# DEERFIELD RIVER WATERSHED

# VOLUNTEER WETLAND MONITORING PROJECT:

# FINAL REPORT 1999-2001

Prepared for:

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November 14, 2003

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ABSTRACT – Twenty-seven wetlands in the Deerfield River watershed were surveyed for selected marshbirds and calling amphibians from 1999-2001. Surveys were conducted by volunteers and project staff. Four of the eight target marshbirds were observed: American bittern, least bittern, sora, and Virginia rail. The Virginia rail and American bittern were the most frequently-encountered marshbirds at survey sites. The number of marshbird species observed was positively correlated with the amount of shallow marsh, aquatic bed, and shrub habitats at wetlands. Eight species of calling amphibians were detected during the three-year study. The most frequently observed species were the spring peeper, green frog, and gray treefrog. The rarest species was the Northern leopard frog. We found no correlation between the number of amphibian species present and the amount of any habitat cover type. We recommend re-surveying these wetlands in approximately five years to track changes that may occur in the abundance and distribution of marshbird and calling amphibian communities in the Deerfield River watershed.

## INTRODUCTION

Between 1780 and the mid-1980s, Massachusetts lost approximately 28% of its wetlands (Dahl 1990). Although outright destruction of wetlands has abated since the 1980s, the United States lost more than 1.2 million acres of inland marshes from 1986 to 1997 (Dahl 2000). This long-term reduction in emergent wetlands or marshes has resulted in the declines of several species of marshbirds (Eddleman et al. 1988; Gibbs and Melvin 1992a.b.c.d.; Veit and Petersen 1993). In Massachusetts, the following marsh-dependent species have special status: the pied-billed grebe (*Podilymbus podiceps*), American bittern (*Botaurus lentiginosus*), least bittern (*Ixobrychus exilis*) and sedge wren (*Cistothorus platensis*) are Endangered; the king rail (*Rallus elegans*) is Threatened, and the common moorhen (*Gallinula chloropus*) is a Species of Special Concern (Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife). In addition to wetland loss and alteration, environmental contaminants, acidification, and human disturbance have contributed to reductions in the breeding populations of these species (Eddleman et al. 1988; Gibbs and Melvin 1992a.b.c.d.).

Currently, there is debate over the role of natural- versus human-induced fluctuations in amphibian population declines (Blaustein et al. 1994; Pechmann and Wilbur 1994). Habitat loss, degradation, and fragmentation are believed to play key roles in this decline (Dodd and Cade 1998; Gibbs 2000; Pope et al. 2000; Guerry and Hunter 2002). Reductions in amphibian populations from roadway mortality (Ashley and Robinson 1996; Findlay and Houlahan 1997; Trombulak and Frissell 1998), introduction of non-native species, including fishes and frogs (Kiesecker and Blaustein 1998; Knapp and Mathews 2000), and chemical contamination of breeding and wintering sites (Stebbins and Cohen 1995; Semlitsch 2002), have been documented.

Between March and July, 1999-2001, calling amphibians and selected marshbirds were surveyed in 11 municipalities in the Massachusetts portion of the Deerfield River watershed, located in western Massachusetts (Figure 1). The objectives of the study were to: (1) gather baseline data on calling amphibians and rare marshbirds and their habitats; (2) identify biologically significant wetlands; for example, those that support rare species and/or a high number of species; and (3) increase landowners' and citizen monitors' awareness of the value and diversity of wetland resources in their communities.

Two local watershed groups sponsored this project: the Green River Watershed Preservation Alliance and the Deerfield River Watershed Association (DRWA). Our project was modeled, in part, on the *Marsh Monitoring Project*, an on-going program that surveys marshbirds and amphibians in the Great Lakes basin (Weeber and Vallianatos 2000).

## STUDY AREA

The Deerfield River watershed is located in Vermont and Massachusetts, and drains a 1,722 sq km (665 sq mi) area. The river travels approximately 113 km (70 mi) from its headwaters in the Green Mountains of Vermont to its confluence with the Connecticut River in Greenfield, Massachusetts (Franklin Co. Planning Dept. 1990). The monitoring project took place in the Massachusetts portion of the watershed, which comprises 900 sq km (347 sq mi). Approximately 80% of the study area is forested, and the region is primarily rural (Franklin Co. Planning Dept. 1990). Twenty-seven wetlands were surveyed in 11 towns; on private, town, and state-owned property (Figure 1).

## METHODS

### Selection of Wetland Survey Sites

Wetlands were evaluated for several criteria, including verification of wetland type, minimum size requirements, volunteer safety, and securing permission from landowners (Serrentino, unpubl. rep., 1999). We used two sources of data to verify wetland type (e.g., marsh versus wooded swamp): (1) color-infrared aerial photographs of the Green River watershed, dated spring 1992 (1:40,000; 1 in = 3,333 ft); and (2) USGS topographical maps (7.5 by 15 minute) of the entire Deerfield River watershed. After this initial evaluation, we conducted field checks of approximately 48 wetlands. We confirmed that each wetland contained a minimum of 0.1 ha (0.3 ac) of aquatic bed or emergent vegetation (Crowley 1994). Several shrub swamps were included because some marshbirds tolerate varying amounts of shrub vegetation (Forbush 1925; Gibbs and Melvin 1992b.).

Because volunteers were conducting surveys, each site was checked for potential safety issues, such as difficult access, poisonous plants, illegal dump sites, and others (Miller ET al.1996).

Lastly, permission from landowners was required before a wetland could be surveyed. Following completion of wetland evaluations, 34 sites were selected as candidates for the project. Twenty-seven wetlands were ultimately surveyed (Table 1).

**Marshbird Surveys**

Survey methodology was adapted from Gibbs and Melvin (1993), Crowley (1994), and Long Point Bird Observatory and Environment Canada (1997). Eight marshbird species were selected after consultation with personnel with the Massachusetts Natural Heritage and Endangered Species Program (S. Melvin, pers. comm.): pied-billed grebe (*Podilymbus podiceps*), American bittern (*Botaurus lentiginosus*), least bittern (*Ixobrychus exilis*), king rail (*Rallus elegans*), Virginia rail (*Rallus limicola*), sora (*Porzana carolina*), common moorhen (*Gallinula chloropus*), and sedge wren (*Cistothorus platensis*). Because of their secretive habits, these marshbirds are surveyed by broadcasting their calls and songs and listening for a response. We used recordings from compact disks (Walton and Lawson 1994) to make 12-14 min cassette tapes of calls and songs. Each tape contained one minute of each species' call with 30 seconds of silence between species, in random order. We used portable tape players, such as the Panasonic Model no. RQ-2102, or similar units, to broadcast calls. After the broadcast, a five-minute passive listening period was included.

Survey stations were established by either project staff or volunteers. Stations were situated adjacent to the marsh edge or roadway, provided that traffic volume during survey periods was low (less than five vehicles per 10 minutes). The centers of each station were approximately 200 m apart, and consisted of a central point located on the baseline of a 100 m radius semi-circle (Long Point Bird Observatory and Environment Canada 1997). Stations were oriented to maximize the amount of marsh vegetation within the 100 m semi-circle.

Each wetland was surveyed three times between May 1$^{st}$ and July 15th, from 0.5 hr before sunrise until 4.5 hr after sunrise (Gibbs and Melvin 1993). Surveys were conducted at least 10 days apart. Weather conditions were recorded at the beginning of each survey and at the end, if more than 30 minutes had elapsed. Air temperature, cloud cover, and wind speed were recorded. Surveys were not conducted during rainy weather, or if wind speeds were greater than 20-30 kph (13-18 mph).

At each station we broadcast the calls and songs of the eight target species and listened for five minutes after the end of the broadcast. We recorded any birds seen or heard during both the broadcast and silent listening periods, including non-target bird species as well. Observations of birds were recorded using the protocol recommended by Long Point Bird Observatory and Environment Canada (1997), with minor changes.

**Calling Amphibian Surveys**

Amphibian survey methods were adapted from Long Point Bird Observatory and Environment Canada (1997) and the North American Amphibian Monitoring Program (NAAMP: S. Jackson, Massachusetts Coordinator, pers. comm.). Amphibians were surveyed by monitoring their breeding sites after sunset. Calling amphibians that may be encountered in the Deerfield River watershed include: spring peeper (*Pseudacris crucifer*), gray treefrog (*Hyla versicolor*), Eastern spadefoot toad (*Scaphiopus holbrookii*), American toad (*Bufo americanus),* Fowler's toad (*Bufo woodhousii fowleri),* Northern leopard frog (*Rana pipiens*), pickerel frog *(Rana palustris*), wood frog (*Rana sylvatica*), green frog (*Rana clamitans melanota*), and bullfrog (*Rana catesbeiana*) (NAAMP: S. Jackson, Massachusetts Coordinator, pers. comm.).

Establishment of survey stations was identical to that described for marshbirds: the centers of stations were 200 m apart and each station consisted of a 100 m radius semi-circle. Frogs calling outside the 100 m semi-circle were included in surveys because it is difficult to determine the exact location of calling individuals after dark. Because of safety concerns associated with night surveys, volunteers were not required to cover an entire wetland. Therefore, we were unable to cover all appropriate habitats at sites greater than approximately 2.0 ha (5.0 ac).

Amphibians were surveyed during four, two-week sampling periods or windows, beginning in late March/early April and ending in early July (www.mp2-usgs.gov/NAAMP/protocol/). These periods or windows coincided with the breeding seasons of the species of interest. Frog surveys began 0.5 hr after sunset at the earliest, and could continue until midnight. Weather conditions were recorded using the same protocol as that described for marshbirds, with the following exceptions: light rain, mist and/or fog was permitted as long as hearing was not impaired, and surveys were conducted only if nighttime temperatures were above the minimum threshold for the sampling window. During the first window, a minimum temperature of 42 degrees F was required for surveys to occur; thereafter a minimum of 50 degrees was in effect for the last three windows.

