



Fall Migration Bird Banding 2018

Mass Audubon's Wellfleet Bay Wildlife Sanctuary

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About Wellfleet Banding Station

Wellfleet Bay Wildlife Sanctuary (41.883 N, 69.996 W) is located in South Wellfleet, MA and is owned and managed by Mass Audubon. James Junda manages the banding station with the cooperation and assistance of sanctuary staff. Two experienced and licensed banders operate the station daily from April 15 – May 31 and September 1 – November 15. Volunteer assistance is used daily and greatly benefits the operation of the station.

It is a valuable addition to a growing collection of banding stations on Cape Cod, being the only station located on the northern arm of Cape Cod. Monomoy Refuge Banding Station (MRBS) is operated in unison with Wellfleet Bay and is located 30km SE near the lighthouse on the southern end of Monomoy National Wildlife Refuge in Chatham. These two stations share protocols, banders and social media outreach. Two other constant-effort banding stations are already operate on or near Cape Cod: Wing Island Banding Station in Brewster (20 km to the WSW) and Manomet Center for Conservation Science (50 km to the W). Operations are based upon the protocols of other constant-effort banding stations in the United States and Canada with an emphasis on standardized research protocols. In addition to collecting and analyzing scientific data to assist in management decisions, Wellfleet Banding Station serves to increase public interest on the sanctuary, Cape Cod and around the world.

History of Banding at Wellfleet Bay

The bird banding pedigree of this property runs deep. The first bird banding station on the property was established in 1929 when well-known ornithologist Dr. Oliver Austin Jr. founded the Austin Ornithological Research Station with his father, Dr. Oliver Austin Sr. The Austins initially caught and banded waterfowl, shorebirds, terns, sparrows and blackbirds using a variety of traps, and began widely mist netting songbirds in the 1940s and 50s, when Oliver Jr. introduced the first Japanese mist nest to the United States. Mass Audubon took over the property in 1958 and continued the ornithological research begun by the Austins. Some bird banding has occurred on the property in 60 out of the last 85 years. Erma “Jonnie” Fisk banded at the sanctuary regularly between 1972 and 1989, mainly for the purpose of public education. 1989 marked the last year of regular banding on the property until 2014.

The abundance of certain birds in the banding data from the Austin years reflects both the methods used by the Austins (duck, sparrow, and tern trapping), as well as the vastly different landscape of Cape Cod during the first half of the 20th century. Open country species like Vesper Sparrow and Grasshopper Sparrow, all but extirpated from the now heavily wooded Outer Cape, were common on the treeless post-agricultural landscape of the Austin era. For example, they reported 183 Vesper and 51 Grasshopper Sparrows banded in 1931 alone (Austin 1932). Incomplete banding data were obtained from the Bird Banding Lab from the Austin years, but based on Austin’s publications it is clear that much of it is missing. Starting in fall 2016 Elora Grahame has begun the process of digitizing and entering all the historical data. She has only entered a few years of data, but has already discovered much, including that banding using mistnets occurred over a decade earlier than previously thought. As this process continues we look forward to improving our understanding of how things have changed in the last 80 years.

Fall Migration Banding

Fall migration banding is a standardized study undertaken annually. It provides the basis for long-term trend analysis of migrating birds using the sanctuary, and is designed to be comparable with the methodology of other fall migration banding stations. The protocol involves regular standardized banding operations with mist-netting effort remaining constant daily, seasonally and annually. The spring migration season extends from September 1 – November 15 with nets open every day at dawn and remaining open for 5 hours (weather permitting). This period encompasses the majority of fall passerine migration, giving a thorough view of the majority of the process, allowing us to operate the station without conflicting with the popular summer events, but still allowing for overlap with fall school programs and the tail end of busy season on Cape Cod.

Outreach and Public Programs

One of our primary goals is to increase knowledge and expose the public to avian life on the sanctuary. To this end, we scheduled banding demonstrations, school visits and made the station available to certain special visitors to the sanctuary. Demos were conducted each Saturday for the entire season. While the banding demonstrations were not completely booked, increased advertising efforts by sanctuary staff had a positive impact and attendance remained steady throughout the fall, even as the crowds thinned on Cape Cod. In total, 40 people attended 5 public demos (8 per demo). In addition to the five banding demos, we recorded a total of 12 more organized visits from different groups this fall. There were 9 school visits, when students from primary to high school came to the station, learned about operations and saw birds up close. Over 450 students spread across a variety of grades attended these programs! Monomoy 7th grade participated in a more in-depth examination of our data collection as part of a program run by Spring Beckhorn, and we hope to expand our part in these types of programs in the future. An adult field school groups with 15 attendees, a single donor group visit arranged by Julie and the Wild Wild Wellfleet winning bid group all had a great visits to the station. All told, we had 17 visits from various groups in the 76 days of the season (down from 29 in 2017) and we hope to expand our education and outreach efforts in Fall 2019.

Our outreach tools were refined and expanded in Fall 2018. Our daily eBird reports were standardized to be completed during a standard period as part of banding operations. The survey is posted on eBird the same day, along with any rare birds captured at the banding station. These standardized counts not only allowed us to document species not caught during mist-netting, but also to increase the visibility of the sanctuary online and attract birders to the property.

The second tool was a dry-erase board in the lobby of the visitor's center, where we posted the top 5 species from the previous week, top 5 species expected in the next week (based on data from previous seasons), top capture of the day (for Wellfleet and Monomoy) and promote the weekly demos. This board was very successful. Most visitors had a look to see how things change daily and weekly throughout the fall, and it functioned to raise awareness of the demos as well as the work conducted at the banding station. We refocused our efforts on social media this fall by posting a picture of an interesting capture on [Twitter](#) and [Instagram](#) each day with some natural history information about the species or individual. We collected an additional 800 followers and hundreds of likes and comments. This as well as our feature in the [Cape Cod Times](#) greatly increased the visibility of the station in 2018.

Volunteers

In Fall 2018, we maintained stability in our core team, with most of our volunteers returning, but health issues limited the participation of a few regulars. Valerie Bourdeau was our most important volunteer, operating as the second bander from Sept 1-21 and Oct 13-31. Jeannette Bragger, Warren Mumford, Tod Christie and Frank Mockler returned and were present two days a week. Teresa Corcoran volunteer once a week in her fourth season and Nick Dorian volunteered on weekend when possible. We tried three new volunteers this fall, but only Peggy Sagan returned multiple times and we look forward to her assistance in the future. Mary Lou Heintz and Jeannette Bragger both suffered from health issues that limited their walking, so they had reduced schedules in 2018.

All volunteers practiced extracting birds, helped with erecting nets and performed the majority of data recording. Volunteers in general showed great improvement this year, becoming much more effective extractors and therefore much more useful to station operation. Over the six weeks when James was on Monomoy, they had to provide a greater level of assistance to the banders on site. This increased responsibility lead to more solo extraction, greater confidence and a big step forward. Moving forward, the station will benefit even more from an experienced volunteer base.

2018 Season Coverage

In Fall 2018, the banding season started on September 1 and ended on November 15, for a total of 76 days. We operated up to a maximum of 22 nets on 61 days for a total of 5527.30 net hours. This is a slight increase of two days of banding from Fall 2017, when we operated on 59 days for 5490.64 hours, which itself was an increase of net hours from 2016 (5352.07), and much higher than 2015 (4173.50) when we operated four fewer nets and 2012 (2763.34) when we did not open until September 21. We banded on 25 days in September, 24 days in October, and 12 days in November. The weather over the fall was good and very steady, except for a few storms causing two-day banding gaps in September and October, accounting for a large proportion of our missed days. With no major hurricanes in 2018, we never missed more than two days in a row, leading to our most days banded of all previous seasons.

Banding

During Fall 2018 operations, we had 2083 captures representing a total of 74 species (Appendix A): 1463 newly banded birds, 581 local recaptures, one foreign recapture, and 37 unbanded. Below, we break this down into the number of birds banded and recaptured daily, standardizing the effort by correcting to 100 net hours.

