2010 – 2013 progress report: Using a Network of Sites to Evaluate How Climate-mediated Changes in the Arctic Ecosystem are Affecting Shorebird Distribution, Ecology and Demography

Richard B. Lanctot,
U.S. Fish and Wildlife Service, Migratory Bird Management

Stephen Brown
Manomet Center for Conservation Sciences

and

Brett K. Sandercock
Kansas State University

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Abstract

To obtain a better understanding of how shorebirds will respond to climate-mediated changes in the Arctic's morphology and ecology, we have established a network of sites, known as the Arctic Shorebird Demographics Network (ASDN), wherein we collected information on a suite of predictor variables thought to be responsive to climate change, with a future goal of correlating these variables with measures of shorebird distribution, ecology, and demography. Starting in 2010, we established nine field sites across the Arctic, from Nome, Alaska to Hudson Bay, Nunavut. The number of sites was expanded from 9 to 11 sites in 2011, 11 to 14 in 2012, and 14 to 16 in 2013. Protocols were adopted/modified from prior studies in the Arctic to create a standardized protocol that has been updated prior to each field season. We have compiled all of the data from the various sites during the first four years of the ASDN operation, and results from all four field seasons are presented here.

A total of 6,691 nests belonging to 38 species were located in the first four years of the study. The largest number of nests belonged to the five ASDN focal species: Dunlin, Semipalmated Sandpipers, Red and Red-necked Phalaropes, and Pectoral Sandpipers. Unexpectedly high number of Western Sandpiper and American Golden-Plovers were also discovered. Nest initiation dates varied tremendously across sites for the focal shorebird species investigated during this study. Apparent nest success was 48% across all sites and species; rates varied between years within sites, and also between sites within years. An investigation into what environmental variables best explain the variation in nest success is underway. A total of 5,237 adults belonging to 29 species were banded in the first four years of the study. The number of adults banded per species ranged from 1 to 1,422 during the study (mean ± SD = 180.6 ± 329.0). ASDN focal species were again captured the most frequently, but like nests, high numbers of Western Sandpipers and American Golden-Plovers were also captured. The highest returns of color-marked adults were observed in Dunlin, Red-necked Phalarope, Semipalmated Sandpiper, Western Sandpiper, and Whimbrel, which should allow adult survival estimates to be made (detailed analysis beginning now). Besides the shorebird data, field personnel kept daily species lists, and established sampling stations to document aquatic and terrestrial invertebrate diversity, phenology, and abundance. In addition, data were collected on predators, small mammals and other alternative prey for predators of shorebirds, snow and surface water, and general climatic variables.

ASDN principal investigators and other partners are collaborating on 18 projects that use the geographically vast and taxonomically rich ASDN data. ASDN studies include investigations of the potential for an ecological mismatch between invertebrate emergence and shorebird hatching, variation in shorebird nest predation across the Arctic, assessment of predator diversity and abundance in relation to human development, and factors affecting shorebird settlement patterns. Avian health issues being investigated include avian influenza, avian malaria, gut microbiota, and mercury exposure. Migratory connectivity studies include projects using light-level geolocators to document migratory pathways and wintering areas of American Golden-Plover, Dunlin, and Semipalmated Sandpipers. An additional study is using stable isotope signatures to document connections between breeding, migration and wintering areas of Semipalmated Sandpipers. Other studies are focusing on the effects of spring phenology on timing of breeding in shorebirds, invertebrate phenology in relation to habitat and weather, long-distance dispersion of moss by shorebirds, and the distribution of Arctic invertebrates.

The ASDN principal investigators have been highly successful at producing products from the data collected at their field sites. Although the major analyses and publications that will

address core objectives of the ASDN have not been completed, investigators have collectively produced 24 peer-reviewed publications, 25 reports, and 57 presentations. We anticipate that many more publications will be produced in the coming years.

Although this report summarizes information collected between 2010 and 2013, we are preparing for the fifth of five originally proposed field seasons. A report summarizing the fifth field season will be available in March 2015.

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Other principal investigators and graduate students running field camps within the Arctic Shorebird Demographic Network are listed in Appendix 1. The data and accomplishments for this report are a product of all of these people.

Table of Contents

Background

The Arctic has experienced the most pronounced warming of the entire world (ACIA 2004). Within the circumpolar Arctic, terrestrial areas in northern Alaska, western Canada, and central Russia have experienced the most rapid warming (Martin et al. 2009). For example, the Arctic Coastal Plain of Alaska is projected to have a 1.6 ° Celsius increase in temperature and a 12% increase in precipitation by 2051 to 2060. Further, the overall length of the frost-free season is expected to increase by 18 days by mid-century, with most of this occurring in the fall (Martin et al. 2009). The higher summer temperatures and longer summer season may increase the amount of water lost to evapotranspiration, resulting in a drier landscape, although enhanced cloud cover, which reduces evapotranspiration, and possible increases in precipitation may counteract this drying trend to some degree. The warmer air temperatures are predicted to accelerate ice wedge degradation and accompanying thermokarst pond development, a pattern already observed that has led to an increase in the proportion of land covered with surface water (Shur et al. 2003).

These climate-mediated habitat changes are likely to have a profound effect on the animals using the Arctic regions of Alaska and Canada, particularly for the millions of shorebirds that breed and raise their young between June and September (Johnson and Herter 1989). Predicting how long-term changes will affect shorebirds, however, is difficult, and it seems likely that there will be both positive and negative effects on any given species. Beyond direct effects on habitat conditions, earlier snowmelt may decouple the apparent synchrony between shorebird breeding chronology and food availability (MacLean 1980). The timing and availability of surface-active insects is critical to shorebirds for egg production (Klaassen et al. 2001), chick growth (Schekkerman et al. 2003), and pre-migratory fattening before southward departure (Connors et al. 1979, 1981; Connors 1984; Andres 1994). Decoupling of phenological events could negatively affect shorebird productivity and survival. In contrast, warmer summers and delayed freeze-up may improve shorebird reproductive success through prolonged availability of invertebrates, since cold weather conditions have been shown to slow chick growth and reduce chick survival (Soloviev et al. 2006). Climate warming may also affect shorebirds indirectly by altering the availability of alternate prey (i.e., Brown Lemming (*Lemmus sibiricus*) and Collared Lemming (*Dicrostonyx groenlandicus*) to shorebird predators (Ims and Fuglei 2005, Kausrud et al. 2008).

Beyond anticipated climate changes and their impacts on shorebirds, humans are causing more direct impacts on the landscape and the bird communities. New and expanding Native villages, along with a recently legalized spring and summer subsistence harvest of shorebirds in Alaska (Alaska Migratory Bird Co-Management Council 2003), may negatively affect shorebirds through habitat alteration and direct mortality. Mineral, oil, and natural gas production in the Arctic has expanded in recent years (Gilders and Cronin 2000, National Research Council 2003), and areas previously closed to oil and gas exploration and development have been leased within Alaska (U.S. Bureau of Land Management 2006). Potential effects of oil and gas development on wildlife include the loss of habitat through the building of roads, pads, pipelines, dumps, gravel pits, and other infrastructure. Roads and pads also increase levels of dust, alter hydrology, thaw permafrost, and increase roadside snow accumulation (Auerbach et al. 1997; National Research Council 2003). Anthropogenic impacts may decrease habitat quantity and quality for nesting shorebirds (Meehan 1986; Troy Ecological Research Associates 1993a; Auerbach et al. 1997). Furthermore, oil field infrastructure may enhance predator numbers by providing denning and nesting habitat and supplemental food (through human garbage) during winter months. An increase in predators may result in lower adult shorebird and nest survival (Eberhardt et al. 1983; Day 1998; National Research Council 2003, but see Liebezeit et al. 2009). Lower adult survival and nesting success may create population sinks in the vicinity of human developments (National Research Council 2003), especially for species with high site fidelity. Therefore, expanding oil development could have cumulative negative effects on breeding shorebirds using the Arctic region of Alaska and Canada.

Goals and Objectives

To obtain a better understanding of how shorebirds will respond to climate-mediated changes in the structure and function of the arctic ecosystem, we established a network of sites in 2010 known as the Arctic Shorebird Demographics Network (ASDN). Biologists at these sites collected information on a suite of predictor variables thought to be responsive to climate change, as well as information on shorebird ecology and demography. Special emphasis was placed on obtaining data on the abundance and distribution of surface water, which affects the distribution and abundance of invertebrates and indirectly the distribution of some shorebird species (e.g., Red and Red-necked Phalaropes). We also collected data to investigate how summer temperatures and growing season length affect insect emergence and abundance, and how the timing of invertebrate emergence relates to adult shorebird breeding phenology, body condition, and survival.

These data were collected within a larger framework of objectives that the ASDN has developed to ascertain why many arctic-breeding shorebird populations are declining. Objectives included:

1) Collecting demographic data (nest survival, adult survival, mate and site fidelity, age at first breeding) on a select group of Arctic-breeding shorebirds that will allow us to assess potential factors limiting population growth.