Frogs were surveyed for four minutes at each station. The identification and location of all species heard calling in the sampling area were recorded. Observations were recorded and mapped according to the protocol outlined in Long Point Bird Observatory and Environment Canada (1997). For each observation, the intensity of calling was identified by a C*all Level Code* of 1, 2 or 3. A C*all Level Code* of 1 was used if *calls were not simultaneous and the number of individuals could be accurately counted*. C*all Level Code* 2 was used if *some calls were simultaneous and the number of individuals could be reliably estimated*. C*all Level Code* 3 was used for a full chorus, e.g., *calls were continuous and overlapping and the number of individuals could not be reliably estimated*.

**Wetland Habitat Evaluations**

Wetland habitats were evaluated for each wetland and at each survey station within wetlands. We used remote sensing to identify and quantify the wetland habitats found at the 24 sites that were surveyed for marshbirds. These data were used determine whether there was a relationship between the amount and type of wetland habitat available, and the presence/absence of marshbirds at each site. We did not perform this analysis for calling amphibians because at most sites we were unable to cover all appropriate habitats. Therefore, calling amphibian habitats were only evaluated at the station level.

Habitat Assessment at Wetlands

Wetlands were delineated on color-infrared aerial photographs taken in April of 1999 and 2000, at a scale of 1:12,000 (1 in = 1,000 ft). We used the methods outlined by the Massachusetts Wetlands Conservancy Program to delineate wetland habitats on aerial photographs (Stone 1994). We classified wetland habitats into the following types: deep marsh, shallow marsh, aquatic bed, shrub swamp, and open water. Deep marsh and shallow marsh were distinguished from each other primarily by differences in water depth (Swain and Kearsley 2000): deep marshes average 15 cm to 1.0 m (6 in to 3.3 ft) deep, whereas shallow marsh or marsh is approximately 15 cm (6 in) deep or less. Wooded swamps were not included because these habitats are not used by the target marshbirds.

To determine the area covered by each habitat type, wetland polygons were photocopied and enlarged to twice their original size. The area of each polygon was calculated with a digital planimeter. The resultant wetland map contained the amount and type of wetland habitats found at the 26 sites.

Habitat Assessments at Stations

At each marshbird and amphibian survey station, we conducted habitat assessments to identify the general features of each station (e.g., wetland permanency or hydroperiod, land use, human influences), and to determine habitat preferences of marshbirds and amphibians within each wetland. Wetland permanency or hydroperiod are terms used to characterize the length of time that a wetland holds water. We followed the protocol described in Long Point Bird Observatory and Environment Canada (1997) with minor changes. First, we determined wetland permanency and identified land use types at each station. Wetland permanency was divided into three categories: permanently flooded, semi-permanently flooded, and seasonally flooded. Land use type was described for the area behind the sampling station. We also identified any human-related effects at the station that may have impacted marshbird or calling amphibian communities, such as stormwater or agricultural runoff, heavily-traveled roadways, and others.

The second part of the assessment involved identifying and quantifying the major vegetative cover types at each station. We visually estimated the percent cover of four major types of wetland vegetation: (1) herbaceous emergent vegetation, (2) open water/floating plants, (3) trees (defined as greater than 5.0 m (16.5 ft) in height), and (4) shrubs and saplings (defined as less than 5.0 m in height). The amount of floating plant cover observed in open water areas was described qualitatively: none, slight, moderate, dense, and unknown.

Because most marshbirds are associated with particular emergent plant species or communities, we identified the four dominant emergents at each station using a visual estimation of cover. Only species that accounted for more than 10% of emergent cover were included. We also recorded any non-native, invasive plants that were present, such as common reed (*Phragmites spp.*), purple loosestrife (*Lythrum salicaria*), Japanese knotweed (*Polygonum cuspidatum*), and others.

## Volunteer Training and Landowner Outreach

Volunteers were required to attend one training session before each monitoring season began. The three-hour classroom session focused on identification of wildlife and plant communities, life history information, survey protocols, and safety issues. During their first visit to a monitoring site, volunteers were accompanied by a staff biologist. At this time, station locations were verified and questions concerning survey protocol and plant and animal identification were answered. Volunteers who were unable to attend classroom sessions received their training during one-on-one field sessions. Several volunteers chose their own monitoring sites. These sites were checked by staff biologists to verify their suitability for the project. Project staff was available during the field season to answer questions from volunteers and confirm observations of rare species.

At the end of each monitoring season, volunteers received a newsletter that included survey results and general information on wetland-related topics. Landowners were also given survey results at this time. At the end of the three-year project, landowners received fact sheets (published by the Connecticut River Joint Commission) that contained information on the importance of maintaining vegetated buffers adjacent to wetlands and riparian areas. Landowners also received a short description of their wetland and a list of the flora and fauna that was observed.

# RESULTS

## Marshbird Surveys

We conducted marshbird surveys at 20 wetlands in 1999 and at 24 in 2000 and 2001 (Table 2). Fewer wetlands were monitored in 1999 because we spent the first field season developing the survey protocols. No sites were surveyed the appropriate number of times (3) in 1999: 60% of wetlands were surveyed once and 40% were surveyed twice (n = 20). However, in 2000 75% of wetlands were surveyed three times (n = 24), and 83.3% were surveyed three times in 2001 (n = 24).

Of the eight target species, three were never observed during the three-year project: king rail, common moorhen, and sedge wren. A pied-billed grebe was heard calling at the North Shelburne site in April, 2000; however, it was never detected during subsequent surveys of the same area. The Virginia rail was the most frequently observed species, occurring at between 16 and 31% of stations during the three-year period (Table 2). This rail, detected at 11 wetlands, was the most widely-distributed marshbird (Table 3). The American bittern was the second most frequently detected species, and was observed at a total of seven wetlands during the three-year study. The sora and least bittern were rarely observed, although the sora was detected more frequently and occupied more wetlands than the least bittern.

To determine which wetlands were the most important to marshbird populations at the study area, each site was evaluated according to the following parameters: (1) total number of marshbird species present; (2) total number of breeding seasons that a species was observed at a site; and (3) total number of adult birds of each species detected at a site. Seven wetlands supported two or more species of marshbirds (Table 3): North Shelburne, Schneck Brook, Chip-and-Putt, Hunt Road, Beaver Pond, Chase, and Rtes. 5&10 North. At five wetlands (Chip-and-Putt, Hunt Road, North Shelburne, Rtes. 5&10 North, Schneck Brook) at least one marshbird species was observed every year the site was surveyed.

We estimated the number of adult birds present at each wetland during the three-year study. A minimum of one adult marshbird was observed at least once in three years at four sites: Ball Field, Hell's Kitchen Road, Leyden Road, and Rte.116 Plainfield. Between one and three individuals of one or more species were present for a minimum of two years at six sites: Schneck Brook, Chip-and-Putt, Hunt Road, Beaver Pond, Rtes. 5&10 North, and Lower Road. North Shelburne supported the highest number of individuals, ranging from 8 to 11 each year.

**Wetland Habitat Evaluations**

Habitat Assessments at Wetlands

To determine if there was a correlation between the amount of each wetland habitat available and the presence of marshbirds at 24 wetlands, we performed a least squares regression between the total number of species observed at wetlands and arcsine-transformed percent of each habitat type. Five habitat types were used in the analysis: shallow marsh, deep marsh, shrub swamp, aquatic bed, and open water. We pooled observations of all species detected during the three-year period because of the low number of observations for three of the four marshbirds (American and least bitterns, and sora). The amount of shallow marsh, aquatic bed, and shrub habitat was positively correlated with the number of species observed (Table 4). No significant relationship was found between the amount of deep marsh or open water habitats and the number of species observed. We repeated the analysis using total size of each wetland (e.g., the sum of all the wetland habitats at each site) and the results were significant (Table 4). As the total size of a wetland increased, the more marshbird species were likely to be present.

Habitat Assessments at Stations

Habitat assessments were conducted at 39 marshbird stations. We added two habitats to the original four cover types: developed (roadways, residential) and agriculture (crop, hayfield, pasture). We found that survey stations intersected non-wetland habitat at five sites (Chase, Oxbow, Phillips Road, Rtes. 5&10 North, and Schneck Brook). This occurred at several sites that were situated adjacent to agricultural habitats or urbanized areas.

Of the six major cover types/habitats found at stations, developed, agriculture, shrubs, and open water/floating plants usually comprised less than 25% of the total cover (Figure 2). Emergents were most frequently encountered in the 25-49% cover class; however, at 15% of stations emergents were the dominant type of cover (e.g., comprising < 75% total cover). Tree cover was most frequently encountered in the 0-24% cover class. At approximately one-third of the stations, trees comprised 25-49% of the cover at stations. Tree coverage at many stations was higher than expected because wetlands were often located within or next to forests.

Wetland permanency at the majority of stations (56.4%) was characterized as permanently flooded. Semi-permanent conditions accounted for 38.5% of the stations, whereas 5.1% of the stations were characterized as seasonally flooded. Within the open water category, floating plant cover was never recorded at more than half of the stations (Table 5). Dense plant cover was observed at 18 % of stations, whereas both slight or moderate plant cover was found at less than 15% of stations.

To determine whether there was a relationship between the two habitats and four cover types (developed, agriculture, emergent vegetation, open water/floating plants, shrubs, and trees) and the number of marshbird species observed at stations, we performed a least squares regression between total number of species and arcsine-transformed percent of each cover or habitat type. We pooled observations of all species detected during the three-year period because of the low number of observations of three of the four marshbirds (American and least bitterns, and sora). There was a significant positive correlation between number of species observed at stations and the amount of emergent cover, whereas the amount of tree cover was negatively correlated with number of species (Table 6).

