

**BIRD MIGRATION MONITORING**  
**AT**  
**CABOT HEAD:**  
**THE FIRST FIVE YEARS (2002-2006)**

*by*

Stéphane Menu  
214 rue des Franciscains  
Québec, QC  
G1R 1J1  
stefmenu@gmail.com

*prepared  
for*

**BRUCE PENINSULA NATIONAL PARK &  
BRUCE PENINSULA BIRD OBSERVATORY**

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## **Introduction**

Migration is among the most impressive and complex phenomena of the animal world. It has long puzzled and awed humans by the numbers of animals involved, distances travelled and feats of navigation. Despite numerous studies and innovative technological developments (like radar, satellite telemetry and stable-isotope analyses – see, for examples, Bart, 2005, Hobson, 2005 and Millikin 2005), many aspects of migration are still relatively poorly known and understood. For instance, the exact migratory path, and all the decisions required to follow it, of a single Yellow-rumped Warbler (scientific names of all species mentioned are in Appendix E), an abundant bird of the boreal forest, is still a mystery!

As argued by Gauthreaux (1996), the first phase of the study of animal behaviour is that of observation and description. It provides the foundation on which hypotheses can be built and further studies implemented. Long-term descriptive studies also provide data sets that can be used as baselines for monitoring purposes. While diverse methods can be used to study migrating birds (see a review in Gauthreaux, 1996); direct observations and banding following well-established protocols are two of the most widely implemented.

Precise monitoring of populations is essential to the understanding and management of natural resources. The Breeding Bird Survey (BBS) is the principle method for monitoring bird populations in the United States and the southern part of Canada. However, breeding ranges of many species in northern Canada are inaccessible to roadside surveys and are therefore poorly monitored by the BBS method. Migration monitoring at observatories across the country can be an effective means of tracking populations of species that nest in remote northern areas of Canada, species whose habitat is rarely sampled by roadside surveys and species that are otherwise difficult to detect during the breeding season (Badzinski and Francis, 2000). The Canadian Migration Monitoring Network (CMMN) is a nation-wide Bird Studies Canada initiative, enacted to assess changes in populations during migration, especially for priority species that are not being adequately monitored by other programs, such as the Breeding Bird Survey and Christmas Bird Count. The network is made of 23 stations across Canada where data are being collected for each bird species during the spring and fall migrations, typically through a standardised capture and observation protocol. Bruce Peninsula Bird Observatory (BPBO) has demonstrated through data collection since 1998 that Cabot Head is a valuable site for monitoring migrating landbirds and can therefore contribute to

the monitoring effort of the CMMN. Indeed, BPBO became a member of the CMMN in fall 2003.

Birds, most notably raptors and songbirds migrate across a broad front, unless particular geographical features concentrate them. Peninsulas, for example, are especially good places to concentrate migrants. Depending on where they are located, they may funnel birds crossing over land toward water or beckon to migrants crossing large water bodies, offering first refuge and rest as they reach the other side. Rain, headwinds, or fog can precipitate fallouts of birds reluctant to cross over water or that are too exhausted to fly any farther after reaching the other side. Bruce Peninsula is therefore particularly suited to studying migration. Cabot Head is a promontory of the northeast headland of the upper Bruce Peninsula in south central Ontario and was designated in 2001 as a Globally Significant Important Bird Area (IBA) by Birdlife International for its significant concentrations of migratory bird species, especially Red-necked Grebes (Cheskey and Wilson, 2001). Cabot Head is adjacent to Bruce Peninsula National Park (BPNP), and as such, is part of the Greater Park Ecosystem. Cabot Head Research Station (CHRS), jointly managed by Ontario Parks and Bruce Peninsula Bird Observatory, is situated on the western side of Wingfield Basin (at 45°15'N, 81°18'W) near the community of Dyer's Bay.

The main role of Bruce Peninsula Bird Observatory is to initiate and direct bird research and monitoring at Cabot Head and its surroundings in a conservation-minded frame. Migration monitoring has been the primary focus of bird research at Cabot Head since 1998. This document reports on results of the first five years (2002-2006) of migration monitoring following a definitive protocol and mist net set-up at Cabot Head Research Station. More specifically, the principal aims of the report are to improve our understanding of migration patterns on the Bruce Peninsula (species, numbers, phenology, residence time, influence of weather, etc.), to provide data that will complement other bird monitoring data currently being collected through the BPNP Ecological Integrity Monitoring Program (e.g. Forest Bird Monitoring Program, Breeding Bird Survey) and to provide data on migration patterns of the Red-necked Grebe, a provincially sensitive species that migrates through the Greater Park Ecosystem in large numbers.

A short history of Cabot Head Research Station, by Ted Cheskey, founding member of BPBO

Cabot Head has long attracted the interest of birders and ornithologists. Cheskey conducted banding during the month of August, 1996 near the Lighthouse. Heagy undertook more intensive work in 1998 in order to explore the potential for migration monitoring of the area. The conservation planning committee working on the Cabot Head Important Bird Area (IBA) conservation plan, saw value in supporting Heagy's efforts in establishing migration monitoring. The Lighthouse proved to be less than adequate due to high tourist visitations and disturbance. Consequently, the preliminary operations were shifted in 2000 to the current site on the west side of Wingfield Basin with the backing of the newly formed Bruce Peninsula Bird Observatory Board (formed mainly from the IBA planning committee). Tenancy of the site by the Bruce Peninsula Bird Observatory was negotiated with Ontario Parks, as the site falls within the Cabot Head Provincial Nature Reserve. Ontario Parks had originally considered removing the buildings, but were convinced by the new BPBO Board and others that the buildings could be restored and used for research and education, within the mandate of Ontario Parks. Wingfield Cottage and Grebe Lodge were restored thanks largely to support from the Protection and Enhancement Fund of the Ontario Ministry of Natural Resources. BPBO gained some initial financial capacity through significant grants from the Ontario Trillium Foundation, as well as other smaller sources, allowing an administration staffing an operations capacity. In 2002, the current protocol for migration monitoring was adopted.

## **Goals and Objectives**

The main goal of the small landbird migration monitoring project at Cabot Head is to contribute to the efforts of the Canadian Migration Monitoring Network (CMMN) to monitor changes in the populations of certain migratory landbird species that are not being adequately monitored by other programs.

The primary objective of migration monitoring at Cabot Head is to generate Standard Migration Counts that represent a consistent sample of the small landbirds migrating through Cabot Head each day during the spring and fall migration. The Standard Migration Counts can be used after several years to calculate long-term population trends for the target species being monitored.

More general objectives of the bird migration research at Cabot Head include:

- to learn more about the composition, magnitude, timing, and demographics of bird migration on the Bruce Peninsula and Great Lakes Basin; and
- to foster the public's understanding and appreciation of birds and bird migration and other aspects of the natural history of the Bruce Peninsula.

## Methods

The migration monitoring program at Cabot Head follows a field protocol (established by Heagy et al, 2003, modified from Heagy 2002) as it is essential for the production of population indices that data collection be consistent over the long term. Standardised capture and observation methods are designed to monitor small landbirds which have been identified as a priority for migration monitoring by the Canadian Migration Monitoring Network (see Appendix A; Francis and Dobbyn 1997). Separate protocols have been used for monitoring Red-necked Grebes and Northern Saw-whet Owls at Cabot Head during migration.

At Cabot Head Research Station, three different methods (banding, census, and casual observations) are used to monitor migration in a defined count area during a specific period and to produce daily Standard Migration Counts. Banding is done using fifteen mist nets operated for 6 hours commencing half an hour before sunrise, weather permitting. Personnel also complete a census that takes for one hour along a fixed route, where all birds seen or heard are recorded. Casual observations are made throughout the count period and supplemental surveys such as visible migration counts and bay watches are completed when circumstances permit.

The Count Area includes Wingfield Basin and land on its western side from the small peninsula of land oriented toward the outlet of the basin (where the net lanes and buildings are situated) to the open jack pine savannah. All counting is done from within these boundaries during the daily Count Period, which is the 7-hour period starting 30 minutes before sunrise and ending 6.5 hours after sunrise. Habitats in the Count Area include rocky shoreline, the former lawn area (presently a mix of short grass, tall grass and poison ivy (*Toxicodendron radicans*)), shrub thickets (dogwood (*Cornus spp.*), *Viburnum sp.*, ninebark (*Physocarpus opulifolius*), *Juniper sp.*), and mixed woods (white cedar (*Thuja occidentalis*), white birch (*Betula papyrifera*), poplar (*Populus sp.*), balsam fir (*Abies balsamea*), maple (*Acer spp.*)) with small openings with juniper barrens (described in Woodhouse, 2002). All birds seen or heard by an observer located within the Count Area during the Count Period are considered “countable”, regardless of whether or not the birds are within the Count Area. For example, all birds on or over Georgian Bay or Middle Bluff that can be seen by binoculars (or aided eye) are countable if the observer is located within the boundaries of the Count Area.

To generate daily Standard Migration Counts, two complementary methods, Standard Observations and Standard Captures, are used at Cabot Head. Standard Observations are composed of a standard census (i.e. a fixed-route, one-hour survey), and incidental observations. The census must be completed regardless of weather conditions (except for violent weather when birds are poorly detected). One skilled person using binoculars follows a specific route starting 1 hour to 1.5 hours after sunrise for exactly 60 minutes and records every bird heard or seen. To ensure that census data is not biased toward the abilities of a single observer, personnel who are skilled enough to do the census rotate this task. Those conducting the census must pay close attention to bird movements over the course of the census in order to avoid double counting the same individual birds. The census route begins at the old dock steps in front of the cottage and then turns toward the point where it loops back up the road on the north side of the point and follows the road up to the jack pine barrens where it ends there. The census route is completed at the same pace regardless of whether there is a large volume of birds or not.

Incidental observations refer to observations made during the standard count period that do not fall under the category of the census or other survey methods (e.g. visible migration counts). The purpose of these observations is to document birds that were not captured or banded, and to assist with determining the estimated total for each species each day.

The goal of the Standard Capture program is to capture, mark, and collect data on a representative sample of the target species present in the Count Area on any particular day. Ideally, all nets in the standard array are used for a set period every day, a full set of data are collected for each bird captured, and each bird is banded with a standard numbered band issued by the Canadian Bird Banding Office. However, the welfare of the birds takes priority over maintaining the complete standard protocol. For example, during periods of high volume of captures, less data could be collected to speed up the banding process and reduce stress on birds. The standard capture effort includes only mist nets. Other nets or traps are used only provided they do not impact on the standard netting efforts. The standard net array consists of 15 small-mesh mist nets in fixed locations. Eleven of the nets are set singly, while 2 sets of 2 nets are set in a line and joined at a central pole. Each individual net has a unique identifier code in order to keep track of net operating times and of where each bird was caught. Nets are grouped into three blocks

(A, B, C) based on distance from the banding lab. Each block of nets covers a variety of habitats and situations. Nets are 12 m long and 2.5 m high with 4 or 5 shelves of 30 or 32 mm mesh made of 110-denier, 2-ply black nylon thread. They are set on 2.5 m<sup>1</sup> poles with the bottom shelf string set at knee height.

All standard nets are operated daily (weather permitting) throughout the spring and fall. Depending on the wind strength and direction, on any given day some nets in a block may be closed, while other nets in the same block that may not be affected by the wind can remain open. Under good conditions, all open nets are checked at 30-minute intervals until they are closed. If conditions are less than ideal, checks should be more frequent. Under normal conditions, nets are closed in the same order they were opened, starting 6 hours after the first net was opened. If, due to weather conditions or other factors, nets are opened later than scheduled or are closed for part of the standard period, the netting period is extended either until the end of the Count Period or until the 6 hour target is reached, whichever comes first.

Captured birds are taken to the banding lab to be processed and banded. In general, all unbanded birds that are captured are banded with a standard numbered band issued by the Bird Banding Office. The minimum data recorded for every banded bird are: band number, species, age, how aged, sex, how sexed, bander, location, date, time of capture, and net number. Additional data that are routinely collected include: wing chord, weight, time weighed, fat score, skull ossification score, cloacal protuberance score, and brood patch development score. Previously banded birds are processed in the same way as unbanded birds, with the exception of birds captured and processed earlier the same day (same-day repeats). These birds are released immediately at the nets.

At Cabot Head, the Standard Migration Count is an estimate of the number of individuals of each species in or passing through the Count Area during the Count Period based on the data collected using the Standard Observation and Standard Capture methods described above. At this station two methods of developing a Standard Migration Count are being used:

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<sup>1</sup> The south pole in net 3 and both poles in net 6 are 5 m and use pulleys.

- **Detected Total (DT)** corresponds to how many birds of each species were *actually detected* (seen, heard, or caught) on a particular day. The Standard Detected Total (DT) for each species is the sum of total Standard Capture (mist netting) plus the total of the Standard Observations (census and incidental observations), minus a correction for any birds that have been double-counted (i.e. observed *and* captured). The DT is never more than the sum of the Standard Captures plus the Standard Observations. Only individuals that are positively identified as to species are included in the DT.

- **Estimated Total (ET)** is an estimate of how many birds of each species were *actually present* (could potentially have been seen, heard, or caught if unlimited effort) on a particular day. The ET is based on the DT and knowledge of migration patterns on a particular day.

Both the DT and ET include individuals that passed through the Count Area and individuals that remained in the Count Area.

## Results

### Migration Monitoring Period

Start and end dates have been slightly different between years (Table 1). Unless specified otherwise, a consistent period was used in order to allow between-year comparisons. Hence, the spring period was from April 16 to June 12 and the fall period from August 16 to October 31.

Table 1. Migration monitoring period at Cabot Head Research Station, 2002-2006.

	Spring		Fall	
	Start	End	Start	End
2002	17 April	12 June	13 August	2 November
2003	16 April	15 June	10 August	1 November
2004	19 April	12 June	16 August	1 November
2005	16 April	11 June	16 August	31 October
2006	16 April	12 June	16 August	31 October

### Diversity

Since 2002, a total of 224 species have been detected, belonging to 17 orders, 46 families, and 24 subfamilies (Appendix E). The diversity is usually higher in spring (average of 165 species, range: 156 – 174), than in fall (average 144 species, range 128 – 157). In total, 201 species have been seen in spring, whereas 193 have been seen in fall. After 2002, between one and 3 new species are added every season (Fig.1). Thirteen species in spring and 12 in fall have been observed only once since 2002 (Fig.2). In total 48 species (22% of the total species detected) have been detected only during one or 2 years. On the other hand 89 species (40%) have been seen each season of each year, and another 53 species (24%) have been seen every year (but not always in both seasons of a given year). These regular species are distributed across all the orders and families observed at Cabot Head (with the ironic exception of House Sparrow, of the Passeridae family, very rarely seen at Cabot Head). Amazingly, 4 species (Great Crested Flycatcher, Eastern Meadowlark, Field Sparrow, and Northern Mockingbird) have been seen every spring, but never in fall. Likewise, 4 species (American Black Duck, Northern Shrike, Northern Saw-whet Owl and Yellow-billed Cuckoo) have been detected during 4 falls, but never in spring.

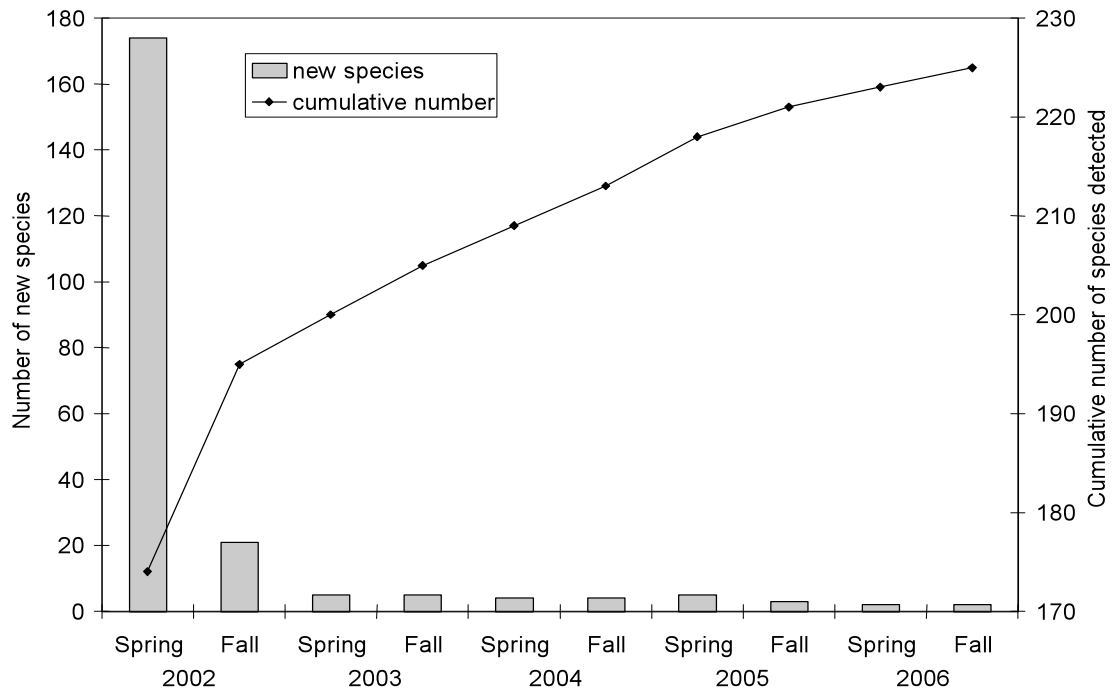


Fig.1. New species and cumulative number of species seen at Cabot Head Research Station, 2002-2006.

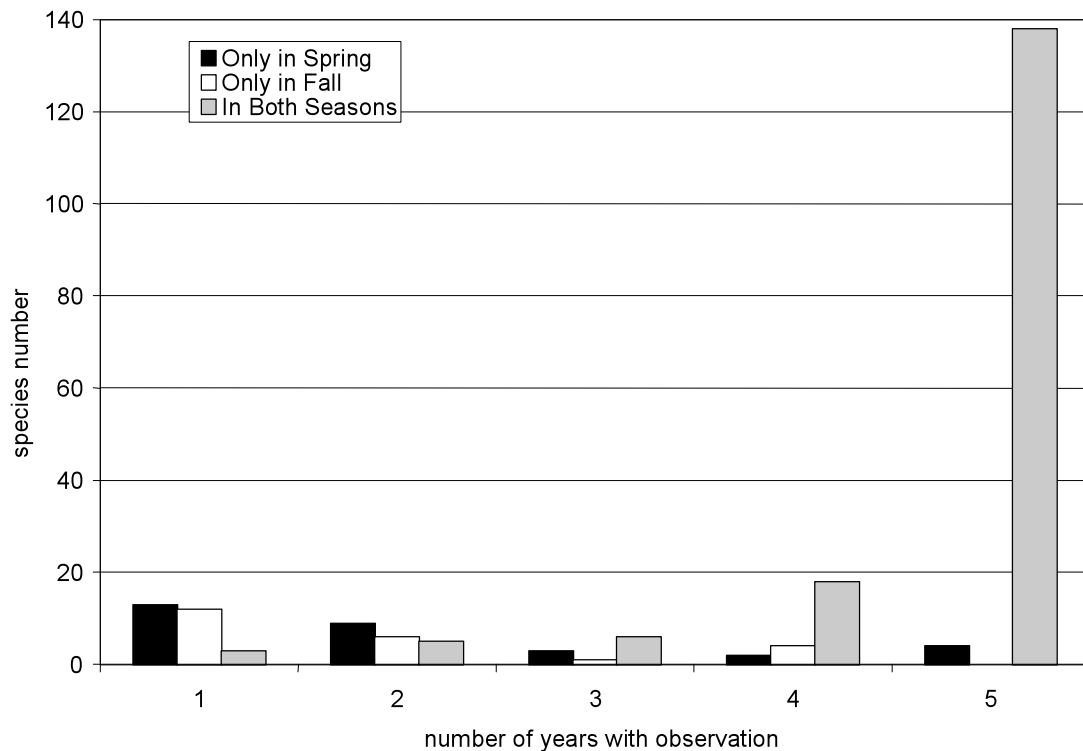


Fig.2. Number of species observed in relation to season and number of years they have been observed at Cabot Head Research Station, 2002-2006.

### Abundance

Based on cumulative DT of all years, many species are seen in small to very small numbers; 116 species (51% of total species across all years) have less than a cumulative total of 100 individuals over the 5 years of monitoring. Forty-three percent of species are relatively common (between 100 and 5000 individuals) and only a few species are extremely abundant (over 5000 individuals)(Fig.3).

Not surprisingly, the most abundant species, as measured by DT, are seen every season of every year (Fig.3). Likewise, rare species (detected during only one or two seasons) are seen in small numbers. The Bonaparte's Gull is an interesting exception: one individual was seen in fall 2002, 2 in fall 2005, but 113 in fall 2003! It is thus considered an infrequent and rare species around Cabot Head, but apparently, unusual conditions occurred in fall 2003 to attract important numbers of this species (for the area). It was especially so on October 27, 2003, when 45 Bonaparte's Gulls were observed on a "feeding frenzy" offshore with Red necked Grebes (32 DT, also a high number for this species from CHRS), flocks of Common Loons (40 DT), Red-breasted Mergansers (72 DT) and numerous Ring-billed and Herring Gulls.

Some frequently observed species (at least 7 seasons out of 10) are also detected in small numbers: 16 of these species have a cumulative total between 50 and 99 individuals and 17 species less than 50 individuals. These species are generally secretive (Northern Waterthrush, for example), at the northern limit of their range (Blue-gray Gnatcatcher), or rare (Peregrine Falcon). On the contrary, species migrating in flocks and during daylight are easily detected in high numbers: Blue Jay, Canada Goose, Double-crested Cormorant, Ring-billed Gull, Black-capped Chickadee, Cedar Waxwing, and Myrtle Warbler<sup>2</sup> are the most common species observed, in decreasing order.

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<sup>2</sup> A subspecies of the Yellow-rumped Warbler

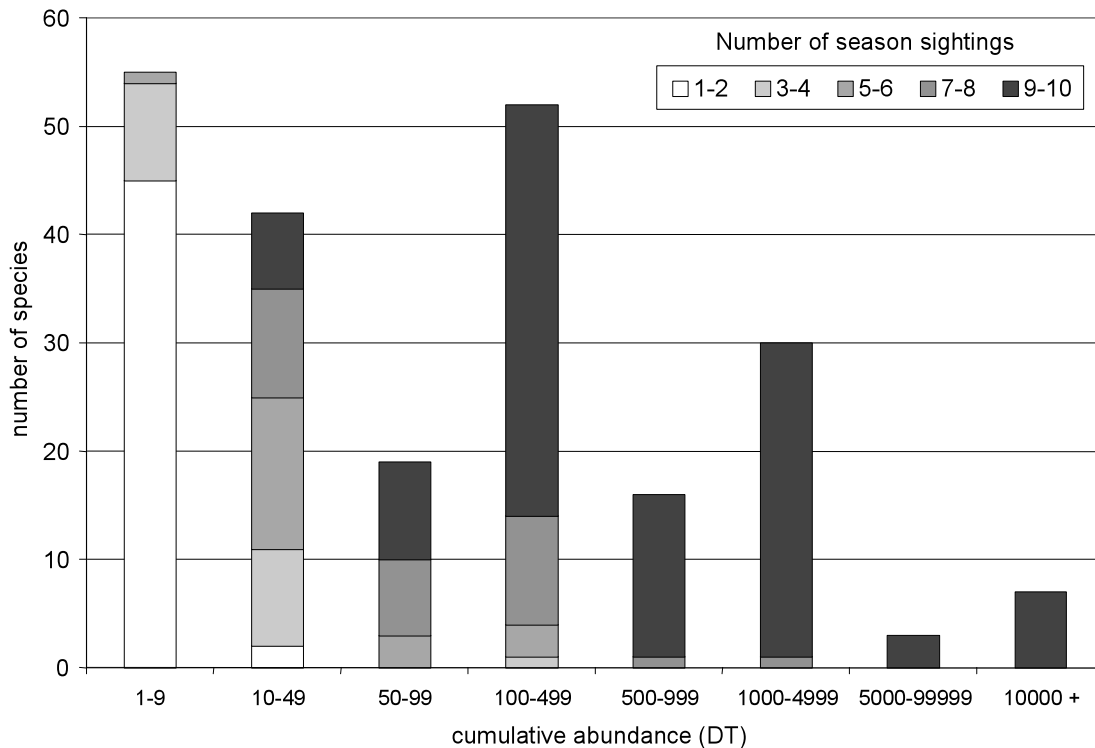


Fig.3. Abundance of species in relation to occasions of sightings at Cabot Head Research Station, 2002-2006.

### Phenology

Even for very abundant species, there is great temporal variation in abundance patterns both within and between seasons (figures for the most important species based on abundance and frequency are shown in Appendix F). Species like Black-capped Chickadee or Pine Siskin show irruptive patterns, with one or a few seasons contributing disproportionately to the DT total. Other species are particularly abundant consistently every spring, but only common or even very rare in fall. Fall migration of some of these species, especially Swallows, is simply too early to be monitored within the time window at CHRS. Similarly, many species more abundant in fall migrate too early in spring to be accurately monitored (American Tree Sparrow and Snow Bunting, for example). However, the geographic features of the Bruce Peninsula, acting as a funnel in spring but not in fall, could explain seasonal differences in abundance for many species. This temporal pattern -a heavy spring migration and almost none in fall - is particularly evident for shorebirds (Killdeer, Solitary Sandpiper), Icterids (Common Grackle, Red-winged Blackbird, Brown-headed Cowbird, Eastern Meadowlark), and birds of prey

(especially soaring species like Turkey Vulture, Broad-winged Hawk, and Sharp-shinned Hawk, but also flapping species like American Kestrel). A more active singing behaviour in spring could also lead to a higher detection rate, resulting in higher measured abundance. Crepuscular or nocturnal species, such as Wilson's Snipe, American Woodcock, and Whip-poor-will, are well detected in spring but rarely in fall. Absent or reduced foliage in spring could also effect detection of songbirds. Warblers, as a group, have their migration fully within the monitoring windows. For the 22 species of warblers detected in sufficient numbers, 19 species are more abundant in spring than in fall, 2 have approximately the same abundance, and only Tennessee Warbler is more abundant in fall. This pattern of higher detected abundance in spring is all the more significant given that population numbers are greatly increased in fall by young birds.

Globally, Blue Jay is the most common species detected at CHRS in spring. This species also shows a temporal pattern, with abundance in spring between 3 to 10 times higher than in fall. Even if it is not a soaring species like *Buteo* hawks, it is possible that Blue Jays are reluctant to cross a large body of water, resulting in a funnelling effect in spring on the peninsula. Being concentrated by the peninsula in their northward flight, Blue Jays could probably turn around when arriving at the tip of the peninsula, increasing the risk of double-counting at Cabot Head. Flocks of Blue Jays are very often seen "milling", flying in one direction, and then another, always along the shoreline and never heading out over Georgian Bay. Special care is taken to prevent double-counting within the same days: following flocks, and not counting a flock of approximately the same size flying back. It is however impossible to prevent double-counting between days. Nonetheless, it seems that Blue Jays move rapidly through the area. In spring 2004, a total of 264 Blue Jays were banded (176 in a baited ground trap) and only 3 of them were recaptured subsequently this same spring (despite the incentive from the seeds in the trap). This is a good indication of a huge, direct, and rapid movement of this species over the Peninsula.

### **Banding**

Since 2002 a total of 16,952 birds of 107 species have been banded using mist nets during the regular count period of the migration monitoring at Cabot Head Research Station (Fig.4 and Appendix C). In addition, 222 birds of 12 species were captured in a baited ground trap in spring 2004 (Appendix D) as a pilot project that was not continued,

and 12,443 birds of 123 species were banded in 1998 and 2000-2001 in the pilot years of the monitoring project. All results, unless otherwise specified, are based on regular banding done between 2002 and 2006. On average, more birds are banded in fall ( $1,808 \pm 441$ ) than in spring ( $1,582 \pm 497$ ). However, variations in captures and diversity between seasons and years are important. In spring, a total of 7,908 birds of 90 species have been banded (low of 1,214 of 61 species in spring 2004 – high of 2,431 of 74 species in spring 2002). In fall, 92 species have been captured for a total of 9,044 banded birds (1,476 of 62 species in fall 2006 – 2,477 of 67 species in fall 2005).

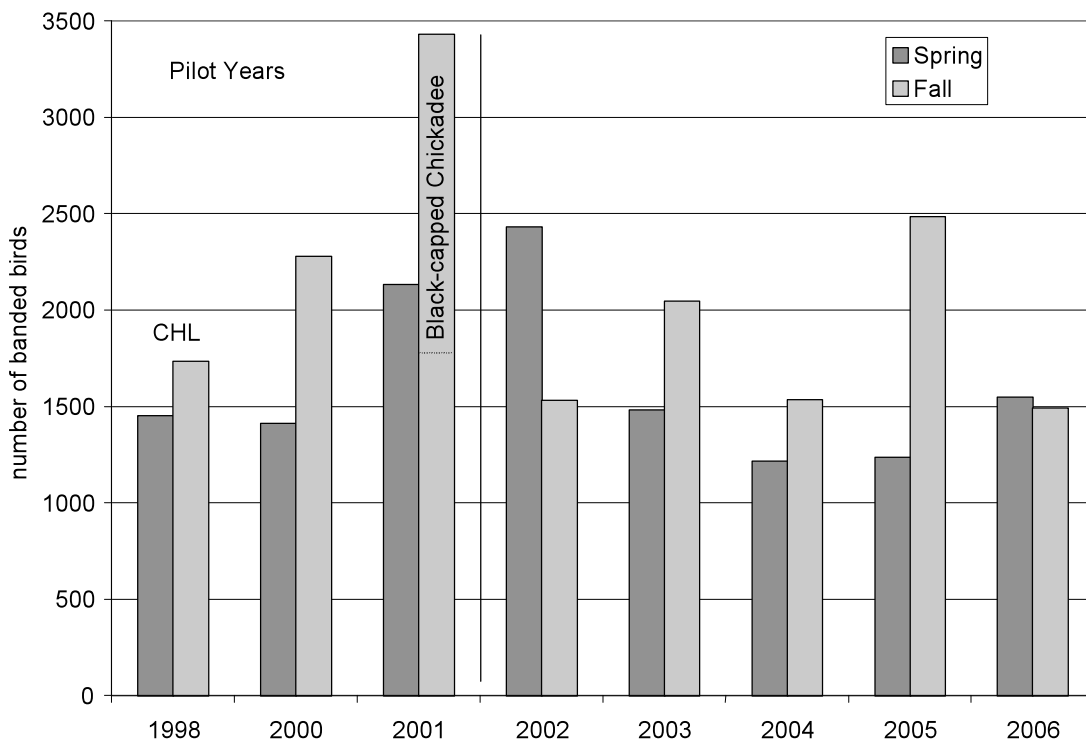


Fig.4. Number of banded birds captured in mist nets by season and year at Cabot Head Research Station and Cabot Head Lighthouse (CHL). The proportion of Black-capped Chickadees banded in 2001 is noted.