2) Documenting contemporary patterns of species presence and abundance (i.e. breeding densities) of shorebirds, and when possible assessing how species assemblages and abundance have changed historically.

3) Documenting seasonal patterns of nest initiation, habitat use, and presence of species.

4) Collecting environmental information, including avian and mammalian predators of shorebirds, alternative prey availability, and weather.

5) Correlating data from objectives 1) through 4) to assess impacts of climate change on shorebird breeding ecology.

6) Participate in projects that take advantage of the ASDN's large geographic footprint, multi-year study, and diversity of shorebird species, to investigate shorebird health, migratory connectivity, and ecotoxicology.

Methods

The methods used in this study rely on the knowledge gained by partners through decades of collective work at shorebird breeding areas in Alaska and Canada. Protocols have been adopted/modified from prior projects such as the Tundra Predator study (Liebezeit et al. 2009), the Arctic Wildlife Observatories Linking Vulnerable Ecosystems (WOLVES) project (http://www.cen.ulaval.ca/arcticwolves/en_project_descrip_CAN_method.htm), and the US Fish and Wildlife Service study protocols from the Barrow Shorebird Breeding Ecology Study (Liebezeit et al. 2007, Naves et al. 2008) and the Arctic National Wildlife Refuge. Version 5 of this protocol was completed in March 2014, and can be found at https://www.manomet.org/ASDN

Results and Discussion

Network Sites Establishment

Nine ASDN sites were established in 2010, ranging from Nome in the western part of Alaska to East Bay in northeastern Canada (Fig. 1). The full suite of activities was not implemented at Cape Krusenstern until 2011. Two new sites, Bylot Island and the Colville River, joined in 2011, and one site, Prudhoe Bay, was down scaled so as to not include marking birds and nest searching in 2011. The ASDN network continued to grow in 2012, with two new sites added in Russia (Chaun River Delta and Lower Khatanga River) and one site added in Canada (Burnt Point). In 2013, the ASDN network expanded again, with the Igloolik and Coats Island sites located in Nunavut, Canada added. Sponsoring organizations and names of the principal investigators at each site are listed in Appendix 1.

Figure 1. Location of the sixteen ASDN sites active at some time between 2010 and 2013. Map courtesy of JF Lamarre.

Database Development and Population

Excel files have been established for the data described below. Most data have GPS locations that will allow georeferencing, and will be incorporated into a geodatabase that is web-accessible. As an example, a list of all data collected at each ASDN site in 2012 and 2013 is presented in Table 1.

- Field camp Metadata: field personnel, plot and sampling locations
- Adult and chick banding records
- Band resighting records
- Nest records
- Snow and surface cover
- Pond water level monitoring
- Lemmings: winter nest counts, incidental observations, intensive trapping
- Predator point counts and area surveys
- Food resources: terrestrial and aquatic invertebrates
- Weather: automated hourly measurements: manual rainfall and snow
- Daily species list
- Daily camp journal

Shorebird Data

Prior to the start of the field season, principal investigators agreed to focus their studies on key species of arctic-breeding shorebirds ('focal species' hereafter) that 1) exhibited high site fidelity and were therefore good candidates for estimating annual survival; 2) were present at two or more ASDN field sites, thereby providing comparative data under different environmental conditions; 3) were sufficiently common to allow reliable estimates of nest success; and 4) were likely to be influenced by climate change, based on a range of reasonable scenarios. Based on these four criteria, we chose our five focal species to be Dunlin, Semipalmated Sandpiper, Pectoral Sandpiper, Red Phalarope, and Red-necked Phalarope. Additional species were monitored at various ASDN camps where they were common or because they were the subject of other studies. A full list of species, with genus and species names, is provided in Appendix 2.

<u>Number and Diversity of Shorebird Nests</u>

A total of 6,691 nests belonging to 38 species were located the first four years of the study (Table 2). The number of nests located in each year of the study has grown from 975 in 2010 to 2,167 in 2013. This increase is partially explained by the higher number of sites operating within the ASDN network, but also reflects an increase in the number of nests found at each site generally. Number of nests per species ranged from 1 to 1,422, with the largest number of nests belonging to the ASDN focal species (i.e., Dunlin, Semipalmated Sandpipers, Red and Red-necked Phalaropes, and Pectoral Sandpipers). Relatively high numbers of nests were also found for American Golden-Plover and Western Sandpiper. Only a single nest was found for two species, including Red-necked Stint and Wood Sandpiper. The number of nests found per ASDN site ranged from 12 to 264 in 2010, from 28 to 447 in 2011, from 36 to 436 in 2012, and from 20 to 403 in 2013 (Table 2). *Sarah Saalfeld and Richard Lanctot have proposed to investigate environmental and social factors that may explain the annual variation in settlement patterns (i.e., species distribution and nest density) of shorebird species found at the ASDN sites across the Arctic.*

Table 1. Site activity and data collected by ASDN sites between 2010 and 2013. See subsequent tables for when surveys were conducted and level of effort expended.

2010	Nome	Cape Krusenstern	Barrow	Ikpikpuk	Prudhoe Bay	Canning River	Mackenzie Delta	East Bay	Churchill
Dates site active	11 May – 14 Jul	10 - 29 Jun	25 May – 31 Jul	9 Jun – 13 Jul	4 Jun – 18 Jul	3 Jun – 12 Jul	9 Jun – 7 Jul	2 Jun – 27 Jul	25 May – 2 Aug
# of personnel	5	2	6 - 10	7-8	5	6-9	3 - 5	6	7
Site latitude	N64.4	N67.1	N71.2	N70.5	N70.2	N70.1	N69.3	N63.9	N58.7
Site longitude	W164.9	W163.5	W156.6	W154.7	W148.5	W145.8	W134.9	W81.7	W93.8
Data collected									
Geo metadata	x	x	x	x	x	x	x	x	x
Nest record	x	x	x	x	x	x	x	x	x
Egg mm	no	x	x	no	no	no	no	no	no
Adult banding	x	x	x	x	x	x	x	x	x
Adult Resight	no	no	x	no	no	no	no	x	no
Chick banding	no	no	x	no	no	no	no	no	no
Weather- hourly	x	no	x	x	x	x	x	x	x
Weather-manual rain fall and snow	x	no	no	x	no	x	x	x	no
Invert collection	x	no	x	x	x	x	x	x	x
Lemming-live and winter nest counts	x	no	x	x	x	x	no	x	no
Predator	x	no	x	x	x	x	x	x	x
Snow melt	no	no	x	x	x	x	no[b]	x	no
Surface water	x	no	x	x	x	x	x	x	no
1st occurrence	x	x	x	x	x	x	x	x	x
Daily species list	x	x	x	x	x	x	x	x	x
Pond hydrology	no	no	no	no	no	no	no	no	no

x = collected data, no = no data.
[b] no snow was present upon arrival.

Table 1 Continued.

2011	Nome	Cape Krusenstern	Barrow	Ikpikpuk	Colville	Prudhoe Bay	Canning River	Mackenzie Delta	Bylot Island	East Bay	Churchill
Dates site active	17 May – 23 Jul	27 May - 4 Jul	27 May – 1 Aug	5 Jun – 17 Jul	18 May – 3 Aug	3 Jun – 18 Jul	2 Jun – 14 Jul	4 Jun – 12 Jul	5 Jun – 5 Aug	11 Jun – 25 Jul	24 May – 2 Aug
# of personnel	5	4	6 - 9	8	2	2 - 3	8	4 - 6	5	4	4
Site latitude	N64.4	N67.1	N71.2	N70.5	N70.4	N70.2	N70.1	N69.3	N73.2	N63.9	N58.7
Site longitude	W164.9	W163.5	W156.6	W154.7	W150.7	W148.5	W145.8	W134.9	W80.1	W81.7	W93.8
Data collected											
Geo metadata	x	x	x	x	x	x	x	x	x	x	x
Nest record	x	x	x	x	x	x	x	x	x	x	x
Egg mm	x	x	x	x	x	x	no	x	x	no	x
Adult banding	x	x	x	x	x	no	x	x	x	x	x
Adult Resight	x	x	x	x	x	x	x	x	x	x	x
Chick banding	x (few)	no	x	no	no	no	no	x	x	no	x
Weather- hourly	x	x	x	x	yes	x	x	x	x	no	x
Weather-manual rain fall and snow	x	x	no	x	yes	no	x	x	x	x	no
Invert collection	x	x	x	x	x	no	x	x	x	x	x
Lemming-live and winter nest counts	None observed	None observed	x	x	None observed	x	x	x	x	x	None observed
Predator	x	x	x	x	x	x	x	x	x	x	x
Snow surveys	x	x	x	x	x	x	x	x	x	x	x
1st occurrence	x	x	x	x	x	x	x	x	x	x	x
Daily species list	x	x	x	x	x	x	x	x	x	x	x
Pond hydrology	x	x	x	x	x	no	x	x	x	no	x

x = collected data, no = no data.

