. crucifer, Bufo americanus*, and *Hyla chrysoscelis*.

This is the first extended study of amphibians and reptiles in an artificial pond in West Virginia and demonstrates that farm ponds can provide habitats for reproduction and foraging for many species. With the rapid loss of natural pools and ponds due to habitat alterations, artificial aquatic systems play an important role in the preservation of amphibians and reptiles in the central Appalachians.

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INTRODUCTION

Purpose of Study

The primary purpose of this study was to determine the phenology of amphibians and reptiles in an artificial pond. In addition, one small marsh located approximately 100 m southwest of the pond and a large marsh located approximately 700 m northwest of the pond were examined. Data were collected daily from February 2003 thru November 2003. The objectives of this study were to: 1) determine community structure 2) establish seasonal activity and 3) determine if there is a difference in types of species present between habitats.

It is uncertain when this pond was constructed but it is known to have existed since 1962. The pond was stocked with large mouth bass, *Micropterus salmoides*, around 1990. The pond also contains bluegill, *Lepomis macrochirus,* which are of unknown origin. The last time it was used as a source of water for livestock was in 1999. The surrounding upland forest was logged in 2000. Since that time it has remained relatively undisturbed with the exception of an occasional fisherman.

Although there have been many studies performed on individual amphibian and reptile species and species complexes that use ponds or marshes as habitat, this is the first documented long-term research study conducted on the phenology of farm ponds in West Virginia.

Further importance of this study is that the information gleaned can be used by any number of sources. Regulatory agencies, scientists and land owners can use this data to make informed decisions to create or alter potential or existing sites that serve or could serve as suitable habitat. In an era when amphibian declines concern many biologists, and the importance of wetland conservation is steadily coming to surface, information that phenology studies provide is invaluable. Paton and Crouch (2002) believe regulators will find phenology data useful and that similar data should be gathered in other parts of North American since phenologies vary with region and latitude.

MATERIALS AND METHODS

Site Descriptions

The site is located near Prichard, West Virginia in Wayne County (Fig. 1). The main purpose of the pond construction was to provide a water supply for livestock. It is fitted with an in and out flow mechanism to regulate water levels. The pond has a southern aspect and an elevation of 202 m (Fig. 2). Its length is approximately 36 m from the dam to the apex in the north end, where an intermittent steam provides its main water supply. The maximum width, which is directly against the dam on the south end, is approximately 38 m. The water inflow pipe that regulates water level is located on the western side of the pond approximately 1 m north from the dam. The pipe is inset 1 m from the western edge of the pond. These measurements vary due to fluctuating water levels. The pond is accessible via an old logging road and has remained undisturbed for approximately eight years.

Woody plants on the western hillside consists primarily of oak and hickory forest interspersed with pawpaw, flowering dogwood, red maple, slippery elm, ironwood, spicebush, and sycamore. Black willow and tulip poplar grow on the dam. The eastern side of the pond consists primarily of herbaceous plants. These plants include representatives from the Families Anacardiaceae, Balsaminaceae, Cannabinaceae, Compositae, Cyperaceae, Gramineae, Juncaceae, Labiatae, Salicaceae, Scrophulariaceae, Scirpus, Solanaceae, Typhaceae, Onagraceae, Polygonaceae, and Polypodiaceae. The most prevalent ground cover along the bank of the pond was *Microstegium vimineum,* an invasive grass.

Marsh 1 is located approximately 700 m northwest of the pond (Fig. 3). It is roughly triangular shaped and located in a depression between a farm road and a large woodpile that lies at the edge of an oak-hickory forest. The marsh measured approximately 30 m long from north to south and 15 m across at the widest point from east to west. A ditch borders the marsh approximately 0.3 m deep that lies on the eastern side between the road and the marsh. The marsh consisted of herbaceous plants. It was dominated by Gramineae and Juncaceae but also consisted of plant families such as Compositae, Cyperaceae, Leguminosae, and Typhaceae.

Marsh 2 is located approximately 100 m southwest of the pond (Fig 4). It is on the edge of the old logging road and is located northeast of a small, deserted barn. The marsh is approximately 10 m long from northwest to southeast and is approximately 5 m across. The marsh is 25 m from the forest edge and is dominated by plant families Gramineae, Juncaceae, and Compositae.

Capture Methods

A drift fence, 125 m long, constructed of landscape cloth manufactured by DuPont was placed around the perimeter of the pond. Approximately 15 cm of the fence was buried in the ground to prevent movement of animals underneath. The cloth was stapled to wooden stakes spaced every 1.8 m apart. One hundred-eight funnel traps were set in groups of four, two placed on either side of the fence facing opposite directions (Fig. 5). The sets were spaced 5.15 m apart. The total length of the individual sets measured 1.7 m from the outer edge of the wire funnels. A gap was allowed between traps to allow space to open lids in order to check the traps.

Traps were constructed of a wire mesh funnel placed into a square hole that was cut into the back of either 1 gallon plastic pails or the side of 5 gallon plastic buckets. The funnels were secured with zip ties. Lids were fastened by bungee cords and a moistened natural sponge was placed in each bucket to keep the trapped animals from drying out. The wire mesh funnels were 43 cm in length and 18.5 cm high by 18.5 cm wide at the mouth, tapering down to 7 cm. Holes were drilled in the buckets to accommodate landscaping staples so the traps could be affixed to the ground. Openings of the funnels were also stapled to the ground via landscaping staples to ensure that the animals could not crawl underneath the traps. The side of the funnels, that had contact with the drift fence, was also stapled to prevent animals from going between the trap and the drift fence.

Six minnow traps were placed in the pond approximately 0.5 m from the bank. Three traps were placed on the east side and three on the west side. They were anchored by 1.8 m of baling wire to allow for fluctuation of the water level.

Minnow traps were also placed in the marshes. Three minnow traps were placed in Marsh 1. One was located at the north end and two were set in the deepest portion in the southern section. Marsh 2 had one minnow trap, which was placed in the center.

Dip netting using a D-net, hand capture, fishing line with baited hooks and hoop nets were techniques also used. The hoop nets were constructed of 3 galvanized steel hoops, 0.75m in diameter, 1.8m in overall body length with a funneled slit opening of 0.5m wide. However, these methods were not used as consistently as the minnow traps and funnel traps.

Biological Data

All traps were checked every 24 hours. Two individuals of each species captured were chosen at random and measured. Sex of each individual was determined when possible. Mass in grams was determined by using a 30 g and a 20 kg scale manufactured by Pesola, and a 100 g scale manufactured by Homs. Smaller individuals were placed in a zip lock bag with the scale attached to the top and larger individuals were placed in a snake bag or citrus bag. The size of the individual was the determinate in scale selection. Specimens were measured using a 150 mm plastic caliper manufactured by Dial Max. For larger individuals a 40 cm stainless steel caliper manufactured by Haglof was used.

The measurements taken varied with the morphology of the species caught. For all salamanders, mass, total length, snout-to-vent length, and cranial width were taken. In addition to these measurements, tail height was also measured on terrestrial and aquatic *Notophthalmus v. viridescens.* Mass was not taken on emerging *N. v. viridescens* red efts because they weighed less than one gram. Measurements for adult toads and frogs included snout-to-vent length, cranial width, nose to eye length, snout length, width between nostrils, distance between eyes, tympanic membrane height and length, eye height and length, tibia length, and thumb width and length. Thumb width and length were not taken on *Pseudacris branchyphona* or *Pseudacris c. crucifer* due to their small size. Mass, total length, snout-to-vent length, top and bottom fin height and total tail height were taken for tadpoles. Subadult measurements were the same as the adult anurans with the exception of individuals with the absence of tympanic membranes and presence of a tail.

Reptile measurements included mass, plastron width and length and carapace width and length for turtles, total length and snout vent length for snakes and total length, snout-to-vent length, and cranial width for lizards.

Environmental Data

Environmental data was collected daily at 2 sites at the pond. Site 1 was located at the south end of the pond on the dam and Site 2 was located at the apex of the pond.

Water temperature and air temperature were measured with Environ Safe thermometers that had a range of -5° C to 50° C. Soil temperature was taken 30 cm from the water line and 122 cm from the water line at a depth of 3 cm. Soil thermometers, manufactured by Reotemp, had a range of -10° C to 110° C. The pH of the water was taken with pH meters manufactured by Oaklon instruments and measured pH to 0.1. Relative humidity was taken with a Digital Max/Min Thermohygrometer manufactured by Thermo-Hygro. Precipitation was measured with a rain gauge to the nearest centimeter. The gauge was manufactured by Tru-Chek, and was affixed to a tree approximately 1 m from the water line. A stake marked in decameter increments was used to calculate water depth. Date and time was recorded as well as observations of the current weather conditions.

Statistical Analysis

An analysis of variance using the SAS software was utilized to run multiple linear regressions in examining environmental correlations and movement of species. Sigma Stat statistical software was used to run Mann-Whitney rank sum tests and t-tests to analyze morphometric data, segment capture comparisons, and entering verses exiting captures.

SPECIES ACCOUNTS

Introduction

Species accounts are listed in order of most to least captures with amphibians listed first. Reptiles are listed last since the number of captures is significantly less than amphibians. The order reflects the combination of both pond and marsh captures for simplicity.

The captures of crayfish were documented originally as a side note. Their species identification and sex determination was not held as a priority since the focus of the study was on amphibians and reptiles. Three species were identified near the completion of the study and their descriptions are listed after the reptile specie accounts.

Amphibians

Notophthalmus v. viridescens

Notophthalmus v. viridescens, the Red-spotted Newt, has a range that includes the eastern United States and southeastern Canada (Johnson 2002). It is found statewide in West Virginia. The total length may be approximately 102 mm for aquatic adults (Green & Pauley 1987). *Notophthalmus v. viridescens* lacks costal grooves and has cranial ridges. *Notophthalmus v. viridescens* has three primary stages beginning at the aquatic larval stage, the eft stage, which is a terrestrial sexually immature subadult, and the sexually mature adult, which is primarily aquatic. Terrestrial stages have rough, glandular skin (Green & Pauley 1987) that serves as protection from desiccation. After transforming from the larval stage distinctive red spots run laterally which is conspicuous through the remainder of the individuals life. The dorsal color of the eft is primarily a bright red. When reaching adulthood the dorsal color ranges from a yellowish olive to bright green. Ventral color is typically lemon yellow with scattered black dots (Green & Pauley 1987). Males are differentiated from females by the presence of enlarged horny excresences on the interior of the hind legs (Green & Pauley 1987).

Notophthalmus v. viridescens was found in abundance at the pond.

Rana clamitans melanota

The range of *Rana clamitans melanota,* Northern Green Frog, extends from southern Ontario east to Newfoundland, and then south to North Carolina and west to Oklahoma (Behler & King 1979). It is found throughout West Virginia in all elevations (Pauley 1993). The snout-to-vent length is approximately 103 mm long for adults. Dorsal color varies from brownish to green and may also have irregular dark spots (Pauley 2001). Ventral color is white and flecked with grayish spots. *Rana clamitans melanota* has large tympanic membranes with dorsal lateral folds that run above them. These dorsal lateral folds extend two-thirds the length of their body (Pauley 2001). Males differ from females by their smaller size and swollen thumbs during breeding season.

Calls may begin in April and sound akin to the low tune picks of an out of tune banjo (Pauley 2001). Breeding can occur in a variety of aquatic habitats such as streams or ponds. Egg are laid in large, flat gelatinous masses approximately 30.5 cm in diameter. Calls and egg masses were noted in the pond as well as first-year and second-year tadpoles.

Pseudacris c. crucifer

Pseudacris c. crucifer, the Northern Spring Peeper, is known throughout southeastern Canada and the eastern United States with the exception of southern Georgia and Florida (Behler & King 1979). It is found throughout West Virginia and at all elevations (Pauley 1993). The adult snout-to-vent length is approximately 40 mm. They have a characteristic dark "X" on the back (Pauley 2001), but during this study it was noted that the crescents of the "X" do not always touch. Dorsal color is typically tan to brown, but individuals that were gray and pinkish orange were also captured. Males were distinguished from females by the presence of a black chin. Ventral color is usually white.

Calling begins in February with the characteristic "peep". Calls were noted at the pond and the marshes from February through May. Breeding can occur in a variety of aquatic habitats and eggs are laid singly and usually attached to submerged vegetation (Pauley 2001). Tadpoles were noted in the marshes and road rut pools on the logging road.

Pseudacris brachyphona

Pseudacris brachyphona, the Mountain Chorus Frog, has a range that runs approximately from southwestern Pennsylvania, south through West Virginia west of the Allegheny Front, through eastern Kentucky and then southward in a narrow strip through Tennessee to northern Alabama (Behler & King 1979). The adult snout vent length is approximately 40 mm. Dorsal pattern usually consists of 2 separate crescent shaped marks, but blotchy patterns were also noted. Dorsal color is typically tan to brown but individuals that ranged from gray and pink were also captured. Males were distinguished from females by the presence of a black chin. Ventral color is usually white.

A field characteristic to distinguish *P. brachyphona* from *P. crucifer* is the white upper lip of *P. brachyphona*. *Pseudacris brachyphona* also has a triangular shaped patch on top of the cranium between the eyes where as *P. crucifer* has a "v" shaped line between the eyes.

Males begin calling in March with a call that sounds like "reek rake". Calls were noted at the marshes from late February to mid-April. Breeding commonly occurs in road puddles and roadside ditches (Pauley 2001). Eggs are laid in small gelatinous clumps containing 10 to 50 eggs (Pauley 2001). A high volume of egg masses were noted in both marshes and road rut pools on the logging road. After a 3 to 4 day hatching period (Pauley 2001), tadpoles were noted in these areas.

