



## CHAPTER 6. **Terrestrial Fauna**

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**Figure 6.1.** Researchers from (a) URI and (b) RIDEM conducting research on ticks on Prudence Island using bait stations and flagging techniques. *Photo from NBNERR photo library.*

a.



b.



**Figure 6.2.** The dung beetle (*Phanaeus vindex*), found for the first time on Prudence Island in September 2005. *Photo by Michael Thomas.*



## Terrestrial Fauna of the NBNERR

### Invertebrates

Of all the terrestrial faunal groups, invertebrates in general have probably received the least amount of study in the NBNERR. The only data sources that were identified include a recent survey of tiger beetles and moths on Prudence Island, studies on ticks—due to concern surrounding tick-borne diseases—and periodic collections and surveys of various invertebrate groups on Prudence Island.

Mello (2002) conducted a survey of lepidoptera (butterflies and moths) and to a lesser extent tiger beetles in order to determine the species composition, habitat use, and distribution of these invertebrates on Prudence Island. The survey was conducted from May through November 2002 using light traps at 12 stations located in different habitats around the island. Five major habitat types were sampled, including grasslands, grassland/shrub mixes, pine barrens, forest/wetland borders, and dunes. Light trap sampling was augmented by observations and netting of butterflies, tiger beetles, and other insects conducted on 13 dates from May through September. From these efforts, 385 species of macrolepidoptera (large moths), 127 species of microlepidoptera (small moths), 33 butterfly species and five tiger beetle species were collected. Two species of lepidoptera, *Zanclognatha martha* (pine barrens *Zanclognatha* moth) and *Poanes viator* (broad-winged skipper) are listed as species of concern in the state. Three species of tiger beetles that were found are also listed in the state, including *Cicindela marginata* and *C. purpurea* (both of concern) and *C. tranquebarica* (threatened). Mello (2002) indicates that all of these species of concern are affiliated with grasslands and/or pine barrens, further indicating the importance of maintaining and restoring these habitats on Prudence Island. Mello also estimated that his study only documented 50 percent of the macrolepidoptera, 15 to 20 percent of microlepidoptera, 67 percent of butterflies, and 60 percent of tiger beetles that might be expected to be found on Prudence Island, illustrating that further surveys are necessary to simply document the species composition of these groups of invertebrates in the NBNERR.

The ticks on Prudence Island have been studied to a greater degree than other invertebrates due to interest in tick-borne diseases (Fig 6.1). These studies have led to an increased understanding of the ecology of these species, especially as it relates to the transmission of tick-borne dis-

eases to humans. Prudence Island is well known as a site where residents and visitors alike exhibit high incidence rates of tick-borne diseases including Lyme disease, babesiosis, and ehrlichiosis. The island supports abundant tick populations due to an overly dense white-tailed deer herd and extensive habitat conditions conducive to tick survival (Raposa and Greene, 2003). Ticks fare well where humidity levels approach 80 percent or higher while they are questing in order to avoid desiccation. These conditions are prevalent on Prudence Island due to the maritime island climate and to the extensive heavy brush and vine cover (e.g., bittersweet) on much of the island.

Prudence Island is home to the deer tick (*Ixodes dammini*), dog tick (*Dermacentor variabilis*), and lone star tick (*Amblyomma americanum*). Hu and Amr (1989) used standard flagging techniques to quantify the relative abundances of the three tick species on the North Prudence Unit of the Reserve in 1988. Of the 120 ticks collected, 49 percent were *I. dammini*; 43 percent were *D. variabilis*, and 8 percent were *A. americanum*. Hyland and Mather (1990) collected ticks from North Prudence a year later, in 1989. In this study, over 1,885 ticks were collected, with 78 percent being *A. americanum*, 18 percent being *I. dammini*, and only 4 percent being *D. variabilis*. Carroll (1990) also used flagging techniques at 10 sites throughout the island to further examine the relative abundance of the three tick species over a larger area. A total of 1,360 ticks were collected, 89 percent of which were *A. americanum*, 6 percent were *D. variabilis*, and 5 percent *I. dammini*. Ticks were collected yet again by Pollack (1996), who stated that of 1,676 ticks, most deer ticks were found at the south end of the island, while most lone star ticks were found at the north end. Dog ticks were fairly evenly distributed throughout the island.

These studies suggest that the dominant species on Prudence Island is probably the lone star tick, *A. americanum*. The differing relative abundances reported by Hu and Amr (1989) are likely due to the fact that they only collected ticks on one date in April when temperatures were 48 F and conditions were damp. Further, larval ticks were not included in this study since they had not yet emerged from eggs. In contrast, Hyland and Mather (1990) collected from May through October and Carroll (1990) collected ticks in July when temperatures were 85 F. Thus, these studies were conducted under conditions more favorable to the collection of all life-history stages of the three tick species.



Carroll et al. (1992) examined the small-scale distribution of the deer tick on residential lawns on Prudence Island. Again using standard flagging techniques, these authors showed that nymphal deer ticks were five times more abundant on lawns adjacent to woods than on lawns adjacent to other lawns. Further, they demonstrated that nymphal deer tick abundance decreased with increasing distance from woods. The prevalence of the Lyme disease-causing spirochete on ticks did not differ between lawn types or among different distances from woods (overall 31 percent of nymphal deer ticks were infected with the spirochete). This indicates that although the risk is decreased, it is still possible to contract Lyme disease on mowed residential lawns.

Work on Prudence Island by Mather and Mather (1990) showed that of the three aforementioned tick species, only *I. dammini* is a competent vector of Lyme disease. They also showed that only *I. dammini* and *D. variabilis* were found using white-footed mice as hosts. However, it was shown earlier that *I. dammini* ticks on Prudence Island carry the causative agents of both Lyme disease (the spirochete *Borrelia burgdorferi*) and human babesiosis (*Babesia microti*) (Anderson et al., 1986). The Anderson et al. (1986) study was designed to test for the presence of both agents on white-footed mice and meadow voles on Prudence and Patience islands. Of the 14 rodents examined, 71 percent were carrying *B. burgdorferi* and 57 percent carried *B. microti*; both agents were found on 36 percent of the rodents. This was the first demonstration that both diseases were present simultaneously in the same small mammal host and the authors suggest that nymphal *I. dammini* may subsequently transmit both diseases to humans.

Aside from these studies on lepidoptera and ticks, the only other sources of information on invertebrates on Prudence Island or in the NBNERR come from periodic invertebrate surveys conducted by visiting researchers. Dragonflies and damselflies were collected from Prudence Island between July 1998 and August 2001 as part of the Rhode Island Odonata Atlas compiled by the Rhode Island Natural History Survey (RINHS). Nine species were collected during this effort, including *Anax junius*, *Enallagma civile*, *Erythrodiplax berenice*, *Ischnura posita*, *Ischnura verticalis*, *Lestes rectangularis*, *Libellula pulchella*, *Pachydiplax longipennis*, and *Sympetrum rubicundulum*. Additional species, including *Pantala flavescens* and *P. hymenaea*, were found on Prudence Island in September 2005 (Brown and Brown, personal communication). Brown and Brown also discovered the presence of the dung beetle (*Phanaeus vindex*) in September

2005 in the South Prudence Unit pine barrens of the Reserve (Fig. 6.2). Prior to this discovery, the only other confirmed sighting of the dung beetle in Rhode Island was on Block Island and, interestingly, the dung beetle on Prudence Island was found using a recent dung pile left by a coyote, which is relatively new to Prudence Island.

It is clear that at present we have only a rudimentary understanding of terrestrial invertebrate species that are present in the Reserve and in other areas of Prudence Island. The studies and surveys conducted to date have resulted in an initial, although far from comprehensive, invertebrate species list. Much more work is needed to simply identify additional species that are present that have not been found in previous efforts. Research and monitoring opportunities focusing on terrestrial invertebrates in the Reserve are plentiful. Beyond species inventories, it is essential to understand how populations of rare and endangered species change over time in response to Reserve land management practices (e.g., the effects of off-road driving, maintenance mowing, and prescribed burning on populations of tiger beetles in the Reserve's pine barrens). It is also important to begin to monitor populations of ticks (and the incidence of contacting tick-borne diseases) to understand how they respond to recent RIDEM efforts to reduce the population of white-tailed deer on Prudence and Patience islands.

## Reptiles and Amphibians

Until recently, the only source of information on reptiles and amphibians (collectively referred to as "herpetofauna") in the NBNERR was from inventories conducted by RIDEM periodically between 1985 and 1998. Based on these inventories, herpetofauna were not present on either Patience or Dyer islands (Ferren 1985; Raithel, personal communication). However, three species were documented on Hope Island and a relatively rich herpetological assemblage totaling 15 species was found on Prudence Island (Raithel, personal communication) (Fig. 6.3; Table 6.1).

Additional information is now available from herpetological surveys conducted by the NBNERR beginning in April 2003. Combined with RIDEM inventories, these surveys provide a solid inventory of herpetofauna, as well as relative abundance, distribution, and habitat use patterns for some species. The NBNERR surveys were all conducted on Prudence Island and included spotted salamander egg mass counts, anuran (frogs and toads) calling surveys in permanent and vernal ponds, and salamander counts using artificial cover boards (Raposa and Rehor,



**Table 6.1.** Reptiles and amphibians observed on Prudence and Hope islands by RIDEM between 1985–1998.

| Location                   | Species                             | Common name                   | Total # observations |
|----------------------------|-------------------------------------|-------------------------------|----------------------|
| Prudence Island            | <i>Ambystoma maculatum</i>          | Spotted salamander            | 6                    |
|                            | <i>Bufo fowleri</i>                 | Fowler's toad                 | 6                    |
|                            | <i>Chelydra serpentina</i>          | Common snapping turtle        | 2                    |
|                            | <i>Chrysemys picta picta</i>        | Eastern painted turtle        | 2                    |
|                            | <i>Clemmys guttata</i>              | Spotted turtle                | 2                    |
|                            | <i>Coluber constrictor</i>          | Northern black racer          | 2                    |
|                            | <i>Eurycea bislineata</i>           | Northern two-lined salamander | 2                    |
|                            | <i>Hemidactylium scutatum</i>       | Four-toed salamander          | 2                    |
|                            | <i>Lampropeltis triangulum</i>      | Eastern milk snake            | 1                    |
|                            | <i>Ophiodrys vernalis</i>           | Eastern smooth green snake    | 4                    |
|                            | <i>Plethodon cinereus</i>           | Northern redback salamander   | 5                    |
|                            | <i>Pseudacris crucifer crucifer</i> | Northern spring peeper        | 2                    |
|                            | <i>Terrapene carolina</i>           | Eastern box turtle            | 5                    |
|                            | <i>Thamnophis sauritis</i>          | Eastern ribbon snake          | 2                    |
| <i>Thamnophis sirtalis</i> | Eastern garter snake                | 6                             |                      |
| Hope Island                | <i>Ophiodrys vernalis</i>           | Eastern smooth green snake    | 1                    |
|                            | <i>Storeria dekayi</i>              | Northern brown snake          | 1                    |
|                            | <i>Thamnophis sirtalis</i>          | Eastern garter snake          | 2                    |

2003). Figure 6.4 shows the locations of each of these NBNERR amphibian surveys.