Table 1 Continued.

2012	Nome	Cape Krusenstern	Barrow	Ikpikpuk	Colville	Prudhoe Bay	Canning River	Mackenzie Delta	Bylot Island
Dates site active	17 May – 23 Jul	19 May - 8 July	24 May – 3 Aug	3 Jun – 19 Jul	18 May – 27 Jul	2 Jun – 21 Jul	2 Jun – 17 Jul	3 Jun – 10 Jul	1 Jun – 15 Aug
# of personnel	4	4	6 - 9	5	2	3	8	5	5
Site latitude	N64.4	N67.1	N71.2	N70.5	N70.4	N70.2	N70.1	N69.3	N73.2
Site longitude	W164.9	W163.5	W156.6	W154.7	W150.7	W148.5	W145.8	W134.9	W80.1
Data Collected									
Geo metadata	x	x	x	x	x	x	x	x	x
Nest record	x	x	x	x	x	no	x	x	x
Egg mm	x	x	x	x	x	x	no	x	x
Adult banding	x	x	x	x	x	no	x	x	x
Adult Resight	x	x	x	x	x	no	x	x	x
Chick banding	x	x	x	no	x	no	no	x	x
Weather- hourly	x	x	x	x	x	x	x	x	x
Weather-manual rain fall and snow	x	x	no	x	x	no	x	no	x
Invert collection	x	x	x	x	x	no	x	x	x
Lemming-live and winter nest counts	no	None observed	x	x	x	x	x	no	x
Predator	x	x	x	x	x	x	x	x	x
Snow surveys	x	x	x	x	x	x	x	x	x
1st occurrence	x	x	x	x	x	x	x	x	x
Daily species list	x	x	x	x	x	x	x	x	x
Pond hydrology	x	x	x	x	x	no	x	no	x

x = collected data, no = no data.

Table 1 Continued.

2012 cont.	East Bay	Churchill	Burnt Point	Chaun River	Lower Khatanga
Dates site active	6 Jun – 27 Jul	1 Jun – 6 Aug	6 Jun – 18 Jul	16 May – 29 Aug	17 June – 18 July
# of personnel	6	6	9	9	4
Site latitude	N63.9	N58.7	N55.2	N68.8	N72.8
Site longitude	W81.7	W93.8	W84.3	E170.5	E106.0
Data Collected					
Geo metadata	x	x	x	x	x
Nest record	x	x	x	x	x
Egg mm	no	x	x	x	x
Adult banding	x	x	no	no	x
Adult Resight	x	x	no	no	no
Chick banding	no	x	no	no	x
Weather- hourly	x	x	x	no	x - daily
Weather-manual rain fall and snow	x	no	x	X	x
Invert collection	x	x	x	no	no
Lemming-live and winter nest counts	x	x	x	no	x
Predator	x	x	no	x	x
Snow surveys	x	x	x	no	no
1st occurrence	x	x	x	x	no
Daily species list	x	x	x	x	no
Pond hydrology	no	x	no	no	no

x = collected data, no = no data.

Table 1 Continued.

2013	Nome	Cape Krusenstern	Barrow	Ikpikpuk	Colville	Prudhoe Bay	Canning River	Mackenzie Delta	Bylot Island
Dates site active	26 May – 14 Jul	24 May - 10 Jul	23 May – 10 Aug	4 Jun – 19 Jul	16 May – 4 Aug	3 Jun – 22 Jul	2 Jun – 21 Jul	6 Jun – 12 Jul	7 Jun – 21 Aug
# of personnel	5	5	12-Jun	4	3	2	6	5	7
Site latitude	N64.4	N67.1	N71.2	N70.5	N70.4	N70.2	N70.1	N69.3	N73.2
Site longitude	W164.9	W163.5	W156.6	W154.7	W150.7	W148.5	W145.8	W134.9	W80.1
Data collected									
Geo metadata	x	x	x	x	x	x	x	x	x
Nest record	x	x	x	x	x	x	x	x	x
Egg mm	x	x	x	x	x	no	no	no	x
Adult banding	x	x	x	x	x	no	x	x	x
Adult Resight	x	x	x	x	x	no	x	x	x
Chick banding	x	x	x	no	no	no	no	x	x
Weather- hourly	x	x	x	x	x	x	x	x	x
Weather-manual rain fall and snow	x	x	no	x	no	no	x	x	x
Invert collection	x	no	x	no	no[b]	no	no	no	x
Lemming-live and winter nest counts	No	None observed	x	x	x	no	x	None observed	x
Predator	x	x	x	x	x	x	x	x	x
Snow surveys	x	x	x	x	x	x	x	x	x
1st occurrence	x	x	x	x	x	x	x	x	x
Daily species list	x	x	x	x	x	x	x	x	x
Pond hydrology	no	no	no	no	no	no	no	no	no

x = collected data, no = no data.
[b] invertebrate data collected for USGS but not reported to ASDN

Table 1 Continued.

2013 cont.	East Bay	Churchill	Burnt Point	Chaun Delta	Lower Khatanga	Igloolik	Coats Island
Dates site active	5 Jun – 25 Jul	1 Jun – 2 Aug	5 Jun – 3 Jul	7 Jun – 9 Jul	20 Jun – 24 Jul	15 Jun – 31 Aug	16 – 30 Jun
# of personnel	5	11	11	3	4	3	4
Site latitude	N63.9	N58.7	N55.2	N68.8	N72.8	N69.4	N62.9
Site longitude	W81.7	W93.8	W84.3	E170.5	E106.0	W81.5	W82.3
Data collected							
Geo metadata	x	x	x	x	x	x	x
Nest record	x	x	x	x	x	x	x
Egg mm	no	no	no	x	no	x	no
Adult banding	x	x	x	x	no	x	x
Adult Resight	x	x	no	no	no	no	no
Chick banding	no	x	no	no	x	no	no
Weather- hourly	no	x	x	no	no	x	no
Weather-manual rain fall and snow	x	x	x	no	x	x	no
Invert collection	x	x	x	no	no	x	no
Lemming-live and winter nest counts	x	x	x	no	x	x	no
Predator	no	no	no	x	no	x	no
Snow surveys	x	x	no	no	no	x	no
1st occurrence	x	x	x	x	no	no	x
Daily species list	x	x	x	x	no	no	x
Pond hydrology	no	no	no	no	no	no	no

x = collected data, no = no data.

Table 2. Number of nests located at ASDN network sites between 2010 and 2013.

	Barrow				Burnt Point		Bylot Island			Cape Krusenstern				Canning River				Chaun Delta		Churchill				Coats Island
	2010	2011	2012	2013	2012	2013	2011	2012	2013	2010	2011	2012	2013	2010	2011	2012	2013	2012	2013	2010	2011	2012	2013	2013
amgp	15	11	15	14	1	--	78	50	77	--	--	--	--	3	2	5	2	--	--	3	4	10	11	--
basa	1	--	4	--	--	--	25	40	27	--	--	--	--	1	--	1	--	--	--	--	--	--	--	--
bbis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
bbpl	--	--	--	--	--	--	8	4	7	--	--	1	1	2	2	--	--	1	--	--	--	--	--	--
bbsa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	--	11	--	--	--	--	--	--	--
bltu	--	--	--	--	--	--	--	--	--	--	--	14	5	--	--	--	--	--	--	--	--	--	--	--
btgo	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cosn	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
crpl	--	--	--	--	--	--	2	2	4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cusa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
dunl	63	69	51	67	8	13	--	--	--	21	14	22	21	12	15	15	12	13	36	26	35	28	34	--
hugo	--	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	--	---	--	--	--	9	12	--
kill	--	--	--	--	3	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
lbdo	17	35	19	15	--	--	--	--	--	--	--	1	--	--	1	1	2	--	2	--	--	--	--	--
lesa	--	--	--	--	9	10	--	--	--	--	--	--	--	--	--	--	--	--	--	8	11	15	9	--
leye	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--
list	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pagp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1	--	--	--	--	--
pesa	38	108	95	65	--	--	1	--	5	--	--	--	--	46	78	18	69	5	10	--	--	--	--	--
rekn	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
reph	72	158	150	106	--	--	5	--	1	--	--	--	--	17	27	14	45	--	--	--	--	--	--	--
rnph	6	12	25	7	--	1	--	--	--	7	12	18	13	29	34	52	37	10	31	15	11	1	1	--
rnst	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ruff	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	5	--	--	--	--	--
rutu	--	1	1	--	--	--	--	--	1	--	--	--	--	3	1	3	2	1	--	--	--	--	--	--
sand	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--
sbdo	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12	18	11	11	--
sepl	--	--	--	--	8	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sesa	43	42	60	84	--	--	--	--	--	17	36	55	40	70	80	136	97	--	--	--	--	--	--	20
spre	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
spts	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
stsa	--	--	--	--	--	--	--	--	--	--	--	--	--	4	5	3	3	--	--	2	2	3	3	--
test	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	5	--	--	--	--	--
wesa	8	10	16	45	--	--	--	--	--	10	10	35	65	--	--	--	--	--	--	--	--	--	--	--
whim	--	--	--	--	10	24	--	--	--	--	--	--	--	--	--	--	--	--	--	20	15	52	57	--
wisn	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	2	--
wosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--
wrsa	1	1	--	--	--	--	10	8	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	264	447	436	403	40	60	129	105	138	55	72	146	145	188	248	248	280	36	91	86	96	132	140	20

Table 2. Continued.

