Landscape of Change Results

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February, 2022



# Have Changes Occurred Between 1880 and Now?

## Birds

### Introduction

In the 1880s, a group of Harvard students known as the Champlain Society spent summers on Mount Desert Island (MDI) conducting surveys of flora and fauna, including birds. Their records, preserved by the Mount Desert Island Historical Society, present an opportunity to evaluate changes in bird populations on the island, which is now home to Acadia National Park. North America has lost nearly [3 billion birds](https://www.birds.cornell.edu/home/bring-birds-back) in recent times. According to Rosenberg et al. (2019), this is a loss of 25% of all birds on the continent since 1970! This shocking decline in North America’s bird population is an important reason why it’s so critical to study bird populations locally.

This study’s objective was to compare the Champlain Society’s records to the past 4 years of eBird and iNaturalist data for Mount Desert Island. Our goals were to determine: 1) how historically recorded species’ relative abundance changed over the last 140 years, 2) if new species are present on the island, and 3) what we hypothesize caused these changes in MDI bird populations.

### Methods

The historical data from the Champlain Society were collected from early July through the first week of September 1880 – 1883. To compare these data to modern day, we used eBird and iNaturalist data filtered to the same time frame (early July through the first week of September), and over the same number of years from 2018 – 2021. To compare how often these species were/are detected, we had to create a qualitative descriptor properly assigned to the species as the historical dataset did not allow for a quantitative analysis. These designations are found in the Champlain Society’s notes (Spelman 1941), are based on their own observations and experiences, and follow the convention of other national and regional bird lists of the period. For the modern dataset, we used a count of the number of times a species was reported and designated a category based on these bins: < 5 = very rare, 5 > 20 = rare, 20 > 50 = uncommon, > 50 = common. These standards are adapted from the American Birding Association (2022).

We used these relative abundances to compare modern and historic times. Due to the qualitative nature of the data, we designated species with changes of **more than one category** into the “increasing” or “decreasing” tables. So, if a species was “common” in the 1880s but is now “uncommon”, that would not constitute a decrease that we can be confident in. Whereas, if a species was “common” in the 1880s but is now “rare”, that would qualify as a decreasing species because we are confident that a change of that magnitude is real. For example, Cliff Swallow was a historically “common” species but now is “very rare” on MDI, and therefore is decreasing. In contrast, Sharp-shinned Hawk was “uncommon” historically and is now “common”, but this difference is not enough to determine if it is increasing and is therefore categorized as “no change.”

### Results

The Champlain Society recorded 98 species, which is less than half (47%) of the 210 species recorded in modern times according to eBird and iNaturalist. The Champlain Society categorized 60 species as common, while today there are 95. This is an increase of 35 common species over 140 years.

When we examined the changes in relative abundance of historically observed bird species over the last 140 years, we found that 8% of these species increased in relative abundance (**Table 1**), 14% decreased (**Table 2**), and 76% exhibited no change (**Figure 1**). **Table 1** also includes more notably increasing species that were not detected by the Champlain Society, but are now uncommon or common on MDI. Some examples of the 8% of historic species that have increased are Black-throated Blue Warbler (**Figure 2**), Blue Jay (**Figure 3**), and Eastern Phoebe (**Figure 4**). Examples of the 14% of historic species that have decreased are American Woodcock (**Figure 5**), Black-crowned Night-Heron (**Figure 6**), and Yellow-bellied Flycatcher (**Figure 7**).

Modern day records show 82 species not recorded by the Champlain Society, that are regularly documented by observers today (**Table 3**). Three of these species were introduced by humans between the 1880s and present day: House Sparrow, European Starling, and Rock Pigeon. For a complete list of relative abundance changes by species see **Table 4**.

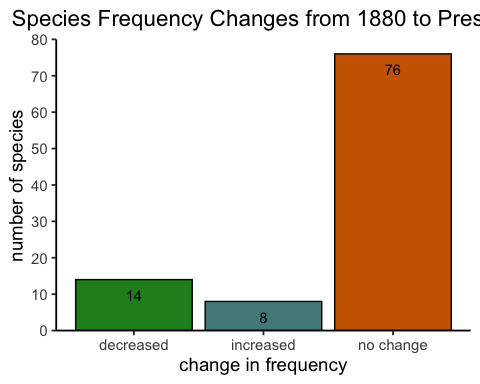
### Conclusion and Next Steps

Of the species recorded by the Champlain Society that have increased in relative abundance, most can be explained by human-caused changes to the landscape. For example, human urbanization of natural landscapes is proposed to be the main reason for Blue Jay range expansion (Smith et al. 2020). Similar reasoning can be attributed to the Eastern Phoebe increase that we have seen. As modern infrastructure developed, bridges and structures have become more prominent, which has been linked to the range expansion of this species (Weeks Jr. 2020). Another cause for some of these species’ local increases can be associated with European colonization. Black-throated Blue Warbler was likely driven out of MDI due to the extensive logging and associated changes to the forest leaving MDI with little appropriate habitat (Irland 1982). In more recent times forested ecosystems have regenerated allowing for Black-throated Blue Warbler to return to the region (Holmes et al. 2020).

Similar changes in the landscape might explain those species that have decreased in relative abundance. For example, the American Woodcock has decreased due to the transition of farmlands to forest (McAuley 2020), while the Black-crowned Night-Heron decrease has been attributed to the loss of wetland habitats (Hothem et al. 2020). Additionally, species that breed in boreal landscapes such as Pine Siskin and Yellow-bellied Flycatcher show local declines due to boreal habitats disappearing from climate warming, habitat degradation, and logging (Price et al. 2013).

We also wanted to look more closely at the species present on MDI today, but not recorded historically by the Champlain Society’s efforts. These species are those whose ranges may have expanded or shifted north due to climate change or other factors, and those that can be attributed to human-caused changes on the landscape. This trend of climate changes and human manipulation of the landscape have had dramatic effects on the birds of MDI, but the effects are often species-specific and highly variable. Future research to explain the changes we saw might incorporate additional data sets, such as the Audubon Christmas Bird Count and Maine Breeding Bird Atlas, as well as analyze changes in Mount Desert Island habitat types and land cover.