Of the 107 species banded, 39 species have been banded every season of every year and 20 species have been banded only once (11 in spring and 9 in fall). Most species, even regularly captured ones, are banded in very small numbers: 57 species have had less than 50 birds captured in cumulative total, i.e. 53% of all species represent only 4.5% of the banding total. On the contrary, 11 species (10% of total) account for 63% of the banding total, with more than 500 individuals captured over 5 years (Fig.5). In total, only 33 species account for 89% of the cumulative banding total.

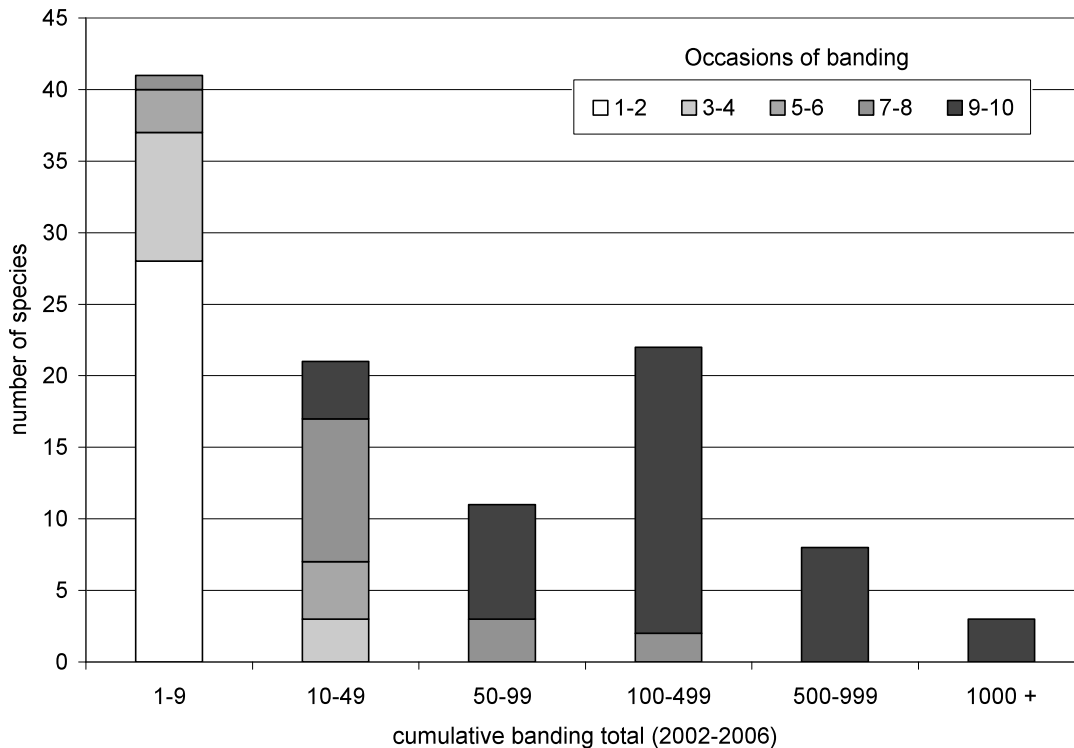


Fig.5. Cumulative banding total in relation to occasions of banding at Cabot Head Research Station (2002-2006).

The 10 most common species banded in a season (which represent between 13 to 16% of the diversity) amount to 59 to 76% of the season banding total. American Redstart is the only species consistently among the 10 most abundant banded species for every season of every year. Both species of Kinglet are also banded in high numbers almost every season. White-throated Sparrow and Myrtle Warbler are 2 other species frequently among the top 10 banded species. However, fluctuations between years in banding totals lead to many different species in the 10 most abundant species (23 species in total). For example, among them, Magnolia, Palm, and Black-and-White Warblers occurred every year but only in spring. On the other hand, Black-throated Green Warbler, and Red-eyed Vireo, are abundant only in fall.

Diversity is usually higher in spring than fall, in number of species banded and in relative proportion. Even if only a handful of species account for 50% of the banding total in both seasons, the number of birds banded in spring is more spread across the range of species. Banding in fall could be overly dominated by one species, either Golden-crowned Kinglet or Black-capped Chickadee, usually accounting for up to 30%

of the banding total. In contrast, the most frequently banded species (usually American Redstart) in spring only represents only 12 to 19% of the total (Table 2).

Table 2. The most abundant banded species (by year and season) and its relative contribution to the banding total.

Most banded species		2002	2003	2004	2005	2006
Spring	Species	BCCH	AMRE	AMRE	AMRE	RCKI
	%of banding total	14%	12%	19%	12%	15%
Fall	Species	GCKI	BCCH	GCKI	BCCH	GCKI
	%of banding total	32%	18%	17%	29%	28%

AMRE: American Redstart; BCCH: Black-capped Chickadee; GCKI: Golden-crowned Kinglet; RCKI: Ruby-crowned Kinglet.

### **Banding Monitoring Effort**

Capture rates are highly variable between seasons and years. Within seasons they also vary greatly, obviously on a daily, but even on a weekly basis (Fig.7a and Fig.8a). The capture rate is determined by dividing the number of birds caught in a net by the number of hours for which the net was operated. Thus, variation in capture rate reflects variation in those two parameters, which are themselves dependent upon various conditions (weather being the major one). Mist net hours are lost when weather conditions (i.e. rain or strong wind) or the presence of a predator are posing a threat to the birds, forcing net closures. On average, a third of the potential hours are lost each season (Tables 3a&b), with difference between years more pronounced in spring. Long periods of favorable weather in fall 2004 and spring 2005 allowed a particularly remarkable coverage, with more than 80% of the potential mist net hours achieved.

Table 3a&amp;b. Capture rates (with or without Black-capped Chickadee), spring 2002-2006 (top) and fall 2002-2006 (bottom).

Year	Total Banded		Net Hours (% lost)	Captures/ Net Hour	
	with	without		with	Without
2002	2432	2090	3333 (34%)	0.73	0.63
2003	1473	1467	3490 (36%)	0.42	0.42
2004	1204	1190	3133 (37%)	0.38	0.38
2005	1236	1230	4193 (18%)	0.29	0.29
2006	1577	1499	3900 (27%)	0.40	0.38
Total	7922	7476	18049 (31%)	0.44	0.41
Average $\pm$ SD	1584 $\pm$ 499	1495 $\pm$ 360	3610 $\pm$ 431		

Year	Total Banded		Net Hours (% lost)	Captures/ Net Hour	
	with	without		with	Without
2002	1530	1501	5077 (31%)	0.31	0.30
2003	2044	1676	5501 (27%)	0.37	0.30
2004	1512	1343	5633 (19%)	0.27	0.24
2005	2477	1760	4774 (31%)	0.52	0.37
2006	1476	1464	4614 (33%)	0.32	0.32
Total	9039	7744	25599 (29%)	0.35	0.30
Average $\pm$ SD	1808 $\pm$ 441	1549 $\pm$ 168	5120 $\pm$ 443		

In spring, the number of realised mist net hours increases as weather gradually improves toward summer. In fall, the trend is reversed, with decreasing realised mist net hours as autumn storms increase with time (Fig.6a&b). Although generally true, this pattern is highly variable between years. As noted before, weather could be exceptionally favourable or detrimental to net operations in some years. Weekly variations in mist net hours are important but also variable among years. For example, in fall 2006, only 10% of mist net hours were lost during the first week of monitoring (August 16 – 22) but an extreme 73% between October 11 and 17.

Despite variations in mist net hours, overall capture rates are relatively similar in fall when the irruptive Black-capped Chickadee is factored out: around 0.30 birds per

mist net hour. Fall 2004 has the lowest capture rate, but it also has the highest percentage of mist net hours realised. Capture rates in spring are more variable, between 0.29 to 0.63 birds per mist net hour (without Black-capped Chickadee), with spring 2002 being exceptional, both for capture rate and actual absolute numbers of banded birds (presented separately in figures for this reason). Again, the year with the lowest capture rate (spring 2005) also has the least mist net hours lost. Good weather to open nets could also mean favourable weather for birds to migrate rapidly through the area and could result in less birds around Cabot Head to be captured (see Influence of weather on migration).

Weekly variation in capture rates and banded numbers is important and extremely variable between years. However, a general trend is evident: in spring, there is a well-defined peak of migration in mid-May (earlier in 2002) (Fig.7a&b). In fall, there is an early, albeit relatively small, peak in early September and a second, bigger, one in mid-October (Fig.8a&b).

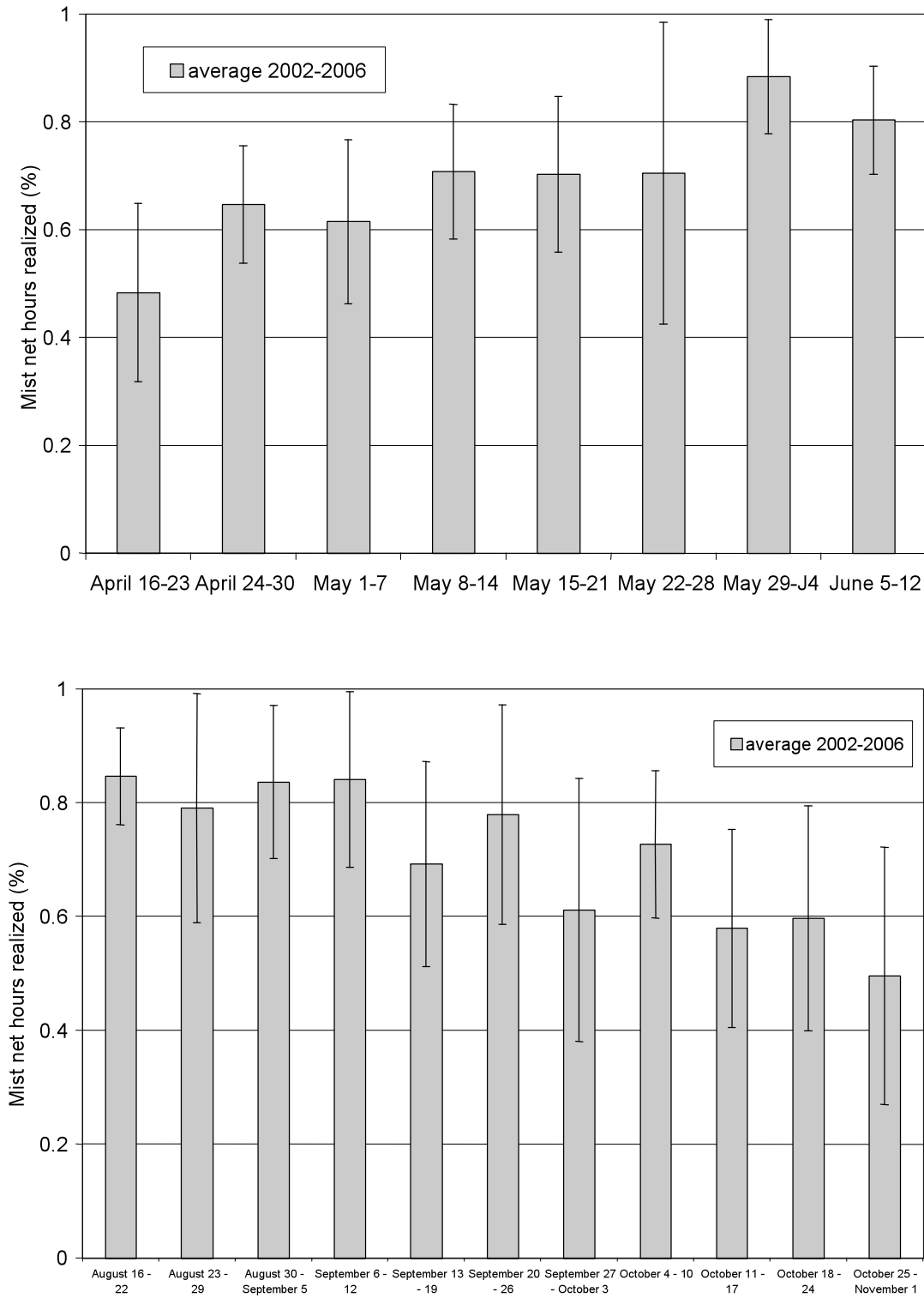


Fig. 6a&b. Spring (top) and fall (bottom) weekly proportion of mist net-hours at Cabot Head Research Station (2002-2006). Error bars show Standard Deviation.

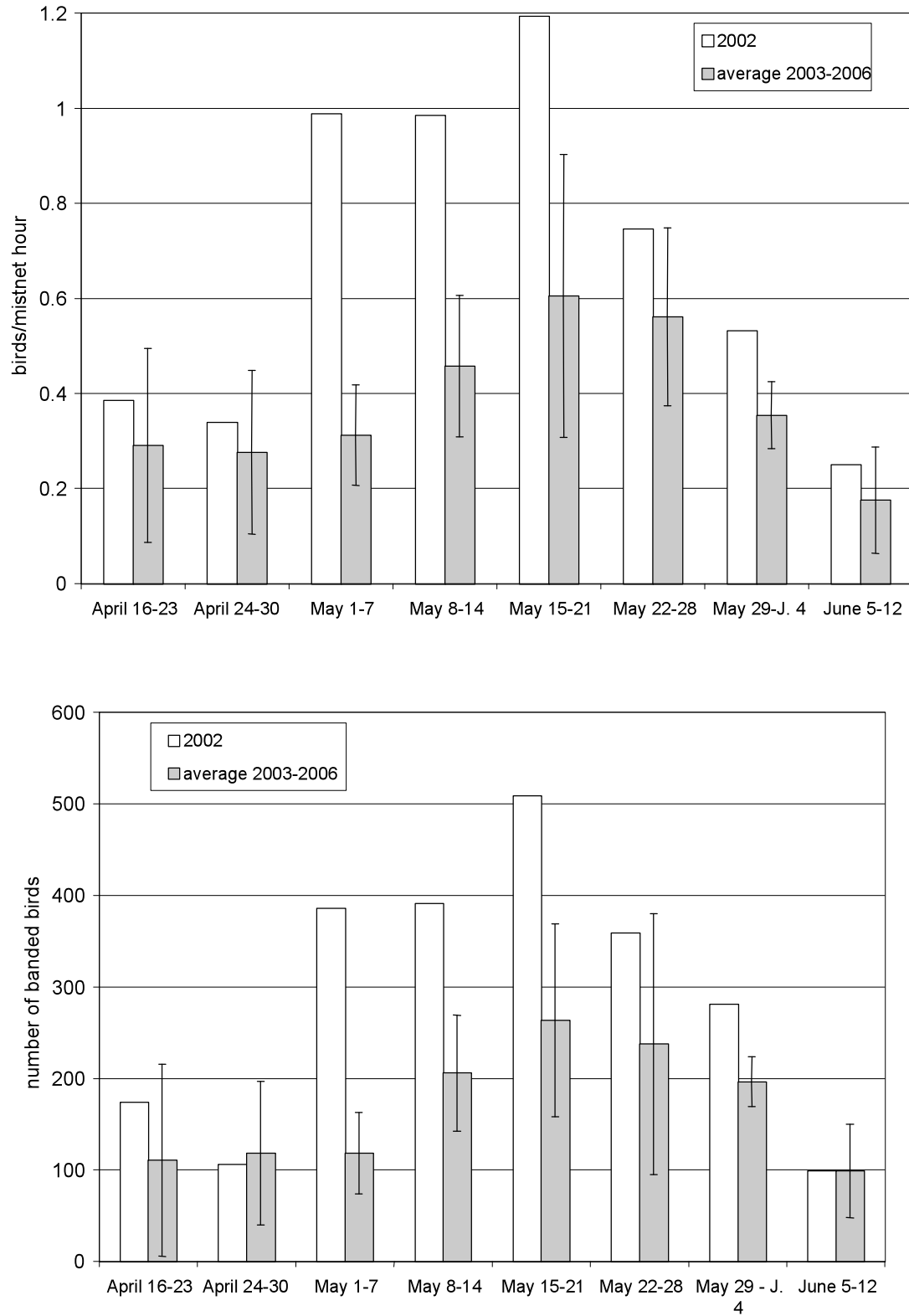


Fig.7a&b. Spring weekly capture rates (top) and number of banded birds (bottom) at Cabot Head Research Station (2002-2006). Error bars show Standard Deviation.

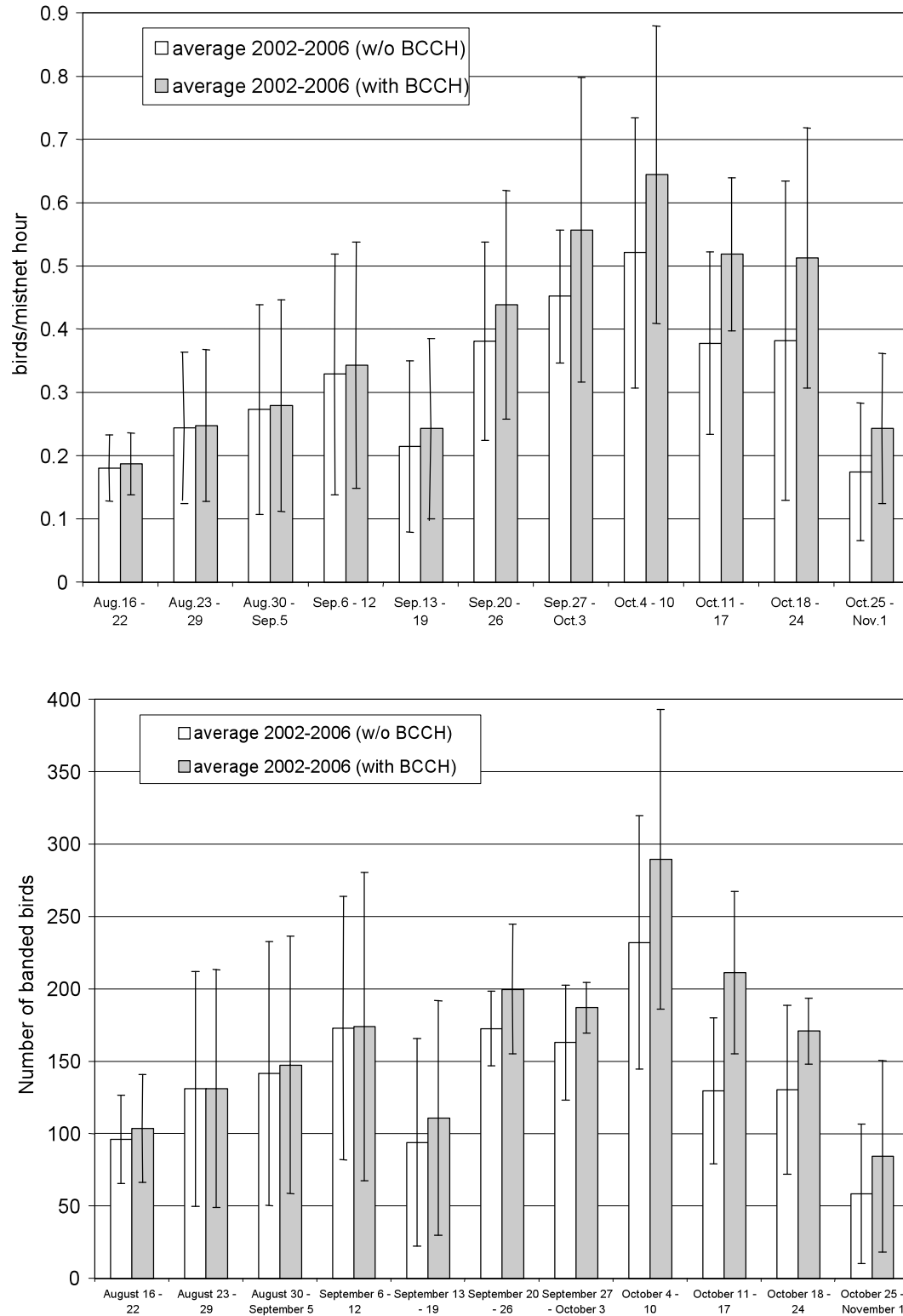


Fig. 8a&b. Fall weekly capture rates (top) and number of banded birds (bottom) at Cabot Head Research Station, 2002-2006 (with or without Black-capped Chickadee). Error bars show Standard Deviation.

## **Influence of Weather on Migration**

Weather has a fundamental influence on migration, both locally and regionally (Richardson, 1990). Weather determines when and from where millions of migrants may take off, land, and remain grounded. Huge movements of songbirds and raptors usually precede a low-pressure system in spring and follow a high-pressure system in fall (Richardson, 1990). In extended periods of favourable weather – for example in spring, with tailwinds, warm temperatures, and lack of rain – most birds take off each night and migrate northwards steadily. By morning they have diffused across the landscape. It may seem at times to the observer that migration is “slow”, when in fact conditions are optimal for large numbers of migrants to move through an area quickly, thus impacting actual observer encounter rate and giving the impression of decreased abundance.

Wind and precipitation are probably the main meteorological factors influencing migration. Birds select for favourable wind conditions both at departure and while aloft to save energy, even so that for some long-distance migrants a tail-wind is an indispensable support to cross large barriers (see a review in Liechti, 2006). Apart from precipitation, wind is the most important weather factor affecting the departure decision of migratory birds. Generally, strong head-winds weaken a bird’s propensity to take off and can promote an accumulation of birds ready for take-off. In contrast, weak winds and tailwinds promote take-offs.

Wind influence can be very local or widespread. For instance, at Cabot Head, numbers of migrants caught or observed are usually low during periods of moderate to strong east winds. Although comparative data are limited, it seems that during periods of predominantly easterly winds, the abundance of migrant birds is highest at Cape Hurd, on the north-western tip of the Bruce Peninsula (Steinacher, pers. comm.). Contrarily, predominant west winds result in more birds at Cabot Head. Precipitation also strongly affects migration, whether by forcing birds to land or by keeping them grounded. During spring 2002 at Cabot Head weather was particularly stormy, with numerous periods of rain. This is possibly one of the reasons so many birds were captured this spring: they were forced to land or were grounded by unfavourable weather. In contrast, extended periods of good weather in fall 2004 and spring 2005 allowed a diffuse and easy migration, resulting in fewer birds observed or caught.

Regional weather conditions can also strongly influence migration. In spring 2006, a large high pressure system with northerlies dominated the upper Great Lakes,

while to the south, on the lower Great Lakes (thus, just south of Cabot Head), low pressure and its associated clouds and rain stalled migration during 2 weeks in mid-May. Despite days with good local weather and consequently good banding coverage at Cabot Head, the number of birds caught was very low, even during what should have been peak migration time. As a consequence of this system, migration was almost completely blocked most of the time over a large area of the Great Lakes. When the conditions finally changed for the better, the birds moved en masse, as indicated by the higher-than-average number of birds caught during the last week of May.

Weather is undoubtedly a huge force driving bird migration. It is very dynamic and its effects are both local and widespread. In the future, with the planned “satellite” migration monitoring station at Cape Hurd, it will be possible to compare the effects of local weather on migration phenology between the northeast and the northwest sides of the tip of the Bruce Peninsula.

## Recaptures

Recapture involves the capture of an already banded bird and could be of 3 kinds at Cabot Head Research Station: a bird could be banded at a different location than CHRS and recaptured at CHRS (called a foreign recapture); banding could have been done at CHRS but in a previous year -it is then a between-season recapture; or, more frequently, a banded bird can be recaptured within the same season of banding, i.e. an American Redstart banded in spring 2005 can be recaptured later that same spring.

Foreign recaptures of songbirds are extremely infrequent at any banding station. At Cabot Head Research Station, 10 birds of 9 species banded at a different location have been recaptured since 2002 (Table 4a). Most recaptures involve relatively short-distance movements (Cape Hurd at the tip of the Bruce Peninsula, southern Ontario, or Ohio). However, an Ovenbird banded during the winter in Belize was recaptured at CHRS 2 years later. A few birds banded at CHRS were recaptured in different locations (Table 4b).

Table 4a&b. Between-stations recaptures of foreign banded birds at CHRS (top) and of birds banded at CHRS, 2002-2006 (bottom).

	Banding location	Banding date	Recapture date	Distance * (km)
Sharp-shinned Hawk	Coatsworth (ON)	4 Oct. 2003	24 Apr. 2004	370
Black-capped Chickadee	Cape Hurd (ON)	20 May 2002	2 June 2002	40
Brown Creeper	Selkirk (ON)	3 Apr. 2006	6 Oct. 2006	289
Hermit Thrush	NW Ohio (USA)	23 Apr. 2002	2 May 2005	462
American Redstart	Old Cut (ON)	13 Sep. 2003	2 June 2004	339
American Redstart	Cape Hurd (ON)	18 May 2003	19 May 2005	40
Ovenbird	Belize	6 Dec. 2001	17 Aug. 2003	3191
White-throated Sparrow	NW Ohio (USA)	8 May 2006	22 May 2006	462

	Recapture location	Banding date	Recapture date	Distance * (km)
Slate-coloured Junco	Border Texas/Louisiana	21 Apr. 2002	12 Mar. 2003	1793
Red-breasted Nuthatch	Sarnia (ON)	9 Oct. 2003	15 Dec. 2003	276
Slate-coloured Junco	North of Sudbury (ON)	10 Oct. 2003	4 May 2004	169
Cape May Warbler	Prince Edward Pt (ON)	5 Sep. 2004	11 May 2005	379
Myrtle Warbler	North Carolina	10 Sep. 2004	23 Oct. 2004	1124

\* between banding and recapture locations

Table 5. Numbers of recaptures at Cabot Head Research Station by season, year and origin.

Recaptures		Within-season	% of total captures	Number of species	Between-season	Number of species	Foreign recaptures
2002	Spring	111	83%	27	22	7	-
	Fall	141	92%	33	11	4	1
2003	Spring	68	69%	22	28	9	1
	Fall	177	89%	30	19	8	1
2004	Spring	80	73%	26	28	7	2
	Fall	130	95%	34	7	3	-
2005	Spring	30	51%	14	28	9	1
	Fall	283	97%	27	7	5	2
2006	Spring	34	54%	15	27	8	1
	Fall	114	91%	29	10	3	1

The vast majority of recaptured birds were banded at Cabot Head. Significantly, recaptures in fall are overwhelmingly of birds banded during the same season (between 89 and 97%), whereas the proportion of between-season recaptures in spring represents a positive trend over the five years to eventually reach almost 50% (Table 5). However, the increase in between-season recaptures is not necessarily due to an increasing total number of banded birds throughout time. Indeed, there is no trend in proportion of between-season recaptures by occasions of recaptures (Fig.9; obviously, no birds from fall 2006 could have been recaptured). For example, birds banded in spring 2002 had 9 occasions of being recaptured in another season whereas birds banded in spring 2005 had only 3. However, fewer birds – in proportion – banded in spring 2002 have been recaptured than those banded in spring 2005. Likewise, birds banded in the 3 pilot years (1998, 2000 and 2001, when a total of 12,443 birds were banded - including 2,378 Black-capped Chickadees!) have not been recaptured in a higher proportion. It is striking that only one bird banded in 1998 (out of 3,184 birds banded) has ever been recaptured (in spring 2006). Banding in 1998 was done at Cabot Head Lighthouse, across the basin from where Cabot Head Research Station is situated, only 500 meters away. Can this short distance be sufficient to prevent recaptures? In absolute numbers, previously banded birds are more often recaptured in spring than in fall. This is especially true for American Redstart.

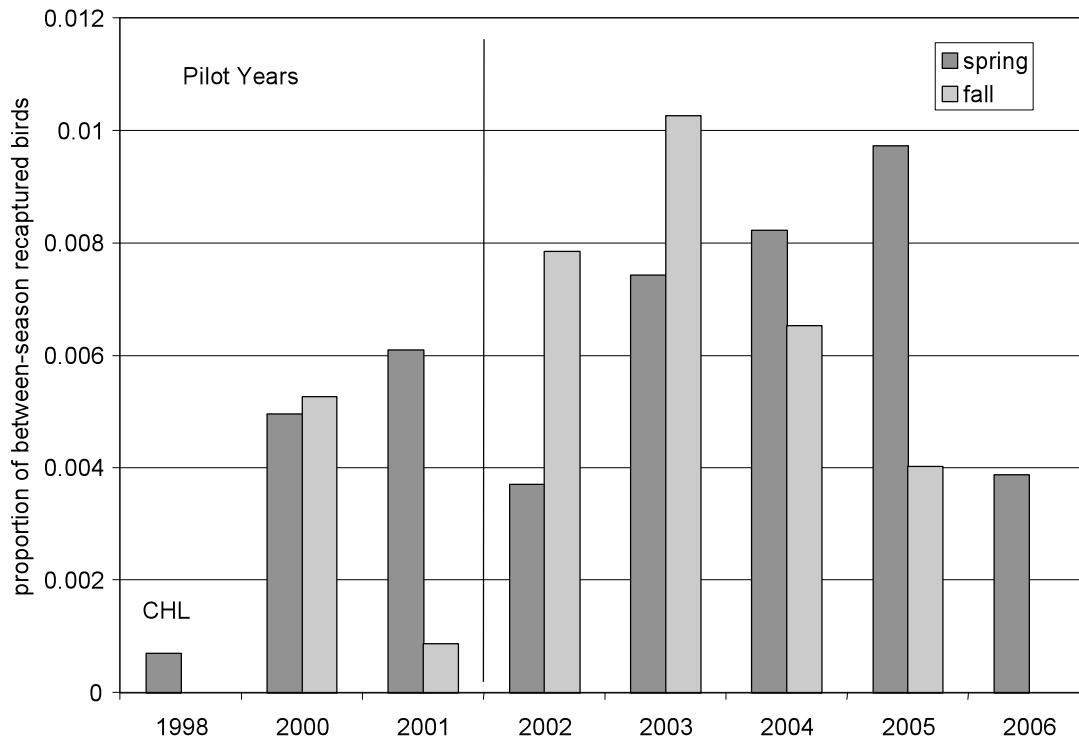


Fig.9. Proportion of between-season recaptured birds in relation with their year and season of banding at Cabot Head Research Station and Lighthouse (1998, 2000-2006).