Bufo a. americanus

Bufo a. americanus, the American Toad, ranges throughout the eastern United States with the exception of the gulf coast states (Behler & King 1979). It is a common toad in West Virginia and is found statewide (Pauley 1993). The snout-to-vent length is approximately 103 mm long for adults. Dorsal color ranges from gray to brown and has scattered irregular black spots (Pauley 2001). The ventral side is typically light colored with dark mottling on chest and anterior portion of the abdomen. Males are distinguished from females by their smaller size and swollen thumbs during breeding season.

Field characteristics to distinguish the American Toads from Fowler's Toads, *Bufo fowleri*, are parotoid glands that are connected via a spur to the cranial ridge. The dorsal irregular black spots may contain 1 or 2 warts, where as a Fowler's Toad black spot contains more than 3 warts per spot (Pauley 2001).

Breeding can occur in any body of water that is standing or very slow moving. Males may begin to call in March, and its call is representative of a high trill that lasts approximately 30 seconds (Pauley 2001). When males and females join in amplexus, eggs are laid in long strands with each egg separated by a gelatinous partition (Pauley 2001). Eggs were noted in both marshes, road rut pools on the logging road and in the shallow areas of the pond. The marshes and road rut pools were inundated with tadpoles, which are coal black (Pauley 2001), and emerging toadlets.

Rana palustris

Rana palustris, the Pickerel Frog, is found in the eastern United States with the exception of the extreme southeast (Behler & King 1979). They have a scattered distribution in West Virginia but probably occur in all counties (Pauley 2001). The snout-to-vent length is approximately 75 mm for adults. Dorsal color is typically tan to brown with 2 rows of squarish blotches (Pauley 2001). The ventral side is white and the undersides of hind legs are bright yellow as well as the posterior portion of the abdomen. The lighter colored dorsal lateral folds extend to the groin (Pauley 2001). Males are distinguished from females by their smaller size and swollen thumbs during breeding season.

Calls may begin in March and are reminiscent of a low-pitched, slow snore (Pauley 2001). Breeding can occur in any body of water that is standing or slow moving. Eggs are deposited in clumps attached to submerged vegetation (Pauley 2001). Calls were noted in early April and tadpoles were found in the pond but not in the marshes.

Hyla chrysoscelis

Hyla chrysoscelis, Cope's Gray Treefrog, has a range that extends throughout southeastern Canada and the eastern United States west to the Heartland. *Hyla chrysoscelis* is not found in southern Florida (Behler & King 1979). *Hyla chrysoscelis* is found in West Virginia from the Allegheny Mountains west to the Ohio River (Pauley 2001). The snout-to-vent length is approximately 60 mm for adults. *Hyla chrysoscelis* has large toe discs and the dorsal color ranges from gray to brown or green. There are dorsal irregular star-shaped markings (Pauley 2001). Ventrally the skin is white and glandular (Pauley 2001) and the undersides of the thighs are a brilliant yellow or orange. Males are distinguished from females by their smaller size and swollen thumbs during breeding season.

Calls may begin in May and breeding occurs in any pool of water. Eggs are deposited in thin surface film. Calls, egg masses, and tadpoles were noted at the marshes, road rut pools and the pond.

Rana catesbeiana

Rana catesbeiana, the Bullfrog, can be found in southeastern Canada, eastern and central United States with the exception of southern Florida, and is an introduced species on the west coast of the United States (Behler & King 1979). They are found throughout West Virginia at a variety of elevations (Pauley 1993). The snout-to-vent length may range up to 18 cm in length, making it the largest frog in West Virginia. Dorsal color can vary from green, gray, brown to black (Pauley 2001) and there may be have dark blotches. The ventral side is white with gray mottling and the snout is green (Pauley 2001). The most distinctive feature is the lateral folds that begin posterior from the corner of the eyes and extend above and behind the tympanic membranes until it diminishes above the front limbs. Males are distinguished from females by their smaller size and swollen thumbs during breeding season.

Calls begin in April and breeding occurs in permanent ponds or slow moving rivers (Pauley 2001). Eggs are laid in large, flat gelatinous masses approximately 61 cm in diameter. Tadpoles were identified at the pond.

Ambystoma maculatum

Ambystoma maculatum, the Spotted Salamander, has a range from eastern southern Canada south through most of Georgia and west to east Texas and the eastern Midwest (Behler & King 1979). *Ambystoma maculatum* occurs in every county in West Virginia and at all elevations (Pauley 2004). Fully mature adults may attain a total length of 127 mm and have approximately 12 costal grooves. Dorsal color can range from slate gray, black to dark purple. Two rows of irregularly spaced rounded yellow spots run from the cranium down to the tip of the tail. Ventral coloring is typically dark gray (Pauley 2004).

Sexually mature adults emerge in late winter or early spring and migrate to breeding pools (Pauley 2004). Cottony white egg masses hatch in 4 to 6 weeks and larvae transform in 2 to 6 months (Pauley 2004). *Ambystoma maculatum* was found in the pond.

Rana sylvatica

Rana sylvatica, the Wood Frog, has a range that includes Canada and northern United States. They are found statewide in West Virginia and at all elevations (Pauley 1993). The snout to vent length is approximately 80 mm in adults. The dorsal color may vary from brown to tan or pinkish (Pauley 2001), with the dorsal lateral folds extending from posterior of the eye to the groin. The most distinctive characteristic is the black mask, which extends from the lower eyelids, over the tympanic membranes and narrowing until it terminates above the elbows. Males are distinguished from females by their smaller size and swollen thumbs during breeding season.

Rana sylvatica is the earliest true frog to emerge from hibernation and may begin calling in February (Pauley 2001). The call sounds similar to quacking ducks (Pauley 2001). Breeding takes place in temporary or permanent pools and eggs are laid in globular masses (Pauley 2001). Calls were noted near Marsh 1.

Eurycea cirrigera

Eurycea cirrigera, the Southern Two-lined Salamander, has a range from southern Virginia to northern Florida and west to the Mississippi River (Behler & King 1979). This species occurs in the southern two-thirds of West Virginia (Pauley 2004). Fully mature adults can have a total length of 120 mm and 13-14 costal grooves. Dorsal color varies from greenish-yellow to bright orange-yellow and is bordered by two black lines that run laterally for more than half way down the tail (Pauley 2004). Ventral color ranges from yellow to orange yellow (Pauley 2004).

Sexually mature females lay eggs attached underneath an object and hatch in 1-2 months (Pauley 2004). Larvae transform in 1-3 years (Pauley 2004). *Eurycea cirrigera* was found at the pond.

Pseudotriton r. ruber

Pseudotriton r. ruber, the Northern Red Salamander, has a range that extends from southern New York west to northern Indiana, and south to Georgia and Alabama

(Behler & King 1979). This species occurs statewide in West Virginia (Pauley 2004). Fully mature adults may achieve a total length of 180 mm and have 16-17 costal grooves (Behler & King 1979). Dorsal color is bright red with distinctive black spots that coalesce with age (Pauley 2004). The ventral is bright red but not spotted and the eyes are yellow.

Eggs, laid in the fall, are attached to the underside of an object and hatch in late winter (Pauley 2004). Larvae transform in 2-3 years (Pauley 2004). *Pseudotriton r. ruber* was found at the pond.

Amystoma opacum

Ambystoma opacum, the Marbled Salamander, has a range that extends from southern New Hampshire to northern Florida, west to east Texas, and north to the southern Great Lakes (Behler & King 1979). This species occurs in every county of West Virginia but probably not in elevations over 3000 feet. (Pauley 2004). Total length of mature adults may reach 127 mm and they have 11-12 costal grooves. Dorsal color is black with light bands. These bands are white in males and grayish in females (Pauley 2004). Ventral color is black.

Breeding season occurs in the fall and eggs hatch in the fall or early winter (Pauley 2004). Larvae transform the following summer (Pauley 2004). *Ambystoma opacum* was found at the pond.

Plethodon glutinosus

Plethodon glutinosus, the Northern Slimy Salamander, occurs throughout West Virginia (Pauley 1993). Mature adults may reach a total length of 200 mm and have 16 costal grooves. Dorsal color is black with white spots that may contain brassy flecks (Pauley 2004). Ventral color is dark.

Eggs are deposited in May or June and hatch in late summer or fall (Pauley 2004). *Plethodon glutinosus* was documented at the pond.

Reptiles

Chelydra s. serpentina

Chelydra s. serpentina, the Eastern Snapping Turtle, is found in parts of southern Canada, and the entire eastern, midwestern and central United States with the exception of Florida and the southern tip of Texas (Behler & King 1979). It is found statewide in West Virginia, including the higher elevations (Pauley & Seidel 2002). Total carapace length may exceed 40 cm and mass can exceed 22 kg. *Chelydra s. serpentina* is a prehistoric looking turtle that is quick to bite. The tail shape is similar to that of a small crocodile and the plastron is small and cross-shaped (Pauley & Seidel 2002).

Chelydra s. serpentina occupies a wide variety of aquatic habitats. Mating occurs from late spring to mid fall with approximately 30 golf ball-sized eggs deposited in May or June (Pauley & Seidel 2002). Nesting occurs in soft soil near a body of water. Hatchings typically have a total carapace length of approximately 40 mm. *Chelydra s. serpentina* was found in the pond and in Marsh 1.

Terrapene c. carolina

Terrapene c. carolina, the Eastern Box Turtle, has a range from southern Maine to Georgia and west to Tennessee, Illinois and Michigan (Behler & King 1979). It is found statewide in West Virginia, with the exception of the higher elevations. Total carapace length may reach 21 cm (Behler & King 1979). *Terrapene c. carolina* has a brown, orange and yellow high-domed carapace with dark stripes and spots (Pauley & Seidel 2002). The most distinctive feature is the hinged plastron, which can be closed to completely protect the ventral surface of the turtle. Males can be distinguished from females by an indention in the plastron and red eyes (Pauley & Seidel 2002).

Terrapene c. carolina is completely terrestrial (Pauley & Seidel 2002). It is likely that mating occurs from the spring to the fall (Pauley & Seidel 2002) but nests from May to July (Behler & King 1979). Three to 8 elliptical eggs are deposited in a flasked-shaped cavity that is approximately 10 cm deep (Behler *et al.* 1979). *Terrapene c. carolina* was found near the marshes and the pond.

Nerodia s. sipedon

Nerodia s. sipedon, the Common Watersnake, has a range that extends from southern Maine to North Carolina, west to central Tennessee, northern Indiana and Illinois, west to eastern Colorado, northeast to Minnesota and southern Ontario and Quebec (Behler & King 1979). It occurs statewide in West Virginia in a variety of aquatic habitats (Pauely 1993). Total length may exceed 122 cm (Behler & King 1979). Dorsal color ranges from gray to dark brown with reddish-brown to black “saddle” bands (Pauley & Seidel 2002), which narrow on the sides. Ventral color ranges from yellow to orange and marked heavily with dark crescent blotches (Pauley & Seidel 2002). Dorsal scales are sharply keeled and the anal plate is divided.

Mating occurs from May to June and typically 15-30 young are born from October to August (Behler & King 1979). The length of juveniles ranges from 10 cm to 30 cm (Behler & King 1979). *Nerodia s. sipedon* was captured at Marsh 1 and the pond.

Scincella lateralis

Scincella lateralis, the Little Brown Skink, has a range that includes southeastern United States to central Texas north to Nebraska (Behler & King 1979). It probably occurs in the southern and eastern sections of West Virginia (Pauley & Seidel 2002), but had not been reported from Wayne County until my study. Total length may reach to 13 cm. Dorsal color is usually brown with black flecks and dark lateral stripes (Pauley & Seidel 2002). They resemble the Two-lined salamander, *Eurycea cirrigera*, in shape, coloration, and markings.

Scincella lateralis habitat occurs in dry, open forest floors (Pauley & Seidel 2002). Eggs are deposited in May or June and hatch in July or August with no maternal care (Pauley & Seidel 2002). *Scincella lateralis* was found at the pond.

Coluber c. constrictor

Coluber c. constrictor, the Northern Black Racer, has a range that extends from southern Maine to eastern Ohio, south to northern South Carolina, northern Georgia, northern Alabama and northeast Mississippi (Behler & King 1979). It occurs statewide in West Virginia in fields and moist forests (Pauley & Seidel 2002). Total length may reach 183 cm (Behler & King 1979). Dorsal and ventral colors are black with a white throat and chin. Juveniles have a white-banded pattern, which disappears by the time they reach approximately 76 cm in length (Pauley & Seidel 2002). Dorsal scales are smooth and the anal plate is divided.

Mating occurs from April to late May and 5 to 28 eggs are laid from mid-June to August underneath cover objects or buried in soft material (Behler & King 1979).

Juveniles hatch from July to September and range from 20 cm to 33 cm in length (Behler & King 1979). *Coluber c. constrictor* was found at the pond.

Thamnophis s. sirtalis

Thamnophis s. sirtalis, the Eastern Gartersnake, has a range that it includes the Atlantic Coast, southern Ontario, and the Midwest south through eastern Texas (Behler & King 1979). It occurs statewide in West Virginia in a wide range of habitats. Total length may be up to 122 cm. Dorsal color ranges from brown, green or gray with lateral stripes on the second and third scale rows (Pauley & Seidel 2002). Dorsal scales are keeled and have a single anal plate.