### Species Changes



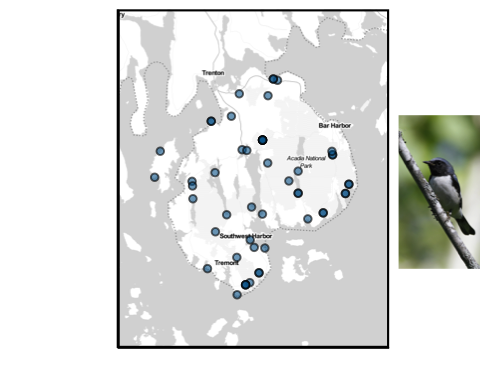
**Figure 1**. This figure shows the number of bird species recorded by the Champlain Society in the 1880s that have increased, decreased, and showed no change in relative abundance from the 1880’s to present day. Data collected on Mount Desert Island, Maine, USA, and provided by eBird and iNaturalist.

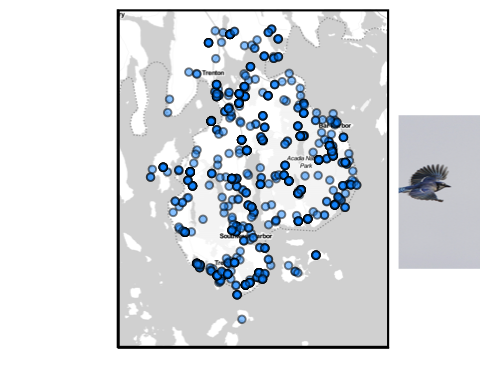
### Increasing Species

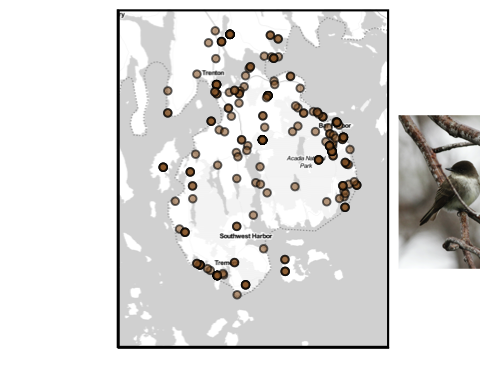
**Table 1**. This table shows the species recorded by the Champlain Society with notable increases in relative abundance. Also included are species with intensive increases in relative abundance that were not recorded in the 1880s by the Champlain Society. There are 33 species that are now common on MDI, and 19 uncommon species that were not present historically. Data collected on Mount Desert Island, Maine, USA, and provided by eBird and iNaturalist.

‘R. a.’ = Relative abundance

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Common name | Scientific name | R. a. 1880’s | R. a. modern | R. a. changes |
| Black-throated Blue Warbler | Setophaga caerulescens | very rare | common | increased |
| Blue Jay | Cyanocitta cristata | rare | common | increased |
| Brown Creeper | Certhia americana | rare | common | increased |
| Eastern Bluebird | Sialia sialis | very rare | uncommon | increased |
| Eastern Phoebe | Sayornis phoebe | rare | common | increased |
| Red Crossbill | Loxia curvirostra | rare | common | increased |
| Red-tailed Hawk | Buteo jamaicensis | very rare | uncommon | increased |
| Solitary Sandpiper | Tringa solitaria | rare | common | increased |
| Black-bellied Plover | Pluvialis squatarola | not detected | uncommon | increased |
| Blackpoll Warbler | Setophaga striata | not detected | uncommon | increased |
| Canada Goose | Branta canadensis | not detected | common | increased |
| Cape May Warbler | Setophaga tigrina | not detected | uncommon | increased |
| Common Eider | Somateria mollissima | not detected | common | increased |
| Common Grackle | Quiscalus quiscula | not detected | common | increased |
| Common Merganser | Mergus merganser | not detected | common | increased |
| Common Raven | Corvus corax | not detected | common | increased |
| Cooper’s Hawk | Accipiter cooperii | not detected | uncommon | increased |
| Double-crested Cormorant | Nannopterum auritum | not detected | common | increased |
| Eastern Towhee | Pipilo erythrophthalmus | not detected | common | increased |
| Eastern Wood-Pewee | Contopus virens | not detected | common | increased |
| European Starling | Sturnus vulgaris | not detected | uncommon | increased |
| Gray Catbird | Dumetella carolinensis | not detected | common | increased |
| Great Black-backed Gull | Larus marinus | not detected | common | increased |
| Great Cormorant | Phalacrocorax carbo | not detected | uncommon | increased |
| Great Crested Flycatcher | Myiarchus crinitus | not detected | uncommon | increased |
| Great Egret | Ardea alba | not detected | uncommon | increased |
| Green-winged Teal | Anas crecca | not detected | uncommon | increased |
| Hooded Merganser | Lophodytes cucullatus | not detected | common | increased |
| House Finch | Haemorhous mexicanus | not detected | common | increased |
| House Sparrow | Passer domesticus | not detected | common | increased |
| Laughing Gull | Leucophaeus atricilla | not detected | common | increased |
| Least Flycatcher | Empidonax minimus | not detected | uncommon | increased |
| Mallard | Anas platyrhynchos | not detected | common | increased |
| Merlin | Falco columbarius | not detected | common | increased |
| Mourning Dove | Zenaida macroura | not detected | common | increased |
| Nelson’s Sparrow | Ammospiza nelsoni | not detected | common | increased |
| Northern Cardinal | Cardinalis cardinalis | not detected | common | increased |
| Northern Gannet | Morus bassanus | not detected | common | increased |
| Palm Warbler | Setophaga palmarum | not detected | uncommon | increased |
| Peregrine Falcon | Falco peregrinus | not detected | common | increased |
| Pileated Woodpecker | Dryocopus pileatus | not detected | common | increased |
| Pine Warbler | Setophaga pinus | not detected | common | increased |
| Red-necked Grebe | Podiceps grisegena | not detected | uncommon | increased |
| Ring-billed Gull | Larus delawarensis | not detected | common | increased |
| Rock Pigeon | Columba livia | not detected | common | increased |
| Ruby-crowned Kinglet | Corthylio calendula | not detected | uncommon | increased |
| Semipalmated Plover | Charadrius semipalmatus | not detected | common | increased |
| Snowy Egret | Egretta thula | not detected | uncommon | increased |
| Swamp Sparrow | Melospiza georgiana | not detected | common | increased |
| Tennessee Warbler | Leiothlypis peregrina | not detected | uncommon | increased |
| Tufted Titmouse | Baeolophus bicolor | not detected | uncommon | increased |
| Turkey Vulture | Cathartes aura | not detected | common | increased |
| Veery | Catharus fuscescens | not detected | uncommon | increased |
| White-breasted Nuthatch | Sitta carolinensis | not detected | common | increased |
| White-winged Scoter | Melanitta deglandi | not detected | common | increased |
| Wild Turkey | Meleagris gallopavo | not detected | common | increased |
| Wilson’s Storm-Petrel | Oceanites oceanicus | not detected | uncommon | increased |
| Wood Duck | Aix sponsa | not detected | common | increased |
| Wood Thrush | Hylocichla mustelina | not detected | common | increased |
| Yellow-bellied Sapsucker | Sphyrapicus varius | not detected | uncommon | increased |