	Colville			East Bay				Igloolik	Ikpikpuk				Lower Khat. River		Mackenzie Delta				Nome				Prudhoe Bay	Grand Totals
	2011	2012	2013	2010	2011	2012	2013	2013	2010	2011	2012	2013	2012	2013	2010	2011	2012	2013	2010	2011	2012	2013	2010	
amgp	1	1	1	--	2	--	--	13	--	--	--	5	--	--	--	1	2	1	--	--	--	--	--	328
basa	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	101
bbis	--	--	--	--	--	--	--	--	--	--	--	--	2	1	--	--	--	--	--	--	--	--	--	3
bbpl	3	6	4	12	10	7	9	1	1	--	4	4	4	3	--	--	--	--	--	--	--	--	--	94
bbsa	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	16
bltu	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	19
btgo	1	--	--	--	--	--	--	--	3	--	--	1	--	--	--	--	--	--	--	--	--	--	--	5
cosn	--	--	--	--	--	--	--	--	--	--	--	--	3	5	--	--	--	--	--	--	--	--	--	8
crpl	--	--	--	--	--	--	--	--	--	--	--	--	1	1	--	--	--	--	--	--	--	--	--	10
cusa	--	--	--	--	--	--	--	--	--	--	--	--	1	1	--	--	--	--	--	--	--	--	--	2
dunl	14	11	19	3	3	4	2	--	20	13	17	17	11	22	--	--	--	--	--	3	2	3	--	739
hugo	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	2	3	--	--	--	--	--	30
kill	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5
lbdo	1	--	1	--	--	--	--	--	2	4	6	13	--	--	--	--	2	1	--	--	--	1	--	124
lesa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	64
leye	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2
list	--	--	--	--	--	--	--	--	--	--	--	--	15	--	--	--	--	--	--	--	--	--	--	15
pagp	--	--	--	--	--	--	--	--	--	--	--	--	8	11	--	--	--	--	--	--	--	--	--	21
pesa	5	10	3	--	--	--	--	--	11	3	4	11	50	17	--	2	1	10	--	1	--	--	10	676
rekn	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2
reph	13	14	16	25	13	5	23	11	10	13	20	23	49	8	--	--	--	--	--	--	--	--	2	840
rnph	18	21	27	--	--	--	--	--	7	9	20	18	7	3	1	7	29	55	24	50	96	80	3	797
rnst	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	1
ruff	--	--	--	--	--	--	--	--	--	--	--	--	16	25	--	--	--	--	--	--	--	--	--	49
rutu	7	14	9	28	12	13	8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	106
sand	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2
sbdo	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	52
sepl	1	--	--	7	11	8	5	--	--	--	--	--	--	--	4	4	5	7	--	--	--	--	--	67
sesa	73	101	109	--	--	2	2	10	62	62	50	64	--	--	1	4	17	29	30	68	61	70	29	1624
spre	--	--	--	--	--	--	--	--	--	--	--	--	2	1	--	--	--	--	--	--	--	--	--	3
spts	--	--	--	--	--	--	--	--	--	--	--	--	5	1	--	--	--	--	--	--	--	--	--	6
stsa	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	2	5	3	--	--	--	--	--	36
test	--	--	--	--	--	--	--	--	--	--	--	--	20	8	--	--	--	--	--	--	--	--	--	35
wesa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	44	90	75	50	--	458
whim	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6	5	9	8	--	--	--	--	--	206
wisn	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1	2	--	8
wosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
wrsa	--	--	--	33	23	17	24	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	136
Total	137	179	189	110	74	56	73	40	116	104	121	158	195	107	12	28	72	117	98	213	235	206	46	6691

Nest Initiation Dates

As an example of how nest initiation varies tremendously across sites for the focal shorebird species investigated during this study, we present data for 2010 and 2011 (Figs. 2, 3). Timing of egg-laying appeared to vary less within sites across years than among sites although no formal analysis has been conducted to date. A number of investigators are exploring initiation date variation in greater detail as part of either core or side project investigations. *Eunbi Kwon and Brett Sandercock are investigating how nest initiation (and consequently egg hatching) relates to timing of insect emergence. Kirsty Gurney and David Ward are investigating how nest initiation relates to satellite-derived measures of NDVI (i.e., tundra green-up) and soil temperature.*

Nest Success and Survival

Most nests (88% across all years) were monitored every 3-5 days for survival. The average apparent nest success rate (no. of nests with at least one young hatching) for all sites and years was 47.8%, but this rate varied among years and sites tremendously (Table 3). Combining all sites across years, the lowest nest success rate was recorded in 2013 (34%) and the highest in 2011 (69%). Combining all years across sites, the lowest nest success rate was recorded at Burnt Point (18%) and the highest was at Barrow (72.5%). The Barrow site was likely artificially high due to a fox removal program occurring at this site (R. Lanctot and S. Saalfeld, in prep.). Corrections to estimates will be available as we continue to proof the data and correct assignments in how field technicians assigned nest fate. We will use the nest survival model in Program Mark to estimate nest daily survival rates (DSR) in the future. *Paul Smith and Joe Liebezeit are analyzing how shorebird nest DSR varies across a large geographic area, and how environmental covariates such as predators, lemmings, weather and invertebrates affect survival rates. Emily Weiser and Brett Sandercock will explore nest success in more detail as part of life cycle analyses.*

Adult and Chicks Captured

A total of 5,237 adults belonging to 29 species were banded between 2010 and 2013 across all field sites (Table 4). The number banded increased from a low of 1,165 in 2010 to a peak of 1,450 in 2012. The number banded in 2013 decreased to 1,284. Despite the addition of two new sites in 2013, which allowed 62 new birds to be banded, the number banded in 2013 decreased from the peak in 2014 due to lower numbers being captured at Barrow, Bylot Island, Cape Krusenstern, and Nome. These decreases were due primarily to higher predation rates at these sites. The total number of species banded each year went from 16 in 2010 to a maximum of 26 in 2013; new sites in Russia added several species not available for banding in early years. Number of adults banded per species ranged from 1 to 1,422, with the largest number of adults banded belonging to the ASDN focal species (i.e., Dunlin, Semipalmated Sandpipers, Red and Red-necked phalaropes, and Pectoral Sandpipers). American Golden-Plover and Western Sandpipers were also banded in good numbers. Eight species were only captured at one location in one year of the study (BBSA, COSN, CRPL, CUSA, LESA, LIST, PAGP, and WISN). In all cases, banding was only conducted during one year at these sites (in other words, more individuals of these species would likely be captured if banding was conducted multiple years). *From most of these individuals, additional data were collected including biometric measurements, molt scores, body condition, and a variety of samples (e.g., blood, feathers, feces) for use in side projects (see below).* Blood and feather samples have been archived either at the U.S. Fish and Wildlife Service Office in Anchorage or with the site investigators.

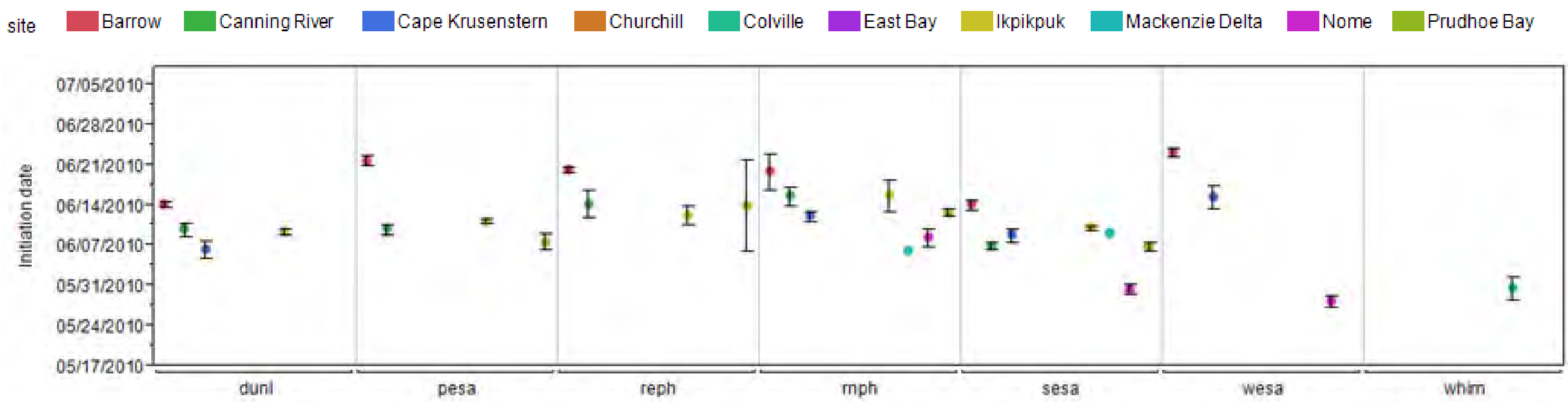

Figure 2. Nest initiation dates of common shorebird taxa found at ASDN sites in 2010.