Mating occurs from late March to early May and 7 to 85 neonates are born in late June to August (Behler & King 1979). Total length of juveniles ranges from 13 to 23 cm. *Thamnophis s. sirtalis* was found at the pond and near Marsh 2.

Eumeces fasciatus

Eumeces fasciatus, the Common Five-lined Skink, has a range from southern New England to northern Florida, west to central Texas, north to Kansas, Wisconsin and east to southern Ontario (Behler & King 1979). It occurs statewide in West Virginia (Pauley & Seidel 2002), but its capture at my site in Wayne County has made it a county record. Total length may get to 20 cm. Dorsal and lateral color is black or dark blue with 5 longitudinal yellow or white stripes (Pauley & Seidel 2002). Juveniles have a bright blue tail that becomes brown with age and the dorsal stripes become less conspicuous. The color of the head of an older male may range from orange to reddish (Pauley & Seidel 2002), making them similar in appearance to *Eumeces laticeps*, the Broad-headed Skink.

Eumeces fasciatus is commonly seen around houses, barns, old buildings, and open forest (Pauley & Seidel 2002). Eggs are laid sometime in June after a probable May or June mating (Pauley & Seidel 2002). The nest is typically under a cover object and is guarded by the female until hatching (Pauley & Seidel 2002). *Eumeces fasciatus* was commonly seen climbing trees near the pond.

Opheodrys a. aestivus

Opheodrys a. aestivus, the Northern Rough Greensnake, has a range that includes the southeastern United States, the southern Midwest and south to west Texas. There are also populations in northeast New Mexico (Behler & King 1979). They are found in the western and central portions of West Virginia at low elevations (Pauley & Seidel 2002). They prefer the understory and herbaceous layers of the forest. Total length may be up to 114 cm. Dorsal color is green with a white or yellowish green belly (Behler & King 1979).

Mating occurs in the spring and the fall with up to 14 eggs deposited under a cover object or in loose soil (Pauley & Seidel 2002). Juveniles hatch from June to August and have a total length from 18 cm to 22 cm (Behler & King 1979). *Opheodrys a. aestivus* was found at the pond.

<u>Crayfish</u>

Cambarus (Cambarus) bartonii cavatus

Cambarus bartonii cavatus occupies a range that includes portions of Indiana, Kentucky, Ohio, Tennessee, Georgia, and West Virginia. The distribution in West Virginia is primarily the western portion of state in major river drainages of the Big Sandy River, Kanawha River, and tributaries of the Ohio River (Jezerinac *et al.*1995).

Habitat includes streams, seeps, and wet roadside ditches. *Cambarus bartonii cavatus* is a burrower that will occupy borrows under rocks near large streams but prefers smaller bodies of water (Jezerinac *et al.*1995). This species was found at both the pond and Marsh 1.

Cambarus (Jugicambarus) dubius

Cambarus dubius has a range "extending southward through the Allegheny Mountains from southwestern Pennsylvania and Kentucky into southwestern Virginia, northwestern North Carolina and as far south in Tennessee as the junction of the Clinch and Holston rivers, and westward on the Cumberland Plateau to headwaters of the South Fork of the Cumberland and Caney Fork rivers in Fentress and Cumberland counties, Tennessee (Jezerinac *et al.*1995, see Dewees,1972.)" The distribution of *Cambarus dubius* in West Virginia, which includes all body forms, is the Allegheny Mountains, and the southern and western portions of the state (Jezerinac *et al.*1995). According to the distribution map of Jezerinac *et al.*1995 the red claw, black body color form is indicated in Wayne County, West Virginia. The Blue body color form was captured at the pond site.

Habitat includes wet areas such as springs, seeps, roadside ditches, stream and creek banks and run-off areas (Jezerinac *et al.*1995). *C. dubius* is a primary burrower that is known to build chambers that are large and complex (Jezerinac *et al.*1995).

Cambarus (Tubericambarus) thomai

Cambarus thomai, the Little Brown Mudbug, is found in portions of Pennsylvania, Ohio, Kentucky, Tennessee and West Virginia. The distribution in West

Virginia is in the Allegheny Plateau and along the western fringes of the state (Jezerinac *et al.*1995).

Habitat includes roadside ditches and seeps. *Cambarus thomai,* is a secondary or primary burrower and complexity of burrows vary (Jezerinac *et al.*1995). *Cambarus thomai* was found at the pond and Marsh 1.

RESULTS

Pond

Two thousand, one hundred and six amphibians and reptiles were captured during this study in 263 trap nights from 22 February 2003 to 22 November 2003. Of these captures, 743 were entering the pond (Fig. 7) and 1363 were exiting (Fig. 8). The comparison between the egress and ingress of captures is significantly different (Table 1,p <0.001).

For purposes of comparison the perimeter around the pond is divided into three segments: hillside, dam, and field (Fig. 6). When the number of captures for entering and exiting within each segment were compared there were significantly more exiting captures for the hillside and field segments (Mann-Whitney Rank Sum Test,p = 0.047 and p = 0.004) than entering. The highest exiting captures were recorded at array 24 with 120 captures and array 17 with 148 captures, both located in the field segment. The difference between dam capture rates was not significant (t test, p = 0.180). Of the trap arrays the highest number of entering captures was recorded at array 25 in the field segment with 126 captures, and array 15 in the dam segment with 59 captures.

There was a total of 2087 amphibian captures in the funnel traps: 1050 adults and 999 subadults, the remaining stage of the remaining 38 captures were unrecorded. Twelve species were captured in the pond and are listed with relative abundance: Green Frog (*Rana clamitans melanota*, 50.6%), Red-spotted Newt (*Notopthalmus v. viridescens*, 37.7%), Northern Spring Peeper (*Psuedacris c. crucifer*, 7.8%), American Toad (*Bufo a. americanus*, 1.9%), Pickerel Frog (*R. palustris*, 0.6%), American Bullfrog (*R. catesbeaina*, 0.4%), Mountain Chorus Frog (*P. brachyphona*, 0.4%), Spotted Salamander (*Ambystoma maculatum*, 0.3%), Southern Two-lined Salamander (*Eurycea cirrigera*, 0.1%), Northern Red Salamander (*Pseudotriton ruber ruber*, 0.1%), Marbled Salamander (*A. opacum*, >0.1%) and the Slimy Salamander (*Plethodon glutinosis*, >0.1%).

Adult anuran captures totaled 305, consisting of 6 species, which were caught, in funnel traps at the pond site (Fig. 9). Adult Spring Peeper captures were higher than the other five species, but sex ratio was more evenly distributed then in anuran other species (Table 2).

Seasonal activity for the Green Frog adults began in April and ended in mid-October. During this period 1,057 adult and subadults were captured (Fig. 10). When subadult captures were included into the total of all anuran captures, Green Frogs comprised 82% (Fig. 11). Peak activity for adults was from mid-April through mid-June with 39 captures. Peak emigration for subadults was in July with 626 captures (Fig. 10).

There were 225 tadpole captures in minnow traps with the highest number caught in M6. Green frog, Pickerel frog, Bullfrog, and Gray treefrog tadpoles were observed and recorded. Green frog and Bullfrog egg masses were also recorded.

The Red-spotted Newt dominated all salamander captures by 98% in the funnel traps (Fig 12). February and March were the peak immigration period while peak emigration was in July (Fig 13). The male to female sex ratio during peak immigration was 1:5.38 versus peak emigration when it decreased to1:2.7. Of all minnow trap captures (Fig. 14), the red-spotted newt comprised 94% with the remaining 6% consisting of tadpoles, bluegill, and large mouth bass. Unlike funnel trap captures the overall male to female sex ratio was 5.4:1 (Table 3).

Relative size differences between sexes and terrestrial and aquatic stages were also significant. Morphometric data shows males have greater tail heights (Mann-Whitney Rank Sum Test, $p<0.001$), cranial widths ($p=0.016$), and longer total lengths ($p=0.003$), but there is not a significant difference between male and female snout to vent lengths ($p=0.319$). Median mass values for females were lower than that of males for both types of traps. Mass of specimens captured on land was also significantly lower than those captured in water (Table 4, $p <0.001$). There is also a difference in mass for both sexes from February through March verses May through November (Mann-Whitney Rank Sum Test, $p<0.001$).

Of the total newt captures, 146 were documented as gravid females. The ratio of aquatic captures verses funnel trap captures was 5.8:1. The average mass of gravid females from the minnow traps was 4.5 grams, compared to funnel trap captures which averaged 3.86 grams. Gravid females were captured in aquatic traps during each month with the exception of August. Peak captures for minnow traps occurred from March through May with 105 individuals. Peak captures in the funnel traps were during March and April with a total of 20 captures. There were only 5 captures of gravid females in the funnel traps for the duration of the study after the spring, which occurred in November.

Eft captures occurred from the 7 July 2003 through 26 October 2003. Peak emigration occurred in July with 12 of the 21 captures. Average mass was less than one gram and total lengths ranged from 26.1 mm to 36.4 mm. Aquatic larvae were captured in a dip net in April.

Presences of reptiles were documented with the following methods; funnel traps with 19 captures, minnow traps with 8 captures, turtle traps with 7 captures, and 44 visual observations. Little Brown Skink (*Scincella lateralis*) and Five-lined Skink (*Eumeces fasciatus*) were captured in funnel traps. Little Brown Skinks were captured in every segment of the pond beginning 24 March 2003 until 24 July 2003. Five-lined Skinks were observed in the hillside segment, usually climbing trees when disturbed, from 9 May 2003 through 6 August 2003.

The Common Watersnake (*Nerodia s. sipedon*) was captured in both funnel and minnow traps. Eleven captures were made consisting of males, females, and one juvenile from 14 April 2003 through 13 September 2003. The sex ratio was 1:1. Other snakes captured and observed at the pond were the Northern Rough Greensnake (*Opheodrys a. aestivus*) (3 from 30 April 2003 until 7 July 2003), the Northern Black Racer (*Coluber c. constrictor*) (4 beginning 3 April 2003 until 3 November 2003), and the Eastern Gartersnake (*Thamnophis s. sirtalis*) (5 from 3 April 2003 to 20 November 2003).

Snapping Turtles (*Chelydra s. serpentina*) were commonly observed from the 20 March 2003 through 6 November 2003. There were 20 captures, 6 of which were in baited hoop traps that were set for 2 trap nights. Adult sex ratio of these hoop trap captures was 1:1. Adults were commonly observed swimming under the surface of the water and, less commonly, basking on the bank of the pond. Five juveniles were captured beginning 26 October 2003.

The Eastern Box Turtle (*Terrapene c. carolina*) was commonly observed around the pond and on the footpath. Six funnel trap captures occurred, all of which were exiting the pond. Two of these captures were juveniles. Eleven were found incidentally along the drift fence. The adult male to female sex ratio was 1:1.8.

Marsh 1

The first capture to occur in Marsh 1, a male Mountain Chorus Frog, was on 24 Febuary 2003. There were 281 adults captured (Fig. 15). Of the 6 anuran species trapped in Marsh 1 (Fig. 16), the Mountain Chorus Frogs dominated the marshes until the 12 April 2003. The first Mountain Chorus Frog egg mass was discovered on 11 March 2003 and was noted in abundance until the end of their breeding season. The Mountain Chorus Frog shared its breeding habitat with the spring peeper, which were captured from 5 March 2003 through 7 May 2003. One female spring peeper was documented 29 October 2003. Larvae of both species was captured and identified via examining tooth rows with a dissecting microscope.

Wood Frogs were captured 6 March 2003 through 17 March 2003. Only two individuals were captured, one was identified as a male and another as a female. No egg masses or larvae were identified.

American Toads were captured 18 March 2003 through the 7 May 2003. Egg masses were first noted on 27 March 2003. The male to female sex ratio was 6.8:1. Larvae were too small to be captured in the minnow traps, but were observed in large numbers. The larvae were sympatric with the Mountain Chorus Frog and Spring peeper larvae.

The Gray Treefrog was the next species to use the marshes as breeding habitat and was captured 7 May 2003 thru 10 July 2003. Larvae were captured 28 July 2003 through 14 August 2003.

Marsh 2

Marsh 2 became active 14 March 2003 and was dominated by Mountain Chorus Frogs. Only 57 total captures were documented in Marsh 2, but of these 16 were Mountain Chorus Frog, 14 American Toad, 11 Northern Spring Peeper, 10 Green Frog, 5 Gray Treefrog, and 1 Garter Snake (Fig. 17). Egg masses of Mountain Chorus Frog, the American Toad and Grey Treefrog were noted. Their larvae, including the Northern Spring Peeper, were identified. This marsh remained active until 8 August 2003.

Environmental Data

Analysis of variance (ANOVA) using multiple linear regressions was used to compare movements of Red-spotted Newts, Green Frogs, Spring Peepers, and Mountain Chorus Frogs, and Pickeral Frogs to the environmental factors measured (air temperature, water temperature, soil temperature, rainfall, and interaction terms, ie, soil x rainfall). The test was found to be significant for Red-spotted Newts ($p=0.0016$, $r^2 = 0.1046$), Green Frogs ($p=0.002\ 7$, $r^2=0.0996$), and Spring Peepers ($p<0.001$, $r^2=.2700$). The amount of rainfall in combination with air temperature had a significant influence on movement of Red-spotted Newts ($p=0.0449$). The amount of rainfall was significant on captures of Northern Spring Peepers (Fig. 18, $p<0.0001$). Other environmental factors, such as soil temperature and water temperature, did not have a significant impact upon captures.