 **Figure 2**. Black-throated Blue Warbler (*Setophaga caerulescens*) modern day distribution across MDI. Data provided by eBird and iNaturalist, 2018 - 2021.

 **Figure 3**. Blue Jay (*Cyanocitta cristata*) modern day distribution across MDI. Data provided by eBird and iNaturalist, 2018 - 2021.

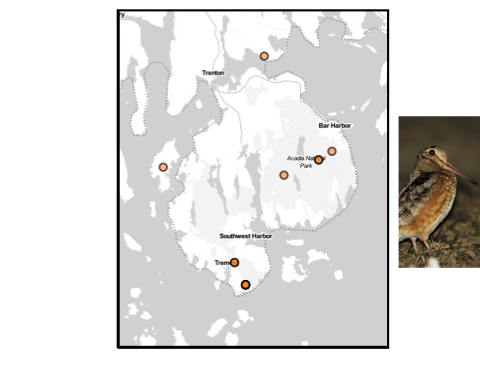
 **Figure 4**. Eastern Phoebe (*Sayornis phoebe*) modern day distribution across MDI. Data provided by eBird and iNaturalist, 2018 - 2021.

### Decreasing Species

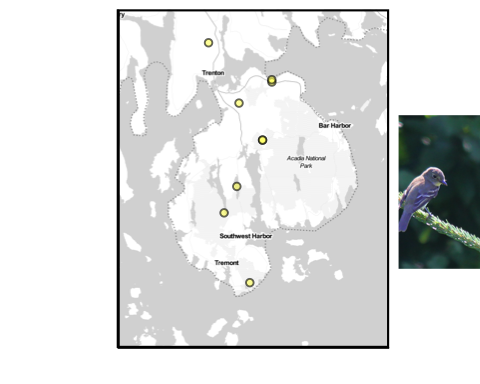
**Table 2**. This table shows the species that exhibited notable decreases in relative abundance since the 1880s. Data collected on Mount Desert Island, Maine, USA, and provided by eBird and iNaturalist.

‘R. a.’ = Relative abundance

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Common name | Scientific name | R. a. 1880’s | R. a. modern | R. a. changes |
| American Woodcock | Scolopax minor | common | rare | decreased |
| Bank Swallow | Riparia riparia | common | rare | decreased |
| Black-billed Cuckoo | Coccyzus erythropthalmus | common | rare | decreased |
| Black-crowned Night-Heron | Nycticorax nycticorax | common | very rare | decreased |
| Black-legged Kittiwake | Rissa tridactyla | uncommon | very rare | decreased |
| Canada Warbler | Cardellina canadensis | common | rare | decreased |
| Chimney Swift | Chaetura pelagica | common | rare | decreased |
| Cliff Swallow | Petrochelidon pyrrhonota | common | very rare | decreased |
| Passenger Pigeon | Ectopistes migratorius | rare | extinct | decreased |
| Pine Siskin | Spinus pinus | common | rare | decreased |
| Ruffed Grouse | Bonasa umbellus | common | rare | decreased |
| Yellow-bellied Flycatcher | Empidonax flaviventris | common | rare | decreased |

 **Figure 5**. American Woodcock (*Scolopax minor*) modern day distribution across MDI. Data provided by eBird and iNaturalist, 2018 - 2021.

 **Figure 6**. Black-crowned Night-Heron (*Nycticorax nycticorax*) modern day distribution across MDI. Data provided by eBird and iNaturalist, 2018 - 2021.

 **Figure 7**. Yellow-bellied Flycatcher (*Empidonax flaviventris*) modern day distribution across MDI. Data provided by eBird and iNaturalist, 2018 - 2021.

### Modern Species not Recorded Historically

**Table 3**. This table shows the species that can be seen regularly (those with the relative frequencies of rare, uncommon, and common) on MDI, but were not documented in the 1880s by the Champlain Society’s efforts.