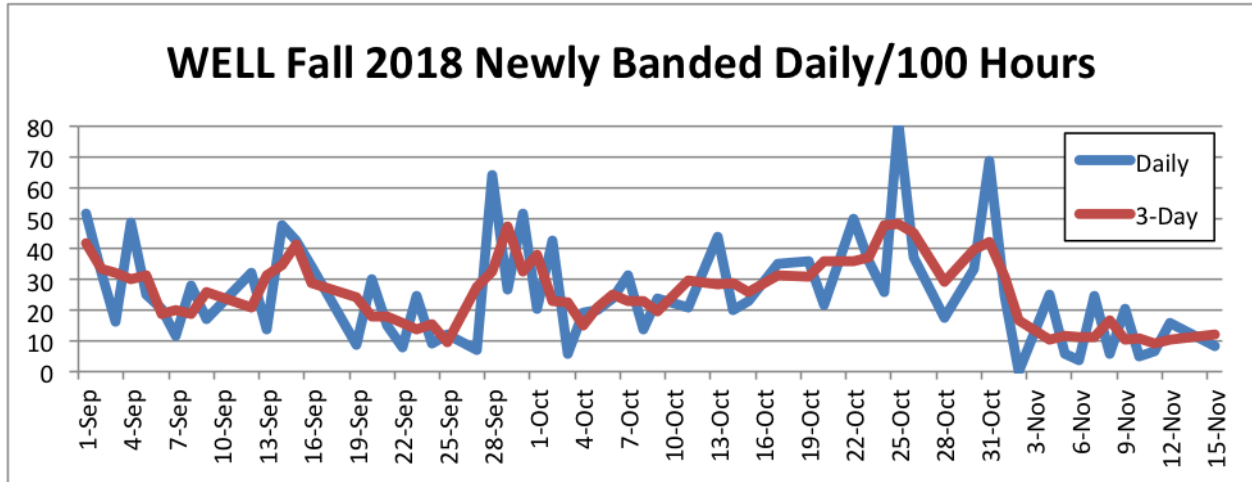


Figure 1- Number of birds banded daily per 100 net hours at Wellfleet Bay Wildlife Sanctuary during fall 2018 operations. Blue line is the daily captures, while the red line is the three-day running average. Banding captures peaked in mid-September, late September/early October and late October.

Capture rates varied throughout the season, averaging around 25 banded per 100 net hours daily as a baseline, with peaks of captures from 40-80 birds as waves of migration occurred. After initially high captures, the rate stayed at about 20-25 a day through September with peaks around the 14th and 28th. The rate drops below 30 a day for the first half of October, before peaking in late October at 40-50 a day. After this wave, the rate drops to about 10 per day for November.

We experienced three peak banding periods, Sep 8-12, Sep 28-Oct 2 and Oct 22-31. Each of these peaks corresponded with a wave of migration associated with a cold front, usually dominated by a given species. Pine Warblers made up 53% of the captures during the first wave (Sep 8-12). The Sep/Oct wave was primarily made up of three species (Pine Warblers (31%), Chipping Sparrows (13%) and Blackpoll Warblers (13%)). The late October wave was more diverse, with no species making up more than 21% of the total and 42 species banded over this period. It was however dominated by a few clades, with kinglets (33%) and sparrows (28%) making up 60% of bandings.

Species Makeup

With 75 species captured, this fall was tied for our second most diverse season, falling behind 2017 (78), equalling 2016 (75), and outpacing 2015 (71) and 2014 (69). We averaged about ten species a day for the entire fall, jumping to ~15 per day for the last two weeks of October, and dropping to 6 per day for November. This steady diversity of captures is a reflection of the large diversity of resident and migrating bird life present throughout the season.

Overall richness was highest during the second half of October peaking on the October 23 (20 species) and October 24 (19). In previous seasons, the peak of diversity occurred in late September/early October with “early” warblers and flycatchers overlapping with “late” warblers, sparrows and thrushes. We missed this peak in 2018, when September migration was fairly weak, but late October migration was strong with larger than normal number of sparrows and thrushes on site. November showed the lowest diversity as goldfinches dominated captures while most other species reached the end of their migration. We had no new species captured in Fall 2018 and our 5-year capture total stands at 112 species.

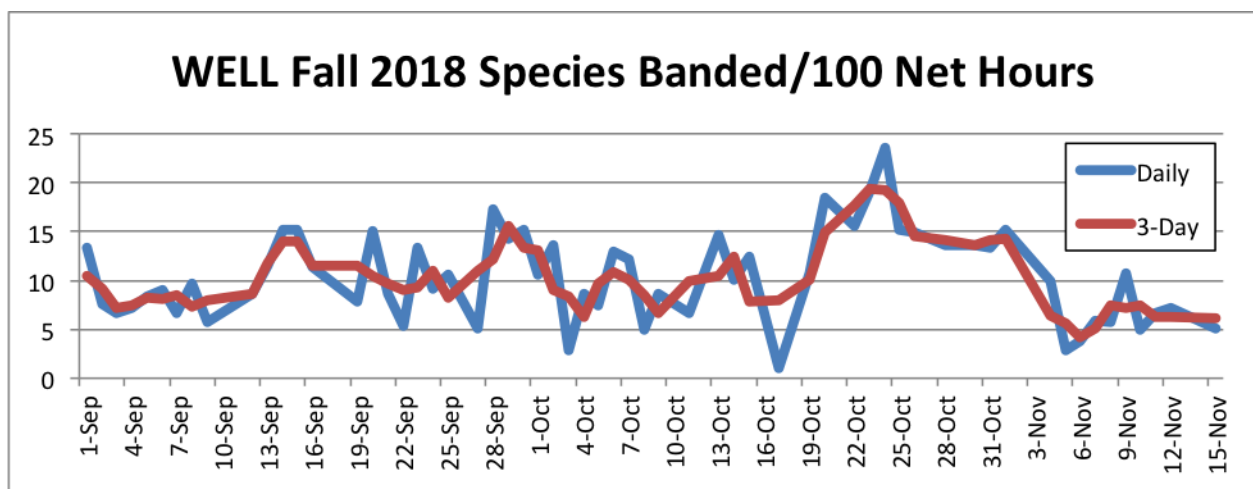


Figure 2- Number of species banded per 100 net hours daily at Wellfleet Bay Wildlife Sanctuary during Fall 2018 operations. Blue line represents daily species total, while the red line represents a running 3-day average. Species richness peaked in late October, but was fairly constant around 10 species per day throughout the season, before dropping slightly over the last two weeks.

Four-Year Comparison

When we look at the four-year data, we see some interesting patterns of abundance. In 2014, there was a peak in captures on the first day, most likely due to locally raised fledglings and resident birds unfamiliar with mist nets getting caught in great numbers (Fig 3). For example, the first net checked on the first day of banding in 2014 had 29 birds in it, mostly chickadees and titmice. This early peak was repeated in 2015, much reduced in 2016 and 2017, and repeated in 2018. 2014 was the busiest season daily, but did not start until September 20. 2015 and 2016 were similar in capture rates, with 2015 busier in October and 2016 busier in September. 2017 had the busiest late October/November due to large flocks of American Goldfinches in the Upland Field and Saltmarsh Edge nets, but was much slower for most of October. 2018 was average for September, slower for most of October, busier than any previous season for the end of October/early November (driven by a strong sparrow migration and steady NW winds), before tanking in November when American Goldfinches were not present to boost our numbers. Across all other seasons, captures are generally low and steady until the second week of October, the busiest time. Captures generally slowed in late October (except in 2018!) before bottoming out into November. Some capture peaks were observed across multiple seasons and linked to a single species. Yellow-rumped Warblers drove the mid to late October peak in 2014-2016, and the peak in the second week of November (2014, 2016 and 2017 only) is driven by the arrival of American Goldfinches.

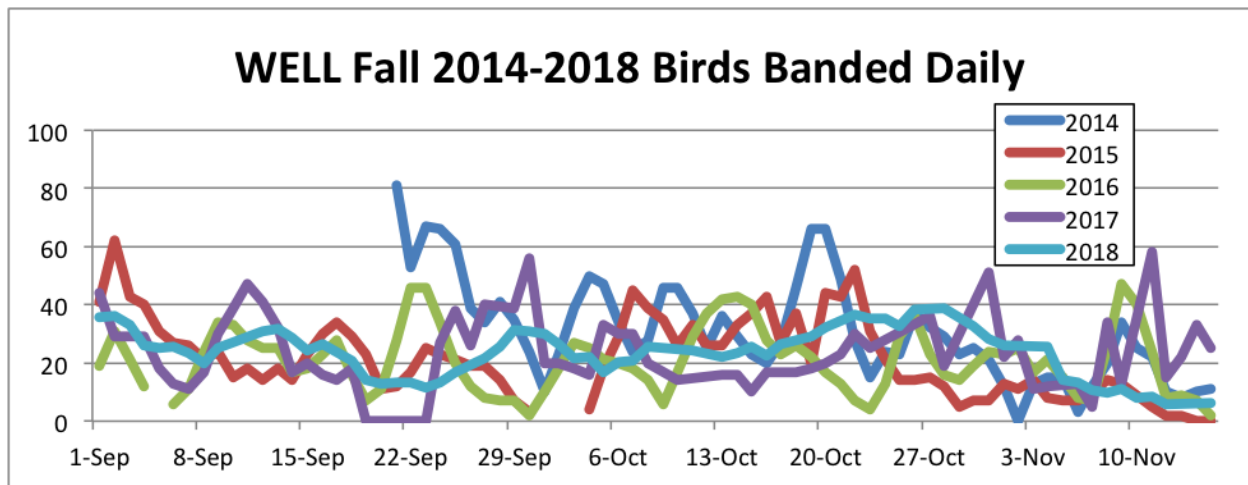


Figure 3- Birds banded daily during fall banding operations at Wellfleet Bay Wildlife Sanctuary from 2014-2018. Banding was busiest in the second week of October, being slower in September and November. 2014 had the busiest daily totals, but overall each season was similar in capture rates.