The protocol for habitat assessments at stations included separating the emergent cover category into groups of species or individual species, such as grasses, sedges and rushes, cattails, and other non-woody plants. However, the majority of volunteers were unable to separate plants into groups of species, or they had difficulty identifying individual species. As a result of this problem, we lacked detailed information on the emergent species found at stations. Therefore, we did not attempt to determine whether there was a correlation between the number of marshbird species at stations and the type of emergent cover.

**Calling Amphibian Surveys**

Wetlands were surveyed for calling amphibians from March to July, 1999 to 2001. We did not include the 1999 surveys in analyses because most surveys did not start until early June, therefore results were biased towards the later-calling amphibians. For example, no wood frogs, American toads, Northern leopard frogs, and pickerel frogs were heard at 19 wetlands in 1999. We also omitted the following sites and years from analyses because the data were not collected correctly or the survey results were not returned: Bement School (2000 only), Rtes. 5&10 North (all surveys), and Catamount (all surveys).

In 2000 and 2001, the number of wetlands surveyed increased from 19 to 25 and 26 respectively. In 2000 the mean number of times each wetland was surveyed was 3.5 (N = 24), and in 2001 the mean increased to 3.9 (N = 24). Most of the missed surveys in 2000 occurred during the first window or survey period at 10 sites: Ballfield, Chase, Hallockville Road, Hawley Bog, Hell's Kitchen Road, North Shelburne, Lower Road, Rte. 116, Schneck Brook, and West Leyden Road. Surveys were missed because of several factors: (1) Many volunteers were unsure when to survey because of a prolonged number of cold nights with temperatures below the survey threshold (e.g., less than 40 degrees F); and (2) Several volunteers dropped out of the project during the first window. In 2001 the number of sites surveyed during the first window increased substantially because volunteers were encouraged to extend the first survey window if weather conditions were unsuitable. As a result of these efforts, the number of wetlands where wood frogs were heard increased from six in 2000 to 14 wetlands in 2001.

We determined the percent of stations where each species occurred, pooling 2000 and 2001 data (Table 7). Spring peepers were found at almost 100% of stations, followed by green frogs (94.4%) and gray treefrogs (86.1%). Bullfrogs and wood frogs were found at over half the stations during the two-year period. Pickerel frogs and American toads were encountered at approximately one-third of the stations, whereas the rarest species, the Northern leopard frog, was found at less than 10% of the stations. Two species were never encountered during surveys: the Eastern spadefoot toad and Fowler's toad.

To determine how frequently each frog was encountered during surveys we summed the number of times each species was recorded at a station and divided this number by the total number of stations surveyed. We refer to this statistic as *percent station-years* (Weeber and Vallianatos 2000). The most frequently observed species, pooling data from 2000 and 2001, was the spring peeper: 94.3% station-years (Table 8). The green frog and gray treefrog were present in more than 50% station-years. Bullfrogs, wood frogs, American toads, and pickerel frogs were observed between 20 and 50% station-years. The Northern leopard frog was rarely encountered.

We calculated the mean calling code for the eight species of frogs observed, pooling data from 2000 and 2001 (Table 8). Mean calling codes ranged from a low of 1.00 for the Northern leopard frog, to a high of 2.57 for the spring peeper. For some species (e.g., the spring peeper and gray treefrog) there was a positive relationship between how often a species was encountered and its calling code. However, other frogs were usually heard at lower calling frequencies, including the bullfrog, green frog, pickerel frog, and Northern leopard frog. Although American toads and wood frogs were not observed as frequently as the spring peeper and gray treefrog, they tended to be heard at higher calling intensities. Pickerel frogs and Northern leopard frogs have softer calls and will call underwater (Tyning 1990; Hunter et al. 1992), making them more difficult to detect during surveys.

The number and diversity of species encountered during surveys varied among sites (Table 9). Six or more species were found at eight sites. The highest number of species (8) was recorded at West Leyden Road. Four or fewer species were found at 10 sites. We detected only three species of calling amphibians at Burnett Pond, Catamount State Forest, and Oxbow.

## Wetland Habitat Evaluations

<u>Habitat Assessments at Stations</u>

Habitat assessments were conducted at 35 stations where calling amphibians were surveyed. The amount of station area covered by developed and agriculture was low (e.g., less than 25%; Figure 3). Emergent, open water/floating plant, and tree cover were present at stations in varying amounts. However, at 20% of stations, emergents accounted for greater than 50% of total cover. Tree cover was recorded at greater than 50% cover at approximately 23% of stations. Shrub cover accounted for less than half the total amount of cover at the majority of stations.

Almost half the stations were characterized as semi-permanently flooded (42.9%). Forty percent of stations were described as permanently flooded, and 17.1% were characterized as seasonally flooded. No floating plant cover was found at slightly more than half the stations (Table 10). At 20% of the stations the floating plant cover was described as dense, whereas slight and moderate amounts occurred at 14.3% of stations.

The types of land use found adjacent to amphibian stations were condensed into seven categories: (1) wetland, (2) recreation (golf course, athletic field, etc.), (3) forest, (4) agriculture, (5) residential, (6) paved roadway, and (7) undeveloped upland (nonforested habitats, such as powerline rights-of-way, abandoned fields, etc.). Wetlands were the most common land use type recorded adjacent to amphibian stations (Figure 4). Forest and paved roadway accounted for the land use types observed at approximately one-third of the stations. Agriculture, recreation, residential, and undeveloped upland occurred adjacent to the fewest stations.

To determine whether there was a relationship between the six habitat cover types and the number of calling amphibian species present at each station, we performed a least squares regression on total number of species and arcsine transformed percentage of each cover type. We pooled observations of all species detected in 2000 and 2001. There was no significant correlation between the number of amphibian species present at stations and any habitat cover type ($p > 0.05$; Table 11).

We also investigated whether there was a correlation between the presence or absence of each amphibian species and six habitat cover types, using logistic regression and arcsine-transformed percent cover. Observations were pooled for all species for 2000 and 2001. It should be noted that the number of observations of pickerel frogs and Northern leopard frogs was probably too low to accurately assess whether there was a significant correlation between these two species and any habitat type. The occurrence of American toads was negatively correlated with emergent cover, while the presence of bullfrogs and green frogs was positively related to the amount of open water/floating plant cover ($p < 0.05$; Table 12). The amount of tree cover and the presence of wood frogs was also positively correlated.

## DISCUSSION

## MARSHBIRD SURVEYS

### Historic and Current Distribution and Breeding Status of Marshbirds in the Deerfield River Watershed

During the three-year project, we located four of the eight target species of marshbirds. Three of the four species that were never observed during surveys (pied-billed grebe, common moorhen, and sedge wren) are considered *rare breeders* in Massachusetts (Veit and Petersen 1993). Their absence from the Deerfield River watershed was probably due to several causes, with the loss of suitable breeding habitat probably the most significant factor. The fourth species, the king rail, is at the northernmost edge of its breeding range in Massachusetts. During a state-wide survey of several marshbirds conducted in Massachusetts from 1990-1992, the pied-billed grebe, king rail, and common moorhen were never observed in the Deerfield River watershed (Crowley 1994). The sedge wren was not included in Crowley's study. Sedge wrens were not observed in the Deerfield River watershed during the Massachusetts Breeding Bird Atlas (BBA), which took place from 1974-79 (BBA, unpubl., *in* Veit and Petersen 1993).

Bagg and Eliott (1937) noted that many of the eight target species had been declining in the Connecticut River valley since the early 1900s. The pied-billed grebe, American bittern, sora, and common moorhen were rare or uncommon breeders, and the breeding status of the least bittern and king rail was unknown at the time of Bagg and Eliott's publication. The Virginia rail and sedge wren were still considered common during the breeding season in suitable habitat (Bagg and Eliott 1937).

<u>American Bittern</u>

In both historic and recent accounts of the distribution of the American bittern during the breeding season in Massachusetts, this marshbird is described as a rare breeder (Bagg and Eliott 1937; Veit and Petersen 1993). We observed American bitterns at 29% of wetlands or at seven sites during the three-year period. In Crowley's (1994) statewide study, American bitterns were present at only 5% of wetlands. Of the five wetlands surveyed in the Deerfield River basin in Crowley's study, this bittern was only detected at the Rtes. 5&10 North site. We did not observe any American bitterns at Rtes. 5&10 North during our study. However, the 8.1 ha wetland was owned by several individuals, and we were unable to gain access to the entire site.

From behavioral observations, we were confident that a mated pair was present at North Shelburne in 2000 and 2001. This site contained the largest emergent wetland in the project (13.4 ha). Other large sites, e.g., Ashfield Lake and Burnett Pond, were comprised primarily of open water with small amounts of emergent wetland confined to one shore. We detected American bitterns in wetlands ranging in size from 2.7 to 13.4 ha, although five of the seven sites were in the 6.0 – 9.5 ha range. Gibbs and Melvin (1992b.) concluded that wetlands between 2.5 - 5.0 ha are the minimum size required to support a breeding pair of American bitterns.

<u>Least Bittern</u>

Least bitterns have likely been rare breeders in western Massachusetts since the early 1900s. Bagg and Eliott (1937) described the least bittern as *probably regular but very rarely observed* in the Connecticut River valley. The decline of least bitterns may have begun as early as the late 1800s because of over-hunting, and was hastened in later years by wetland destruction and degradation. Veit and Petersen (1993) described these marshbirds as *rare and local* during the breeding season. Crowley (1994) found least bitterns at 12 sites state-wide, and had no sightings in the Deerfield River watershed. During our study, the least bittern was the rarest marshbird of the four observed, occurring at only one site (North Shelburne). Because most wetlands were surveyed for three years, it is doubtful that we missed this marshbird.