|  |  |  |
| --- | --- | --- |
| Common name | Scientific name | Relative abundance |
| American Kestrel | Falco sparverius | rare |
| American Oystercatcher | Haematopus palliatus | rare |
| Arctic Tern | Sterna paradisaea | rare |
| Atlantic Puffin | Fratercula arctica | rare |
| Baltimore Oriole | Icterus galbula | rare |
| Black-bellied Plover | Pluvialis squatarola | uncommon |
| Blackpoll Warbler | Setophaga striata | uncommon |
| Brown-headed Cowbird | Molothrus ater | rare |
| Canada Goose | Branta canadensis | common |
| Cape May Warbler | Setophaga tigrina | uncommon |
| Carolina Wren | Thryothorus ludovicianus | rare |
| Common Eider | Somateria mollissima | common |
| Common Grackle | Quiscalus quiscula | common |
| Common Merganser | Mergus merganser | common |
| Common Murre | Uria aalge | rare |
| Common Raven | Corvus corax | common |
| Cooper’s Hawk | Accipiter cooperii | uncommon |
| Double-crested Cormorant | Nannopterum auritum | common |
| Eastern Towhee | Pipilo erythrophthalmus | common |
| Eastern Wood-Pewee | Contopus virens | common |
| European Starling | Sturnus vulgaris | uncommon |
| Field Sparrow | Spizella pusilla | rare |
| Gray Catbird | Dumetella carolinensis | common |
| Great Black-backed Gull | Larus marinus | common |
| Great Cormorant | Phalacrocorax carbo | uncommon |
| Great Crested Flycatcher | Myiarchus crinitus | uncommon |
| Great Egret | Ardea alba | uncommon |
| Great Shearwater | Ardenna gravis | rare |
| Green-winged Teal | Anas crecca | uncommon |
| Hooded Merganser | Lophodytes cucullatus | common |
| House Finch | Haemorhous mexicanus | common |
| House Sparrow | Passer domesticus | common |
| House Wren | Troglodytes aedon | rare |
| Killdeer | Charadrius vociferus | rare |
| Laughing Gull | Leucophaeus atricilla | common |
| Least Flycatcher | Empidonax minimus | uncommon |
| Lesser Black-backed Gull | Larus fuscus | rare |
| Lincoln’s Sparrow | Melospiza lincolnii | rare |
| Mallard | Anas platyrhynchos | common |
| Merlin | Falco columbarius | common |
| Mourning Dove | Zenaida macroura | common |
| Nelson’s Sparrow | Ammospiza nelsoni | common |
| Northern Cardinal | Cardinalis cardinalis | common |
| Northern Gannet | Morus bassanus | common |
| Northern Goshawk | Accipiter gentilis | rare |
| Northern Mockingbird | Mimus polyglottos | rare |
| Olive-sided Flycatcher | Contopus cooperi | rare |
| Palm Warbler | Setophaga palmarum | uncommon |
| Peregrine Falcon | Falco peregrinus | common |
| Philadelphia Vireo | Vireo philadelphicus | rare |
| Pileated Woodpecker | Dryocopus pileatus | common |
| Pine Warbler | Setophaga pinus | common |
| Razorbill | Alca torda | rare |
| Red-breasted Merganser | Mergus serrator | rare |
| Red-necked Grebe | Podiceps grisegena | uncommon |
| Red-necked Phalarope | Phalaropus lobatus | rare |
| Red-shouldered Hawk | Buteo lineatus | rare |
| Ring-billed Gull | Larus delawarensis | common |
| Rock Pigeon | Columba livia | common |
| Rose-breasted Grosbeak | Pheucticus ludovicianus | rare |
| Ruby-crowned Kinglet | Corthylio calendula | uncommon |
| Sanderling | Calidris alba | rare |
| Scarlet Tanager | Piranga olivacea | rare |
| Semipalmated Plover | Charadrius semipalmatus | common |
| Snowy Egret | Egretta thula | uncommon |
| Surf Scoter | Melanitta perspicillata | rare |
| Swamp Sparrow | Melospiza georgiana | common |
| Tennessee Warbler | Leiothlypis peregrina | uncommon |
| Tufted Titmouse | Baeolophus bicolor | uncommon |
| Turkey Vulture | Cathartes aura | common |
| Veery | Catharus fuscescens | uncommon |
| Warbling Vireo | Vireo gilvus | rare |
| Whimbrel | Numenius phaeopus | rare |
| White-breasted Nuthatch | Sitta carolinensis | common |
| White-rumped Sandpiper | Calidris fuscicollis | rare |
| White-winged Scoter | Melanitta deglandi | common |
| Wild Turkey | Meleagris gallopavo | common |
| Wilson’s Storm-Petrel | Oceanites oceanicus | uncommon |
| Wood Duck | Aix sponsa | common |
| Wood Thrush | Hylocichla mustelina | common |
| Yellow-bellied Sapsucker | Sphyrapicus varius | uncommon |
| Yellow-billed Cuckoo | Coccyzus americanus | rare |

### Total Species List Changes

**Table 4**. This table depicts the species recorded by the Champlain Society with their relative abundance status from the 1880s contrasted with today’s. Data collected on Mount Desert Island, Maine, USA, and provided by eBird and iNaturalist.