DISCUSSION AND CONCLUSION

The phenology of amphibians and reptiles observed in the pond and marshes was expected for this area of West Virginia (Green & Pauley 1987). Since the data of species present agrees with the literature, a further look why the community structure is different from the pond verses the marshes was merited.

A key component that influences the amphibian community structure in a wetland is the presence or absence of fish. The presence of fish is known to have dramatic direct and indirect effect on amphibian populations (Smith *et al.* 1999). While the marshes lacked fish, the pond supported two species, Bluegill, *Lepomis macrochirus*, and Large Mouth Bass, *Micropterus salmoides.* Direct effects may be fish feeding on amphibians and their larvae or an indirect effect which could be fish eating a shared food source. Evidence from this study that supports this is the difference in anuran community structure in the marshes verses the pond (Figs. 9, 16, and 17). For example, Mountain Chorus Frogs were observed in both marshes, but not at the pond. Fish are known to prey on them (Smith *et al.* 1999), so this may be an explanation of their absence in the pond.

The most prevalent species captured in this study were Red-spotted Newts and Northern Green Frogs. Both species previously were found to be significantly affected by the presence of Bluegill (Smith *et al.* 1999). In a study conducted by Smith et al. 1999, densities of Gray Treefrogs (*H. versicolor*), Eastern Newts (*N. viridescens*) and predaceous insects decreased while Bullfrog density increased with the presence of Bluegill. They contributed the decline of Gray Treefrogs to the predation of tadpoles by

Bluegill. Eastern Newts declined because they share the same prey items as Bluegills, which include cladocerans, particularly *Daphina* species (Smith *et al.* 1999, Mellors 1975; Mittelbach 1981; Werner *et al.* 1983). Bullfrogs increased in density because Bluegill consume the Bullfrogs predator, dragon fly larvae. This produces an indirect effect on Bullfrog populations (Smith *et al.* 1999).

The primary mechanisms of survival against predation for amphibians may be attributed to toxicity and behavioral modification. The Red-spotted Newt (Smith *et al.* 1999; Kats *et al.*1988) and Bullfrog tadpoles (Kruse *et al.* 1977) are known to be unpalatable to fish. Bullfrog tadpoles and Green frog tadpoles have been shown to decrease activity and exhibit spatial avoidance to dragonfly larvae, a predator (Relyea *et al.* 1999). It has also been shown that amphibians can alter their behavior response to predators through chemical cues from predators (Saenz *et al.* 2003; Wilbur, 1997; Van Buskirk, 2001, Saenz *et al.* 2003). For example anurans such as *Rana sphenocephala* may use chemical cues in response to the presence of crayfish to induce early hatching (Saenz *et al.* 2003).

My results showed a difference in trap effectiveness based on the number of captures. This is probably due to the density of aquatic vegetation which serves as a refuge for amphibians and amphibian larvae to escape predation. Adult fish could not access the minnow traps due to the density of the vegetation in combination with shallow water in the minnow traps, which were all placed in patches of varying densities of aquatic vegetation. However, juveniles of both fish species were captured in minnow traps in the vegetation. Aquatic vegetation may have served as protection from predation by adult Large Mouth Bass and be one reason for the difference in captures between traps placed in vegetation (M1, M4, M5, M6) and those with less vegetation (M2, M3) (Fig. 9).

It is well known that the invasion of a predatory fish may lead to the extirpation of salamander populations (Sexton *et al.* 1994), which may account for the lack of abundance of salamanders. For example, the lack of Spotted Salamanders in the pond may be explained by Sexton et al. (1994) and Ireland's (1989) study on survivorship who found that female Spotted Salamanders do not select breeding ponds on the basis of successful recruitment (Sexton *et al.* 1994). I captured 5 males and 1 female. This may indicate that both sexes may return to the pond even if there is little breeding success.

The presence of one Marbled Salamander captured at my site is puzzling, because the original habitat was altered by the construction of the pond, this area may have been suitable breeding habitat in the past, or this particular salamander's orientation may be skewed. Marbled Salamanders are known to orientate to breeding areas (Shoop *et al.* 1972). Preferred egg deposition habitat is depressions that will fill with water at a later date (Shoop *et al.* 1972). The slope to the pond basin may be the cue necessary for both these salamanders to orientate towards breeding areas (Shoop *et al.* 1972). If the cue is water, which would explain the presence of other species of salamanders captured that was not as prolific as the Red-spotted Newt.

It is important to look beyond the pond and consider the surrounding landscape when taking into account the phenology of amphibians. Pond-breeding amphibians depend upon wetlands for reproduction and upland forests for foraging, hibernating and/or traveling (Guerry *et al.* 2002; Zug 1993; Stebbins and Cohen 1995). The composition of the segments that surround the pond is critical to the population success of its occupants.

Shade, ground cover, and slope play a factor in the distribution of captures. The trap arrays with the highest number of captures occurred in places where shade was most available in regard to entering individuals. Array 25, in the field segment, had the highest entering captures of all trap arrays. Array 25 is located next to a Black Willow (*Salix nigra*), which is covered with Poison Ivy (*Rhus radicans*) and flanked by some small shrubs. This is the only area in this segment that was shaded. Array 15, located toward the western end of the dam, had the second highest entering captures (59). This array was located under several individuals of Tuliptree (*Liriodendron tulipifera*).

Exiting captures occurred more uniformly around the pond. But the most significant observation is that the locations of the trap arrays with the highest total captures occur where the slope of the bank is less steep. Array 17 had the highest amount of exiting captures (148) and is visibly the lowest spot near the pond. The capture of tadpoles and fishes in array 17 after flooding indicates that this is the lowest point near the pond.

In a study of how amphibian distributions were associated with the area of forested habitat and the proximity of ponds to a forest habitat (Guerry *et al*. 2002) it was found that Wood Frogs, American Toads, Green Frogs and Eastern Newts were only associated with ponds surrounded by forest. Spring Peepers were found in all of the 116 ponds they examined indicating their prolific nature and ability to colonize ponds in numerous habitats. Guerry et al. (2002) found that the American Toad had a negative correlation in ponds surrounded by forest because forest surrounding the pond is not critical for their reproduction or survival. The pond at my study site, although not under a closed canopy was forested along one side, providing the necessary complementary habitat for these amphibians to survive during the non-breeding season.

Wood Frogs were not found at my pond but were captured at both marshes. With only 3 captures, a plausible explanation may be that my study had not been initiated early enough and that the trapping technique in the marshes was not as effective as the drift fence technique employed at the pond. Had the marshes been enclosed with a drift fence using funnel and minnow traps there may have been a greater capture rate. The marshes were also dry for a 7 to 10 day period before the minnow traps were set, thus eliminating any chances of larvae capture.

Spring Peepers were captured at all 3 of my sites. Spring Peepers require warmer water, greater dissolved oxygen concentrations, and greater periphyton concentrations than the other species examined (Skelly *et al.* 2002). The pond had the highest number of captures (163) verses the marshes (76 total). The fact that the forest canopy is primarily open over the pond makes this suitable breeding habitat. In a study by Skelly et al. (2002), the effects of forest canopy play a role in amphibian distribution, a closed canopy over a pond has a deleterious effect in spring peeper larvae (Skelly *et al.* 2002). Both marshes in my study were within approximately 30 m of the forest and proved to be better breeding habitat for Spring Peepers than the pond.

The peak of ingress and egress of Red-spotted Newts is similar to what Gill (1979) found during a 4 year study in Virginia. Due to the fact that my study did not cover an entire 12-month period it is difficult to ascertain how many newts over-wintered in the pond. The first minnow trap captures in February indicated that some

Red- spotted Newts did over-winter, which also correlates with Gill's (1978) observations. The immigration and emigration of newts prior to the implementation of the drift fence/ funnel traps cannot be addressed in this study. However, in studies completed by Gill (1978) and Johnson (2002) no movement of newts was found in December and January, indicating that adult newts over-winter in the ponds. The appearance of dry, granular skin on incoming funnel trap captures observed in February indicate a terrestrial period prior to migration to the pond.

Gill (1978) observed adults leaving ponds due to heat stress or other extreme physical conditions and he also observed newts hiding in or under vegetation to avoid high temperatures. Since captures the pond were minimal for both types of traps during the warmest part of the summer, I concluded that Red-spotted Newts went into deeper water to minimize heat stress.

I found an increase of body mass for both sexes of Red-spotted Newts between the spring and the fall. This agrees with Gill (1979), who found that mass increases due to preparation for over wintering. Unlike the results Gill (1978) obtained, I found that sex ratios in aquatic traps were primarily male biased with the exception of July through September. Similarly to Johnson's (2002) study of a Florida pond, I found that the sex ratio is female biased during peak immigration and emigration periods.

Statistical analyses of environmental factors were conducted on species which had significant captures to produce an accurate reflection on how environmental factors affected their movement. Red-spotted Newts and Spring Peepers had a tendency to move when there was significant rainfall. Air temperature also was a factor for newts and there was a decrease in activity during the warmer and drier months. Gill (1978) and Johnson

(2002) also reflected similar environmental trends in their studies. Since Spring Peepers were only captured from the end of February until mid-May, air temperature was not a predominate factor in their movement to breeding areas.

There was an unusually high amount of precipitation during the course of this study. Environmental data associated with precipitation (relative humidity, soil temperature, and water temperature) were not strongly correlated with the movement of amphibians as perhaps they might have been if it were a drier year. Since this is not a long-term study it is difficult to ascertain normality of movement patterns and species composition. A wet year may or may not be an accurate reflection what this pond and marshes normally experience in a drier year.

Species of reptiles caught in and around the pond was not surprising. Snapping Turtles and Box Turtles were expected captures due to habitat. Juveniles of both species were caught and this is a reasonable indication that both species were breeding and nesting in or near the site. Habitat and location is suitable for the species of snakes captured and I believe that a trap designed specifically for snakes in addition to the funnel traps would have yielded additional captures for the study. Little is known about the Little Brown Skink in West Virginia, but due to its capture here I feel that this location would be a prime study site in order to learn more about the species.

In conclusion, the three major objectives of this study have been met. I determine that the structure of the breeding and seasonal activity of amphibians varied throughout the year as expected and most literature supports. Also, I was able to determine that there was a difference in amphibian species composition between the marsh habitat and the pond habitat. It is essential to note that while some important conclusions can be drawn from data presented in this paper, more data are necessary before different trends between population structure, breeding success, and seasonal activity can be well-documented due to seasonal variation and natural population fluctuations.

I believe that future wetland and pond studies need to treat the terrestrial component as equally as the aquatic component. Due to the relatively short duration of the study, and the lack of funding and resources available for this study, I believe that it was not adequate enough to be able to establish useful long-term trends. Further long-term studies of established wetlands and ponds at varying elevations are needed in West Virginia to provide a baseline for future amphibian and reptile studies. Not only are these studies needed academically, but also to provide useful information to the agencies that protect and conserve wetlands as functioning systems and critical habitat.

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APPENDIX I: TABLES

Table 1. Comparison of total amphibian and reptile entering and exiting captures in pond.

Group	Arrays	Median	25%	75%
Entering	27	27.000	12.250	31.750
Exiting	27	44.000	29.500	62.000

$P<0.001$ Mann-Whitney Rank Sum Test

Table 2. Sex ratios for adult anuran captures in pond funnel traps.

Species	Male to Female Ratio	Total Male to Female
Bufo americanus	1.9:1	20:17
Rana catesbeiana	1.5:1	2:3
Rana c. melanota	2.8:1	44:25
Rana palustris	3:1	9:3
Pseudacris brachyphona	3.5:1	7:2
Pseudacris c. crucifer	1:1	78:73

Table 3. Sex ratios of adult *Nototphalmus v. viridescens* in pond minnow traps.

Month	Male to Female Ratio	Total Male to Female
February	10.8:1	381:39
March	16.7:1	2015:128
April	5.8:1	1088:228
May	3.9:1	933:319
June	2.1:1	340:313
July	1:1.6	34:54
August	1:2.4	9:13
September	1:1	14:14
October	7.2:1	155:25
November	23.8:1	760:32

Table 4. *N. v. viridescens* median mass by sex and pond trap type.

