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A Study of the Timing and Intensity of Landbird Fall Migration at BLM Campbell Tract from 1997 to 2013

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Cover photo
A ruby-crowned kinglet after being banded during the fall migration study.

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A Study of the Timing and Intensity of Landbird Fall Migration at BLM Campbell Tract from 1997 to 2013

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Orange-crowned warbler

May 2025

Swainson’s thrush

Acknowledgments

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Field crew members of the Campbell Tract banding station, from left to right: Betty Freist, Bernice Hagino, Sarah Steel, Christin Isaacson, Keiko Kashaba, and Bruce Seppi.

Donna Dewhurst, field crew member of the Campbell Tract banding station.

Chris Maack, field crew member of the Campbell Tract banding station.

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Abstract

The timing and intensity of landbird fall migration was studied at Campbell Tract in Anchorage, Alaska, from 1997–2013 using mist netting and banding of birds. A total of 12,082 individual birds from 36 species were captured and banded during 14,215 net hours of mist netting. The 10 most abundant species captured were slate-colored junco, ruby-crowned kinglet, myrtle warbler, Wilson's warbler, hermit thrush, orange-crowned warbler, yellow warbler, black-capped chickadee, golden-crowned kinglet, and fox sparrow. The average capture rate (number of birds captured per 100 net hours) for all 36 species was 82. The average capture rate for after hatch year (AHY), or adult, birds was 7. The average capture rate for hatch year (HY) birds was 79. The proportion of HY birds captured averaged 86% and ranged from 71% to 94%. Weak positive relationships were found between capture rates of AHY and HY birds and summer temperature and precipitation. A weak negative relationship was also found between AHY capture rates and average summer temperatures. The timing and intensity of the fall migration varied among years with peaks in capture rates for all species changing from late August to mid-September. A-type and B-type Neotropical migrant birds comprised between 73% and 97% of individual birds captured at the Campbell Tract banding station in fall for years 1997–2013, averaging 88% across all years. A total of 185 individual birds of 10 species returned to the station from 1 to 4 years after banding and included both resident and migrant species. Eight birds of four species banded at Campbell Tract were recovered at other locations and included yellow warbler, slate-colored junco, hermit thrush, and black-capped chickadee.

Boreal chickadee

1. Introduction

The Bureau of Land Management (BLM) Anchorage Field Office studied and monitored the fall migration of landbirds at Campbell Tract in Anchorage, Alaska, from 1997 to 2013 using systematic methods for mist netting and banding of birds. The first year of fall banding was spent training new bird banders for work on BLM-managed lands in western Alaska, with help from the Alaska Bird Observatory in Fairbanks (Pogson et al. 1996). The banding effort continued in subsequent years to monitor the fall migration of landbirds at Campbell Tract and gain information about landbird migration in fall in south-central Alaska.

The objectives of the study were to: (1) describe and monitor the timing and intensity of the fall migration of landbirds in the Anchorage area; (2) determine landbird population and productivity trends in relation to fall migration; (3) describe the species composition of landbirds at Campbell Tract during fall migration; (4) describe age and sex ratios of migrant landbirds in fall at Campbell Tract; (5) attempt to determine factors affecting capture rates of landbirds in fall; and (6) promote bird conservation by providing bird banding demonstrations and educational presentations on the conservation of birds to school groups and members of the public. This report presents the findings of 17 years of fall migration banding at Campbell Tract.

American robin

2. Study Area

2.1 History

Campbell Tract is a 730-acre parcel of land managed by the BLM Anchorage Field Office and located within the city of Anchorage, Alaska (latitude 61.152906 N, longitude -149.783306 W) (Figure 1). Through a military withdrawal of federal lands, the Campbell Airstrip and quarters were originally constructed in 1942 by the U.S. Army as a World War II military installation for fighter aircraft and troops stationed there during the war. In 1965, Campbell Tract was developed as a fire control center for statewide firefighting operations, and the Anchorage Field Office facilities were established. Over time, firefighting operations were moved to Fairbanks, and the facilities and lands became the BLM Anchorage Field Office administrative site. The administrative site is set aside for the BLM to maintain federal interagency office facilities, maintenance shops, a warehouse, a 5,000-foot gravel airstrip and four helipads, communication and weather station sites, and the South Zone Aviation Dispatch Center.

The Campbell Creek Science Center was constructed on Campbell Tract in 1996. The center is a BLM environmental education facility that provides educational programs and curriculum to approximately 40,000 local and virtual school children and adults annually.

Campbell Tract is surrounded by approximately 4,260 acres of the Municipality of Anchorage's Far North Bicentennial Park on the northeast, east, and south sides; by Heritage Land Bank lands to the northwest; and by residential neighborhoods to the west (Figure 1). The Chugach Range and Chugach State Park lay 2 miles east of the area.

Campbell Tract is also designated as a special recreation management area, providing year-round outdoor recreation opportunities in a natural setting for more than 500,000 visitors

Figure 1. Banding station location within the Municipality of Anchorage.

annually. The special recreation management area currently hosts a 25-mile nonmotorized trail system that supports recreation activities including walking, running, mountain and fat tire biking, orienteering, horseback riding, Nordic skiing, sled dog mushing, skijoring, nature study, and wildlife viewing.

2.2 Vegetation

The vegetation of Campbell Tract and the surrounding area is naturally a boreal forest, consisting of a mix of paper birch, white spruce, and balsam popular in drier areas and black spruce in wetter areas. The understory of mature forested areas consists of forbs, lichens, moss, and fungi. Riparian areas near Campbell Creek support large black cottonwood and a mixed spruce and birch forest with an understory of alder and willow shrubs. Guyer (2000) provides a detailed description of the vegetation of Campbell Tract.

Disturbed and compacted areas along roads and trails are often dominated by alder and willow shrubs. The vegetation cover is a result of human activities, including military use in the 1940s and 1950s that disturbed existing native plant communities. Disturbed areas are gradually regrowing into early successional stages of cottonwood, alder, and willow shrubs, and in less compacted areas into white spruce. Browsing pressure from moose keep some areas with palatable forage from moving past early successional stages. A large portion of the mature white spruce in the area have been killed by spruce bark beetle, with many dead standing spruce trees. Regrowth of white spruce and birch is occurring is some areas. However, white spruce stands will likely become dominated by birch and other hardwoods over time.

2.3 Wildlife

Campbell Tract provides habitat for many species of wildlife and serves as a buffer and migration corridor between urban areas and the Chugach Mountains, potentially reducing wildlife conflicts with people. Moose are common and use Campbell Tract for calving in the spring and for winter habitat. The South Fork of Campbell Creek supports small runs of coho, chinook, and sockeye salmon and Dolly Varden and grayling. Wolves occasionally pass through the area and move along the Chugach Range during seasonal changes and in search of prey. Black bears spend summers throughout the area, and brown bears concentrate along Campbell Creek in summer when salmon are present (Farley et al. 2008). Snowshoe hares are abundant and support a lynx population. Coyotes are seen and heard in the area. Other wildlife species present include pine marten, beaver, red fox, porcupine, red squirrel, flying squirrel, wood frog, and several species of microtine rodents.

2.4 Banding Station Location

The banding station was located at the north end of Campbell Airstrip, using existing trails for access (Figure 2). Habitats within reach of the banding station included mixed coniferous and deciduous forest dominated by white spruce, cottonwood, and paper birch. Disturbed areas along trails were dominated by willow and alder shrubs, regrowth of white spruce, and heavily moose-browsed cottonwood and birch regrowth in early successional stages. Mist net lanes were cleared to allow nets to be set to capture birds using the surrounding habitats without disturbing the birds' movements and use of the habitats.

Figure 2. Campbell Tract fall migration banding station net locations.

Sharp-shinned hawk

3. Methods

3.1 Mist Nets

Birds were captured with an array of mist nets following guidelines suggested by Ralph et al. (1993). The crew used black mist nets 2.6 m high by 12 m long with 30 mm mesh in all years of the study (Association of Field Ornithologists model HTX). Nets were supported by two 10-feet-high metal conduit poles tied with guy lines through an eye bolt at the top of the pole to surrounding vegetation or ground stakes.

At each net, brush and ground vegetation were cleared along the length of the net in a narrow lane to prevent entanglement with the nets, yet allow the capture of birds moving through the habitats and allow ease of extraction of captured birds. Nets were placed in both forested and shrub habitats in areas that offered a transition between taller mixed forest vegetation and shrub habitats to capture birds moving between the two habitat types. The orientation of the net lanes and distance between nets followed the natural growth of vegetation types and ranged between 10 m to 2,000 m distance from the portable weatherport banding station. Captured birds were removed from the nets and placed in cotton fabric bags and carried to the banding station where they were processed, banded, and released (Figure 2).

3.2 Mist Netting

The intent of the study was to maintain a constant and consistent mist netting effort each year during fall migration. In fall 1997, the banding effort served as a training session provided by the Alaska Bird Observatory on mist netting and banding birds for BLM staff. Therefore, nets were operated in 1997 for only 11 days over a 16-day period using up to 20 nets in various locations to find net positions with the highest capture rates (Table 1). From 1998 to 2013, 10 nets were used at the same locations each year (Figure 2). Ten nets were consistently operated for the duration of the study due to the availability of field crew. Careful attention was given to the welfare of captured birds, including quick removal of birds from the nets to minimize the handling and holding time of the birds before banding. Mist netting and banding occurred each year from approximately August 15 to September 15 with some variation among years (Table 1). Banding occurred only during weekdays from 6 a.m. to 12 p.m., with later net openings as the season progressed as sunrise became later in the morning. Banding was cancelled for the day if it was raining and water droplets accumulated on nets or if morning temperatures were below freezing and nets were frozen. Nets were closed early if it started to rain after the nets were open and water droplets accumulated on the nets.

Except for 1997 as a training year, the goal of the banding station was: (1) to operate 10 nets in the same position each day and across years and (2) to have nets open for approximately 6 hours per day (weather permitting) during most of the days between approximately August 15 and September 15.

3.3 Banding

All birds captured were banded with standard U.S. Fish and Wildlife Service aluminum bands issued by the Bird Banding Laboratory in Patuxent, Maryland, using banding techniques from Ralph et al. (1993). Data recorded for each newly captured bird included band number, species, age, sex, wing chord and tail length (mm), weight (to the nearest 0.1 gram), date, time of capture, net site number, determination of body fat levels, reproductive condition (cloacal protuberance or brood patch), degree of skull pneumatization for age determination, and sharpness of the breastbone as an indication of muscle mass. Determinations of the shape and wear of primary, secondary, and tail feathers

Table 1. Mist netting and banding effort during fall migration of landbirds at Campbell Tract from 1997–2013. Capture rate equals number of birds captured per 100 net hours.

Year	# of Nets	Range of Dates	Days of Banding	Net Hours	# Captured	Capture Rate
1997	20*	Aug 13–Aug 28	11	1,089	367	33.7
1998	10	July 23–Sept 15	26	921	963	104.5
1999	10	Aug 16–Sept 16	24	1,055	862	81.7
2000	10	Aug 15–Sept 15	23	1,050	1,252	119.2
2001	10	Aug 15–Sept 14	22	950	1,225	128.9
2002	10	Aug 15–Sept 18	23	907	842	92.8
2003	10	Aug 14–Sept 13	21	830	1,083	130.5
2004	10	Aug 11–Sept 14	23	895	1,123	125.5
2005	10	Aug 9–Sept 16	20	830	755	91.0
2006	10	Aug 17–Sept 18	19	842	590	70.0
2007	10	Aug 16–Sept 14	20	775	459	59.2
2008	10	Aug 19–Sept 19	17	670	423	63.1
2009	10	Aug 18–Sept 17	22	717	245	34.2
2010	10	Aug 16–Sept 15	20	799	386	48.3
2011	10	Aug 17–Sept 16	22	928	763	82.2
2012	10	Aug 15–Sept 14	17	608	531	87.3
2013	10	Aug 13–Sept 20	12	349	213	61.0

were recorded and used to aid age determination and species identification for some species. Feather measuring procedures used for species identification and age determinations followed Pyle (1997). During times when large numbers of birds were present and capture rates were high, only the band number, species identification, age, and sex were recorded to minimize the time captured birds remained in the nets and holding times before banding.

Additional data used for species identification and age and sex determination were regularly recorded for most species and used based on data and information in Pyle (1997). The criteria used to make determinations of body fat, molt, reproductive condition, and feather wear were adapted from Ralph et al. (1993). The crew also used age and sex determination criteria from volume II of the "North American Bird Banding Manual" (USFWS and CWS 1977).

3.4 Daily Banding Effort

Data were collected daily on the banding effort and the number of birds captured and number of net sites open, net opening and closing times, and total daily net hours. For each species, the number of after hatch year (AHY) and hatch year (HY) birds was recorded, as well as birds of unknown age and recaptured birds. An AHY bird is defined as a bird banded in any year after it was hatched. For passerines, an AHY bird is considered an adult. An HY bird is a bird banded in the year it was hatched. When it was not possible to age a captured bird, it was banded and recorded as age unknown. Capture rates (number of birds captured per 100 net hours) were calculated to standardize net capture numbers (Ralph et al. 1993). A net hour is defined as the operation of a 12 m long by 2 m high net for 1 hour.

3.5 Data Analysis

The data analysis is based on total capture rates of all species and not individual species. Although some species were more abundant than others and the data include both resident and migrant species, it was assumed the larger sample size was more informative of the species present at Campbell Tract during fall migration and would better explain the interannual variation of the number of birds migrating in fall.

A total of 36 species of birds were captured and banded at Campbell Tract during the study (Table 2). The 10 most abundant species captured across all years were slate-colored junco, ruby-crowned kinglet, myrtle warbler, Wilson's warbler, hermit thrush, orange-crowned warbler, yellow warbler, black-capped chickadee, golden-crowned kinglet, and fox sparrow (Table 2). These 10 species accounted for 89% of total birds captured during all years of the study.

3.6 Factors Affecting Fall Capture Rates

The capture rates of birds varied widely across years (Table 1). Pogson et al. (1996) and DeSante and Geupel (1987) have suggested possible relationships between annual weather variables and mist netting capture rates of landbirds during fall migration. These relationships focus on summer precipitation and temperatures that may affect bird productivity that relates to fall migration intensity. In addition, the possible relationships between weather factors and fall bird migration capture rates in the Anchorage area at Campbell Tract were analyzed. The following relationships were examined and evaluated:

1. The relationship between fall capture rates of HY and AHY birds in the same year.
2. The relationship between fall capture rates of HY and AHY birds and weather during the summer breeding season, including average temperature and total rainfall in June and July of the same year.
3. The relationship between fall capture rates of HY and AHY birds and fall weather, including average temperature and total precipitation during fall migration in August and September.

Table 8 shows weather record data for Anchorage from the National Weather Service Anchorage Weather Forecast Office for the months of June, July, August, and September for the years 1997–2013. Data from June and July were considered to represent the summer breeding season, and data from August and September were considered to represent the fall migration season.

Average temperature and total rainfall for each year were compared to mist net capture rates. Total precipitation was determined by summing the precipitation recorded for each month in each year. The average temperature for Anchorage in each season was determined by averaging the average temperature for each month. Departures from normal average temperatures were calculated by averaging departures from normal temperature in each month across years. Departures from normal precipitation in each season were calculated by summing the departures from normal precipitation for each month in each season.