‘R. a.’ = Relative abundance

|  |  |  |  |
| --- | --- | --- | --- |
| Common name | Scientific name | R. a. 1880’s | R. a. modern |
| Alder Flycatcher | Empidonax alnorum | common | common |
| American Bittern | Botaurus lentiginosus | rare | uncommon |
| American Black Duck | Anas rubripes | common | common |
| American Crow | Corvus brachyrhynchos | common | common |
| American Goldfinch | Spinus tristis | common | common |
| American Redstart | Setophaga ruticilla | common | common |
| American Robin | Turdus migratorius | common | common |
| American Woodcock | Scolopax minor | common | rare |
| Bald Eagle | Haliaeetus leucocephalus | common | common |
| Bank Swallow | Riparia riparia | common | rare |
| Barn Swallow | Hirundo rustica | common | common |
| Barred Owl | Strix varia | uncommon | common |
| Bay-breasted Warbler | Setophaga castanea | common | uncommon |
| Belted Kingfisher | Megaceryle alcyon | common | common |
| Black Guillemot | Cepphus grylle | common | common |
| Black Scoter | Melanitta americana | rare | uncommon |
| Black-and-white Warbler | Mniotilta varia | common | common |
| Black-billed Cuckoo | Coccyzus erythropthalmus | common | rare |
| Black-capped Chickadee | Poecile atricapillus | common | common |
| Black-crowned Night-Heron | Nycticorax nycticorax | common | very rare |
| Black-legged Kittiwake | Rissa tridactyla | uncommon | very rare |
| Black-throated Blue Warbler | Setophaga caerulescens | very rare | common |
| Black-throated Green Warbler | Setophaga virens | common | common |
| Blackburnian Warbler | Setophaga fusca | common | common |
| Blue Jay | Cyanocitta cristata | rare | common |
| Blue-headed Vireo | Vireo solitarius | common | common |
| Bobolink | Dolichonyx oryzivorus | uncommon | uncommon |
| Bonaparte’s Gull | Chroicocephalus philadelphia | uncommon | common |
| Boreal Chickadee | Poecile hudsonicus | rare | very rare |
| Broad-winged Hawk | Buteo platypterus | common | common |
| Brown Creeper | Certhia americana | rare | common |
| Canada Warbler | Cardellina canadensis | common | rare |
| Cedar Waxwing | Bombycilla cedrorum | common | common |
| Chestnut-sided Warbler | Setophaga pensylvanica | common | common |
| Chimney Swift | Chaetura pelagica | common | rare |
| Chipping Sparrow | Spizella passerina | common | common |
| Common Loon | Gavia immer | uncommon | common |
| Common Nighthawk | Chordeiles minor | common | common |
| Common Tern | Sterna hirundo | common | common |
| Common Yellowthroat | Geothlypis trichas | common | common |
| Dark-eyed Junco | Junco hyemalis | common | common |
| Downy Woodpecker | Dryobates pubescens | common | common |
| Eastern Bluebird | Sialia sialis | very rare | uncommon |
| Eastern Kingbird | Tyrannus tyrannus | uncommon | rare |
| Eastern Phoebe | Sayornis phoebe | rare | common |
| Golden-crowned Kinglet | Regulus satrapa | common | common |
| Great Blue Heron | Ardea herodias | common | common |
| Greater Yellowlegs | Tringa melanoleuca | uncommon | common |
| Hairy Woodpecker | Dryobates villosus | common | common |
| Hermit Thrush | Catharus guttatus | common | common |
| Herring Gull | Larus argentatus | common | common |
| Indigo Bunting | Passerina cyanea | rare | very rare |
| Leach’s Storm-Petrel | Hydrobates leucorhous | rare | rare |
| Least Sandpiper | Calidris minutilla | common | common |
| Lesser Yellowlegs | Tringa flavipes | uncommon | common |
| Long-tailed Duck | Clangula hyemalis | very rare | very rare |
| Magnolia Warbler | Setophaga magnolia | common | common |
| Nashville Warbler | Leiothlypis ruficapilla | common | uncommon |
| Northern Flicker | Colaptes auratus | common | common |
| Northern Harrier | Circus hudsonius | rare | uncommon |
| Northern Parula | Setophaga americana | common | common |
| Northern Waterthrush | Parkesia noveboracensis | rare | rare |
| Osprey | Pandion haliaetus | common | common |
| Ovenbird | Seiurus aurocapilla | common | common |
| Pectoral Sandpiper | Calidris melanotos | very rare | very rare |
| Pied-billed Grebe | Podilymbus podiceps | rare | very rare |
| Pine Siskin | Spinus pinus | common | rare |
| Purple Finch | Haemorhous purpureus | common | common |
| Red Crossbill | Loxia curvirostra | rare | common |
| Red-breasted Nuthatch | Sitta canadensis | common | common |
| Red-eyed Vireo | Vireo olivaceus | common | common |
| Red-tailed Hawk | Buteo jamaicensis | very rare | uncommon |
| Red-winged Blackbird | Agelaius phoeniceus | uncommon | common |
| Ring-necked Duck | Aythya collaris | rare | very rare |
| Ruby-throated Hummingbird | Archilochus colubris | common | common |
| Ruddy Turnstone | Arenaria interpres | uncommon | rare |
| Ruffed Grouse | Bonasa umbellus | common | rare |
| Savannah Sparrow | Passerculus sandwichensis | common | common |
| Semipalmated Sandpiper | Calidris pusilla | common | common |
| Sharp-shinned Hawk | Accipiter striatus | uncommon | common |
| Short-billed Dowitcher | Limnodromus griseus | uncommon | rare |
| Solitary Sandpiper | Tringa solitaria | rare | common |
| Song Sparrow | Melospiza melodia | common | common |
| Spotted Sandpiper | Actitis macularius | common | common |
| Swainson’s Thrush | Catharus ustulatus | common | common |
| Tree Swallow | Tachycineta bicolor | common | common |
| Vesper Sparrow | Pooecetes gramineus | rare | rare |
| White-throated Sparrow | Zonotrichia albicollis | common | common |
| White-winged Crossbill | Loxia leucoptera | rare | uncommon |
| Wilson’s Warbler | Cardellina pusilla | rare | rare |
| Winter Wren | Troglodytes hiemalis | common | common |
| Yellow Warbler | Setophaga petechia | common | common |
| Yellow-bellied Flycatcher | Empidonax flaviventris | common | rare |
| Yellow-rumped Warbler | Setophaga coronata | common | common |
| Eastern Whip-poor-will | Antrostomus vociferus | rare | very rare |
| Passenger Pigeon | Ectopistes migratorius | rare | extinct |
| Cliff Swallow | Petrochelidon pyrrhonota | common | very rare |
| Purple Martin | Progne subis | rare | very rare |

### References

American Birding Association (2022). ABA Checklist; Checklist Codes. <https://www.aba.org/aba-checklist/>

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## Insects

### Introduction

In the early 1900s, William Procter, a biologist associated with the Mount Desert Island Biological Laboratory, inventoried the insects of MDI over 30 field seasons. These records have been preserved by Acadia National Park archives, and were published in Volume 7 of the Biological Survey of the Mount Desert Region (1946). This, in a similar fashion to the Champlain Society’s bird records, allowed for an opportunity to evaluate changes of insect diversity in and around Acadia National Park.

We focused on two groups of insects that are generally known as pollinators: Butterflies (order Lepidoptera), and Bees (family Apidae). Pollination is a critical ecosystem service performed by animals that 75% of the world’s plants rely on to reproduce (Natural Resource Council, 2007). This includes species of fruits, vegetables, and other plants that we rely upon for food, drugs, and oxygen (USDA 2021). However, these species are facing many threats such as parasites, pathogens, pesticides and environmental stressors that are causing major die-off of many pollinating insects (USDA 2021).

This study’s objective was to examine how the local Lepidoptera and Apidae insects have changed between the early 1900’s and present day. Our goals were to determine: 1) how well did Landscape of Change’s citizen science efforts do in engaging the public to survey insects on MDI, 2) what species are no longer present that were recorded 100 years ago, and 3) what species are present today that were not recorded by Procter.