Least bitterns appear to avoid high altitude-freshwater wetlands and unstable water regimes in some regions of the Northeast (Gibbs and Melvin 1992c). These two factors may account, in part, for their rarity at some locations in the watershed. Beaver activity at several wetlands caused water levels to fluctuate between surveys during a single year, and between years. In Massachusetts most breeding records of the least bittern (historic and recent) have been reported from the eastern part of the state (Veit and Petersen 1993).

Virginia Rail

Virginia rails were a common and well-distributed marshbird in the Connecticut River Valley in the early 1900s (Bagg and Eliott 1937). They remain the most common breeding rail in Massachusetts up to the present (Veit and Petersen 1993). Crowley (1994) found Virginia rails in 61% of wetlands surveyed throughout the state, including five sites located within the Deerfield River watershed. We surveyed four of Crowley's five sites (Rtes. 5&10 North, Chase, Bement School, and Chip-and-Putt) and detected Virginia rails at all these sites except Bement School.

We detected Virginia rails at 46% of wetlands, and this species was the most frequently observed marshbird in the watershed. Virginia rails were found in wetlands ranging from 3.3 - 13.4 ha in size. From behavioral cues, it appeared that at least one breeding pair was present at Rtes. 5&10 North, and one or more pairs were breeding at North Shelburne and Chip-and-Putt.

Sora

The sora was characterized as a rare breeder in the Connecticut River Valley by Bagg and Eliott (1937). Veit and Petersen (1993) continued to refer to the sora as an uncommon breeder, with most sightings from eastern Massachusetts, with the exception of Cape Cod. Soras were not often detected during our surveys. They were found at 13% of wetlands, which was similar to Crowley's (1994) results: 15% state-wide. We observed soras at three sites: North Shelburne, Schneck Brook, and Rtes. 5&10 North. Crowley (1994) recorded these rails at Chip-and-Putt and Rtes. 5&10 North. It is unlikely that soras, if present, went undetected at Chip-and-Putt. This site was surveyed for three years and boats were used in 2000 and 2001, which allowed access to the entire wetland. The largest number of soras occurred at North Shelburne, where approximately two to three pairs were present.

In Massachusetts, soras were more likely to occur at sites with greater amounts of cattails and increasing edge between aquatic bed/open water and emergent vegetation (Crowley 1994). In the Deerfield River watershed, several wetlands appeared to contain appropriate habitat for breeding soras, but no birds were detected at these sites. Hell's Kitchen Road, Hunt Road, and Beaver Pond are sedge and grass-dominated wetlands located in DuBuque Memorial State Forest. These sites had areas of open water interspersed with emergent vegetation, and were similar in size to Schneck Brook, where a sora was observed in 2000. The absence of soras at DuBuque State Forest may be attributed to the lack of cattails at these wetlands or the absence of open habitats adjacent to wetlands, such as croplands and hayfields, for foraging (Johnson and Dinsmore 1986).

## Marshbirds and Habitat Assessments

Because of the low number of observations of most marshbirds, we analyzed habitat preferences by pooling observations of all species for the three-year period. Discussions of habitat preference will focus on the American bittern and Virginia rail because these two species accounted for most of the observations of marshbirds in the Deerfield River watershed.

We analyzed habitat preferences at two levels: preference for, no preference, or avoidance of six cover types available at stations and five habitat types at wetlands. The number of marshbird species observed at stations was positively related to the amount of emergent cover available at each station. However, marshbirds avoided stations with larger amounts of tree cover. The amount of tree cover was larger than expected, and was probably related to two factors. Forty-one percent of the stations were situated adjacent to forests. Secondly, because stations were large (200 m baseline with a 100 m radius), the semi-circle often intercepted the forest edge. Given that most wetlands were located adjacent to either forested or agricultural habitats, it would be interesting to determine, in future studies, whether there is a correlation between the presence of marshbirds and adjacent habitat types.

Results were different when we investigated the relationship between number of species present at wetlands and total area of each wetland habitat type. The positive relationship between the amount of shallow marsh, aquatic bed, and shrub area and the presence of marshbird species was similar to that reported in studies conducted in Maine (Gibbs and Melvin 1990) and Massachusetts (Crowley 1994). In Maine, American bitterns preferred wetlands dominated by both cattails (*Typha* spp.) or fine-leaved emergents (e.g., sedges, rushes, and grasses), and open water with floating and submerged plants (aquatic bed). In Massachusetts (Crowley 1994), habitat preferences were similar to Maine. In Maine and other areas, American bitterns were primarily found in wetlands larger than 5.0 ha (Brown and Dinsmore 1986; Gibbs and Melvin 1990), whereas in Massachusetts they were detected in wetlands < 10.0 ha (Crowley 1994). In the Deerfield River watershed, these bitterns were found in wetlands as small as 2.7 ha, and as large as 13.4 ha. Smaller wetlands may have been used by foraging birds (S. Melvin, pers. comm.).

In Maine, Virginia rails occurred in wetlands with greater areas of aquatic bed, fine and broad-leaved emergents, and increasing length of edge between aquatic bed/open water and rooted vegetation (Gibbs and Melvin 1990). Pure stands of cattails were also favored by these rails. In Crowley's statewide survey (1994), results were similar to those observed in Maine. Virginia rails were detected more frequently in broad- and fine-leaved emergents, and were less tolerant of urbanization. Virginia rails do not appear to be area-sensitive (Brown and Dinsmore 1986; Gibbs and Melvin 1990; Crowley 1994). We found Virginia rails in wetlands ranging in size from 2.7 to 13.4 ha.

## Future Recommendations

Gibbs and Melvin (1992b., c.) recommended that American and least bittern populations be surveyed every 3-5 years after baseline surveys have occurred. Therefore, we hope to re-survey these wetlands in five years to determine whether changes have occurred in marshbird distribution and abundance, and wetland habitats and adjacent land use. Many survey sites in the Deerfield River watershed exhibited changes in water levels and vegetation composition during the three-year period, primarily because of beaver activity. In addition, we found that approximately half of the wetlands had one or more species of non-native plant. The species most frequently encountered were bittersweet nightshade (*Solanum dulcamara*), honeysuckle (*Lonicera* spp.), common reed (*Phragmites* spp.), purple loosestrife (*Lythrum salicaria*), and multiflora rose (*Rosa multiflora*). Few of these non-native species were the dominant components of vegetative cover at the majority of sites.

Wetlands that were most valuable to marshbirds in the Deerfield River watershed included: North Shelburne, Schneck Brook, Chip-and-Putt, Hunt Road, Beaver Pond, Chase, Rtes. 5&10 North, and Lower Road. The presence of marshbirds at these wetlands may have been related to several factors, including the overall size of each wetland, the number and type of wetland habitats at each site, and the type of land use adjacent to each wetland (e.g., agriculture versus forest, developed versus undeveloped). Larger wetlands, which usually contain more habitat types than smaller ones, provide marshbirds with a variety of cover types and water depths for nesting, foraging, and raising young (Brown and Dinsmore 1986; Gibbs and Melvin 1990).

## CALLING AMPHIBIAN SURVEYS

The three most common and widely-distributed species of calling amphibians in the watershed were the spring peeper, green frog, and gray treefrog, respectively. Our results were similar to those reported in the first five years of an on-going study occurring in the Great Lakes ecosystem (Weeber and Vallianatos 2000). In the Great Lakes study, the spring peeper and green frog were the most frequently encountered amphibians. The results of our study are not unexpected because the spring peeper and green frog are considered abundant throughout their range in Massachusetts, and other parts of New England (Tyning 1990; Hunter et al. 1992; Kenney and Burne 2000).

Spring peepers and green frogs breed in a variety of wetland habitats. Spring peepers are found in wet meadows, marshes, and wooded swamps, with varying hydroperiods (Tyning 1990; Hunter et al. 1992). Green frogs are a more aquatic species, breeding in ponds, wooded swamps, marshes, and the slower-flowing sections of rivers and streams (Tyning 1990; Hunter et al. 1992). In a Michigan study, the distribution of spring peepers and green frogs was positively associated with open canopy ponds (Skelly et al. 1999). We found no correlation between the occurrence of spring peepers and any of the six cover/habitat types at stations. However, there was a significant positive correlation between green frogs and the amount of open water at stations.

The gray treefrog was found in almost all wetlands in the study area. This treefrog breeds in ponds, wooded swamps, vernal pools, and the backwaters of rivers and streams (Tyning 1990; Hunter et al. 1992). We did not find any correlation between the frequency of gray treefrogs and any of the cover types at stations. However, in Michigan these frogs were positively associated with open versus closed canopy ponds (Skelly et al.1999).

Intermediate in occurrence and distribution were the bullfrog and wood frog. In the Deerfield River watershed, bullfrogs were only observed in wetlands with areas of open water, including beaver-created ponds and impoundments. In Michigan, bullfrogs were found in ponds that were permanently flooded and had open canopies (Skelly et al.1999). The bullfrog is an aquatic species that breeds in permanent wetlands, such as ponds, lakes, and slow-moving rivers and streams (Tyning 1990; Hunter et al. 1992).

Wood frogs, unlike bullfrogs, breed in temporary ponds, bogs, and the shallower areas of beaver-created marshes and swamps (Tyning 1990; this study). Although we observed wood frogs at sites with permanent water regimes, these frogs appeared to be calling from areas that were seasonally flooded. Wood frogs also called from vernal pools located adjacent to wetlands. In the Deerfield River watershed, the occurrence of wood frogs was positively associated with the amount of tree cover at stations. In a Michigan study (Skelly et al. 1999), wood frogs were usually observed in closed canopy ponds with temporary and intermediate water regimes. In northern Maine, the presence of wood frogs was positively associated with the amount of forest adjacent to breeding ponds (Guerry and Hunter 2002).