Spotted salamander egg mass counts were conducted in seven ponds on Prudence Island on April 23, 2003. Three of the seven ponds surveyed contained spotted salamander egg masses and one pond contained 353 egg masses (Raposa and Rehor, 2003), which is one of the highest counts ever recorded in Rhode Island (Timm, personal communication).

Anural call surveys were conducted at seven permanent and vernal ponds on Prudence Island on six dates between April and June 2003. Anuran calling surveys documented the presence of only one species, the Northern spring peeper *Pseudacris crucifer crucifer*. However, this species was found at all but one pond surveyed, and was present on all dates, indicating its ubiquitous nature on Prudence Island. Activity levels of the spring peeper varied temporally during the survey and peaked sharply in late April.

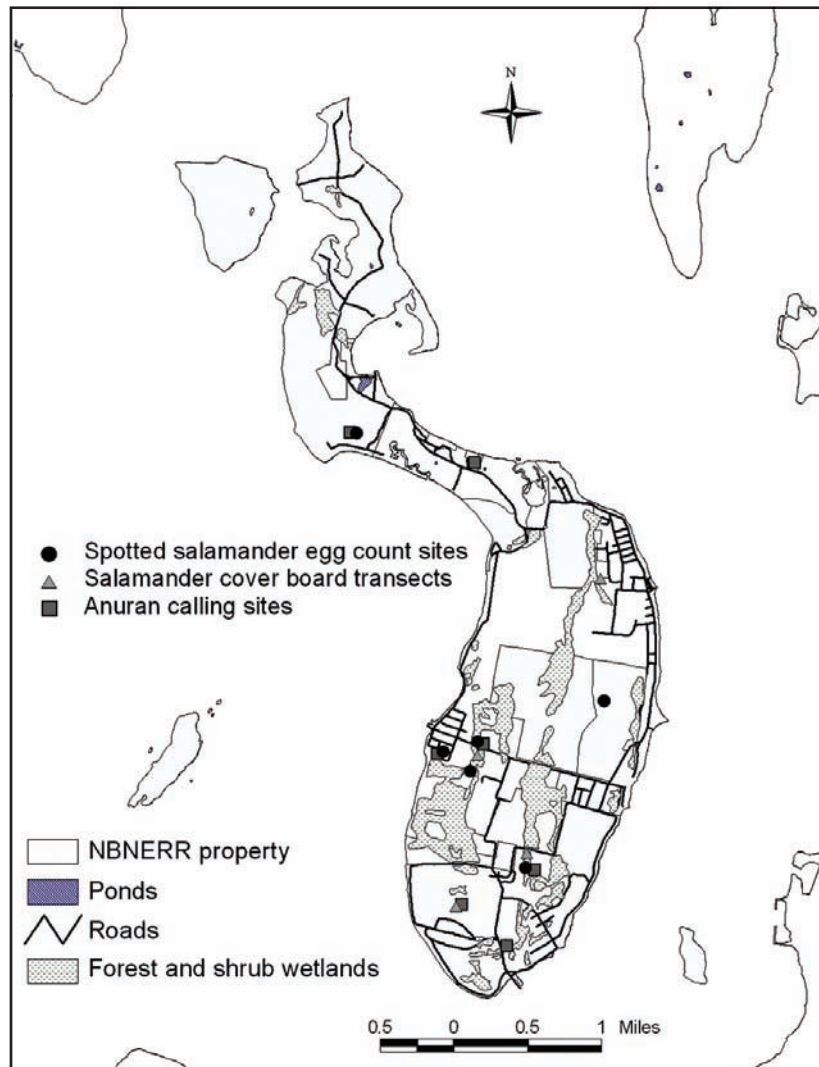
Salamander cover boards were placed along four transects on Prudence Island, with each transect consisting of eight sets of paired boards (16 boards total). Three transects were checked for salamanders on 10 dates in 2003; the fourth transect was established later than the others and was checked only six times. Three species of salamanders were documented during the cover board survey, including the Northern redback (*Plethodon cinereus*), spotted (*Ambystoma maculatum*), and four-toed (*Hemidactylium scutatum*) salamanders. Of these, the Northern redback salamander was by far the most abundant species (87 individuals counted compared to four four-toed and one spotted salamander), and only this species displayed a seasonal pattern, clearly peaking in abundance in early June (Fig. 6.5).

Only one other source was found that provides information on herpetofauna associated with the NBNERR. Satchwill et al. (1981), while reporting results from a fish survey, noted that two Northern diamondback terrapins (*Malaclemys terrapin*) were captured in a fyke net near Jenny Creek marsh on Prudence Island. However, the continued presence of this species cannot be confirmed, as it has not been reported around Prudence Island for over 20 years.

In summary, 17 species of reptiles and amphibians have been documented on Prudence Island, and three have been found on Hope Island. Based on the available information, neither Patience nor Dyer islands support reptiles or amphibians. In contrast, 45 species are reported to occur in the whole of Rhode Island (August et al., 2001). Thus, compared to the mainland, Patience, Hope, and Dyer islands are severely depauperate of herpetological fauna (based on limited information), while Prudence Island, despite its relative small size compared to the mainland, supports just under half of all Rhode Island species. However, aside from species composition lists, and in some cases measures of relative abundance, distribution, and habitat use, very little is known about the ecology of herpetofauna in the NBNERR and it is unknown how these populations are changing over time. As is the case with invertebrates, this situation provides an excellent opportunity for further research into the ecology of herpetofauna in the NBNERR. In particular, more comprehensive surveys should be conducted to confirm or refute the absence of herpetofauna on both Patience and Hope islands. Research also needs to be conducted to explore patterns of distribution and abundance among the islands of the Reserve (in the context of island biogeography) and how herpeto-



**Figure 6.3.** Several amphibians and reptiles found on Prudence Island include: (a) spotted turtle (*Clemmys guttata*); (b) Northern redback salamander (*Plethodon cinereus*); (c) snapping turtle (*Chelydra serpentina*); and (d) spotted salamander (*Ambystoma maculatum*). Photo from NBNERR photo library.



**Figure 6.4.** Locations of amphibian surveys, including spotted salamander egg mass counts, salamander cover board transects, and anuran calling surveys. Data from Raposa and Rehor, 2003. GIS pond and wetland data courtesy of RIGIS.

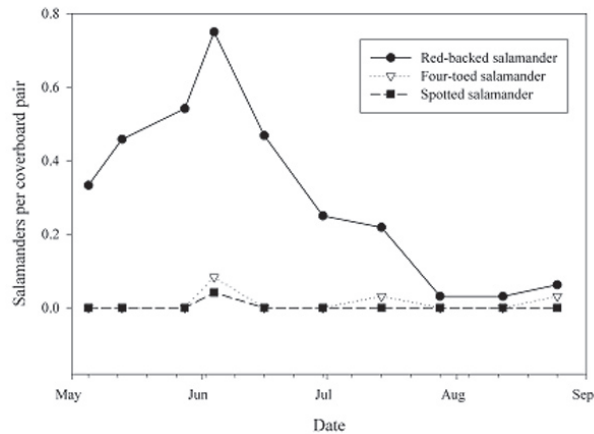
fauna respond to upland management and restoration activities.

## Birds

Prudence, Patience, Hope, and Dyer islands provide important habitat for an abundant and diverse bird community that attracts birders and researchers alike. The earliest reported bird-related research at the NBNERR began in 1964 when an annual maritime nesting bird monitoring program was initiated around the Rhode Island coastline. This ongoing program includes a number of sites that are now located within the Reserve and is described in detail in Ferren and Myers (1998). Further research on bird communities includes breeding bird surveys that were conducted on Patience Island in 1985 (Ferren, 1985) and on Prudence Island in 1981, 1990, 2003, and 2004 (MacLachlan, 1981; Enser, 1990; Enser et al., unpublished data). A multifaceted study focusing on estuarine waterbirds and migrating songbirds was conducted on Prudence Island in the late 1990s (Osenkowski and Paton, 2000; Paton and Osenkowski, 2000). All of these studies have focused on bird communities or groups of targeted species. In contrast, Diquinzio (2000, 2001) focused her master's thesis on a single species, the salt marsh sharp-tailed sparrow, while she was a graduate research fellow at the Reserve. Ancillary bird data come from wildlife surveys conducted by NBNERR beginning in 2003 (Raposa and Rehor, 2004) and from casual observations and personal communications with local experts.

## Maritime Nesting Birds

The longest record of birds in the Reserve comes from a maritime nesting bird monitoring program conducted by RIDEM (Ferren and Myers, 1998; see also Chapter 11, which focuses on estuarine birds throughout Narragansett Bay). This annual survey began in 1964, is ongoing, and covers a period of over 40 years. It involves locating, identifying, and counting all of the nests of a targeted subset of coastal bird species along the coast of Rhode Island, including the shoreline of Narragansett Bay, all of the bay islands, and Block Island. Target species include colonial herons and egrets, glossy ibis (*Plegadis falcinellus*), terns, gulls, and cormorants. Maritime bird nesting sites have been identified throughout coastal Rhode Island and in the Reserve on Hope, Dyer, and Prudence islands (Fig. 6.6). This survey clearly illustrates that the composition and abundance of maritime nesting birds at individual sites can vary considerably over time due to factors that include the

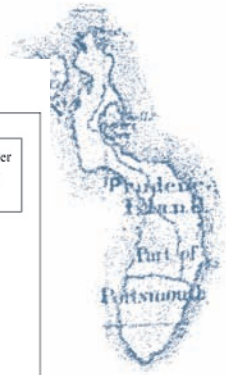


**Figure 6.5.** Abundance of salamanders found under paired coverboards during 2003 on Prudence Island. Data from Raposa and Rehor, 2003.

return of long-displaced species to Narragansett Bay and significant disturbance-mediated movements of species among island nesting sites (Ferren and Myers, 1998).

Despite its relative large size, Prudence Island has only one location that has been identified as a maritime bird nesting site by Ferren and Myers (1998). Gull Point, a sandy spit with an associated small salt marsh on the northeast side of Potter Cove, has sporadically supported least tern (*Sterna albifrons*) nests beginning in 1984, although none has been recorded there since 1995 (Appendix 6.1). Ferren and Myers (1998) also note, however, that other maritime birds had historically nested on Prudence Island before their study began. They note that common terns were found nesting on Gull Point in 1946 and that a large colony of black-crowned night herons (*Nycticorax nycticorax*) persisted in Crow Swamp near the southwest corner of Prudence in the late 1800s and early 1900s.