Scatter plots, simple linear regressions, and correlations between variables were used to compare weather variables with variations in capture rates among years (Neter et al. 1985). To evaluate results of the regressions and correlations, the coefficients of determination, or r-squared, were compared, where the highest r-squared values represented the strongest relationships between variables. Data were analyzed, plotted, and graphed using XLSTAT (2020).

Table 2. Summary of bird species captured at Campbell Tract during fall migration 1997–2013.

Species	AHY	HY	Unknown	Captures	Recaptures	Captures and Recaptures
Sharp-shinned hawk	1	4	0	5	1	6
Downy woodpecker	4	9	1	14	2	16
Northern flicker	2	4	1	7	1	8
Alder flycatcher	13	79	1	93	2	95
Steller's jay	1	0	0	1	0	1
Black-capped chickadee*	**58**	**579**	**39**	**676**	**487**	**1,163**
Boreal chickadee	11	131	5	147	78	225
Brown creeper	0	14	0	14	0	14
Red-breasted nuthatch	4	10	0	14	1	15
Arctic warbler	0	2	0	2	0	2
Golden-crowned kinglet	**14**	**187**	**0**	**201**	**13**	**214**
Ruby-crowned kinglet	**88**	**1,375**	**8**	**1,471**	**48**	**1,519**
Gray-cheeked thrush	1	6	0	7	0	7
Swainson's thrush	16	116	3	135	2	137
Hermit thrush	**66**	**849**	**3**	**918**	**133**	**1,051**
American robin	9	13	0	22	2	24
Varied thrush	4	22	0	26	1	27
Orange-crowned warbler	**73**	**727**	**6**	**806**	**18**	**824**
Yellow warbler	**76**	**614**	**2**	**692**	**8**	**700**
Myrtle warbler	**103**	**916**	**3**	**1,022**	**17**	**1,039**
Townsend's warbler	3	45	1	49	0	49
Blackpoll warbler	6	85	1	92	1	93
Northern waterthrush	6	52	0	58	6	64
Wilson's warbler	**53**	**917**	**6**	**976**	**27**	**1,003**
American tree sparrow	0	7	1	8	0	8
Chipping sparrow	0	1	0	1	0	1
Savannah sparrow	0	5	0	5	0	5
Fox sparrow	**14**	**179**	**1**	**194**	**3**	**197**
Lincoln's sparrow	12	105	4	121	1	122
Golden-crowned sparrow	9	144	0	153	5	158
Gambel's white-crowned sparrow	7	102	0	109	5	114
Slate-colored junco	**230**	**3,596**	**22**	**3,848**	**345**	**4,193**
Rusty blackbird	1	4	0	5	0	5
White-winged crossbill	1	0	0	1	0	1
Pine siskin	1	11	0	12	0	12
Common redpoll	62	115	0	177	7	184
Total	**949**	**11,025**	**108**	**12,082**	**1,214**	**13,296**

***Bolded species are the 10 most abundant species captured across all years (does not include recaptures).**

4. Results

4.1 Banding Effort and Capture Rates

Table 1 shows ranges of banding dates, net hours, and capture rates. Ten nets were used in all years except for 1997, when up to 20 nets at a time were used to train staff. The number of days banding ranged from 11 in 1997 to 26 in 1998. Yearly net hours ranged from 349 in 2013 to 1,089 in 1997, a difference of 3.12 times. The number of birds captured and banded each year ranged from 213 in 2013 to 1,252 in 2000, a difference of 5.88 times. Capture rates (number of birds captured per 100 net hours) ranged from 33.7 in 1997 to 130.5 in 2003, a difference of 3.87 times.

4.2 Bird Species Captured

A total of 36 species were captured during the study (Table 2). The 10 most abundant species captured across all years (not including recaptures) were slate-colored junco, ruby-crowned kinglet, myrtle warbler, Wilson's warbler, hermit thrush, orange-crowned warbler, yellow warbler, black-capped chickadee, golden-crowned kinglet, and fox sparrow (Table 2), which accounted for 89% of the total number of birds captured.

A total of 1,214 birds were recaptured during netting operations and included both same day and interannual recaptures (Table 2). The most abundant recaptured species included black-capped chickadee, slate-colored junco, hermit thrush, boreal chickadee, ruby-crowned kinglet, Wilson's warbler, orange-crowned warbler, and myrtle warbler. These eight species accounted for 95% of all recaptured birds. Newly banded birds and recaptures accounted for 91% and 9% of the total captures respectively.

4.3 Number of Species Captured

A total of 12,082 individual birds of 36 species were captured and banded at the station from 1997–2013 (Table 3). The total number of species captured each year ranged from 17 in 2013 to 27 in 2000 and averaged 24 species annually. The rarest species captured over the study included Steller's jay (1), arctic warbler (2), chipping sparrow (1), and white-winged crossbill (1).

4.4 Capture Rates across Years

The average capture rate for all 36 species of birds captured from 1997 to 2013 was 82 birds captured per 100 net hours (Table 4). Capture rates ranged from 34 birds captured per 100 net hours in 1997 and 2009 to 130 birds captured per 100 net hours in 2003. The total capture rate for all species was 3.8 times higher in 2003 than in 1997 and 2009. Species with the highest average capture rates across all years were slate-colored junco (26.37) and ruby-crowned kinglet (10.47). The range of years between 2000 and 2004 had the highest capture rates of the project (Table 4).

Table 3. Comparison of the number of birds captured at Campbell Tract during fall 1997–2013.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Sharp-shinned hawk	-	-	-	1	-	-	-	-	-	1	1	2	-	-	-	-	-	5
Downy woodpecker	2	-	-	-	2	2	2	-	2	-	-	2	-	-	1	1	-	14
Northern flicker	-	1	-	-	2	-	-	-	-	1	1	2	-	-	-	-	-	7
Alder flycatcher	5	5	1	10	10	11	12	10	8	5	6	2	-	2	3	3	-	93
Steller's jay	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Black-capped chickadee	36	33	52	56	65	63	40	50	52	38	42	35	15	32	40	23	4	676
Boreal chickadee	-	10	13	5	13	14	6	13	13	10	6	13	2	9	12	6	2	147
Brown creeper	-	2	-	-	-	2	1	-	-	1	-	3	2	-	3	-	-	14
Red-breasted nuthatch	-	1	-	1	2	-	1	6	2	-	-	1	-	-	-	-	-	14
Arctic warbler	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2
Golden-crowned kinglet	13	28	13	5	15	4	13	8	18	17	1	5	10	37	13	1	-	201
Ruby-crowned kinglet	36	97	72	123	164	82	89	112	117	132	67	96	40	50	58	112	24	1,471
Gray-cheeked thrush	2	-	1	-	-	-	-	-	1	-	-	-	-	-	-	3	-	7
Swainson's thrush	8	5	2	7	7	5	8	12	12	10	3	14	4	11	15	7	5	135

Table 3 continued.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Hermit thrush	20	45	62	61	131	67	70	78	65	35	36	29	34	37	53	50	45	918
American robin	-	2	-	1	1	2	1	2	-	2	2	1	1	1	4	1	1	22
Varied thrush	-	3	2	-	3	1	2	1	1	1	1	-	1	2	3	4	1	26
Orange-crowned warbler	14	112	86	64	85	49	83	56	31	36	20	9	13	9	63	40	36	806
Yellow warbler	11	56	46	84	73	61	90	68	54	34	24	19	6	10	24	24	8	692
Myrtle warbler	47	97	123	141	95	41	102	183	28	19	16	28	3	31	51	15	2	1,022
Townsend's warbler	-	2	5	5	5	1	15	6	2	-	2	-	-	-	2	3	1	49
Blackpoll warbler	3	3	17	15	11	3	10	10	2	2	2	5	-	1	5	2	1	92
Northern waterthrush	2	1	7	8	11	3	2	3	4	2	4	1	-	5	2	3	-	58
Wilson's warbler	28	117	73	192	107	58	61	54	29	33	23	46	28	23	63	18	23	976
American tree sparrow	-	-	-	2	-	3	-	1	2	-	-	-	-	-	-	-	-	8
Chipping sparrow	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Savannah sparrow	1	-	-	1	1	-	-	1	1	-	-	-	-	-	-	-	-	5
Fox sparrow	7	2	8	21	13	15	13	8	21	16	9	17	9	6	10	13	6	194
Lincoln's sparrow	3	13	8	4	19	10	8	14	9	7	7	4	2	2	8	1	2	121

Table 3 continued.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Golden-crowned sparrow	1	7	4	21	40	20	8	12	8	9	6	2	5	3	3	4	-	153
Gambel's white-crowned sparrow	5	13	4	12	22	2	14	14	1	9	2	2	1	2	4	1	1	109
Slate-colored junco	121	305	253	403	311	321	427	400	270	170	178	79	69	110	187	193	51	3,848
Rusty blackbird	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	5
White-winged crossbill	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Pine siskin	-	1	1	-	-	-	4	1	2	-	-	-	-	-	2	1	-	12
Common redpoll	2	2	8	7	17	2	-	-	-	-	-	1	-	2	134	2	-	177
Total	**367**	**963**	**862**	**1,252**	**1,225**	**842**	**1,083**	**1,123**	**755**	**590**	**459**	**423**	**245**	**386**	**763**	**531**	**213**	**12,082**
Net hours/ year	**1,089**	**921**	**1,055**	**1,050**	**950**	**907**	**830**	**895**	**830**	**842**	**775**	**670**	**717**	**799**	**928**	**608**	**349**	**14,215**
Number of species/ year	**21**	**26**	**24**	**27**	**26**	**25**	**26**	**25**	**26**	**23**	**23**	**26**	**18**	**22**	**25**	**25**	**17**	

Table 4. Comparison of capture rates (number of birds captured per 100 net hours) of bird species captured at Campbell Tract during fall 1997–2013.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average capture rate
Sharp-shinned hawk	-	-	-	0.10	-	-	-	-	-	0.12	0.13	0.30	-	-	-	-	-	0.16
Downy woodpecker	0.18	-	-	-	0.21	0.22	0.24	-	0.24	-	-	0.30	-	-	0.11	0.16	-	0.21
Northern flicker	-	0.11	-	-	0.21	-	-	-	-	0.12	0.13	0.30	-	-	-	-	-	0.17
Alder flycatcher	0.46	0.54	0.09	0.95	1.05	1.21	1.45	1.12	0.96	0.59	0.77	0.30	-	0.25	0.32	0.49	-	0.71
Steller's jay	-	-	-	0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	0.10
Black-capped chickadee	3.31	3.58	4.93	5.33	6.84	6.95	4.82	5.59	6.27	4.51	5.42	5.22	2.09	4.01	4.31	3.78	1.15	4.59
Boreal chickadee	-	1.09	1.23	0.48	1.37	1.54	0.72	1.45	1.57	1.19	0.77	1.94	0.28	1.13	1.29	0.99	0.57	1.10
Brown creeper	-	0.22	-	-	-	0.22	0.12	-	-	0.12	-	0.45	0.28	-	0.32	-	-	0.25
Red-breasted nuthatch	-	0.11	-	0.10	0.21	-	0.12	0.67	0.24	-	-	0.15	-	-	-	-	-	0.23
Arctic warbler	-	-	0.09	-	-	-	0.12	-	-	-	-	-	-	-	-	-	-	0.11
Golden-crowned kinglet	1.19	3.04	1.23	0.48	1.58	0.44	1.57	0.89	2.17	2.02	0.13	0.75	1.39	4.63	1.40	0.16	-	1.44
Ruby-crowned kinglet	3.31	10.53	6.82	11.71	17.26	9.04	10.72	12.51	14.10	15.68	8.65	14.33	5.58	6.26	6.25	18.42	6.88	10.47
Gray-cheeked thrush	0.18	-	0.09	-	-	-	-	-	0.12	-	-	-	-	-	-	0.49	-	0.22
Swainson's thrush	0.73	0.54	0.19	0.67	0.74	0.55	0.96	1.34	1.45	1.19	0.39	2.09	0.56	1.38	1.62	1.15	1.43	1.00

Table 4 continued.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average capture rate
Hermit thrush	1.84	4.89	5.88	5.81	13.79	7.39	8.43	8.72	7.83	4.16	4.65	4.33	4.74	4.63	5.71	8.22	12.89	6.70
American robin	-	0.22	-	0.10	0.11	0.22	0.12	0.22	-	0.24	0.26	0.15	0.14	0.13	0.43	0.16	0.29	0.20
Varied thrush	-	0.33	0.19	-	0.32	0.11	0.24	0.11	0.12	0.12	0.13	-	0.14	0.25	0.32	0.66	0.29	0.24
Orange-crowned warbler	1.29	12.16	8.15	6.10	8.95	5.40	10.00	6.26	3.73	4.28	2.58	1.34	1.81	1.13	6.79	6.58	10.32	5.70
Yellow warbler	1.01	6.08	4.36	8.00	7.68	6.73	10.84	7.60	6.51	4.04	3.10	2.84	0.84	1.25	2.59	3.95	2.29	4.69
Myrtle warbler	4.32	10.53	11.66	13.43	10.00	4.52	12.29	20.45	3.37	2.26	2.06	4.18	0.42	3.88	5.50	2.47	0.57	6.58
Townsend's warbler	-	0.22	0.47	0.48	0.53	0.11	1.81	0.67	0.24	-	0.26	-	-	-	0.22	0.49	0.29	0.48
Blackpoll warbler	0.28	0.33	1.61	1.43	1.16	0.33	1.20	1.12	0.24	0.24	0.26	0.75	-	0.13	0.54	0.33	0.29	0.64
Northern waterthrush	0.18	0.11	0.66	0.76	1.16	0.33	0.24	0.34	0.48	0.24	0.52	0.15	-	0.63	0.22	0.49	-	0.43
Wilson's warbler	2.57	12.70	6.92	18.29	11.26	6.39	7.35	6.03	3.49	3.92	2.97	6.87	3.91	2.88	6.79	2.96	6.59	6.58
American tree sparrow	-	-	-	0.19	-	0.33	-	0.11	0.24	-	-	-	-	-	-	-	-	0.22
Chipping sparrow	-	-	-	0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	0.10
Savannah sparrow	0.09	-	-	0.10	0.11	-	-	0.11	0.12	-	-	-	-	-	-	-	-	0.10
Fox sparrow	0.64	0.22	0.76	2.00	1.37	1.65	1.57	0.89	2.53	1.90	1.16	2.54	1.26	0.75	1.08	2.14	1.72	1.42
Lincoln's sparrow	0.28	1.41	0.76	0.38	2.00	1.10	0.96	1.56	1.08	0.83	0.90	0.60	0.28	0.25	0.86	0.16	0.57	0.82
Golden-crowned sparrow	0.09	0.76	0.38	2.00	4.21	2.21	0.96	1.34	0.96	1.07	0.77	0.30	0.70	0.38	0.32	0.66	-	1.07

Table 4 continued.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average capture rate
Gambel's white-crowned sparrow	0.46	1.41	0.38	1.14	2.32	0.22	1.69	1.56	0.12	1.07	0.26	0.30	0.14	0.25	0.43	0.16	0.29	0.72
Slate-colored junco	11.11	33.12	23.98	38.38	32.74	35.39	51.45	44.69	32.53	20.19	22.97	11.79	9.62	13.77	20.15	31.74	14.61	26.37
Rusty blackbird	-	-	-	-	-	-	-	-	-	-	-	0.75	-	-	-	-	-	0.75
White-winged crossbill	-	-	-	-	-	-	-	-	-	-	-	-	-	0.13	-	-	-	0.13
Pine siskin	-	0.11	0.09	-	-	-	0.48	0.11	0.24	-	-	-	-	-	0.22	0.16	-	0.20
Common redpoll	0.18	0.22	0.76	0.67	1.79	0.22	-	-	-	-	-	0.15	-	0.25	14.44	0.33	-	1.90
Total	**33.70**	**104.57**	**81.71**	**119.24**	**128.95**	**92.83**	**130.48**	**124.47**	**90.96**	**70.07**	**59.23**	**63.13**	**34.17**	**48.31**	**82.22**	**87.34**	**61.03**	**82.14**
Net Hours/ Year	**1,089**	**921**	**1,055**	**1,050**	**950**	**907**	**830**	**895**	**830**	**842**	**775**	**670**	**717**	**799**	**928**	**608**	**349**	

4.5 Capture Rates of Adult Birds

The average capture rate for adult, or AHY, birds from 1997 to 2013 was 7 birds captured per 100 net hours (Table 5). Capture rates by year ranged from 2.20 birds in 2010 to 17.05 birds in 1998. The total capture rate for all species was 7.75 times higher in 1998 than in 2010. Species with the highest average capture rates across all years for AHY birds were slate-colored junco (1.69) and myrtle warbler (0.88). The years of 1998, 1999, 2001, 2011, and 2012 had the highest capture rates for AHY birds (Table 5).