Group	N	Median	25%	75%
Female, Funnel Traps	283	2.500	2.500	3.000
Female, Minnow Traps	181	3.300	3.000	4.000
Male, Funnel Traps	91	3.000	2.500	3.500
Male, Minnow Traps	1033	3.500	3.000	4.000

$p<0.001$ Mann-Whitney Rank Sum Test

APPENDIX II: FIGURES

Figure 1. Location of study sites in the Prichard Quadrangle, West Virginia

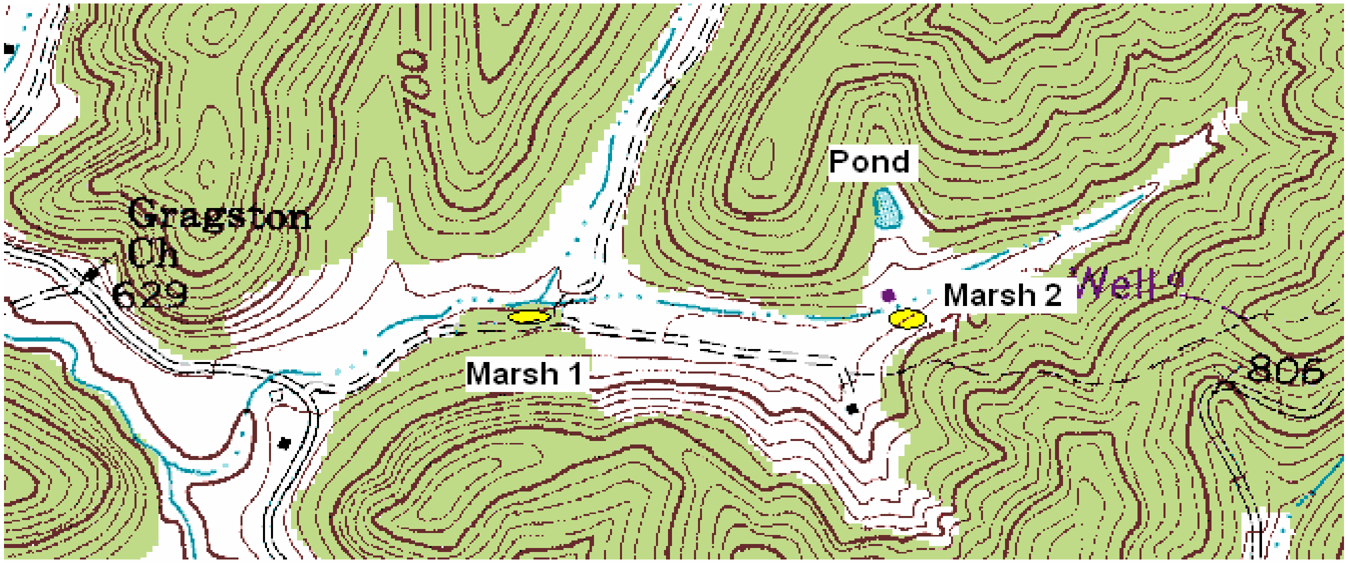

700
Pond
Gragston
Ch
629
Marsh 2
Well
Marsh 1
806

Figure 2. South facing photograph of the pond.

Figure 3. Photograph of Marsh 1.

Figure 4. Photograph of Marsh 2.

Figure 5. Photograph of the drift fence and funnel trap array.

Figure 6. Pond segment chart. Outer numbers indicate trap arrays.

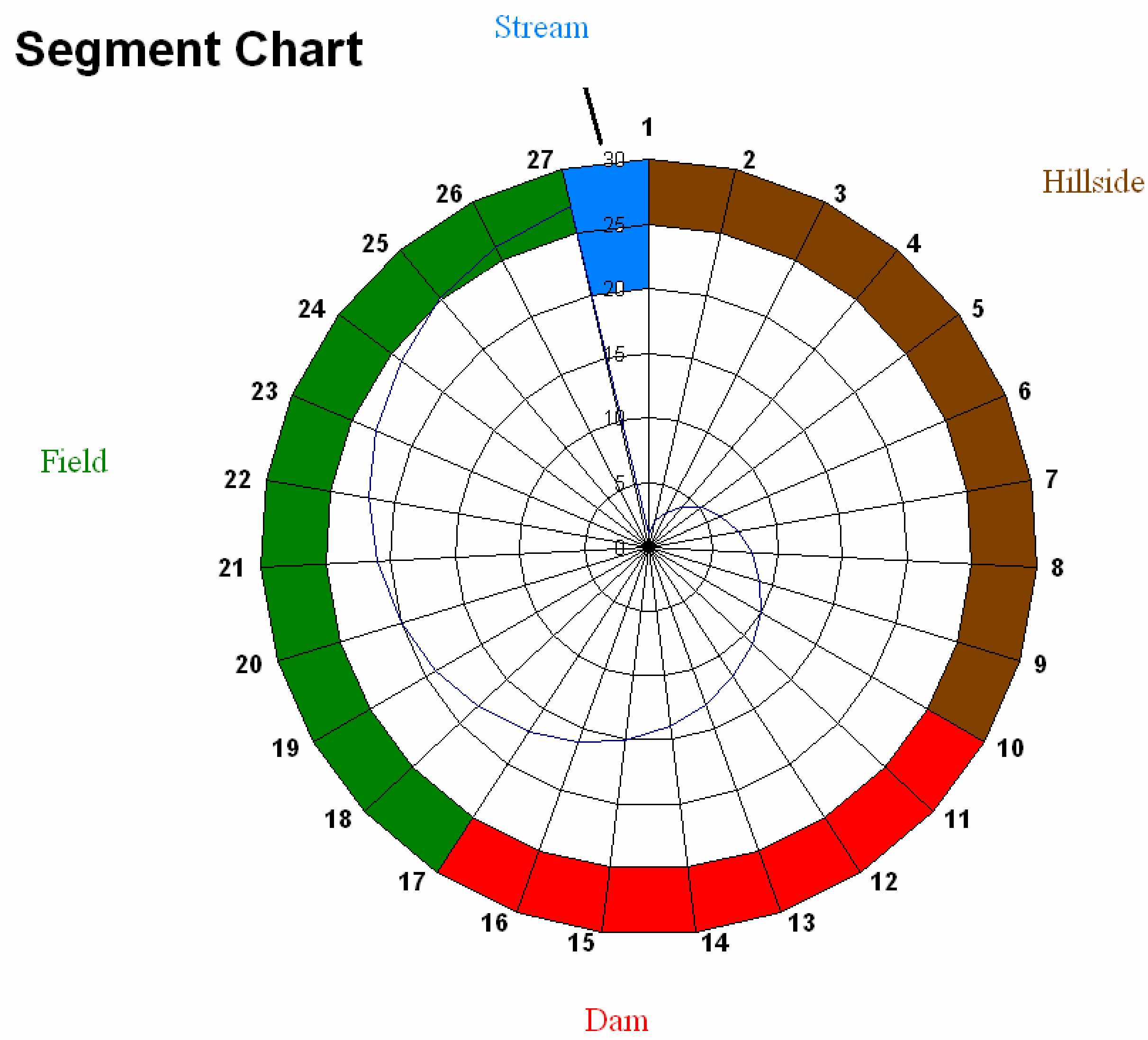

Segment Chart
Stream
Hillside
Field
Dam
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
0
5
10
15
20
25
30

Figure 7. Entering amphibian and reptile captures per trap array at the pond.

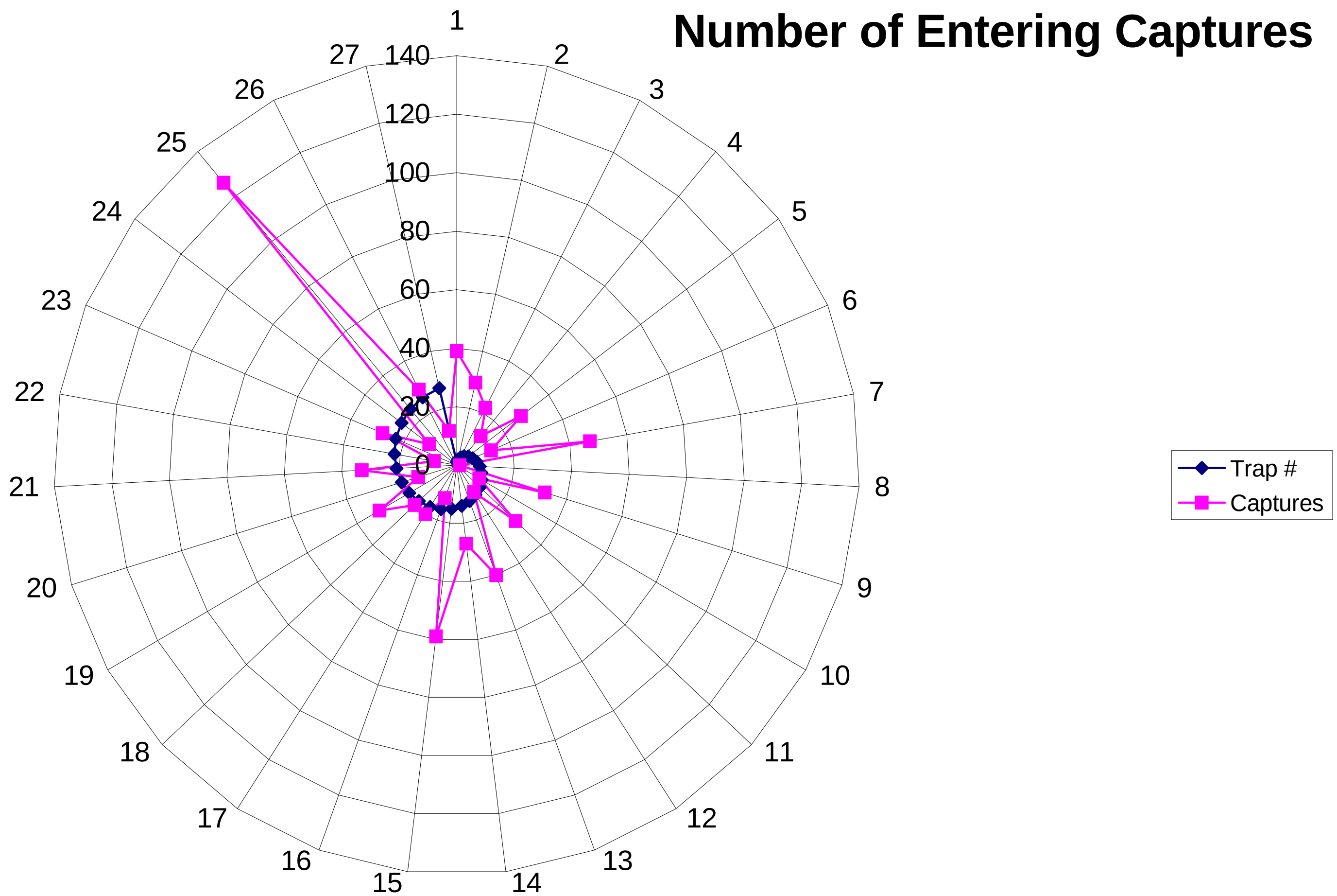

Number of Entering Captures
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
140
120
100
80
60
40
20
0
Trap #
Captures

Figure 8. Exiting amphibian and reptile captures per trap array at the pond.

Number of Exiting Captures

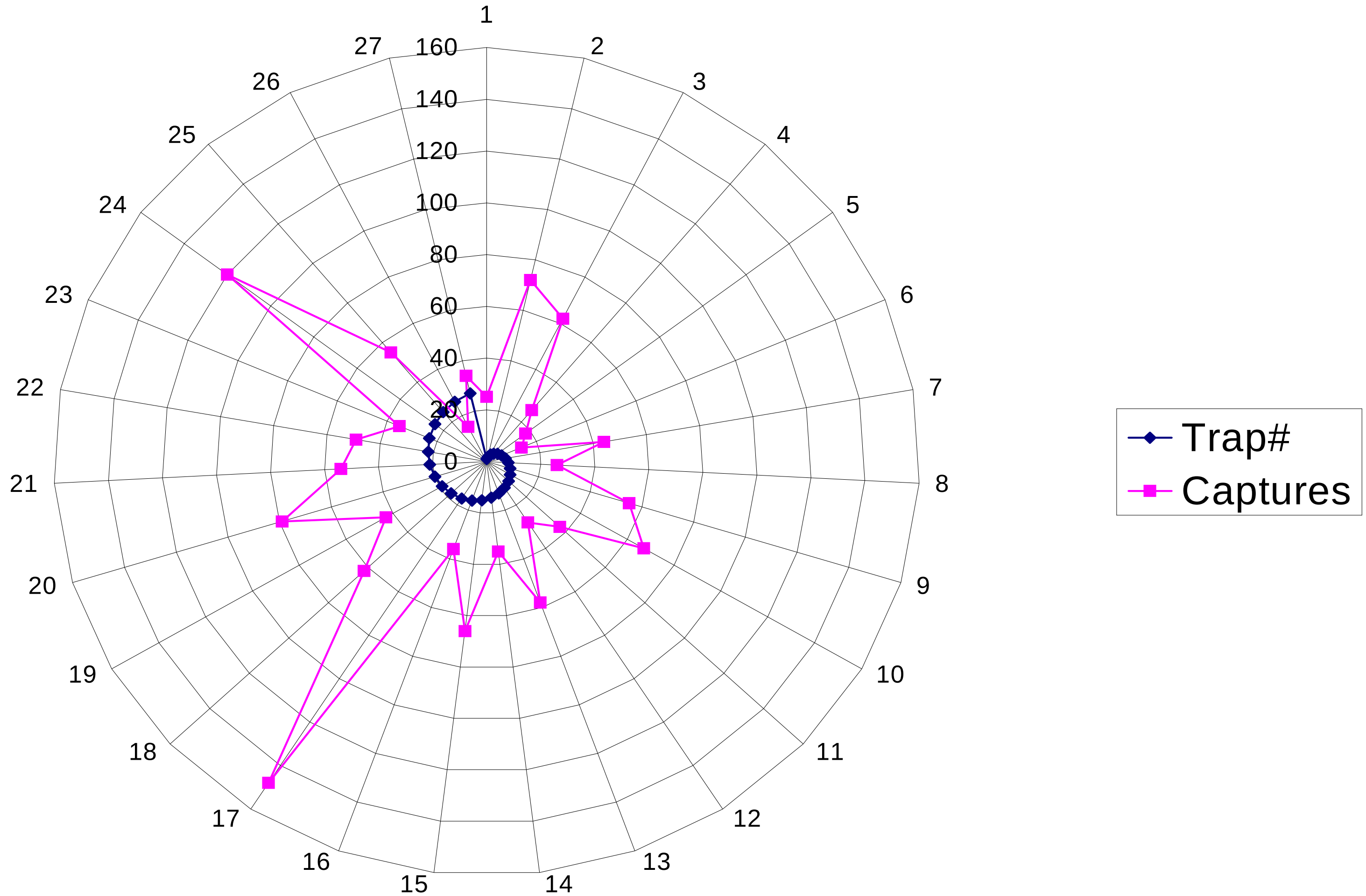


Figure 9. Total Anuran captures at the pond.