In contrast to Prudence and Patience islands (on which maritime birds do not nest), Hope and Dyer islands continually support impressive colonies of nesting maritime birds despite their small size (Fig. 6.7). For example, in 2003 Dyer Island supported over 429 nests of gulls (290 herring gull, *Larus argentatus*, nests; 139 great black-backed gull, *Larus marinus*, nests) and was one of only 10 sites in Rhode Island used by nesting American oystercatchers (*Haematopus palliatus*). Although it no longer does so, Dyer Island also supported a sizable heronry for approximately 13 years between 1980 and 1992. Even more impressive are the nesting colonies found on Hope Island and on some of its surrounding rocky outcrops. Hope Island currently supports one of the most diverse and abundant heronries in Rhode Island and has done so for much of the survey period. Of the three sites in Rhode Island where nesting black-crowned night herons are currently found, Hope Island supports the largest



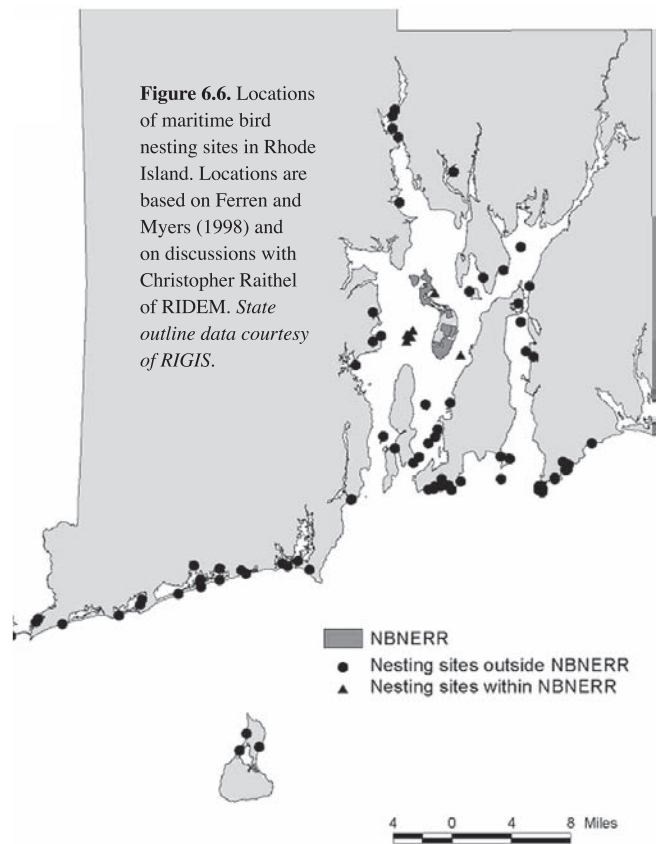


colony while also supporting large numbers of herring gulls, great black-backed gulls, and double-crested cormorants (*Phalacrocorax auritus*). Hope Island represents such an important nesting area that the state closes the island to human use throughout the nesting period (April 1 through August 15). Surrounding Hope Island are three rocky outcrops, known as Little Gooseberry Island, Despair Island, and Scup Rock, that are also nesting sites for maritime birds including herring gulls, great black-backed gulls (Little Gooseberry Island and Scup Rock), and common terns (*Sterna hirundo*) (Despair Island).

### Songbirds

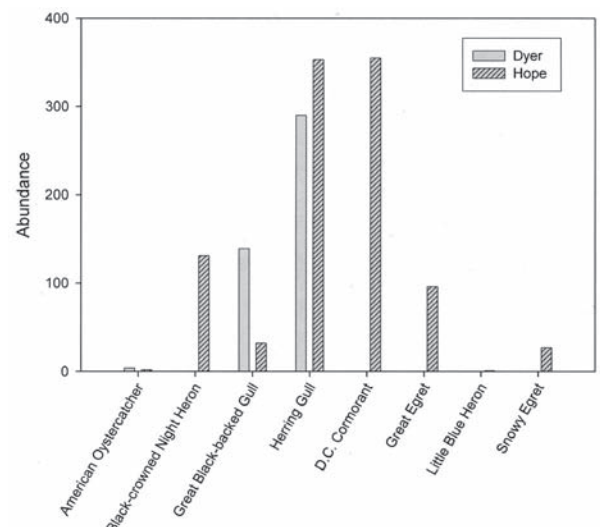
Ferren (1985) conducted the first and only survey of breeding birds (Fig. 6.8) on Patience Island. This was a one-day survey that was conducted by walking in and around the island for four hours (between 1000 and 1400) on 4 June 1985. A total of 324 individual birds representing 35 species was found, although not all of them were confirmed as breeding (Appendix 6.1). The most abundant species were gray catbird (*Dumetella carolinensis*; 56 individuals; 17 percent of the total number of birds), common yellowthroat (*Geothlypis trichas*; 52; 16 percent), rufous-sided towhee (*Pipilo erythrophthalmus*; 31; 10 percent), yellow warbler (*Dendroica petechia*; 17; 5 percent), American redstart (*Setophaga ruticilla*; 17; 5 percent), and white-eyed vireo (*Vireo griseus*; 16; 5 percent). Red-winged blackbird (*Agelaius phoeniceus*), sharp-tailed sparrow (*Ammodramus caudacutus*), and swamp sparrow (*Melospiza georgiana*) were observed in or in close proximity to the small salt marsh along the southeast side of the island, while European starling (*Sturnus vulgaris*), house finch (*Carpodacus mexicanus*), and rock dove (*Columba livia*) were observed in human-modified habitats (open clearings and buildings).

Breeding birds have been surveyed more often on Prudence Island. Andrew MacLachlan, then a RIDEM ranger-naturalist, surveyed breeding and nonbreeding birds during the summer and fall of 1981. Most of the survey was conducted between June and October 1981, although some additional surveys were made in May 1981. Data were collected either by general observations made by the naturalist around the island or during one of four morning walks in the middle and northern sections of Prudence as part of the Breeding Bird



**Figure 6.6.** Locations of maritime bird nesting sites in Rhode Island. Locations are based on Ferren and Myers (1998) and on discussions with Christopher Raithel of RIDEM. State outline data courtesy of RIGIS.

Atlas project (Enser, 1992). Eighty-one species of birds were observed during this survey, 48 of which may have been breeding (14 species confirmed breeding, 21 probable, 13 possible) (MacLachlan, 1981) (Appendix 6.1). Unfortunately, this study did not include quantitative data on bird abundance, nor did it describe species distributions. Therefore, this study provides only a species list of breeding and nonbreeding birds around Prudence Island at that time.



**Figure 6.7.** Abundance of maritime nesting birds on Dyer and Hope islands in the NBNERR in 2003. Data are from the long-term maritime nesting bird monitoring program, provided by RIDEM.





A more systematic survey of breeding birds was conducted on Prudence Island from 5 June to 8 June 1990 (Enser, 1990). Although the authors of this study used more than one survey method, most of the study was focused on results from point counts. Point counts were made at 59 points along four routes—three walking transects at the north end, southwest corner, and interior of the island, and one driving transect that covered much of Prudence (Fig. 6.9). At each point, recordings were made of all birds seen or heard within 10 minutes. Other techniques (e.g., using prerecorded bird calls and site/species/habitat-specific surveys) were also applied to detect species that might not be found during the early morning point sampling or in habitats where points were located. Eighty-three species of birds were recorded during this survey, 69 of which were considered to be breeding on the island (Appendix 6.1). The other 14 species included wading birds, gulls, and shorebirds, but species names or counts were not provided in the report (Enser, 1990). The most abundant species in this study were gray catbird (119 pairs; 11 percent of the total number of birds), rufous-sided towhee (104; 10 percent), common yellowthroat (93; 9 percent), yellow warbler (66; 6 percent), American robin (*Turdus migratorius*; 57; 5 percent), and house wren (53; 5 percent). These same six species were also observed at the highest number of survey points (i.e., most frequently) indicating their ubiquitous distribution on the island. More recently, Enser's (1990) survey was repeated annually from 2003 through 2006, although results of these surveys have yet to be synthesized.

Mist nets were used to conduct surveys of migrating songbirds on Prudence Island in 1999 (Fig. 6.10) (Osenkowski and Paton, 2000). Mist nets (12 meters (m) long, 30-millimeter (mm) mesh) were used to collect birds at four stations on Prudence. The stations were located on the North Prudence Unit between Narragansett Bay and the north end farm (called the North Reserve Station), in Coggeshall Marsh (Coggeshall Cove Station), adjacent to Nag Marsh near the center of the island (Nag Pond Station), and along a power-line clearing near the NBNERR Learning Center (Power-line Station) (Fig. 6.9). The number of sample dates and number of nets in operation varied among stations, although all sampling occurred between 19 August and 28 October 1999. The total number of net-hours also varied among stations (656 net hours at Power-line, 415 at Nag Pond, 131 at North Reserve, and 249 at Coggeshall Cove). On each sample day, mist-nets were generally operated for five hours, beginning 0.5 hour before sunrise. A total of 2,296 birds representing 63 species were captured during the mist-netting study (Appendix 6.1). The most abundant species

included gray catbird (32 percent of the total by abundance), yellow-rumped warbler (*Dendroica coronata*; 24 percent), ruby-crowned kinglet (*Regulus calendula*; 7 percent), song sparrow (*Melospiza melodia*; 4 percent), and black-capped chickadee (*Parus atricapillus*; 4 percent). Peak captures were made during the second week of October. Species diversity was not considered particularly high when compared to similar monitoring conducted on Block Island, R.I., although the Nag Pond and Coggeshall Cove mist-net stations had capture rates that were high compared to most banding stations in North America (Osenkowski and Paton, 2000).

The salt marshes on Prudence Island support populations of the salt marsh sharp-tailed sparrow. DiQuinzio (2000) and DiQuinzio et al. (2001) examined site fidelity, survival, and nesting ecology of this species in the marshes on Prudence Island and in marshes along mainland Rhode Island from 1994 to 1998. Some notable findings from DiQuinzio et al. (2001) were that adult return rates (after migrating) of adult sharp-tailed sparrows did not differ between marshes on Prudence Island and mainland sites, while return rates of juveniles were significantly higher at Prudence Island marshes (as well as Sachuest Point salt marsh in Middletown, R.I.) than at marshes along the south shore of Rhode Island. It was also found that individual sparrows often moved between nearby marshes on Prudence Island (e.g., between Coggeshall Marsh and Providence Point marsh at the tip of Prudence), but that movements between Prudence and mainland marshes did not occur. The density of adult female sparrows on Prudence Island was 1.1 birds ha<sup>-1</sup>, which was towards the low end of the range of densities observed at mainland sites (0.7–3.3 birds ha<sup>-1</sup>) (DiQuinzio, 2000).