4.6 Capture Rates of Hatch Year Birds

The average capture rate for HY birds from 1997 to 2013 was 79 birds captured per 100 net hours (Table 6). Capture rates by year ranged from 28 birds in 1997 to 175 birds in 2003. The total capture rate for all species was 6.25 times higher in 2003 than in 1997. Species with the highest average capture rates across all years for HY birds were slate-colored junco (25.45) and ruby-crowned kinglet (9.76). The years of 2000, 2001, 2003, and 2004 had the highest capture rates for HY birds (Table 6).

4.7 Proportion of Hatch Year Birds Captured

The proportion of HY birds captured compared to AHY birds is shown in Table 7. The proportion of HY birds captured in the falls of 1997–2013 averaged 86% and ranged between 71% in 1999 to 94% in 2009. The species with the lowest proportions of HY birds captured were Steller's jay (0%), American robin (71%), pine siskin (38%), white-winged crossbill (0%), and common redpoll (23%).

Table 5. Comparison of capture rates (number of birds captured per 100 net hours) of AHY birds captured at Campbell Tract during fall 1997–2013.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average capture rate
Sharp-shinned hawk	-	-	-	-	-	-	-	-	-	0.12	-	-	-	-	-	-	-	0.12
Downy woodpecker	0.18	-	-	-	0.11	-	-	-	-	-	-	-	-	-	-	-	-	0.15
Northern flicker	-	-	-	-	0.11	-	-	-	-	-	0.13	-	-	-	-	-	-	0.12
Alder flycatcher	-	0.32	-	-	0.11	0.22	0.24	-	0.12	-	0.13	-	-	0.13	0.11	0.16	-	0.17
Steller's jay	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	0.10
Black-capped chickadee	0.64	1.3	1.14	0.86	0.11	0.66	0.24	0.45	0.96	1.07	0.13	0.45	-	0.13	0.32	0.66	-	0.61
Boreal chickadee	-	0.65	0.38	0.1	0.11	-	-	-	0.12	-	-	-	-	-	-	0.16	-	0.25
Brown creeper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Red-breasted nuthatch	-	-	-	-	0.11	-	0.12	0.22	0.12	-	-	-	-	-	-	-	-	0.14
Arctic warbler	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Golden-crowned kinglet	-	0.33	0.38	0.1	-	0.22	-	-	-	-	-	0.15	-	0.25	0.11	-	-	0.22
Ruby-crowned kinglet	0.18	1.74	0.95	0.38	0.84	0.33	0.36	0.11	0.76	0.36	0.26	0.3	-	-	0.75	3.12	0.57	0.73
Gray-cheeked thrush	-	-	0.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.09
Swainson's thrush	0.09	0.33	-	-	-	-	0.12	0.11	0.12	-	-	-	-	0.13	0.32	0.33	0.86	0.27

Table 5 continued.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average capture rate
Hermit thrush	0.64	0.54	0.85	0.29	0.53	0.11	-	0.22	0.36	0.12	0.39	0.6	-	0.5	0.65	0.82	2.58	0.61
American robin	-	-	-	-	0.11	-	0.12	0.22	-	-	-	-	-	0.43	-	0.16	-	0.21
Varied thrush	-	0.11	-	-	0.11	-	-	-	-	-	-	-	-	-	0.22	-	0.29	0.18
Orange-crowned warbler	0.28	1.52	0.85	-	1.05	0.22	0.12	-	0.24	0.12	0.13	0.15	0.14	-	1.72	1.64	0.57	0.63
Yellow warbler	0.46	0.76	0.19	0.86	0.84	0.66	1.33	0.22	0.72	-	-	-	0.14	-	1.07	1.32	0.29	0.68
Myrtle warbler	1.38	3.26	1.23	0.67	0.63	0.77	0.48	0.22	0.96	-	0.13	0.6	-	-	0.75	0.33	-	0.88
Townsend's warbler	-	0.11	-	-	-	0.11	-	-	-	0.12	-	-	-	-	-	-	-	0.11
Blackpoll warbler	0.09	-	0.28	-	0.21	-	-	-	-	-	-	-	-	-	-	-	-	0.19
Northern waterthrush	-	-	0.09	0.1	0.21	-	-	-	0.12	-	-	-	-	-	0.22	-	-	0.15
Wilson's warbler	0.46	0.54	0.76	0.76	0.53	0.22	-	0.11	0.24	-	-	0.15	0.14	-	1.19	0.66	0.29	0.47
American tree sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Chipping sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Savannah sparrow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Fox sparrow	-	0.11	0.09	-	0.42	-	-	-	0.36	-	-	-	0.28	-	0.22	-	0.29	0.25
Lincoln's sparrow	-	-	0.19	-	0.21	0.11	-	-	-	0.12	0.26	-	0.14	-	0.32	-	-	0.19

Table 5 continued.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average capture rate
Golden-crowned sparrow	0.09	0.11	-	0.1	0.42	0.11	-	-	-	-	0.13	-	-	-	0.11	-	-	0.15
Gambel's white-crowned sparrow	-	-	0.09	-	0.11	-	-	0.11	-	0.12	-	0.15	-	-	-	0.16	-	0.12
Slate-colored junco	0.83	5.21	1.99	2.67	2.63	1.87	0.84	1.01	0.96	0.71	1.81	0.75	1.53	0.25	2.05	3.13	0.57	1.69
Rusty blackbird	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
White-winged crossbill	-	-	-	-	-	-	-	-	-	-	-	-	-	0.13	-	-	-	0.13
Pine siskin	-	-	-	0.1	0.11	-	0.48	-	0.24	-	-	-	-	-	-	-	-	0.23
Common redpoll	0.09	0.11	0.57	0.67	1.05	0.22	-	-	-	-	-	0.15	-	0.25	3.45	0.33	-	0.69
Total	**5.41**	**17.05**	**10.12**	**7.76**	**10.78**	**5.72**	**4.45**	**3.00**	**6.48**	**2.74**	**3.50**	**3.45**	**2.37**	**2.20**	**13.58**	**12.98**	**6.31**	**6.94**
Net hours/ year	**1,089**	**921**	**1,055**	**1,050**	**950**	**907**	**830**	**895**	**830**	**842**	**775**	**670**	**717**	**799**	**928**	**608**	**349**	

Table 6. Comparison of capture rates (number of birds captured per 100 net hours) of HY birds captured at Campbell Tract during fall 1997–2013.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average capture rate
Sharp-shinned hawk	-	-	-	0.10	-	-	-	-	-	-	0.13	0.30	-	-	-	-	-	0.18
Downy woodpecker	-	-	-	-	-	0.22	0.24	-	0.12	-	-	0.30	-	-	0.11	0.16	-	0.19
Northern flicker	-	0.11	-	-	-	-	-	-	-	0.12	-	0.30	-	-	-	-	-	0.18
Alder flycatcher	0.46	0.22	0.09	0.86	0.95	0.99	1.20	1.12	0.84	0.36	0.65	0.30	-	0.13	0.22	0.33	-	0.58
Steller's jay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Black-capped chickadee	2.66	1.74	3.22	4.38	6.74	6.28	4.58	5.14	5.18	3.09	5.29	4.78	1.95	3.88	4.09	2.96	0.86	3.93
Boreal chickadee	-	0.11	0.76	0.38	1.26	1.54	0.72	1.45	1.33	1.19	0.77	1.94	0.28	1.13	1.19	0.82	0.57	0.97
Brown creeper	-	0.23	-	-	-	0.22	0.12	-	-	0.12	-	0.45	0.28	-	0.32	-	-	0.25
Red-breasted nuthatch	-	0.11	-	0.10	0.11	-	-	0.45	0.12	-	-	0.15	-	-	-	-	-	0.17
Arctic warbler	-	-	0.09	-	-	-	0.12	-	-	-	-	-	-	-	-	-	-	0.11
Golden-crowned kinglet	1.19	2.71	0.85	0.38	1.58	0.22	1.57	0.89	2.17	2.02	0.13	0.60	1.39	4.38	1.29	0.16	-	1.35
Ruby-crowned kinglet	3.03	8.58	5.88	11.33	16.42	8.71	10.36	12.40	13.37	15.20	8.13	14.03	5.58	6.26	5.28	15.13	6.30	9.76
Gray-cheeked thrush	0.18	-	-	-	-	-	-	-	0.12	-	-	-	-	-	-	0.49	-	0.26
Swainson's thrush	0.64	0.22	0.19	0.67	0.74	0.55	0.84	1.23	1.33	1.19	0.39	1.79	0.56	1.25	1.29	0.82	0.57	0.84

Table 6 continued.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average capture rate
Hermit thrush	1.19	4.34	5.02	5.43	13.26	7.17	8.43	8.49	7.47	4.04	4.26	3.43	4.46	4.13	5.06	7.40	10.32	6.11
American robin	-	0.22	-	0.10	-	0.22	-	-	-	0.24	0.26	0.15	0.14	0.13	-	-	0.29	0.19
Varied thrush	-	0.22	0.19	-	0.21	0.11	0.24	0.11	0.12	0.12	0.13	-	0.14	0.25	0.22	0.66	-	0.21
Orange-crowned warbler	1.01	10.42	7.20	6.00	7.89	5.18	9.74	6.15	3.49	4.16	2.32	1.19	1.67	1.13	5.06	4.93	9.74	5.13
Yellow warbler	0.55	5.32	3.98	7.14	6.74	6.62	58.19	7.37	5.78	4.04	3.10	2.84	0.70	1.25	1.51	2.63	2.00	7.04
Myrtle warbler	2.94	7.12	10.24	12.76	9.37	3.75	11.81	20.33	2.41	2.26	1.94	3.58	0.42	3.88	4.74	2.14	0.57	5.90
Townsend's warbler	-	0.11	0.47	0.38	0.42	0.11	1.81	0.67	0.12	-	0.26	-	-	-	0.22	0.49	0.29	0.45
Blackpoll warbler	0.18	0.33	1.33	1.43	0.95	0.33	1.08	1.12	0.24	0.24	0.26	0.75	-	0.13	0.11	0.33	0.29	0.57
Northern waterthrush	0.18	0.11	0.57	0.67	0.95	0.33	0.24	0.34	0.36	0.24	0.52	0.15	-	0.63	-	0.49	-	0.41
Wilson's warbler	2.11	12.05	6.16	17.43	10.74	6.39	7.35	5.92	3.25	3.80	2.97	6.72	3.77	0.13	5.60	2.30	6.30	6.06
American tree sparrow	-	-	-	0.19	-	0.33	-	0.11	0.24	-	-	-	-	-	-	-	-	0.22
Chipping sparrow	-	-	-	0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	0.10
Savannah sparrow	0.09	-	-	0.10	0.11	-	-	0.11	0.12	-	-	-	-	-	-	-	-	0.11
Fox sparrow	0.64	0.11	0.66	2.00	0.95	1.65	1.57	0.89	2.05	1.90	1.16	2.53	0.98	0.75	0.86	2.14	1.43	1.31
Lincoln's sparrow	0.18	1.19	0.57	0.38	1.79	0.99	0.96	1.56	1.08	0.71	0.52	0.60	0.14	0.25	0.54	0.16	0.57	0.72
Golden-crowned sparrow	-	0.65	0.38	1.90	3.79	2.09	0.96	1.34	0.96	1.07	0.75	0.30	0.70	0.38	0.22	0.16	-	1.04

Table 6 continued.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average capture rate
Gambel's white-crowned sparrow	0.46	1.41	0.28	1.24	2.21	0.22	1.69	1.45	-	0.95	0.13	0.15	0.14	0.25	0.43	-	0.29	0.75
Slate-colored junco	10.19	27.58	21.90	35.71	30.11	35.28	51.45	44.70	32.53	20.07	23.00	12.80	8.09	13.27	20.15	31.74	14.04	25.45
Rusty blackbird	-	-	-	-	-	-	-	-	-	-	-	0.60	-	-	-	-	-	0.60
White-winged crossbill	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Pine siskin	-	-	0.09	-	-	-	-	0.11	-	-	-	-	-	-	0.22	0.16	-	0.15
Common redpoll	0.09	0.11	0.09	-	0.74	-	-	-	-	-	-	-	-	-	10.99	-	-	2.40
Total	**27.97**	**85.32**	**70.21**	**111.16**	**118.03**	**89.50**	**175.27**	**123.45**	**84.80**	**67.13**	**57.07**	**60.73**	**31.39**	**43.59**	**69.72**	**76.60**	**54.43**	**79.20**
Net hours/ year	**1,089**	**921**	**1,055**	**1,050**	**950**	**907**	**830**	**895**	**830**	**842**	**775**	**670**	**717**	**799**	**928**	**608**	**349**	

Table 7. Proportion of HY birds captured compared to AHY birds captured at Campbell Tract during fall 1997–2013.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average proportion of HY birds captured
Sharp-shinned hawk	-	-	-	1	-	-	-	-	-	0	1	1	-	-	-	-	-	0.75
Downy woodpecker	0	-	-	-	1	1	1	-	0.50	-	-	1	-	-	1	1	-	0.81
Northern flicker	-	1	1	-	-	-	-	-	-	1	0	1	-	-	-	-	-	0.80
Alder flycatcher	1	0.40	0.40	1	0.82	0.82	0.83	1	0.88	1	0.83	1	-	0.50	0.67	0.67	-	0.79
Steller's jay	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Black-capped chickadee	0.81	0.59	0.59	0.84	0.90	0.90	0.95	0.92	0.87	0.76	0.98	0.91	1	0.97	0.95	0.83	1	0.87
Boreal chickadee	-	0.14	0.14	0.80	1	1	1	1	0.92	1	1	1	1	1	0.92	0.83	1	0.86
Brown creeper	-	1	-	-	-	1	1	-	-	1	-	1	1	-	1	-	-	1
Red-breasted nuthatch	-	1	1	1	-	-	0	0.66	0.50	-	-	1	-	-	-	-	-	0.74
Arctic warbler	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1
Golden-crowned kinglet	1	0.89	0.89	0.80	0.50	0.50	1	1	1	1	1	0.80	1	0.95	0.92	1	-	0.89
Ruby-crowned kinglet	0.94	0.81	0.81	0.97	0.95	0.95	0.97	0.99	0.95	0.98	0.97	0.98	1	1	0.88	0.83	0.92	0.94
Gray-cheeked thrush	1	-	0	-	-	-	-	-	1	-	-	-	-	-	-	1	-	0.75