If we combine 2014-2017 into a single data series, we can make some more direct comparisons to the 2018 data (Fig. 4). 2018 had an early batch of residents on the first few days of banding, similar to 2014 and 2015. Then 2018 followed the patterns seen in previous years with a few exceptions. First, it was slower in late September and most of October than in previous years. Then a huge surge occurs over the last week of October, driven by steady and strong NW winds, and huge flocks of sparrows that filled the sanctuary. Numbers were again very low in November as the American Goldfinches never seemed to arrive.

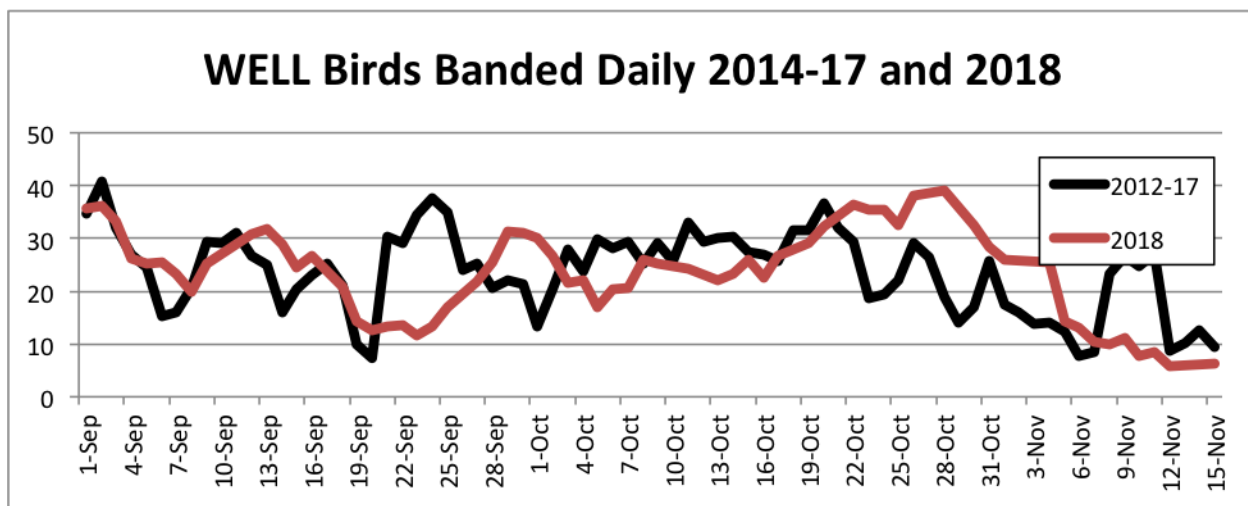


Figure 4- Birds banded daily during banding operations at Wellfleet Bay Wildlife Sanctuary from 2014-2018. Data from 2014-2017 is combined to better emphasize the differences in timing from the fall 2018 season.

Common Captures

Next, we will look at some of the more common species encountered to further examine how the sanctuary is used by various species. Table 1 lists the top 30 most common species captured in fall 2018 with totals for 2014-17 included.

Pine Warbler (325) was our most numerous capture for the second year, after jumping to third place in 2016. Much of this rise is due to the increased captures driven by the addition of Net 19 in the field partway through the Fall 2016 season. Gray Catbird numbers doubled from 2017 (140), regaining the second position. Black-capped Chickadees (161) numbers rebounded after falling about 12% in 2017, the lowest capture total of any year. Blackpoll Warbler (156) numbers shot up, almost doubling all previous years combined, a reflection of the continued spruce budworm outbreak in the boreal forest.

Ruby-crowned Kinglets also had a huge year, with more captures than all previous years combined. Chipping Sparrows numbers were down from the banner 2017 year, but still more than double all previous season, reflecting the increased capture rates of Net 19 for this species which often flocks with Pine Warblers in fall. White-throated Sparrow were way up, almost tripling the 2017 total, reflecting the strong October sparrow migration. American Goldfinch numbers were down over 50% from 2017 and 2016. This is unexplained, but they did not arrive in large numbers before the end of the season.

Song Sparrow numbers were double 2017, but on par for most years.

Swamp Sparrow were captured at triple the rate of any previous seasons, a reflection of the strong October sparrow migration. Golden-crowned Kinglets were also way up. We had more Brown Creepers in 2018 than all previous years combined, likely a reflection of a good breeding season and the strong October migration. Red-breasted Nuthatches almost doubled all previous seasons combined. This is a bi-annual irruptive migration driven by seed crop failures in northern pine forests. This failure of seed crops may be responsible for the strong October migration, as cascade effects from the pine seed crop failure may impact other species using these habitats. Or it could be a combination of very good breeding season

Table 1- Top 30 most common species captured at Wellfleet Bay Wildlife Sanctuary in Fall 2018, including the totals for 2014-17.

Species	2018	2017	2016	2015	2014
1. Pine Warbler	325	199	138	32	33
2. Gray Catbird	292	140	133	200	88
3. Black-capped Chickadee	161	125	150	189	136
4. Blackpoll Warbler	156	20	44	18	9
5. Ruby-crowned Kinglet	137	31	51	15	28
6. Chipping Sparrow	107	158	27	21	47
7. White-throated Sparrow	78	28	14	17	45
8. American Goldfinch	75	171	161	87	48
9. Song Sparrow	66	32	46	71	58
10. Swamp Sparrow	54	15	20	17	14
11. Golden-crowned Kinglet	51	22	32	14	6
12. Brown Creeper	42	7	19	3	10
13. Red-breasted Nuthatch	36	8	15	2	0
14. Yellow-rumped Warbler	34	105	102	50	132
15. Northern Cardinal	33	35	51	42	68
16. Carolina Wren	30	12	7	9	19
17. House Wren	26	13	1	2	1
18. American Redstart	24	38	27	15	5
18. Eastern Phoebe	24	27	20	15	17
20. Eastern Bluebird	23	9	46	22	13
21. Slate-colored Junco	22	6	35	5	48
22. Red-eyed Vireo	21	32	36	31	23
23. Hermit Thrush	20	2	8	10	16
24. Common Yellowthroat	16	42	13	28	9
24. Downy Woodpecker	16	6	28	17	10
26. Field Sparrow	15	14	16	27	23
27. Blue Jay	13	35	62	57	16
30. White-crowned Sparrow	11	0	1	0	1
30. Palm Warbler	11	32	18	3	0

and prolonged and unusually steady NW winds in October driving a strong coastal migration, which may not be reflected in more interior locations.

Interestingly Yellow-rumped Warblers numbers were 1/3 of the previous two seasons and our lowest total ever. This common October migrant capture rate should have benefited from the steady NW winds in late October, but still numbers were way down. Yellow-rumps are cyclic and may be experiencing a down cycle as the other boreal warblers (Cape May and Blackpoll), who are dominant on breeding grounds, boom. Northern Cardinals remain down but steady, perhaps an artifact of the small net mesh size adopted in 2016. Carolina Wren numbers continue to increase as they recover from the deadly snowy winter of 2014/15 that decimated the population across Cape Cod. House Wrens continued the upward trend seen in 2017 and seem to be having a few good years in a row. American Redstarts were down slightly after having a banner year in 2017.

Eastern Phoebe held steady and Eastern Bluebirds rebounded from a slow 2017. Juncos continued their bi-annual variation with an up year in 2018, following the pine nut specialist pattern of abundance. Red-eyed Vireos were down slightly, reflecting the slow September migration in 2018. Hermit Thrushes were up, again likely influenced by the steady NW winds in late October, when their migration is peaking. Common Yellowthroats were down, after being up in 2017, but down in 2016, following a bi-annual pattern of breeding success. Downy Woodpeckers rebounded from a slow 2017 and were on par with other seasons. Field Sparrows remain down from 2014/15, even with an increased net presence in the Upland Fields, showing a real downturn for this species on the sanctuary. Blue Jays were way down after three successful breeding seasons, likely reflecting a poor acorn crop in 2018. White-crowned Sparrows had a great year, with five times the captures of all previous years combined. Both young and adults were present in huge numbers, reflecting both a successful breeding season and a strong migration on Cape Cod. Adult numbers should not vary much from year to year and would not be reflective of breeding success. After two strong years, Palm Warbler numbers were down 66% in 2018. This late October migrant was not buoyed by the NW winds over this period, reflecting a very poor breeding output (similar to Yellow-rumped Warbler). Eastern Towhee's are not included on this list, because we only had 4 captures in 2018 after averaging 36 a year for 2014-16. This may partially be a result of our smaller mesh size allowing the larger songbird to escape, but our eBird surveys mirror this decline; Towhees were only recorded on 21/55 days, usually only a single individual.

Uncommon Captures

On the other end of the spectrum are the birds encountered only once or twice in a season. These birds may not pass through the sanctuary in large numbers (or may be present but not captured often), but still shed light on avian habitat use. Species only banded twice this fall are: Brown Thrasher, Common Grackle, Lincoln's Sparrow, Tennessee Warbler and White-breasted Nuthatch.