### Methods

Landscape of Change focuses broadly on two groups of insects that include pollinating species: family Apidae and order Lepidoptera. While the Landscape of Change citizen science project took place in 2021, a broader effort to crowdsource biodiversity data of the Downeast and Acadia Region using iNaturalist has been ongoing since 2012. To determine how well these efforts did in engaging citizen scientists to record these insects, we compared the number of species on MDI identified to species by the iNaturalist community 2012 - 2021, and compared this to a historical collection of insects compiled by Procter in the early 1900s (1927 - 1950 with a few earlier records). We used only iNaturalist records that were identified to species and labeled as Research Grade. We then compared these two data sets to examine species not recorded 100 years ago, and specific changes in threatened or endangered species.

Acadia National Park has archives of all specimens collected in and around the park from historic times to modern day. This includes specimens from more intensive scientific surveys such as the Maine Bumble Bee Atlas, and bio-blitzes. We used this expanded dataset of bumble bees to get a better representation of insect changes in the region.

### Results

Between Lepidoptera and Apidae, Procter had collected 1,360 species, while the iNaturalist community over the last 10 years identified 362 species. The iNaturalist community identified 20% (n = 274) of the 1,360 species that Procter documented in the 1900s. This means there were 88 species identified by the iNaturalist community that were not recorded by Procter’s efforts, and were likely not present in the early 1900s (**Table 1**). For a full look at the species diversity between all families, see **Figure 1**.

We examined the bumble bees (*Bombus* spp.) to represent a group of pollinating insects. There were 10 species recorded by Procter, and 9 species recorded today on MDI. However, there are only six species in common between historic and modern times. Procter identified four species that are no longer present on MDI: three of which are cuckoo-bumble bees, and the other is the Rusty-patched Bumble Bee (**Table 2**). Additionally, there are three species that we have documented today that were not collected by Procter: Brown-belted Bumble Bee, Common Eastern Bumble Bee, and Sanderson’s Bumble Bee (**Table 2**).

Threatened and endangered species were another category we wanted to explore the status of on MDI. There were two species recorded that are currently listed as either state or federally threatened or endangered. Historically, Procter collected specimens of a Maine endangered species known as the [Edwards’ Hairstreak](https://www.maine.gov/ifw/docs/endangered/edwardshairstreak_106_107.pdf) (*Satyrium edwardsii*). Today, this species is barely found at 3 sites throughout the entire state of Maine. Another species, the federally endangered [Rusty-patched Bumble Bee](https://ecos.fws.gov/ecp/species/9383) (*Bombus affinis*), has experienced a similar fate as the Edwards’ Hairstreak. This species was collected by Procter in the early 1900’s, and was once widespread across most of the eastern United States (U.S. Fish & Wildlife Service 2021). The Rusty-patched Bumble Bee has experienced large-scale range reductions and can no longer be found in most of the northeastern US.

### Conclusions and Next Steps

It is apparent that iNaturalist observers recorded dramatically fewer species than Procter, but much of this can be attributed to the difference in methods: Procter’s intensive and long-term specimen collection method vs. the casual and minimally invasive photo documentation of iNaturalist. Based on this analysis, we cannot conclude that a species found by Procter but not recorded in iNaturalist is absent or decreasing. We can, however, be confident in determining that species not found by Procter but documented in iNaturalist are present and increasing. It may be that closer examination of these species and the reasons for their range expansion might tell us something about the species we aren’t finding.While iNaturalist’s methods are much safer and less invasive, there are limitations as many insects can only be identified to species in the hand with equipment such as loupes, microscopes, etc. That said, we would not have the modern data set for comparison without community efforts by citizen scientists. Continued careful and extensive photographic evidence collected via iNaturalist can be subsidized with intensive, scientist-led bio-blitzes to get a better understanding of the insect populations of MDI.

The bumble bees are a great example of pollinators to look into due to many researchers and projects focused on this group. Of the four species that are no longer found on MDI, three are cuckoo-bumble bees, a group that invades other bumble bee colonies, kills the queen, and takes control of the workers. These species have been undergoing large-scale range reductions, and some of this can be attributed to their host species also decreasing (Colla et al. 2012). An example is the Ashton’s Cuckoo-Bumble Bee, and its host, the Rusty-patched Bumble Bee which is now federally endangered because of its population loss (more on this species below). There were also three species of bumble bee that have become present on MDI since Procter was surveying the area. These three now occur here for various reasons. The Brown-belted Bumble Bee has been linked to human-developed land, increasing as planted meadows, roadsides, and urbanization have become more common (Novotny et al. 2021). Somewhat similarly, the Common Eastern Bumble Bee has shown impressive range expansion due to human introduction and commercialization of bumble bees (Palmier & Sheffield 2019). This species is also thought to be replacing species that have decreased due to landscape and climate change, such as the Rusty-patched Bumble Bee, due to its highly generalized habitat use (Palmier & Sheffield 2019). The Rusty-patched Bumble Bee has experienced large-scale range reductions, once having been present on MDI, but now cannot be found in the state of Maine (U.S. Fish & Wildlife Service, 2021). This species requires grasslands and prairies, an ecosystem that has taken devastating losses due to degradation, fragmentation, and conversion to industrial agriculture or development (U.S. Fish & Wildlife Service, 2021).

According to the MDIFW Endangered Species Program (2003), the Edward’s Hairstreak has undergone a major range restriction and today has only been found at three sites in southwestern Maine. The extensive reduction in abundance of this species can largely be attributed to the loss of their native habitat, pitch pine-scrub oak barrens, which have been reduced to less than 50% of their historic range due to climate change and human development along the coast (MDIFW, 2003).

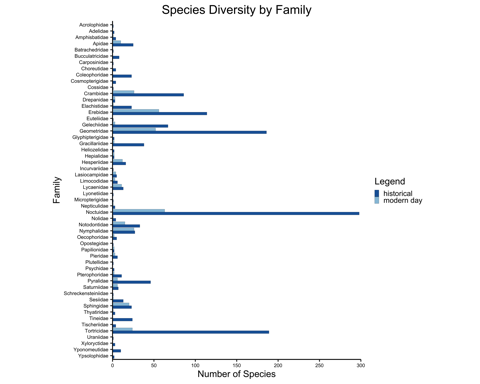
Future research could incorporate additional data sets, such as bio-blitzes that were conducted from the early 2000s to 2016. The addition of these data will provide us with a more complete snapshot of what species are currently present on the island, and how we can make management recommendations to help the native insects of our region.