Striking differences in nest location and nest success rate were also apparent between Prudence Island and mainland marshes. Most nests (63 percent) on Prudence Island were found in salt meadow habitats, while just over half (51 percent) mainland nest locations were in mixed salt meadow and short *Spartina alterniflora* areas. Nest success on Prudence Island was only 22 percent compared to 74 percent on the mainland. Of the failed nests on Prudence, some (11 percent) were due to predation, but most (78 percent) were due to flooding. DiQuinzio (2000) attributes the high degree of failed nests on Prudence Island to the lack of tidal restrictions and the generally exposed nature of marshes on Prudence Island, which is located in the open center of Narragansett Bay. Thus, despite the relatively pristine nature of the salt marshes on Prudence Island (according to DiQuinzio), the high energy and exposure of these marshes leads to a high

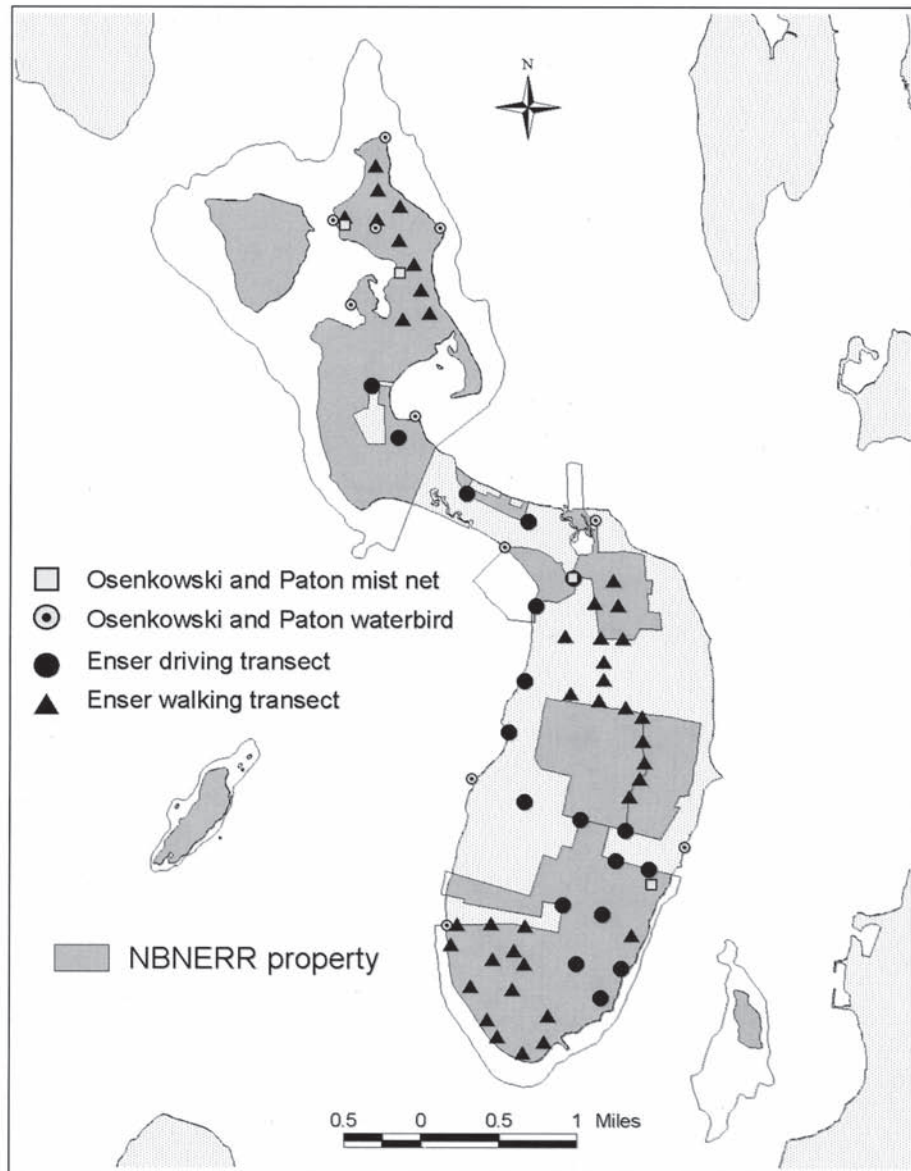


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**Figure 6.8.** Common breeding birds in the NBNERR include: (a) gray catbird (*Dumetella carolinensis*) and (b) yellow warbler (*Dendroica petechia*). Photo from U.S. Fish & Wildlife Service photo library.



**Figure 6.9.** Locations of all bird sampling stations on Prudence Island described in Enser (1990) and Osenkowski and Paton (2000). Station locations were approximated based on information and figures provided in the original reports.

degree of failed nests and possibly to the relatively low density of sharp-tailed sparrows as compared to mainland sites. On the other hand, DiQuinzio (2000) also found that the only environmental variable that was positively related to nest success was vegetation cover height (mostly due to high success rates in *Phragmites*). None of the nests on Prudence Island was found in *Phragmites*, which is relatively uncommon on Prudence. This absence also partially explains the low success rate of sharp-tailed sparrow nests on Prudence Island.

### Estuarine Waterbirds

A survey of estuarine waterbirds was conducted in 1997 and 1998 to quantify the spatial distribution of birds in the nearshore waters around Prudence Island and to examine seasonal patterns in abundance and distribution (Paton and Osenkowski, 2000). Twelve point-count stations were established around Prudence where nearshore estuarine waters could be observed (Fig. 6.9). Twenty-one surveys were conducted at each station between 20 June 1997 and 10 April 1998. During each survey, counts were made of all birds (including terrestrial birds) that were observed within a 250-m radius during a 5- to 10-minute period. Results were presented for the summer-fall season (all 1997 sampling) and the winter-spring season (1998 sampling). Most of the results from this survey are reported in Paton and Osenkowski (2000), but Osenkowski presents some additional data in an undated supplemental report. According to this study, the most abundant estuarine waterbirds include the herring gull (13.9 percent of all birds, plus an additional 12.9 percent for unidentified gull species), common goldeneye (*Bucephala clangula*; 13.7 percent), American black duck (*Anas rubripes*; 8.7 percent), brant (*Branta bernicla*; 4.4 percent), red-breasted merganser (*Mergus serrator*; 3.8 percent), double-crested cormorant (3.1 percent), horned grebe (*Podiceps auritus*; 2.7 percent), Canada goose (*Branta canadensis*; 2.6 percent), and white-winged scoter (*Melanitta deglandi*; 2.4 percent). Similarly, Raposa and Rehor (2004) found that the most abundant waterbird species were (in decreasing order) the herring gull, Canada goose, American black duck, common goldeneye, brant, bufflehead (*Bucephala albeola*), red-breasted merganser, and great black-backed gull. Although no long-term datasets exist to track trends in waterbird community composition and species abundance, Paton and Osenkowski (2000) suggested that even though waterbirds are currently common around Prudence Island, the numbers do not seem as high

as in the past (e.g., 30 to 40 years ago). As evidence, they note the observation of more than 20,000 scaup off of the north end of Prudence in the 1960s; this is an order of magnitude larger than any waterbird sightings in recent efforts.

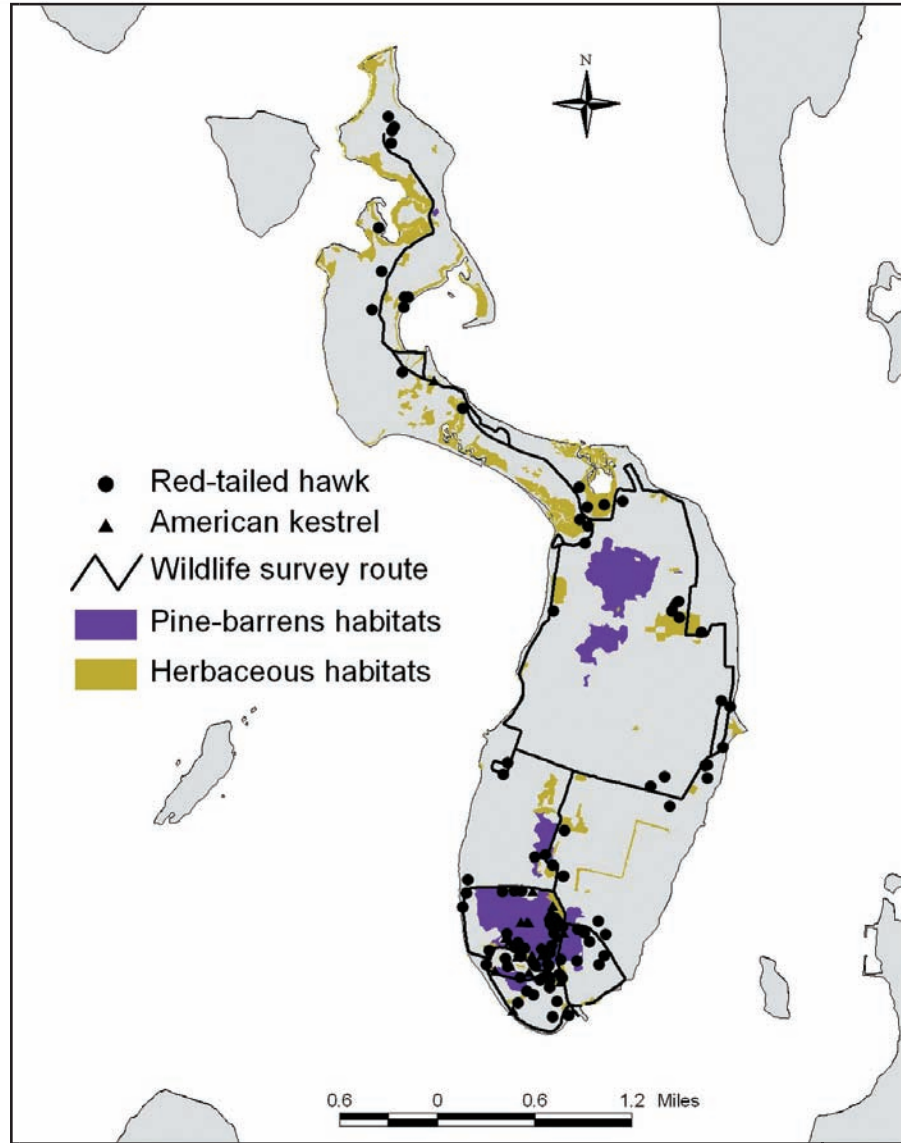
### Summary

Based on the research described above, 151 species of birds have been observed on and around Prudence, Patience, Hope, and Dyer islands (Appendix 6.1). The Eastern bluebird (*Sialia sialis*), turkey vulture (*Cathartes aura*), snow bunting (*Plectrophenax nivalis*) (Raposa, personal observation), and yellow-breasted chat (*Icteria virens*) (Enser, personal observation) have all been observed on Prudence Island since 2001, bringing the total to 155. This represents just over half (50.3 percent) of the 308 total bird species that are listed as occurring in Rhode Island, not including casual (species that do not normally occur here but have been seen more than five times), accidental (seen less than five times), or hypothetical species (Conway, 1992). This relatively high percentage probably results from multiple interacting factors, including the diversity of terrestrial and estuarine habitats found around the Reserve (Chapter 5), the amount of protected open space on the islands, and the level of effort devoted to surveying birds in the area (i.e., more effort can lead to more species observed).