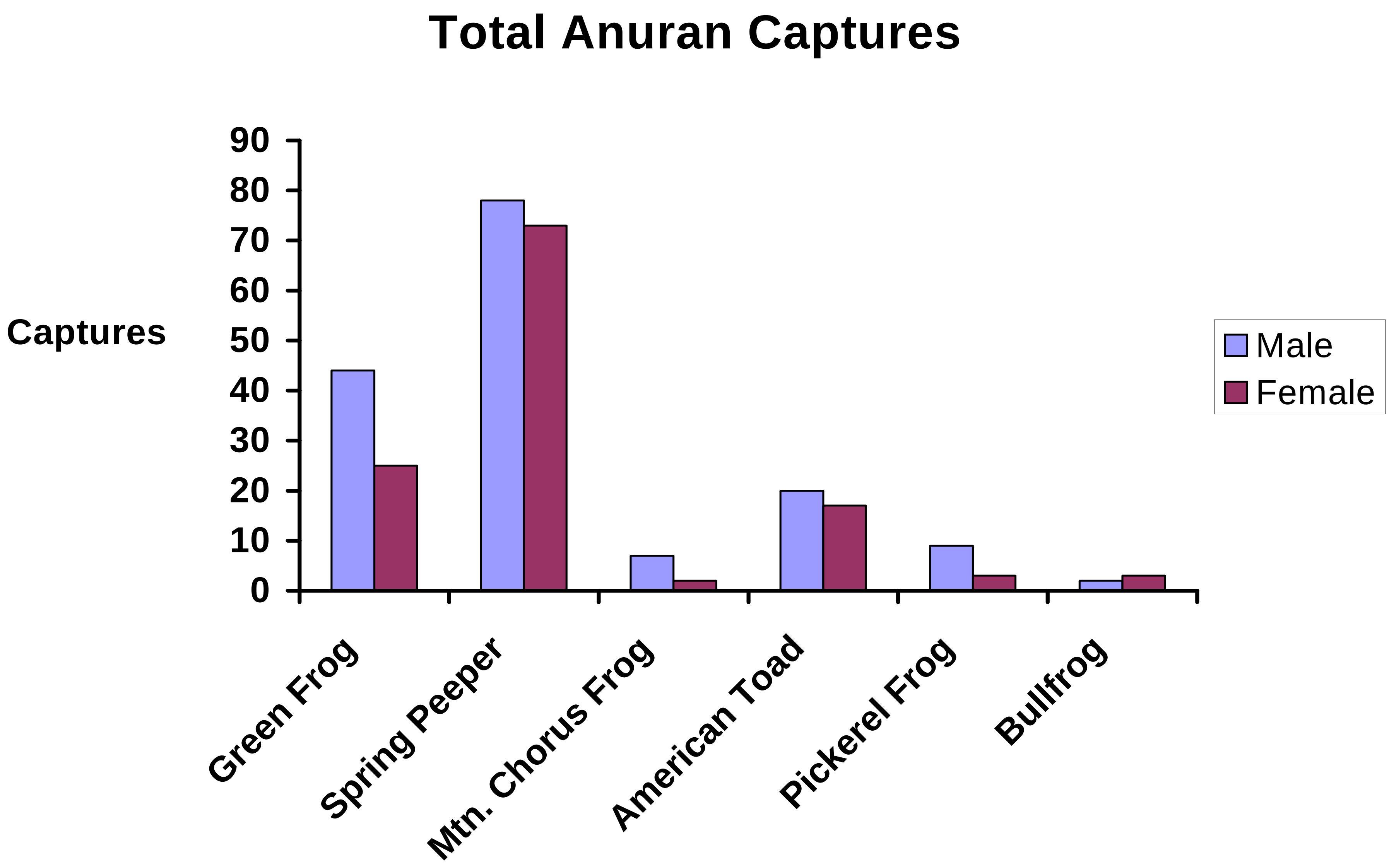
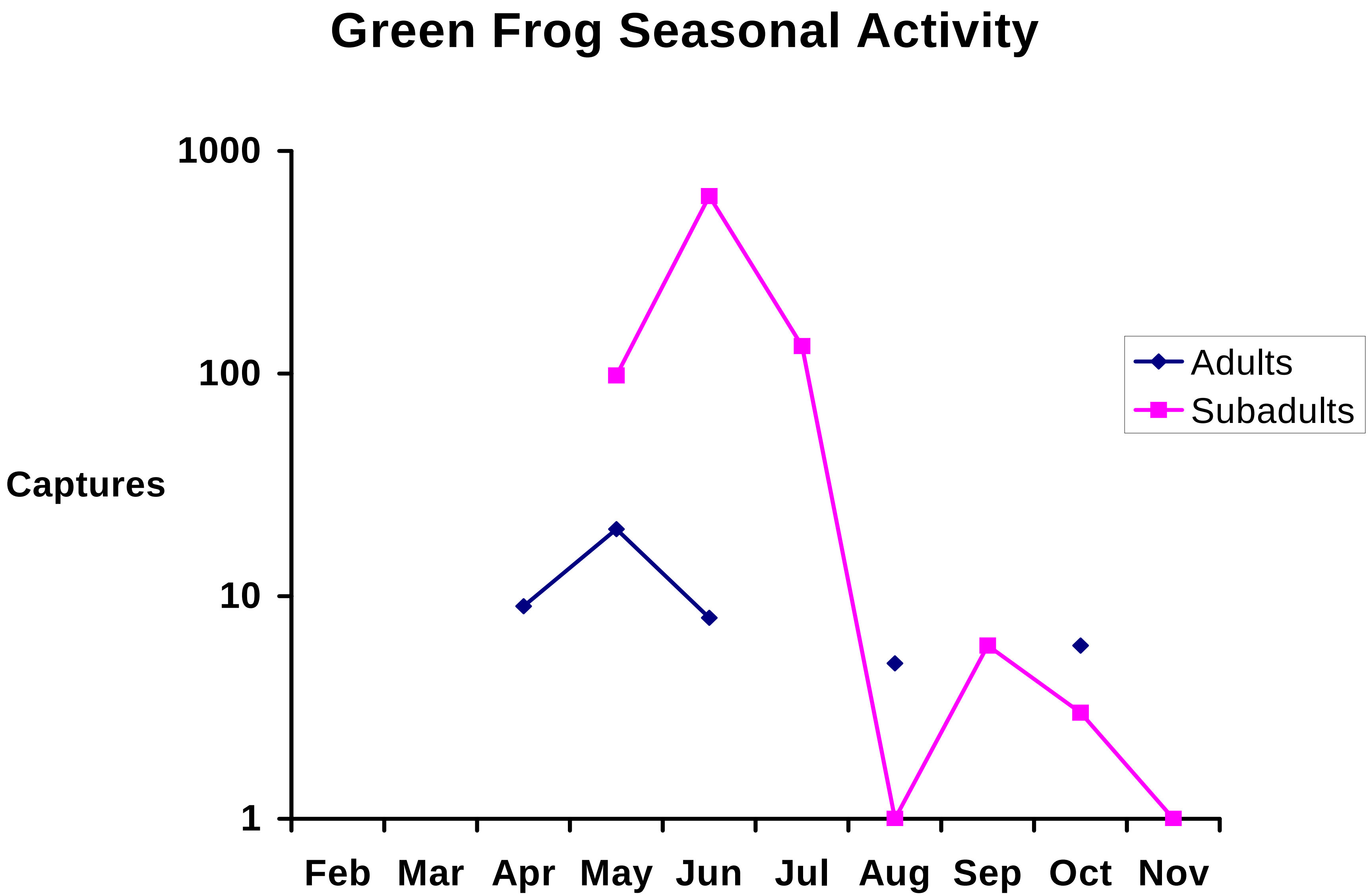

Total Anuran Captures
Captures
90
80
70
60
50
40
30
20
10
0
Green Frog
Spring Peeper
Mtn. Chorus Frog
American Toad
Pickerel Frog
Bullfrog
Male
Female

Figure 10. Northern Green Frog adult and subadult seasonal activity at the pond.



Green Frog Seasonal Activity
1000
100
10
1
Captures
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Adults
Subadults

Figure 11. Percent of total anurans captured at the pond.

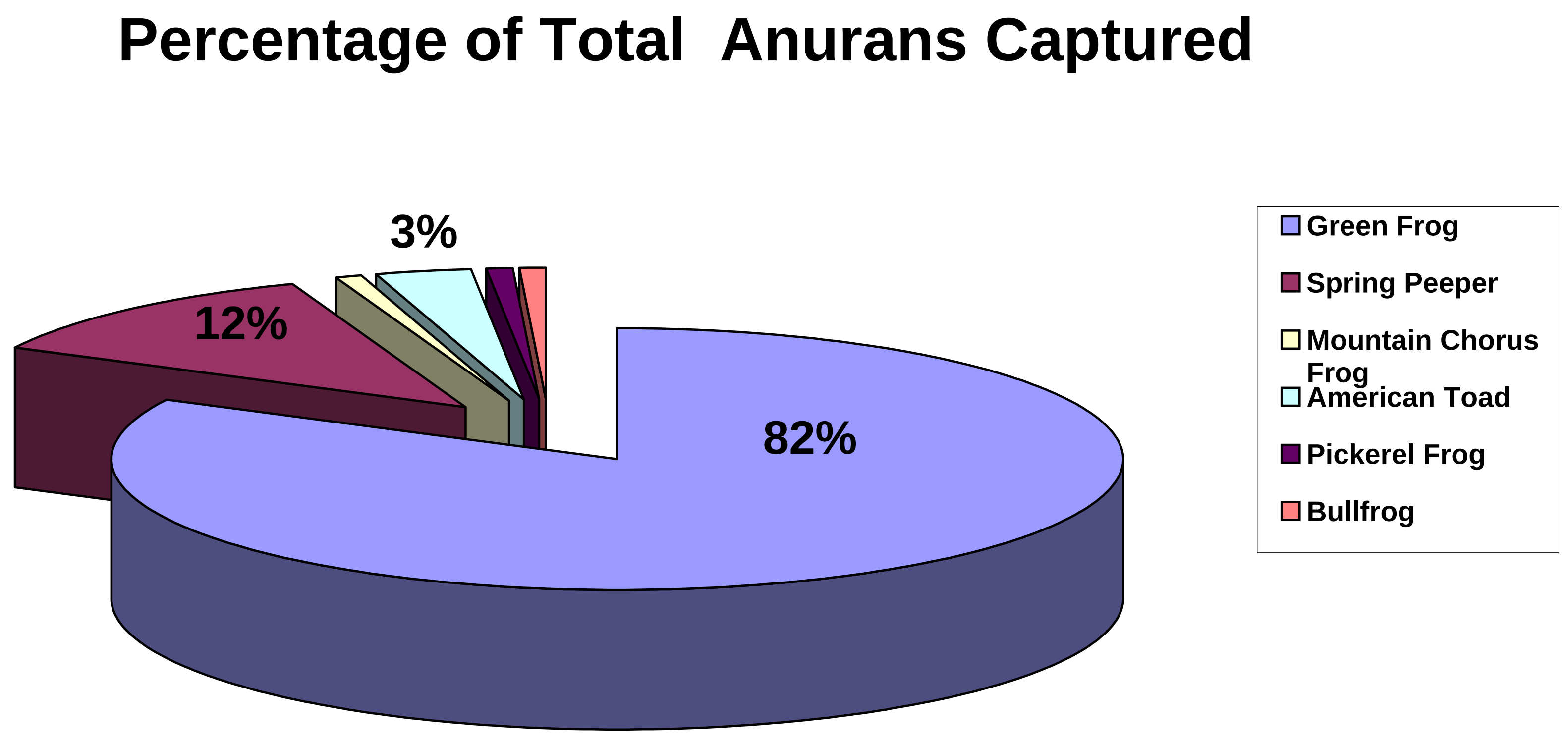

Percentage of Total Anurans Captured
3%
12%
82%
Green Frog
Spring Peeper
Mountain Chorus Frog
American Toad
Pickerel Frog
Bullfrog

Figure 12. Terrestrial salamander captures at the pond.