## Stopover Ecology

### Within-season recaptures

Within-season recapture rates are highly variable between species, seasons, and years (Table 6). For the most commonly-banded birds, recapture rates could be as high as 40% for one season, but also as low as 0% for the same species a different season. However, on average, and across a wide range of species, within-season recapture rates are usually higher in fall than spring. Some commonly-banded birds are rarely recaptured, either within or between seasons: both species of Kinglets, and Magnolia and Myrtle Warblers, for example. The highest recapture rates occur for resident species banded in small numbers (Black-capped Chickadee in fall 2002 and 2006). In irruptive years, such as the fall of 2003 and 2005, less than 10% of Chickadees were recaptured, indicating a strong movement through the area. Likewise, Black-throated Green Warbler is rarely recaptured.

Most within-season recaptured birds are recaptured only once, and often shortly after banding (a day or two). This demonstrates that birds are not heavily using this site as a stopover location to rest and refuel, suggesting that the majority of songbird species

encountered at Cabot Head are passage migrants. According to guidelines and recommendations established by the Canadian Migration Monitoring Network, this is ideal for compiling meaningful population trends (Hussell and Ralph, 1996). However, a careful analysis presents a slightly different picture, indicating that some species encountered at Cabot Head are indeed only passage migrants, while others could use the area as a stopover, and probably more so in years of high food availability. *Catharus* thrushes, for example, show a profound difference between spring and fall in their recapture rates. Even if the sampling size is low, it is evident that thrushes have a higher probability of recapture in fall than in spring, indicating that they likely use Cabot Head as a stopover site in the fall.

Capture and recapture depend on several factors: the probability of capture per se, variable among species due to different behaviour and proportion of breeding residents; and the individual's status, which could require a longer stopover in the area. The highest rates of recapture are found for locally breeding species such as Common Yellowthroat (quite consistently for this species but more so in fall than spring; Table 6). However, capture depends as much on species behaviour as on its abundance. Species foraging at ground or mid levels like Thrushes, Common Yellowthroat and Sparrows are usually recaptured in higher proportion (although the low absolute numbers urge caution on interpretation). However, yearly variations between and within species are important. Furthermore, Slate-coloured Junco, a ground-dwelling species, is rarely recaptured, indicating that not only foraging behaviour plays a role in capture. Variation in food availability could also influence recapture rates between species and years. In interpreting table 6, particular caution should be used, considering the small sample sizes of many species. For example, no Hermit or Swainson's Thrushes were recaptured at all in fall 2002, not very surprising given their low banding totals (of 16 and 11, respectively) of that fall. With only slightly more Swainson's banded in fall 2004 (16), it took only 2 recaptures to achieve a proportion of 13%. Comparatively, resident species like Red-breasted Nuthatch and Black-capped Chickadee could show high recapture rate in years without invasion, as in the fall of 2002 and 2006.

Despite those limitations, it is still possible to detect certain seasonal and yearly patterns. With the exception of falls 2002 and 2006, only 5 to 7% of banded Black-capped Chickadees are recaptured. The same is true for Golden-crowned Kinglets: despite a good sample size (hundreds banded every year), only 5 to 7% are ever

recaptured within the fall and 0 to 17% in spring. Furthermore, no Kinglets have ever been recaptured between seasons. Observations indicate that these 2 species actively move through the area during the day, leaving it relatively rapidly (except for a few resident Chickadees).

*Catharus* Thrushes have a relatively high capture rate in fall, but this was especially true in fall 2005. This season was notable for the abundance of chokecherry fruit (*Prunus virginiana*), which attracted fruit-eating species and modified their behaviour. Not only *Catharus* thrushes were recaptured in high number, but also Myrtle Warbler. The latter species is rarely recaptured, both in spring and fall (between 0 to 7%). However, in fall 2005, 11% of newly banded individuals were recaptured. It is another indication that fall 2005 was indeed noteworthy due to good food availability for species that normally do not stop for long at Cabot Head.

### **Length of stopover**

The minimum length of stay can be estimated by using the time between the first and last capture of an individual. However, this method has several problems. It is a minimum length, as a captured individual could obviously be present before its first capture and after its last. This method tends therefore to underestimate the length of stay. It also includes only individuals captured at least twice. The birds captured only once can move through the area and leave, or stay but without being recaptured. Not including birds captured only once tends to overestimate the stopover length. The minimum length of stay should therefore be considered as an indication and not as an absolute number. Details of specific stopover length are given in species accounts when data is available.

For a species like American Redstart, birds can be truly migrants moving through the area while others are local breeders staying from spring to fall. Length of stay is thus further complicated by a mix of migrants and local breeders. In fall, birds of local origin could also present different lengths of stay as compared with migrants within a single species. Furthermore, local birds (either adult breeders in spring and fall or local hatch birds) have a higher probability of capture than birds just moving through. It is therefore difficult to differentiate between migrants and locals or determine stopover times for a species like American Redstart.

Table 6. Proportion of recapture among the newly banded birds for selected species (n = number of banded birds), Cabot Head Research Station, 2002-2006.

Species	Season	2002		2003		2004		2005		2006	
		%	n	%	n	%	n	%	n	%	n
Red-eyed Vireo	Spring	0%	10	0%	13	0%	14	40%	10	0%	15
	Fall	12%	51	14%	117	6%	31	16%	239	6%	52
Black-capped Chickadee	Spring	5%	342	0%	6	0%	14	17%	6	0%	22
	Fall	38%	29	6%	368	9%	169	9%	717	25%	12
Red-breasted Nuthatch	Spring	6%	17	0%	1	0%	2	0%	2	0%	17
	Fall	60%	5	4%	26	11%	62	19%	73	18%	17
Brown Creeper	Spring	17%	6	10%	30	0%	9	0%	20	4%	45
	Fall	15%	53	8%	48	4%	28	3%	32	15%	46
Golden-crowned Kinglet	Spring	0%	6	16%	77	17%	36	0%	33	3%	186
	Fall	7%	490	8%	321	5%	262	10%	113	7%	407
Gray-cheeked Thrush	Spring	0%	1	0%	3	20%	5	0%	4	0%	1
	Fall	21%	19	25%	16	25%	12	50%	22	0%	9
Swainson's Thrush	Spring	0%	13	0%	12	0%	21	0%	27	0%	42
	Fall	0%	11	13%	38	13%	16	17%	36	10%	10
Hermit Thrush	Spring	0%	8	7%	14	0%	6	0%	16	0%	12
	Fall	0%	16	12%	34	17%	24	33%	48	11%	57
Nashville Warbler	Spring	4%	227	0%	61	6%	18	0%	49	3%	34
	Fall	0%	41	2%	48	4%	24	14%	78	6%	32
Magnolia Warbler	Spring	7%	184	1%	144	4%	109	2%	116	4%	81
	Fall	6%	17	0%	29	12%	25	12%	34	10%	20
Myrtle Warbler	Spring	1%	244	0%	68	0%	49	0%	28	3%	34
	Fall	3%	90	2%	92	0%	34	10%	204	7%	70
Black-thr. Green Warbler	Spring	5%	38	7%	27	8%	25	7%	15	8%	25
	Fall	3%	116	3%	116	6%	115	2%	81	0%	29
Black and White Warbler	Spring	8%	78	8%	72	10%	42	0%	42	2%	43
	Fall	19%	26	13%	30	12%	17	20%	15	8%	12
American Redstart	Spring	12%	104	6%	171	6%	223	4%	152	4%	197
	Fall	9%	103	17%	197	11%	85	6%	65	15%	66
Common Yellowthroat	Spring	18%	56	8%	60	11%	45	4%	49	0%	27
	Fall	18%	17	29%	35	26%	31	35%	23	19%	26
White-crowned Sparrow	Spring	0%	17	16%	19	50%	14	0%	69	3%	37
	Fall	14%	29	0%	22	20%	79	8%	26	16%	19
White-throated Sparrow	Spring	3%	71	0%	25	8%	26	2%	91	2%	47
	Fall	29%	49	17%	42	11%	84	26%	199	7%	43

**Between-season recaptures**

For birds banded between 2002 and spring 2006, 100 individuals of 16 species have been recaptured in another season of their banding. Another 35 birds of 12 species banded during the pilot years have also been recaptured from 2002 onwards. Among the 100 recaptured birds (banded between 2002 and 2006), 80 have been recaptured in only one occasion (including 6 from spring 2006 that had only one occasion of recapture, in fall 2006), 18 birds of 8 species (mostly local breeders) have been recaptured twice and only 2 birds (one American Redstart and one Black-capped Chickadee) have been recaptured 3 times. Therefore, it is an all-the-more striking example of fidelity and survival that 2 American Redstarts banded in spring 2001 were recaptured 6 and 8 times, respectively, since spring 2002. Seasons of banding do not appear to influence later recaptures, as recaptured birds are from both seasons in almost equal numbers (48 from spring and 52 from fall). Most birds are recaptured the following season or year of their banding. For recaptured birds banded in spring, 63% are recaptured the following fall and another 21% the next year in spring. For recaptured birds banded in fall, 88% are recaptured the following spring and another 12% one year later in fall.

In proportion, almost all between-season recaptures are anecdotal, as only a few individuals per species (between 1 and 6) are concerned. In fact, only American Redstart has a significant number of recaptured birds: 60 birds, representing 4.1% of their total banding number. Between-season recapture rates are extremely low, from 0.2% (for Myrtle Warbler) to 4.1% (for American Redstart). Only a resident species, the Hairy Woodpecker, has a higher recapture rate of 11.8%, but that represents only 2 individuals recaptured (from a banding total of 17).

Between-season recaptures of Black-capped Chickadees are extremely low, almost negligible. Indeed, only 7 Chickadees out of more than 4,000 banded (including pilot years) have ever been recaptured a following season. It confirms the irruptive nature of movement for this species and the probable high mortality among hatch-year (HY) birds. In years of high young production, hatch-year birds disperse in fall and are then captured in impressive numbers. However, most move through Cabot Head area quickly (see within-season recaptures) and do not settle. Furthermore, it is likely that high mortality occurs during winter. In fact, only one Black-capped Chickadee banded in irruptive falls (which happened in 2002, 2003, and 2005) has ever been recaptured. Banded in fall 2002, this individual was recaptured in spring and fall 2003. The oldest

recapture is from a bird banded as HY in fall 2002 and recaptured 4 times afterwards: in spring and fall 2003, in spring 2004 and 2006. It is most certainly a resident bird, 6 years old in 2006 (still far from the oldest known record of 12 years and 5 months; see [www.pwrc.usgs.gov/BBL/homepage/longvrec.htm](http://www.pwrc.usgs.gov/BBL/homepage/longvrec.htm)).

A total of 10 Red-eyed Vireos (including 4 banded during the pilot years) have been recaptured between seasons or years. Red-eyed Vireos show a strong fidelity to Cabot Head area: 5 of the recaptured birds have been recaptured in more than one season, especially in spring. Of a total of 18 recaptures, 13 occurred in spring. For example, one after-hatch-year Vireo banded in spring 2000 was recaptured every spring up to 2003 and also in fall 2003 (when its band had to be removed due to infection). Surprisingly, birds banded in fall are never recaptured in another fall, even when recaptured in more than one spring. However, the most remarkable recapture is of a Red-eyed Vireo that was banded as an after-second year in spring 1998 at the Cabot Head Lighthouse. Never recaptured until spring 2006 at Cabot Head, it is then at least 10 years old! This ties the oldest record of a Red-eyed Vireo in North America: “Age of oldest known Red-eyed Vireo at least 10 yr (Klimkiewicz et al. 1983).” (Quoted from Cimprich et al., 2000).

Only 6 Black-throated Green Warblers have been recaptured in a later season (0.1% of the 2002-2006 banding total). Two of them, banded in spring, were only recaptured the following fall. The 4 other Black-throated Green Warblers, banded either in spring or in fall, were only recaptured in spring (in 2 consecutive springs for 2 individuals). The longest span between banding and recapture for the Black-throated Green warbler is for an individual banded in the pilot years as an after-hatch year (AHY) female with a brood patch in fall 2000, and recaptured in fall 2003.

American Redstart is not surprisingly the species with the highest between-season recapture rate, it being perhaps the commonest of local breeders. Since 2002, 78 individuals have been recaptured (including 18 birds banded in 2000 and 2001), which represent 3.7% of all American Redstarts banded from 2000 (recapture rate of birds banded in 2002-2006 is 4.1%). Birds banded in spring are slightly more likely to be recaptured (recapture rates of 3% for birds banded in spring and 2% in fall). A bird banded in spring could be recaptured the following fall (after a mere 2 to 4 months), but this is the case of only 12 birds out of 29 (including the 4 birds banded in spring 2006 that can only be recaptured the following fall). Not including birds banded in spring 2006, only a third of American Redstarts banded in spring are recaptured the following

fall. Instead, most birds are recaptured the following year in spring. A bird banded in fall needs to survive the fall and spring migrations and the winter to be recaptured the following spring, which could explain their lower recapture rate. Most of them (87%) are recaptured the following spring. Most American Redstarts banded in 2002-2006 (83%) have been recaptured only once and another 15% twice. Only one American Redstart, banded in spring 2004 as a second-year (SY) male, has been recaptured 3 times (the 2 following springs and in fall 2006). Furthermore, a Redstart banded as a SY male in spring 2001 has been recaptured every year since and almost every season. This male is certainly a breeder at Cabot Head, being always recaptured several times every spring from late May to the last days of banding in mid-June, and showing a cloacal protuberance increasing with time.

The oldest American Redstart at Cabot Head is a female banded as after-second year (ASY) in spring 2001 and recaptured every spring afterwards, up to spring 2006. Being born in 1999 or earlier, she is at least 7 years old (the oldest American Redstart on record in North America is 10 years and one month; see [www.pwrc.usgs.gov/BBL/homepage/longvrec.htm](http://www.pwrc.usgs.gov/BBL/homepage/longvrec.htm) ).

Among species recaptured on more than one occasion are Song Sparrow (a common local breeding species) and Hairy Woodpecker (a resident species). The other recaptures are more anecdotal. For example, the only Northern Rough-winged Swallow banded at Cabot Head (in spring 2000) was recaptured in spring 2003. One pair of this species breeds almost every year in the shipwreck in Wingfield Basin. In spring 2004 a banded Rough-winged Swallow was observed several times around the shipwreck, almost certainly the same individual. Among Sharp-shinned Hawks banded at Cabot Head, only one, an AHY male banded in fall, was recaptured the following spring.

## Net Analysis

Mist net locations at Cabot Head have been permanently set in place in 2002 and any changes to this array will have to be carefully considered with respect to protocol and existing data sets. The standard net array is located primarily in forest edge assemblages although 4 nets are operating in relatively open, shrub habitat (A1-2, C14-15. See description in Appendix B).

There is a significant amount of variation in capture rates for each net: every season, captures are localised in a few very productive nets (Fig.10. No data are available for 2002). The five most productive nets usually account for more than 50% of all the birds caught, while totalling about a third of the mist net hours. Despite seasonal and yearly differences, A1, B9, and C15 are among the most productive nets. Location, and thus difference in habitats, can explain variation in capture rates. However, differences in species behaviour may also account for this variation. Among the most numerous-caught species, various patterns of capture are evident (Fig.12&13). American Redstart is usually captured in nets located in low vegetation dominated by deciduous trees (Fig.11). Kinglets are more loosely associated with nets among coniferous trees. Fruit-eaters like Red-eyed Vireo and Cedar Waxwing have their captures concentrated in the nets close to chokecherry trees (A1, 2 & 3, B6, 7 & 8) (Fig.14).

Although Black-capped Chickadee is captured in every net, it is disproportionately captured in net C13 (Fig.14). For example, in fall 2003, during a small irruptive year, 70% of birds caught in the net C13 were of this species and almost 45% of chickadees were caught in this net. In fall 2005, during an important invasion, C13 was still the best net to catch this species: 58% of birds caught in this net were Chickadees, representing 22% of their total. C13 is the closest net to the shoreline, in a rather open area of low trees. Chickadees usually move through the area in loose flocks: after foraging in trees and shrubs, when a few individuals fly away to cross an open area, they are rapidly followed by the rest of the flock. This behaviour could explain the success of net C13 in catching Chickadees. However, the flocks of chickadees were large and abundant in fall 2005, resulting in a “swamping” effect: the captures were more evenly distributed throughout all the nets.

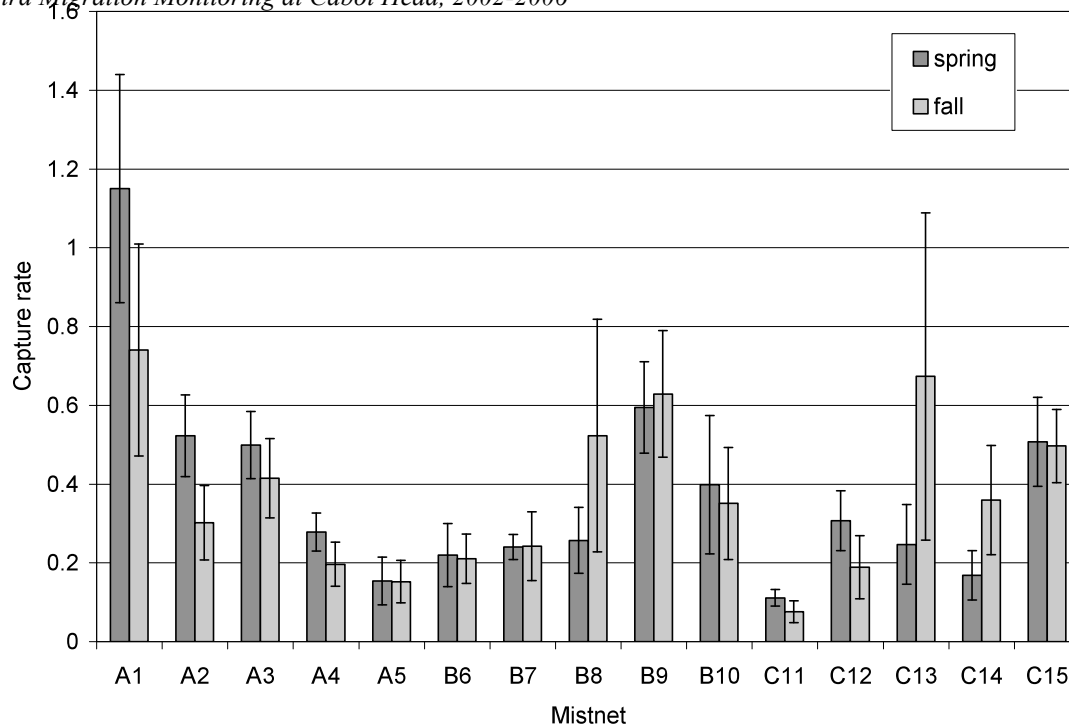


Fig.10. Spring and fall capture rates per mist net at Cabot Head Research Station (average 2003-2006).

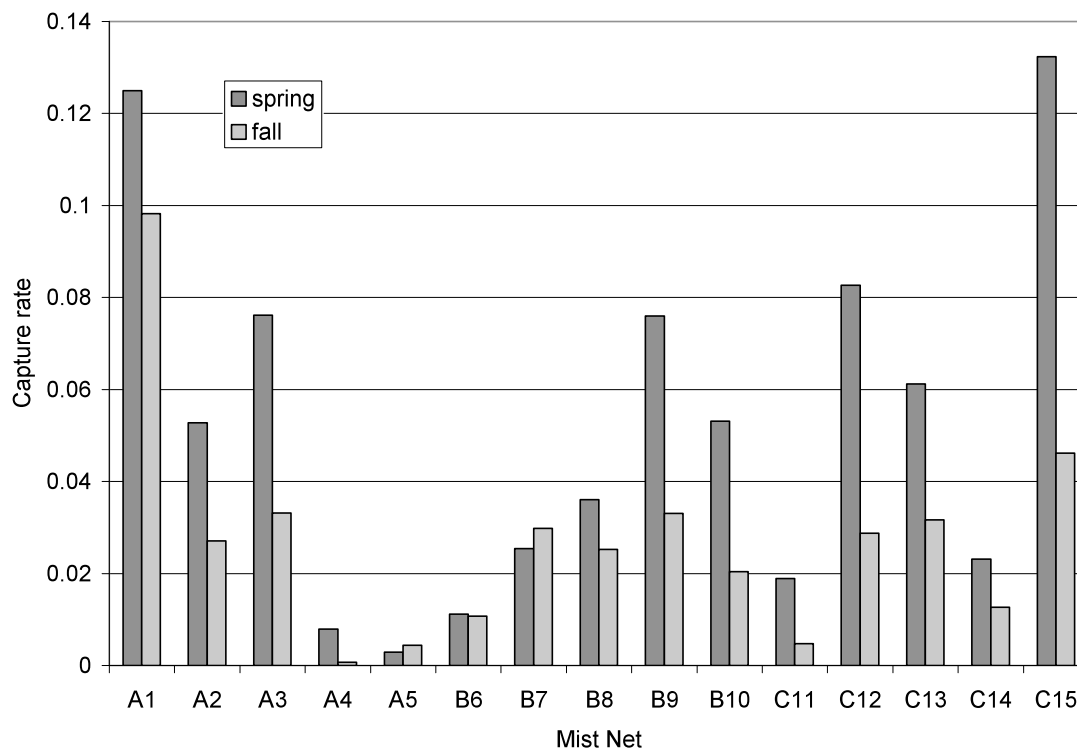


Fig.11. Spring and fall capture rates per mist net for American Redstart at Cabot Head Research Station (average 2003-2006).

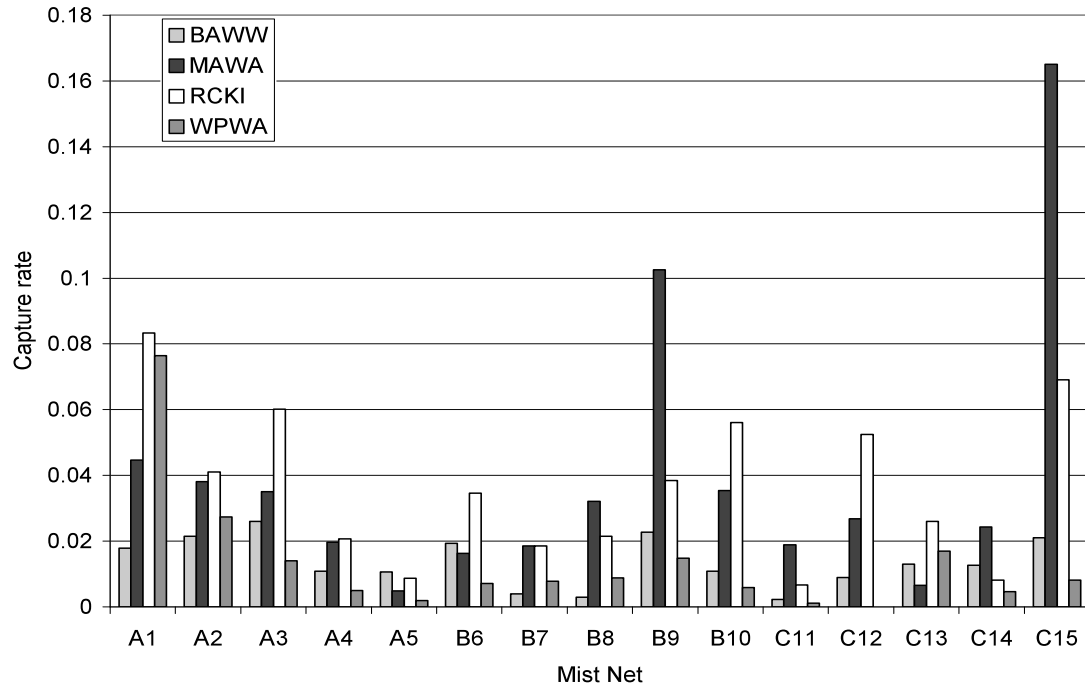


Fig.12. Spring capture rate by mist net of Black-and-White Warbler (BAWW), Magnolia Warbler (MAWA), Ruby-crowned Kinglet (RCKI) and Western Palm Warbler (WPGA) at Cabot Head Research Station (average 2003-2006).

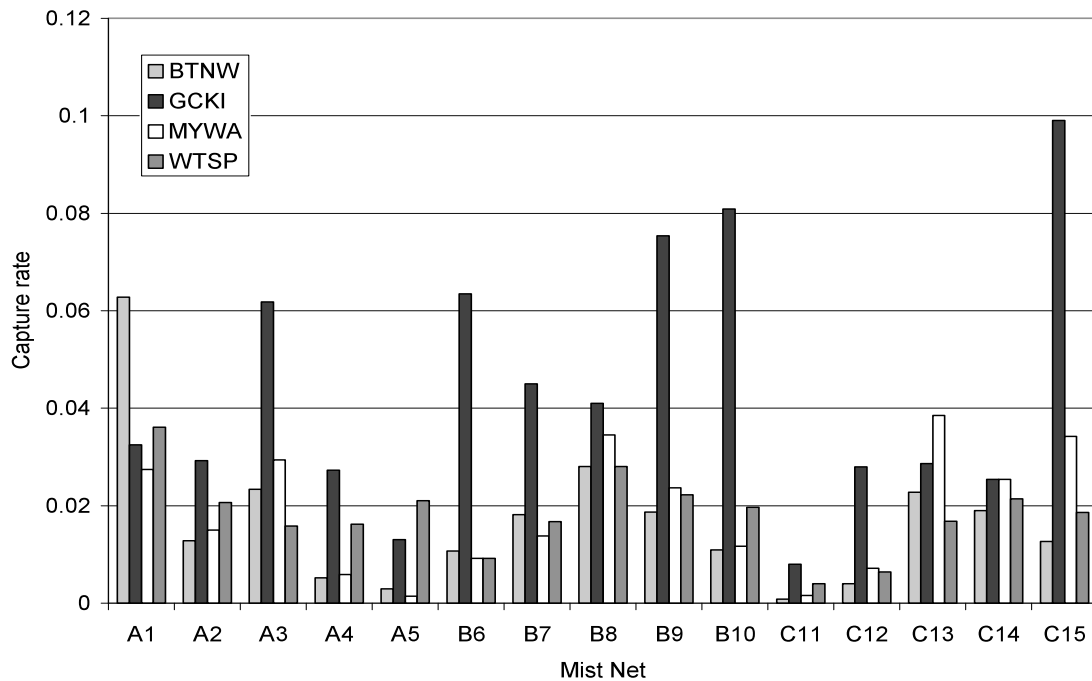


Fig.13. Fall capture rate by mist net of Black-throated Green Warbler (BTNW), Golden-crowned Kinglet (GCKI), Myrtle Warbler (MYWA) and White-throated Sparrow (WTSP) at Cabot Head Research Station (average 2003-2006).

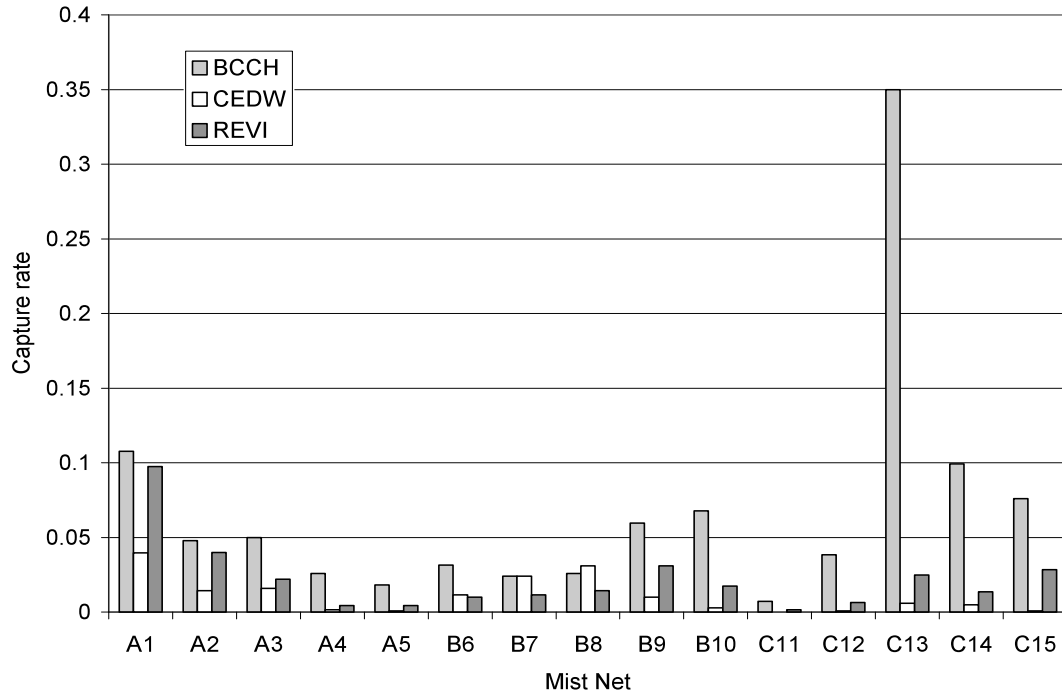


Fig.14. Fall capture rate by mist net of Black-capped Chickadee (BCCH), Cedar Waxwing (CEDW) and Red-eyed Vireo (REVI) at Cabot Head Research Station (average 2003-2006).

## Species Accounts

For a selection of species monitored at CHRS, species accounts present a short description of breeding and wintering ranges, details on migration phenology (by age and sex, if appropriate), residence time, numbers detected, and other information (if pertinent: recaptures, morphometrics, etc). Included are focal species of the Bruce Peninsula National Park Ecological Integrity Monitoring Program: American Redstart, Red-eyed Vireo, Black-throated Green Warbler, Least Flycatcher, Eastern Wood-Pewee, Ovenbird, and Veery. To obtain a reasonable sample size, the other species detailed in the accounts must have at least 50 individuals on average banded in a season (with the exception of *Catharus* thrushes). General migration phenology figures for all these species are presented in Appendix F.

### Least Flycatcher

A small drab flycatcher of open woods, the Least Flycatcher is one of the smallest and most common flycatchers in North America. It breeds across a large band from southern Yukon to Newfoundland and the northern states of the USA (farther south along the Appalachians). It winters from southern Mexico to Central America (Briskie, 1996).

In spring, the first Least Flycatchers at Cabot Head were detected on May 6. However, very few birds are present before mid-May. Afterwards, numbers increase sharply at Cabot Head and Least Flycatchers are present regularly up to the end of May. Then, migration draws to an end in June, when numbers detected decline rapidly. The spring migration of Least Flycatcher is thus concentrated in the second half of May. Numbers detected in fall are much smaller than in spring. Nevertheless, it appears that the migration is less protracted, with birds moving through from mid-August (when monitoring starts) to mid-September. The last Least Flycatchers of fall were detected on October 2 (in 2006).