The diversity of habitats found on the island undoubtedly attracts birds. Vigness Raposa (2004) determined that most of the songbirds examined were distributed around Prudence Island in response to specific habitat types, rather than in response to coarser measures such as vegetation structure. The coastline of Prudence Island is composed of numerous shallow coves that provide protected habitats for rafts of migratory ducks (e.g., bufflehead, merganser, goldeneye) and other species throughout the winter. The dry, sandy areas at the south end and central portions of the island support pine barrens and open grasslands that are utilized heavily by species such as red-tailed hawk (*Buteo jamaicensis*) and American kestrel (*Falco sparverius*) (Figs. 6.11 and 6.12). The numerous meadow and fringe marshes, particularly on the northern half of the island, provide important foraging habitat for wading birds such as great egret (*Casmerodius*



**Figure 6.10.** URI researchers sampling breeding birds on Prudence Island. Photo from NBNERR photo library.



**Figure 6.11.** Locations of red-tailed hawk and American kestrel observed during the 2003–2004 NBNERR wildlife driving surveys (Raposa and Rehor, 2004) in relationship to pine barrens and herbaceous (including upland grasslands and meadows and estuarine salt marshes) habitats.



a.



b.

**Figure 6.12.** Common raptors on Prudence Island include: (a) red-tailed hawk (*NBNERR photo library*) and (b) American kestrel (*U.S. Fish & Wildlife Service photo library*).



*albus*), snowy egret (*Egretta thula*), great blue heron (*Ardea herodias*), and glossy ibis (*Plegadis falcinellus*). The marshes also provide overwintering habitat for ducks, geese, and other species. Numerous small streams that empty into Narragansett Bay from Prudence Island provide freshwater to coastal birds and attract dense concentrations of species such as herring gull, great black-backed gull, brant, Canada goose, mute swan (*Cygnus olor*), ducks, and crows (Raposa, personal observation).

The relatively isolated nature of all four of the islands may also help attract large numbers of maritime wading birds. None of the islands is directly accessible by car (cars on Prudence arrive by ferry), and all but Prudence receive very few visitors. Birds on all of the islands, Prudence included, generally receive very little disturbance from humans. The year-round human population on Prudence is only about 150 people, and even though this swells to over 2,000 at times in the summer, the impenetrable habitats and high tick populations act to keep people out of most of the habitats favored by a number of bird species. Hope Island is the most isolated island in Narragansett Bay; its closest points are the southwest side of Prudence at approximately 1.53 miles and Quonset Point on the mainland at 1.66 miles. The abundant and diverse assemblage of nesting birds on Dyer and Hope islands is undoubtedly due in part to the isolated nature of these islands as well as to the lack of predators such as red fox and raccoon (Raposa and Rehor, 2004).

While it is not possible to quantitatively compare results from the various surveys described above because of differences in sampling techniques, habitats, and sample locations, some patterns are clear. It seems that the most abundant songbird species on Prudence and Patience islands is the gray catbird. It was the most abundant species on Patience (Ferren, 1985) and Prudence (Enser, 1990; Osenkowski and Paton, 2000), and the high abundance of this species is undoubtedly due to the proliferation of the thick undergrowth, brush, and thorn-scrub habitats that this species prefers (Peterson, 1980). Other abundant songbird species such as yellow-rumped warbler, ruby-crowned kinglet, rufous-sided towhee, yellow warbler, and common yellowthroat (Appendix 6.1) also prefer these kinds of habitats along with the marshes and forests that are also common on Prudence. These types of species were relatively less abundant during the Paton and Osenkowski (2000) estuarine waterbird study, although these sampling stations were deliberately selected to observe estuarine waterbirds (e.g., ducks, gulls, geese).

Species that occur in noticeably low numbers in each study represent those that are often

associated with humans, such as the house sparrow (*Passer domesticus*), rock dove, and common grackle (*Quiscalus quiscula*). This is partly due to sample station selection, since sampling stations were not established in the vicinity of Homestead or other residential areas on the island. An exception was the observance of 446 European starlings during the Paton and Osenkowski (2000) estuarine waterbird study. However, large numbers of starlings were observed only at a single station near a residential community along the southeast shore of Prudence Island. More recently, Raposa and Kutcher (unpublished data) sampled breeding birds specifically from residential and forested areas and found striking differences in bird communities among the two treatments, with large numbers of human-associated birds observed in residential areas. Even so, human development is limited on Prudence Island (Chapter 4), and these species are probably not abundant on an island-wide basis.

Some notable species, populations, or communities of birds have been documented on at least one of the islands during the bird surveys described here. For example, Dyer Island is one of only 10 nesting sites in Rhode Island for the locally rare American oystercatcher (Ferren and Myers, 1998), while Hope Island supports the single most species-rich nesting colony of coastal birds in the state. In addition, Prudence Island may support the greatest abundance of breeding screech owls (*Otus asio*) in Rhode Island (Enser, 1990) and has recently been found to support the rare yellow-breasted chat (Enser, personal observation).

In summary, the diversity of natural habitats, both coastal and upland, attracts a rich and diverse avifauna to the islands of the Reserve, providing ample opportunity for bird-watching, monitoring, and research. However, it has been over 18 years since breeding birds were surveyed on Patience Island, and even then the survey was only for four hours on one day. Breeding birds have not been surveyed on Hope or Dyer islands. It is recommended that quantitative surveys be initiated on Patience, Hope, and Dyer islands to provide baseline information on bird use of these islands. It is also recommended that a meta-analysis be performed of breeding bird surveys that have already been conducted (1990, 2003–2006) in order to assess temporal changes in the avifauna of Prudence Island. On a broader scale, it is also essential that the Reserve determine the relative value of each Reserve island for migrating songbirds compared to other locations in Narragansett Bay and on Block Island (renowned as a stopover site for migratory birds) to help guide its habitat stewardship and management programs.



## Mammals

Due to limited research, very little is known about the ecology of mammals on Prudence, Patience, Hope, and Dyer islands. The only available sources of information on mammals include a mammal trapping survey conducted in the 1950s (Cronan and Brooks, 1962), recent NBNERR wildlife surveys (Raposa and Rehor, 2004), and annual summaries of deer population dynamics on Prudence Island provided by RIDEM (e.g., Gibson and Suprock, 2000). Ancillary information on small rodent abundance is also available from studies relating to ticks and tick-borne diseases. At best, these data sources allow for the compilation of mammal species lists and a time series record of white-tailed deer population size.

### Early Mammal Surveys

The first information on mammals on Prudence Island was collected during a statewide mammal survey conducted by RIDEM, URI, and the U.S. Fish and Wildlife Service between 1955 and 1957 (Cronan and Brooks, 1962). The survey was conducted mainly by trapping, although additional information was obtained through collections of road kill, nuisance animals, and animals that were turned in by the public. This was not a quantitative survey and it was not always clear whether or not certain species were present on Prudence or the other three islands that constitute the NBNERR. Prudence Island was sometimes specifically mentioned, but often all of the islands of Narragansett Bay were collectively mentioned as a group. Based on this survey, gray squirrel (*Sciurus carolinensis*), white-footed mouse (*Peromyscus leucopus*), meadow vole (*Microtus pennsylvanicus*), muskrat (*Ondatra zibethica*), Norway rat (*Rattus norvegicus*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), mink (*Mustela vison*), striped skunk (*Mephitis mephitis*), and white-tailed deer were all present on Prudence Island in the 1950s (Fig. 6.13). The white-footed mouse was also reported on Patience Island. It was also likely that the house mouse (*Mus musculus*), eastern cottontail rabbit (*Sylvilagus floridanus*), and little brown (*Myotis lucifugus*), big brown (*Eptesicus fuscus*), and red (*Lasiurus borealis*) bats were found on Prudence Island during the time of the survey, although this was not explicitly stated.

### NBNERR Surveys

More recent mammal data are available from wildlife surveys initiated by the NBNERR in 2003.

The two components of this effort include weekly driving surveys around Prudence Island to document all visible mammals (and other wildlife) and scent stations to determine the presence and general distribution of mammalian scavengers and predators on each of the islands (detailed methods are available in Raposa and Rehor, 2004). The information gained from using scent stations is limited due to a small sample size ( $n=12$ ; nine on Prudence, one each on Patience, Hope, and Dyer) and to a single sampling date (26 March 2003). With this in mind, red fox, raccoon, and feral cat (*Felis domesticus*) were the only species attracted to scent stations on Prudence Island. Red fox and raccoon were frequently observed (six and seven stations visited on Prudence, respectively), suggesting that these two species are ubiquitously distributed around Prudence Island. Red fox was the only species found on Patience Island, and no species were recorded from either Hope or Dyer islands. Although extremely limited, these results from Dyer and Hope islands, when coupled with the presence of established estuarine bird colonies (Ferren and Myers, 1998), support the premise that these islands are not inhabited by predatory mammals.

The most complete dataset regarding mammals on Prudence Island was obtained from a multiyear wildlife driving survey (Raposa and Rehor, 2004). This survey was conducted by driving an approximately 20-mile route around Prudence Island (Fig. 6.14) each week between 6 January 2003 and 18 April 2005. In 2003, four surveys were conducted on each date (at dawn, midday, dusk, and night) to account for diel variability in activity patterns. In 2004 and 2005, this was reduced to only dawn and dusk surveys on each date. Based on 2003 data (compiled by Raposa and Rehor, 2004), eight mammal species were observed on Prudence Island, including white-tailed deer (7,753 total individuals sighted), Eastern cottontail rabbit (252), Eastern gray squirrel (186), red fox (87), raccoon (85), feral cat (65), mink (8), and northern river otter (*Lontra canadensis*) (1). No additional mammal species were observed in either 2004 or 2005. Some species exhibited clear seasonal patterns that may reflect real changes in abundance throughout the year (e.g., more eastern cottontail rabbits are born into the population in spring and summer) (Fig. 6.15). Other changes may simply be due to changes in the detection ability of the observer. For example, the fewer sightings of gray squirrels in summer may simply be due to the difficulty of seeing these smaller animals through thick summer vegetation and leaves in which they are found. This is a problem common to all line-transect surveys (Krebs, 1989), and since detection function was not determined for the NBNERR surveys, care must be taken when interpreting the results. How-



**Figure 6.13.** Common mammals found on Prudence Island include: (a) red fox and (b) raccoon. *Photo from U.S. Fish & Wildlife Service photo library.*



ever, the NBNERR data are useful for identifying species that are present and where they are typically found on Prudence Island since every sighting location of some target species was located on a map.

The most recent confirmed mammal species present on Prudence Island is the coyote (*Canis latrans*; Fig. 6.16). Anecdotal accounts from Prudence Island residents suggest that one or two animals were present on the island in the past, but these sightings were not officially confirmed. However, in spring 2005 NBNERR staff saw one animal in the pine barrens in the South Prudence Unit, and the presence of at least two coyotes in this area was confirmed in June 2005 by capturing both animals on film using a motion-detection camera. More recently, NBNERR staff members have observed coyote scat on other parts of Prudence Island, including in the North Prudence Unit.