Table 7 continued.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average proportion of HY birds captured
Swainson's thrush	0.88	1	1	1	1	1	0.88	1	0.92	1	1	1	1	0.91	0.80	0.71	0.67	0.93
Hermit thrush	0.63	0.89	0.89	0.95	0.99	0.99	1	0.97	0.95	0.97	0.92	0.86	1	0.89	0.99	0.90	0.80	0.92
American robin	-	1	-	1	1	1	0	0	-	1	1	1	1	1	0	0	1	0.71
Varied thrush	-	1	1	-	1	1	1	1	0.50	1	1	-	1	1	0.50	1	0	0.86
Orange-crowned warbler	0.79	0.87	0.87	1	0.96	0.96	0.98	1	0.94	0.97	0.95	0.89	0.92	1	0.76	0.70	0.94	0.91
Yellow warbler	0.55	0.88	0.88	0.89	0.90	0.90	0.89	0.97	0.89	1	1	1	0.83	1	0.58	0.67	0.88	0.87
Myrtle warbler	0.72	0.69	0.69	0.95	0.98	0.98	0.96	0.99	0.71	1	0.94	0.86	1	1	0.86	-	1	0.90
Townsend's warbler	-	1	1	0.80	1	1	1	1	0.50	-	1	-	-	-	1	1	1	0.94
Blackpoll warbler	0.67	1	1	1	1	1	1	1	1	1	1	1	-	1	1	1	1	0.98
Northern waterthrush	1	1	0	0.86	1	1	1	1	0.75	1	1	1	-	1	0	0	-	0.77
Wilson's warbler	0.82	0.97	0.97	0.96	0.97	0.97	1	0.98	0.93	1	1	0.98	0.96	1	0.83	0.78	0.96	0.95
American tree sparrow	-	-	-	1	1	1	1	-	1	-	-	-	-	-	-	-	-	1
Chipping sparrow	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Savannah sparrow	1	-	-	1	1	-	-	1	1	-	-	-	-	-	-	-	-	1
Fox sparrow	1	0.50	0.50	1	1	1	1	1	0.90	1	1	1	0.78	1	0.80	1	0.83	0.90

Table 7 continued.

Species captured	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Average proportion of HY birds captured
Lincoln's sparrow	1	1	1	1	0.90	0.90	1	1	1	0.86	0.67	1	0.50	1	0.63	1	1	0.91
Golden-crowned sparrow	0	0.86	0.86	0.95	0.95	0.95	1	1	1	1	1	1	1	1	0.67	1	-	0.89
Gambel's white-crowned sparrow	1	1	1	1	1	1	1	0.93	1	0.89	0.50	0.50	1	1	1	0	1	0.87
Slate-colored junco	0.93	0.87	0.87	0.99	0.95	0.95	0.99	0.98	0.97	0.96	0.93	0.94	0.86	0.98	0.90	0.90	0.96	0.94
Rusty blackbird	-	-	-	-	-	-	-	-	-	-	-	0.80	-	-	-	-	-	0.80
White-winged crossbill	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	0
Pine siskin	-	0	0	0	-	-	0	1	0	-	-	-	-	-	1	1	-	0.38
Common redpoll	0.50	0.50	0.50	0	0	0	-	-	-	-	-	0	-	0	0.76	0	-	0.23
Overall (all species)	**0.77**	**0.80**	**0.71**	**0.85**	**0.91**	**0.91**	**0.86**	**0.93**	**0.83**	**0.93**	**0.90**	**0.90**	**0.94**	**0.87**	**0.78**	**0.74**	**0.88**	**0.86**
Net hours/ year	**1,089**	**921**	**1,055**	**1,050**	**950**	**907**	**830**	**895**	**830**	**842**	**775**	**670**	**717**	**799**	**928**	**608**	**349**	

4.8 Weather and Capture Rate Relationships

To account for possible variability introduced from differences in daily net hours and the annual number of days banding, capture rates and temperature and precipitation variables from the National Weather Service (Table 8) were compared for three different ranges of years: 1998–2004, 1998–2006, and the full project length from 1997–2013. The years 1998–2004 had the highest number of days banding; the years 1998–2006 each had 800 or greater net hours; and the full length of the project (1997–2013) had all the variability associated with difference in net hours and number of days banding.

Simple linear regressions between capture rates and temperature and precipitation variables for all years of banding showed no significant relationships, as no R^2 values were above 0.18 (Table 9). In the 1998–2006 analysis, a weak positive relationship exists between AHY capture rates and summer precipitation (R^2 = 0.47) (Table 9, Figure 3). In the 1998–2004 analysis, a weak positive relationship was found between AHY capture rates and summer precipitation (R^2 = 0.46) and HY capture rates and average summer temperatures (R^2 = 0.47) shown in Table 9 and Figure 3. A weak negative relationship was also found between AHY capture rates and average summer temperatures (R^2 = 0.41) (Table 9, Figure 3).

A comparison between the capture rates of HY and AHY birds for all 17 years of banding shows that the capture rates of the two age classes seem to diverge. From the years 1997 to 2006, HY capture rates increased while AHY rates declined; then both increased for the remaining years from 2006 to 2013 (Figure 4). However, capture rates increased during those same years when a comparison is made between all age classes (Figure 4).

Table 8. Summary of summer and fall weather in Anchorage, Alaska, for the years 1997–2013. Data acquired from the National Weather Service, Anchorage Weather Forecast Office (weather.gov/wrh/Climate?wfo=afc).

		Temperature (degrees F)		Precipitation (inches)	
Year	Month	Average	Departure from Normal	Total	Departure from Normal
1997	June	56.7	0.8	1.02	-0.42
	July	60.8	1.2	1.82	-0.46
	August	58.1	0.6	2.93	5.44
	September	50.4	1.1	3.1	-0.57
1998	June	54.7	-1.2	2.7	1.68
	July	57.3	-2.3	0.91	-0.91
	August	53.8	-3.7	3.17	0.21
	September	49	-0.3	0.73	-2.37
1999	June	55.3	-0.6	1.1	0.08
	July	58.4	-1.2	2.06	0.24
	August	56.9	-0.6	4.4	1.47
	September	48.9	-0.4	3.19	0.09
2000	June	55.1	-0.8	1.43	0.41

Table 8 continued.

		Temperature (degrees F)		Precipitation (inches)	
Year	Month	Average	Departure from Normal	Total	Departure from Normal
2000	July	56.8	-2.8	2.58	0.76
	August	54.8	-2.7	1.68	-1.25
	September	47	-2.3	3.24	0.14
2001	June	58.1	2.2	0.24	-0.78
	July	57.7	-1.9	4.49	2.67
	August	58.3	0.8	0.97	-1.96
	September	49.2	-0.1	1.14	-1.96
2002	June	53.4	-2.5	1.07	0.05
	July	59.7	0.1	1.37	-0.45
	August	56.9	-0.6	3.21	0.28
	September	50.1	0.8	3.57	0.47
2003	June	55.8	-0.1	0.86	-0.16
	July	62.2	2.6	1.25	-0.57
	August	57.8	0.3	2.36	-0.57
	September	49	-0.3	1.95	-1.15
2004	June	57.4	1.5	0.86	-0.16
	July	61.8	2.2	0.69	-1.13
	August	61.2	3.7	0.76	-2.17
	September	45	-4.3	7.61	4.51
2005	June	56.9	1	1.05	0.03
	July	61.4	1.8	0.96	-0.86
	August	58.1	0.6	2.55	-0.38
	September	51.4	2.1	3.94	0.84
2006	June	54.4	-1.5	1.35	0.33
	July	58.2	-1.4	1.04	-0.78
	August	54.9	-2.6	5.64	2.71
	September	49.5	0.2	3.14	0.04
2007	June	54.5	-1.4	1.09	0.07
	July	58.2	-1.4	1.46	-0.36
	August	58.2	0.7	1.62	-1.31
	September	50.2	1.2	3.91	0.81

Table 8 continued.

		Temperature (degrees F)		Precipitation (inches)	
Year	Month	Average	Departure from Normal	Total	Departure from Normal
2008	June	51.6	-4.3	0.59	-0.43
	July	55.8	-3.8	3.25	1.82
	August	55.6	-1.9	0.93	2
	September	48.4	-0.9	3.2	0.1
2009	June	54.2	-1.7	0.57	-0.45
	July	59.4	-0.2	1.21	0.61
	August	56.2	-1.3	2.57	-0.36
	September	49	-0.3	1.17	-1.93
2010	June	54.3	-1.6	1.09	0.07
	July	56.5	-3.1	3.14	1.32
	August	56.6	-0.9	3.03	0.1
	September	49.7	0.4	1.03	-2.07
2011	June	54.3	-1.6	1.19	0.17
	July	58	-1.6	1.92	0.1
	August	55.5	-2	3.93	1
	September	49.7	0.4	0.63	-2.47
2012	June	54.9	-1	1.37	0.35
	July	56.3	-3.3	2.14	0.32
	August	56.7	-0.8	1.82	-1.11
	September	49	-0.3	6.12	3.02
2013	June	59.4	3.5	0.38	-0.64
	July	69.2	2.6	1.02	-0.8
	August	58.5	1	5.04	2.11
	September	49.2	-0.1	5.56	2.46

Table 9. Results of linear regressions and correlations used to describe factors affecting capture rates during fall migration at Campbell Tract (nh = net hours).

Analysis Using Data from 1997–2013	Equation	R^2
HY birds/100 nh in fall x average fall temperature	y = 258.16 - 3.37x	0.009
HY birds/100 nh in fall x total fall precipitation	y = 92.66 - 2.27x	0.019
HY birds/100 nh in fall x average summer temperature	y = -201.15 + 4.93x	0.085
HY birds/100 nh in fall x summer precipitation	y = 78.38 + 0.32x	0
HY birds/100 nh in fall x deviation in summer precipitation	y = 78.83 + 4.07x	0.019
AHY birds/100 nh in fall x average fall temperature	y = 68.6 - 1.16x	0.074
AHY birds/100 nh in fall x total fall precipitation	y = 8.73 - 0.303x	0.023
AHY birds/100 nh in fall x average summer temperature	y = 9.79 - 0.049x	0.001
AHY birds/100 nh in fall x summer precipitation	y = 1.38 + 1.92x	0.182
AHY birds/100 nh in fall x deviation in summer precipitation	y = 6.78 + 1.41x	0.160
All birds/100 nh in fall x summer precipitation	y = 68.16 + 5.02x	0.025
All birds/100 nh in fall x average summer temperature	y = 120.64 + 3.57x	0.061
Correlations		
AHY birds/100 nh x HY birds in fall		0.018
All birds/100 nh x HY birds in fall	**87.6% of all birds is explained by HY birds**	**0.876**
All birds/100 nh x AHY birds in fall		0.124

Analysis Using Data from 1998–2006	Equation	R^2
AHY birds/100 nh in fall x total fall precipitation	y = 14.90 - 1.24x	0.369
AHY birds/100 nh in fall x summer precipitation	**y = -1.07 + 2.98x**	**0.474**
AHY birds/100 nh in fall x deviation in summer precipitation	y = 7.13 + 1.87x	0.355

Analysis Using Data from 1998–2004	Equation	R^2
HY birds/100 nh in fall x average summer temperature	**y = -822.44 + 16.24x**	**0.473**
AHY birds/100 nh in fall x average summer temperature	**y = 129.45 - 2.10x**	**0.417**
AHY birds/100 nh in fall x summer precipitation	**y = -0.509 + 2.88x**	**0.465**
All birds/100 nh in fall x average summer temperature	y = 320.15 + 7.52x	0.330

R^2 = proportion of the variance in the dependent variable (Y axis) explained by the independent variable (X axis).

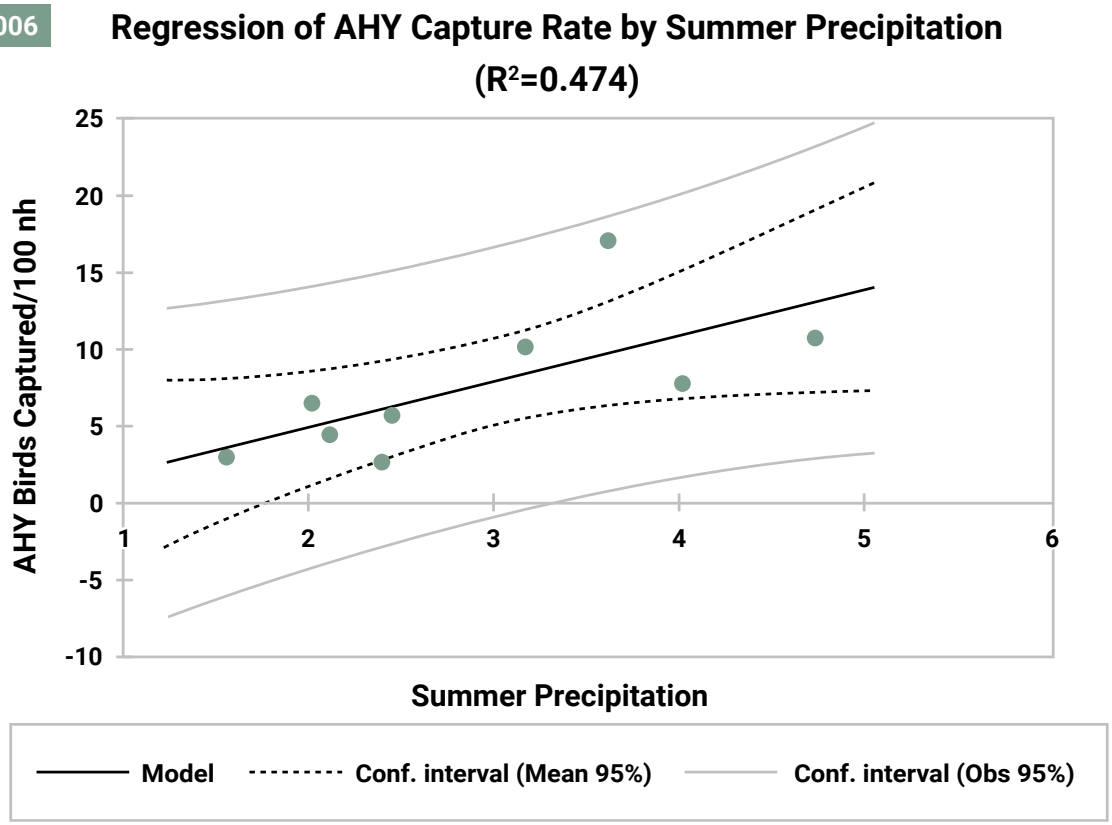
1998–2006 = years with 800 or greater net hours.

1998–2004 = highest capture rate and highest number of banding days.

Alternative analysis used to reduce variability in net hours, capture rates, and number of banding days.

Figure 3. Linear regression comparisons of fall capture rates of HY and AHY birds at Campbell Tract and summer precipitation and average summer temperatures from 1998–2004 and 1998–2006. Weather data obtained online from the National Weather Service.