Species banded only once: Alder Flycatcher, Black-billed Cuckoo, Cape May Warbler, Connecticut Warbler, Indigo Bunting, Least Flycatcher, Mourning Warbler, Northern Parula, Olive-sided Flycatcher, Philadelphia Warbler, Pine Siskin, Veery, Wilson's Warbler, Yellow-bellied Flycatcher and Yellow-bellied Sapsucker.

Seasonal Variation in Diversity

Diversity and species make-up varied throughout the season, with capture rates of individual species changing as the season progressed. Within this ebb and flow, certain resident species, i.e. Black-capped Chickadee are present throughout the fall. Pine Warbler was in the number one position for all of September, fell to second place by the first half of October, before falling off the list entirely for the final month. Other summer breeders - Common Yellowthroat, Eastern Phoebe, Chipping Sparrow, House Wren, and Gray Catbird - followed a similar pattern, peaking in September then declining later in the fall. Yellow-rumped Warblers start to appear in early October, peak in late October and decline into November. Wintering species such as White-throated Sparrow, American Goldfinch, Ruby and Golden-crowned Kinglet are either absent or present in smaller numbers early in the fall, before increasing greatly in numbers as they settle in for winter. Most migrant species peak over a week or two as they pass through on their way to warmer climes: Brown Creeper, American Redstart, Blackpoll Warbler, Red-eyed Vireo, etc.

Table 2- The most common species banded weekly at Wellfleet Bay Wildlife Sanctuary in Fall 2018. Some species like Black-capped Chickadee are present throughout the fall, others present early in the season before declining i.e. House Wren, Gray Catbird, Pine Warbler or were absent at the start of the season and increasing in numbers later in the fall, i.e. Hermit Thrush, Ruby-crowned and Golden Crowned Kinglets.

Period 1		Period 2		Period 3		Period 4		Period 5	
Aug 30–Sep 15		Sep 16-Sep 30		Oct 1-Oct 15		Oct 16-Oct 31		Nov 1-Nov 15	
1. PIWA ¹	158	PIWA	63	BLPW	101	RCKI	79	AMGO	35
2. GRCA ²	74	GRCA	38	PIWA	38	WTSP ¹⁸	41	RCKI	22
3. CHSP ³	26	CHSP	30	CHSP	25	GCKI ¹⁹	41	WTSP	12
4. BCCH ⁴	22	BLPW ¹¹	14	GRCA	19	SOSP	28	SOSP	9
5. EAPH ⁵	11	REVI ¹²	9	RCKI ¹⁴	13	BRCR ²⁰	26	YRWA	6
6. EABL ⁶	10	AMRE ¹³	7	SWSP ¹⁵	10	SWSP	20	NOCA ²²	6
7. CARW ⁷	9	EABL	6	YRWA ¹⁶	10	BLPW	18	GCKI	5
8. RBNU ⁸	8	EAPH	5	BCCH	7	YRWA	17	BCCH	5
9. AMGO ⁹	7			SOSP ¹⁷	7	AMGO	16	HETH ²³	4
10. HOWR ¹⁰	7					SCJU ²¹	16		

Legend

- | | | |
|---------------------------|---------------------------|----------------------------|
| 1. Pine Warbler | 9. American Goldfinch | 17. Song Sparrow |
| 2. Gray Catbird | 10. House Wren | 18. White-throated Sparrow |
| 3. Chipping Sparrow | 11. Blackpoll Warbler | 19. Golden-crowned Kinglet |
| 4. Black-capped Chickadee | 12. Red-eyed Vireo | 20. Brown Creeper |
| 5. Eastern Phoebe | 13. American Redstart | 21. Slate-colored Junco |
| 6. Eastern Bluebird | 14. Ruby-crowned Kinglet | 22. Northern Cardinal |
| 7. Carolina Wren | 15. Swamp Sparrow | 23. Hermit Thrush |
| 8. Red-breasted Nuthatch | 16. Yellow-rumped Warbler | |

Recaptures

There were 583 recaptures in the fall of 2018: 476 repeats - individuals recaptured within the same year at the banding station, 106 returns - individuals banded on site in previous seasons (vs. 109 in 2017 and 162 in 2016), and one foreign recap. The volume of recaptures (583) compared to birds banded (1462) represents a very high recap to banded ratio over 1:3. This rate implies individuals captured on site often remain on site for a time, leading to high recapture rates. Recaptures fluctuated around ~10/100 hours from September 1 until early November (Fig 5) with peaks in late September and late October. The diversity of recaptures followed a similar pattern, starting low then settling around five species a day in September and October with peaks corresponding with migration waves.

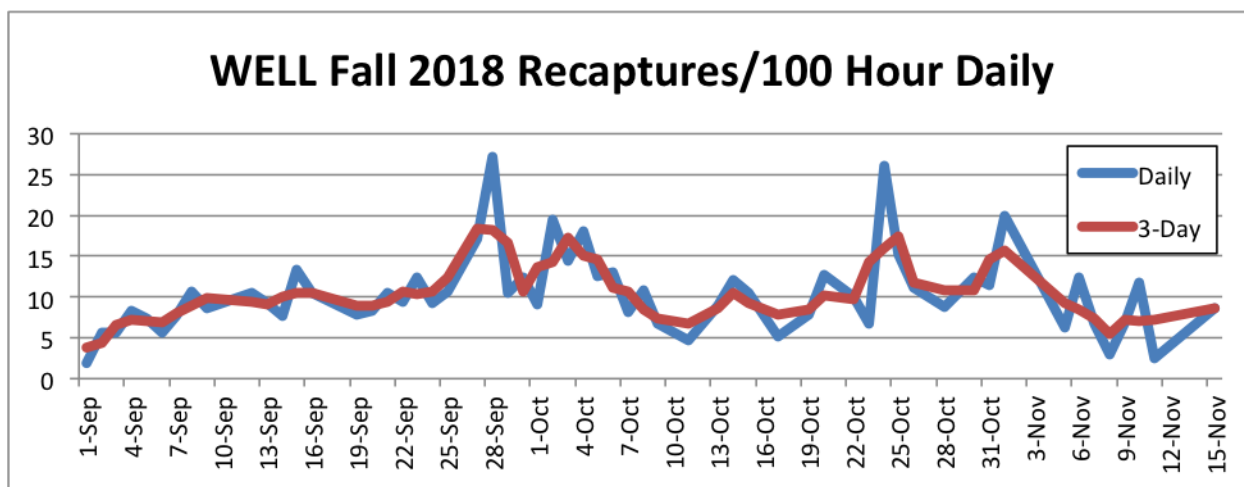


Figure 5- Number of birds recaptured per 100 net hours daily during fall 2018 banding operations. Recapture peaks corresponded with migration peaks.

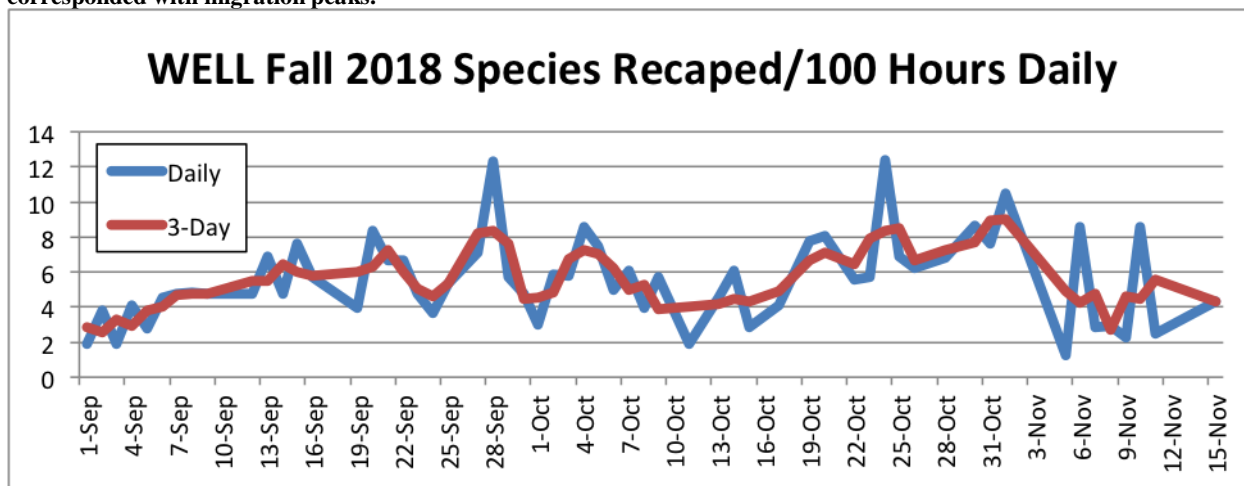


Figure 6- Number of species captured per 100 net hours daily during fall 2018 banding operations. Diversity of recaptures stayed constant from September through the end of banding in November with a couple peaks during waves of migration.