### Modern Species not Recorded by Procter

**Table 1**. This table shows the 88 species that the iNaturalist community identified over the past 10 years that were not recorded by Procter in the 1900s. Data collected on Mount Desert Island, Maine, USA, and provided by iNaturalist and the National Park Service.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Order | Super family | Family | Scientific name | Common name |
| Hymenoptera | Apoidea | Apidae | Bombus griseocollis | Brown-belted Bumble Bee |
| Hymenoptera | Apoidea | Apidae | Bombus impatiens | Common Eastern Bumble Bee |
| Hymenoptera | Apoidea | Apidae | Xylocopa virginica | Eastern Carpenter Bee |
| Lepidoptera | Bombycoidea | Saturniidae | Callosamia promethea | Promethea Silkmoth |
| Lepidoptera | Bombycoidea | Sphingidae | Hemaris aethra | Diervilla Clearwing |
| Lepidoptera | Bombycoidea | Sphingidae | Manduca sexta | Carolina Sphinx |
| Lepidoptera | Gelechioidea | Gelechiidae | Arogalea cristifasciella | White Stripe-backed Moth |
| Lepidoptera | Gelechioidea | Autostichidae | Gerdana caritella |  |
| Lepidoptera | Gelechioidea | Gelechiidae | Scrobipalpula manierreorum |  |
| Lepidoptera | Geometroidea | Geometridae | Idaea dimidiata | Single-dotted Wave |
| Lepidoptera | Geometroidea | Geometridae | Macaria aemulataria | Common Angle |
| Lepidoptera | Geometroidea | Geometridae | Macaria pustularia | Lesser Maple Spanworm Moth |
| Lepidoptera | Geometroidea | Geometridae | Nematocampa resistaria | Horned Spanworm Moth |
| Lepidoptera | Geometroidea | Geometridae | Rheumaptera prunivorata | Cherry Scallop Shell Moth |
| Lepidoptera | Geometroidea | Geometridae | Xanthotype | Crocus Geometer Moths |
| Lepidoptera | Hepialoidea | Hepialidae | Sthenopis pretiosus | Gold-spotted Ghost Moth |
| Lepidoptera | Noctuoidea | Noctuidae | Acronicta fallax | Green Marvel |
| Lepidoptera | Noctuoidea | Noctuidae | Acronicta funeralis | Funerary Dagger |
| Lepidoptera | Noctuoidea | Noctuidae | Acronicta insita | Large Gray Dagger |
| Lepidoptera | Noctuoidea | Noctuidae | Acronicta oblinita | Smeared Dagger |
| Lepidoptera | Noctuoidea | Erebidae | Apantesis figurata | Figured Tiger Moth |
| Lepidoptera | Noctuoidea | Erebidae | Apantesis virgo | Virgin Tiger Moth |
| Lepidoptera | Noctuoidea | Erebidae | Arctia parthenos | St. Lawrence Tiger Moth |
| Lepidoptera | Noctuoidea | Nolidae | Baileya doubledayi | Doubleday’s Baileya Moth |
| Lepidoptera | Noctuoidea | Noctuidae | Bellura obliqua | Cattail Borer Moth |
| Lepidoptera | Noctuoidea | Noctuidae | Calophasia lunula | Toadflax Brocade Moth |
| Lepidoptera | Noctuoidea | Erebidae | Chytolita morbidalis | Morbid Owlet |
| Lepidoptera | Noctuoidea | Erebidae | Cycnia tenera | Delicate Cycnia Moth |
| Lepidoptera | Noctuoidea | Notodontidae | Datana contracta | Contracted Datana Moth |
| Lepidoptera | Noctuoidea | Erebidae | Doryodes spadaria | Dull Doryodes Moth |
| Lepidoptera | Noctuoidea | Noctuidae | Elaphria alapallida | Pale-winged Midget |
| Lepidoptera | Noctuoidea | Erebidae | Euchaetes egle | Milkweed Tussock Moth |
| Lepidoptera | Noctuoidea | Noctuidae | Eudryas grata | Beautiful Wood-nymph |
| Lepidoptera | Noctuoidea | Noctuidae | Eupsilia vinulenta | Straight-toothed Sallow |
| Lepidoptera | Noctuoidea | Noctuidae | Feltia herilis | Master’s Dart |
| Lepidoptera | Noctuoidea | Erebidae | Haploa clymene | Clymene Moth |
| Lepidoptera | Noctuoidea | Erebidae | Hypena manalis | Flowing-line Snout |
| Lepidoptera | Noctuoidea | Noctuidae | Lithophane baileyi | Bailey’s Pinion Moth |
| Lepidoptera | Noctuoidea | Erebidae | Lophocampa caryae | Hickory Tussock Moth |
| Lepidoptera | Noctuoidea | Noctuidae | Maliattha synochitis | Black-dotted Glyph |
| Lepidoptera | Noctuoidea | Erebidae | Mycterophora inexplicata | Pale-edged Snout Moth |
| Lepidoptera | Noctuoidea | Noctuidae | Neoligia exhausta | Exhausted Brocade |
| Lepidoptera | Noctuoidea | Noctuidae | Noctua pronuba | Large Yellow Underwing |
| Lepidoptera | Noctuoidea | Noctuidae | Oligia strigilis | Marbled Minor |
| Lepidoptera | Noctuoidea | Erebidae | Panopoda rufimargo | Red-lined Panopoda Moth |
| Lepidoptera | Noctuoidea | Noctuidae | Psectraglaea carnosa | Pink Sallow |
| Lepidoptera | Noctuoidea | Erebidae | Zanclognatha laevigata | Variable Fan-foot |
| Lepidoptera | Papilionoidea | Hesperiidae | Anatrytone logan | Delaware Skipper |
| Lepidoptera | Papilionoidea | Hesperiidae | Carterocephalus mandan | Arctic Skipper |
| Lepidoptera | Papilionoidea | Lycaenidae | Celastrina lucia | Northern Azure |
| Lepidoptera | Papilionoidea | Nymphalidae | Coenonympha california | Common Ringlet |
| Lepidoptera | Papilionoidea | Hesperiidae | Epargyreus clarus | Silver-spotted Skipper |
| Lepidoptera | Papilionoidea | Hesperiidae | Erynnis juvenalis | Juvenal’s Duskywing |
| Lepidoptera | Papilionoidea | Lycaenidae | Glaucopsyche lygdamus | Silvery Blue |
| Lepidoptera | Papilionoidea | Nymphalidae | Lethe anthedon | Northern Pearly-eye |
| Lepidoptera | Papilionoidea | Nymphalidae | Lethe appalachia | Appalachian Brown |
| Lepidoptera | Papilionoidea | Nymphalidae | Limenitis arthemis arthemis | American White Admiral |
| Lepidoptera | Papilionoidea | Hesperiidae | Lon hobomok | Hobomok Skipper |
| Lepidoptera | Papilionoidea | Lycaenidae | Lycaena phlaeas hypophlaeas | Eastern American Copper |
| Lepidoptera | Papilionoidea | Nymphalidae | Megisto cymela | Little Wood Satyr |
| Lepidoptera | Papilionoidea | Nymphalidae | Nymphalis l-album | Compton Tortoiseshell |
| Lepidoptera | Papilionoidea | Papilionidae | Papilio canadensis | Canadian Tiger Swallowtail |
| Lepidoptera | Papilionoidea | Papilionidae | Papilio polyxenes | Black Swallowtail |
| Lepidoptera | Papilionoidea | Nymphalidae | Phyciodes cocyta | Northern Crescent |
| Lepidoptera | Papilionoidea | Lycaenidae | Satyrium liparops | Striped Hairstreak |
| Lepidoptera | Papilionoidea | Nymphalidae | Speyeria cybele | Great Spangled Fritillary |
| Lepidoptera | Papilionoidea | Hesperiidae | Thymelicus lineola | Essex Skipper |
| Lepidoptera | Pterophoroidea | Pterophoridae | Geina buscki | Buck’s Plume Moth |
| Lepidoptera | Pyraloidea | Crambidae | Anania hortulata | Small Magpie |
| Lepidoptera | Pyraloidea | Crambidae | Donacaula longirostrallus | Long-beaked Donacaula Moth |
| Lepidoptera | Pyraloidea | Crambidae | Eoparargyractis plevie |  |
| Lepidoptera | Pyraloidea | Pyralidae | Hypsopygia olinalis | Yellow-fringed Dolichomia Moth |
| Lepidoptera | Pyraloidea | Crambidae | Microcrambus biguttellus | Gold-striped Grass-veneer |
| Lepidoptera | Pyraloidea | Pyralidae | Pococera expandens | Striped Oak Webworm Moth |
| Lepidoptera | Pyraloidea | Crambidae | Scoparia biplagialis | Double-striped Scoparia Moth |
| Lepidoptera | Pyraloidea | Crambidae | Sitochroa palealis | Carrot Seed Moth |
| Lepidoptera | Sphingoidea | Sphingidae | Sphinx poecila | Northern Apple Sphinx |
| Lepidoptera | Tortricoidea | Tortricidae | Acleris forsskaleana | Maple Leaftier Moth |
| Lepidoptera | Tortricoidea | Tortricidae | Archips dissitana | Boldly-marked Archips Moth |
| Lepidoptera | Tortricoidea | Tortricidae | Cenopis reticulatana | Reticulated Fruitworm Moth |
| Lepidoptera | Tortricoidea | Tortricidae | Eucosma ochroterminana | Buff-tipped Eucosma Moth |
| Lepidoptera | Tortricoidea | Tortricidae | Eucosma parmatana | Aster Eucosma Moth |
| Lepidoptera | Tortricoidea | Tortricidae | Gymnandrosoma punctidiscanum | Dotted Gymnandrosoma Moth |
| Lepidoptera | Tortricoidea | Tortricidae | Pelochrista derelicta | Derelict Pelochrista Moth |
| Lepidoptera | Tortricoidea | Tortricidae | Platynota exasperatana | Exasperating Platynota Moth |
| Lepidoptera | Tortricoidea | Tortricidae | Sparganothis tristriata | Three-streaked Sparganothis Moth |
| Lepidoptera | Zygaenoidea | Limacodidae | Apoda biguttata | Shagreened Slug Moth |
| Lepidoptera | Zygaenoidea | Limacodidae | Euclea delphinii | Spiny Oak-slug Moth |