1998–2006



1998–2004

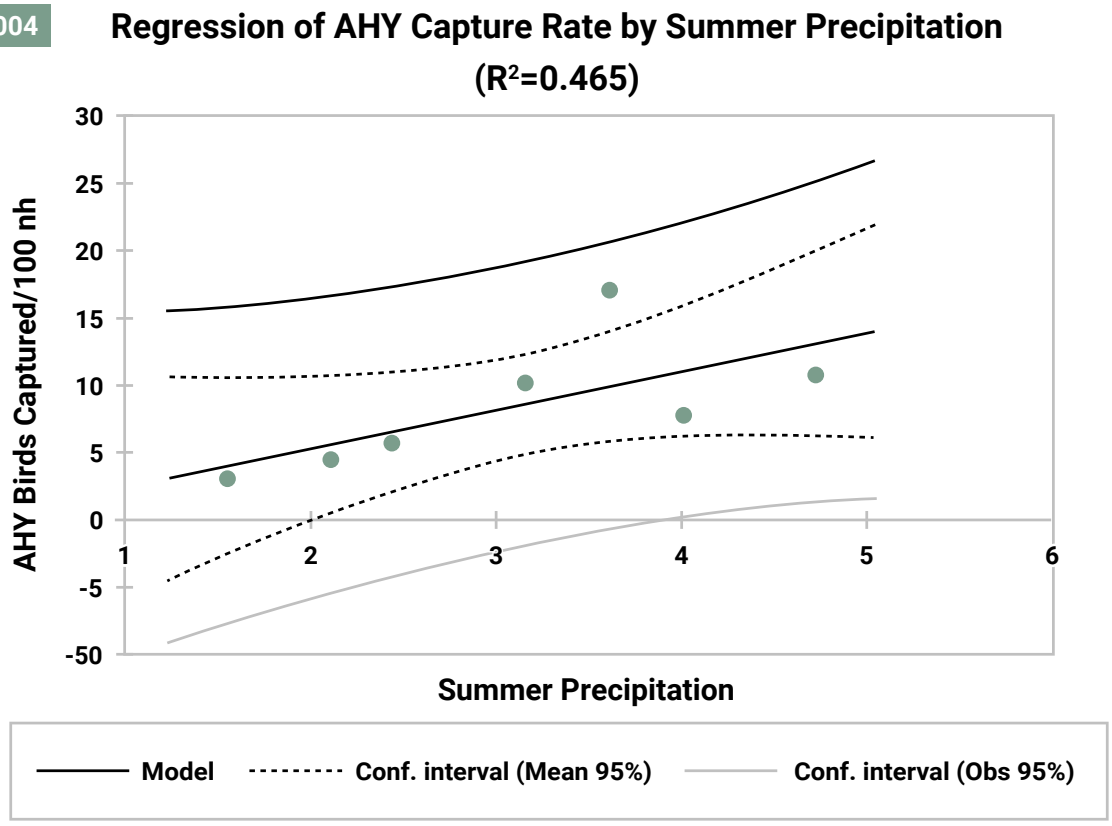
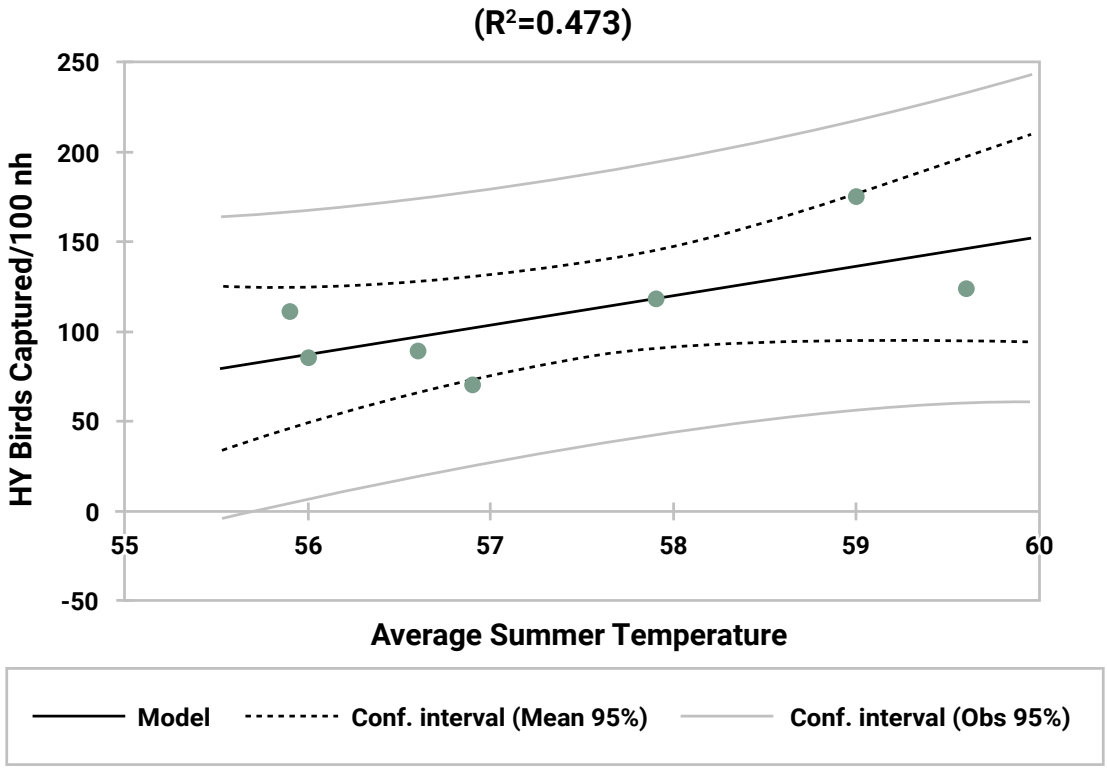


Figure 3 continued. Linear regression comparisons of fall capture rates of HY and AHY birds at Campbell Tract and summer precipitation and average summer temperatures from 1998–2004 and 1998–2006. Weather data obtained online from the National Weather Service.

1998–2004 **Regression of HY Capture Rate by Average Summer Temperature**



1998–2004 **Regression of AHY Capture Rate by Average Summer Temperature**

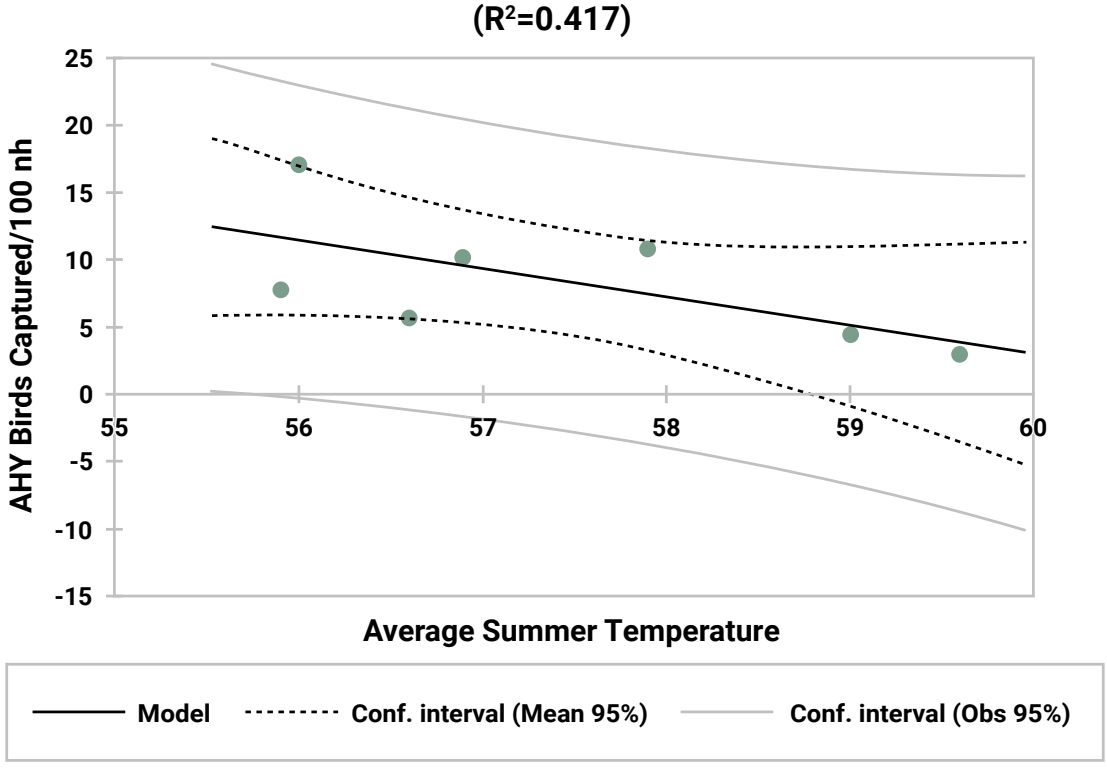
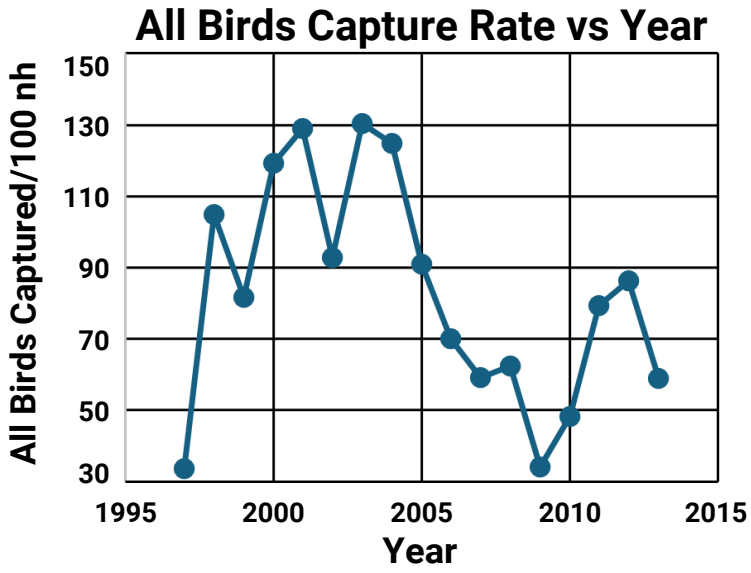
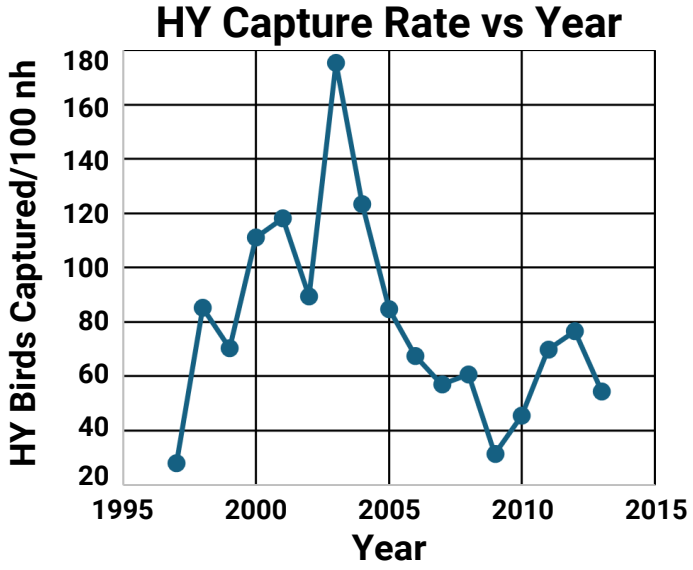
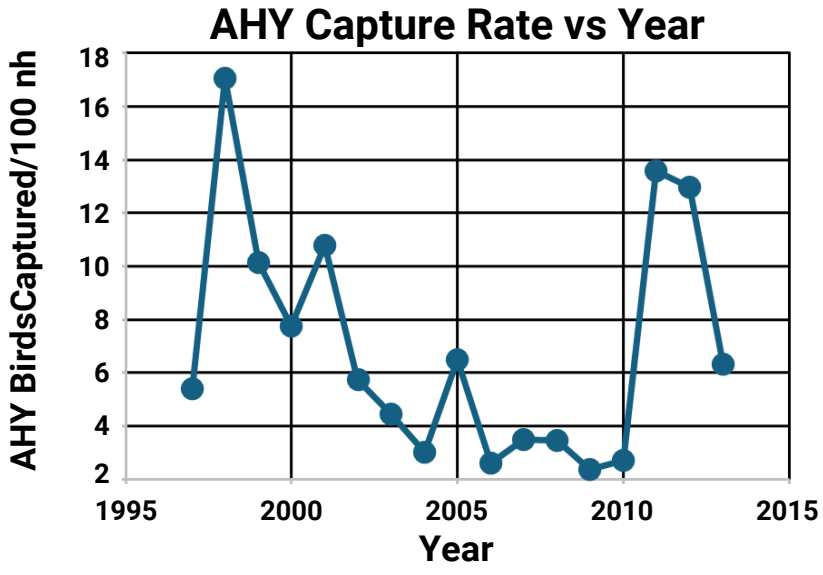


Figure 4. Capture rates of all birds, HY birds, and AHY birds from 1997–2013.







4.9 Migrant Bird Strategies

Neotropical migrant birds comprised between 73% and 97% of individual birds captured at the Campbell Tract banding station in fall for years 1997–2013, averaging 88% across all years (Table 10 and Table 11a). Between 16% and 67% of birds captured and banded over 17 years of the study were A-type Neotropical migrants (average 27%) with winter ranges that are in Central and South America. B-type Neotropical migrant birds with winter ranges in the southern U.S. and northern portions of Mexico and Central America comprised between 20% and 73% (average 60%) of the birds captured. Nearctic migrants with winter ranges that are entirely in the U.S. and Canada, comprised between 0.5% and 20% (average 5%) of the birds captured. Between 3% and 13% (average 8%) of the birds captured were resident species that are largely nonmigratory.

The only Palearctic migrant banded was the arctic warbler, with less than 0.01% of individual birds captured.

The pattern of the number of bird species captured was similar to the number of individual birds captured. Between 64% and 82% (average 71%) of the species captured in fall from 1997–2013 were Neotropical migrants (Table 11b). A-type Neotropical migrants made up 28% to 43% (average 37%) of the species captured each fall, and B-type Neotropical migrants comprised 28% to 41% (average 34%) of the species captured. Nearctic migrants comprised from 6% to 23% (average 17%) of the species captured, and resident species comprised between 8% and 17% (average 12%) of the species captured. Arctic warbler was the only Palearctic species captured in the falls of 1999 and 2003.

Table 10. Migration strategies of bird species captured at Campbell Tract in fall 1997–2013 (Pogson et al. 1996).

A-Type Neotropical Migrants
Alder flycatcher
Gray-cheeked thrush
Swainson's thrush
Orange-crowned warbler
Yellow warbler
Townsend's warbler
Blackpoll warbler
Northern waterthrush
Wilson's warbler
Lincoln's sparrow
Chipping sparrow

Nearctic Migrants
Reb-breasted nuthatch
Golden-crowned kinglet
Varied thrush
American tree sparrow
Golden-crowned sparrow
Rusty blackbird
Common Redpoll
White-winged crossbill

Palearctic Migrants
Arctic warbler

B-Type Neotropical Migrants
Sharp-shinned hawk
Northern flicker
Ruby-crowned kinglet
Hermit thrush
American robin
Savannah sparrow
Gambel's white-crowned sparrow
Pine siskin
Fox sparrow
Slate-colored junco
Myrtle warbler

Residents
Downy woodpecker
Black-capped chickadee
Boreal chickadee
Steller's jay
Brown creeper

Table 11a. Comparison of the number of individual birds from different biogeographical realms captured at Campbell Tract during fall migration 1997–2013.