### White-Tailed Deer

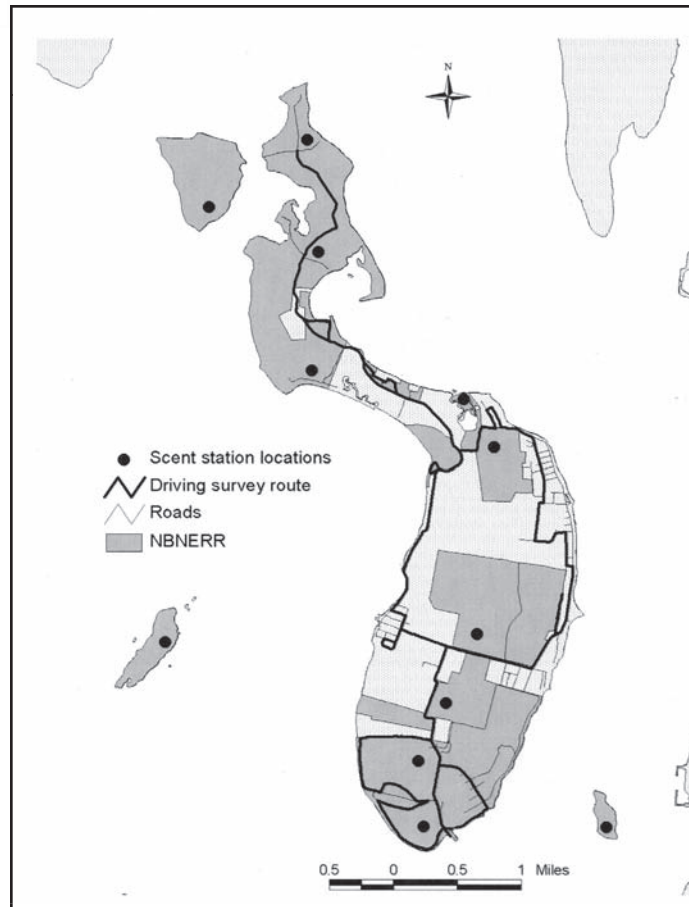
The white-tailed deer is easily the most abundant and ubiquitous medium-to-large mammal species present on Prudence and Patience islands (Fig. 6.17). Prudence Island is well known as a premier bow-hunting site in New England, and deer are readily visible on much of the island throughout the year. White-tailed deer have been the focus of more monitoring than any other mammal species on Prudence Island, primarily because of their value as a game species, but also due to their effects on island habitats and their role in the life cycle of ticks. Deer were by far the most commonly sighted mammal on Prudence Island during a multiyear driving survey (Raposa and Rehor, 2004), and during this study they were abundant throughout the year (Fig. 6.15) and on all parts of the island.

RIDEM has estimated the size of the deer population, hunting rate, recruitment, mean weight, and other population parameters from 1977 to the

present on Prudence Island (Gibson and Suprock, 2000). Since 1977, the density of white-tailed deer on Prudence Island has exceeded 30 deer km<sup>-2</sup> (79 mile<sup>-2</sup>) according to RIDEM population estimates (Fig. 6.18). Mean density between the years of 1977 and 1999 was 47 deer km<sup>-2</sup> (120 mile<sup>-2</sup>), with a peak of 66 deer km<sup>-2</sup> (169 mile<sup>-2</sup>) in 1993. Between the years of 1991 and 1995, deer density did not drop below 64 deer km<sup>-2</sup> (164 mi<sup>-2</sup>). More recent data indicate that deer numbers remain high on Prudence Island (Gibson, personal communication). When deer herds are overabundant, the results include altered or degraded forest understory (Tilghman, 1989; Healy, 1997), a reduction in food and cover for other species (McShea and Rappole, 1997), and an increase in the abundance of ticks and the incidence of tick-borne diseases among humans (Anderson et al., 1987; Krause et al., 2002). RIDEM recognizes the extreme overabundance of deer on Prudence, and in 2003 and 2004 the agency facilitated the largest hunting quotas yet for deer (over 300 deer were taken each year). It is expected that these quotas and future efforts will lead to the long-term reduction in deer density on the island in order to improve deer health, forest regeneration, and to reduce tick abundance and the incidence of disease (Gibson, personal communication).

### Summary

Based on the limited information available, approximately 15 species of mammals are currently present on Prudence Island (assuming that the rodents and bats described in Conan and Brooks (1962) are indeed currently present on the island). Anecdotally, most locals agree that striped skunk was never present on the island, in contradiction with results described by Cronan and Brooks (1962). In contrast, the dearth of information limits the confidence with which the number of mammal species



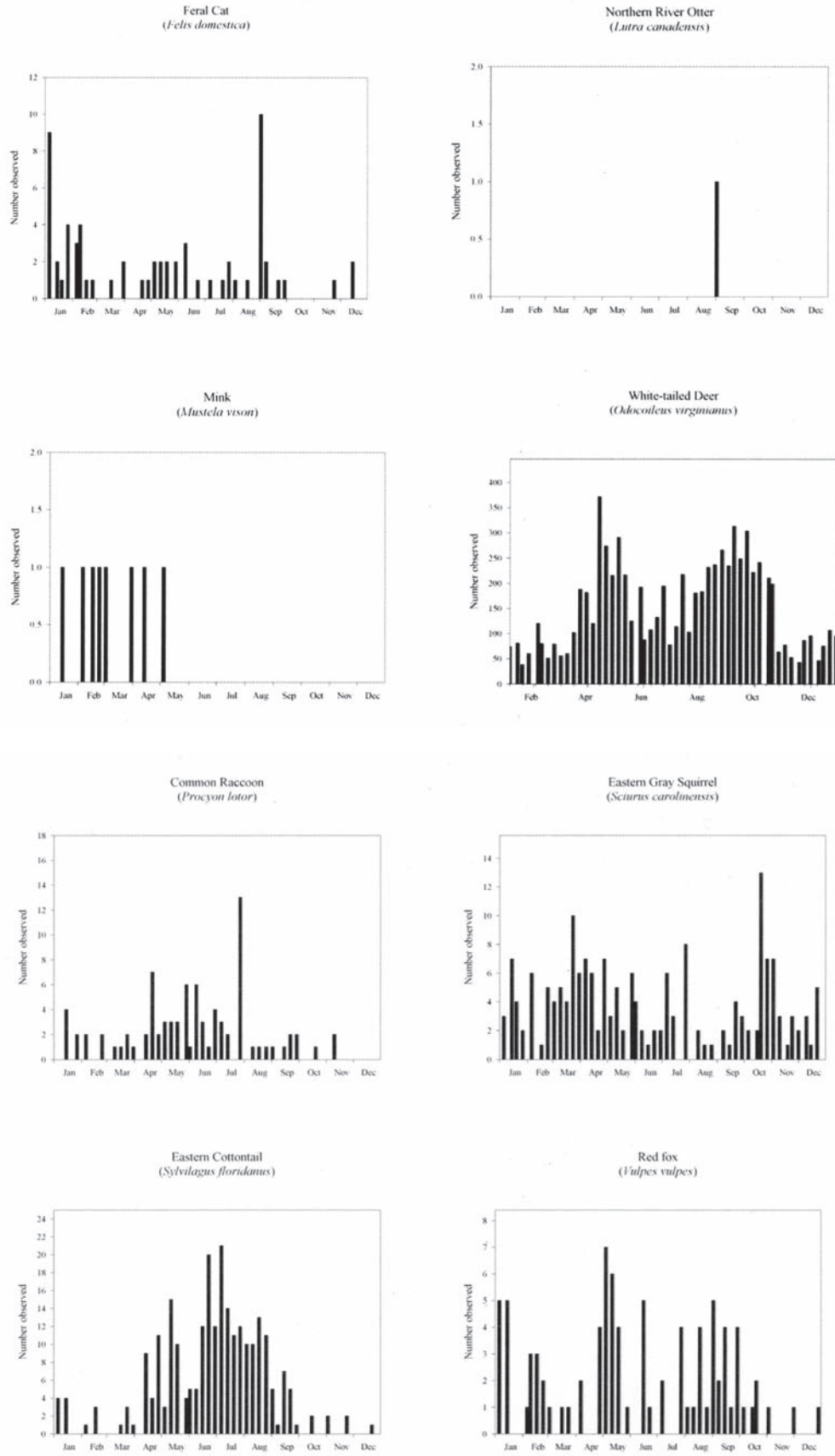
**Figure 6.14.** Locations of scent stations on each of the NBNERR islands and the driving survey route on Prudence Island.

on Patience, Hope, and Dyer islands can be stated. However, mammalian predators and scavengers are apparently absent from either Hope or Dyer islands, partly explaining the success of the heronries and other colonial wading bird populations on these islands. Also important is the absence of white-tailed deer from Hope and Dyer islands. This absence helps to limit the abundance of ticks and probably helps limit the distribution of invasive species, such as Asiatic bittersweet, that are resistant to deer browsing (Ward, 2000). Thus, the absence of deer from these islands may help result in substantially different floral and faunal communities compared to Prudence and Patience islands, suggesting that these higher trophic-level species are exhibiting some degree of top-down control on island ecosystem function.

Due to the limited body of work on mammals it is essential that more research be conducted to better understand the functional roles of mammals on the NBNERR island ecosystems. It would also be useful to understand how these species are responding to human activities and manipulations (e.g., prescribed burns and the creation of wildlife

openings) on these island settings. Additional quantitative surveys of white-tailed deer populations on Prudence Island are needed in recognition of the limits of semiannual spotlight surveys (the RIDEM Division of Fish and Wildlife conducts one evening spotlight survey in spring and again in fall, and the NBNERR driving surveys clearly demonstrate that there is high variability in deer sightings on a weekly basis (Fig. 6.15)). It is also essential to determine which habitats and areas of the island deer are using during different times of the year and the ecological effects of the deer herd reductions that are currently under way (Gibson, personal communication). In addition, a prime opportunity now exists to study the effects of the introduction of a top predator (the coyote) to Prudence Island, which has been lacking such a predator (aside from humans) for at least hundreds of years. Coyotes that are new to the island will surely find ample food supplies in the form of deer, and other small mammals and animals. Their effects on the deer herd and in turn other ecosystem components on Prudence should be monitored and studied to document the effects of predator reintroduction and to determine the extent to which top-down control affects coastal New England island ecosystems.





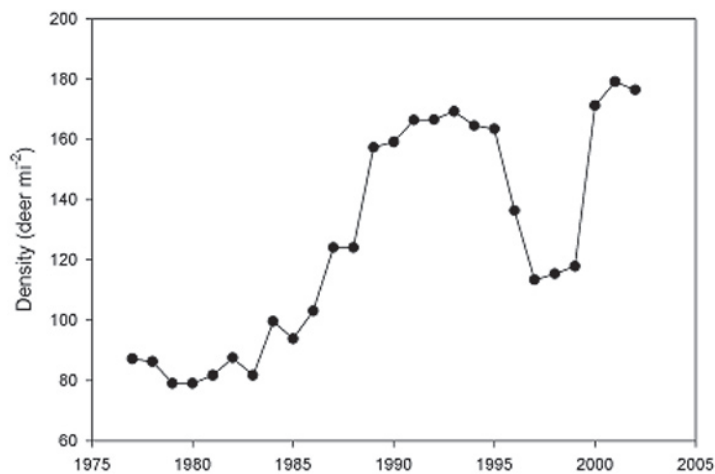
**Figure 6.15.** The number of sightings of mammal species over time on Prudence Island in 2003. All sighting data are from wildlife driving surveys conducted by the NBNERR (Raposa and Rehor, 2004).