The least frequently encountered amphibians in the Deerfield River watershed were the American toad, pickerel frog, and Northern leopard frog. In the Great Lakes, the American toad and Northern leopard frog were found more frequently than at our study site (Weeber and Vallianatos 2000). The pickerel frog was rarer in the Great Lakes ecosystem compared to the Deerfield River watershed. Pickerel frogs and American toads were found in approximately the same frequency and distribution at our study area. American toads may be characterized as habitat generalists (Hunter et al. 1992; Guerry and Hunter 2002). These toads breed in temporary ponds and flooded areas, marshes, wooded swamps, and the protected areas of lakes and rivers (Tyning 1990; Hunter et al. 1992). We observed the American toad in only eight of 26 wetlands. These sites varied from wetlands with permanent water regimes, such as impoundments and beaver-created ponds, to seasonally flooded vernal pools. The presence of American toads was negatively associated with the amount of emergent cover at wetlands. This result may be related to our small sample size for this species. In other studies, American toads were positively associated with open canopy ponds (Skelly et al. 1999), and avoided breeding sites located adjacent to increasing areas of forest (Guerry and Hunter 2002).

Pickerel frogs breed in both open and closed canopy wetlands, such as marshes, wooded swamps, bogs, and rivers and streams (Hunter et al. 1992; Kenney and Burne 2000). In the Deerfield River watershed, pickerel frogs were not associated with any particular cover type. DeGraaf and Yamasaki (2001) characterized the pickerel frog as frequently occurring on the shorelines of permanent waterbodies, but dispersing to adjacent upland and wetland habitats during the summer.

The Northern leopard frog was the least commonly encountered species of the eight calling amphibians found in the Deerfield River watershed; therefore, we were unable to determine its habitat preferences within the watershed. Leopard frogs breed in ponds, marshes, and the protected areas of rivers, streams, and lakes (Tyning 1990; Hunter et al. 1992). This frog is often associated with open habitats, where it disperses after breeding (Pope et al. 2000). In northern Maine, leopard frogs appeared to avoid breeding sites located in large, forested areas (Guerry and Hunter 2002). Similarly, leopard frogs were more likely encountered in open versus closed canopy ponds in Michigan (Skelly et al. 1999).

Two species were never encountered during the project: Fowler's toad and the spadefoot toad. The Fowler's toad is more common in eastern Massachusetts, although it has been found in the Connecticut River valley. Like the spadefoot toad, it prefers drier areas with sandy or well-drained soils (Kenney and Burne 2000). The spadefoot toad is listed as Threatened by the Massachusetts Natural Heritage and Endangered Species Program, and is difficult to find because of its secretive habits (Tyning 1990).

We compared the average calling codes of the eight species of anurans found in the Deerfield River watershed with that reported in Weeber and Vallianatos (2000). In our study, the spring peeper and wood frog were detected in the largest choruses, whereas in the Great Lakes basin the spring peeper and gray treefrog called at the highest intensities. Mean calling codes between several species were similar in both studies: spring peeper, gray treefrog, green and pickerel frogs. Larger numbers of spring peepers, wood frogs, gray treefrogs, and American toads were heard at wetlands in the Great Lakes region, compared to the number of calling green frogs, pickerel frogs, and bullfrogs at our study site. We did not have enough observations of the Northern leopard frog to make any conclusions about their calling intensity.

We may not have adequately sampled all calling amphibians at the study area during the three-year period. Pickerel and leopard frogs, and American toads may have been present in higher numbers and at additional sites during 2000 and 2001. The number of surveys and time of year that surveys took place may have decreased the likelihood of detecting species with shorter breeding seasons, for example, the wood frog and American toad. Pickerel and leopard frogs have softer calls compared to spring peepers and gray treefrogs. Both these species may call underwater, making them more difficult to detect than other frogs (Tyning 1990; M. Burne, Massachusetts Division of Fisheries and Wildlife, pers. comm.). The calls of species that are heard over short distances may have been overwhelmed by louder-calling species or were not detected due to differences among surveyors' hearing abilities. Both volunteers and project staff reported difficulties hearing some species' calls over the loud choruses of spring peepers and gray treefrogs at several sites.

Because surveys were completed before midnight, species that call in the early-morning hours may have been missed. In a study where surveys were conducted for 24-hour periods, investigators found differences in calling periods and intensities among frogs (Bridges and Dorcas 2000). Bridges and Dorcas (2000) used an automated system to record calling amphibians during a 24-hour period and found that the calling intensity of bullfrogs and green frogs peaked between midnight and 06:00, compared to several hylid species which peaked from 20:00 to 23:00.

**Future Recommendations**

The survey methods we used to monitor populations of calling amphibians in the Deerfield River watershed appeared adequate to detect the common species, such as spring peepers, green frogs, and gray treefrogs. However, we may not have adequately sampled species that are explosive breeders (wood frogs, American toads), have calls that may be more difficult to detect (Northern leopard and pickerel frogs), and those that may call more frequently in the early morning hours (bullfrogs, green frogs). Because we plan to re-survey these wetlands in approximately five years, it may be possible to use two different methods. Volunteers would survey wetlands using the methods outlined in this report. However, project staff would conduct additional surveys that were designed to detect several target species, such as American toads and Northern leopard frogs.

Although we collected basic weather data before and after each survey, we lacked climatic data that would help explain the distribution, movements, and abundance of amphibians. Heyer et al. (1994) recommend collecting weather data for several weeks before surveys begin, and provide a list of the minimum weather and site variables that should be collected in most amphibian surveys. In future surveys, additional weather data should be collected at several sites, including date of last rainfall, pH, water depth, and water temperature.

The threats faced by amphibians at monitoring sites from human activities include mortality from vehicle collisions, runoff from roadways and agricultural fields, and destruction and alteration of wetland and adjacent habitats. Because more than half the sites are adjacent to paved roadways, on-road vehicle kills are probably a major cause of mortality to local populations. The hazards of roadways to breeding and dispersing amphibians have been well-documented (Ashley and Robinson 1996; Findlay and Houlihan 1997; Findlay and Bourdages 2000). Risks from roadways can have effects from as far away as 2 km (Findlay and Bourdages 2000). Other than direct mortality from vehicle collisions, roadways facilitate the spread of invasive non-native plants, encourage residential and industrial development, increase siltation rates, and modify the hydrology of rivers, streams, ponds, and other types of wetlands.

Maintenance of wetlands with a variety of hydroperiods, types of vegetative cover, and size are crucial to the long-term health of amphibian populations at the regional scale (Skelly et al. 1999; Semlitsch 2002). Preventing the fragmentation of breeding sites and winter and summer habitats will also contribute to the protection of the amphibian community in the Deerfield River watershed (Semlitsch and Bodie 1998; Skelly et al. 1999; Pope et al. 2000; Snodgrass et al. 2000).

## ACKNOWLEDGMENTS

The Deerfield River Watershed Association and Green River Watershed Preservation Alliance thank the following organizations and agencies for providing financial support for the project from 1999 to 2001: Volunteer Monitoring Grants Program and the Massachusetts Environmental Trust (Massachusetts Executive Office of Environmental Affairs), Riverways Small Grants Program (Massachusetts Department of Fisheries, Wildlife, and Law Enforcement), Sweet Water Trust, and the Living Springs Foundation. Janice Stone, Dennis Swartwout, and the Natural Resources Assessment Group (Plant and Soil Sciences Department, University of Massachusetts) provided access to aerial photographs of the Deerfield River watershed. Donna Petersen and David Goodwin allowed us the use of their stereoscopes. We received information on survey methods from Matt Burne, Suzy Fowle, Scott Jackson, and Scott Melvin. Don Pugh assisted with production of the map of the Deerfield River watershed. Alexander J. Haro, Robert Packard, and Christine Duerring (Deerfield River Watershed Team Leader) provided support and help in ways too numerous to count. We extend a special thanks to all the volunteers and landowners who participated in the project.

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**Figure 1: Location of wetland survey sites in the Deerfield River watershed, Massachusetts, 1999-2001. Twenty-seven wetlands were surveyed for calling amphibians and marshbirds in 11 towns. Solid dots represent survey sites.**