### Comparisons by Insect Families



**Figure 1**. Comparison of the number of species by family from modern iNaturalist data and historical data collected by Procter in the 1900’s. Data collected on Mount Desert Island, Maine, USA, and provided by iNaturalist and the National Park Service.

### Pollinators

**Table 2**. This table shows just the bumble bee species that modern day sources (iNaturalist, Acadia National Park BioBlitz, and Maine Bumble Bee Atlas) and Procter identified, and when they were present on MDI. Data collected on Mount Desert Island, Maine, USA, and provided by iNaturalist and the National Park Service.

|  |  |  |  |
| --- | --- | --- | --- |
| Common name | Scientific name | Present 1900 | Present modern |
| Ashton’s cuckoo bumble bee | Bombus ashtoni | yes | no |
| Brown-belted bumble bee | Bombus griseocollis | no | yes |
| Common eastern bumble bee | Bombus impatiens | no | yes |
| Confusing bumble bee | Bombus perplexus | yes | yes |
| Half-black bumble bee | Bombus vagans | yes | yes |
| Lemon cuckoo-bumble bee | Bombus citrinus | yes | no |
| Northern amber bumble bee | Bombus borealis | yes | yes |
| Rusty-patched bumble bee | Bombus affinis | yes | no |
| Sanderson’s bumble bee | Bombus sandersoni | no | yes |
| Tri-colored bumble bee | Bombus ternarius | yes | yes |
| Two-spotted bumble bee | Bombus bimaculatus | yes | yes |
| Yellow-banded bumble bee | Bombus terricola | yes | yes |
| Yellowish cuckoo-bumble bee | Bombus fervidus | yes | no |

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