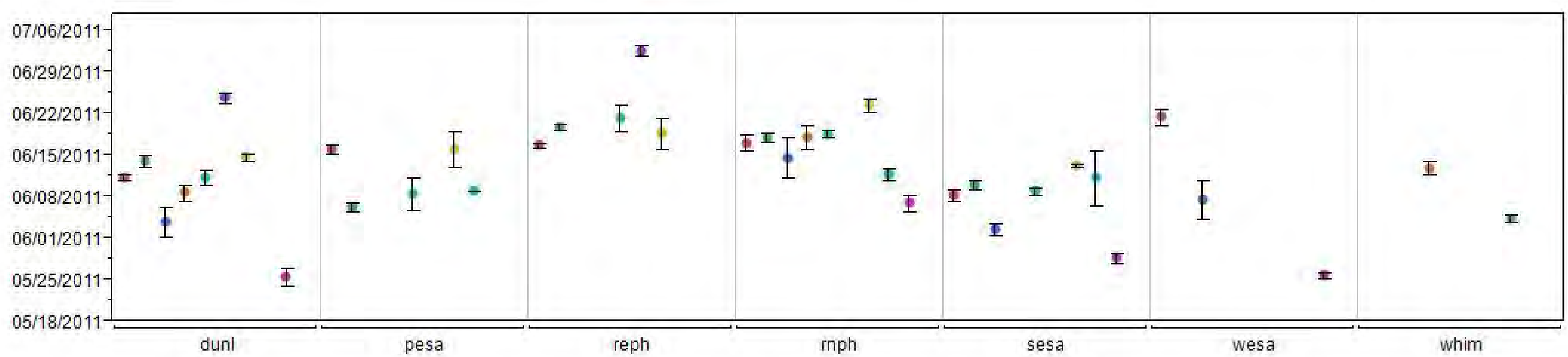

Figure 3. Nest initiation dates of common shorebird taxa found at ASDN sites in 2011.

Table 3. Apparent nest success [% hatch, (n)] of shorebirds breeding at ASDN network sites between 2010 and 2013. Species not breeding at each site denoted with "--".

	Barrow				Burnt Point		Bylot Island			Cape Krusenstern				Canning River				Chaun Delta	Churchill			Coats Island
	2010	2011	2012	2013	2012	2013	2011	2012	2013	2010	2011	2012	2013	2010	2011	2012	2013	2013	2011	2012	2013	2013
amgp	28 (14)	91 (11)	80 (15)	64 (14)	100 (1)	--	63 (24)	4 (50)	3 (77)	--	--	--	--	33 (3)	0 (2)	0 (5)	0 (2)	--	--	70 (10)	82 (11)	--
barg	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
basa	100 (1)	--	75 (4)	--	--	--	90 (20)	10 (40)	15 (27)	--	--	--	--	0 (1)	--	0 (1)	--	--	--	--	--	--
bbis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
bbpl	--	--	--	--	--	--	33 (3)	25 (4)	14 (7)	--	--	0 (1)	100 (1)	50 (2)	0 (2)	--	--	--	--	--	--	--
bbsa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0 (3)	--	36 (11)	--	--	--	--	--
bltu	--	--	--	--	--	--	--	--	--	--	--	0 (14)	0 (5)	--	--	--	--	--	--	--	--	--
btgo	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cosn	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
crpl	--	--	--	--	--	--	--	50 (2)	50 (4)	--	--	--	--	--	--	--	--	--	--	--	--	--
cusa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
dunl	56 (62)	91 (56)	75 (51)	70 (67)	13 (8)	62 (13)	--	--	--	71 (14)	100 (12)	68 (22)	29 (21)	75 (12)	0 (15)	7 (15)	42 (12)	17 (36)	83 (35)	57 (28)	88 (34)	--
hugo	--	--	--	--	--	0 (3)	--	--	--	--	--	--	--	--	--	--	--	--	--	67 (9)	42 (12)	--
kill	--	--	--	--	0 (3)	0 (2)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
lbdo	12 (17)	62 (34)	68 (19)	53 (15)	--	--	--	--	--	--	--	100 (1)	--	--	0 (1)	0 (1)	50 (2)	50 (2)	--	--	--	--
lesa	--	--	--	--	11 (9)	60 (10)	--	--	--	--	--	--	--	--	--	--	--	--	--	60 (15)	67 (9)	--
leye	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	50 (2)	--	--
list	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pagp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0 (1)	--	--	--	--
pesa	50 (36)	79 (106)	85 (95)	75 (65)	--	--	--	--	0 (5)	--	--	--	--	54 (46)	38 (78)	6 (18)	35 (69)	30 (10)	--	--	--	--
rekn	--	--	--	--	--	--	--	0 (1)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
reph	66 (67)	85 (155)	89 (150)	84 (106)	--	--	100 (1)	--	0 (1)	--	--	--	--	41 (17)	48 (27)	7 (14)	31 (45)	--	--	--	--	--
rnph	100 (1)	91 (11)	92 (25)	100 (7)	--	0 (1)	--	--	--	0 (5)	86 (7)	50 (18)	31 (13)	62 (29)	44 (34)	13 (52)	43 (37)	6 (31)	100 (2)	100 (1)	100 (1)	--
rnst	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ruff	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	60 (5)	--	--	--	--
rutu	--	100 (1)	100 (1)	--	--	--	--	--	0 (1)	--	--	--	--	33 (3)	100 (1)	33 (3)	50 (2)	--	--	--	--	--
sand	--	--	--	--	--	--	--	--	--	--	--	--	--	0 (1)	--	--	--	--	--	--	--	--
sbdo	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	36 (11)	73 (11)	--
sepl	--	--	--	--	0 (8)	14 (7)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sesa	67 (42)	98 (42)	80 (60)	46 (84)	--	--	--	--	--	43 (7)	86 (35)	64 (55)	8 (40)	79 (72)	65 (80)	14 (136)	34 (97)	--	--	--	--	20
spre	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
spts	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
stsa	--	--	--	--	--	--	--	--	--	--	--	--	--	25 (4)	80 (5)	33 (3)	33 (3)	--	--	67 (3)	67 (3)	--
test	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	40 (5)	--	--	--	--
wesa	50 (8)	50 (10)	69 (16)	60 (45)	--	--	--	--	--	33 (3)	86 (7)	66 (35)	12 (65)	--	--	--	--	--	--	--	--	--
whim	--	--	--	--	0 (10)	8 (24)	--	--	--	--	--	--	--	--	--	--	--	--	20 (15)	29 (52)	74 (57)	--
wisn	--	--	--	--	0 (1)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0 (1)	50 (2)	--
wosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0 (1)	--	--	--	--
wrsa	0 (1)	100 (1)	--	--	--	--	0 (2)	13 (8)	19 (16)	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	56 (254)	83 (427)	83 (436)	68 (403)	8 (40)	28 (60)	70 (50)	9 (105)	9 (138)	48 (29)	89 (61)	57 (146)	15 (145)	63 (190)	46 (248)	13 (248)	35 (280)	19 (91)	63 (32)	46 (132)	74 (140)	(20)

Table 3. Continued.