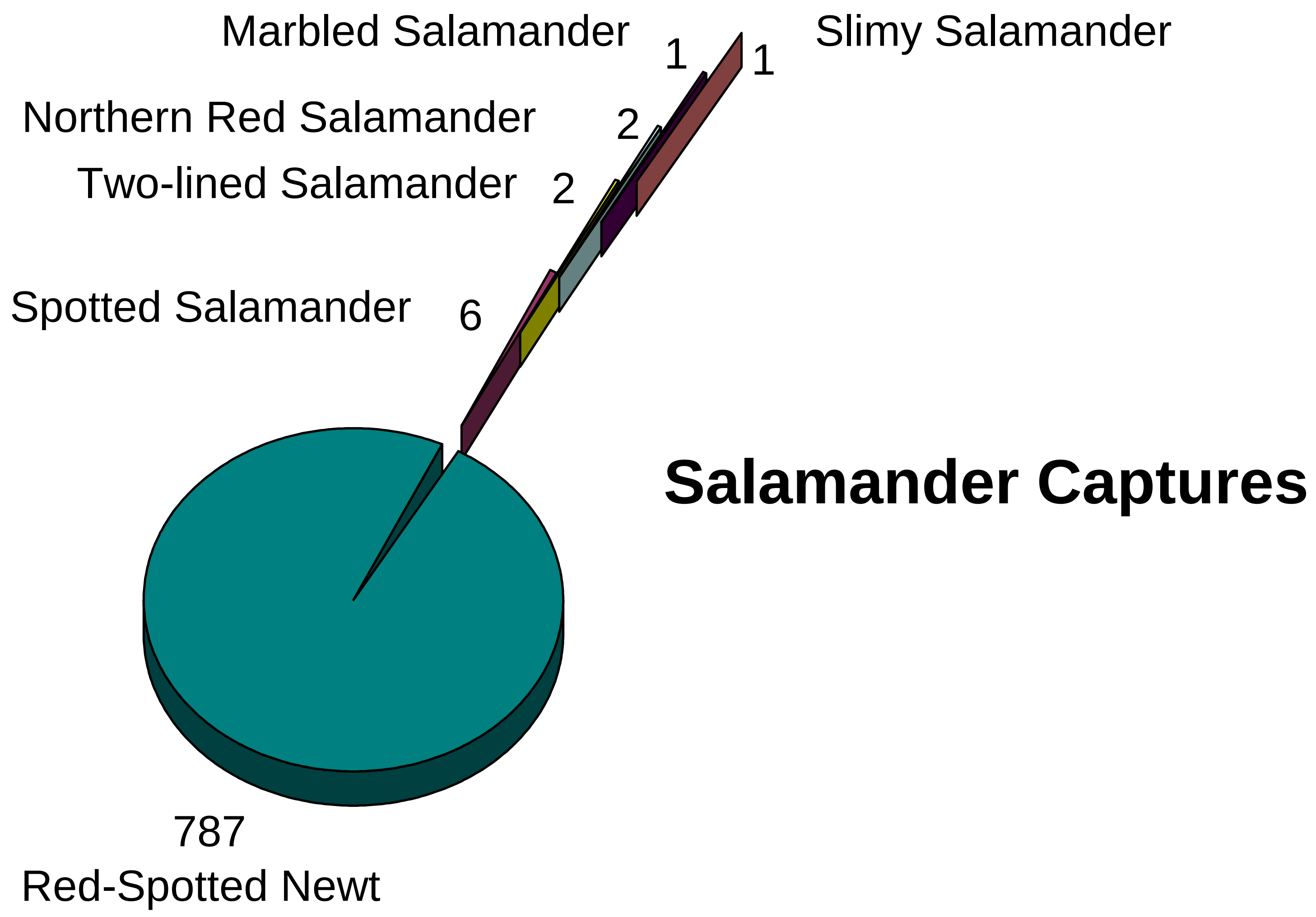

Marbled Salamander
1
Slimy Salamander
1
Northern Red Salamander
2
Two-lined Salamander
2
Spotted Salamander
6
Salamander Captures
787
Red-Spotted Newt

Figure 13. Terrestrial movement of *Notophthalmus v. viridescens* at the pond.

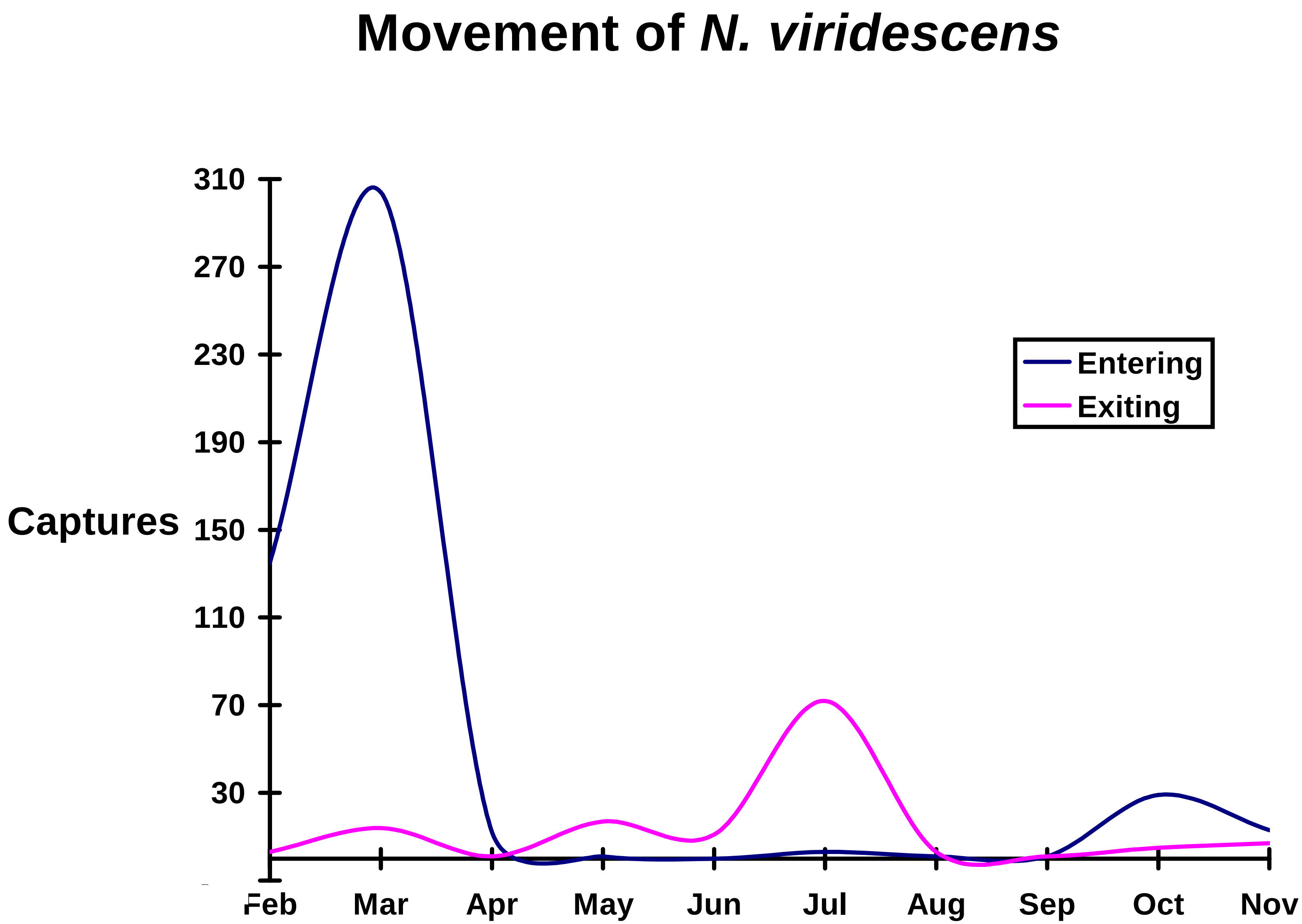

Movement of N. viridescens
Captures
310
270
230
190
150
110
70
30
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Entering
Exiting

Figure 14. Total collective minnow trap captures at the pond.

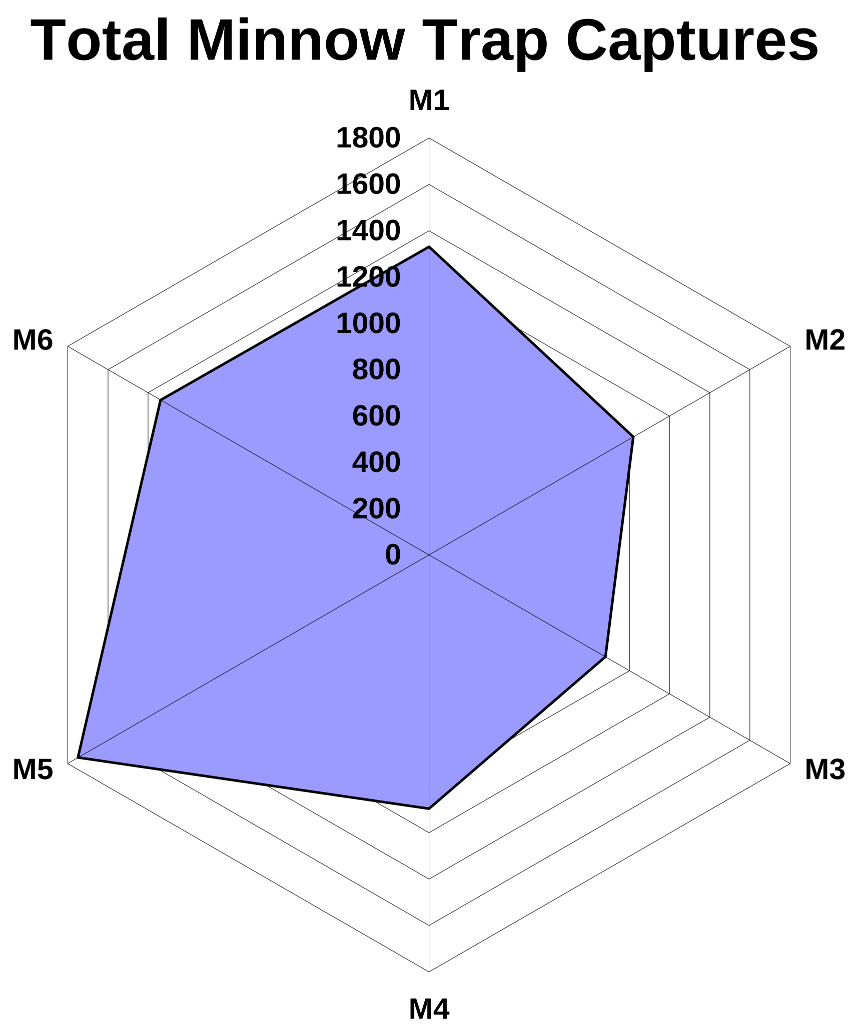

Total Minnow Trap Captures
M1
M2
M3
M4
M5
M6
1800
1600
1400
1200
1000
800
600
400
200
0

Figure 15. Total amphibian and reptile captures in Marshes 1 & 2.

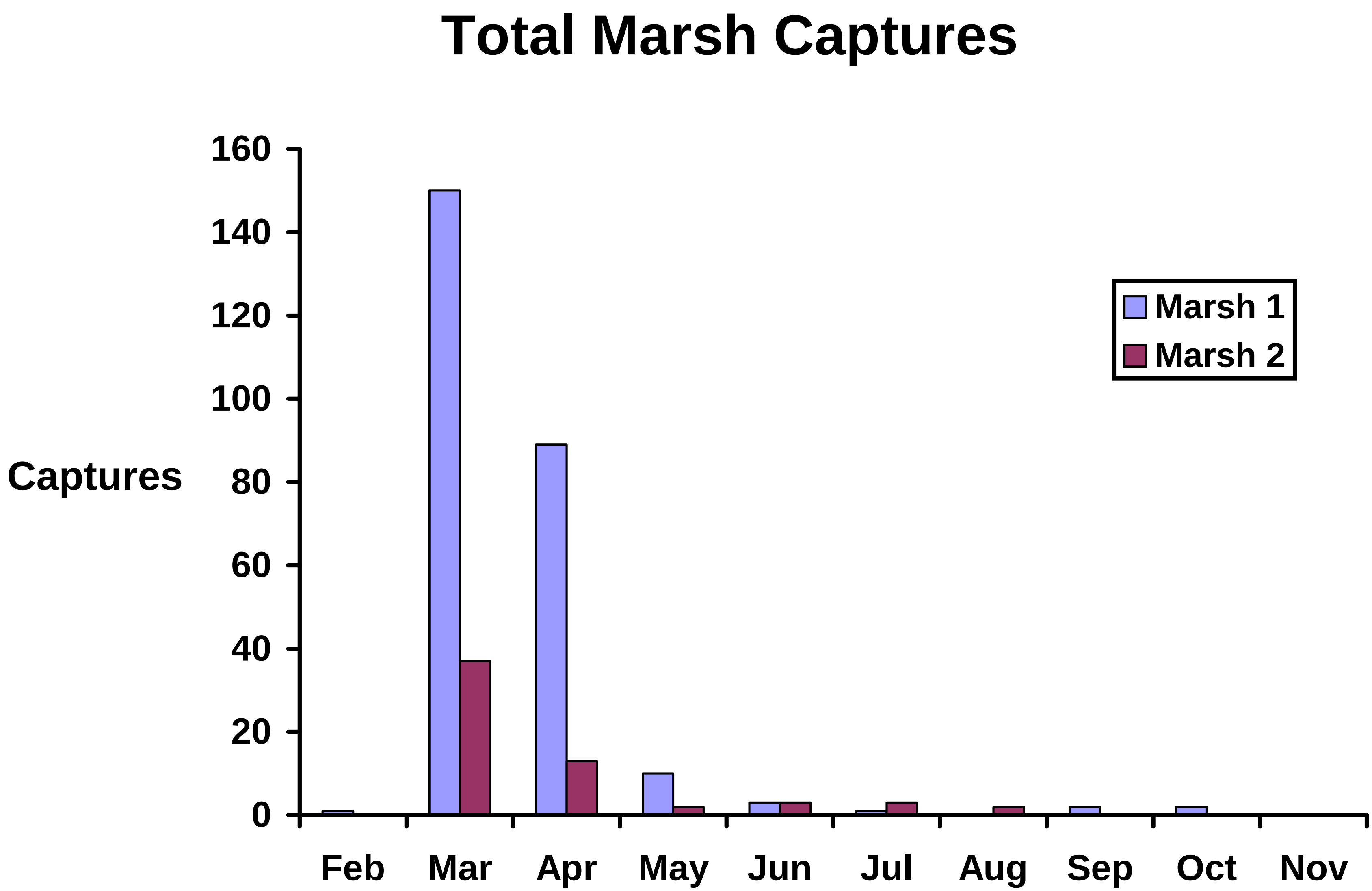

Total Marsh Captures
Captures
160
140
120
100
80
60
40
20
0
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Marsh 1
Marsh 2

Figure 16. Percent total amphibian and reptile captures in Marsh 1.