Only 99 Least Flycatchers in total were banded during the 5 years, most of them in spring (Fig.15). Birds seem to move through the area rapidly, as only 2 banded Least Flycatchers were ever recaptured at Cabot Head. One bird in spring was recaptured the following day of its banding, on a rainy day. The other one was recaptured on August 18, 2 days after the original banding. Both birds experienced a minor weight decrease of 4%. Most birds (91%) captured in fall are hatch year, whereas too many individuals are of

undetermined age (i.e. after-hatch-year instead of second- or after-second-year) in spring to estimate an age-ratio. Least Flycatchers in fall are slightly but not significantly smaller and lighter than birds in spring (Table 7). Most birds, especially in fall, have no or only a small amount of subcutaneous fat.

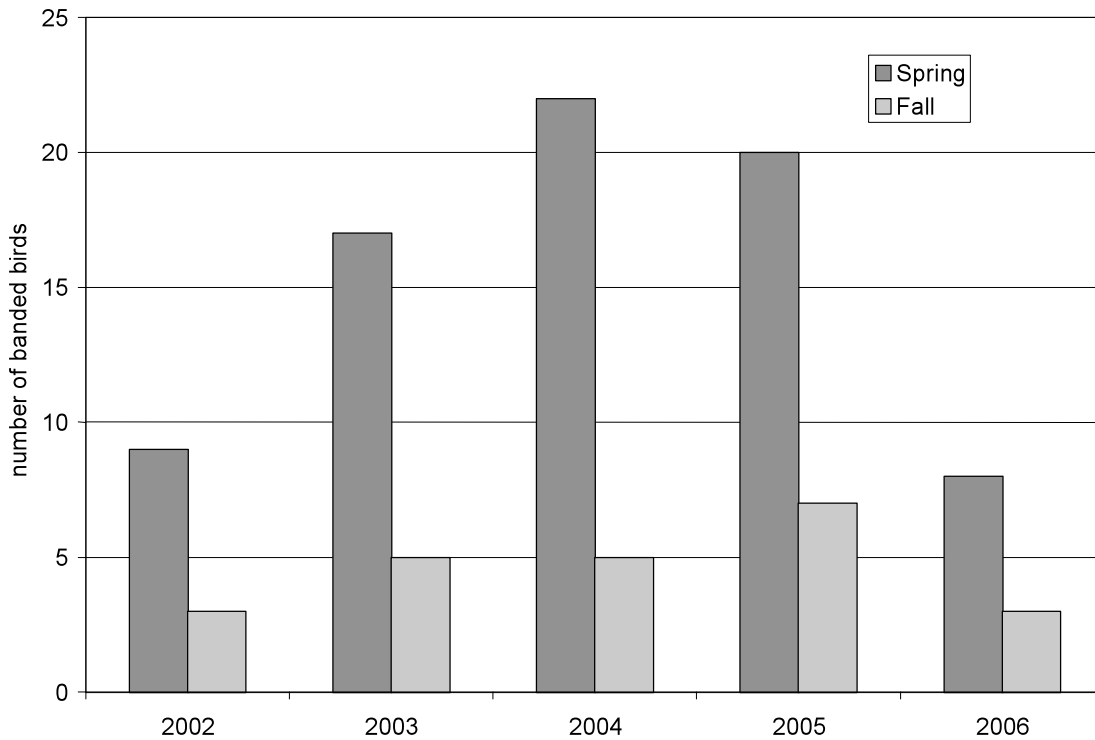


Fig.15. Number of banded Least Flycatchers by year and season at Cabot Head Research Station (2002-2006).

Table 7. Morphometric data for Least Flycatcher banded in spring and fall at Cabot Head Research Station, 2002-2006 (average  $\pm$  Standard Deviation).

	n	Wing chord (mm)	Weight (g)	Fat (0 to 7)
Spring	76	60.0 $\pm$ 2.3	9.9 $\pm$ 0.9	0.4 $\pm$ 0.7
Fall	23	59.3 $\pm$ 2.6	9.5 $\pm$ 0.9	0.1 $\pm$ 0.3
Total	99	59.7 $\pm$ 2.4	9.8 $\pm$ 0.9	0.3 $\pm$ 0.6

*Empidonax* Flycatchers are notoriously difficult to identify when silent. This particularity leads to a few unidentified flycatchers in fall (but not in spring). This problem was especially severe in fall 2006, when only 3 Least Flycatchers were detected (through banding) compared with 20 *Empidonax* sp. Combined with an overall small sample size, this example illustrates the monitoring difficulty of this species.

### Eastern Wood-Pewee

The Eastern Wood-Pewee is a long distance migrant that breeds in the Eastern deciduous forests of North America and winters in northern South America. It is a common summer bird of deciduous forests, although easily overlooked if not for its persistent song (McCarthy, 1996).

In spring, the earliest Eastern Wood-Pewee was detected on May 18 (in 2003 and 2004). However, spring migration really begins a week later at Cabot Head and peaks in late May to early June. It seems that some Eastern Wood-Pewees are still moving through the area in mid-June, when the monitoring ends. Thus, this species is one of the latest birds to migrate to its breeding grounds in spring. Only 4 individuals have been detected in fall (and none captured) between August 31 and October 12. Clearly this sample size is extremely small, but suggests that fall migration of Eastern Wood-Pewee occurs in a large temporal window, contrary to spring. Other Great Lakes Bird Observatories have similar migration timing patterns (see, for example, results from Braddock Bay Bird Observatory, on the south shore of Lake Ontario – [www.bbbo.org/research/timing.html](http://www.bbbo.org/research/timing.html)).

In 5 years of monitoring, only 12 Eastern Wood-Pewees have been captured in total. Eastern Wood-Pewee is a bird of the middle or upper part of the understorey, where it catches insects in the air. This behaviour is probably one reason why this species is more often detected through census and casual observations than through banding.

Table 8. Morphometric data for Eastern Wood-Pewee banded in spring at Cabot Head Research Station, 2002-2006 (average  $\pm$  Standard Deviation).

	n	Wing chord (mm)	Weight (g)
Spring	12	79.6 $\pm$ 4.7	13.6 $\pm$ 0.9

### **Red-eyed Vireo**

The Red-eyed Vireo is a long-distance migrant, breeding largely across North America and wintering in the Amazonian basin (where a resident population lives). It is a very common bird of eastern deciduous forests (Cimprich, Moore, and Guilfoyle, 2000).

Although the earliest Red-eyed Vireo at Cabot Head was seen on April 30 in 2005, spring migration usually starts in mid-May, peaks in early June and decreases after mid-June. The end of the spring migration is thus not well covered at Cabot Head. Similarly, the fall migration beginning is probably not covered, although it is hard to distinguish between local birds and migrants in early August. Numbers of Red-eyed Vireos detected increase sharply in August to peak at the end of this month and then decline slowly throughout September. Only a few individuals are seen during the first week of October and the latest one ever detected was on October 28 in 2004 (which, strangely, was a year with the lowest abundance). The fall migration phenology varies between years, with, for example, a very marked peak at the end of August in 2005, whereas the migration was more spread out in 2003. Red-eyed Vireos are far more abundant in fall than spring, numbers of birds captured being about 12 times more in fall. Hatch-year birds account on average for 95% of birds captured in fall (range: 90% in 2004 – 98% in 2005). Red-eyed Vireo abundance in fall is highly variable between years (DT from 92 in 2004 to 668 in 2005). This is reflected in numbers of birds banded as well, from 31 to 239. These fluctuations could be partly due to food availability at Cabot Head, especially chokecherry. Although not precisely quantified, a large fruit crop was noted in 2003 and especially in 2005. However, it seems that 2006 was also a good year for chokecherry, but there were not many Vireos banded this fall. The use of chokecherry was particularly evident in the fall of 2003 and 2005, as a high proportion of birds were recaptured throughout the season.

Except for 3 birds in 2005, no birds banded in spring were recaptured within the same season. However, previously banded vireos are recaptured every spring (Table 9; see also Recaptures). A good proportion of recaptured vireos showed a well-defined cloacal protuberance, whereas very few newly captured individuals have one. It is a good indication that returning vireos are probably local breeders.

Table 9. Recaptures of previously banded Red-eyed Vireos at Cabot Head Research Station (2002-2006).

Recapture of Red-eyed Vireo			2002		2003		2004		2005		2006		
banding year	banding season	age at banding	S	F	S	F	S	F	S	F	S	F	CP
1998	Spring	ASY									1		3
2000	Spring	AHY	1		1	1							
		AHY		2	1	3	1						2 (in 2003)
	Fall	SY			1								
2002	Fall	AHY							1				
2003	Fall	AHY					1		1				
		AHY							1		2		
2005	Spring	ASY								1			
		ASY								1			
	Fall	HY									3		
		HY									1		3

ASY: after-second-year; SY: second-year; AHY: after-hatch-year; HY: hatch-year.

S: spring; F: fall. CP: cloacal protuberance.

Vireos captured later in the season have, on average, a higher content of fat and a higher mass (Fig.16). Although fat-deposition strategies employed during migration are highly variable among species, seasonal differences in fat reserves are partly endogenously programmed in circannual patterns (Gwinner 1990). It is thus possible that fat-deposition in Red-eyed Vireos is controlled, at least partly, by increased night length in autumn at Cabot Head.

Minimum length of stay, as determined by first capture date and last capture date, is highly variable between individuals, but on average, longer in fall 2003 than fall 2005 (other years have a sample size too small):  $8.56 \text{ days} \pm 5.50$  in 2003 and  $5.24 \pm 3.80$  in 2005. Despite a longer average length of stay in 2003, no birds increased their fat content (4 individuals actually had a lower fat content at recapture). In contrast, in 2005, a majority of individuals had a higher fat content at their last recapture than at banding (Table 10). Among the highest increase in fat level of any single bird was a Red-eyed Vireo that, in a 10-day period, increased its fat level from 1 to 6 and its weight by an astonishing 41% (from 18.0 to 22.7g).

Table 10. Change in fat level for recaptured Red-eyed Vireos in fall at Cabot Head Research Station (2002-2006).

Red-eyed Vireo	Change in fat level							
	-2	-1	0	1	2	3	4	5
2002		1	3	2				
2003	3	1	12					
2004			2					
2005	1	1	15	8	5	4	2	1
2006			1		1	1		

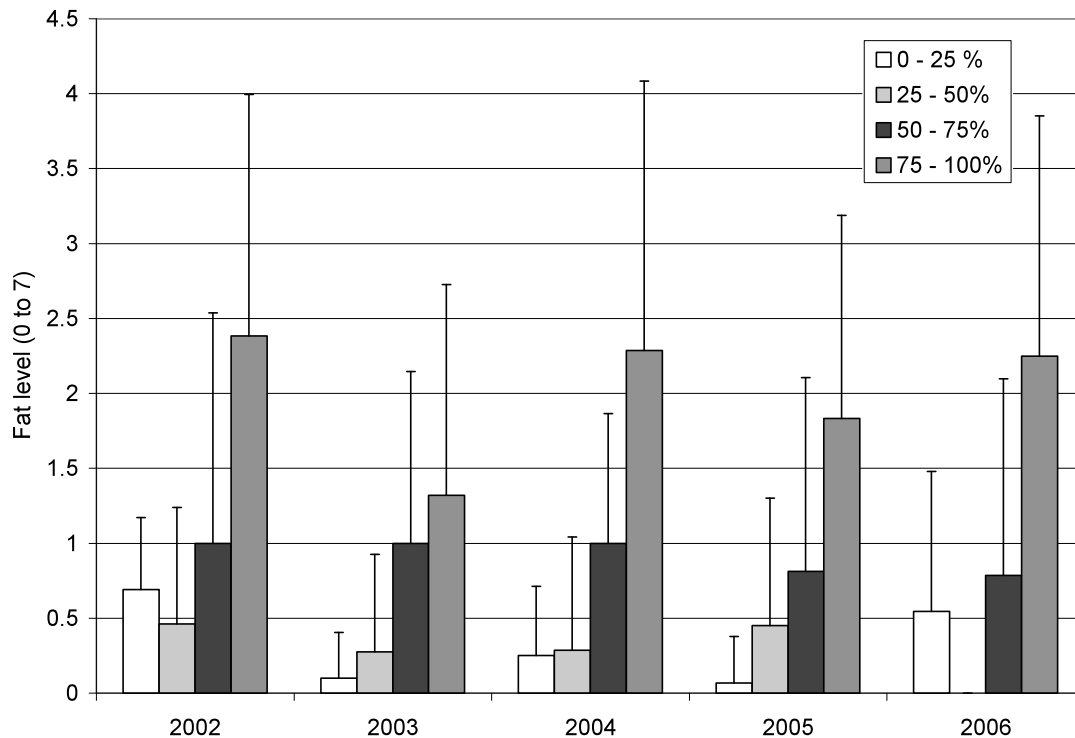


Fig.16. Average fat level of Red-eyed Vireos in fall by quartile (based on total number of banded birds) and year of banding at Cabot Head Research Station (2002-2006).

### Black-capped Chickadee

The Black-capped Chickadee is widely distributed across North America. It is a sedentary bird, but with irruptive behaviour after years of good breeding (Smith, 1993).

At Cabot Head, there is a resident population of Black-capped Chickadees. However, several irruptive episodes of various amplitudes occurred during a few seasons. Irruption occurred in the spring of 2002 and, to a lesser extent, 2006, and in the fall of 2003, 2004, and especially 2005 (Fig.17). These irruptions are reflected in banded

numbers, with the highest total in fall 2005 (Fig.18). There was also a major irruption in fall 2001, when 1,656 Chickadees were banded (with a different set of mist nets). Almost all birds (98%) banded in fall are hatch year. Within-season recaptures are at the lowest during irruptive years, indicating a rapid movement of the large flocks of Black-capped Chickadees through the Cabot Head area. In non-irruptive years, Black-capped Chickadees are mainly resident and sedentary, resulting in a high recapture rate (for example, 25% in fall 2006 and 38% in fall 2002).

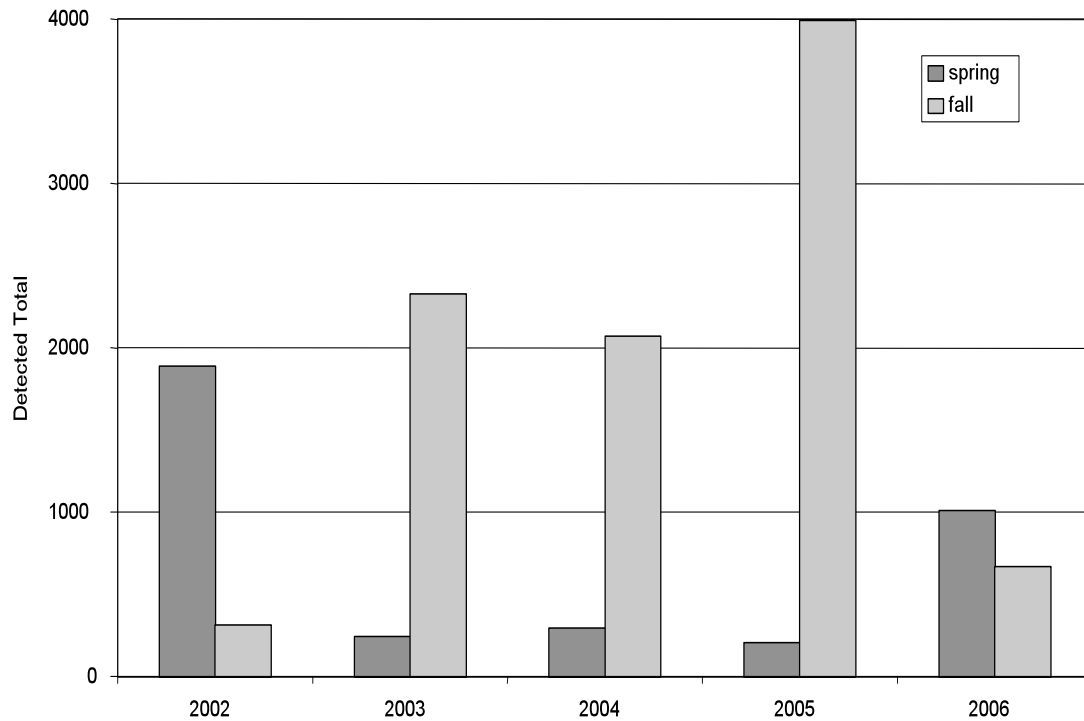


Fig.17. Detected totals of Black-capped Chickadees by year and season at Cabot Head Research Center (2002-2006).

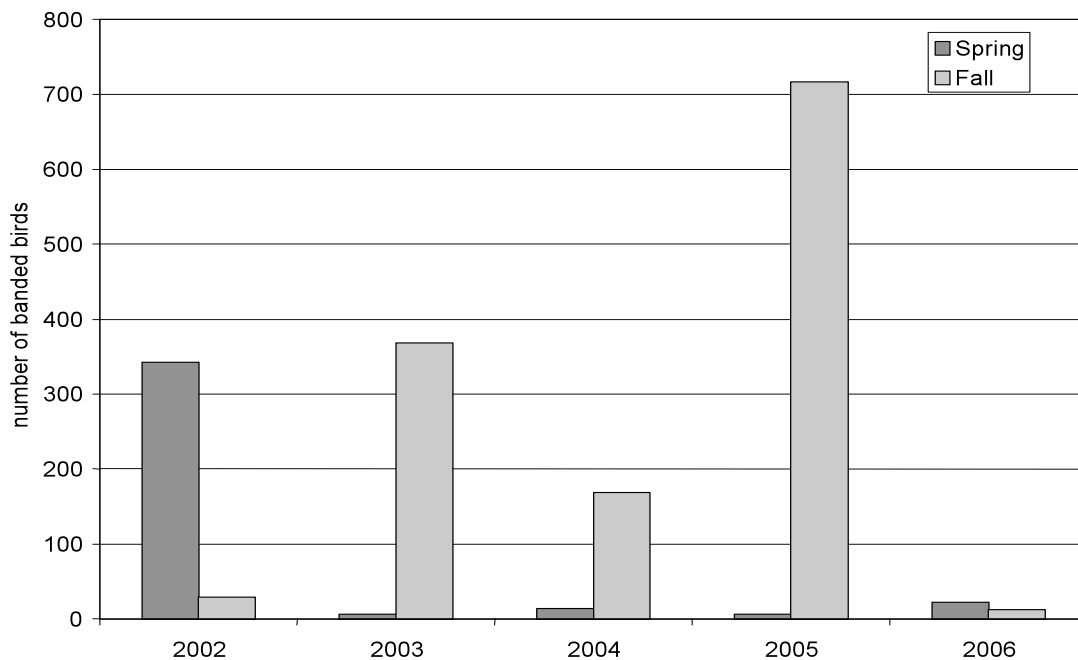


Fig.18. Banded numbers of Black-capped Chickadees by year and season at Cabot Head Research Center (2002-2006).

### **Golden-crowned Kinglet**

The Golden-crowned Kinglet is an abundant bird of coniferous forests. It breeds from Alaska eastward to Newfoundland, southward to northern United States and further southward along the eastern and western mountain ranges. It is a short-distance migrant (some populations being sedentary), wintering from southern Alaska and southern Canada to southern United States and northern Mexico (Ingold and Galati, 1997).

Spring migration of Golden-crowned Kinglet is already under way at Cabot Head when monitoring starts in mid-April. The sex ratio (as calculated by number of males divided by number of females) of banded individuals is strongly biased towards females (average of 0.37), which indicates that males certainly migrate earlier than females, as is the case with the Ruby-crowned Kinglet. After the peak in late April (mostly composed of females), numbers of Golden-crowned Kinglets decline sharply and this species is quite rare already after the first week of May (even though the last record is on May 26). Fall migration, in contrast, is well monitored within the time window at Cabot Head. Fall migration of Golden-crowned Kinglets starts in late September (with the earliest record on August 31), with most individuals moving through in October. Detected numbers decline sharply at the end of October. However, abundance is quite variable, with a 14-times difference between the lowest detected total (in fall 2005) and the highest (in fall 2006) (Fig.19). Therefore, the average temporal pattern (as presented in Appendix F) is greatly influenced by the high abundance of Golden-crowned Kinglets in fall 2006. The migration this fall was characterised by an early peak in late September followed by a higher one in early October. Then, due to bad weather, there was a lull in mid-October shortly followed by an even greater peak in late October. Afterwards, numbers detected and banded declined sharply as the migration monitoring drew to an end. A very high proportion of birds banded in fall are hatch year (94%). Contrary to Ruby-crowned Kinglet, timing of migration in fall is similar between sex for Golden-crowned Kinglet (Fig.20).

No banded Golden-crowned Kinglets have ever been recaptured between seasons or years. Furthermore, very few birds are recaptured within the same season of banding (5 to 10% in fall).

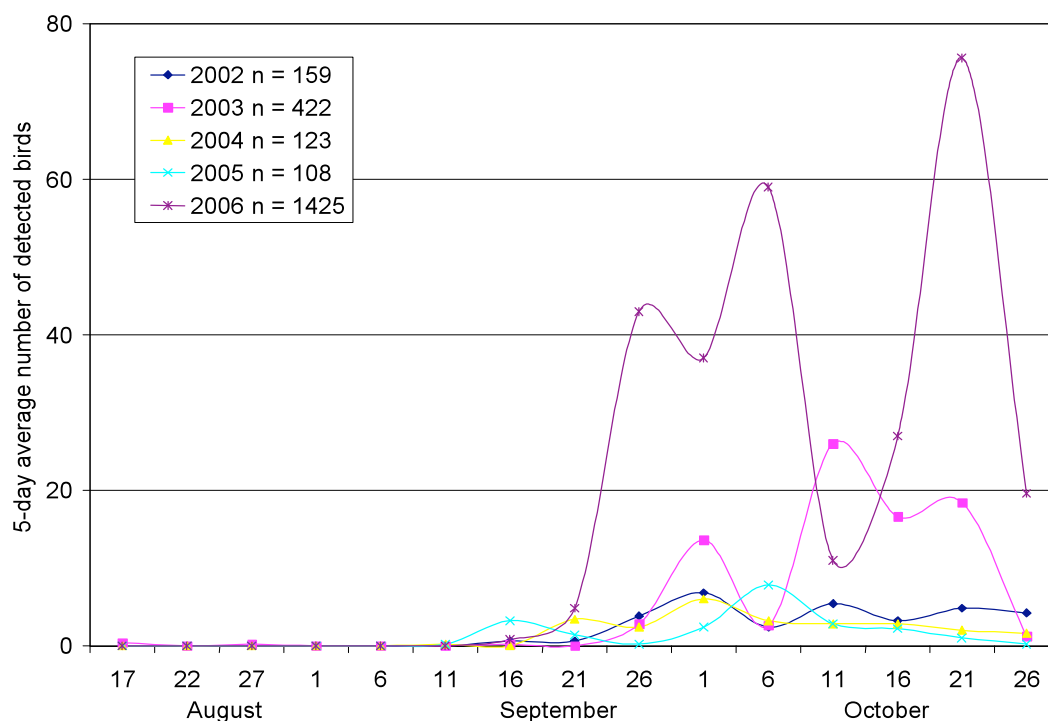


Fig.19. Yearly variation of detected numbers of Golden-crowned Kinglets in fall at Cabot Head Research Station (2002-2006).

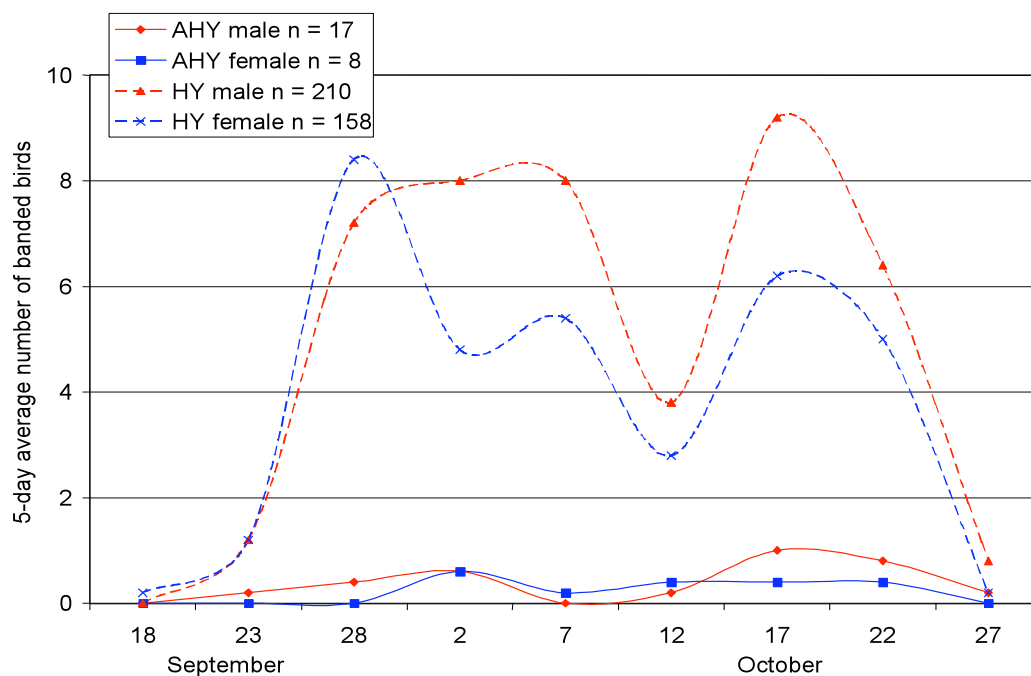


Fig.20. Fall phenology in relation to age and sex for Golden-crowned Kinglets at Cabot Head Research Station (average 2002-2006).

### **Ruby-crowned Kinglet**

An abundant summer bird of the boreal forest and the western mountains, the Ruby-crowned Kinglet is a short distance migrant, wintering in the southern states of the USA and in Mexico (Ingold and Wallace, 1994).

At Cabot Head, Ruby-crowned Kinglets are already present when migration monitoring starts in spring, albeit in small numbers. Temporal patterns are quite variable between years. In most years, movements of Ruby-crowned Kinglets present 2 distinct peaks: the early one in late April and the later in early May (Fig.21). There is a strong sexual difference in migration timing: male Kinglets migrate at Cabot Head, on average, 15 days earlier than the females (Fig.22). Almost no males are banded when female captures peak! Thus, it is interesting to note that in 2002 and 2003, the sex ratio was strongly biased towards females and that the migration pattern presented only the early May peak. Therefore, it is more than likely that most of the male migration, being too early, was missed in those 2 years. After mid-May, Ruby-crowned Kinglets become rare, the last one being detected on May 29.

Fall migration starts in mid-September (only 3 Ruby-crowned Kinglets were detected in August 15, likely local breeders.) and is finished at the end of October. As in spring, it is quite variable, both in numbers detected and banded as well as in temporal patterns (Fig.23). Ruby-crowned Kinglets are usually most common in October, when their migration peaks most of the years. However, in fall 2006, the peak was earlier, in late September. Eighty-five percent of birds banded in fall are hatch year. As in spring, there is a sexual temporal difference in migration, although less marked. About half of the females migrate 3 weeks earlier than males in fall (Fig.24). This difference in timing of migration by sex is observed across North America (Swanson *et al.*, 1999).

Both in spring and fall, within-season recapture rates are relatively low (between 1 to 7%), except in spring 2004 (with 14% birds banded recaptured in this spring). No banded Kinglets have ever been recaptured between seasons. Observations at Cabot Head show that flocks of Kinglets move through the area quite rapidly, while feeding, thus reducing the probability of recapture.

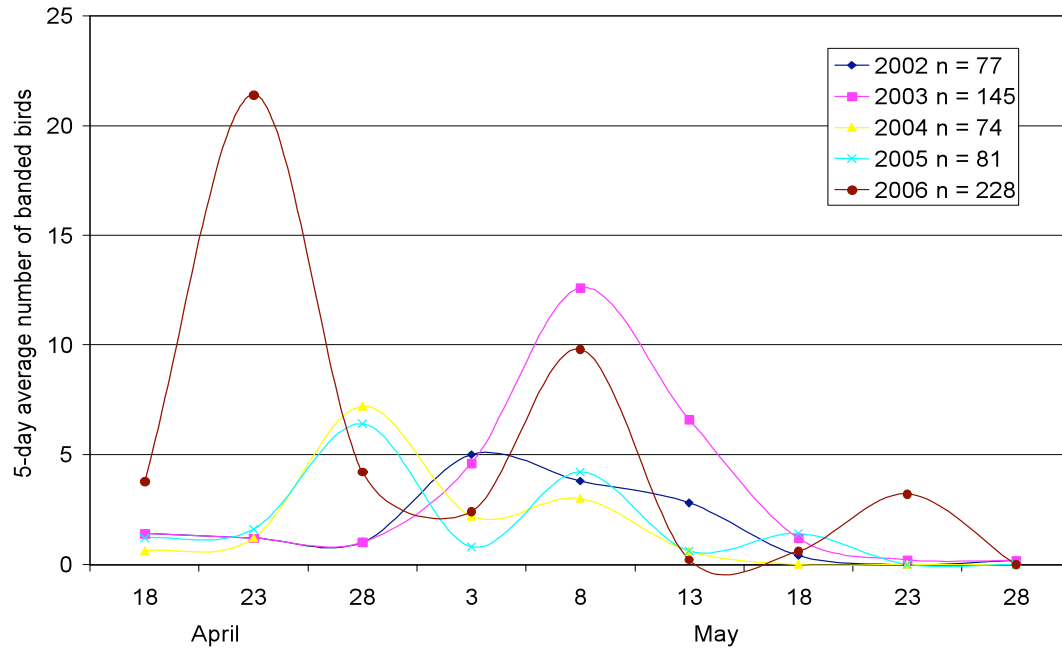


Fig.21. Yearly variation of banded numbers of Ruby-crowned Kinglets in spring at Cabot Head Research Station (2002-2006).