	Colville			East Bay				Igloolik	Ikpikpuk				Lower Khat. River		Mackenzie Delta				Nome				Prud. Bay
	2011	2012	2013	2010	2011	2012	2013	2013	2010	2011	2012	2013	2012	2013	2010	2011	2012	2013	2010	2011	2012	2013	2010
amgp	--	0 (1)	0 (1)	--	0 (2)	--	--	13	--	--	--	0 (5)	--	--	--	100 (1)	0 (2)	0 (1)	--	--	--	--	--
barg	100 (1)	--	--	--	--	--	--	--	33 (3)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
basa	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
bbis	--	--	--	--	--	--	--	--	--	--	--	--	0 (2)	100 (1)	--	--	--	--	--	--	--	--	--
bbpl	33 (3)	100 (6)	75 (4)	45 (11)	38 (8)	14 (7)	33 (9)	1	--	--	50 (4)	0 (4)	0 (4)	33 (3)	--	--	--	--	--	--	--	--	--
bbsa	--	--	--	--	--	--	--	--	--	--	--	0 (2)	--	--	--	--	--	--	--	--	--	--	--
bltu	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
btgo	--	--	--	--	--	--	--	--	--	--	--	0 (1)	--	--	--	--	--	--	--	--	--	--	--
cosn	--	--	--	--	--	--	--	--	--	--	--	--	33 (3)	20 (5)	--	--	--	--	--	--	--	--	--
crpl	--	--	--	--	--	--	--	--	--	--	--	--	0 (1)	100 (1)	--	--	--	--	--	--	--	--	--
cusa	--	--	--	--	--	--	--	--	--	--	--	--	100 (1)	0 (1)	--	--	--	--	--	--	--	--	--
dunl	72 (11)	73 (11)	37 (19)	0 (3)	0 (2)	50 (4)	50 (2)	--	50 (2)	85 (13)	41 (17)	6 (17)	9 (11)	68 (22)	--	--	--	--	--	--	0 (2)	67 (3)	--
hugo	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100 (1)	50 (2)	0 (3)	--	--	--	--	--
kill	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
lbdo	0 (1)	--	100 (1)	--	--	--	--	--	0 (2)	100 (2)	17 (6)	8 (13)	--	--	--	--	0 (2)	0 (1)	--	--	--	100 (1)	--
lesa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100 (2)	--	0 (1)	--	--	--	--	--
leye	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
list	--	--	--	--	--	--	--	--	--	--	--	--	47 (15)	--	--	--	--	--	--	--	--	--	--
pagp	--	--	--	--	--	--	--	--	--	--	--	--	0 (8)	45 (11)	--	--	--	--	--	--	--	--	--
pesa	67 (3)	80 (10)	33 (3)	--	--	--	--	--	33 (3)	100 (2)	75 (4)	0 (11)	4 (50)	29 (17)	--	100 (2)	0 (1)	10 (10)	--	--	--	--	14 (7)
rekn	--	--	--	100 (1)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
reph	67 (12)	86 (14)	44 (16)	43 (23)	0 (8)	20 (5)	26 (23)	11	50 (2)	89 (9)	75 (20)	26 (23)	18 (49)	75 (8)	--	--	--	--	--	--	--	--	0 (1)
rnph	72 (18)	81 (21)	44 (27)	--	--	--	--	--	33 (3)	50 (4)	30 (20)	28 (18)	29 (7)	100 (3)	100 (1)	86 (7)	7 (29)	5 (55)	54 (24)	60 (50)	72 (96)	36 (80)	--
rnst	--	--	--	--	--	--	--	--	--	--	--	--	0 (1)	--	--	--	--	--	--	--	--	--	--
ruff	--	--	--	--	--	--	--	--	--	--	--	--	25 (16)	52 (25)	--	--	--	--	--	--	--	--	--
rutu	67 (6)	71 (14)	22 (9)	21 (19)	50 (12)	0 (13)	13 (8)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100 (2)
sand	--	--	--	100 (1)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sbdo	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sepl	100 (1)	--	--	20 (5)	45 (11)	25 (8)	80 (5)	--	--	--	--	--	--	--	100 (4)	100 (4)	40 (5)	43 (7)	--	--	--	--	--
sesa	71 (69)	84 (101)	48 (109)	--	--	0 (2)	50 (2)	10	56 (9)	86 (59)	62 (50)	6 (64)	--	--	100 (1)	100 (4)	35 (17)	28 (29)	67 (20)	44 (30)	69 (61)	26 (70)	67 (18)
spre	--	--	--	--	--	--	--	--	--	--	--	--	0 (1)	100 (1)	--	--	--	--	--	--	--	--	--
spts	--	--	--	--	--	--	--	--	--	--	--	--	20 (5)	100 (1)	--	--	--	--	--	--	--	--	--
stsa	--	100 (1)	--	--	--	--	--	--	--	--	--	--	--	--	--	100 (2)	20 (5)	0 (3)	--	--	--	--	--
test	--	--	--	--	--	--	--	--	--	--	--	--	50 (20)	88 (8)	--	--	--	--	--	--	--	--	--
wesa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	50 (22)	47 (42)	61 (75)	38 (50)	--
whim	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100 (6)	100 (5)	0 (9)	0 (8)	--	--	--	--	--
wisn	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0 (1)	0 (2)	--
wosa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
wrsa	--	--	--	25 (32)	21 (14)	12 (17)	33 (24)	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	70 (125)	82 (179)	45 (189)	22 (95)	29 (57)	14 (56)	33 (73)	(40)	41 (24)	85 (89)	54 (121)	11 (158)	19 (195)	56 (107)	100 (12)	96 (28)	17 (72)	13 (117)	56 (55)	49 (102)	67 (235)	33 (206)	52 (31)

Table 4. Number of adult birds banded at each ASDN site by species from 2010-2013. Numbers include those banded previously but recaptured in subsequent years.

	Barrow				Burnt Point	Bylot Island			Cape Krusenstern				Canning River				Chaun Delta	Churchill				Coats Island	Colville River		
	2010	2011	2012	2013	2013	2011	2012	2013	2010	2011	2012	2013	2010	2011	2012	2013	2013	2010	2011	2012	2013	2013	2011	2012	2013
amgp	19	15	27	14	--	43	98	27	--	--	--	--	--	--	--	--	--	--	--	5	11	--	--	--	--
basa	2	--	6	--	--	3	53	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--
bbpl	--	--	--	--	--	--	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
bbsa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
bltu	--	--	--	--	--	--	--	--	--	--	17	5	--	--	--	--	--	--	--	--	--	--	--	--	--
btgo	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cosn	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
crpl	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
cusa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
dunl	105	147	63	54	3	--	--	--	30	26	16	21	23	19	3	8	35	46	50	27	47	--	6	12	18
hugo	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--
kill	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--
lesa	--	--	--	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
lbdo	15	48	28	15	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
list	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pagp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pesa	26	50	79	64	--	--	--	1	--	--	--	--	39	38	13	24	--	--	--	--	--	--	3	--	--
reph	61	44	98	105	--	--	--	--	--	--	--	--	11	7	7	2	--	--	--	--	--	--	4	13	--
rnph	8	9	23	7	--	--	--	--	2	12	13	6	19	10	21	4	3	6	3	--	--	--	2	--	9
ruff	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
rutu	--	2	1	--	--	--	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	8	3	5
sepl	--	--	--	--	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
sesa	85	61	81	60	--	--	--	--	18	58	59	27	102	51	49	67	--	--	--	--	--	30	31	14	16
stsa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
test	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
wesa	15	10	21	44	--	--	--	--	11	19	49	41	--	--	--	--	--	--	--	--	--	--	--	--	--
whim	--	--	--	--	15	--	--	--	--	--	--	--	--	--	--	--	--	39	12	34	29	--	--	--	--
wisn	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
wrsa	--	1	--	--	--	--	31	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	336	387	427	363	33	46	189	28	61	115	155	100	201	125	93	105	38	91	65	67	88	30	54	42	48

Table 4. Continued.

	East Bay				Igloolik	Ikpikpuk				Lower Khat. River		Mackenzie Delta				Nome				Prudhoe Bay	Grand Total
	2010	2011	2012	2013	2013	2010	2011	2012	2013	2012	2013	2010	2011	2012	2013	2010	2011	2012	2013	2010	
amgp	--	--	--	--	15	--	--	--	5	--	--	--	1	--	1	--	--	--	--	--	281
basa	--	--	--	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	68
bbpl	--	12	6	6	--	--	--	--	--	--	3	--	--	--	--	--	--	--	--	--	34
bbsa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	5
bltu	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	22
btgo	--	--	--	--	--	6	1	--	--	--	1	--	--	--	--	--	--	--	--	--	8
cosn	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--	--	--	--	--	--	3
crpl	--	--	--	--	--	--	--	--	--	--	2	--	--	--	--	--	--	--	--	--	2
cusa	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	1
dunl	1	--	--	--	--	35	31	21	13	--	21	--	--	--	--	--	2	2	--	6	891
hugo	--	--	--	--	--	--	--	--	--	--	--	--	1	3	2	--	--	--	--	--	9
kill	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4
lesa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3
lbdo	--	--	--	--	--	8	--	--	--	--	--	--	--	--	--	--	--	--	--	1	116
list	--	--	--	--	--	--	--	--	--	--	3	--	--	--	--	--	--	--	--	--	3
pagp	--	--	--	--	--	--	--	--	--	--	7	--	--	--	--	--	--	--	--	--	7
pesa	--	--	--	--	--	30	--	--	--	--	6	--	8	--	8	--	2	8	--	20	419
reph	36	--	--	16	--	18	9	19	16	2	4	--	--	--	--	--	--	--	--	5	477
rnph	--	--	--	--	--	13	10	15	16	--	--	6	13	16	37	18	55	116	37	5	514
ruff	--	--	--	--	--	--	--	--	--	1	13	--	--	--	--	--	--	--	--	--	14
rutu	21	12	13	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	78
sepl	8	--	--	--	--	--	--	--	--	--	--	8	6	3	2	--	--	--	--	--	34
sesa	--	--	--	--	12	50	68	47	45	--	--	9	14	17	29	39	104	74	70	35	1422
stsa	--	--	--	--	--	--	--	--	--	--	--	4	4	2	1	--	--	--	--	--	11
test	--	--	--	--	--	--	--	--	--	1	5	--	--	--	--	--	--	--	--	--	6
wesa	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	60	184	106	42	--	602
whim	--	--	--	--	--	--	--	--	--	--	--	6	7	5	2	--	--	--	--	--	149
wisn	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	--	2
wrsa	20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	52
Total	86	24	19	27	29	160	119	102	95	4	69	33	54	46	82	117	349	306	149	80	5237

Chicks were also captured and banded at Barrow (2010 - 2013), Bylot (2011-2013), Cape Krusenstern (2012-2013), Churchill (2012-2013), Colville (2012), Lower Khatanga River (2012-2013), Mackenzie Delta (2012-2013), and Nome (2011-2013). We do not summarize the numbers here but they exceeded 3000.