Returns

We had 82 individual returns (individuals banded in a previous season and recaptured in fall 2018) representing 21 species. The majority were year-round residents: American Goldfinch (6), American Robin (1), Black-capped Chickadee (25), Blue Jay (6), Carolina Wren (1), Downy Woodpecker (1), Eastern Bluebird (1), Field Sparrow (1), Northern Cardinal (6), Red-breasted Nuthatch (1), Red-bellied Woodpecker (2), and Song Sparrow (2). With some of these birds being originally banded in 2014, we look forward to re-encountering them each year.

The others were mostly made up of summer breeders captured before initiating migration: Chipping Sparrow (6), Common Yellowthroat (2), Eastern Towhee (1), Gray Catbird (6), House Wren (2) and Pine Warbler (9).

Finally, two were overwintering species not found know to breed on the sanctuary. First, a Swamp Sparrow (1) originally banded on 1-Nov-2016 and not reencountered since. We also had two White-throated Sparrows: one banded as a second-year in April 2018 and recaptured this fall on 12-November, the other originally banded on 29-Oct-2014 as an after-hatching-year, then recaptured in November 2016 and April 2018! These sparrow returns show that Wellfleet Bay Wildlife Sanctuary is a yearly overwintering site for these birds.

Net Productivity

We assessed the productivity and usage of all nets (see map Appendix C) and summarized the data in Table 3. Nets are placed along two loops, the Silver Spring Loop 1, 2, 3, 5, 6, 7, 16, 18, 20, 21, 24 and the Bay View Loop 9-15, 19, 22, 26, 61. Nets fell into four broad habitats: semi-open field - Upland Fields (1, 3, 9, 11, 18, 19, 61, 20, 22), freshwater mature forest/thicket along - Silver Spring (2, 5-7, 16, 21, 24), dense Black Locust forest - the Maze (10, 12, 15, 26) and Saltmarsh Edge (13, 14).

The majority of nets were two-year-old Avinet 12x2.6m 32mm nylon nets. There were two abnormal nets: (Net 61) was a 6x2.6m standard height 4 tier net and (Net 6) was actually one 12x1.3m two tier net. Net 6 net was hung in a more elevated position to avoid flooding at this location. The previous nets were 38mm (replaced September 16 2016) and the quality and mesh size of the nets may have impacted capture rates along the lines laid out in Heimerdinger and Leberman (1966). Larger passerines such as Eastern Towhee and Gray Catbird as well as Sharp-shinned Hawk may have been captured more often in the (larger mesh size) old nets, while smaller species like warblers, chickadees and sparrows were likely captured more often in the new nets. These new nets have put the station in line with what is commonly used at other stations and increased capture rates overall.

Table 3- Net effort and capture rates for newly banded and recaptures during Fall 2018 banding operations at Wellfleet Bay Wildlife Sanctuary.

Net	Net hours	Banded	Recaps	Total Captures	Banded /100 Net Hours	Recaptures /100 Net Hours
1	269.14	25	15	45	9.3	5.6
2	277.64	56	27	83	20.2	9.7
3	243.46	39	14	54	16.0	5.8
5	282.65	36	16	52	12.7	5.7
6*	137.73	37	20	62	26.9	14.5
7	284.81	49	28	78	17.2	9.8
9	255.46	60	29	90	23.5	11.4
10	271.81	78	53	134	28.7	19.5
11	211.12	136	31	170	64.4	14.7
12	265.14	55	21	76	20.7	7.9
13	210.97	107	39	146	50.7	18.5
14	237.79	94	66	160	39.5	27.8
15	281.31	43	20	65	15.3	7.1
16	289.82	51	43	98	17.6	14.8
18	272.47	46	13	61	16.9	4.8
19	256.97	246	30	278	95.7	11.7
21	289.82	34	27	64	11.7	9.3
22	222.13	34	12	48	15.3	5.4
24	270.31	77	25	104	28.5	9.2
25	288.82	46	23	70	15.9	8.0
26	271.81	80	21	101	29.4	7.7
61*	136.15	33	8	41	24.2	5.9
Total	5490.64	1462	581	2080	26.5	10.5

*1/2 coverage net

The net hours (effort) varied greatly among nets, from 136 hours at Net 61 (a 6m net) to 289 hours at Net 16 and 21. Several factors contributed to these differences. Net 61 was a 6m net and Net 6 was 1.2m tall net, each with half the coverage of a 12x2.4m net, hours for these nets were counted at 0.5 the rate of 12m nets. Nets were also be closed piecemeal in reaction to weather conditions, generally wind, but also occasionally rain or cold. The Upland Field nets (3, 9, 11, 19, 22, 61) and Saltmarsh Edge nets (13, 14) were the most exposed and therefore most affected by wind and rain. Balancing capture rate and exposure is very important, some nets capture significantly more birds but are also more exposed to wind. For example, the Upland Field and Saltmarsh Edge nets have the highest capture rates but are also the most impacted by wind. Finding a balance between net exposure and capture rates has proven key to net placement.

Net 19 was the busiest net (95.7 banded per 100 net hours), followed by Net 11 (64.4). Both of these nets were in the upland fields and were impacted by large flocks of Pine Warblers, Chipping Sparrows and Eastern Bluebirds present in this habitat each fall.

Species By Habitat

The banding station is composed of a mix of habitats attracting a diverse collection of bird species. Some species like Blackpoll Warbler, Gray Catbird, White-throated Sparrow and Black-capped Chickadee were present in all habitats, with catbirds and chickadees occupying a Top 5 position in each habitat (Table 4). Other species like Eastern Bluebirds were more likely occur in a single given habitat, with 19/23 (83%) of captures occurring along in Upland Fields.

Table 4- Four major habitats represented at Wellfleet Bay Wildlife Sanctuary, including the most common species captured in nets in each habitat during Fall 2018 operations:

a) Upland Fields- dry brushy open fields b) Silver Spring- mature mixed fresh water riparian forest
c) Maze- dense secondary growth dry black locust forest d) Saltmarsh Edge- brushy saltmarsh edge

a) Upland Fields: Nets 1,3,9,11,18,19,20,22,61		b) Silver Spring: Nets 2,5,6,7,16,21,24,25	
Species	Captures	Species	Captures
1. Pine Warbler	298	1. Gray Catbird	180
2. Chipping Sparrow	102	2. Black-capped Chickadee	59
3. Black-capped Chickadee	39	3. Blackpoll Warbler	46
4. American Goldfinch	29	3. Ruby-crowned Kinglet	39
4. Gray Catbird	29	5. White-throated Sparrow	38
6. Blackpoll Warbler	27	6. Carolina Wren	22
7. Ruby-crowned Kinglet	20	7. Northern Cardinal	22
8. Eastern Bluebird	19	8. American Redstart	18
8. Slate-colored Junco	19	9. Brown Creeper	17
8. Song Sparrow	19	9. Swamp Sparrow	12
11. Golden-crowned Kinglet	16	11. Song Sparrow	11
12. White-throated Sparrow	15	12. Golden-crowned Kinglet	11
13. Field Sparrow	12	13. Red-breasted Nuthatch	11

c) The Maze: Nets 10,12,15,26		d) Saltmarsh Edge: Nets 13,14	
Species	Captures	Species	Captures
1. Blackpoll Warbler	62	1. Black-capped Chickadee	37
2. Gray Catbird	50	2. Swamp Sparrow	34
3. Ruby-crowned Kinglet	49	3. Gray Catbird	31
4. American Goldfinch	33	4. Song Sparrow	30
5. Black-capped Chickadee	26	5. Ruby-crowned Kinglet	29
5. White-throated Sparrow	18	6. Blackpoll Warbler	21
7. Golden-crowned Kinglet	17	7. Pine Warbler	16
8. Yellow-rumped Warbler	12	8. House Wren	9
9. Brown Creeper	10	9. American Goldfinch	7
9. Red-eyed Vireo	8	9. White-throated Sparrow	7
9. Hermit Thrush	8	9. Golden-crowned Kinglet	7
9. Red-breasted Nuthatch	7	9. Eastern Phoebe	7
		9. Red-breasted Nuthatch	7

The Upland Fields had the most unique entries with four: Chipping Sparrow, Field Sparrow, Eastern Bluebird and Slate-colored Junco. Silver Springs had three unique entries: Carolina Wren, Northern Cardinal and American Redstart. The Maze had two unique entries: Yellow-rumped Warbler and Hermit Thrush, while Saltmarsh Edge had only one, Eastern Phoebe. The variation in habitat is key to promoting diversity during songbird migration. By targeting each of these habitats, we aim to quantify that diversity.

Migrant Captures by Habitat

Capture rates varied greatly among habitat (Table 5). The Saltmarsh Edge is by far the busiest habitat with 68.2 captures per 100 hours. The Maze was the slowest habitat at 28.8 captures per 100 hours, falling behind Upland Fields (42.1) and the Maze (34.5). Each habitat proved valuable to birds on site and we will continue to maximize and diversify our effort among them.