Number of Individuals Captured																		
	1997		1998		1999		2000		2001		2002		2003		2004		2005	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Neotropical	313	85	877	91	769	89	1,154	92	1,068	87	731	87	1,009	93	1,083	92	657	87
Type A	76	21	314	33	246	29	390	31	328	27	201	24	289	27	233	21	505	67
Type B	237	65	563	58	523	61	764	61	740	60	530	63	720	66	799	71	152	20
Nearctic	16	4	41	4	27	3	36	3	77	6	30	4	24	2	28	2	31	4
Resident	38	10	45	5	65	8	62	5	80	7	81	10	49	5	63	6	67	9
Palearctic	0	0	0	0	1	0.1	0	0	0	0	0	0	1	0.1	0	0	0	0
Total birds	**367**		**963**		**862**		**1,252**		**1,225**		**842**		**1,083**		**1,123**		**755**	

	2006		2007		2008		2009		2010		2011		2012		2013		1997-2013
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Avg. %
Neotropical	514	87	402	88	356	84	210	86	300	78	554	73	490	92	206	97	88
Type A	129	22	91	20	100	24	53	22	63	16	185	24	104	20	76	36	27
Type B	385	65	311	68	256	61	157	64	237	61	369	48	386	73	130	61	60
Nearctic	27	5	8	2	14	3	16	7	45	12	153	20	11	2	1	0.5	5
Resident	49	8	49	11	53	13	19	8	41	11	56	7	30	6	6	3	8
Palearctic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01
Total birds	**589**		**459**		**423**		**245**		**386**		**763**		**531**		**213**		

Table 11b. Comparison of the number of bird species from different biogeographical realms captured at Campbell Tract during fall migration 1997–2013.

Number of Species Captured																		
	1997		1998		1999		2000		2001		2002		2003		2004		2005	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Neotropical	16	76	18	69	17	71	19	70	18	69	16	64	17	65	18	72	18	69
Type A	9	43	9	35	10	42	10	37	9	35	9	36	9	35	9	36	10	38
Type B	7	33	9	35	7	29	9	33	9	35	7	28	8	31	9	36	8	31
Nearctic	3	14	5	19	4	17	5	19	5	19	5	20	4	15	5	20	5	19
Resident	2	10	3	12	2	8	3	11	3	12	4	16	4	15	2	8	3	12
Palearctic	0	0	0	0	1	4	0	0	0	0	0	0	1	4	0	0	0	0
Total species	**21**		**26**		**24**		**27**		**26**		**25**		**26**		**25**		**26**	

	2006		2007		2008		2009		2010		2011		2012		2013		1997-2013
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Avg. %
Neotropical	17	74	18	78	17	65	12	67	15	68	17	68	18	72	14	82	71
Type A	8	35	9	39	8	31	5	28	8	36	9	36	10	40	7	41	37
Type B	9	39	9	39	9	35	7	39	7	32	8	32	8	32	7	41	34
Nearctic	3	13	3	13	5	19	3	17	5	23	4	16	4	16	1	6	17
Resident	3	13	2	9	4	15	3	17	2	9	4	16	3	12	2	12	12
Palearctic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5
Total species	**23**		**23**		**26**		**18**		**22**		**25**		**25**		**17**		

4.10 Annual Return of Banded Birds

Birds that were recaptured at the banding station at least 1 year after banding are considered interannual returns. A total of 185 individual birds of 10 species returned to the station from 1 to 4 years after banding and included both resident and migrant species (Appendix 1). Returned species in order of abundance included black-capped chickadee (96), slate-colored junco (53), hermit thrush (21), boreal chickadee (8), myrtle warbler (2), Swainson's thrush (1), orange-crowned warbler (1), ruby-crowned kinglet (1), American robin (1), and downy woodpecker (1). Black-capped chickadee, slate-colored junco, and hermit thrush accounted for 92% of the returned birds. Most of the returns were within 1 year (70%), with 22% returning after 2 years, and 7% within 3 years. A single black-capped chickadee banded as a hatch year in 2004 was recaptured 4 years later in 2008, and a single hermit thrush banded as a hatch year in 2007 was recaptured 4 years later in 2011 (Appendix 1). Seventy-nine percent of the return captures were banded as HY birds, and 21% as AHY. Black-capped chickadees were most often recaptured in multiple years, followed by slate-colored junco and hermit thrush.

4.11 Band Recoveries

Eight birds of four species banded at Campbell Tract were recovered at other locations and included yellow warbler, slate-colored junco, hermit thrush, and black-capped chickadee (Table 12). One A-type Neotropical migrant (HY yellow warbler) was banded in September 1998 and was recovered by banders in Monterey, California, in September 1999. Five B-type Neotropical migrants (1 HY hermit thrush, 4 HY slate-colored juncos) were recovered (Anchorage, Alaska; Soldotna, Alaska; Weyburn, Saskatchewan Canada; Anchorage, Alaska; and Sterling, Alaska) as window-killed birds or found dead at feeders. Two resident black-capped chickadees were recovered—one by banders at the Eagle River Nature Center north of Anchorage and one as an injured bird turned into the Bird Treatment and Learning Center in Anchorage. No banded Nearctic or Palearctic migrants were recovered at other locations.

Table 12. Birds banded at Campbell Tract in fall 1997–2013 that were recovered at other locations.

Species	Banding Date	Age	Recapture Date	Recapture Age	Recapture Location
Yellow warbler	9/4/98	HY	9/24/99	AHY	Monterey, CA
Slate-colored junco	8/28/03	HY	7/30/04	AHY	Soldotna, AK
Slate-colored junco	9/13/04	HY	4/4/05	AHY	Weyburn, Canada
Hermit thrush	8/16/04	HY	9/13/04	HY	Anchorage, AK
Slate-colored junco	8/10/05	HY	8/16/05	HY	Anchorage, AK
Slate-colored junco	8/28/03	HY	7/30/04	AHY	Sterling, AK
Black-capped chickadee	8/27/02	HY	11/22/02	HY	Eagle River, AK
Black-capped chickadee	9/3/13	UNK	10/22/13	UNK	Anchorage, AK

4.12 Migration Intensity and Timing by Year

Figure 5 shows daily migration intensity (number of birds captured per 100 net hours) and timing during fall migration at Campbell Tract from 1997 to 2013. The graphs for each year of banding show that migration peaks were variable across the years. Generally, from 1997 to 2010, peak capture rates occurred in the last week of August and declined through the fall, with some later increases in September. From 2011 to 2013, migration peaks (increased capture rates) were later in the season in the first week of September, then trailed off to low levels in the second and third week of September until most migrant species were no longer captured at the banding station.

4.13 Avian Malaria in Alaska

In the fall of 2011, while operating the banding station, blood samples were collected from captured birds as part of a cooperative study with San Franciso State University to determine the presence of avian malaria parasites (*Plasmodium* species) in migrant and resident birds in Alaska. Blood samples were collected from the brachial veins of 167 birds from 20 species of resident and nonresident migratory birds in fall to determine the presence of avian malaria. The overall study found both resident and hatch year birds were infected with *Plasmodium* as far north as 64 degrees north latitude, providing some of the first evidence that avian malaria transmission occurs in these latitudes and climates (Loiseau et al. 2012).

Figure 5. Annual capture rates showing daily migration intensity and timing during fall migration at Campbell Tract from 1997–2013.

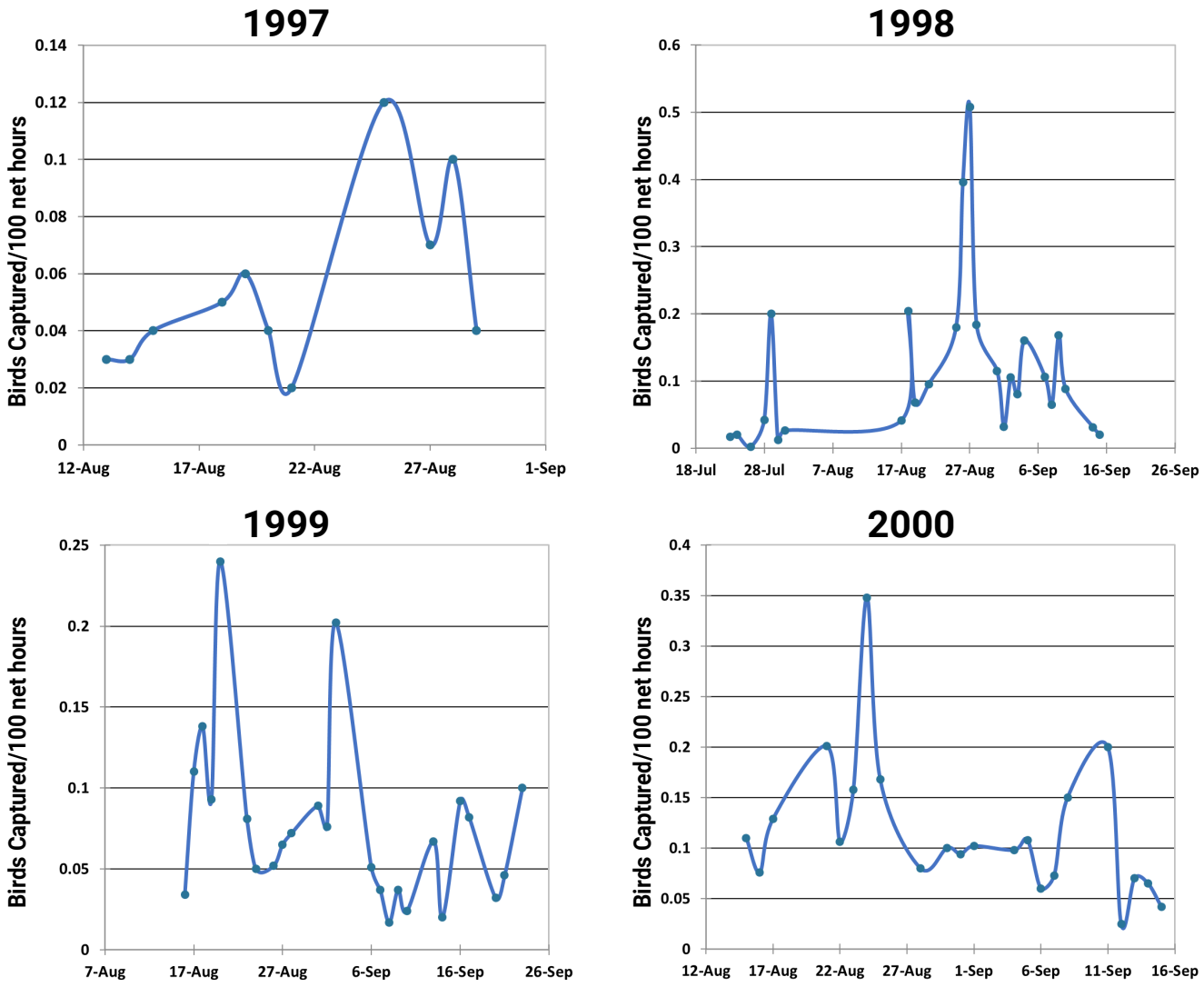


Figure 5 continued. Annual capture rates showing daily migration intensity and timing during fall migration at Campbell Tract from 1997–2013.

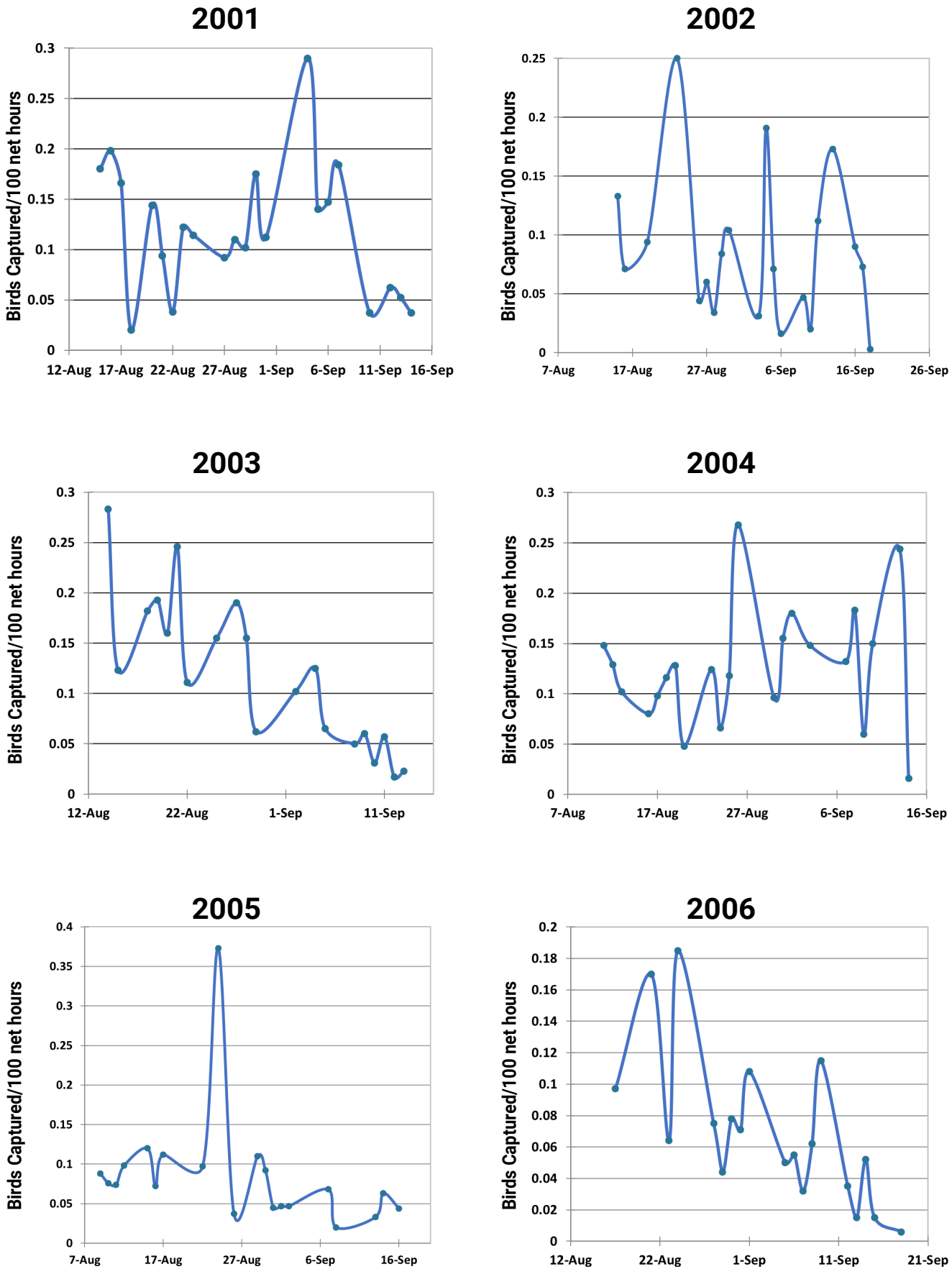


Figure 5 continued. Annual capture rates showing daily migration intensity and timing during fall migration at Campbell Tract from 1997–2013.