Adult Return Rate

The percentage of color-marked adults that return from year to year is difficult to show either in a table or figure since individuals may be resighted one to four years after being marked and new individuals are being banded each year as well. In Table 5 below, we illustrate the number marked in 2010 that returned in 2011 for our five focal species. Comparable return rates have been observed in subsequent years. The highest returns were observed in Dunlin, Red-necked Phalarope, Semipalmated Sandpiper, Western Sandpiper, and Whimbrel. The percentage returning varied substantially among sites within each species, especially Red-necked Phalarope and Western Sandpiper. Our preliminary data suggest that sufficient numbers of birds returned for Dunlin, Semipalmated Sandpiper and Red-necked Phalarope for each of these species to obtain reliable adult survival estimates. Much lower return rates were observed in Red Phalarope and Pectoral Sandpiper, making adult survival estimates impossible to calculate. Other species, such as American Golden-Plover, Long-billed Dowitcher, Ruddy Turnstone, Western Sandpiper, and Whimbrel had sizeable numbers of birds banded at one or two sites; adult survival estimates may be possible for some of these but will be based on a much smaller geographic scale. For most of the species not listed in Table 5, adult return rates are not meaningful because the number of birds marked was too small at any given site. In these situations, it might be necessary to pool data from multiple sites on a given species. A post-doctoral research associate, Emily Weiser, was recently hired to analyze adult survival rates among shorebirds at the ASDN sites. She will work with Brett Sandercock to conduct these demographic analyses.

Table 5. Estimates of the percentage of color-marked individuals returning to ASDN sites in 2011. A ″-‶means no individuals of that species were banded at that ASDN site and available to be resighted.

	Nome	Cape Krusenstern	Barrow	Ikpikpuk	Canning River	Mackenzie Delta	Churchill
Dunlin	-	43%	27%	30%	27%	-	39%
Pectoral Sandpiper	-	-	0%	0%	8%	-	-
Red Phalarope	-	-	3%	11%	0%	-	-
Red-necked Phalarope	25%	50%	26%	8%	26%	0%	0%
Semipalmated Sandpiper	66%	11%	22%	48%	40%	22%	-
Western Sandpiper	69%	9%	13%	-	-	-	-
Whimbrel	-	-	-	-	-	33%	13%

Daily Species List

All ASDN sites recorded a daily species list between 2010 and 2013; in most cases this list included not only presence and absence of birds and mammals but also a rough count of the number of animals as well as a measure of effort made to detect these animals (e.g., number of people involved in the count). These data provide a good measure of relative abundance, especially for species that fluctuate dramatically in number from year-to-year. Good examples of such "irruptive" species include Snowy Owls (*Bubo scandiacus),* Pomarine Jaegers (*Stercorarius pomarinus*) and lemmings, which can vary tremendously in population numbers among years. Many of the ASDN sites have also contributed their bird observation data to eBird, which is a real-time, online checklist program that collects bird observations made by recreational and professional bird watchers (http://ebird.org/content/ebird/about), as well as the Arctic Breeding Birds Conditions Survey (http://www.arcticbirds.ru/).

Food Resources

ASDN sites established sampling stations to document aquatic and terrestrial invertebrate diversity, phenology, and abundance. Each ASDN site established five replicate samples in the following three habitats: aquatic, mesic terrestrial, and dry terrestrial. Data collection dates and sample acquisition for 2010 – 2013 are listed in Table 6. Few sites collected invertebrate data in 2013 due to no money being able to process samples. To date, all of the 2010-2012 terrestrial samples have been processed and only a few of the 2012 aquatic samples remain to be processed. This work is being done by Bob Wisseman of Aquatic Biology Associates, Inc. Three sites have opted to process their own invertebrate data, including Bylot Island, Nome, and Churchill.

An example of the invertebrate information obtained from this sorting process is presented in Figure 4 for the Barrow site. Because these data are so voluminous, we do not report them here. Food resource data are being used in several core and side-project investigations that include many of the ASDN sites. *Dan Rinella is using this information along with pond hydrology and weather data to predict dates of invertebrate emergence (see below). Eunbi Kwon and Brett Sandercock are exploring how patterns of invertebrate emergence relate to nest hatching (i.e., the mismatch hypothesis; e.g. see Figure 5). Other researchers are using invertebrate data as covariates to explain density of shorebird nests and nest success. Finally, the invertebrate biologist community has taken an interest in the invertebrate species themselves (see side project descriptions below).*

Predator and Alternative Prey Surveys

Avian and mammalian predators were surveyed by conducting point counts weekly throughout the summer at each ASDN site in 2010 (Table 7). During the fall of 2010, ASDN collaborators requested a protocol change to address the low encounter rates for predators at some arctic sites. Accordingly, an index approach was developed to cover a wider geographic area within each study area and allow predator abundances to be recorded throughout the day. Some ASDN sites continued point count surveys in 2011 to ensure long-term continuity in data collection. As part of this change, observers were also instructed to count Brown and Collared lemmings during these surveys (see version 2 protocol). Lemmings and other small mammals are also inventoried by conducting daily opportunistic counts and a single nest count transect shortly after snow melt. The opportunistic data are recorded on daily species lists.

Table 6. Range and number of food resource data collection events at ASDN sites between 2010 and 2013. Number of collection events is noted in parentheses. Each collection event represents 3 to 5 samples, except for where both bottle traps and sweep net samples were employed for aquatic sampling (East Bay in 2010, and Nome and Canning River in 2011). Twice as many samples were collected at the latter three sites. no: samples not collected.

	Terrestrial		Aquatic
Site	Dry	Mesic	
2010			
Nome	4 June – 10 July (13)	4 June – 10 July (13)	4 June – 10 July (13)
Cape Krusenstern	no	no	no
Barrow	14 June – 29 July (16)	20 June – 29 July (14)	23 June – 29 July (13)
Ikpikpuk	13 June – 13 July (11)	13 June – 10 July (10)	14 June – 13 July (11)
Prudhoe Bay	12 June – 11 July (10)	12 June – 11 July (10)	12 June – 11 July (10)
Canning River	13 June – 7 July (9)	13 June – 7 July (9)	13 June – 7 July (9)
Mackenzie Delta	15 June – 7 July (8)	15 June – 7 July (8)	15 June – 7 July (8)
East Bay	23 June – 25 July (11)	23 June – 25 July (11)	23 June – 25 July (11)
Churchill	2 June – 1 Aug (21)	2 June – 1 Aug (21)	2 June – 1 Aug (21)
2011			
Nome	25 May - 21 July (20)	31 May – 21 July (18)	7 June – 21 July (15)
Cape Krusenstern	3 June – 3 July (11)	3 June – 3 July (11)	3 June – 3 July (11)
Barrow	4 June – 28 July (19)	4 June – 28 July (19)	7 June – 28 July (19)
Ikpikpuk	8 June – 14 July (13)	8 June – 14 July (13)	8 June – 14 July (13)
Prudhoe Bay	no	no	no
Canning River	8 June – 8 July (11)	8 June – 8 July (11)	8 June – 8 July (11)
Colville	28 May – 13 July (16)	3 June – 13 July (14)	31 May – 13 July (15)
Mackenzie Delta	8 June – 11 July (12)	8 June – 11 July (12)	8 June – 11 July (14)
East Bay	19 June – 24 July (13)	19 June – 24 July (10)	no
Churchill	9 June – 30 July (18)	9 June – 30 July (18)	9 June – 30 July (18)
Bylot	12 June – 17 Aug (34)	14 June – 17 Aug (32)	14 June – 1 Aug (23)
2012			
Nome	26 May – 19 July (20)	26 May – 19 July (20)	29 May – 19 Jul (19)
Cape Krusenstern	30 May – 8 July (14)	2 Jun – 8 July (13)	2 Jun – 8 Jul (13)
Barrow	7 June – 28 July (18)	7 June – 28 July (18)	7 June – 28 July (18)
Ikpikpuk	10 Jun – 13 July (12)	10 Jun – 13 Jul (12)	13 Jun – 13 Jul (12)
Prudhoe Bay	no	no	no
Canning River	9 Jun – 12 Jul (12)	12 Jun – 12 Jul (11)	9 Jun – 12 Jul (12)
Colville	28 May – 18 Jul (18)	6 Jun – 28 Jul (15)	6 Jun – 18 Jul (15)
Mackenzie Delta	10 Jun – 7 Jul (10)	10 Jun – 7 Jul (10)	10 Jun – 7 Jul (10)
East Bay	20 Jun – 19 Jul (11)	24 Jun – 19 Jul (9)	no
Churchill	6 Jun – 30 Jul (19)	6 Jun – 30 Jul (19)	6 Jun – 30 Jul (19)
Bylot	15 Jun – 16 Aug (35)	15 Jun – 14 Aug (34)	23 Jun – 31 Jul (20)
Burnt Point	16 Jun – 16 Jul (16)	16 Jun – 16 Jul (16)	no
Chaun Delta	no	no	no
Lower Khatanga	no	no	no

Table 6. Cont.