Table 5- Number of migrant captures per habitat and net loop during Fall 2018 banding operations at Wellfleet Bay Wildlife Sanctuary. Migrants are defined as birds ONLY present during migration, not being present during breeding or winter

Habitat	Captures/ 100 hours	Migrant Captures	Migrant Cap /100 hours
Upland Fields	42.1	56	3.0
The Maze	34.5	102	9.4
Saltmarsh Edge	68.2	40	8.9
Silver Spring	28.8	116	5.5

Cape at same longitude), 3) Winter Resident - present only in nonbreeding season and overwintering on Cape Cod, 4) Migrant - present only in spring or fall migration neither breeding nor wintering on Cape Cod. As a migration banding station, our biggest interest in how the birds in the migrant category are using habitats on the sanctuary. In fall 2018, we caught 214 migrants a total of 304 times, adding to our 2017 total of 194 and well outpacing the 2016 total of 136 migrant captures. This increase over 2016 and 2017 is the result of the adoption of nets with smaller mesh capturing more warbler-sized birds (more likely to be a migrant), as well as a very successful breeding season for many spruce budworm species.

Migrant captures were split among the four habitats (Table 4). Saltmarsh Edge and the Maze were by far the most favored, with 9.4 and 8.9 migrants per 100 net hours respectively followed by Silver Spring (5.5) and Upland Fields (3.0). The presence of migrants in all habitats reinforces the need to cover all habitats with our netting effort.

Daily eBird Census

In Fall 2018, we continued our protocol for visual and auditory counts of birds on site, an expansion adopted in fall 2016 to account for birds not captured in mistnets. In addition, a daily count of birds allowed for more participation of volunteers, who could engage in birding activities even when banding was slow. It also allowed us to do more outreach for the station and sanctuary. By posting birds on eBird daily, we hoped (and succeeded) in attracting visitors to the sanctuary and to our demos.

The protocol for the eBird census was developed so that birds could be counted early in the morning without interfering with banding operations. We started the count during the first net check after set-up, 40 minutes after opening at sunrise. The count continued for two net checks (lasting about 1 hour and 15 minutes), allowing each paid bander a chance to walk each net loop. It was limited to that duration to not double count the same birds, as we walk the same loops for the entire day. In addition to walking the two loops, five specific locations (all along or adjacent to the net loops) were carefully monitored each day: 1) the Saltmarsh Overlook near the visitor's center, 2) bird feeders behind the visitor's center, 3) top of Bay View along the trail just past Net 12, using a spotting scope to survey flats between the sanctuary and Lieutenant Island, 4) solar panel field near Net 4, and 5) the saltmarsh creek past Net 13, with surveyors walking to the main creek intersection (located 100m into the marsh) when tide cycle allowed. By surveying these specific areas, we were able to account for birds using all habitats found on the sanctuary (for census map, see Appendix C).

We completed 55 eBird counts, one for each day we were on site during the proper survey period in the morning. We observed 127 species, 68 of which were not included in the banding data and would not have otherwise been recorded. Three species were encountered every day of the season, all species known for being loud, visible and common as well as a year-round resident: American Crow, Black-capped Chickadee and Blue Jay. Seven additional species were observed at least 50/55 days: American Goldfinch, Greater Yellowlegs, Eastern Bluebird, Northern Cardinal, Red-breasted Nuthatch, Herring Gull and Double-crested Cormorant. On the other end of the spectrum, 24 species were only observed a

single time, reinforcing the need for focused counting daily: American Pipit, Bay-breasted Warbler, Black Scoter, Black-and-white Warbler, Black-necked Stilt, Blue-gray Gnatcatcher, Bonaparte's Gull, Clay-colored Sparrow, Dickcissel, Eastern Screech-owl, Gadwall, Green-winged Teal, Lincoln's Sparrow, Mallard, Marsh Wren, Nashville Warbler, Northern Parula, Peregrine Falcon, Purple Martin, Saltmarsh Sparrow, Sanderling, Savannah Sparrow, Spotted Sandpiper, Yellow-breasted Chat. Common Ravens appeared regularly on our list for the first time (one sighting from 2014-2017 combined), with up to four individuals present for at least 10 days this fall! For a complete list of eBird species and the number of days encountered, see Appendix B.

The number of species observed daily stayed very constant, averaging between 30 and 40 species a day for the majority of the season (Fig 7). The high day was Sep-30 and Oct-7 with 50 species and the slowest day was Nov-2 with 26 species.

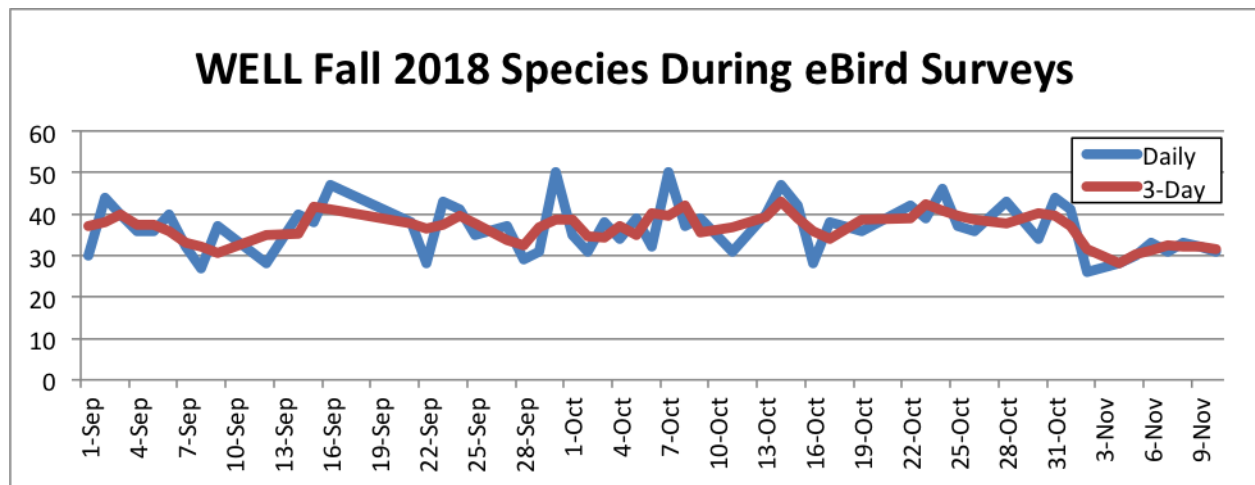


Figure 7- Number of species observed during fall 2018 eBird surveys at Wellfleet Bay Wildlife Sanctuary. The numbers observed stayed very constant across the season, hovering between 35 and 40 species daily.

Summary

Fall 2018 was another great season at Wellfleet banding station. Overall, we captured a nice diversity of birds: summer breeders, migrants, overwintering, and year-round residents. Our data is already providing interesting findings on habitat use by landbirds on the sanctuary. Now that we are in our fifth fall of operation, we begin to see inter-annual variations emerge and look forward examining this more closely.

The reactivation of the Monomoy Refuge Banding Station has added to the scope of our study and allows for direct comparison between the two stations as well as more synchronicity in outreach between Wellfleet Bay and Monomoy National Wildlife Refuge. We are very pleased with our efforts to expand beyond basic morphometric data collection and start asking specific questions, and we are excited to expand our molt studies and increase our outreach with nestling bandings. Our research is only part of a much wider scientific effort at the sanctuary and by Mass Audubon more broadly. We are very pleased to contribute to these endeavors, content in the knowledge that our research will be combined with broader findings to help influence conservation action and policy.

Moving Forward

We had a wonderful fifth season in Fall 2018, very promising in terms of captures and public outreach. All of our group visits went well and we introduced a lot of folks to bird banding in the hope of increasing their understanding and empathy for these animals. We look further to building on our successes in 2019, improving both the quality of our data collection and the volume and impact of our outreach efforts.

We were very pleased with the increased volume and quality of our outreach attempts. Both in terms of our bigger presence in the visitor's center, in the form of a daily capture list along with an informative display that increases visitor knowledge of the station and hopefully leads to an increase in banding demo attendance. Our much-expanded social media presence has expanded our reach beyond the physical grounds of the sanctuary and brought our birds to the wider world. Finally, we can adopt a more structured framework to teach banding to members who are interested in helping at least once a week. This allows us to provide special education for dedicated visitors and train useful volunteers that can benefit the banding station and sanctuary in the future.

Acknowledgements

First and foremost, we thank our skilled and dedicated banders for their hard work and perseverance throughout the fall. Thank you Mikayla Thistle and Frankie Tousley, our wonderful banders who braved the harshness of Monomoy and Wellfleet Bay. Our most important volunteer Valerie Bourdeau, who dedicated every day for six weeks to this project. Every day on site was improved by the presence of our attentive and interested volunteers: Mary Lou Heintz, Jeanette Bragger, Teresa Corcoran, Nick Dorian, Warren Mumford, Tod Christie and Peggy Sagan.