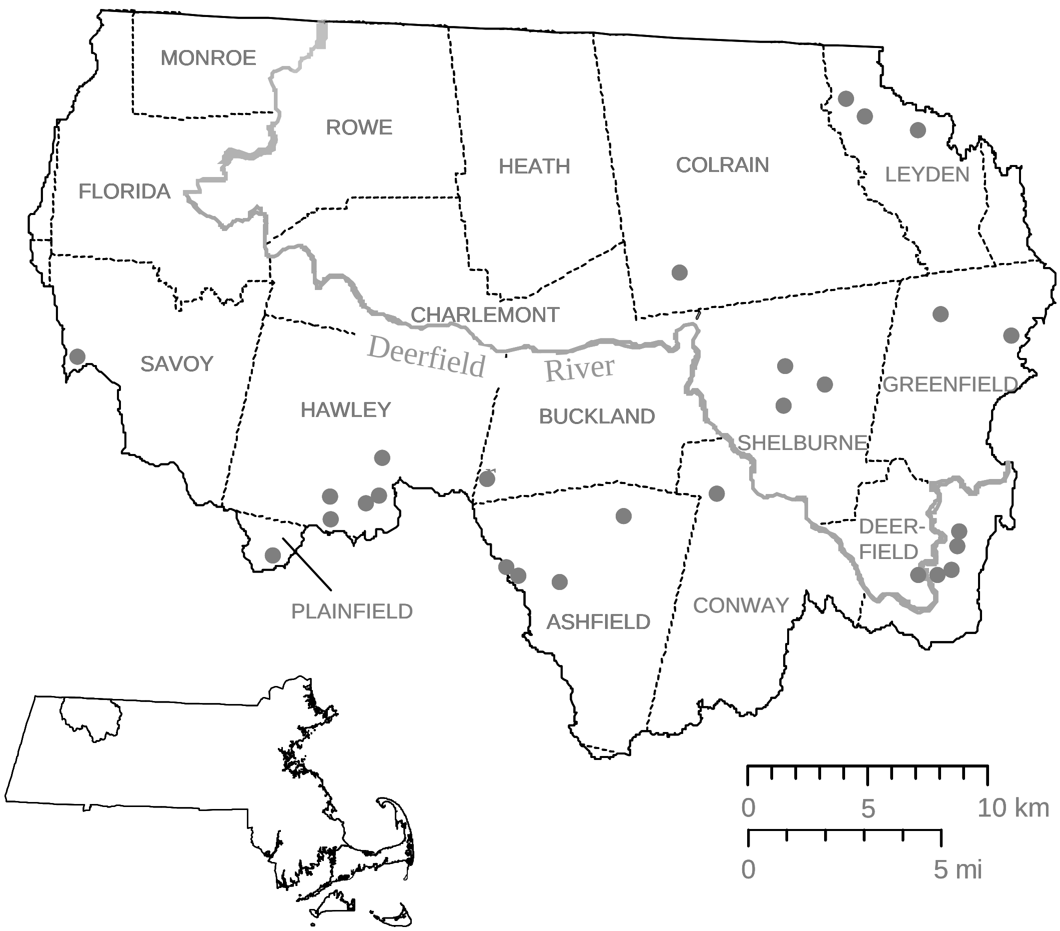


**Table 1: List of wetland survey sites, location, and number of years surveyed, Deerfield River watershed, Massachusetts, 1999-2001.**

| | | Number of Years Wetland Surveyed for Wildlife | |
|---|---|---|---|
| **Wetland** | **Town** | **Marshbirds** | **Calling Amphibians** |
| Ashfield Lake | Ashfield | 2 | 3 |
| Ball Field | Shelburne | 2 | 2 |
| Beaver Pond | Hawley | 3 | 3 |
| Bell Road | Leyden | 3 | 3 |
| Bement School | Deerfield | 3 | 3 |
| Brattleboro Road | Leyden | 3 | 3 |
| Burnett Pond | Savoy | 3 | 2 |
| Catamount | Colrain | 0 | 1 |
| Cemetery Road | Buckland | 0 | 2 |
| Chase | Deerfield | 3 | 3 |
| Chip-and-Putt | Shelburne | 3 | 3 |
| Hallockville Road | Hawley | 3 | 3 |
| Hawley Bog | Hawley | 3 | 3 |
| Hell's Kitchen Road | Hawley | 3 | 3 |
| Hunt Road | Hawley | 3 | 3 |
| Leyden Road | Greenfield | 3 | 3 |
| Lower Road | Deerfield | 3 | 3 |
| North Shelburne | Shelburne | 3 | 3 |
| Oxbow | Deerfield | 3 | 3 |
| Phillips Road | Ashfield | 3 | 3 |
| Powerline | Ashfield | 2 | 3 |
| Rtes. 5&10 North | Deerfield | 2 | 1 |
| Route 116 | Plainfield | 3 | 2 |
| Schneck Brook | Conway | 2 | 3 |
| Shrub Swamp | Ashfield | 0 | 2 |
| Tree Farm | Greenfield | 3 | 3 |
| West Leyden Road | Leyden | 3 | 3 |

**Table 2: The number of wetlands and stations surveyed per year, percent of wetlands surveyed three times, and percent of stations at which each marshbird species was detected during the three-year study. Note: The number of stations does not equal the number of wetlands surveyed because some wetlands contained more than one station.**

| | | | | Marshbird Species | | | |
|---|---|---|---|---|---|---|---|
| Year | No. of Wetlands Surveyed | No. of Stations Surveyed | Percent of Wetlands Surveyed 3X | American Bittern | Least Bittern | Virginia Rail | Sora |
| 1999 | 20 | 31 | 0 | 3.2 | 3.2 | 16.1 | 9.7 |
| 2000 | 24 | 39 | 75.0 | 12.8 | 5.1 | 30.8 | 12.8 |
| 2001 | 24 | 39 | 83.3 | 23.1 | 7.7 | 23.1 | 7.7 |

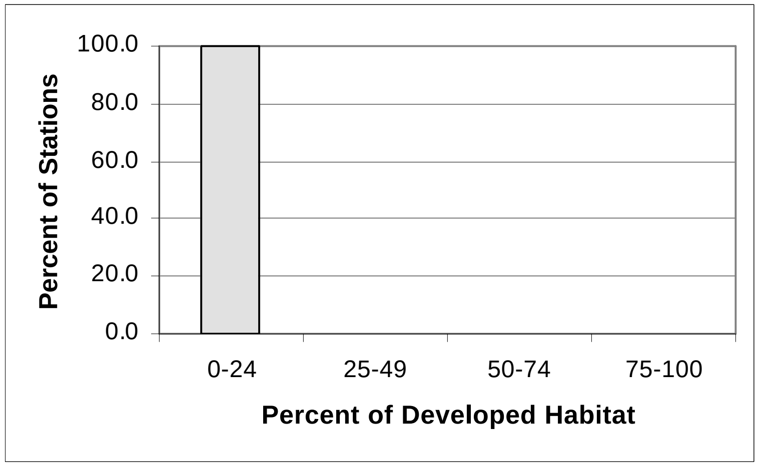
**Table 3: Wetlands where marshbirds were present, 1999-2001, including number of years each species detected at a wetland, total species observed per wetland, and number of years each wetland was surveyed.**

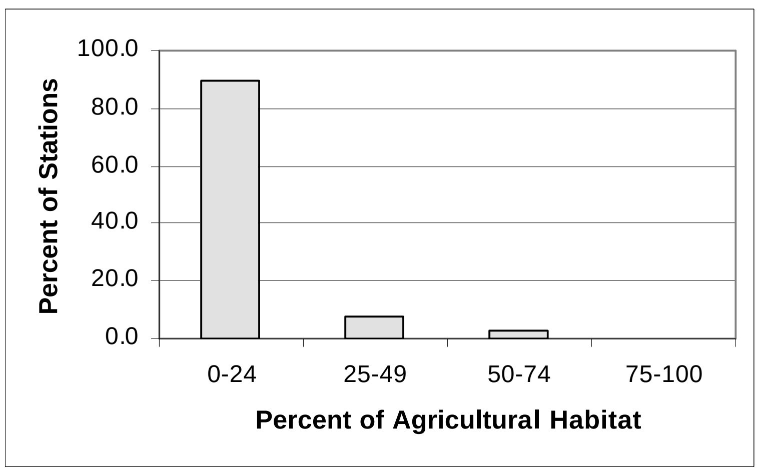
| | Number of Years Each Species Present at Wetland | | | | | |
|---|---|---|---|---|---|---|
| Wetland | American Bittern | Least Bittern | Virginia Rail | Sora | Total Number of Species Present | Number of Years Wetland Surveyed |
| North Shelburne | 2 | 3 | 3 | 3 | 4 | 3 |
| Schneck Brook | 2 | | 1 | 1 | 3 | 2 |
| Chip-and-Putt | 1 | | 3 | | 2 | 3 |
| Hunt Road | 2 | | 2 | | 2 | 3 |
| Beaver Pond | 1 | | 2 | | 2 | 3 |
| Chase | 1 | | 1 | | 2 | 3 |
| Rtes. 5&10 North | | | 2 | 1 | 2 | 2 |
| Lower Road | | | 2 | | 1 | 3 |
| Hell's Kitchen Road | | | 1 | | 1 | 3 |
| Leyden Road | | | 1 | | 1 | 3 |
| Rte. 116, Plainfield | | | 1 | | 1 | 3 |
| Ball Field | 1 | | | | 1 | 2 |
| Total number of wetlands where species was observed | 7 | 1 | 11 | 3 | | |

**Table 4: Results of least squares regression between the total number of marshbird species observed at each site and the amount of each habitat type present (n = 26 wetlands) and the total size of each wetland. Observations of the four marshbird species were pooled for the three-year period (* = $p < 0.05$; ** = $p < 0.01$).**

| Wetland Habitat Types | coefficient | r - value | p - value |
|---|---|---|---|
| Shallow Marsh | 0.165 | 0.652 | 0.001** |
| Deep Marsh | 0.113 | 0.134 | 0.534 |
| Shrub | 0.125 | 0.410 | 0.047* |
| Aquatic Bed | 0.214 | 0.408 | 0.048* |
| Open Water | -0.021 | 0.166 | 0.439 |
| Total Size of Wetland | 0.117 | 0.412 | 0.046* |

**Figure 2: Distribution of marshbird stations by habitat/cover type. Percent of all stations (n = 39) are distributed into four habitat/cover frequency bins (0-24%, 25-49%, 50-74%, 75-100%).**