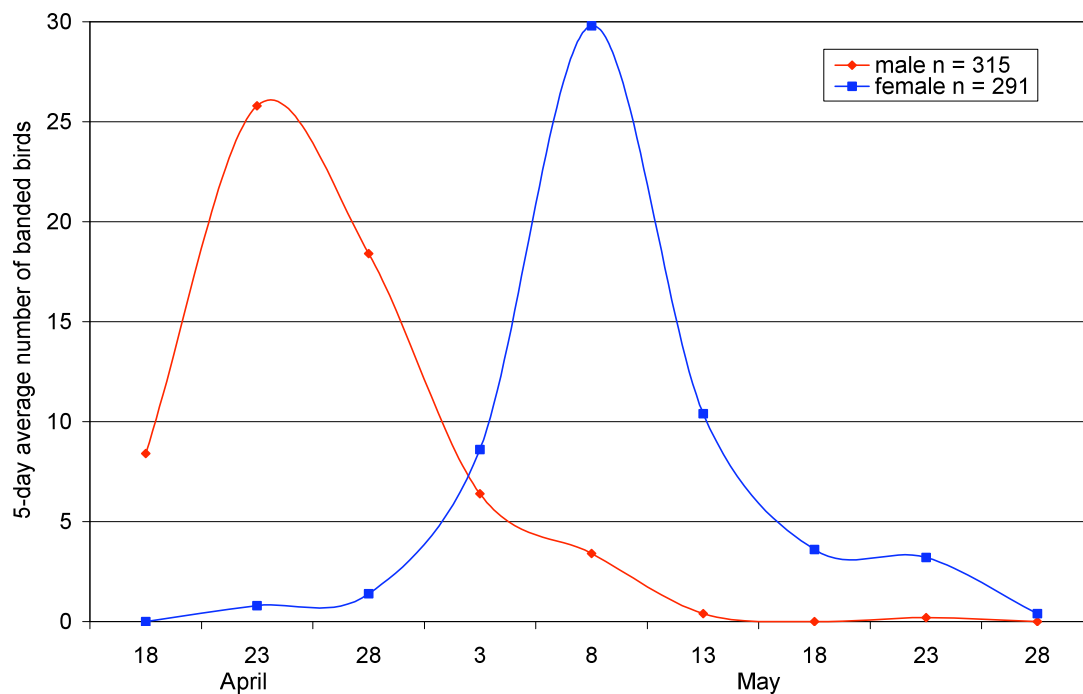


Fig.22. Spring phenology in relation to sex for Ruby-crowned Kinglets at Cabot Head Research Station (average 2002-2006).

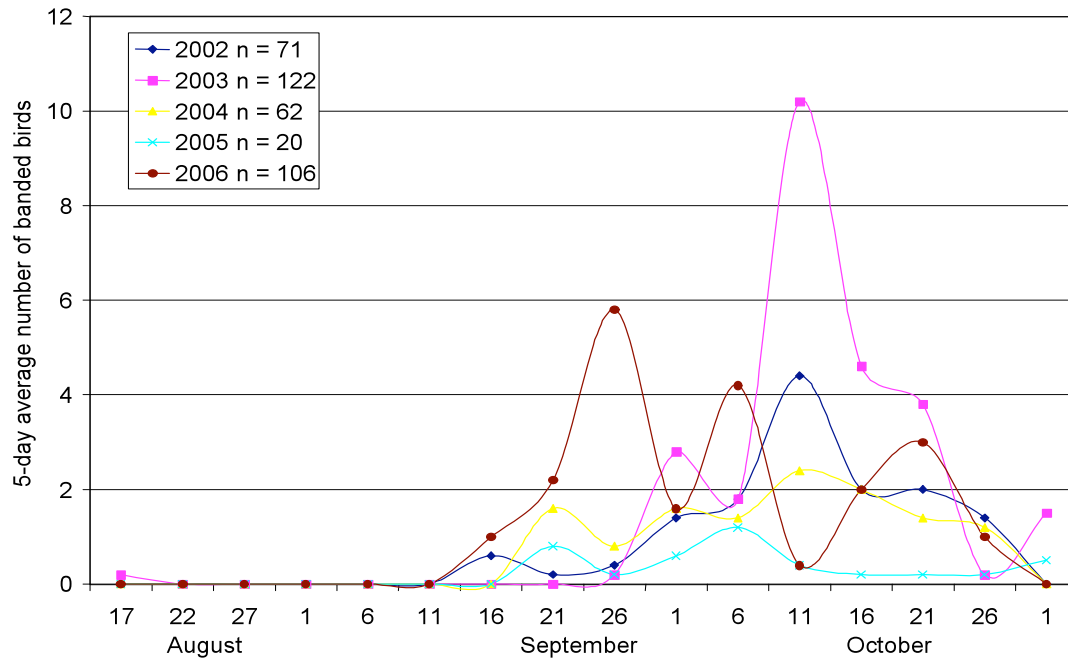


Fig.23. Yearly variation of banded numbers of Ruby-crowned Kinglets in fall at Cabot Head Research Station (2002-2006).

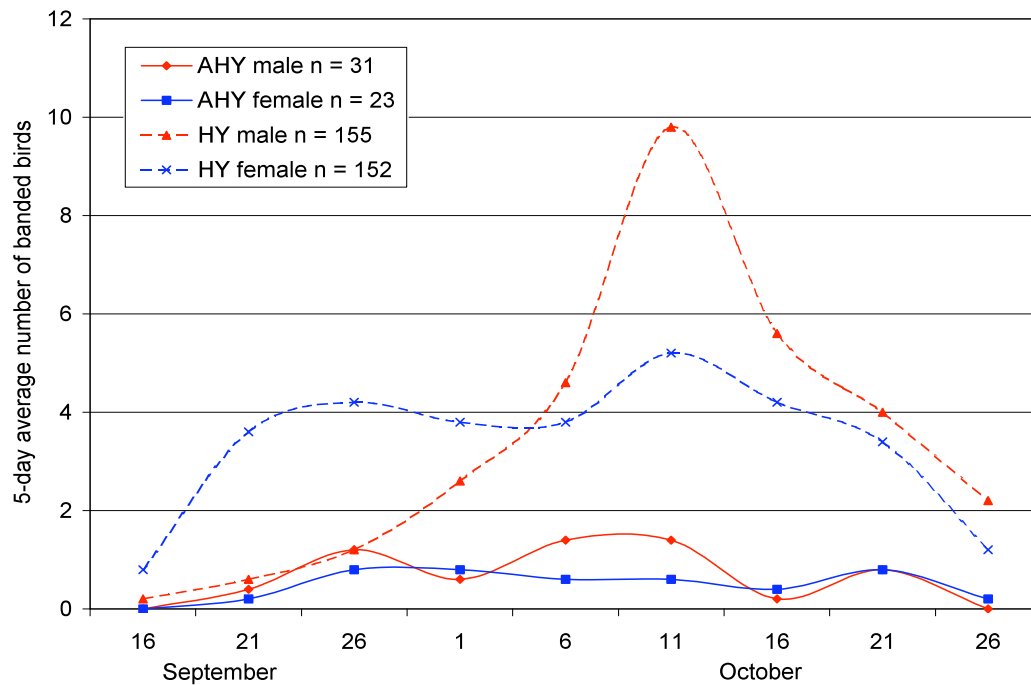


Fig.24. Fall phenology in relation to age and sex for Ruby-crowned Kinglets at Cabot Head Research Station (average 2002-2006).

### Veery

The Veery is a long-distance migrant that breeds across North America and winters in South America. Long thought to winter across the northern third of South America, it was recently shown that the wintering grounds of the Veery are restricted to central and southern Brazil (Remsen, 2001).

It breeds in damp, deciduous forests and riparian habitats, with dense understorey. Although a breeder on the Bruce Peninsula and north of it, it is detected only in small numbers at Cabot Head, especially in fall. The very earliest Veery was detected on April 24, but migration really starts early May and numbers detected increase rapidly in the second week of May. Then, most of the detected birds move through during 2 weeks. Migration tapers off afterwards, with a few birds left in June. Fall migration is not well monitored at Cabot Head, as very few birds are detected (mostly through banding). It nevertheless appears that migration is concentrated from mid-August to early September (with 2 late individuals captured towards the end of September).

Age determination is relatively easy for *Catharus* thrushes, in both seasons. In spring, between 45 to 67% of birds are second-year birds, the rest ASY (the only bird caught in 2002 was an ASY). All birds captured in fall are hatch year. The average weight is not significantly different across age, whereas hatch-year birds tend to have shorter wings than ASY birds (the latter measured in spring). Furthermore, this difference still exists, although reduced, in spring between shorter-winged SY birds and ASY. The latter tend also to be heavier and to have more fat, on average, even though the difference is not as marked (Table 11). Only one Veery has ever been recaptured at Cabot Head: a HY bird caught on September 23 was recaptured 3 days later. Its fat had increased from 0 to a 2 level, as well as its weight from 31g to 34.1g (a 10% increase).

Table 11. Morphometric data for Veery banded in spring and fall at Cabot Head Research Station, 2002-2006 (average  $\pm$  Standard Deviation).

Season	Age	n	Wing chord (mm)	Weight (g)	Fat (0 to 7)
Spring	SY	28	95.4 $\pm$ 2.6	30.5 $\pm$ 1.9	1.2 $\pm$ 1.4
	ASY	24	96.9 $\pm$ 3.5	31.5 $\pm$ 2.6	1.7 $\pm$ 0.9
	Total	54	96.0 $\pm$ 3.1	30.8 $\pm$ 2.3	1.4 $\pm$ 1.2
Fall	HY	11	94.1 $\pm$ 2.7	30.9 $\pm$ 2.1	0.8 $\pm$ 1.2
Total		65	95.6 $\pm$ 3.1	30.8 $\pm$ 2.3	1.31 $\pm$ 1.2

### Gray-cheeked Thrush

Among the *Catharus* thrushes, the Gray-cheeked Thrush is the northernmost breeding species, from Newfoundland to Alaska and even in northeastern Siberia. It is a long-distance migrant, wintering in northern South America, east of the Andes (Lowther *et al.*, 2001). In Ontario, it breeds only in the extreme north, close to the Hudson Bay shoreline.

At Cabot Head, this species is barely detected in spring but more abundant in fall. Almost all the birds are detected through banding, not surprisingly for this shy skulker of the underbrush. It is a late migrant in spring, the first individuals being detected in late May with birds moving throughout June. In fall, migration is concentrated in September. The first Gray-cheeked Thrushes are detected in early September (September 5 being the earliest). After mid-September, numbers increase rapidly to peak in the third week of the month. Numbers decline gradually up to early October, with the last Gray-cheeked Thrushes detected on October 8.

Even though sample sizes are quite small (especially in spring), it appears that Gray-cheeked Thrushes are more likely to be recaptured in fall than in spring. Like many other species, spring migration proceeds quickly, whereas birds in fall tend to linger (increasing their probability of recapture during the same season). Indeed, a high percentage of Gray-cheeked Thrushes are recaptured in fall (21 to 50%), except in fall 2006 when no birds (out of 9) were recaptured. For recaptured birds, there is a positive and significant relationship between minimum length of stays (of  $4.2 \pm 2.5$  days on average) and weight gain (Fig.25). Despite small sample sizes, it is interesting to note that the highest average weight (for all banded birds) occurred in fall 2006 (when there was no recapture), whereas the lowest was in fall 2005, which has the highest proportion of recaptures (Table 12). Fall 2005 was also a season with an abundant crop of chokecherry fruit, which could have influenced bird decision in staying or not at Cabot Head for an extended period.

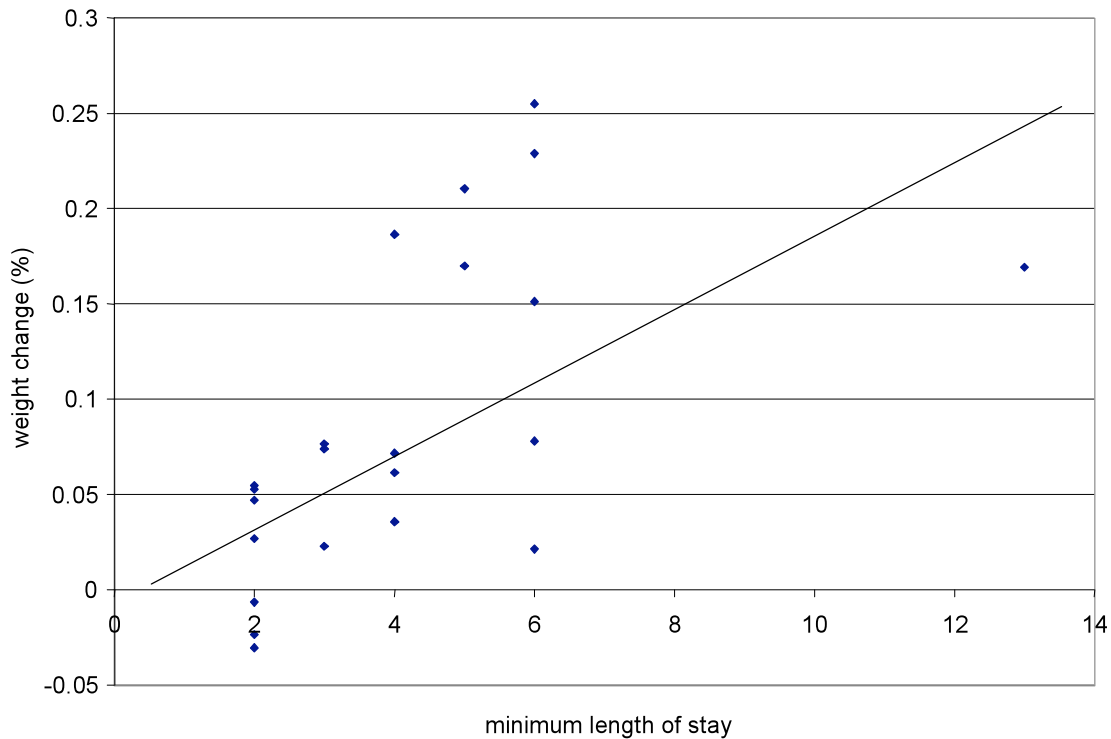


Fig.25. Weight change (in proportion) in relation to minimum length of stay for recaptured Gray-cheeked Thrushes at Cabot Head Research Station in fall (2002-2006). (regression:  $R^2 = 0.35$ ;  $P = 0.004$ ).

Table 12. Weight of banded Gray-cheeked Thrushes at Cabot Head in fall (2002-2006).

	Average weight ( $\pm$ SD) (g)	Range	n	% recapture
2002	33.1 $\pm$ 2.9	28.5 – 38.6	18	21%
2003	31.1 $\pm$ 2.7	27.3 – 36.5	16	25%
2004	32.7 $\pm$ 2.4	29.3 – 38.8	12	25%
2005	30.8 $\pm$ 1.9	27.5 – 36.0	22	50%
2006	34.4 $\pm$ 3.1	31.3 – 40.8	9	0%

### Swainson's Thrush

A long-distance migrant, the Swainson's Thrush breeds in the northern mixed forest and the boreal forests across Canada and winters in northern South America (Evan Mack and Yong, 2000). Swainson's Thrush also breeds in limited locations on the upper Bruce Peninsula, including talus slopes near Cabot Head where it can be locally common (Cheskey, pers. comm.). This species is very secretive during migration and has rarely been studied for either stage of its life-history (Mack and Yong, 2000).

At Cabot Head, the first birds are detected (mostly through banding) in the second week of May (earliest on May 10), with numbers building up to peak in late May. Migration continues in smaller numbers in June, with the last thrush detected on June 9. Like the Gray-cheeked Thrush, fall migration is principally in September at Cabot Head. However, the first Swainson's Thrushes are detected in late August (the earliest on August 24) and could be local birds. In October, numbers decline sharply compared to September with the last Thrush detected on October 10.

A hatch-year Swainson's Thrush banded on September 16 in 2003 was recaptured on June 3, 2004, the only individual ever recaptured between seasons. No thrushes banded in spring ( $n = 110$ ) have been recaptured in the same season, indicating a very swift movement through Cabot Head at this time of year. Oppositely, about 13% of the 111 Swainson's Thrushes banded in fall were recaptured later within the same season. Their average minimum length of stay ( $4.4 \pm 3.3$  days [2 – 12]) is quite similar to Gray-cheeked Thrush, but there is no significant linear relation between length of stay and weight gain ( $P = 0.77$ ; Fig.26.). Some individuals increased their weight by almost 20% in one day!

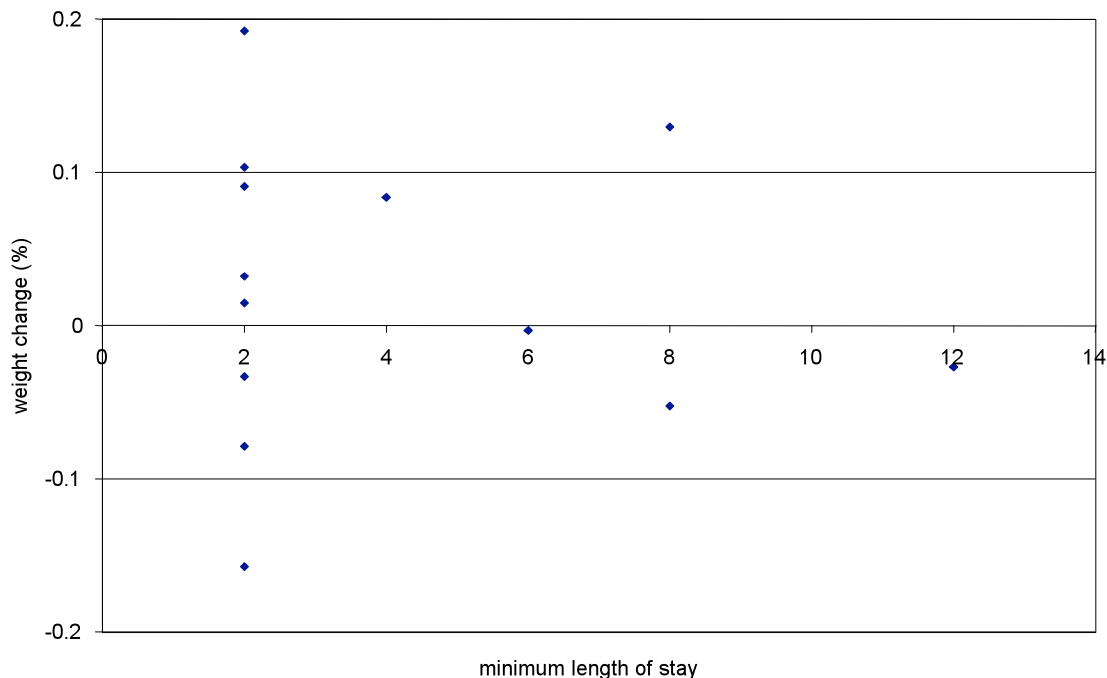


Fig.26. Weight change (in proportion) in relation to minimum length of stay for recaptured Swainson's Thrushes at Cabot Head Research Station in fall (2002-2006).

### Hermit Thrush

The Hermit Thrush breeds in mixed forests and throughout the boreal forest in eastern North America and winters in the southern states of the USA. A short-distance migrant, its migration is earlier in spring and later in fall than the other *Catharus* thrushes (Jones and Donovan, 1996). This species also breeds on the Bruce Peninsula, principally favouring sparsely wooded areas with exposed rocks.

At Cabot Head, the majority of Hermit Thrushes migrate from late April to mid-May, with a slight peak in early May. Numbers then decline and only a few individuals are left in June (probably local breeders). In fall, only a few individuals are detected in August and early September (detection is achieved especially through banding, like almost all Hermit Thrushes in fall). These are likely locally hatched young, especially in August. Migration really starts in the third week of September with numbers increasing steadily. The peak is in early October and Hermit Thrush becomes increasingly rare afterwards.

Like the other *Catharus* thrushes, within-season recaptures in spring are extremely infrequent: only one banded Hermit Thrush was recaptured the same spring, in 2003. Within-season recaptures are more common in fall, with 17% of recaptures in total. As it is the case for the other *Catharus* Thrushes, the highest recapture rate is in fall 2005. Hermit Thrushes, based on recaptures, stayed longer than the other thrushes ( $6.1 \pm 4.8$  days [2 – 24]). Like the Swainson's Thrush, there is no significant linear relation between length of stay and weight gain ( $P = 0.81$ ; Fig.27).

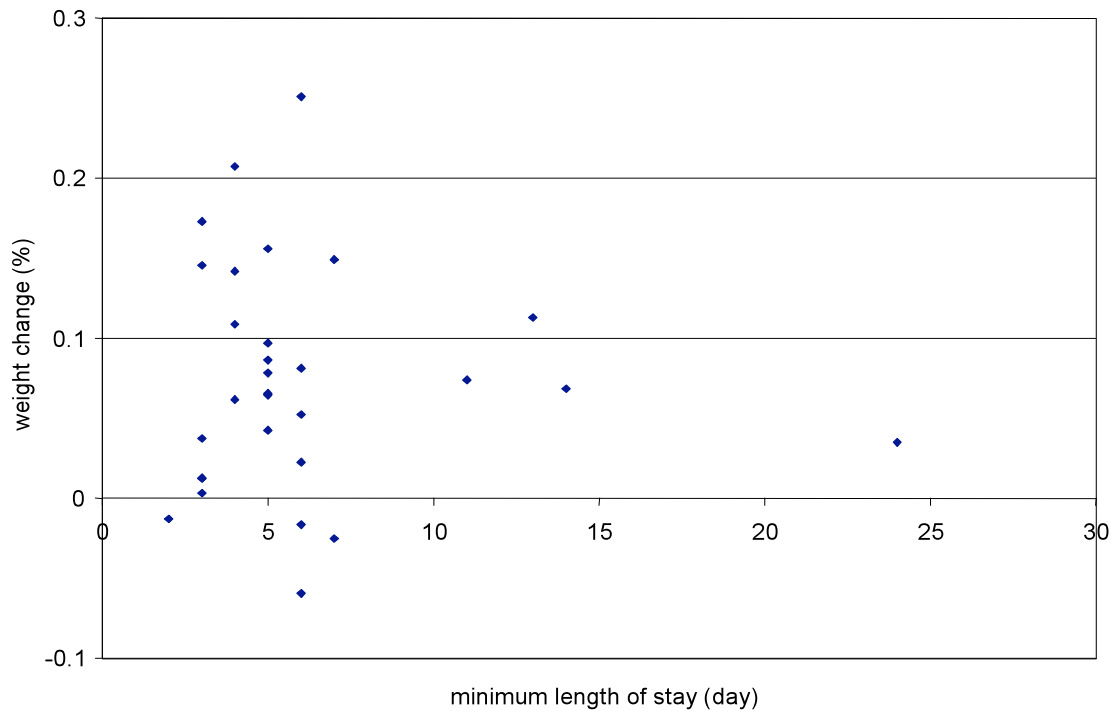


Fig.27. Weight change (in proportion) in relation to minimum length of stay for recaptured Hermit Thrushes at Cabot Head Research Station in fall (2002-2006).

### Nashville Warbler

A small songbird of second-growth forests, the Nashville Warbler breeds in both north-central North America and an isolated portion of the mountainous Pacific Northwest. It nests on the ground and feeds almost exclusively on insects. It winters primarily in southern Mexico. It could thus be considered an intermediate (between a short- and long-distance) migrant (Williams, 1996).

It is a relatively early migrant in spring, compared to other warblers. The first individuals of Nashville Warbler are detected in late April, but this species becomes more common in early May. Numbers increase rapidly in the first part of May, then peak in the middle of the month and decline afterwards as rapidly, with very few individuals left (including territorial singing birds) at the end of May. The spring migration is thus very concentrated into a 2-week time frame in May. Within this short period, ASY males migrate about 5 days earlier than the other birds. There is no difference for the other categories (ASY females and SY males and females - Fig.28). More males of both ages (but especially ASY) are captured than females in spring. It is possible that males are more likely to be caught in spring, due to territorial behaviour (chase between male

singers). Among warblers, two other species (Magnolia and Black-throated Green Warblers) are captured in spring with a strong bias towards males. There are almost as many ASY birds captured in spring as SY birds.

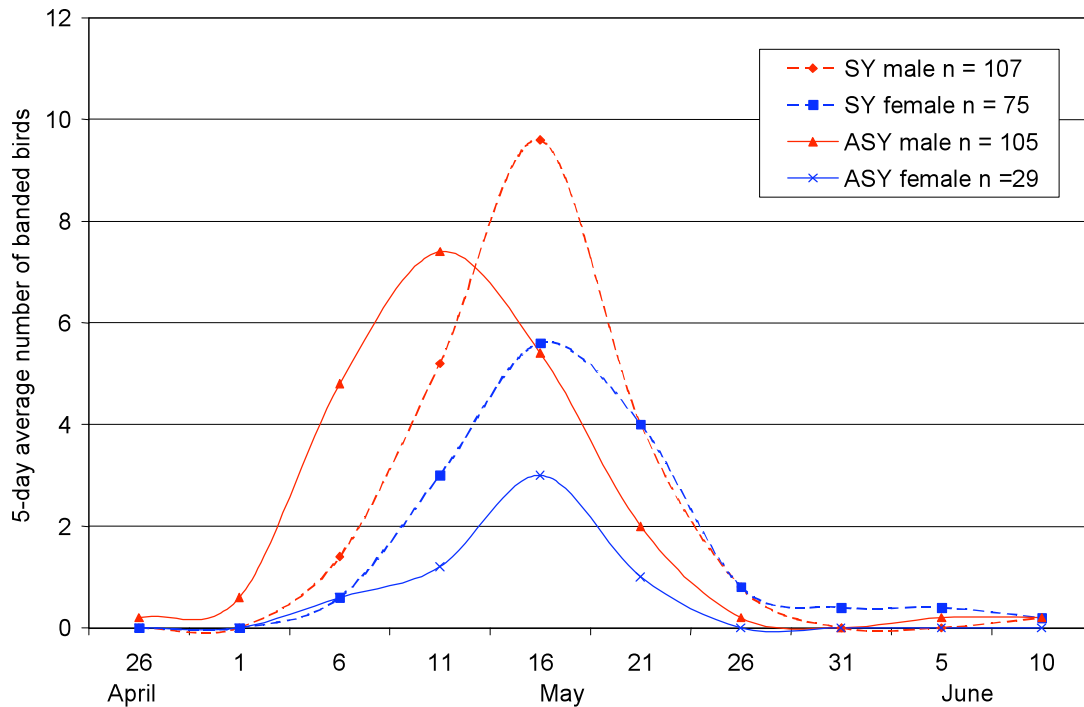


Fig.28. Spring phenology in relation to age and sex for Nashville Warbler at Cabot Head Research Station (average 2002-2006).

Fall migration of Nashville Warbler is more extended than in spring. Very few birds are detected at the beginning of the monitoring period, indicating that few breeders are present in the area. Numbers build up quite rapidly to reach the greatest abundance from the end of August to mid-September. This species is rarely detected afterwards, although birds are seen well into early October (the latest record being on October 28). There is no difference in timing of migration between males and females, regardless of age, and the sex ratio is relatively balanced, contrary to spring.

Very few Nashville Warblers are recaptured in spring, confirming a swift movement through the area. There were no recaptures at all in spring 2003 and 2005. Recaptures were concentrated mainly in spring 2002, with 10 individuals caught (although representing only 4% of the total banded). Therefore, the sample size is too

small and biased towards a specific year to be used to estimate length of stay. It appears instead that Cabot Head is not used as a spring or fall stopover by this species. Indeed, few birds are recaptured in fall. As in spring, most recaptures were from one year, fall 2005, when 14% of the banded birds were recaptured. As mentioned earlier, conditions in this fall were particularly favourable, with an abundant chokecherry crop that many species seem to have taken advantage of.

### **Magnolia Warbler**

A colourful warbler, the Magnolia Warbler is a long-distance migrant that breeds in boreal and mixed forests across Canada and in the northeast of the USA and winters in Central America and the Greater Antilles (Hall, 1994).

Spring migration at Cabot Head is well concentrated in the second half of May. The first Magnolia Warblers are detected in early May (first record on May 2), but numbers are very small up to mid-May. Magnolia Warblers then move through the area en masse during 2 weeks. Fewer and fewer birds migrate afterwards in June, with the last Magnolia Warbler detected in June 15. As in most species, males (with no difference between SY and ASY) migrate about 10 days earlier than females (especially SY). The sample size is too small to determine a temporal pattern of ASY females. (Fig.29). There is a bias towards males in spring captures of Magnolia Warbler (as well as in fall for AHY birds, although slightly less marked). In spring, ASY males are captured almost 5 times more than ASY females! Second-year birds are dominant in spring, representing 74% of captured birds of known age. For most species of warblers with enough sample size and when age determination is possible, SY birds tend to be more abundant than ASY in spring (with the notable exception of Black-and-White and Nashville Warblers).

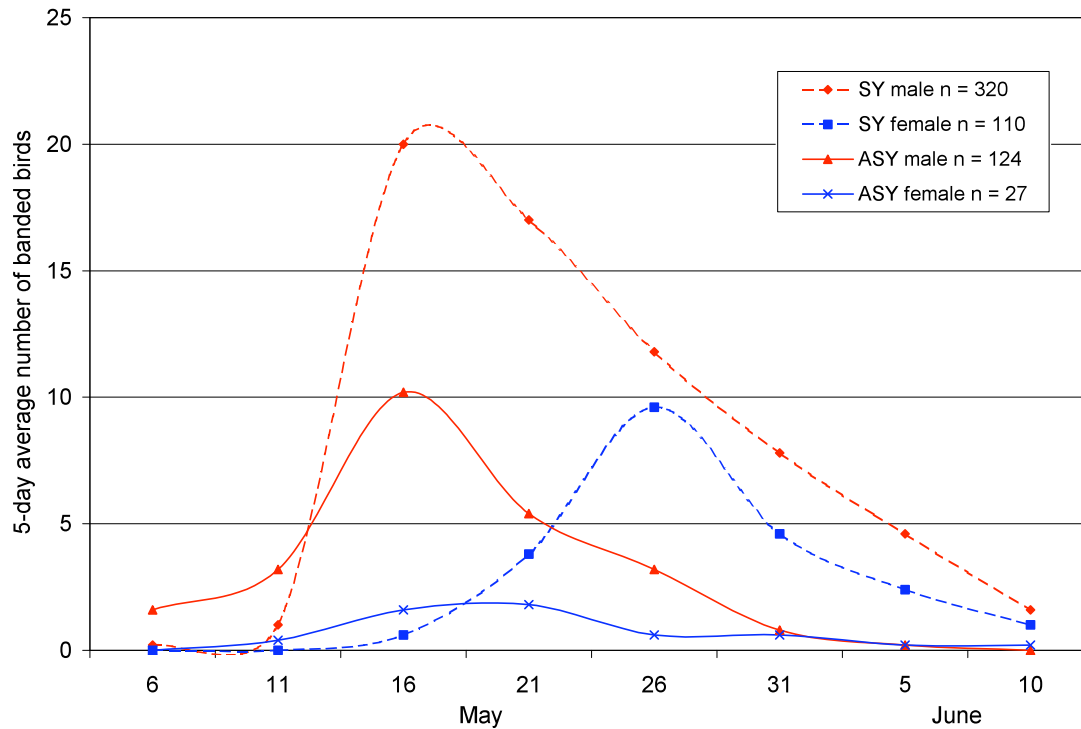


Fig.29. Spring phenology in relation to age and sex for Magnolia Warbler at Cabot Head Research Station (average 2002-2006).

Magnolia Warblers are less common in fall than in spring (both banded and detected). Birds move during a one-month period, from mid-August to mid-September, without any marked peak. Numbers of Magnolia Warbler decline steadily afterwards, with the last ones in early October (latest record on October 11). Most birds (89%) captured in fall are hatch year, an age where sex is almost impossible to determine.