Thanks to everyone at the sanctuary, but especially Mark Faherty, Bob Prescott, Julie Towne, Melissa Lowe-Cestaro and Jenette Kerr for working hard to keep this station rolling, and to everyone in the education department including Emily Wolfe, Spring Beckhorn and Joel Wagner for prepping and focusing the children during banding demos. Of course, we appreciate all the help from the sanctuary volunteers and staff, too many to name, but thanks to you all the same.

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Appendix A- List of All Species Captured at Wellfleet

Table 6- List of the 109 species banded since start of banding operations at Wellfleet Bay Wildlife Sanctuary. Totals are broken down by season, with the number of individuals banded per season listed.

Species	Fall 2014	Spring 2015	Fall 2015	Spring 2016	Fall 2016	Spring 2017	Fall 2017	Spring 2018	Fall 2018
1 Acadian Flycatcher	0	0	1	0	0	0	1	0	0
2 Alder Flycatcher	0	0	0	0	0	1	0	0	1
3 American Goldfinch	48	63	1	56	147	36	159	82	67
4 American Redstart	5	2	14	2	27	4	29	18	17
5 American Robin	14	9	22	5	12	1	4	18	4
6 American Tree-sparrow	2	0	1	0	1	0	0	0	0
7 Baltimore Oriole	10	21	11	15	3	13	1	45	4
8 Barn Swallow	0	2	0	1	0	0	0	0	0
9 Black-and-white Warbler	1	4	1	9	3	5	4	14	4
10 Bay-breasted Warbler	0	0	0	0	0	1	0	0	0
11 Black-billed Cuckoo	1	0	0	1	1	0	1	0	1
12 Black-capped Chickadee	136	33	94	36	100	11	55	128	40
13 Blue-gray Gnatcatcher	0	0	0	0	0	0	1	1	0
14 Blue-headed Vireo	5	0	12	0	8	2	8	2	5
15 Blue Jay	16	10	47	2	56	5	30	10	5
16 Blackpoll Warbler	9	0	18	9	44	11	19	23	135
17 Brown Creeper	10	0	3	1	18	0	6	5	34
18 Brown-headed Cowbird	0	5	0	5	0	3	0	2	0
19 Brown Thrasher	0	2	2	1	4	0	0	0	1
20 Black-throated Blue Warbler	1	2	2	1	20	3	6	5	6
21 Black-throated Green Warbler	1	1	6	0	4	1	5	2	0
22 Blue-winged Warbler	1	0	0	1	0	0	0	1	0
23 Canada Warbler	0	0	0	1	0	4	2	5	0
24 Carolina Wren	7	0	5	1	7	6	8	1	12
25 Cape May Warbler	0	0	0	0	0	0	6	14	1
26 Cedar Waxwing	0	1	1	2	2	7	1	1	0
27 Chestnut-sided Warbler	0	1	0	1	0	0	134	2	0
28 Chipping Sparrow	47	11	20	27	26	21	2	33	94
29 Clay-colored Sparrow	0	0	0	0	2	0	6	0	0
30 Common Grackle	0	28	2	15	5	20	2	12	2
31 Common Yellowthroat	9	18	28	13	13	29	35	47	11
32 Connecticut Warbler	0	0	1	0	1	0	0	0	1
33 Dickcissel	1	0	0	0	1	0	0	0	0
34 Downy Woodpecker	10	1	12	0	25	0	3	7	9
35 Eastern Bluebird	13	0	18	0	46	1	5	8	19
36 Eastern Kingbird	0	1	0	2	0	1	0	6	0
37 Eastern Phoebe	17	0	14	4	19	4	25	6	23
38 Eastern Towhee	21	17	43	10	22	5	7	9	4
39 Eastern Wood Pewee	0	0	0	0	1	1	1	0	0
40 Eurasian Starling	0	0	0	0	0	1	0	0	0
41 Field Sparrow	23	3	20	9	12	4	9	9	9
42 Fox Sparrow	1	0	1	0	0	0	0	0	0
43 Great-crested Flycatcher	0	4	1	4	0	1	0	1	3
44 Golden-crowned Kinglet	6	0	14	4	32	5	20	68	47
45 Gray-cheeked Thrush	3	0	1	1	0	0	0	0	3
46 Gray Catbird	88	155	184	78	129	105	101	141	137
47 Hairy Woodpecker	5	3	3	0	4	1	3	3	0
48 Hermit Thrush	16	0	10	5	8	0	2	0	13
49 House Finch	32	5	14	5	12	1	10	6	8
50 House Sparrow	1	2	0	6	1	7	0	3	0
51 Hooded Warbler	0	0	0	1	0	1	0	1	0
52 House Wren	1	3	2	0	2	1	10	14	12
53 Indigo Bunting	3	1	1	0	0	1	2	0	1
54 Kentucky Warbler	0	0	0	0	0	1	0	0	0

Species	Fall 2014	Spring 2015	Fall 2015	Spring 2016	Fall 2016	Spring 2017	Fall 2017	Spring 2018	Fall 2018
55 Least Flycatcher	0	1	0	0	2	1	1	3	1
56 Lincoln Sparrow	1	0	1	3	6	1	6	4	2
57 Louisiana Waterthrush	0	1	0	0	0	0	0	0	0
58 Magnolia Warbler	3	5	0	10	6	20	10	40	5
59 Marsh Wren	1	0	0	0	2	0	1	0	0
60 Mourning Warbler	0	0	0	0	1	1	3	0	1
61 Nashville Warbler	3	0	11	0	4	2	13	3	6
62 Northern Cardinal	68	20	29	27	46	20	25	21	20
63 Northern Mockingbird	0	1	0	3	0	2	0	10	0
64 Northern Flicker	9	1	8	2	5	1	3	5	7
65 Northern Parula	0	1	0	1	0	3	2	18	1
66 Northern Waterthrush	3	3	5	3	4	2	19	14	4
67 North. Rough-winged Swallow	0	0	0	1	0	0	0	0	0
68 Orange-crowned Warbler	5	0	3	0	4	0	7	0	10
69 Orchard Oriole	0	6	0	1	0	3	0	17	0
70 Olive Sided Flycatcher	0	0	0	0	0	1	0	0	1
71 Ovenbird	0	2	2	2	1	3	4	4	4
72 Palm Warbler	5	0	3	5	18	6	31	2	11
73 Philadelphia Vireo	2	0	0	0	1	0	6	0	0
74 Pine Siskin	1	0	0	0	0	0	0	0	1
75 Pine Warbler	33	12	32	16	136	25	173	29	263
76 Prairie Warbler	0	3	2	7	4	5	8	3	0
77 Purple Finch	2	1	0	0	2	0	0	0	0
78 Red-bellied Woodpecker	2	0	2	2	0	1	2	2	6
79 Red-breasted Nuthatch	0	1	2	6	13	2	7	11	23
80 Rose-breasted Grosbeak	0	0	1	0	0	0	4	2	0
81 Ruby-crowned Kinglet	28	1	14	15	51	7	30	27	114
82 Red-eyed Vireo	23	2	28	1	36	2	30	5	18
83 Red-winged Blackbird	2	38	1	13	1	13	1	22	0
84 Savannah Sparrow	2	0	0	2	0	2	0	5	0
85 Slate-colored Junco	48	1	5	0	34	3	6	0	21
86 Scarlet Tanager	2	1	1	0	0	1	1	0	0
87 Song Sparrow	58	6	61	8	43	10	23	22	50
88 Summer Tanager	0	0	1	0	0	0	0	0	0
89 Swamp Sparrow	14	0	0	3	20	4	14	0	33
90 Swainson's Thrush	0	0	1	0	3	0	0	2	3
91 Tennessee Warbler	0	1	0	0	0	0	3	0	2
92 Tree Swallow	0	71	0	17	0	19	0	34	0
93 Tufted Titmouse	24	1	38	4	33	6	23	16	9
94 Veery	1	1	2	1	1	1	1	0	1
95 Warbling Vireo	0	0	0	0	3	0	0	1	0
96 White-breasted Nuthatch	3	3	2	4	4	2	1	2	0
97 White-crowned Sparrow	1	1	0	0	1	0	0	1	9
98 White-eyed Vireo	1	0	2	0	0	0	3	0	1
99 White-throated Sparrow	45	2	15	25	12	4	22	15	58
100 Willow Flycatcher	0	0	0	2	0	0	0	1	0
101 Wilson's Warbler	0	0	3	1	6	5	10	15	1
102 Winter Wren	0	0	0	0	2	0	0	0	7
103 Wood Thrush	0	0	0	2	0	0	0	2	0
104 Yellow-bellied Flycatcher	0	1	0	0	0	0	0	0	1
105 Yellow-breasted Chat	1	0	3	0	3	0	3	0	4
106 Yellow-bellied Sapsucker	2	0	1	1	0	0	2	1	1
107 Yellow-billed Cuckoo	0	0	1	0	0	0	2	0	3
108 Myrtle Warbler	132	1	50	12	102	9	105	20	33
109 Yellow Warbler	1	2	0	4	2	11	2	17	0
110 Yellow-throated Warbler	0	0	0	0	0	1	0	0	0
Season Total	67	59	68	65	72	72	74	72	69