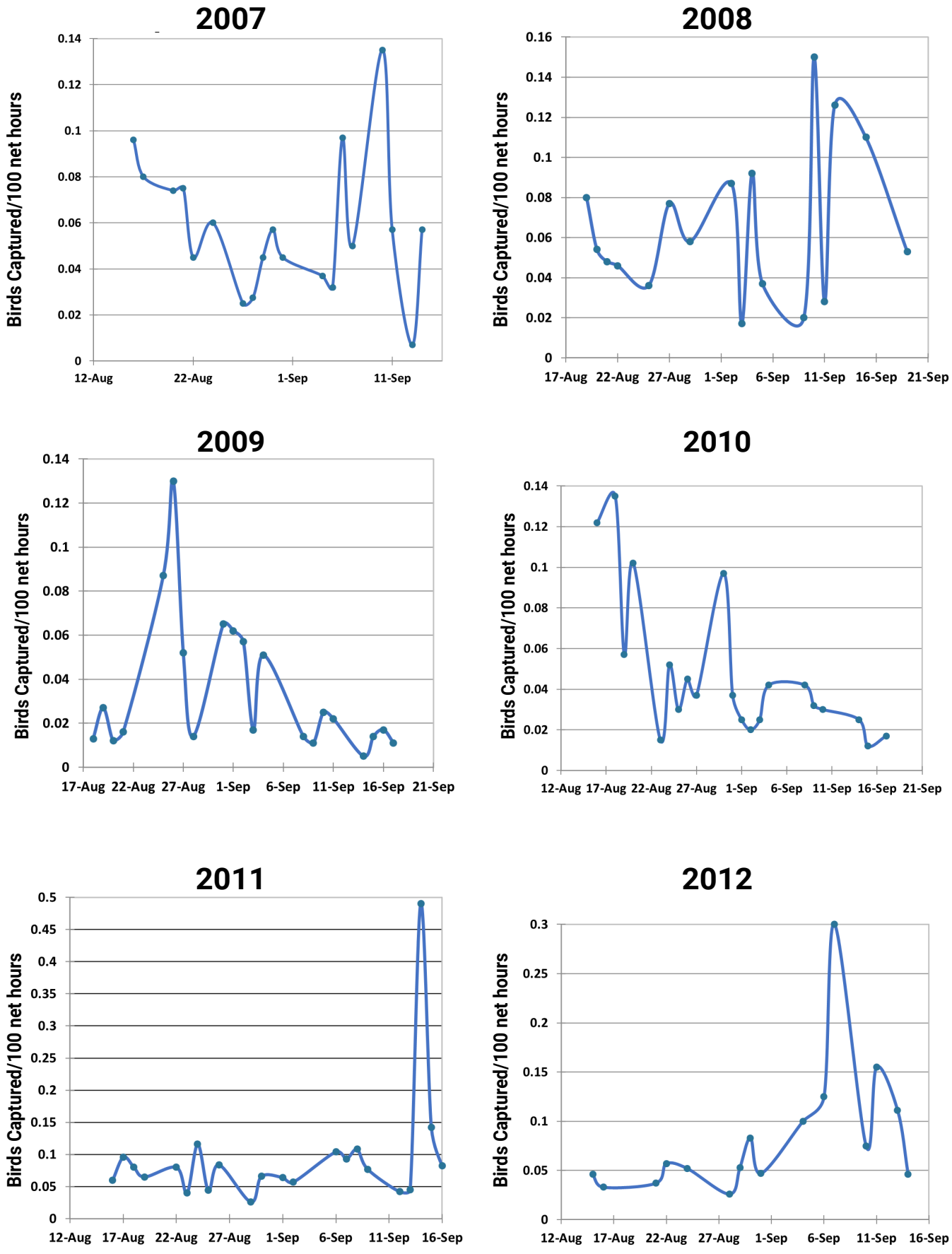
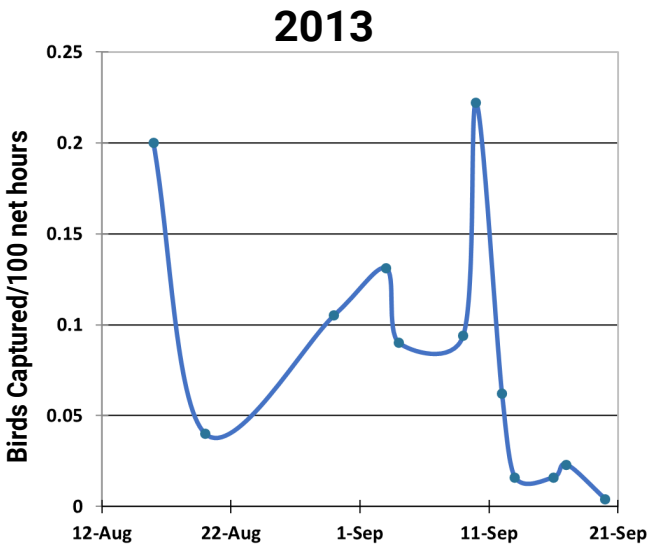


Figure 5 continued. Annual capture rates showing daily migration intensity and timing during fall migration at Campbell Tract from 1997–2013.



5. Discussion

5.1 Banding Effort

The variation in the number of net hours and number of days banding among years was due to weather delays and cancellations that prevented the operation of the nets for the day or delays in net openings and early net closures. Banding was cancelled for the day or nets were opened late or closed early if water or ice accumulated on the nets and increased the risk of mortality of birds captured. This was especially true in 2012 and 2013 (Table 1) when daily rain and windstorms moved through the area for consecutive days, reducing the number of days of banding before most of the migrant species left the area in migration. It was also observed that banding days following a night of clear and calm weather conditions resulted in lower capture rates, apparently due to migrants moving out of the area by migrating during overnight weather conditions that were advantageous to their movements. Higher capture rates and the number of birds captured tended to occur in pulses, when many mixed flocks of birds (both migrant and resident species) were present during overcast and rainy days but migrant species were no longer present on the following clear days, apparently having left the area for the season.

5.2 Dominant Species

Across all years of fall banding at Campbell Tract, slate-colored junco was the most abundant species captured accounting for 32% of all species captured (Table 2). Slate-colored junco, ruby-crowned kinglet, myrtle warbler, Wilson's warbler, and hermit thrush were the five most abundant species captured in all years of the study and together comprised 68% of the total birds captured. In addition to the top five most abundant species, orange-crowned warbler, yellow warbler, black-capped chickadee, golden-crowned kinglet, fox sparrow, common redpoll, golden-crowned sparrow, boreal chickadee, Swainson's thrush, Lincoln's sparrow, Gambel's white-crowned sparrow, alder flycatcher, blackpoll warbler, northern waterthrush, and Townsend's warbler were the 20 most abundant species captured, accounting for 99% of the species captured in the falls of 1997 to 2013 at the banding station.

5.3 Yearly Variation in Capture Rates

The total capture rate for all species in 2003 (130 birds captured per 100 net hours) was the highest capture rate of the study, and the capture rates in 1997 and 2009 (both 34 birds captured per 100 net hours) were the lowest (Table 4). Nets were operated for only 11 days in August of 1997 as a training year and 22 days in 2009 in August and September. These years had similar capture rates, but due to variability in the number of nets and timing of their operation, it is unlikely the same factors affected capture rates and intensity of migration in the area. However, Figure 5 does show that capture rates peaked to similar levels in the last week of August in both 1997 and 2009. There seems to be a decline in capture rates for the last 9 years of the study (2005–2013), even for abundant species like slate-colored junco that may be explained by reduced net hours, especially in 2013 (Table 1).

The years between 2000 and 2004 had the highest average capture rates (119 birds captured per 100 net hours over 5 years) compared to the average capture rate for all other years (68 birds captured per 100 net hours). This difference may be due to migrant birds using habitats in the Anchorage area other than Campbell Tract during fall migration or using other migration routes. Also, this banding dataset may not be an accurate measure of the magnitude of differences in abundance of birds among years.

It may be difficult for the banding station to

measure differences in abundance of migrant birds among years, especially when effort (total net hours) was affected by weather and varied among years. Also, nets were not consistently operated every day during fall migration due to staff availability. The movements of migrant landbirds are affected by weather and birds move in pulses during fall migration in Anchorage, remaining in an area during stormy or rainy weather and migrating over night when clear weather moves in. It is likely pulses of birds moved through the area on days the station was not operated, and the birds that moved through the area during those days were missed.

5.4 Annual Migration Timing and Intensity

The timing and intensity of fall migration at Campbell Tract varied among years, with peaks in capture rates for all species changing from late August to mid-September as the years progressed (Figure 5). Some years had peak capture rates in late August (1997–2006; 2009–2010). However, in 2007 and 2008 and 2011–2013, capture rates peaked in the second week of September (Figure 5). The timing of these differences may be explained by changing weather patterns in Anchorage in fall, with more fall wind and rainstorms delaying the timing of migration pulses of birds and the first freezing temperatures occurring later in the fall, resulting in longer food availability in fall and later leaf drop of deciduous trees that provide cover to migrating birds. The normal first frost date for Campbell Tract is September 10 (National Weather Service 2025), and the average end of the growing season in Anchorage ranges from September 21–30 (PlantsMaps 2025). On September 7, 1998; August 23 , 2000; and September 10–11, 2012, freezing temperatures overnight froze the station mist nets, and banding was delayed or cancelled for the day. Freezing temperatures likely affected bird movements and capture rates for the day in those years (Figure 5) and likely reduced food availability at the station.

5.5 Yearly Variation in Capture Rates for HY and AHY Birds

Hatch year birds comprised 71% to 94% of the birds captured each fall from 1997 to 2013 and averaged 86% across all years (Table 7). The correlation between all ages of birds captured and HY birds is 87.6% and suggests the capture rate of HY birds is a strong indication of total capture rates (Table 9). This is represented graphically in Figure 4, shown across all years of this study. In years when capture rates of all ages of birds were higher (1998–2005), HY capture rates were also high (1998–2005) and AHY captures rates were lower (1999–2008). The abundance of HY birds in fall could be explained by the fact that HY birds represent the annual production of birds for the season. Alaska is at the northern end of their migration route, and landbird numbers in August and September include both adult birds and all of their production of the year, just as they are starting their migration to wintering areas and before the mortality associated with migration has occurred. For some species of landbirds, it was observed that the number of adult birds increased later in the season, especially in mid-September, and peak migration times had higher hatch year capture rates, suggesting adult birds migrate later in the fall.

5.6 Factors Affecting Capture Rates (Precipitation and Temperatures in Summer and Fall)

Simple linear regressions between summer precipitation and capture rates of AHY birds in fall show a weak relationship (Table 9 and Figure 3). Regressions also show a weak relationship between capture rates of both HY and AHY birds and summer temperature and precipitation (Table 9 and Figure 3).

The positive relationship between AHY capture rates and summer precipitation in Anchorage may suggest increased summer rainfall could increase food availability for breeding birds. However, the relationship is weak (R^2 = 0.465,

1998–2004; R^2=0.474, 1998–2006), and birds captured at the Campbell Tract banding station may have migrated from breeding grounds outside the Anchorage area that experienced different summer precipitation. Many factors that were not accounted for in this study likely affected the intensity of migration of adult landbirds. The timing of their movement through the Anchorage area (i.e., banding effort timing in relation to migration pulses of birds) and the use of net capture rates to determine the migration intensity or annual productivity (HY birds) may therefore be misleading.

The positive (HY birds) and negative (AHY birds) relationship between capture rates and average summer temperatures were also weak and may also be related to food availability in summer.

There is a strong correlation between capture rates of HY birds and all birds captured in fall (R^2 = 0.876). This suggests that capture rates of HY birds in fall is an indication of productivity. However, using capture rates and the inconsistent amount of days banding among years (caused by fall storms in Anchorage) may not be sensitive enough to measure annual changes in bird productivity.

5.7 Migration Strategies

A-type and B-type Neotropical migrants comprised the largest portion of individual birds captured at Campbell Tract. The species of birds in these groups migrate to winter ranges in the southern U.S. and Central and South America, and returned birds captured in subsequent years suggest migrants use migration routes and habitats along the way for multiple years. The timing of migration differed among species and age groups, with alder flycatcher typically captured only in August and adult fox sparrow and Swainson's thrush more commonly captured later in migration in September. Ruby-crowned kinglet and hermit thrush were the last migrant species to move through the banding station and were captured until mid- to late September, when all other migrant species had moved out of the area for the season.

5.8 Returns

The station recorded a total of 185 banded birds that returned to Campbell Tract in subsequent years (Appendix 1). Returns included both migrant and resident birds from 10 species. Black-capped chickadee was the most common return species at the station. Resident-returned birds included black-capped chickadee that returned in multiple years (1–4 years), downy woodpecker (1 year), and boreal chickadee (1–3 years). Resident species returns suggest these birds had home ranges that included the net array of the banding station, or their use of habitats in August and September was similar among years. Migrant species returns included hermit thrush (1–4 years), myrtle warbler (1 year), slate-colored junco (1–3 years), and ruby-crowned kinglet (1 year). Migrant returns show that these species used the same habitats annually in fall and suggest their migration routes included Campbell Tract, in some cases for multiple years.

5.9 Recoveries

Data on recovered birds banded at Campbell Tract show the movement of migrant birds and some evidence of the hazards of migration. Eight birds banded at the Campbell Tract birding station were recovered at other locations. Five of the eight were found dead at bird feeders or likely victims of window collisions. An AHY yellow warbler recovered in Monterey, California, provides evidence of warblers migrating to and from Alaska in both fall and spring over multiple years and their use of Campbell Tract habitats in fall. The recovery of a resident black-capped chickadee in Eagle River, Alaska, in November of the same year, approximately 20 miles away from Campbell Tract, suggests hatch year black-capped chickadees move to different areas in fall, possibly to disperse from areas where they hatched.

Varied thrush

6. Summary

The timing and intensity of landbird migration at Campbell Tract is likely influenced by multiple factors including weather and habitat changes. Monitoring landbird migration to determine trends in bird population and productivity changes using mist netting and banding requires a long-term, consistent netting effort throughout fall migration. The fall weather patterns in Anchorage and south-central Alaska, with consecutive and repeated days of rain and wind, make a consistent mist netting and banding effort difficult in August and September. Fall weather patterns had the largest effect on attempts to accurately determine bird population and productivity trends. The banding station study at Campbell Tract did however provide a good account of the species composition and age and sex ratios of landbirds in fall migration. Precipitation and temperature variables in summer and fall in Anchorage accounted for less than 50% of the variability in capture rates.