Only 3 individuals have ever been recaptured from a previous season, and all of them were banded in the previous spring (which could indicate that they were local breeders). Very few birds banded in spring are recaptured within the same season (from 1 to 7%), which seems to indicate a rapid movement through the area. In fall, a higher proportion (up to 12%) is sometimes recaptured, but the small general sample size of banded birds precludes meaningful conclusions. As with other species, it is however evident that migration in fall is more extended and birds have a tendency to stay in the Cabot Head area longer than in spring, a general pattern across many species.

### **Yellow-rumped (Myrtle) Warbler**

The Myrtle Warbler (the subspecies of Yellow-rumped Warbler that breeds and migrates through Cabot Head) is a short-distance migrant that breeds across a vast area in North America and winters mainly in the south of the USA, but also in Central America and the West Indies (Hunt and Flaspohler, 1998). Consequently, it is an early migrant, being already present, although in small numbers, at the beginning of the migration monitoring in mid-April. Numbers of Myrtle Warbler rapidly build up toward the end of April to peak in early May. Many Myrtle Warblers still move through up to the third week of May. Migration then tapers off quite rapidly at the end of May and only a few Myrtle Warblers are seen in June. However, this general pattern is relatively variable between years (Fig.30a). For example, in spring 2006, a huge movement occurred between April 29 and May 2. During these 4 days, around 1,900 Myrtle Warblers were detected, for an Estimated Total of 2,600 (more in this short period than the usual numbers for an entire spring, as determined in the other years!). Most of the time, Myrtle Warblers move rapidly in flocks flying above the tree canopy and perch only for brief periods. This behaviour could explain the wide discrepancy between numbers detected and numbers banded: only in spring 2002 and fall 2005 were more than 200 individuals captured. Therefore, it is difficult to draw strong inferences from banding data, especially on phenology in relation to age and sex. Not only are numbers banded low in comparison to numbers detected, but also timing of capture does not correspond to migration peaks, as detected through visual observations, especially in spring (Fig.30b). It appears that most captures in spring are later in season, past the detected peak. In most species, ASY birds usually migrate earlier than SY in spring, which would suggest that ASY Myrtle Warblers are not well represented in the banding sample. Indeed, 78% of banded birds in spring are SY.

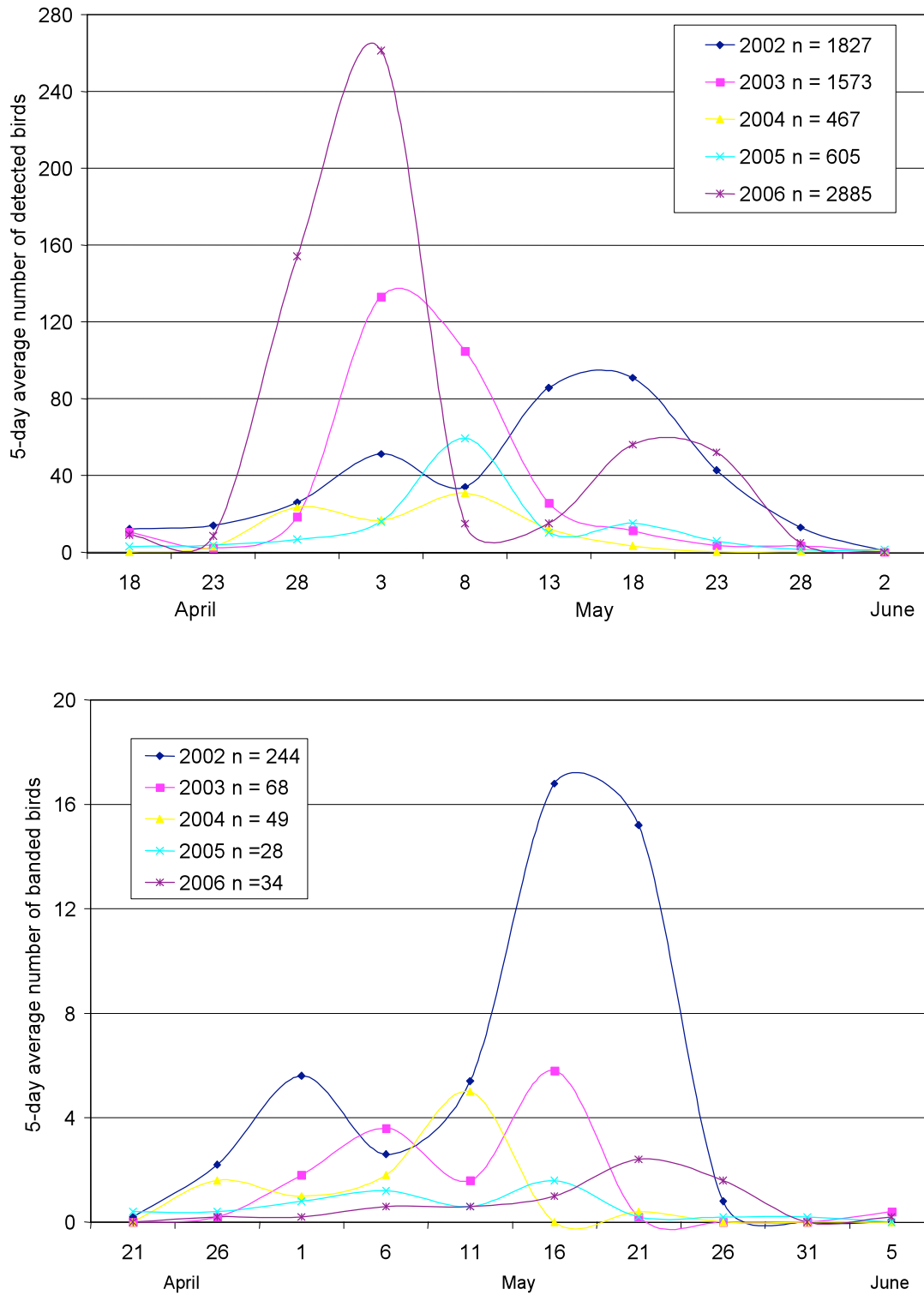


Fig.30a&b. Yearly variation of detected (top) and banded (bottom) numbers of Myrtle Warbler at Cabot Head Research Station (2002-2006).

Fall migration starts slowly in mid-August (birds detected at this time might be local breeders). Numbers increase steadily towards a first peak in early September. There is a lull in mid-September before a second and more important peak in late September and early October. Numbers of Myrtle Warbler detected at Cabot Head then decline rapidly afterwards, this species being rare after mid-October. The last observation was on October 30. Interestingly, this pattern of migration with 2 distinct major periods of movement is evident every year (with some variations) and could correspond to 2 distinct populations or breeding locations of this species. In fact, the Great Lakes area seems to be a crossroad for songbirds, with migrants coming either from the northwest or the northeast (Dunn *et al.* 2006). It would be interesting to test the origin (through stable isotope analyses) of Myrtle Warblers in relation to their time of passage through Cabot Head. In fall, like other species, HY birds dominate the banding sample, with 88% of captured individuals. Among warblers, the migration of Myrtle Warbler is thus the earliest in spring and the latest in fall.

In spring, within-season recaptures are extremely rare: 2 birds in 2002 and one in 2006 (1 and 3% of banded total, respectively). This low recapture rate confirms that Myrtle Warblers move rapidly through the area in spring and do not use it as a stopover habitat. Recapture rates in fall are slightly higher than in spring, but still very low (from 2% to 11%, with no recaptures in 2004). In fact, it is principally in fall 2005 that Myrtle Warblers were recaptured quite often: 11% of banded birds were recaptured at least once. Their average minimum length of stay was  $6.3 \pm 5.1$  days. The majority (13 out of 21) was present for at least 5 days, the longest minimum stay being 21 days. There is a significant linear relation between weight gain and length of stay ( $R^2 = 0.37$ ,  $P = 0.005$ ); birds staying the longest tend to gain the most weight (Fig.31). As mentioned earlier, this fall was characterised by an abundance of Chokecherry fruit at Cabot Head and Myrtle Warblers certainly took advantage of it.

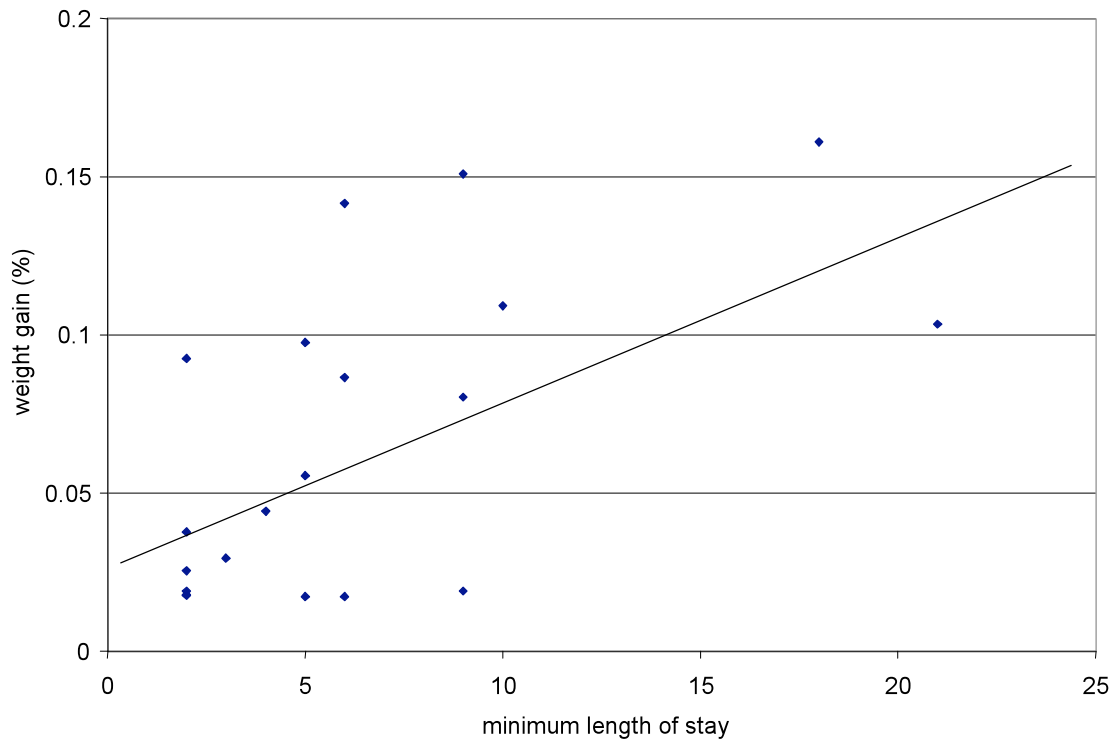


Fig.31. Weight change (in proportion) in relation to minimum length of stay in fall 2005 for recaptured Myrtle Warbler at Cabot Head Research Station (regression:  $R^2 = 0.37$ ,  $P = 0.005$ ).

### Black-throated Green Warbler

The Black-throated Green Warbler is a long-distance migrant, breeding in a large belt of coniferous and mixed forest across North America, through Ontario north to the southern boreal forest, and down the Appalachian Mountains. The species winters in Mexico and Central America (with small numbers in the Caribbean and northern South America)(Morse, 1993).

In spring, Black-throated Green Warblers arrive first in late April, then build up slowly in numbers in early May to peak in the latter half of May and then taper off in June. A proportion of birds, certainly small, stay in the Count Area to breed: a handful of males have been captured with a well-developed cloacal protuberance in June, as well as one female with a recessing brood patch and a few young in juvenile plumage in August. However, it is likely that the population of breeding birds is low in the Cabot Head area, as Black-throated Green Warblers are detected in relatively small numbers in mid-August, when monitoring starts again. Then, numbers rise sharply during the second half of August to peak at the end of this month and in the first week of September.

Afterwards, the detected numbers of Black-throated Green Warblers decline sharply after mid-September, the last birds being observed at the end of September. The latest observation of just one individual was made in October 8 (both in 2003 and 2004). Thus, the fall migration is concentrated into less than 3 weeks.

In spring, males migrate on average 15 days earlier than females. Sample size is quite small, but it appears nonetheless that second-year males migrate at the same time as after-second-year males (as opposed to American Redstarts, for example, where after-second-year males migrate the earliest). The number of ASY females captured is too small to draw firm conclusions (Fig.32a). In fall, no difference in timing of migration seems to exist between sexes (Fig.32b).

Like Nashville and Magnolia Warblers, the sex ratio is strongly biased towards males in spring, for both ages but especially for ASY. Too many birds with undetermined sex are caught in fall to provide a meaningful sex ratio. It is likely that many undetermined HY birds are female, as this sex does not show strong plumage characteristics early in life. It is extremely striking that almost no adult (after-hatch-year) birds have been captured in fall: Only 5 birds in total for the 5 years (and 4 captured in fall 2004 alone!). Adult birds certainly migrate earlier in fall, before the start of the migration monitoring period.

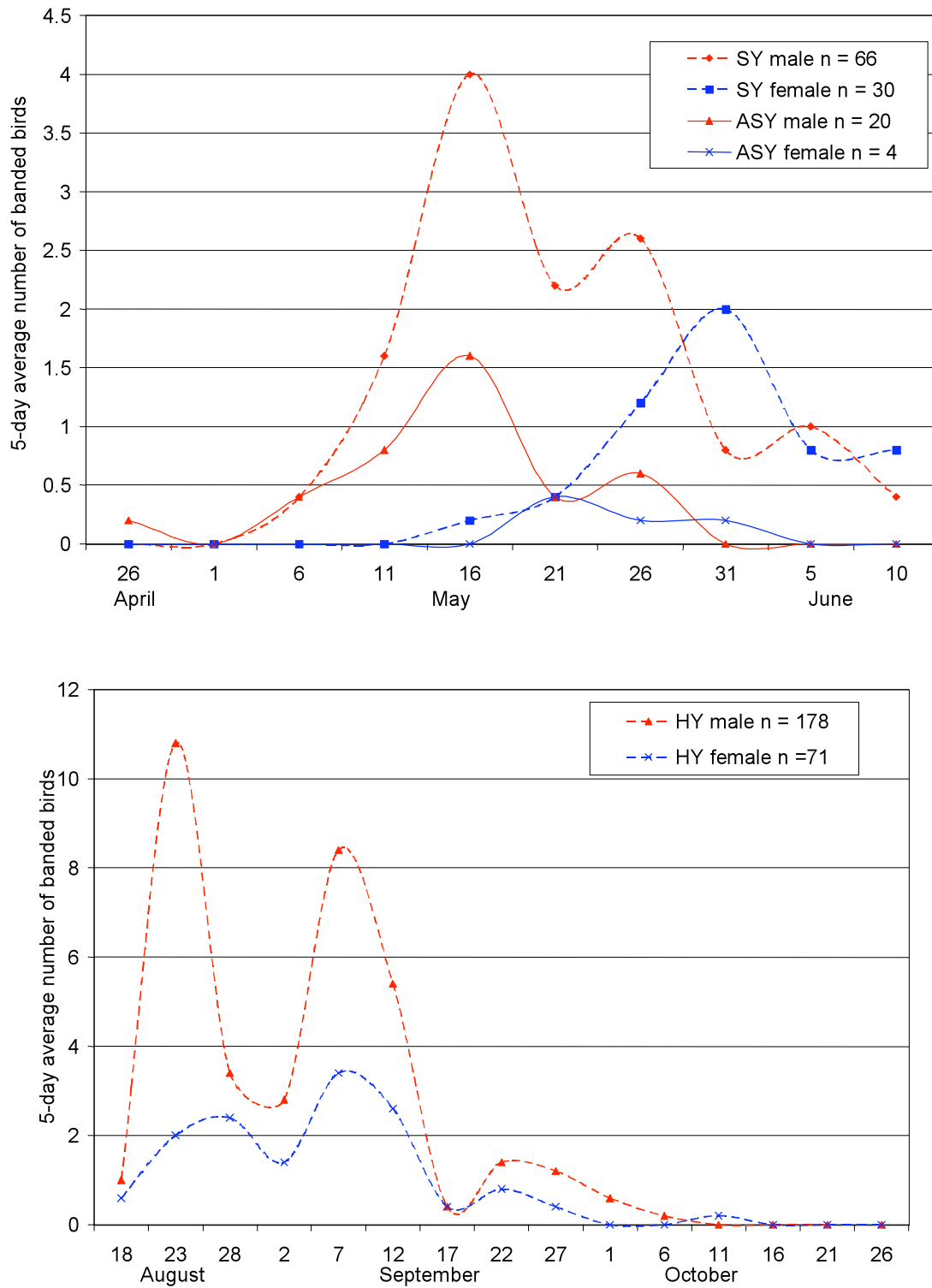


Fig.32a&b. Spring (top) and fall (bottom) phenology in relation to sex for hatch-year Black-throated Green Warbler at Cabot Head Research Station (average 2002-2006).

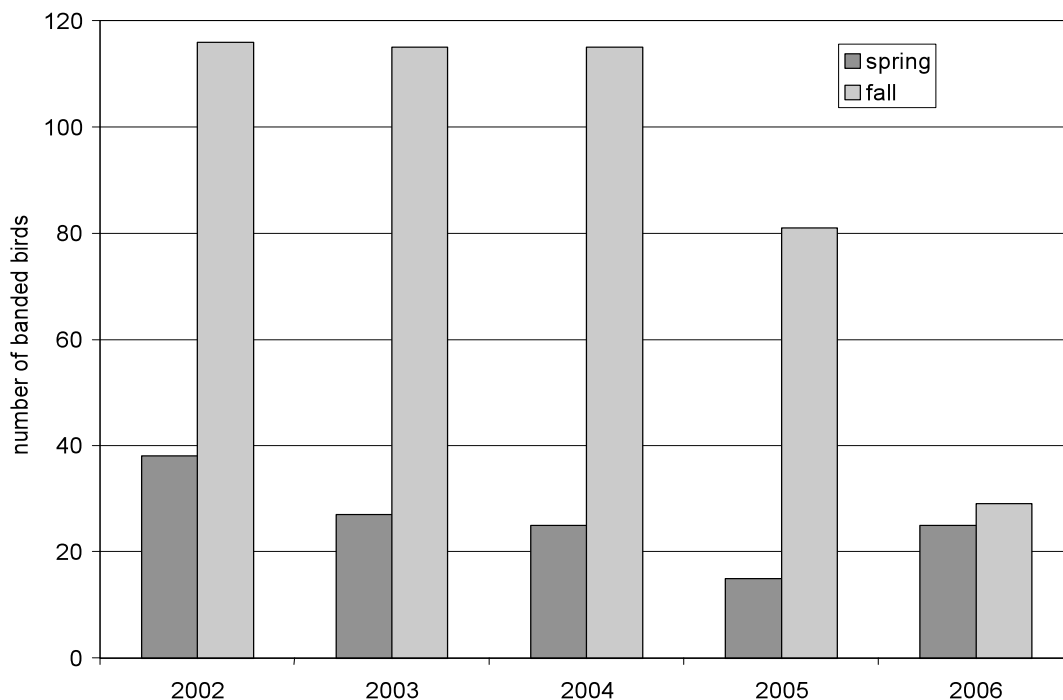
A total of 10 birds have been recaptured in spring. Most of them were recaptured within the same season of banding, but 2 were banded a previous fall. The average minimum length of stay is  $10.6 \pm 8.0$  days (range: 3 – 28 days). Of the 6 males recaptured, 5 of them show a well-developed cloacal protuberance, a good indication of their breeding status and thus, of being resident in the area. Among the 29 newly banded birds checked for CP/BP in spring, only 5 males (including one later recaptured) had developed cloacal protuberances and no females show evidence of any brood patch. Only one female (captured in mid-June) of the 4 recaptured had a brood patch in an early stage of development. It is possible that brood patch develops later in the breeding season, after the spring monitoring period. Among the birds recaptured in spring, 3 were recaptured more than once and all of them had a CP or a BP developed every season (this characteristic was not verified in 2002), indicating breeding status. It is also an anecdotal, but strong, example of site fidelity for breeding birds. Weight of recaptured birds is relatively constant throughout recaptures. Among the 12 occasions with multiple weights, only 2 present a (positive) fluctuation of more than 10% between the lowest and the highest weights. One of them is particularly interesting: a second-year female was captured 6 times, from banding on May 27 to the last recapture in June 14. Her weight showed almost no variation during the first 5 captures (May 27 to June 8), being on average  $7.9 \pm 0.1$ g. However, on her last capture, on June 14, her weight had increased 28% to 10.1g! It is very possible that an egg was developing at this time.

Within-season recapture rate is even lower in fall than in spring: only 3.3% of newly marked birds (i.e. 15) were recaptured during the same season of their banding. Not surprisingly, the minimum length of stay is shorter than in spring (where it concerns mainly breeding resident birds): only  $5.1 \pm 2.6$  days (range: 2 – 10). All the within-season recaptures are hatch-year birds. There were also 3 recaptures of birds banded in a previous season: 2 of them banded (and also recaptured) the previous spring. The other bird was banded as an AHY female in early August 2000 and was recaptured in fall 2003, the last Black-throated Green Warbler of the season (October 8), being then at least 4 years old (oldest record of 5 years and 11 months; see <http://www.pwrc.usgs.gov/BBL/homepage/longvrec.htm>). Fluctuations in weight among recaptured birds are relatively small, between 5 to 10% of the original weight at banding. These observed small fluctuations in mass gain and loss may simply reflect natural variations in weight.

Only one bird experienced an important decline (of 13.5%) of its mass in the 8 days between the original banding and the last recapture (with a constant fat level of 0).

Birds are banded in higher numbers in fall than in spring (Fig.33). However, there was a sharp decline in birds banded in fall after 3 relatively steady years. In fall 2006, the banding total was only 25% of that of the first 3 years! As mentioned earlier, the peak of migration occurs from late August to mid-September, the 10 first days of September being particularly important. During this period in fall 2006, adverse weather conditions were prevalent. An entire day of banding was lost due to rain and moderately strong to strong winds (4 to 6 on the Beaufort scale) on 9 days out of 10! Winds came from east, northeast, or south: all directions not very favourable for bird migration in fall at Cabot Head. Thus, the very low banding total of Black-throated Green Warblers in fall 2006 is more likely a result of weather factors than changes in population levels. More years of data are obviously needed to determine population trends, but it already appears, at least for this species, that local weather conditions are an important factor in fluctuations of number of birds banded.

Fig.33. Number of banded Black-throated Green Warblers by year and season at Cabot



Head Research Station (2002-2006).

#### **Western Palm Warbler**

The Palm Warbler, like the Yellow-rumped Warbler, is a short-distance migrant, breeding in bogs and fens in the boreal forest from the Northwest Territories to

Newfoundland and wintering in the southern United States and the Caribbean. However, it is a spring migrant not as early as the Yellow-rumped Warbler. The Western Palm Warbler is the subspecies migrating through Cabot Head (Wilson, 1996).

Although the first individuals at Cabot Head are detected in late April (April 23 for the first record), Palm Warblers start to move through the area in early May. Their numbers increase rapidly to peak in mid-May then decline just as rapidly afterwards. This species becomes quite rare after May 25, with only 5 individuals detected in June (across the 5 years of monitoring). Spring migration is concentrated into less than 3 weeks in May. Fall migration is also concentrated during 2 weeks in early September, although numbers detected are 10 times less than in spring. As no Palm Warblers breed on the Bruce Peninsula, the first birds detected in late August are thus true migrants (the earliest on August 24). After the migration peak, some birds are still detected up to mid-October (October 12 is the latest record). Interestingly, more birds were detected in fall 2006 than in all the other falls combined.

Age and sex determination for this species is nearly impossible in spring, and only age can be determined in fall, when very few birds are banded. Therefore, no phenology based on age and sex can be done for Palm Warbler. This species moves rapidly through the Cabot Head area, as only 3 birds in total have ever been recaptured, all of them in spring 2002 when a record 216 individuals were banded.

### **Black-and-White Warbler**

The Black-and-White Warbler is a quite distinctive warbler, in both plumage and behaviour. Wearing its namesake plumage, it forages for insects while creeping along the trunks and branches of trees. Common in summer throughout the eastern United States and Canada, it has an unusually extensive winter range that extends from Florida to Venezuela and Colombia (Kricher, 1995).

At Cabot Head, the first Black-and-White Warblers are seen in late April (first record on April 25), but as with most warblers, numbers increase steadily in early May to peak in mid-May. Numbers decline sharply just after the peak, but then stabilise at the same level up to the end of the spring monitoring. A first, but quite small, wave of mostly male Black-and-White Warblers can be detected in early May, with no difference between SY and ASY birds. There is no difference in timing of migration by sex and age during the peak, but more SY females are migrating towards the end of the spring

migration than other age and sex classes (Fig.34). When including birds of undetermined age, the sex ratio is also balanced. It seems then that this species does not have a pronounced difference in spring migration between age and sex, compared to other warblers. It is also interesting to note that about the same numbers of SY birds as ASY birds are captured.

In fall, Black-and-White Warbler is already abundant when monitoring starts in mid-August. In fact, numbers detected are at the highest during the first week of monitoring. Starting at the end of August, numbers decline steadily up to mid-September. Afterwards, Black-and-White Warblers are quite rare even though the last record is on September 30. Not enough birds are banded to determine different patterns of migration based on age or sex. It is likely that the earliest part of fall migration is missed at Cabot Head. Therefore, it is difficult to draw conclusions, on, for example, the low proportion of hatch-year (65% on average) in banded birds.

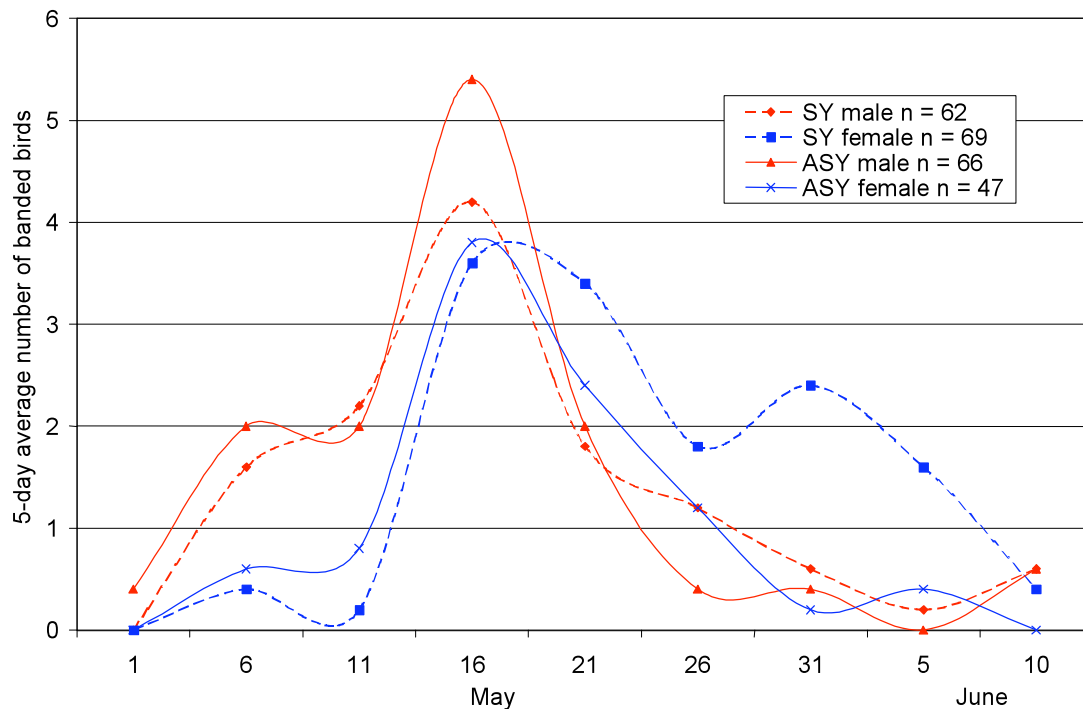


Fig.34. Spring phenology in relation to age and sex for Black-and-White Warbler at Cabot Head Research Station (average 2002-2006).

Between 2 and 9% of birds banded in spring are recaptured during the same season. Their average minimum length of stay is  $6.3 \pm 5.7$  days. In fact, in most springs, the majority of birds stayed between 2 and 5 days, indicating a relatively fast movement through the area. However, one or two individuals have a longer apparent stay (from 10 to 23 days), which could indicate that they are local breeders. In fall as in spring, most recaptured birds (i.e. 70%) have a relatively short average minimum length of stay (between 2 and 6 days). However, some birds (regardless of age or sex) stay a very long time, from 13 to 41 days! The longest apparent presence comes from an AHY female first banded on August 13 (in 2002) and last recaptured on September 22! During this period, her weight increased by 12%. However, the vast majority of recaptured birds - either in spring or fall - present only small variations in weight, even for birds with long periods of stay.

### **American Redstart**

The American Redstart is a common bird across North America, breeding in various habitats. A long-distance migrant, it winters in Mexico, Central America, and Caribbean. Some Redstarts also winter in southern Florida, Texas, and California (Sherry and Holmes, 1997). This species is especially common at Cabot Head.

At Cabot Head, it is a relatively late migrant in spring. The first American Redstarts are detected only in mid-May (first one on May 13). Numbers increase steadily during the second half of the month to peak at the end of May. American Redstart numbers decrease somewhat during June but stay relatively high, as an abundant local population of breeders exists at Cabot Head. In fall, that abundant local population of adult breeders along with the young produced during the summer obscures the migration pattern. Hence, average numbers of American Redstart are high and stay high from the start of migration monitoring in mid-August to mid-September, where they decline quite sharply. In the overall view, no clear pattern emerges. Using yearly banding temporal data and within-season recaptures (see below and Fig.35), it appears that local birds are caught mainly in August and that the early September peak could be due to populations from northern areas.

In spring, there is a marked differential phenology by sex and age for American Redstart. Despite yearly variations in spring migration, ASY males migrate about a week earlier than SY males and females (of both age classes), which is consistent with patterns observed in New England and south Canada (Sherry and Holmes, 1997). The last individuals to move through are mostly SY females (Fig.36).