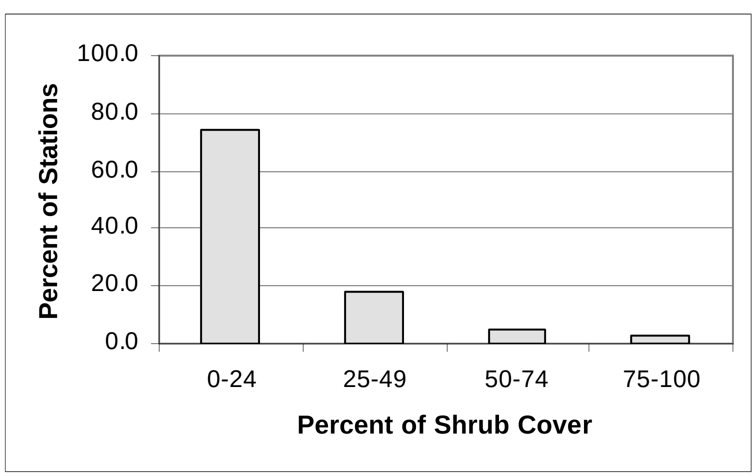
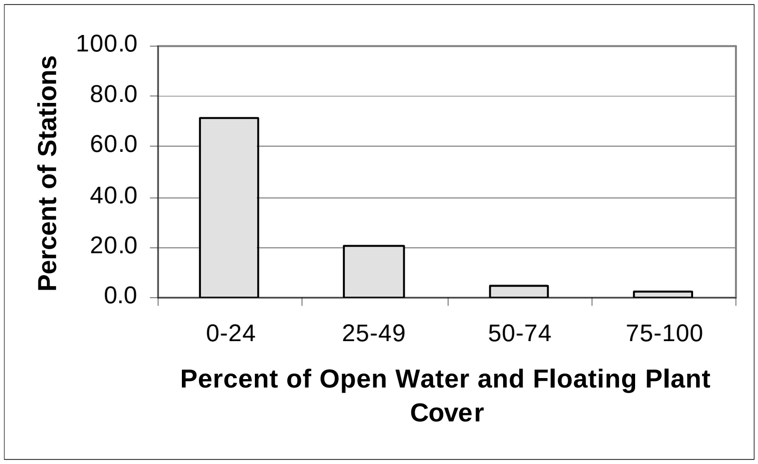
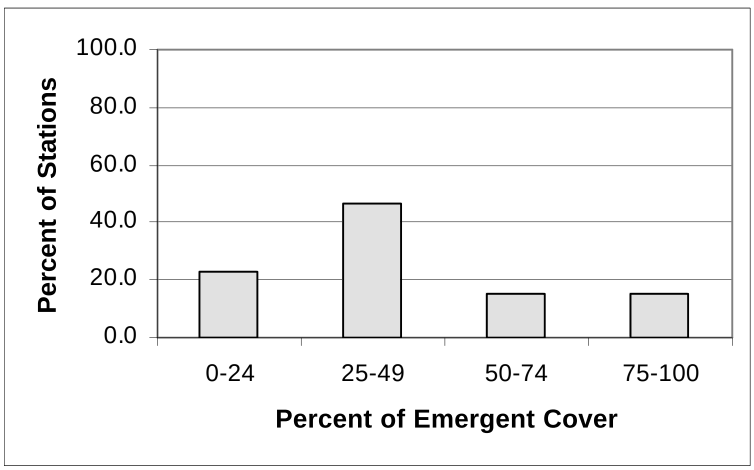



**Figure 2: (continued) Distribution of marshbird stations by habitat/cover type. Percent of all stations (n = 39) are distributed into four habitat/cover frequency bins (0-24%, 25-49%, 50-74%, 75-100%).**



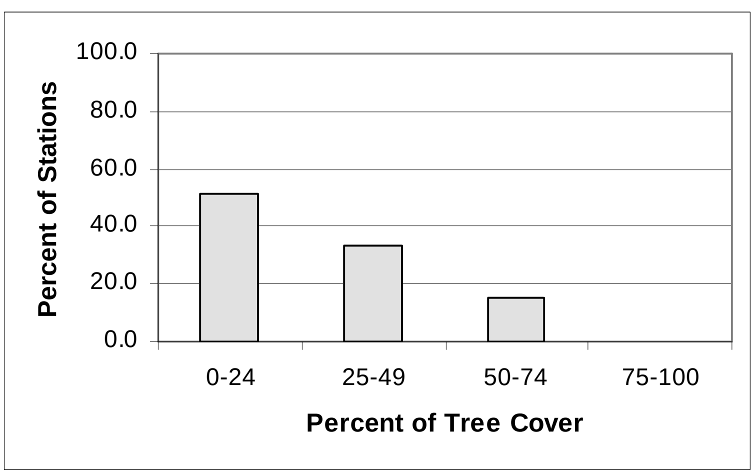



**Table 5: Percent of marshbird stations (n = 39) distributed into 5 floating plant cover density categories.**

| Floating Plant Cover Densities | Percent of Stations |
|---|---|
| None | 59.0 |
| Slight | 10.3 |
| Moderate | 12.8 |
| Dense | 18.0 |
| Unknown | 0.0 |

**Table 6: Results of least squares regression between the total number of marshbird species and arcsine-transformed percent of each cover type. Observations of all species are pooled for the three-year period (* = p < 0.05; ** = p < 0.01).**

| Habitat Cover Types at Marshbird Stations | coefficient | r-value | p-value |
|---|---|---|---|
| Developed | 0.005 | 0.015 | 0.926 |
| Agriculture | -0.011 | 0.113 | 0.492 |
| Emergents | 0.020 | 0.418 | 0.008** |
| Open Water/Floating Plants | 0.006 | 0.096 | 0.560 |
| Trees | -0.024 | 0.400 | 0.012* |
| Shubs | -0.011 | 0.172 | 0.295 |

**Table 7: Percent of stations where calling amphibians were present, by species, 2000 and 2001 pooled; n = 36.**

| Species | Percent of Stations Present |
|---|---|
| American Toad | 30.6 |
| Gray Treefrog | 86.1 |
| Spring Peeper | 97.2 |
| Bullfrog | 55.6 |
| Green Frog | 94.4 |
| Pickerel Frog | 30.6 |
| Northern Leopard Frog | 8.3 |
| Wood Frog | 52.8 |

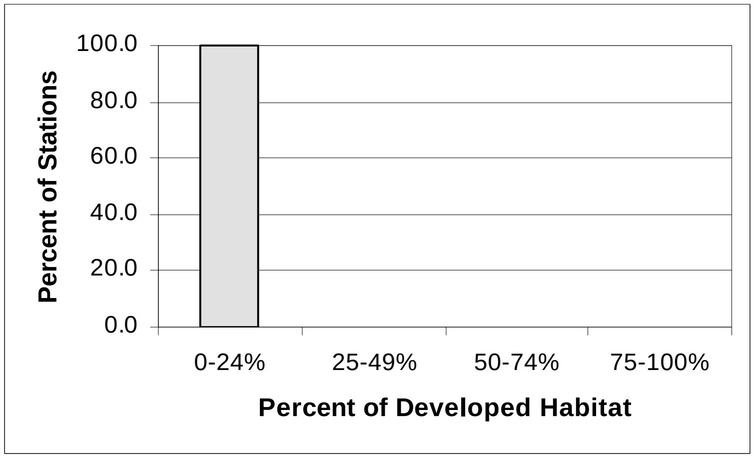
**Table 8: Percent of occurrence (station-years) and mean calling code, by amphibian species, 2000 – 2001 data pooled. Data collected from a total of 70 station-years.**

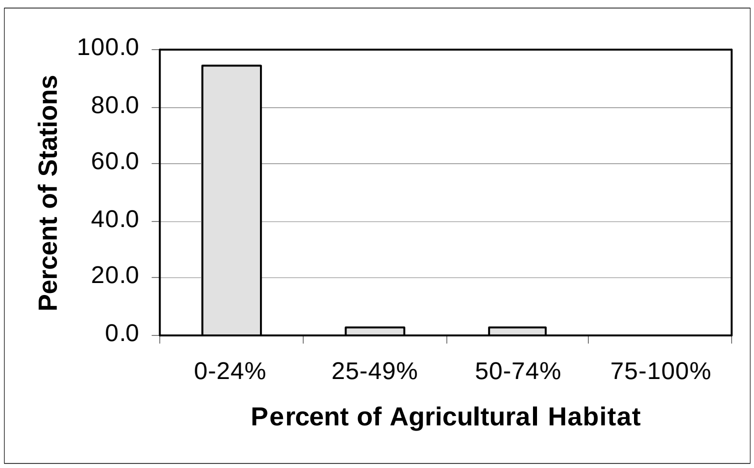
| Species | Percent Station-Years Present | Mean Calling Code |
|---|---|---|
| American Toad | 22.9 | 1.77 |
| Gray Treefrog | 67.1 | 1.81 |
| Spring Peeper | 94.3 | 2.57 |
| Bullfrog | 47.1 | 1.17 |
| Green Frog | 87.1 | 1.35 |
| Pickerel Frog | 21.4 | 1.20 |
| Northern Leopard Frog | 5.7 | 1.00 |
| Wood Frog | 37.1 | 2.11 |

**Table 9: Composition and number of calling amphibian species present at each wetland, 1999 -2001 (data from 26 wetlands).**

| Wetland | American Toad | Gray Treefrog | Spring Peeper | Bullfrog | Green Frog | Pickerel Frog | Northern Leopard Frog | Wood Frog | Total Species |
|---|---|---|---|---|---|---|---|---|---|
| West Leyden Road | X | X | X | X | X | X | X | X | 8 |
| Ashfield Lake | X | X | X | X | X | X | | X | 7 |
| Schneck Brook | | X | X | X | X | X | X | X | 7 |
| Brattleboro Road | X | X | X | X | X | | | X | 6 |
| Leyden Road | X | X | X | X | X | X | | | 6 |
| Lower Road | X | X | X | X | X | X | | | 6 |
| Powerline | | X | X | X | X | | X | X | 6 |
| Tree Farm | X | X | X | X | X | | | X | 6 |
| Ballfield | X | X | X | | X | | | X | 5 |
| Bell Road | | X | X | X | X | | | X | 5 |
| Bement School | X | X | X | X | X | | | | 5 |
| Cemetery Road | | X | X | | X | X | | X | 5 |
| Hell's Kitchen Road | | X | X | X | X | | | X | 5 |
| North Shelburne | | X | X | X | X | X | | | 5 |
| Phillips Road | | X | X | X | X | | | X | 5 |
| Rt. 116 Plainfield | | X | X | X | X | | | X | 5 |
| Beaver pond | | | X | X | X | X | | | 4 |
| Chase | | X | X | | X | | | X | 4 |
| Chip-and-Putt | | X | X | X | X | | | | 4 |
| Hallockville Road | | X | X | | X | | | X | 4 |
| Hawley Bog | | X | X | X | X | | | | 4 |
| Hunt Road | | X | X | X | X | | | | 4 |
| Shrub Swamp | | X | X | | X | | | X | 4 |
| Burnett Pond | | | X | | X | | | X | 3 |
| Catamount State Forest | | | X | | X | | | X | 3 |
| Oxbow | | X | | X | X | | | | 3 |
| Total Wetlands Present | 8 | 23 | 25 | 19 | 26 | 8 | 3 | 17 | |