Percent Total Captures in Marsh 1

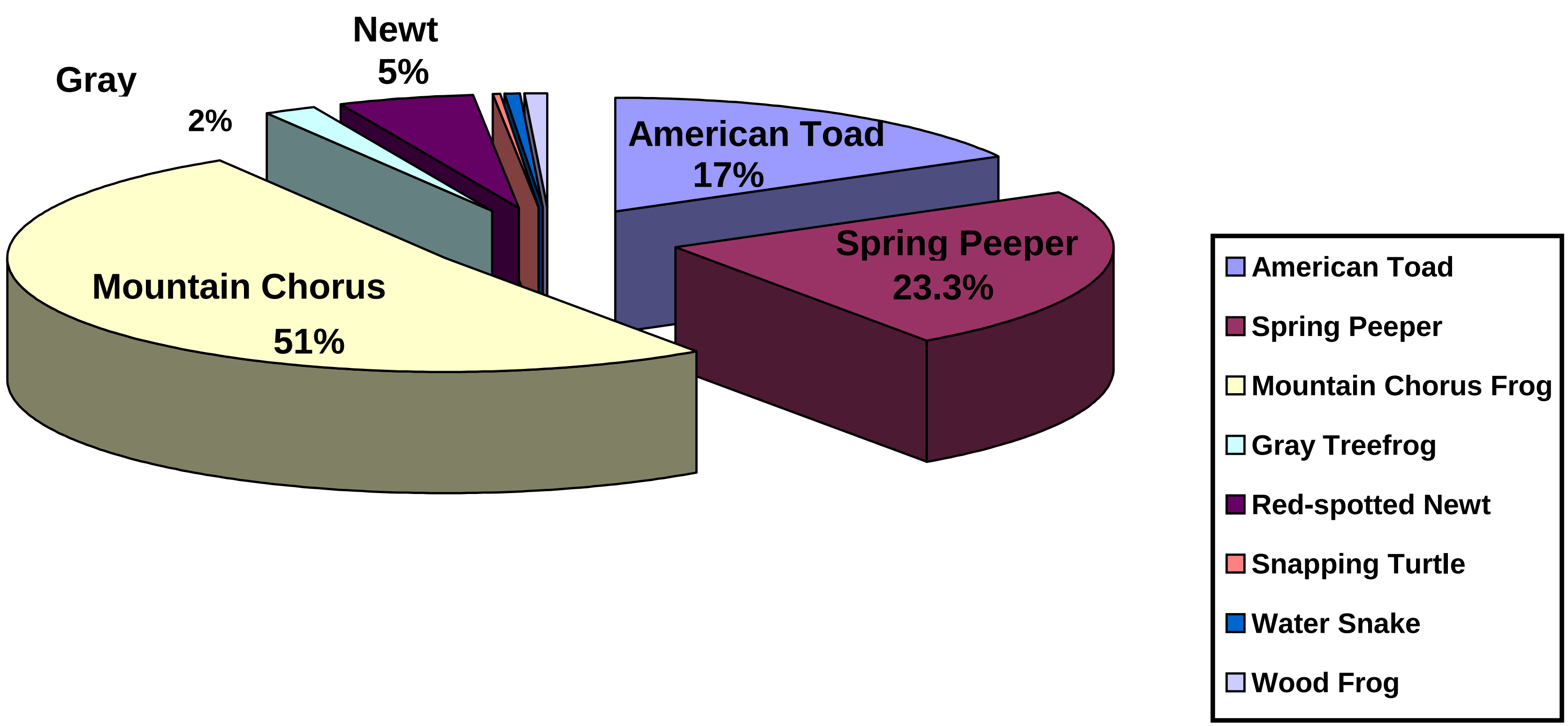


Figure 17. Percent total amphibian and reptile captures in Marsh 2.

Percentage of Captures in Marsh 2

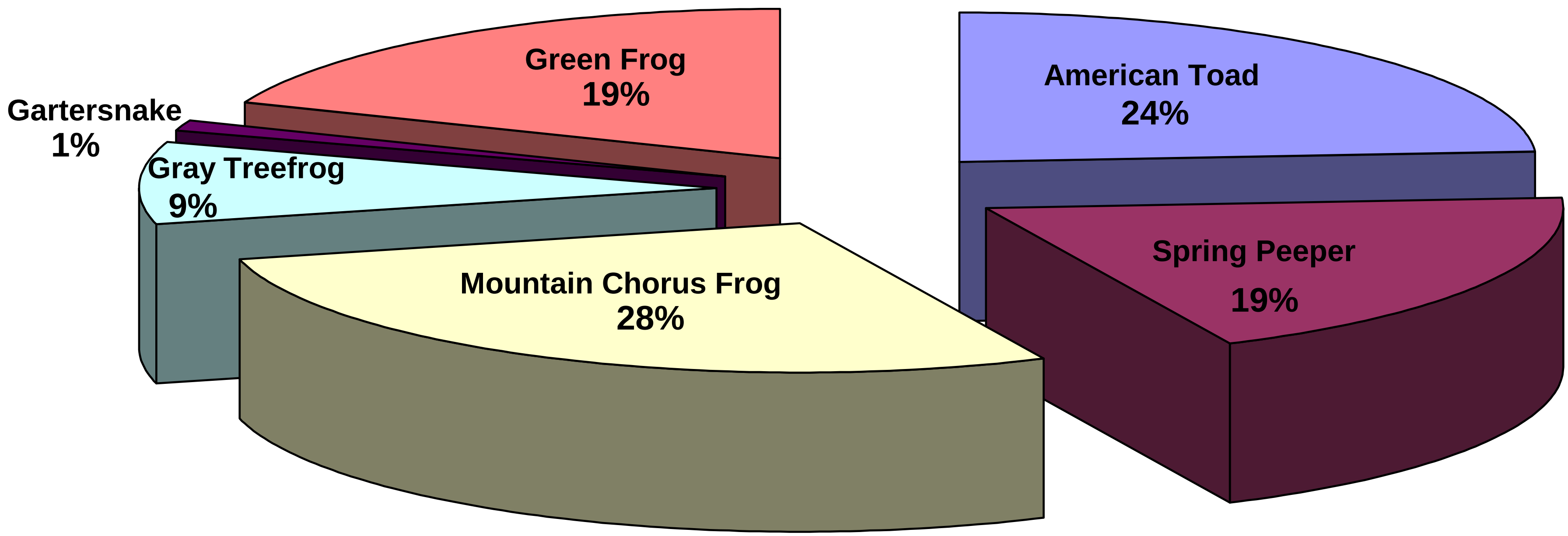
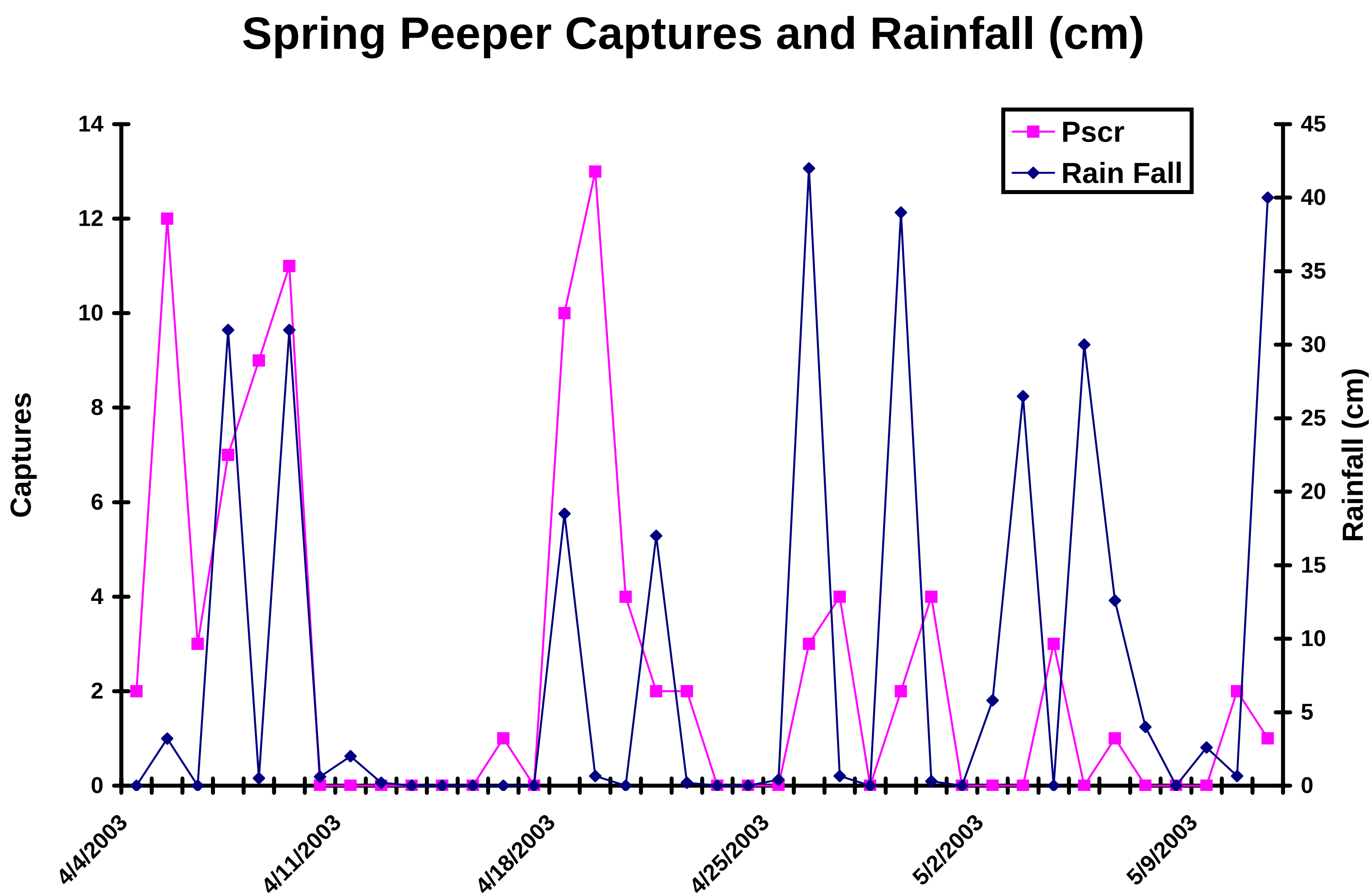


Figure 18. Spring Peeper captures and rainfall (cm).


Spring Peeper Captures and Rainfall (cm)
Pscr
Rain Fall
Captures
Rainfall (cm)
14
12
10
8
6
4
2
0
45
40
35
30
25
20
15
10
5
0
4/4/2003
4/11/2003
4/18/2003
4/25/2003
5/2/2003
5/9/2003

Curriculum Vitae

Vanessa A. Dozeman

Education:

2004 Master of Science
Marshall University; Huntington, West Virginia
Major Coursework: Biological Sciences
Thesis: Use of an artificial pond and marshes by amphibians and reptiles in West Virginia

2002: Regents Bachelor's of Art
Marshall University; Huntington, West Virginia

1994- 1996, 2000-2001: Grand Valley State University; Allendale, Michigan
Major Coursework: Biological Sciences
Activities: Crew and Fencing

1992-1992: University of Findlay; Findlay, Ohio
Major Coursework: Equestrian Studies
Activities: Horse Club

Work Experience:

2003: Field Technician; Turtle Survey, West Virginia Department of Natural Resources
Responsibilities: conducted intensive trapping, took morphometric data, documented locations, and photographed individual animals to find current distribution of all species of aquatic turtles in West Virginia

Field Technician; Stream Salamander Survey, United States Geological Survey
Responsibilities: carried out established protocol for capturing and recording data to find the potential effects of habitat disturbance on stream salamanders in West Virginia.

Co-investigator; Mud River Ecological Assessment, United States Army Corps of Engineers- Huntington District
Responsibilities: inventories of amphibians, reptiles and birds; including call surveys of birds and frogs, aquatic trapping, time constraint surveys, and microhabitat assessment

Field Technician, National Park Service
Responsibilities: to survey amphibian and reptiles on the C and O Canal and National Parks in the Maryland, West Virginia, and Virginia Tri-state area. Survey methods included call surveys and microhabitat assessments

Field Technician; Gauley River National Recreational Area, US Department of Interior and National Park Service
Responsibilities: conduct surveys of amphibian and reptile species in the Gauley River; survey methods include call surveys and microhabitat assessment

2002-present: Independent Contractor; Glenmalure Farm: Paris, Kentucky
Responsibilities: Equine therapist, rider

1998-2003: Horse Technician; Highland Farm: Paris, Kentucky
Responsibilities: Equine therapist, care of competition hitch of Clydesdales, assisted with cattle operations including branding, calving, vaccinating, tagging, sorting and herding

Posters:

DOZEMAN, VANESSA AND THOMAS K. PAULEY, Use of an artificial pond by amphibians and reptiles in West Virginia, Annual meeting of the Association of Southeastern Biologists, 2004.