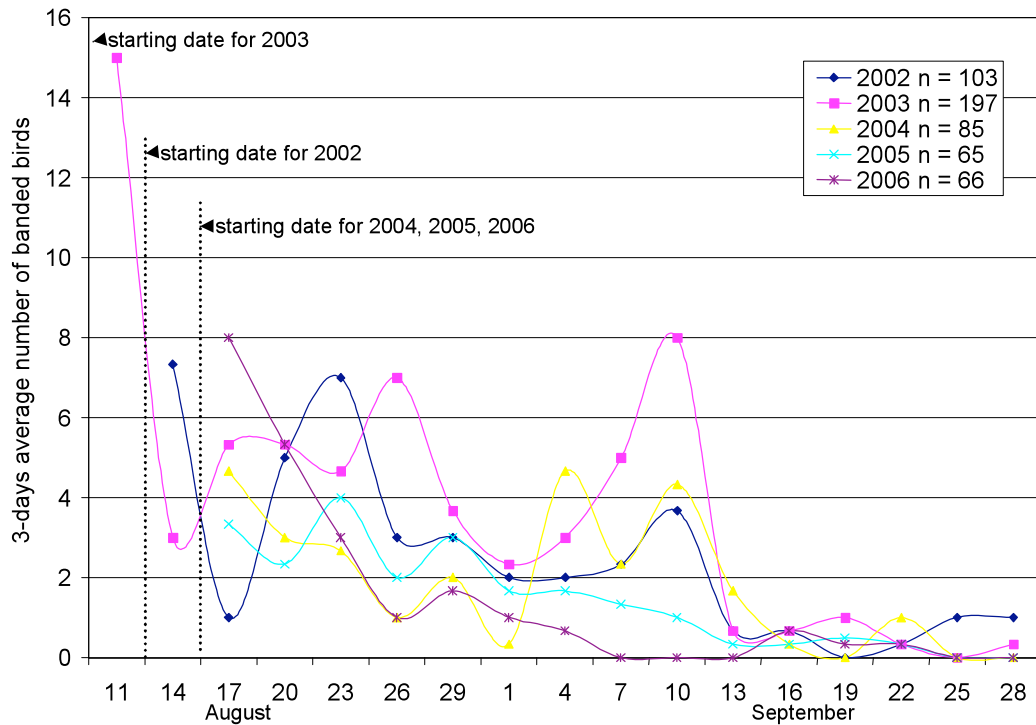


Fig.35. Fall banding of American Redstart by year at Cabot Head Research Station (2002-2006).

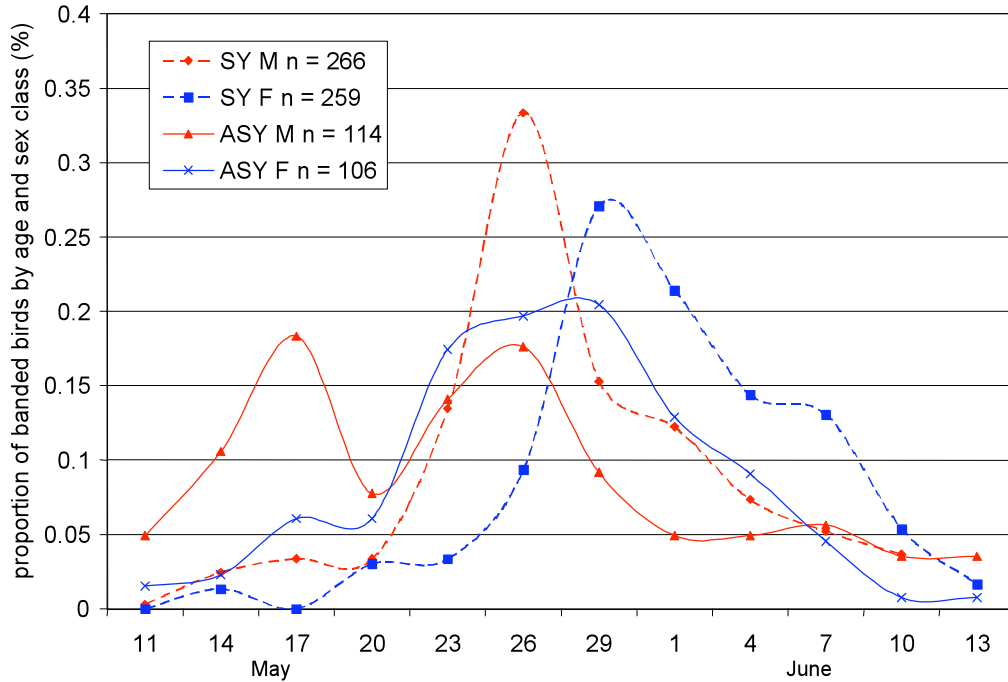


Fig.36. Spring phenology in relation to sex and age of American Redstart (in proportion of total banded numbers)

Between 4% and 6% of newly banded American Redstarts are recaptured in spring (49 birds in total), and 8% to 16% in fall (59 birds in total). In spring, the average minimum length of stay is  $8.4 \pm 6.7$  days (range 2 – 25) for the 49 newly banded and recaptured birds. Yearly average minimum length of stay varies between 7 to 10.8 days, but sample sizes are small and range of variation high. Proportion of second-year (SY) to after-second-year (ASY) for newly banded birds recaptured in spring is similar than for birds never recaptured. After-second-year birds, and especially males, tend to have longer length of stay than second-year birds (Fig.37a). After-Second-Year birds with length of stay of only one day are previously banded birds recaptured only once during spring. A total of 45 previously banded birds have also been recaptured in spring (between-season recaptures). Contrary to newly banded birds, a high percentage of them (62%) are captured more than once during one season. It is likely that those birds are returning local birds, staying longer in the area and increasing their probability of capture. Excluding previously banded birds recaptured only once gives an average minimum length of stay of  $13.7 \pm 6.4$  days (range 2- 27). The longest minimum detected presence is 27 days in 2004 for an ASY male banded in 2001.

Only 2 individuals (banded in 2001) have been recaptured every spring. Their minimum length of stay varies from 1 to 24 days for the female and from 9 to 24 days for the male. Other birds recaptured in more than one spring could have very different lengths of stay between years. Of the 84 American Redstarts recaptured in spring, 21 have been recaptured more than one spring (birds recaptured in spring 2006 are excluded, as they can not have been recaptured another spring yet).

In fall, 59 newly banded birds have been recaptured at least once during the same season. Contrary to spring, very few previously banded birds are recaptured in fall: only 5 compared to 45 in spring. Within-season recaptured birds are more likely to be after-hatch-year birds. Only 47% of recaptured birds are hatch-year, while on average, 76% of all the American Redstarts captured in fall are hatch-year. Again, it is likely that local breeders account for most of the birds recaptured several times during a season. It is possible that territorial adults have a probability of capture higher than HY birds, maybe due to territorial conflicts. Male Redstarts are commonly observed chasing each other from late spring to late summer. Though it is not recorded at the Research Station, we often find 2 American Redstarts side by side in a net, one of them often an ASY male, likely a participant in a chase. As in spring, adult birds tend to have a longer minimum

length of stay than young birds, although slightly less pronounced than in spring (Fig.37b). For most years, fall banding presents two distinct periods: August with steady captures declining towards the end of the month and a peak in early September more or less pronounced depending on years. We can hypothesize that birds captured in August are mostly local birds (breeders and HY) whereas birds captured in September are birds from elsewhere (from different populations). If birds captured in September are mostly non-local individuals, then they should be less likely than local birds to be recaptured (as they would stay for a shorter time than local birds). Indeed, almost all birds recaptured in fall were first captured in August.

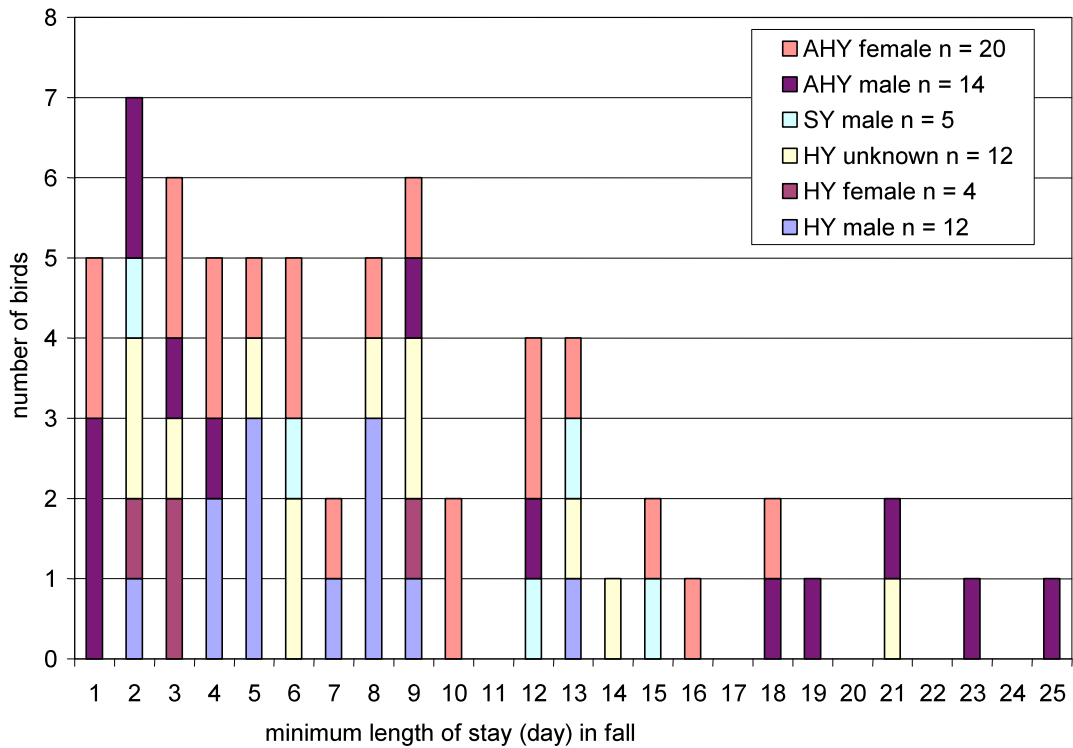
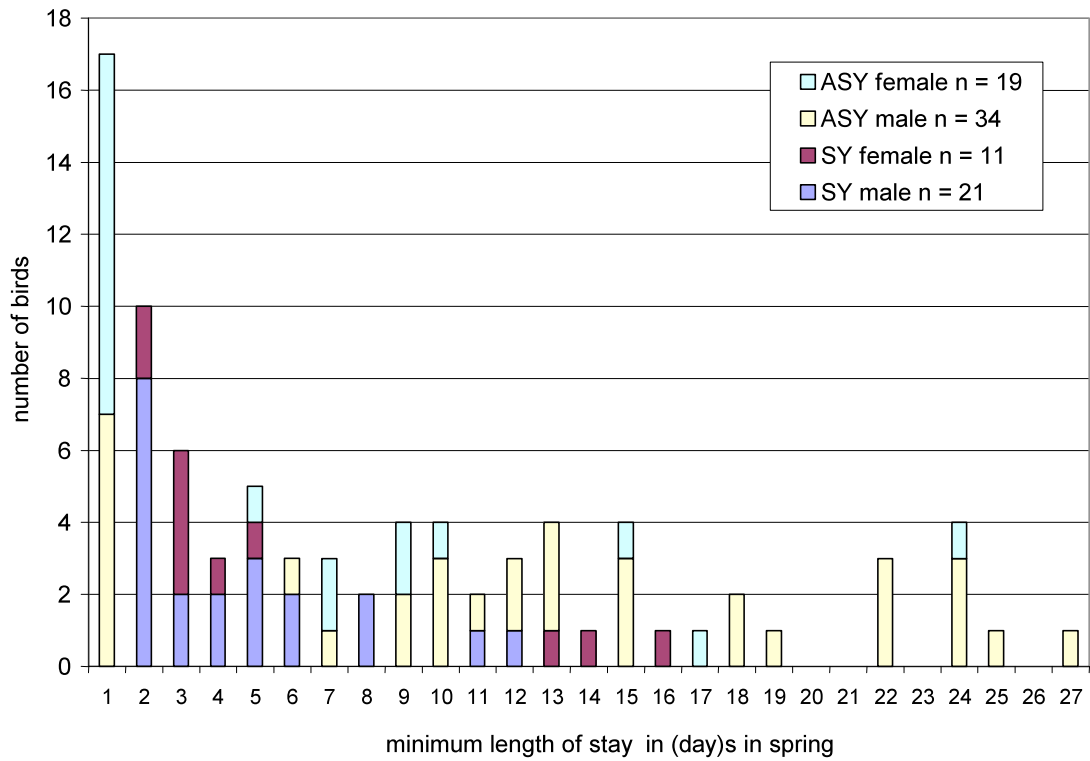


Fig.37a&b. Minimum length of stay in spring (top) and fall (bottom) for recaptured American Redstart at Cabot Head Research Station (2002-2006).

### **Ovenbird**

Like the Black-throated Green Warbler, the Ovenbird is a long-distance migrant that breeds in a wide swath in eastern and central North America and winters in Central America and the West Indies. It is a very common summer bird of deciduous, mixed, and southern boreal forests, conspicuous while singing its telltale song. A ground-nesting bird, it is considered a sensitive species because of its preference for large unfragmented mature forests (Gibbs and Faborg, 1990, Van Horn and Donovan, 1994).

In spring, Ovenbirds arrive first in early May (May 6 was the earliest date), increase in numbers slowly in the first half of May to peak during the last part of this month. A mix of migrant and resident birds probably make up the individuals detected in June (territorial singing Ovenbirds are a common occurrence at this time). Fall migration of Ovenbird is poorly monitored at Cabot Head, as most birds detected are through banding. It nonetheless appears that Ovenbirds migrate during a quite extended window, from the start of monitoring in August up to the third week of September. The latest Ovenbird was detected on October 2. No migration phenology based on sex or age could be determined, as Ovenbird is a species without sexual difference in plumage and not enough birds with a known age are monitored in spring. However, a large proportion (30%) of birds captured in spring have a developed cloacal protuberance, indicating male. Unfortunately, CP/BP was checked only in 2005 and 2006 for this species. In fall, 89% of the birds captured were hatch year.

Only one previously banded Ovenbird was ever recaptured at Cabot Head. An individual banded in May 2004 was recaptured the following spring, also in May. At the time of its recapture, it had a well-developed CP (score of 3), indicating a probable local breeder. Within-season recaptures are relatively rare in spring and slightly more common in fall. In spring, only 7 birds have been recaptured in the same season (5 of them in 2002). All of them have been recaptured the day after their banding, and 3 of these individuals were recaptured the following day as well. The resultant average minimum length of stay is  $2.3 \pm 0.5$  days. It is interesting to note that most recaptures occurred in 2002, when weather conditions were often poor, with lots of storms and rain. A bird banded in Belize in December 2001 as an AHY was recaptured in mid-August 2003 as an AHY in active moult. This is just anecdotal evidence but indicates a strong connection between breeding and wintering grounds of migrant birds! Eleven birds banded in fall (13% of banding total) were recaptured within the same season, in the same age ratio as

that of all birds banded for this species. The average minimum length of stay of  $5.1 \pm 2.1$  days is more than twice as long as in spring, certainly reflecting the less urgent drive to migrate that is prevalent in fall compared to spring. This longer stay at Cabot Head was not used to put on weight as the great majority of recaptured birds in fall had very minor weight variation (between  $-0.005$  to  $0.06\%$ ). Only 2 birds increased significantly their weight, by  $15.8\%$  and  $15.1\%$ , in 4 and 10 days, respectively (with no change in their fat level, still at 0).

Ovenbirds are captured in small numbers at Cabot Head. Like almost all the other warblers (Tennessee and Black-throated Green Warblers being notable exceptions), more ovenbirds are banded in spring than in fall (Fig.38).

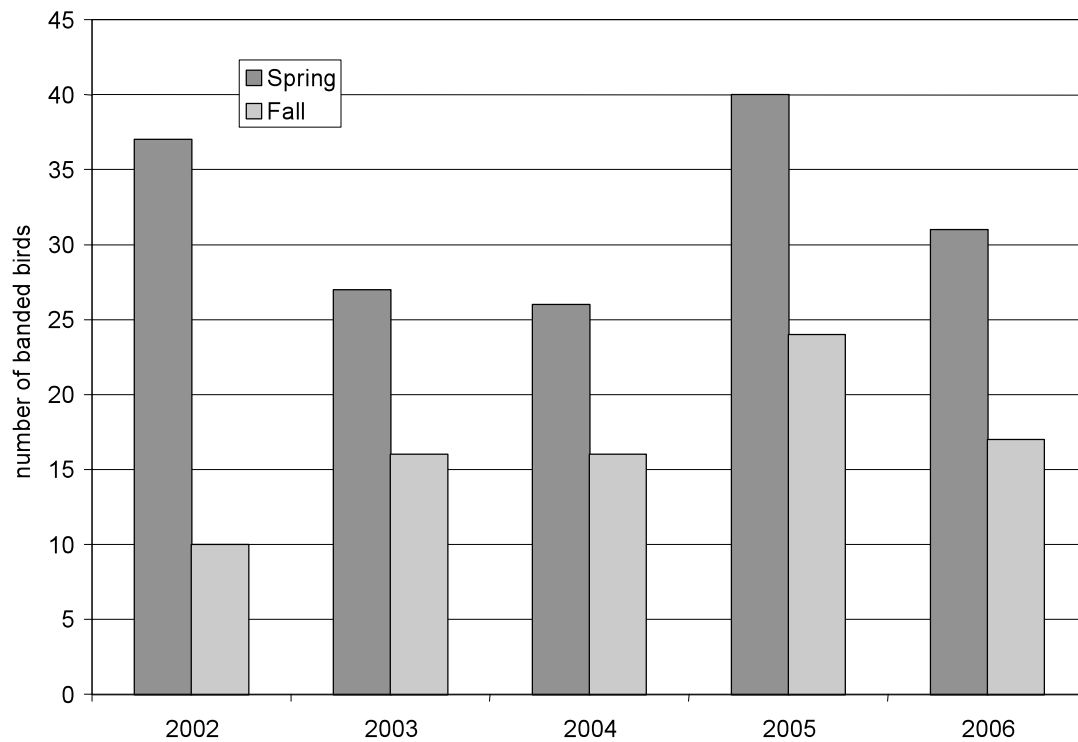


Fig.38. Number of banded Ovenbirds by year and season at Cabot Head Research Station (2002-2006).

### **Common Yellowthroat**

A skulking warbler of wet thickets and shrubby habitats, the Common Yellowthroat is a short-distance migrant that breeds across a vast area of North America (from the Yukon to Newfoundland all the way down to Mexico) and winters accordingly from the southern states of the USA to Central America and the Greater Antilles (Guzy and Ritchison, 1999). Common Yellowthroat is a common breeder around Cabot Head.

At Cabot Head, the first Common Yellowthroats are detected in early May (May 6 being the earliest), but numbers remain low up to mid-May. Then, Common Yellowthroats are more and more frequent, with the migration peak being at the end of May and into early June. Numbers detected steadily decline afterwards. As in many species, males tend to arrive earlier than females in spring: AHY males peak 10 days before females and SY males about 5 days earlier than the females (Fig.39). Age determination in spring contains a large degree of uncertainty, resulting in a higher proportion of AHY compared to ASY. Therefore, AHY birds are a mix of unknown proportion of ASY and SY birds. However, AHY males still arrive earlier than SY males. In contrast, there is no measurable difference in the timing of migration for females by age. Fewer Common Yellowthroats are detected and banded in fall than in spring. Birds are common at the start of fall migration monitoring, reflecting a local breeding population (detected as well by territorial singers in late spring). Although numbers increase slightly in early September, there is no obvious peak in fall. After mid-September, most Common Yellowthroats have moved through; numbers detected decline steadily and the species is almost completely gone by the end of the month. The latest Common Yellowthroat was detected on October 13. Like many other banded species, most birds (89%) captured in fall are hatch year.

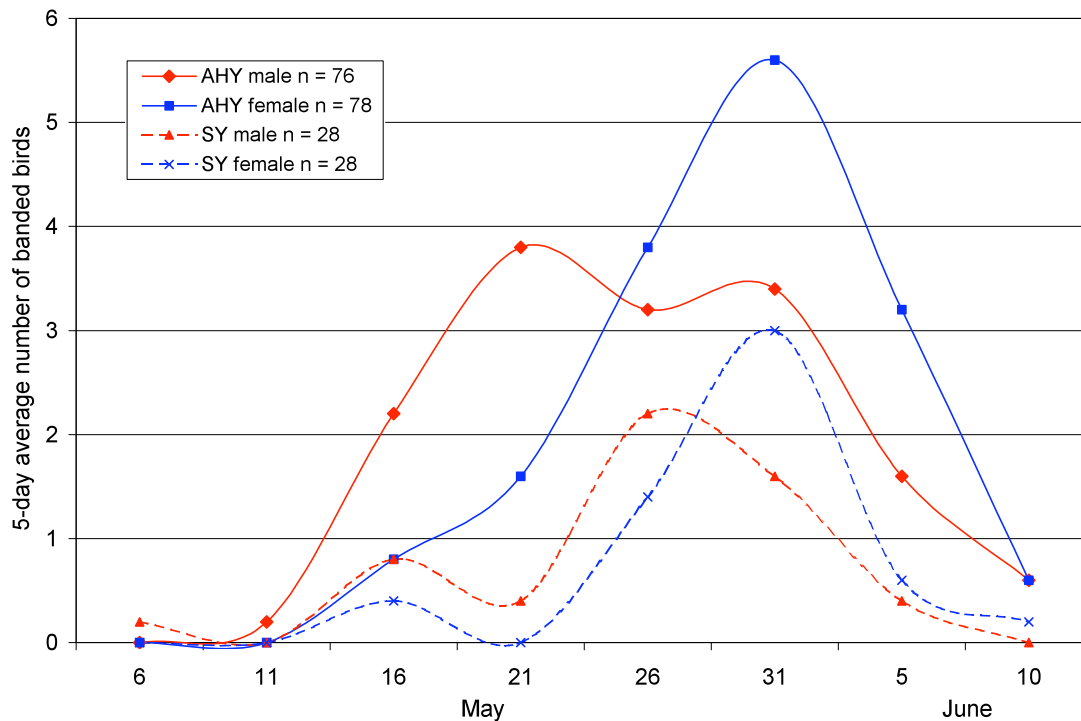


Fig.39. Spring phenology in relation to age and sex for Common Yellowthroat at Cabot Head Research Station (average 2002-2006).

Relatively few Common Yellowthroats banded in spring are recaptured during the same season (from 0 to 18%) and their average minimum length of stay is quite short ( $3.8 \pm 2.1$  days). No significant changes in weight occur for the recaptured individuals. Only one bird banded another year was recaptured in spring; a Common Yellowthroat banded as an AHY male in August 2000 was recaptured in spring 2003. He had a well-developed cloacal protuberance in spring 2003, indicating a breeder, probably local. Although sample size is relatively small, much more within-season birds are recaptured in fall in proportion (from 18% to 35%). However, no birds banded a previous year or season have ever been recaptured in fall. The average minimum length of stay is 3 times longer for birds recaptured in fall than in spring. However, there is a large variation between individuals (average of  $9.4 \pm 6.6$  days, range: 2 - 34). As in spring, there is no significant gain or loss of weight during their stay, with one notable exception. One HY male increased his weight by 40% in 4 days!

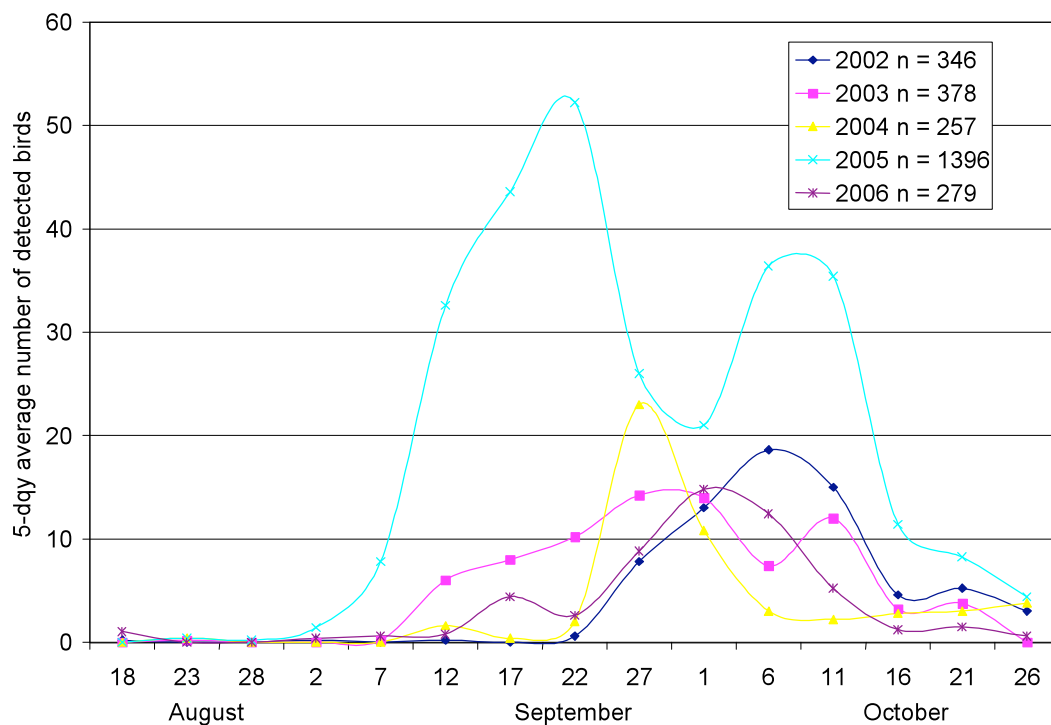
### White-throated Sparrow

A very common bird of boreal and mixed forests, the White-throated Sparrow is a short-distance migrant, breeding across Canada and wintering all across the midwestern and eastern United States, as well as in the American Southwest and the Pacific Coast. It is an extremely abundant bird of the boreal forests, maybe one of the most common songbirds of this biome (Falls and Kopachena, 1994). Consequently, despite numerous studies on this species, migration routes and behaviour are not well-documented (Falls and Kopachena, 1994). Therefore, even if numbers of White-throated Sparrows detected or banded at Cabot Head are very small in relation to the global population, monitoring can provide significant insights into this species' migratory habits.

In spring, White-throated Sparrows are already present at Cabot Head when migration monitoring starts in mid-April. However, numbers detected are relatively low until early May. Then, numbers increase sharply with the migration peak being very narrow and concentrated in early May. White-throated Sparrows become rare after mid-May, even though they are still detected up to the last day of monitoring in June. Sex and age are almost unidentifiable in spring for this species. It is thus impossible to determine patterns among different age or sex classes. A small proportion of banded birds are recaptured in spring (from 2% to 8%), confirming a quick movement through Cabot Head area. No White-throated Sparrows have been recaptured between seasons. However, a bird banded in Ohio near Sandusky close to the southwest shore of Lake Erie on May 8, 2006 was recaptured two weeks later at Cabot Head (on May 22).

Very few White-throated Sparrows are present in August at Cabot Head, suggesting that it is a rare breeder in the immediate area (even though it is a common breeder on the upper Bruce Peninsula). Numbers increase quite rapidly in early September and stay quite high up to mid-October. This sparrow then becomes less common but is still present to the end of the fall migration monitoring. However, most of the September records (especially before September 20) are due to the 2005 fall migration, as the White-throated Sparrows were especially abundant that fall (Fig.40). During fall 2005, 4 to 6 times more sparrows were detected than in the other seasons. Likewise, the recapture rate (26%) in fall 2005 was higher than other falls (7% to 17%, but 29% in fall 2002). As noted before, the abundance of chokecherry could have attracted more White-throated Sparrows and for a longer period of time at Cabot Head in fall 2005. In fall 2005, the average minimum length of stay was  $8.4 \pm 6.9$  days (range 2 –

29 days). There is a positive and significant correlation between minimum length of stay and weight increase during this time (Fig.41). Birds staying more than 10 days increased their weight by at least 10%, and up to 40%. In fall 2002, a high proportion of birds were recaptured (29%), although the sample size of banded birds is much lower than in 2005. The 14 birds recaptured stayed on average slightly less than in 2005 (minimum length of  $7.6 \pm 5.5$  days, range 2 – 23), and their weight change was also less pronounced. For the 8 individuals with data, the increase was generally less than 20%, except for the White-throated Sparrow that stayed the longest: in 23 days, its weight increased by 25% from



23.1g to 28.8g.

Fig.40. Yearly variation of detected numbers of White-throated Sparrow in fall at Cabot Head Research Station (2002-2006).

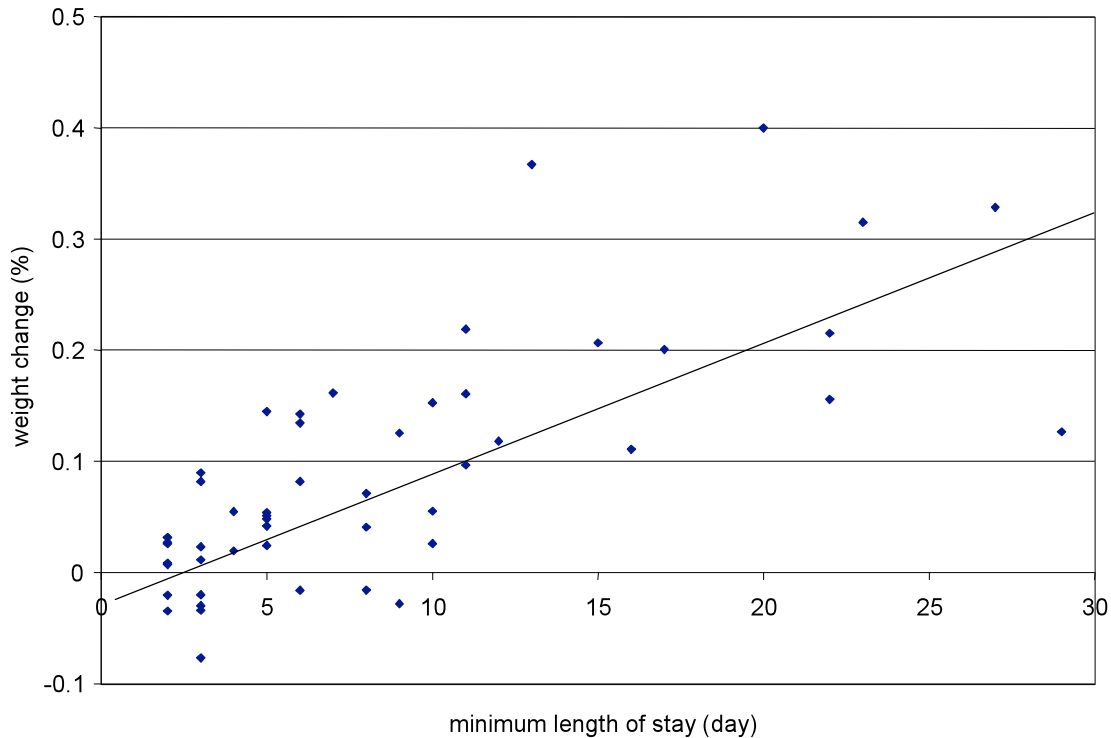


Fig.41. Weight change (in proportion) in relation to minimum length of stay in fall 2005 for recaptured White-throated Sparrow at Cabot Head Research Station (regression:  $R^2 = 0.39$ ,  $P < 0.001$ ).