**Figure 3: Distribution of calling amphibian stations by habitat/cover type. Percent of all stations (n = 35) are distributed into four habitat/cover frequency bins (0-24%, 25-49%, 50-74%, 75-100%).**



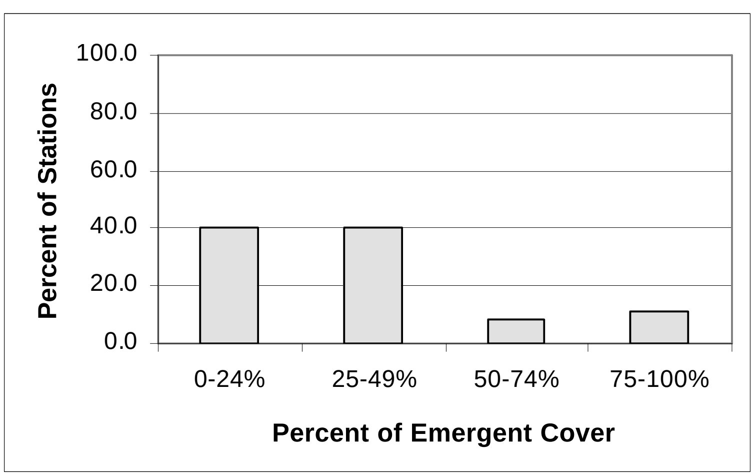
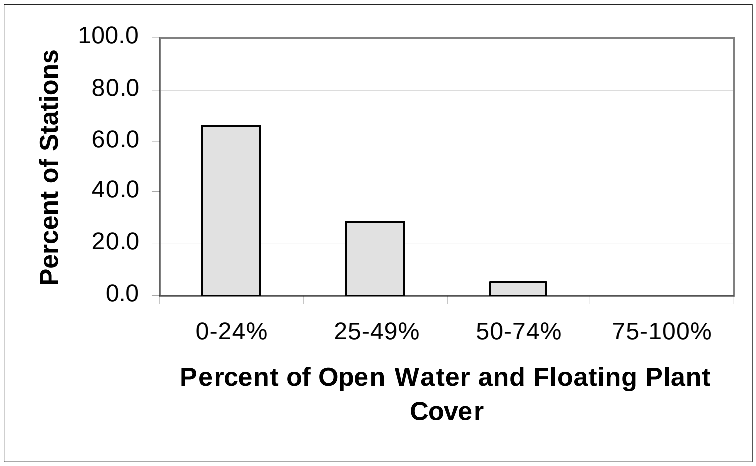
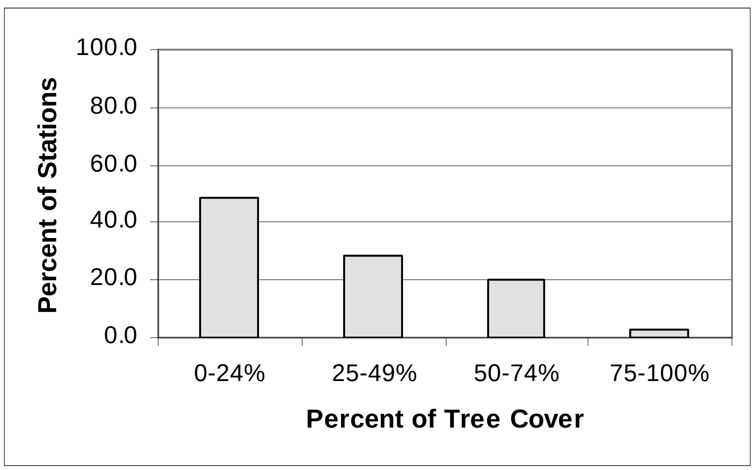



**Figure 3: (continued) Distribution of calling amphibian stations by habitat/cover type. Percent of all stations (n = 35) are distributed into four habitat/cover frequency bins (0-24%, 25-49%, 50-74%, 75-100%).**



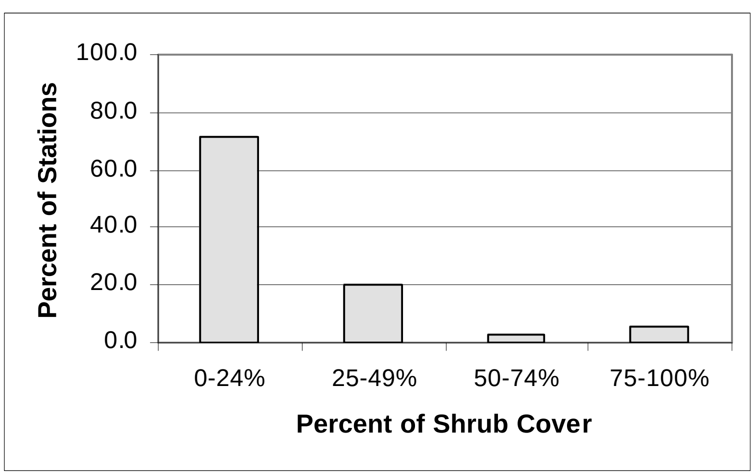



**Table 10: Percent of calling amphibian stations (n = 35) distributed into 5 floating plant cover density categories.**

| Floating Plant Cover Densities | Percent of Stations |
|---|---|
| None | 51.4 |
| Slight | 14.3 |
| Moderate | 14.3 |
| Dense | 20.0 |
| Unknown | 0.0 |

**Figure 4: The percent of calling amphibian stations at which each land use type occurred (n = 35 stations).**

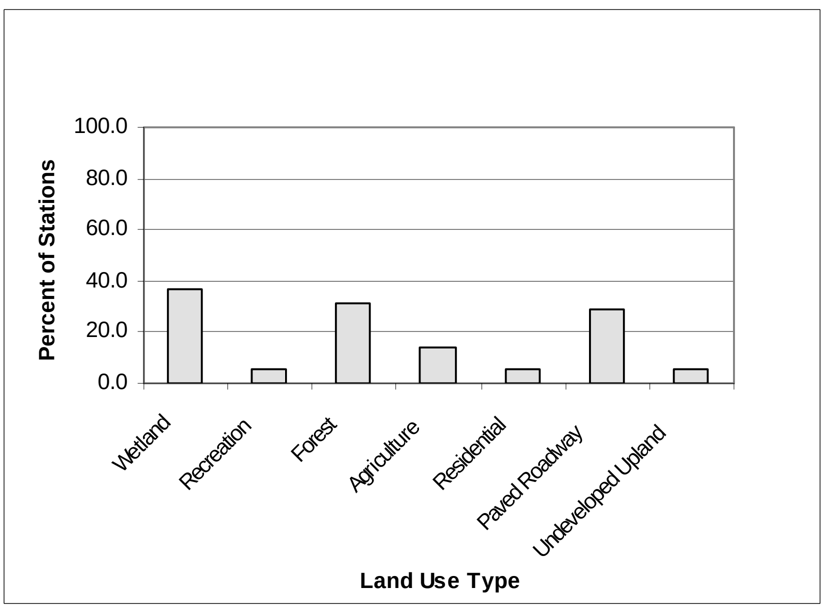


**Table 11: Results of least squares regression between the total number of calling amphibian species and arcsine-transformed percent of each cover type. Observations of all species are pooled for 2000 and 2001 (* = p < 0.05; ** = p < 0.01).**

| Habitat Cover Types at Calling Amphibian Stations | coefficient | r-value | p-value |
|---|---|---|---|
| Developed | -0.074 | 0.178 | 0.306 |
| Agriculture | 0.005 | 0.043 | 0.806 |
| Emergents | -0.015 | 0.250 | 0.147 |
| Open Water/Floating Plants | 0.023 | 0.288 | 0.093 |
| Trees | 0.004 | 0.062 | 0.725 |
| Shubs | -0.001 | 0.013 | 0.943 |

**Table 12: Results of the logistic regression (p-values) performed on habitat cover types and presence of each calling amphibian species at 35 stations. Observations of all species are pooled for 2000 and 2001 (* = p < 0.05).**

| Habitat Cover Types at Calling Amphibian Stations | American Toad | Bullfrog | Green Frog | Gray Treefrog | Northern Leopard Frog | Pickerel Frog | Spring Peeper | Wood Frog |
|---|---|---|---|---|---|---|---|---|
| Developed | 0.238 | 0.059 | 0.622 | 0.425 | 0.543 | 0.211 | 0.729 | 0.966 |
| Agriculture | 0.337 | 0.127 | 0.622 | 0.425 | 0.543 | 0.211 | 0.066 | 0.784 |
| Emergents | -0.031* | 0.417 | 0.248 | 0.089 | 0.508 | 0.399 | 0.186 | 0.084 |
| Open Water/Floating Plants | 0.175 | 0.008* | 0.021* | 0.329 | 0.901 | 0.679 | 0.903 | 0.593 |
| Trees | 0.563 | 0.447 | 0.153 | 0.102 | 0.473 | 0.303 | 0.944 | 0.015* |
| Shubs | 0.227 | 0.502 | 0.406 | 0.385 | 0.995 | 0.659 | 0.256 | 0.650 |