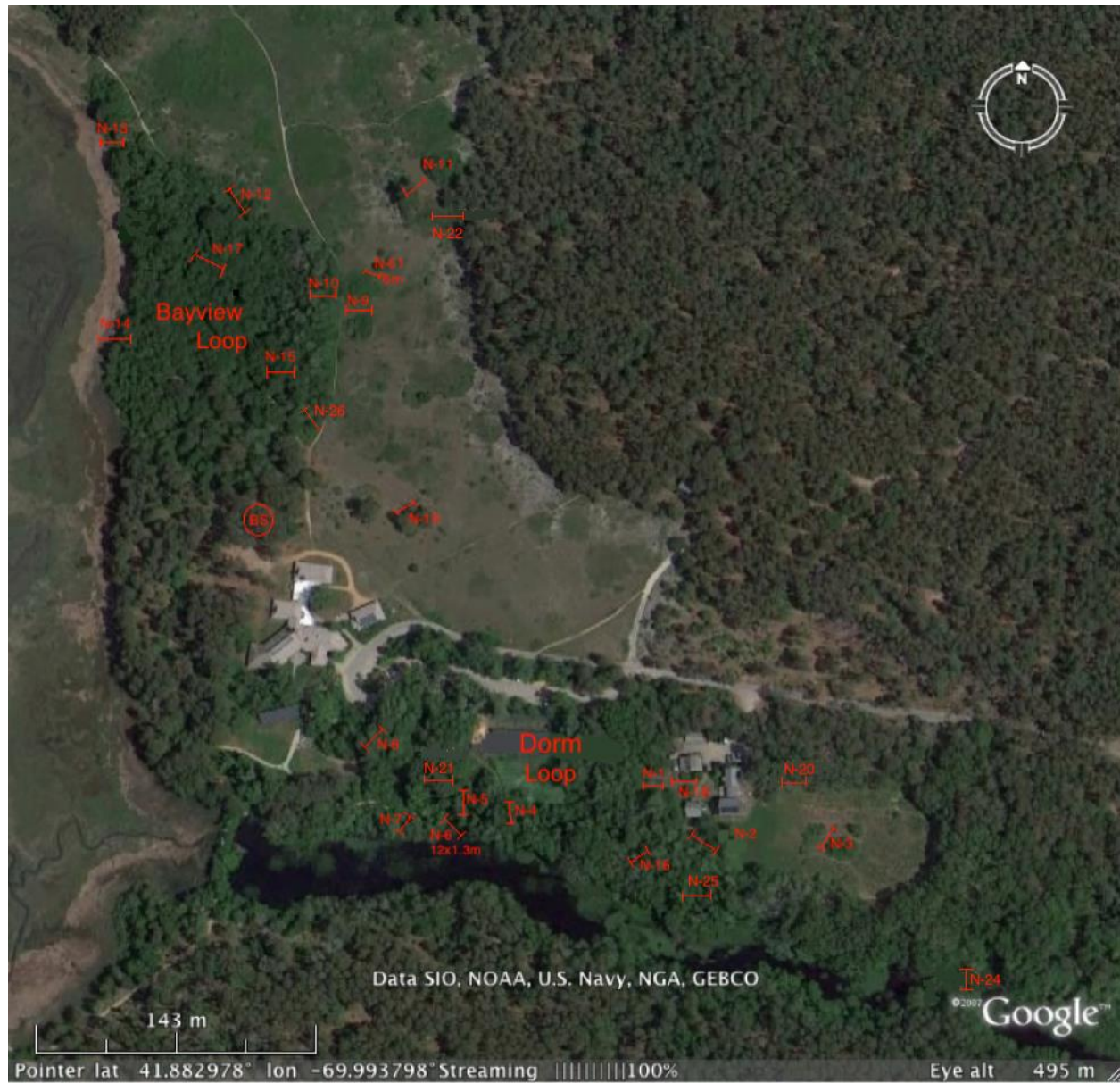
Appendix B- Lists of All Species Observed During Census At Wellfleet Bay Fall 2018

Table 7- List of the 123 species and number of days observed during daily eBird census at Wellfleet Bay Wildlife Sanctuary during Fall 2018 banding operations.

Species	Days	Species	Days
1 American Crow	55	65 Turkey Vulture	7
2 Black-capped Chickadee	55	66 Brown Creeper	6
3 Blue Jay	55	67 Bufflehead	6
4 American Goldfinch	54	68 House Wren	6
5 Greater Yellowlegs	54	69 Northern Harrier	6
6 Red-breasted Nuthatch	54	70 Palm Warbler	6
7 Northern Cardinal	52	71 Yellow-bellied Sapsucker	6
8 Herring Gull	51	72 Cooper's Hawk	5
9 Double-crested	50	73 Forster's Tern	5
10 Eastern Bluebird	50	74 Great Crested Flycatcher	5
11 Northern Flicker	50	75 Merlin	5
12 Great Blue Heron	48	76 Ruby-throated	5
13 Gray Catbird	47	77 Swamp Sparrow	5
14 Wild Turkey	47	78 Willet	5
15 Red-bellied Woodpecker	46	79 Yellow-billed Cuckoo	5
16 Belted Kingfisher	45	80 American Redstart	4
17 Downy Woodpecker	44	81 Black-throated Green	4
18 Tufted Titmouse	43	82 Common Eider	4
19 Mourning Dove	42	83 Common Yellowthroat	4
20 American Robin	41	84 Northern Gannet	4
21 Chipping Sparrow	40	85 Red-eyed Vireo	4
22 Carolina Wren	39	86 White-rumped Sandpiper	4
23 Pine Warbler	37	87 American Kestrel	3
24 American Black Duck	36	88 Black-throated Blue	3
25 Black-bellied Plover	35	89 Common Loon	3
26 Red-winged Blackbird	35	90 Hermit Thrush	3
27 White-breasted Nuthatch	34	91 Lesser Yellowlegs	3
28 Hairy Woodpecker	33	92 Osprey	3
29 Great Black-backed Gull	32	93 Tennessee Warbler	3
30 Song Sparrow	31	94 Winter Wren	3
31 Eastern Phoebe	29	95 Barn Swallow	2
32 House Sparrow	25	96 Black-billed Cuckoo	2
33 Tree Swallow	23	97 Blue-winged Teal	2
34 Common Grackle	22	98 Brown Thrasher	2
35 Eastern Towhee	21	99 Canada Goose	2
36 Dunlin	20	100 Olive-sided Flycatcher	2
37 Whimbrel	20	101 Orange-crowned Warbler	2
38 Blackpoll Warbler	19	102 White-winged Scoter	2
39 Ruby-crowned Kinglet	19	103 Wood Duck	2
40 White-throated Sparrow	19	104 American Pipit	1
41 Cedar Waxwing	18	105 Bay-breasted Warbler	1
42 Laughing Gull	18	106 Black Scoter	1
43 Semipalmated Plover	18	107 Black-and-white Warbler	1
44 Yellow-rumped Warbler	18	108 Black-necked Stilt	1
45 Common Tern	17	109 Blue-gray Gnatcatcher	1
46 Snowy Egret	15	110 Bonaparte's Gull	1
47 Fish Crow	13	111 Clay-colored Sparrow	1
48 Dark-eyed Junco	12	112 Dickcissel	1
49 Red-tailed Hawk	11	113 Eastern Screech-Owl	1
50 Semipalmated Sandpiper	11	114 Gadwall	1
51 Common Raven	10	115 Green-winged Teal	1
52 House Finch	10	116 Lincoln's Sparrow	1
53 Ring-billed Gull	10	117 Mallard	1
54 White-crowned Sparrow	10	118 Marsh Wren	1
55 Brant	9	119 Nashville Warbler	1
56 Solitary Sandpiper	9	120 Northern Parula	1
57 European Starling	8	121 Peregrine Falcon	1
58 Golden-crowned Kinglet	8	122 Purple Martin	1
59 Baltimore Oriole	7	123 Saltmarsh Sparrow	1
60 Field Sparrow	7	124 Sanderling	1
61 Great Egret	7	125 Savannah Sparrow	1
62 Least Sandpiper	7	126 Spotted Sandpiper	1
63 Sharp-shinned Hawk	7	127 Yellow-breasted Chat	1
64 Short-billed Dowitcher	7		

Appendix C- Maps of Wellfleet Wildlife Sanctuary Banding Station

Figure 8- Map of Net and Banding Station Locations at Wellfleet Banding Station in Fall 2018.



Appendix C- Maps of Wellfleet Wildlife Sanctuary Banding Station

Figure 9- Map of Wellfleet Banding Station eBird Census loop. The Dorm Loop is marked in red and The Bay View loop is marked in pink. In addition to walking each loop twice, five specific spots (marked with an X) are checked each day: Saltmarsh Creek, Bay View Overlook, Saltmarsh Overlook, Visitor's Center Feeder and Solar Panels.