### Slate-coloured Junco

The Dark-eyed Junco has an extensive range across North America, with well-defined sub-species. The “Slate-coloured Junco” is the most widespread and common form of the species, and the subspecies that migrates through Cabot Head. This subspecies is a short-distance migrant, breeding from Alaska to Newfoundland in boreal and northern mixed forests and wintering all across the USA and in northern Mexico (Nolan et al., 2002). This species breeds locally on the upper Bruce Peninsula, mainly in conifer habitats, often associated with exposed rocky areas and cliffs (Cheskey, pers. comm.).

Slate-coloured Juncos are already present in good numbers when spring migration monitoring starts at Cabot Head. Large fluctuations in numbers and phenology exist between years (Fig.42a). For example, most birds were probably missed in the early spring of 2005. In some springs, migration peaks in the second half of April, whereas in others, it is in early May. In all years (except 2002), Juncos are rarely detected at Cabot Head after mid-May. With too many birds of unknown age and sex, it is not possible to determine a migration phenology based on these criteria. Recaptures occurred only in 3

springs and only in high proportion in 2002 and 2004. However, small sample sizes preclude any strong inferences.

Although a few individuals are present in mid-August when the fall migration monitoring starts, possibly reflecting local breeders, this species is rarely encountered before the end of September, with a rapid increase of its numbers afterwards. Juncos are relatively common throughout October, but abundance and temporal patterns are quite variable between years (Fig.42b). Accordingly, the end of the Junco migration is more or less covered in the monitoring window. As it is the case with most species, hatch-year birds dominate in captured individuals (84%). Like in spring, it is not possible to determine a phenology in relation with sex. Between 2% to 9% of banded birds are recaptured during the same fall. No birds previously banded have ever been recaptured at Cabot Head, both in spring and fall.

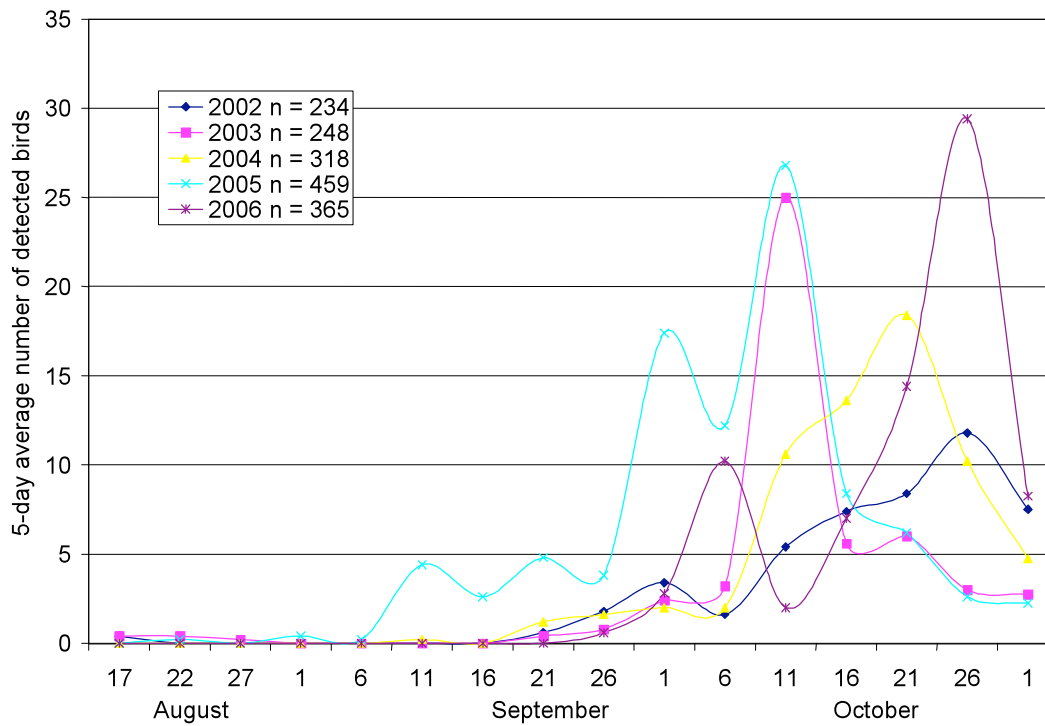
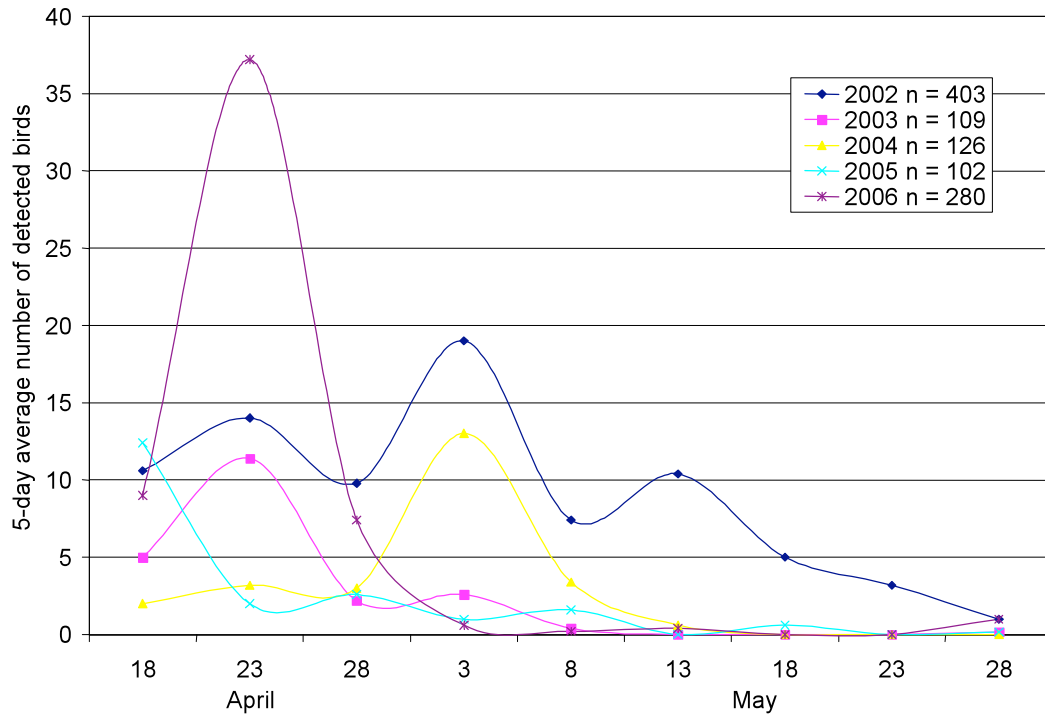


Fig.42a&b Yearly variation of detected numbers of Slate-coloured Juncos in spring (top) and in fall (bottom) at Cabot Head Research Station (2002-2006).

## **Red-necked Grebe**

The red-necked Grebe breeds from north-central Ontario westwards to the Yukon and winters on both coasts of North America. It migrates through the Great Lakes area both in spring and fall; some individuals even winter on the lower Great Lakes (Stout and Neuchterlein, 1999).

The Red-necked Grebe has been surveyed at Cabot Head since 1999. Important congregations of this species, especially in Dyer's Bay, led to designation of the area as an Important Bird Area (Cheskey and Wilson, 2001). The Red-necked Grebe survey takes place from April 1<sup>st</sup> to mid-May on the Cabot Head lighthouse road, from Dyer's Bay dock to the lighthouse. Volunteer observers take approximately 12 minutes at each of five observing points (totalling one hour of standardised observing), spaced two to three kilometres from each other, north from Dyer's Bay dock to Cabot Head lighthouse. The vast majority of the shoreline to 1.5 km offshore, from Dyers Bay to the Cabot Head light station can be observed, depending on weather and lake conditions. All waterfowl observed at each station are recorded on standardised data sheets. Ideally, surveys are done biweekly. However, coverage was variable between years, as it is highly dependent on weather conditions. Daily surveys of Red-necked Grebes have been done as well on Lake Superior shores, at Whitefish Point and Thunder Cape Bird Observatories since 1999 (available data only to 2004).

Total numbers of Red-necked Grebes are highly variable between years at every station (Fig.43). It is likely that Grebes are feeding on alewives and that fluctuations in abundance of Grebes at discrete locations may reflect fluctuating populations of prey there. Highly variable ice-out times between years on the lake at Cabot Head seem also to greatly influence the presence of grebes early in the season. It is possible that grebes do exploratory flights until the ice conditions permit longer-range migration. Consequently, at Cabot Head, an early, albeit small, movement of Red-necked Grebes is detected in early April in some years. Regardless of years, Red-necked Grebe migration peaks between April 22 and 28 at Cabot Head (except in 2004 when total detected numbers were very low). After the peak, numbers decline quickly and Red-necked Grebes are rare after May 10 at Cabot Head (Fig.44). Timing at Whitefish Point (230km northwest of Cabot Head) seems to be more variable between years (Fig.45a). The peak of migration could be from late April to early May. In 2002, when the highest numbers of Red-necked

Grebes was counted at Whitefish Point, the migration at Cabot Head was concentrated in just a few days: 20% of the detected total was counted between April 27 and 30 and another 50% was counted in just one day, May 5. However, in other years like 2000, the bulk of Red-necked Grebes had already moved through before April 20. At Thunder Cape, on the western side of Lake Superior (680 km northwest of Cabot Head), movements of Red-necked Grebes were concentrated in the same few days in early May regardless of the years (Fig.45b). At this site, most Grebes migrate from April 26 to May 10, thus later than the other more eastern sites, reflecting the westward movement of migrating grebes.

Daily counts at Whitefish Point and Thunder Cape are highly variable, sometimes up to a 100-fold factor. At the extreme, on May 4, 2002, at Whitefish Point, only 23 Grebes were counted whereas a high of 1412 was detected the following day. Then, a mere 25 birds were detected after this peak, on May 6. Conditions of observation are not known for this particular occasion, but waterfowl movements are known to occur suddenly and sometimes in impressive numbers. Thus, a biweekly census at Cabot Head is likely to miss some important movements of Red-necked Grebes. Another crucial point is in understanding their stopover behaviour, as the same individuals could be counted multiple times if they stay in the area more than a day. Their stopover behaviour might be linked to concentrations of fish stocks, such as smelt or alewives, which could explain the changes in grebe numbers over time. Local fishermen believe that smelt numbers can be very high off Dyer's Bay in the spring and could thus attract large flocks of Red-necked Grebes. If smelt, or other important fish, populations decline, the area may become less attractive to grebes, unless replaced by a similar species.

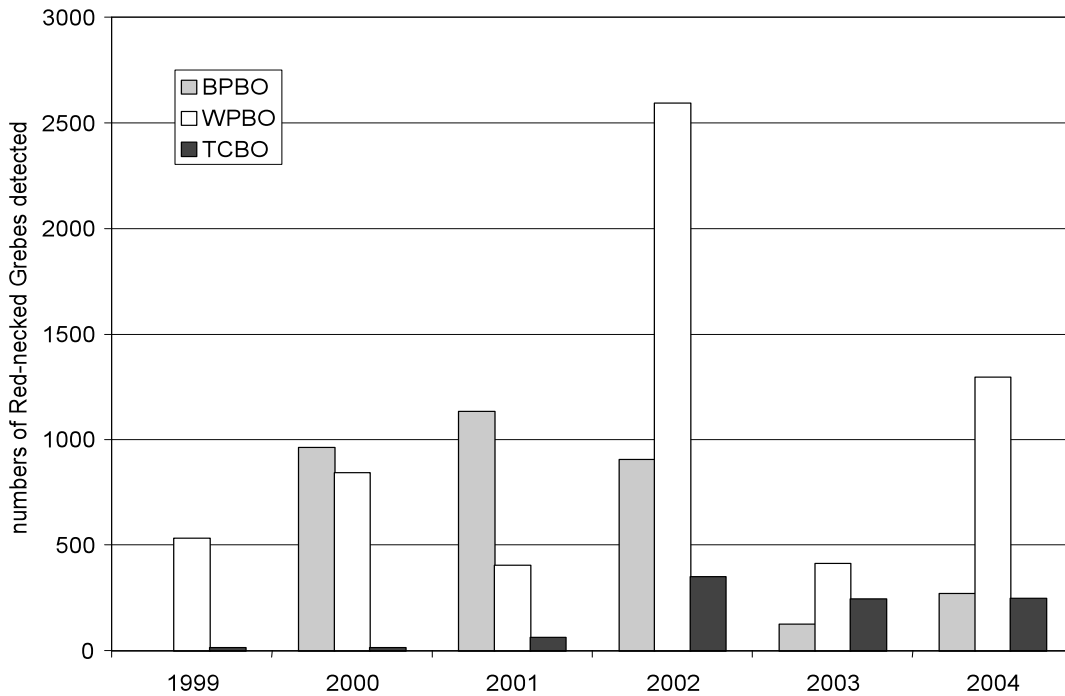


Fig.43. Yearly numbers of detected Red-necked Grebes by Bruce Peninsula (BPBO), Whitefish Point (WPBO) and Thunder Cape (TCBO) Bird Observatories.

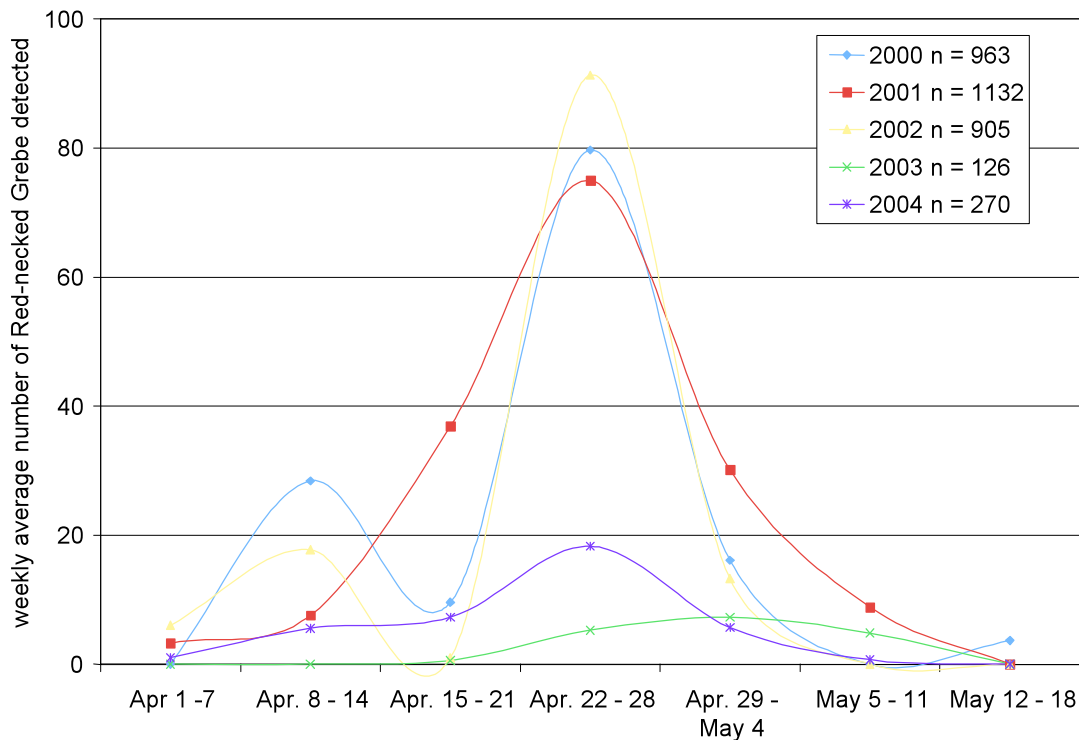


Fig.44 Weekly average numbers of Red-necked Grebes by year at Cabot Head (2000-2004).

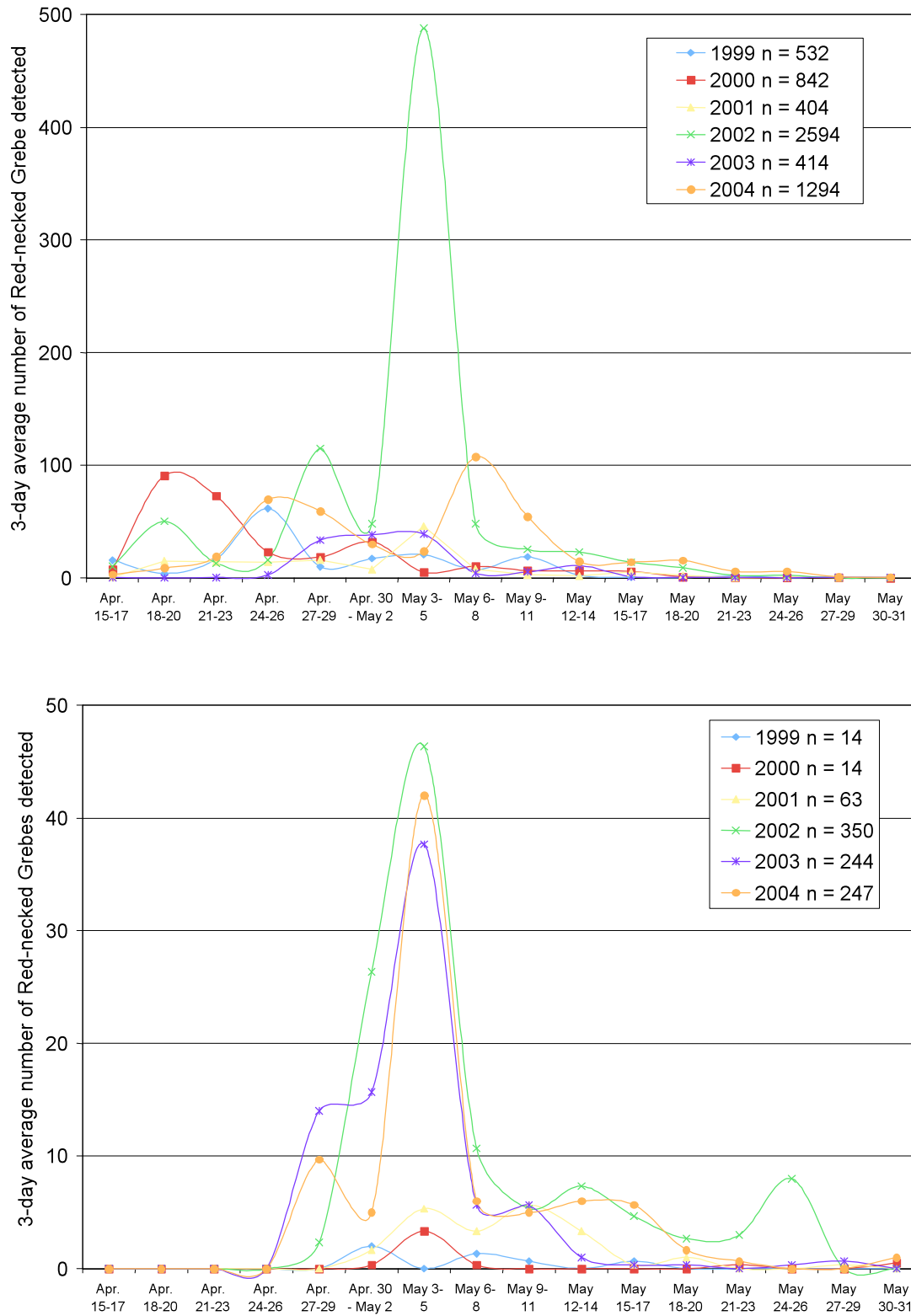


Fig. 45a&b 3-day average numbers of Red-necked Grebes by year at Whitefish Point (top) and at Thunder Cape (bottom) (1999-2004).

## Owl Banding

The Northern Saw-whet Owl breeds from the Appalachian Mountains to the Maritimes, across southern Canada in a relatively narrow band and in mountainous areas from British Columbia to Mexico, avoiding deserts and high plains. Most populations are sedentary, except for owls breeding from Alberta to Québec, which migrate extensively (Cannings, 1993). The Boreal Owl lives year-round in its namesake habitat, the boreal forest, with populations extending southwards along the Rocky Mountains (the southernmost populations being in New Mexico). It is usually non-migratory but presents irruptive movements in response to population cycles of its prey, mainly small rodents (Hayward, and Hayward. 1993).

During the pilot years, owl banding was done extensively by Heagy and collaborators, both at the Lighthouse and at the Cabot Head Research Station. Net set-up was different than the one used afterwards, precluding direct comparisons. However, the high number of owls captured by Heagy *et al.* (Table 13a) indicated the good potential of owl monitoring at Cabot Head. Thus, owl banding was started again in fall 2004 and has occurred every fall since. As the project is still in its exploratory phase, periods of banding and nets used were slightly different between years, (Table 13b). Owl banding is considered non-standard banding.

For the period 2004-2006, a sound system broadcasting non-stop Saw-whet Owl calls was placed in the middle of a perimeter delimited by 3 hawk nets (nets with a bigger mesh size than mist nets). Some songbird mist nets were also opened (A3, A4 and B6 in fall 2004, A4 and B6 in fall 2005 and B7 and B8 in fall 2006). Nets were opened approximately half an hour after dusk and run for 6 to 8 hours (or less if no owls were caught after 4 hours). Every fall, captures occurred only on a few nights. No owls were captured when wind strength was above 3 on the Beaufort scale. Noise produced by strong winds (notably waves on the rocky shore) may have drowned out the lure effect, thus reducing the capture probabilities.

A total of 41 Northern Saw-whet Owls and 2 Boreal Owls were captured and banded between 2004 and 2006 (Table 13b). The 2 Boreal Owls, a hatch-year male and female, were captured during the same night, October 28, in 2004. A little more than half of the Saw-whet Owls were hatch-year birds and 27% were second-year birds (Table 14). Northern Saw-whet Owls banded were disproportionately female, between 75 and 86% of them, depending on the year. For the pilot years, females accounted for 88% of the

owls captured in spring (too many owls were of undetermined sex in fall to obtain a valid sex ratio). Age proportion in fall for the pilot years was very similar to the latter period, with 55% Saw-whet Owls being hatch-year birds and 29% second-year birds.

Only one recapture occurred in the 3 seasons of owl banding (between 2004 and 2006). On October 12, 2004, the first owl caught was already banded! It was determined as an after-third-year female, by plumage, wing length, and weight. This owl was banded 4 years ago, on October 10, 2000, at a banding station in Wisconsin.

Table 13a&b. Northern Saw-whet Owl (NSWO) and Boreal Owl (BOOW) banding summary in spring and fall of 1998, 2000 and 2001 (top) and fall of 2004-2006 (bottom).

a.

Year	Period of banding	Nights with capture (first and last)	Captures
1998	Fall	19 (Sept. 23 - Oct. 31)	107 NSWO
2000	Spring	11 (Ap.11 – May 30)	49 NSWO
	Fall	23 (Sept. 26 – Oct. 25)	68 NSWO 2 BOOW
2001	Spring	1 (April 29)	1 NSWO
	Fall	10 (Oct. 7 – Oct. 24)	24 NSWO

b.

Year	Period of banding	Mist net hours	Nights with banding	Nights with capture (first and last)	Captures
2004	Oct.10 - Nov.6	423	15	6 (Oct.10 - Oct.29)	19 NSWO 2 BOOW
2005	Sept. 18 – Oct. 28	270.5	13	4 (Oct. 10 – Oct. 28)	7 NSWO
2006	Oct. 1 - 31	382	14	6 (Oct. 5 – Oct. 26)	14 NSWO

Table 14. Sex and age of the banded Northern Saw-whet Owls, Cabot Head Research Station, falls 2004-2006.

	Sex	Hatch Year	Second Year	After second year	Third year	After third year	After hatch year	Total
2004	Unknown	3						3
	Male	3	1					4
	Female	3	4	3	1	1		12
2005	Male					1		1
	Female	3	1	1	1			6
2006	Unknown	1	1					2
	Male	2						2
	Female	6	4				1	11
Total		21	11	4	2	2	1	41

### Evaluation of Monitoring Methods used at Cabot Head

Regardless of the method used, the migration count can never be a complete tally of every bird present at or passing over a site. Instead, observers record a sample of the population. The more standardised the method, the more consistent and useful the counts are. Therefore, standardisation helps ensure that proportion of the population counted remains similar from day to day and year to year and that data are comparable.

Census and incidental observations are relatively unselective as to species and can be made in almost all weather conditions (keeping in mind that secretive species are more difficult to detect). However, these observations are dependent on observer ability to detect and identify birds. Accordingly, census is usually done by highly experienced observers who are capable of identifying over 90% of the species encountered by sight and sound. In contrast, banding is objective (all birds caught are identified and counted) but is relatively selective with regard to species. Species that move through the canopy or fly over the area are not caught in nets but could be observed on visual counts or in the census. Secretive species are more difficult to sample, though casual observations contribute to records. Census and casual observations, however, are vulnerable to double-counting. Furthermore, when an important volume of birds is captured, requiring most of the effort, there is a potential to miss large numbers of individuals. With these limitations in mind, special care is taken in determining estimated totals for each species each day. Banding is the only method that provides detailed demographic information on age and

sex classes, condition of brood patch, cloacal protuberance, subcutaneous fat, and moult. All these data can be used to formulate hypotheses about population changes and to separate residents from migrants to some extent. However, it is essential to ensure that captures occur within the same general phenology of migration to be able to extrapolate banding data to the general population.

While some nets are relatively sheltered, Cabot Head is still an exposed coastal location, which makes it difficult to maintain a standardised netting procedure, due to frequent adverse weather. As a consequence, about a third of mist net hours are lost every season. Banding captures should not be the only independent count method, but rather as a component of a daily estimated total and also to determine age and sex composition of the population. Census, in addition to being dependent on observer skills, is also restricted in time and therefore has the potential to miss a large portion of the visible migration. At Cabot Head, it is not infrequent to have massive movements after mid-morning, when a census is already completed. Thus, casual observations are important to record these events. However, when they are combined with large volume of birds captured, banding becomes a priority and less time can be devoted to casual observations, resulting in incomplete monitoring. Having consistently adequate staffing of the Research Station is therefore a priority. This means for the key times - all of the spring period and September and October - there should be two experienced volunteers to assist the station scientist.

A combination of monitoring methods is probably the best way to give the most accurate estimates of migrant birds. Some species are well monitored by the 3 methods and their estimates are likely to be the most robust, as advantages and disadvantages of each method are factored out. Important factors that could influence the presence and length of stay of migrants are food availability and habitat change over time. At present, no methods have been established to measure these factors, although an initial baseline assessment of vegetation and habitats was made (Woodhouse, 2002) that will serve as a standard for habitat change in the future. As mentioned earlier, obvious food sources like chokecherry fruit have a profound effect on use of Cabot Head by certain species. It is likely that other sources of food, more difficult to evaluate (i.e. insects, fish), could also vary and accordingly affect migrants feeding on them. It would be of value to evaluate the effect on migration of both habitat change and food availability.

## **Importance of the Bruce Peninsula as a Migration Corridor**

Based on number of species and abundance of individuals detected at Cabot Head, the Bruce Peninsula is a major migration corridor. The 100-km long peninsula jutting into Lake Huron and Georgian Bay certainly acts as a funnel in spring, concentrating migrants as they move northward over land. In fall, the Bruce Peninsula is a beacon for birds after their crossing of Georgian Bay. The diversity and relatively well-preserved habitats of the peninsula are crucial for migrant birds during stopover, where they can rest and feed. Migration is a highly variable phenomena at different time and spatial scales and results at Cabot Head reflect the influence of various factors (local and regional weather, population changes, food availability, etc.). On a yearly average, about 140 species are detected at Cabot Head Research Station. Some are extremely numerous, like Blue Jay and Canada Goose, whereas others are relatively rare (Peregrine Falcon, Wood Thrush). Migration of priority species as defined by CMMN and of focal species of the BPBN Ecological Integrity Monitoring Program are relatively well covered, except for a few species. Migration monitoring at Cabot Head Research Station provides excellent opportunities to document many demographic parameters of species otherwise difficult to study (like boreal species) and to complement other surveys done during the breeding and wintering periods.

## **Conclusion**

The first 5 years of monitoring at Cabot Head Research Station following the same protocol have already yielded a vast array of information and an increasingly precise picture of bird migration has appeared. Migration patterns of many species are now better defined for the Bruce Peninsula. Furthermore, BPBO data improves our understanding on how weather influences local migration. The number of years of monitoring is still limited to detect population trends, but establishing a long-term database is an essential step towards a better understanding and monitoring of migrant birds. A defining characteristic of migration is the skewed distribution: many species with few individuals, and a handful of species that are extremely abundant. Furthermore, abundance varies greatly between seasons and years, and even within seasons. In a relatively well-defined window of time for migration, a species can be suddenly extremely abundant one day due to particular weather conditions. Stochastic events thus

greatly influence outcome of banding. Dynamic changes, both temporal and spatial, are the main constant in nature, which is why the Canadian Migration Monitoring Network, a pan-Canadian network of long-term monitoring stations, is key to success in unravelling the extraordinarily complex and fascinating phenomena that is bird migration.

Many questions still remain to be investigated. At a coastal site like Cabot Head, it would be important to better understand the water-crossing behaviour for some migrant species (like Blue Jays and Icterids, for example). The new observation tower at the Bruce Peninsula National Park Visitor Centre would be a perfect location to conduct observations of migrants at the tip of the Peninsula. Combined with the possible banding station at Cape Hurd (on the northwest tip of the peninsula), these observations will also help to determine the effects of local weather on migration patterns and use of the peninsula. For a few important species (for example, American Redstart and Black-throated Green Warbler), there are a certain proportion of local breeders within detected numbers at Cabot Head, which complicates analysis of migration pattern. It would be necessary to determine the proportion of resident breeders by, for example, standard mist-netting (from mid-June to mid-August) following a MAPS protocol (DeSante, 1992).

Other projects could be implemented at Cabot Head Research Station to improve our understanding of migration. For example, as most songbirds migrate at night, night call monitoring with automated technology (Millikin, 2005) might reveal more on a usually hidden aspect of migration. Another important contribution would be to determine breeding and wintering ranges of migrants moving through Cabot Head more precisely. Recent techniques like double-isotope analyses allow the determination of migratory connectivity and seasonal interactions by a completely different approach than Capture-Mark-Recapture methods (Hobson, 2005). Collaborative work in between Bruce Peninsula Bird Observatory and Nicaraguan ornithologists could also provide precious knowledge in this important aspect of migration.

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