**Figure 6.16.** The coyote has recently been discovered on Prudence Island. *Photo by Numi Mitchell, The Conservation Agency.*



**Figure 6.17.** The white-tailed deer is the most conspicuous mammal on Prudence Island. It is often overabundant on the island, exacerbating problems with invasive plant species and ticks and tick-borne diseases. *Photo from NBNERR photo library.*



**Figure 6.18.** Density of white-tailed deer on Prudence Island from 1979–2002. Density values were calculated by dividing the size of the total population by the area of Prudence Island (14.4 km<sup>2</sup>). *Deer population data through 1999 are from Gibson and Suprock (2000); data from 2000 through 2002 are from Gibson (personal communication).*



## Appendix 6.1 Birds of the Reserve

Abundance of bird species observed or captured on Prudence, Patience, Hope, or Dyer islands from studies summarized in this chapter. For each species, the island(s) where it was observed is noted, along with the data source and season. \* = species was present; B = species was present and considered breeding; x = nesting birds were present; w/s = winter/spring; s/f = summer/fall. For the Enser (1990) study, all species indicated in this table were considered breeding by Enser. Those indicated with numbers are the species that were enumerated by Enser; those indicated with a "B" were simply noted in the original text as breeding. Species names and associations are in accordance with the American Ornithologists' Union checklist.

| Family                  | Species                            | Common Name               | Ferren   | Maclachlan | Enser 1990 | Paton and    | Paton and    | Paton et al. | Ferren and |
|-------------------------|------------------------------------|---------------------------|----------|------------|------------|--------------|--------------|--------------|------------|
|                         |                                    |                           | 1985     | 1981       | 1990       | Osenkowski   | Osenkowski   | 2000         | Myers      |
|                         |                                    |                           | Patience | Prudence   | Prudence   | Prudence w/s | Prudence s/f | Prudence     | PPHD       |
|                         |                                    |                           |          |            |            |              |              | (banding)    |            |
| Anatinae                | <i>Aix sponsa</i>                  | wood duck                 |          |            | B          |              |              |              |            |
|                         | <i>Anas acuta</i>                  | Northern pintail          |          |            |            | 3            |              |              |            |
|                         | <i>Anas americana</i>              | American wigeon           |          |            |            | 11           |              |              |            |
|                         | <i>Anas platyrhynchos</i>          | mallard                   |          |            |            | 8            | 2            |              |            |
|                         | <i>Anas rubripes</i>               | American black duck       |          | B          | B          | 1392         | 159          |              |            |
|                         | <i>Anas strepera</i>               | gadwall                   |          |            |            |              | 26           |              |            |
|                         | <i>Aythya marila</i>               | greater scaup             |          |            |            | 3            |              |              |            |
|                         | <i>Aythya</i> sp.                  | scaup sp.                 |          |            |            | 2            |              |              |            |
|                         | <i>Branta bernicla</i>             | brant                     |          |            |            | 775          | 1            |              |            |
|                         | <i>Branta canadensis</i>           | Canada goose              |          | *          | B          | 369          | 96           |              |            |
|                         | <i>Bucephala albeola</i>           | bufflehead                |          |            |            | 204          | 55           |              |            |
|                         | <i>Bucephala clangula</i>          | common goldeneye          |          |            |            | 1932         | 505          |              |            |
|                         | <i>Bucephala islandica</i>         | Barrow's goldeneye        |          |            |            | 3            | 2            |              |            |
|                         | <i>Clangula hyemalis</i>           | long-tailed duck          |          |            |            | 3            |              |              |            |
|                         | <i>Cygnus olor</i>                 | mute swan                 |          |            | B          | 2            |              |              |            |
|                         | <i>Lophodytes cucullatus</i>       | hooded merganser          |          |            |            | 5            | 10           |              |            |
|                         | <i>Melanitta fusca</i>             | white-winged scoter       |          | *          |            | 46           | 387          |              |            |
|                         | <i>Melanitta nigra</i>             | black scoter              |          |            |            | 1            |              |              |            |
|                         | <i>Melanitta perspicillata</i>     | surf scoter               |          |            |            | 2            |              |              |            |
|                         | <i>Mergus serrator</i>             | red-breasted merganser    |          |            |            | 592          | 92           |              |            |
| Phasianidae             | <i>Phasianus colchicus</i>         | ring-necked pheasant      |          | B          | 9          |              |              |              |            |
| Odontophoridae          | <i>Colinus virginianus</i>         | common bobwhite           |          |            | 2          |              |              |              |            |
| Gaviidae                | <i>Gavia immer</i>                 | common loon               |          | *          |            | 19           | 1            |              |            |
| Podicipedidae           | <i>Podiceps auritus</i>            | horned grebe              |          |            |            | 369          | 105          |              |            |
|                         | <i>Podiceps grisegena</i>          | red-necked grebe          |          |            |            | 3            |              |              |            |
| Phalacrocoracidae       | <i>Phalacrocorax auritus</i>       | double-crested cormorant  |          | *          |            | 7            | 552          |              | x          |
|                         | <i>Phalacrocorax carbo</i>         | great cormorant           |          |            |            | 113          | 2            |              |            |
|                         | <i>Phalacrocorax</i> sp.           | cormorant sp.             |          |            |            | 14           | 1            |              |            |
| Ardeidae                | <i>Ardea alba</i>                  | great egret               |          | *          |            | 4            | 89           |              | x          |
|                         | <i>Ardea herodias</i>              | great blue heron          |          | *          |            | 4            | 4            |              |            |
|                         | <i>Bubulcus ibis</i>               | cattle egret              |          |            |            |              |              |              | x          |
|                         | <i>Butorides striatus</i>          | green heron               |          | *          | B          |              |              |              |            |
|                         | <i>Egretta caerulea</i>            | little blue heron         |          | *          |            |              | 4            |              | x          |
|                         | <i>Egretta thula</i>               | snowy egret               |          | *          |            |              | 127          |              | x          |
|                         | <i>Egretta tricolor</i>            | tricolored heron          |          |            |            |              | 2            |              |            |
|                         | <i>Nycticorax nycticorax</i>       | black-crowned night heron |          | *          |            |              | 1            |              | x          |
|                         |                                    | egret sp.                 |          |            |            |              |              | 1            |            |
| Threskiornithidae       | <i>Plegadis falcinellus</i>        | glossy ibis               |          | *          |            |              | 17           |              | x          |
| Accipitridae            | <i>Accipiter cooperii</i>          | cooper's hawk             |          | *          |            | 1            |              |              |            |
|                         | <i>Accipiter striatus</i>          | sharp-shinned hawk        |          | *          |            | 4            |              | 1            |            |
|                         | <i>Buteo jamaicensis</i>           | red-tailed hawk           |          | B          |            | 8            |              |              |            |
|                         | <i>Buteo platypterus</i>           | broad-winged hawk         |          | *          |            |              |              |              |            |
|                         | <i>Circus cyaneus</i>              | northern harrier          |          | *          |            | 2            |              |              |            |
|                         | <i>Pandion haliaetus</i>           | osprey                    |          | *          |            |              | 4            |              |            |
| Falconidae              | <i>Falco sparverius</i>            | American kestrel          |          | B          | B          | 2            |              |              |            |
| Haematopodidae          | <i>Haematopus palliatus</i>        | American oystercatcher    |          |            |            |              | 8            |              | x          |
| Charadriidae            | <i>Charadrius semipalmatus</i>     | semipalmated plover       |          | *          |            |              | 12           |              |            |
|                         | <i>Charadrius vociferus</i>        | killdeer                  |          |            | B          |              |              |              |            |
|                         | <i>Pluvialis squatarola</i>        | black-bellied plover      |          | *          |            |              | 1            |              |            |
|                         |                                    | plover sp.                |          |            |            |              | 1            |              |            |
| Scolopacidae            | <i>Actitis macularia</i>           | spotted sandpiper         |          | *          |            |              | 4            |              |            |
|                         | <i>Arenaria interpres</i>          | ruddy turnstone           |          | *          |            |              | 27           |              |            |
|                         | <i>Calidris alba</i>               | sanderling                |          | *          |            | 26           |              |              |            |
|                         | <i>Calidris minutilla</i>          | least sandpiper           |          |            |            |              | 13           |              |            |
|                         | <i>Catoptrophorus semipalmatus</i> | willet                    |          |            |            |              | 2            |              |            |
|                         | <i>Scolopax minor</i>              | American woodcock         |          |            | B          |              |              |              |            |
|                         | <i>Tringa melanoleuca</i>          | greater yellowlegs        |          | *          |            |              | 1            |              |            |
|                         |                                    |                           |          |            |            |              |              |              |            |
| Laridae                 | <i>Larus argentatus</i>            | herring gull              |          | *          |            | 1182         | 1300         |              | x          |
|                         | <i>Larus atricilla</i>             | laughing gull             |          | *          |            |              | 95           |              |            |
|                         | <i>Larus delawarensis</i>          | ring-billed gull          |          | *          |            |              | 22           |              |            |
|                         | <i>Larus marinus</i>               | great black-backed gull   |          | *          |            | 375          | 330          |              | x          |
|                         | <i>Larus philadelphia</i>          | Bonaparte's gull          |          | *          |            | 24           | 9            |              |            |
|                         | <i>Larus</i> sp.                   | gull sp.                  |          |            |            |              | 2295         |              |            |
|                         | <i>Sterna albifrons</i>            | least tern                |          | *          |            |              | 16           |              | x          |
| <i>Sterna dougallii</i> | roseate tern                       |                           |          |            |            | 2            |              |              |            |