Wilson’s warbler

Appendix 1: Interannual Return of Individual Birds Banded at Campbell Tract During Fall Migration 1997–2013

Species	Banding Date	Return Date	Age at Banding	Years between Capture
Black-capped chickadee	8/13/1997	9/7/1999	AHY	2
Black-capped chickadee	8/13/1997	9/6/1999	HY	2
Black-capped chickadee	8/19/1997	8/20/1997	AHY	
		8/27/1997	AHY	
		9/2/1998	AHY	1
Black-capped chickadee	8/19/1997	8/27/1997	HY	
		8/29/1997	HY	
		8/21/2000	HY	3
Black-capped chickadee	8/19/1997	8/25/1997	HY	
		8/21/1998	HY	1
		9/4/1998	HY	1
		9/20/1999	HY	2
		2/23/1999	HY	2
Black-capped chickadee	8/21/1997	2/22/2000	AHY	3
Black-capped chickadee	8/27/1997	8/28/1998	HY	1
		9/7/1999	HY	2
Black-capped chickadee	8/28/1997	9/2/1999	HY	2
Black-capped chickadee	8/29/1997	8/29/1997	HY	
		7/28/1998	HY	1
		7/30/1998	HY	1
		9/4/1998	HY	1
Slate-colored junco	8/20/1997	9/9/1998	HY	1
Slate-colored junco	8/25/1997	8/26/1998	AHY	1
Slate-colored junco	8/19/1997	8/19/1998	AHY	1
		9/4/1998	AHY	1
Orange-crowned warbler	8/15/1997	8/18/1998	AHY	1

Species	Banding Date	Return Date	Age at Banding	Years between Capture
Hermit thrush	8/25/1997	7/30/1998	AHY	1
Black-capped chickadee	8/21/1998	8/19/1999	HY	1
Black-capped chickadee	8/21/1998	8/19/1999	HY	1
		9/11/2000	HY	2
Black-capped chickadee	7/23/1998	9/2/1999	HY	1
Black-capped chickadee	7/28/1998	7/30/1998	HY	
		8/23/1999	HY	1
Slate-colored junco	8/26/1998	8/31/1999	HY	1
Slate-colored junco	9/8/1998	8/17/1999	HY	1
Slate-colored junco	9/3/1998	8/26/1999	AHY	1
Slate-colored junco	9/7/1998	8/20/1999	AHY	1
Hermit thrush	7/31/1998	8/27/1999	AHY	1
Swainson's thrush	8/17/1998	9/12/2001	HY	3
Boreal chickadee	7/23/1998	9/17/1999	AHY	1
Black-capped chickadee	4/6/1999	8/23/1999	AHY	
		2/22/2000	AHY	1
Black-capped chickadee	4/6/1999	8/23/1999	AHY	
		4/18/2000	AHY	1
		8/16/2002	AHY	3
		9/17/2002	AHY	3
Black-capped chickadee	8/19/1999	8/17/2001	HY	2
		9/4/2001	HY	2
Black-capped chickadee	9/13/1999	9/20/1999	AHY	
		8/31/2000	AHY	1
Black-capped chickadee	9/7/1999	9/8/1999	HY	
		8/12/2000	HY	1
Black-capped chickadee	9/6/1999	9/13/1999	HY	
		9/15/2000	HY	1
		8/21/2001	HY	2
Black-capped chickadee	9/13/1999	9/20/1999	AHY	
		8/31/2000	AHY	1
Black-capped chickadee	9/7/1999	9/8/1999	HY	
		8/17/2000	AHY	1
Slate-colored junco	8/27/1999	8/31/2000	AHY	1

Species	Banding Date	Return Date	Age at Banding	Years between Capture
		9/5/2000	AHY	1
Slate-colored junco	8/31/1999	9/5/2000	AHY	1
Hermit thrush	9/2/1999	9/6/1999	AHY	
		9/10/1999	AHY	
		9/13/2000	AHY	1
Slate-colored junco	8/24/1999	9/11/2002	AHY	3
Black-capped chickadee	8/23/2000	9/4/2000	HY	
		9/12/2000	HY	
		8/23/2001	HY	1
		8/28/2001	HY	1
Black-capped chickadee	8/23/2000	9/11/2000	HY	
		8/17/2001	HY	1
		8/30/2001	HY	1
		8/15/2002	HY	2
Black-capped chickadee	8/31/2000	9/23/2000	HY	
		8/30/2001	HY	1
		9/4/2001	HY	1
Black-capped chickadee	9/12/2000	9/12/2000	HY	
		5/18/2001	HY	1
		5/25/2001	HY	1
Slate-colored junco	8/22/2000	9/6/2001	AHY	1
Slate-colored junco	8/31/2000	8/30/2001	AHY	1
		9/5/2002	AHY	2
Hermit thrush	8/15/2000	8/2/2001	HY	1
Black-capped chickadee	8/23/2001	8/19/2002	HY	1
		9/11/2003	HY	2
Black-capped chickadee	8/29/2001	9/13/2003	HY	2
Black-capped chickadee	9/4/2001	8/16/2002	AHY	1
		9/13/2002	AHY	1
Black-capped chickadee	8/15/2001	8/21/2001	HY	
		8/16/2002		1
Black-capped chickadee	8/16/2001	8/17/2001	HY	
		8/21/2001	HY	
		8/27/2002	HY	1

Species	Banding Date	Return Date	Age at Banding	Years between Capture
Black-capped chickadee	9/4/2001	8/19/2002	HY	1
Black-capped chickadee	9/4/2001	9/13/2002	HY	1
Slate-colored junco	8/28/2001	9/3/2002	AHY	1
Slate-colored junco	8/30/2001	8/28/2002	HY	1
Slate-colored junco	9/5/2001	9/9/2002	AHY	1
Slate-colored junco	9/12/2001	8/19/2003	HY	2
Slate-colored junco	9/13/2001	9/6/2002	HY	1
Slate-colored junco	8/20/2001	8/30/2001	HY	
		9/5/2002		1
Hermit thrush	9/4/2001	8/21/2003	HY	2
Hermit thrush	8/23/2001	9/4/2002	HY	1
		8/30/2003	HY	2
Black-capped chickadee	8/15/2002	8/17/2004	HY	2
		8/12/2005	HY	3
Black-capped chickadee	8/15/2002	8/14/2003	HY	1
Black-capped chickadee	8/27/2002	8/11/2003	HY	1
		8/18/2003	HY	1
Black-capped chickadee	8/15/2002	9/11/2003	HY	1
		10/30/2004	HY	2
Black-capped chickadee	8/15/2002	8/10/2003	HY	1
		9/2/2003	HY	1
Black-capped chickadee	8/15/2002	9/11/2003	HY	1
		10/30/2004	HY	2
Black-capped chickadee	8/15/2002	8/10/2003	HY	1
		9/2/2003	HY	1
Slate-colored junco	8/16/2002	7/25/2003	HY	1
Slate-colored junco	8/23/2002	5/28/2004	HY	2
Slate-colored junco	8/26/2002	8/27/2003	HY	1
Slate-colored junco	9/5/2002	8/31/2004	HY	2
Hermit thrush	9/13/2002	8/20/2003	HY	1
Hermit thrush	8/19/2002	8/26/2005	HY	3
Downy woodpecker	9/11/2002	3/19/2003	HY	1
Black-capped chickadee	8/14/2003	8/25/2004	HY	1
Black-capped chickadee	8/14/2003	8/13/2004	HY	1

Species	Banding Date	Return Date	Age at Banding	Years between Capture
Black-capped chickadee	8/14/2003	8/13/2004	HY	1
		8/15/2005	HY	2
Black-capped chickadee	8/18/2003	9/11/2003	HY	
		9/14/2004	HY	1
		9/31/2004	HY	1
		9/14/2005	HY	2
Slate-colored junco	8/14/2003	8/13/2004	HY	1
Slate-colored junco	8/14/2003	9/8/2005	HY	2
Slate-colored junco	8/19/2003	8/30/2004	HY	1
Hermit thrush	8/27/2003	8/24/2004	HY	1
Hermit thrush	8/27/2003	6/23/2004	HY	1
		8/24/2004	HY	1
Hermit thrush	8/22/2003	8/31/2005	HY	2
		9/27/2005	HY	2
Black-capped chickadee	8/13/2004	8/15/2005	HY	1
Black-capped chickadee	8/13/2004	8/15/2005	HY	1
Black-capped chickadee	8/31/2004	9/14/2004	HY	
		8/10/2005	HY	1
		8/12/2005	HY	1
Black-capped chickadee	8/11/2004	8/26/2005	HY	1
		8/24/2006	HY	2
Black-capped chickadee	8/11/2004	8/25/2004	HY	
		8/17/2005	HY	1
Black-capped chickadee	8/11/2004	8/26/2005	HY	1
		8/24/2006	HY	2
Black-capped chickadee	8/11/2004	8/25/2004	HY	
		8/17/2005	HY	1
Black-capped chickadee	8/11/2004	8/10/2005	HY	1
		8/15/2005	HY	1
Black-capped chickadee	8/11/2004	8/25/2004	HY	
		8/11/2005	HY	1
Black-capped chickadee	8/11/2004	8/15/2005	HY	1
Black-capped chickadee	8/16/2004	8/10/2005	AHY	1
Black-capped chickadee	8/17/2004	8/30/2005	HY	1

Species	Banding Date	Return Date	Age at Banding	Years between Capture
Black-capped chickadee	8/17/2004	8/25/2004	HY	
		9/14/2004	HY	
		9/1/2006	HY	2
		9/14/2006	HY	2
		9/18/2006	HY	2
Black-capped chickadee	8/11/2004	8/19/2004	AHY	
		8/17/2005	AHY	1
Black-capped chickadee	8/11/2004	8/24/2005	AHY	1
Black-capped chickadee	8/11/2004	8/22/2007	HY	3
Black-capped chickadee	8/17/2004	9/4/2007	HY	3
Black-capped chickadee	8/11/2004	9/3/2008	HY	4
Slate-colored junco	8/24/2004	8/17/2005	HY	1
		8/29/2006	HY	2
		8/28/2006	HY	2
Slate-colored junco	8/18/2004	9/2/2005	HY	1
Slate-colored junco	8/23/2004	8/9/2005	HY	1
Boreal chickadee	8/11/2004	9/14/2005	HY	1
Boreal chickadee	8/11/2004	8/16/2005	HY	1
Boreal chickadee	8/11/2004	8/9/2005	HY	1
Myrtle warbler	6/23/2004	8/24/2004	AHY	
		8/27/2005	HY	1
Black-capped chickadee	8/16/2005	4/18/2006	HY	1
Black-capped chickadee	8/16/2005	8/29/2006	HY	1
		9/11/2006	HY	1
Black-capped chickadee	8/16/2005	8/16/2007	HY	2
Boreal chickadee	8/15/2005	9/14/2007	HY	2
Black-capped chickadee	8/16/2005	9/7/2007	HY	2
Black-capped chickadee	8/15/2005	9/3/2008	HY	3
Slate-colored junco	8/9/2005	8/28/2007	AHY	2
Hermit thrush	8/11/2005	9/8/2006	HY	1
Slate-colored junco	8/9/2005	9/7/2006	AHY	1
		9/11/2007	AHY	2
		8/22/2007	AHY	2
Slate-colored junco	9/2/2005	8/29/2007	AHY	2

Species	Banding Date	Return Date	Age at Banding	Years between Capture
Black-capped chickadee	8/30/2006	8/22/2007	HY	1
Black-capped chickadee	8/21/2006	8/22/2007	HY	1
Black-capped chickadee	8/21/2006	8/29/2007	HY	1
Black-capped chickadee	4/14/2006	8/30/2007	AHY	1
Black-capped chickadee	8/21/2006	8/30/2007	HY	1
Black-capped chickadee	4/18/2006	9/11/2007	AHY	1
Black-capped chickadee	4/18/2006	8/30/2007	AHY	1
Black-capped chickadee	9/1/2006	9/4/2007	HY	1
Black-capped chickadee	8/21/2006	9/7/2007	HY	1
Black-capped chickadee	8/30/2006	9/11/2007	HY	1
Black-capped chickadee	8/30/2006	9/11/2007	HY	1
Black-capped chickadee	8/21/2006	8/31/2007	HY	1
Black-capped chickadee	4/18/2006	8/30/2007	HY	1
Black-capped chickadee	8/21/2006	8/21/2008	HY	2
Black-capped chickadee	8/21/2006	9/3/2009	HY	3
Slate-colored junco	8/17/2006	8/20/2007	HY	1
Slate-colored junco	9/11/2006	8/30/2007	HY	1
Slate-colored junco	9/7/2006	9/7/2007	HY	1
Slate-colored junco	9/7/2006	9/5/2008	HY	2
Slate-colored junco	8/21/2006	8/21/2007	HY	1
Slate-colored junco	8/21/2006	8/20/2008	HY	2
Slate-colored junco	8/21/2006	9/2/2008	HY	2
Slate-colored junco	9/7/2006	9/15/2009	HY	3
Slate-colored junco	8/31/2006	9/15/2009	HY	3
Slate-colored junco	9/7/2006	9/9/2009	HY	3
Slate-colored junco	8/21/2006	8/16/2007	HY	1
Slate-colored junco	8/17/2006	8/30/2007	HY	1
Hermit thrush	9/6/2006	9/4/2008	HY	2
Hermit thrush	9/6/2006	8/27/2008	HY	2
Myrtle warbler	8/23/2006	8/22/2007	HY	1
Black-capped chickadee	8/21/2007	8/20/2008	HY	1
Black-capped chickadee	8/17/2007	8/25/2008	HY	1
Black-capped chickadee	8/17/2007	9/3/2008	HY	1
Black-capped chickadee	8/31/2007	8/31/2009	HY	2

Species	Banding Date	Return Date	Age at Banding	Years between Capture
Black-capped chickadee	8/21/2007	8/20/2008	HY	1
Black-capped chickadee	8/31/2007	8/31/2009	HY	2
Black-capped chickadee	8/21/2007	8/20/2008	HY	1
Slate-colored junco	8/27/2007	9/5/2008	HY	1
Slate-colored junco	8/24/2007	8/25/2008	HY	1
Slate-colored junco	8/16/2007	9/2/2008	HY	1
Slate-colored junco	8/31/2007	8/27/2009	HY	2
Hermit thrush	8/21/2007	9/7/2011	HY	4
Hermit thrush	8/30/2007	9/2/2008	HY	1
Black-capped chickadee	8/20/2008	9/17/2009	HY	1
Black-capped chickadee	8/20/2008	9/1/2009	HY	1
Slate-colored junco	8/22/2008	9/4/2009	HY	1
Slate-colored junco	8/29/2008	9/8/2009	AHY	1
Slate-colored junco	8/22/2008	9/4/2009	AHY	1
Hermit thrush	8/29/2008	8/31/2009	HY	1
Boreal chickadee	9/4/2008	9/15/2009	HY	1
Boreal chickadee	9/4/2008	9/12/2011	HY	3
Hermit thrush	8/21/2009	8/24/2010	HY	1
Black-capped chickadee	8/16/2010	8/7/2011	HY	1
Black-capped chickadee	8/30/2010	8/17/2011	HY	1
Black-capped chickadee	8/20/2010	8/19/2011		1
Black-capped chickadee	8/18/2010	8/22/2011	HY	1
Black-capped chickadee	9/14/2010	8/26/2011	HY	1
Black-capped chickadee	8/18/2010	8/30/2011	HY	1
Slate-colored junco	8/16/2010	9/6/2011	HY	1
Slate-colored junco	9/13/2010	9/13/2012	HY	2
Hermit thrush	9/14/2010	9/7/2011	AHY	1
Boreal chickadee	8/16/2010	9/14/2011	HY	1
Hermit thrush	9/13/2010	9/15/2011	HY	1
American robin	8/23/2010	8/26/2011	HY	1
Slate-colored junco	9/8/2011	8/30/2012	HY	1
Hermit thrush	9/8/2011	9/6/2012	HY	1
Ruby-crowned kinglet	8/19/2011	8/16/2012	HY	1
No recaptures in 2013				

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