|               |                                   |                               |    |   |     |     |      |     |     |   |
|---------------|-----------------------------------|-------------------------------|----|---|-----|-----|------|-----|-----|---|
|               | <i>Sterna hirundo</i>             | common tern                   |    | * |     |     | 54   |     | x   |   |
|               | <i>Sterna sp.</i>                 | tern sp.                      |    |   |     |     | 3    |     |     |   |
| Columbidae    | <i>Columba livia</i>              | rock pigeon                   | 9  | B | B   | 28  | 10   |     |     |   |
|               | <i>Zenaidura macroura</i>         | mourning dove                 |    |   | B   | 39  | 36   | 55  |     |   |
| Cuculidae     | <i>Coccyzus americanus</i>        | yellow-billed cuckoo          |    | B |     |     |      |     |     |   |
| Strigidae     | <i>Bubo virginianus</i>           | great horned owl              |    |   | B   |     |      |     |     |   |
|               | <i>Otus asio</i>                  | screech owl                   |    | * | B   |     |      |     |     |   |
| Caprimulgidae | <i>Caprimulgus vociferus</i>      | whip-poor-will                |    | B | B   |     |      |     |     |   |
| Apodidae      | <i>Chaetura pelagica</i>          | chimney swift                 |    |   | B   |     |      |     |     |   |
| Trochilidae   | <i>Archilochus colubris</i>       | ruby-throated hummingbird     | 1  | B | B   |     |      |     |     |   |
| Alcedinidae   | <i>Megasceryle alcyon</i>         | belted kingfisher             |    | * |     |     | 4    |     |     |   |
| Picidae       | <i>Colaptes auratus</i>           | common flicker                | 1  | B | 13  | 23  | 6    | 4   |     |   |
|               | <i>Melanerpes erythrocephalus</i> | red-headed woodpecker         |    | * |     |     |      |     |     |   |
|               | <i>Picoides pubescens</i>         | downy woodpecker              |    | B | 2   |     |      | 8   |     |   |
|               | <i>Picoides villosus</i>          | hairy woodpecker              |    |   | B   |     |      | 1   |     |   |
|               |                                   | woodpecker sp.                |    |   |     |     |      | 3   |     |   |
| Tyrannidae    | <i>Contopus virens</i>            | Eastern wood pewee            |    | B | 10  |     |      | 2   |     |   |
|               | <i>Empidonax traillii</i>         | willow flycatcher             |    |   | 3   |     |      | 1   |     |   |
|               | <i>Empidonax virescens</i>        | acadian flycatcher            |    |   |     |     |      | 1   |     |   |
|               | <i>Myiarchus crinitus</i>         | great crested flycatcher      | 1  |   | 7   |     |      | 2   |     |   |
|               | <i>Sayornis phoebe</i>            | Eastern phoebe                |    |   | B   | 1   | 2    | 7   |     |   |
| Vireonidae    | <i>Tyrannus tyrannus</i>          | Eastern kingbird              | 2  | B | 5   |     | 17   |     |     |   |
|               | <i>Vireo griseus</i>              | white-eyed vireo              | 16 | B | 34  |     |      | 20  |     |   |
|               | <i>Vireo olivaceus</i>            | red-eyed vireo                |    | * | 27  |     |      | 4   | 8   |   |
| Corvidae      | <i>Vireo philadelphicus</i>       | Philadelphia vireo            |    |   |     |     |      | 1   |     |   |
|               | <i>Corvus brachyrhynchos</i>      | American crow                 | 10 | B | B   | 80  | 1089 |     |     |   |
|               | <i>Corvus ossifragus</i>          | fish crow                     |    |   |     |     | 3    |     |     |   |
|               | <i>Corvus sp.</i>                 | crow sp.                      |    |   |     |     | 105  | 142 |     |   |
|               | <i>Cyanocitta cristata</i>        | blue jay                      |    | B | 16  |     | 9    |     | 3   |   |
| Hirundinidae  | <i>Hirundo rustica</i>            | barn swallow                  | 1  | B | 2   |     |      | 35  |     |   |
|               | <i>Stelgidopteryx serripennis</i> | Northern rough-winged swallow | 1  |   |     |     |      |     |     |   |
|               | <i>Tachycineta bicolor</i>        | tree swallow                  | 1  | B | 1   |     |      | 125 |     |   |
| Paridae       |                                   | swallow sp.                   |    |   |     |     |      | 401 |     |   |
|               | <i>Baeolophus bicolor</i>         | tufted titmouse               | 1  | B | 20  |     |      |     | 9   |   |
| Sittidae      | <i>Parus atricapillus</i>         | black-capped chickadee        | 2  | B | 25  | 40  | 9    | 82  |     |   |
|               | <i>Sitta carolinensis</i>         | white-breasted nuthatch       |    | B | 1   |     |      |     |     |   |
| Certhiidae    | <i>Certhia americana</i>          | brown creeper                 |    |   |     |     |      |     | 1   |   |
| Troglodytidae | <i>Thryothorus ludovicianus</i>   | Carolina wren                 | 2  | B | 24  | 3   |      |     | 18  |   |
|               | <i>Troglodytes aedon</i>          | house wren                    | 10 | B | 53  |     |      | 2   | 7   |   |
| Regulidae     | <i>Regulus calendula</i>          | ruby-crowned kinglet          |    |   |     |     |      |     | 164 |   |
|               | <i>Regulus satrapa</i>            | golden-crowned kinglet        |    |   |     |     | 6    |     | 34  |   |
| Turdidae      | <i>Catharus fuscescens</i>        | veery                         | 9  | B | 38  |     |      | 6   | 8   |   |
|               | <i>Catharus guttatus</i>          | hermit thrush                 |    |   |     |     |      |     | 8   |   |
|               | <i>Catharus minimus</i>           | gray-cheeked thrush           |    |   |     |     |      |     | 1   |   |
|               | <i>Hyllocichla mustelina</i>      | wood thrush                   | 2  | B | 26  |     |      |     | 3   |   |
|               | <i>Turdus migratorius</i>         | American robin                | 6  | B | 57  | 43  | 79   | 21  | 727 |   |
| Mimidae       | <i>Dumetella carolinensis</i>     | gray catbird                  | 56 | B | 119 |     |      | 88  | 727 |   |
|               | <i>Mimus polyglottos</i>          | Northern mockingbird          |    | B | 10  | 24  | 47   | 3   |     |   |
| Sturnidae     | <i>Toxostoma rufum</i>            | brown thrasher                |    | B | 13  |     |      | 7   | 7   |   |
|               | <i>Sturnus vulgaris</i>           | European starling             | 14 | B | 8   | 446 | 143  |     |     |   |
| Bombycillidae | <i>Bombycilla cedrorum</i>        | cedar waxwing                 | 1  | B | 5   |     | 27   | 1   |     |   |
| Parulidae     | <i>Dendroica caerulescens</i>     | black-throated blue warbler   |    |   |     |     |      |     | 9   |   |
|               | <i>Dendroica coronata</i>         | yellow-rumped warbler         |    | * |     |     |      |     | 543 |   |
|               | <i>Dendroica discolor</i>         | prairie warbler               | 3  | B | 15  |     |      | 8   | 4   |   |
|               | <i>Dendroica palmarum</i>         | palm warbler                  |    |   |     |     |      |     | 13  |   |
|               | <i>Dendroica pensylvanica</i>     | chestnut-sided warbler        |    | B | 11  |     |      | 2   |     |   |
|               | <i>Dendroica petechia</i>         | yellow warbler                | 17 | B | 66  |     |      | 20  |     |   |
|               | <i>Dendroica pinus</i>            | pine warbler                  |    |   | 3   |     |      |     |     |   |
|               | <i>Dendroica striata</i>          | blackpoll warbler             |    |   |     |     |      |     | 40  |   |
|               | <i>Dendroica virens</i>           | black-throated green warbler  |    |   |     |     |      |     | 2   |   |
|               | <i>Geothlypis trichas</i>         | common yellowthroat           | 52 | B | 93  |     |      | 25  | 38  |   |
|               | <i>Icteria virens</i>             | yellow-breasted chat          |    |   |     |     |      |     |     | 2 |
|               | <i>Mniotilta varia</i>            | black-and-white warbler       |    |   |     | 10  |      |     |     | 5 |
|               | <i>Oporornis agilis</i>           | Connecticut warbler           |    |   |     |     |      |     |     | 1 |
|               | <i>Seiurus aurocapilla</i>        | ovenbird                      |    |   |     | 5   |      | 1   |     | 7 |



|              |                                  |                                |    |   |     |  |    |    |    |
|--------------|----------------------------------|--------------------------------|----|---|-----|--|----|----|----|
|              | <i>Seiurus noveboracensis</i>    | Northern waterthrush           |    |   |     |  |    | 1  |    |
|              | <i>Setophaga ruticilla</i>       | American redstart              | 17 | B | 36  |  | 3  | 11 |    |
|              | <i>Vermivora pinus</i>           | blue-winged warbler            |    |   | 12  |  |    | 3  |    |
|              | <i>Vermivora ruficapilla</i>     | Nashville warbler              |    |   |     |  |    | 7  |    |
|              | <i>Wilsonia pusilla</i>          | Wilson's warbler               |    |   |     |  |    | 1  |    |
| Thraupidae   | <i>Piranga olivacea</i>          | scarlet tanager                |    |   | 3   |  |    | 3  |    |
| Emberizidae  | <i>Ammodramus caudacutus</i>     | saltmarsh sharp-tailed sparrow | 3  | B | B   |  | 2  | 1  |    |
|              | <i>Ammodramus maritimus</i>      | seaside sparrow                |    | B |     |  |    |    |    |
|              | <i>Junco hyemalis</i>            | dark-eyed junco                |    |   |     |  | 29 | 75 |    |
|              | <i>Melospiza georgiana</i>       | swamp sparrow                  | 1  |   |     |  |    | 49 |    |
|              | <i>Melospiza melodia</i>         | song sparrow                   | 13 | B | 42  |  | 91 | 93 | 94 |
|              | <i>Passerculus sandwichensis</i> | savannah sparrow               |    |   |     |  |    | 5  |    |
|              | <i>Pipilo erythrophthalmus</i>   | Eastern towhee                 | 31 | B | 104 |  | 3  | 51 | 43 |
|              | <i>Spizella arborea</i>          | American tree sparrow          |    |   |     |  | 37 | 1  | 1  |
|              | <i>Spizella pusilla</i>          | field sparrow                  |    |   | 14  |  |    | 1  | 6  |
|              | <i>Zonotrichia albicollis</i>    | white-throated sparrow         |    |   |     |  | 39 |    | 77 |
|              | <i>Zonotrichia leucophrys</i>    | white-crowned sparrow          |    | * |     |  |    |    | 3  |
|              |                                  | sparrow sp.                    |    |   |     |  |    | 85 |    |
| Cardinalidae | <i>Cardinalis cardinalis</i>     | Northern cardinal              | 10 | B | 20  |  | 6  | 5  | 33 |
|              | <i>Passerina cyanea</i>          | indigo bunting                 |    |   |     |  |    |    | 1  |
|              | <i>Pheucticus ludovicianus</i>   | rose-breasted grosbeak         |    |   | 2   |  |    |    | 1  |
| Icteridae    | <i>Agelaius phoeniceus</i>       | red-winged blackbird           | 5  | B | 5   |  | 64 | 30 |    |
|              | <i>Icterus galbula</i>           | Baltimore oriole               |    | B | 2   |  |    |    | 1  |
|              | <i>Molothrus ater</i>            | brown-headed cowbird           | 1  | B | 21  |  | 4  | 10 |    |
|              | <i>Quiscalus quiscula</i>        | common grackle                 | 5  | B | 11  |  |    | 12 |    |
| Fringillidae | <i>Carduelis tristis</i>         | American goldfinch             | 5  | B | 18  |  | 3  | 74 | 48 |
|              | <i>Carpodacus mexicanus</i>      | house finch                    | 11 | B | 14  |  | 7  | 1  | 11 |
|              | <i>Carpodacus purpureus</i>      | purple finch                   | 4  |   | 1   |  |    | 6  | 5  |
| Passeridae   | <i>Passer domesticus</i>         | house sparrow                  |    |   | B   |  | 5  | 4  |    |

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