	Terrestrial		Aquatic
Site	Dry	Mesic	
2013			
Nome	29 May – 13 July (16)	1 June – 13 July (15)	no
Cape Krusenstern	no	no	no
Barrow	1 June – 31 July (20)	1 June – 31 July (20)	7 June – 31 July (18)
Ikpikpuk	no	no	no
Prudhoe Bay	no	no	no
Canning River	no	no	no
Colville	no	no	no
Mackenzie Delta	no	no	no
East Bay	15 Jun – 22 Jul (11)	15 Jun – 22 Jul (11)	no
Churchill	7 Jun – 31 Jul (18)	7 Jun – 31 Jul (18)	4 Jun – 31 Jul (19)
Bylot	17 Jun – 16 Aug (30)	17 Jun – 16 Aug (30)	no
Burnt Point	17 Jun – 2 Jul (8)	17 Jun – 2 Jul (8)	no
Chaun Delta	no	no	no
Lower Khatanga	no	no	no
Igloolik	28 Jun – 2 Aug (13)	28 Jun – 2 Aug (13)	no
Coats Island	no	no	no

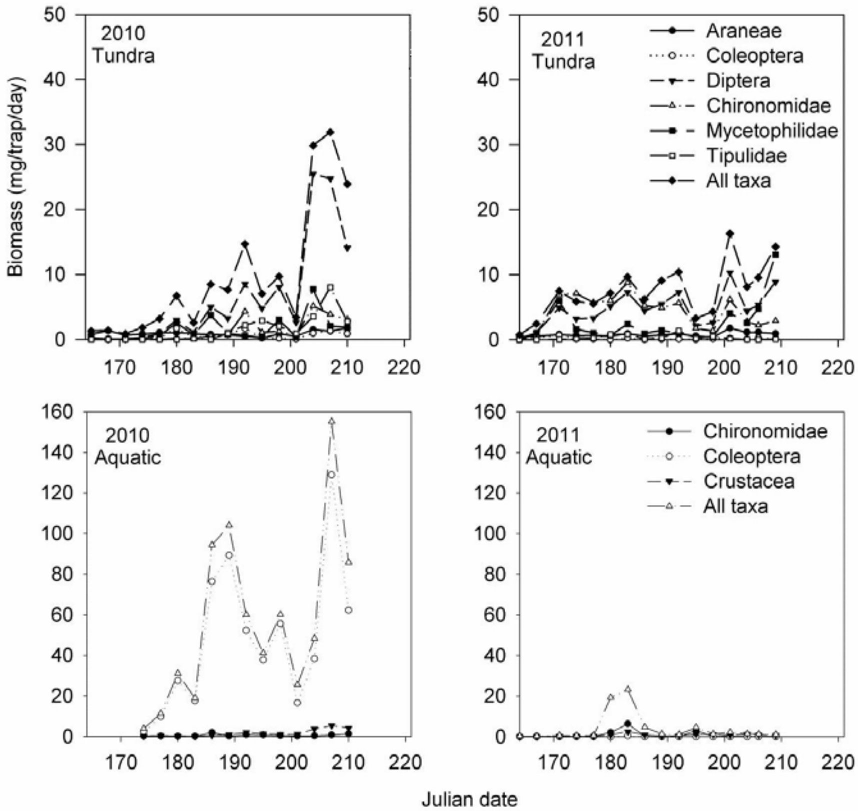

Figure 4. Seasonal variation in invertebrate biomass from mesic/xeric tundra samples and aquatic samples near Barrow, Alaska from 2010 - 2011.

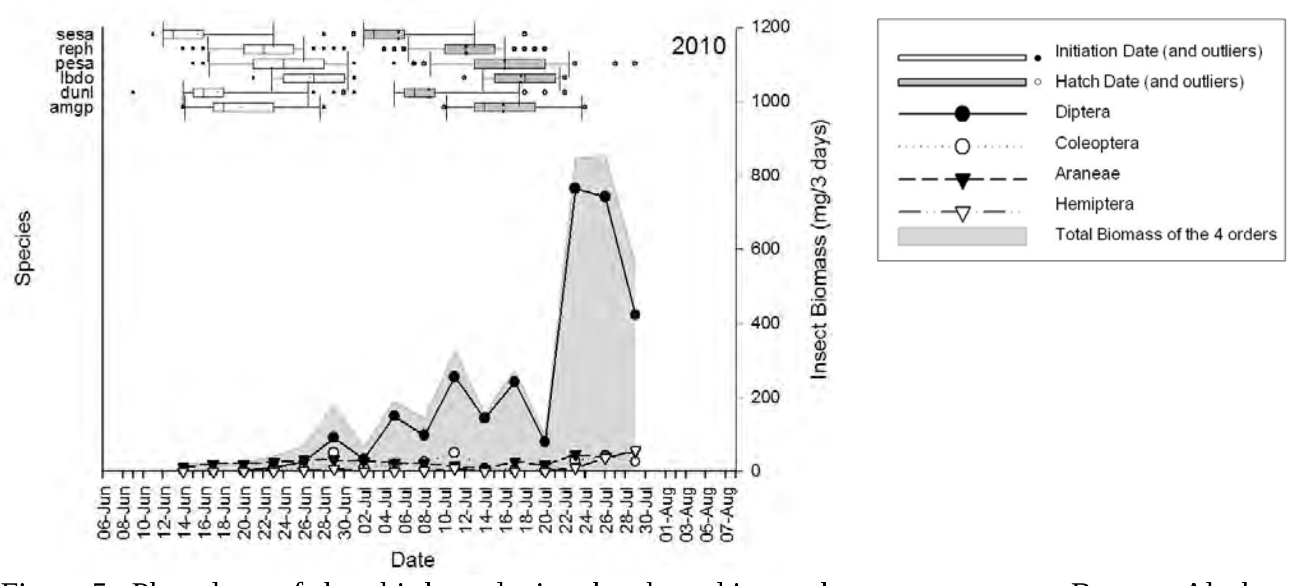

Figure 5. Phenology of shorebird egg-laying, hatch, and invertebrate emergence at Barrow, Alaska, in 2010. Biomass abundance is listed for four dominant invertebrate orders (all families combined) separately and together (gray shaded area). Box plots illustrate 25% and 75% quartiles, median (solid line), mean (dashed line), and outliers (dots outside of bars).

Snow and Surface Water

Snow cover was measured at the beginning of each field season to estimate the date of 50% snow melt and to obtain information on the rates of snow melt for comparison among years and among sites. Surface water was measured less intensively, with the goal to obtain general rates of water loss from the tundra through time. The approach to measure snow and surface water changed between 2010 and 2011 (Table 8). In 2010, personnel collected visual measures of snow cover at a minimum of 10 fixed locations (e.g., at 50 m square quadrats) every other day until 90% of the snow had melted. Surface water, in contrast, was measured independently of snow by locating three unique sites within each of four habitat types: the troughs of high-centered polygons, the centers of low-centered polygons, small ponds or waterbodies, and non-polygonized areas. At each of these locations, water depth was recorded once a week throughout the field season. Not all sites had each of these habitat types and not all sites recorded these data. In 2011 and thereafter, snow and surface water measurements were combined. To do this, we expanded the measurements done at the snow sites in 2010 to include all surface cover features (e.g., snow, water, and land). To accomplish both snow and surface water objectives, surface cover was recorded every other day during the beginning of the season when the snow melts quickly, and then weekly to the end of the field season to gauge changes in surface water. No water depths were recorded during the 2011 to 2013 period, but rather the percentage of each quadrat that had water was recorded. *Snow melt dates are being used as covariates in nest initiation and nest survival core studies within the ASDN.*

Climatic conditions

Climate data were collected at a federally maintained weather facility in a nearby community (fixed) or with remote weather stations (remote) at all ASDN sites (Figure 6, Table 9). Data were collected for air temperature, relative humidity, as well as wind speed and direction at most sites. In addition, field crews measured precipitation (snow, rain) manually using rain/snow gauges. Similar data from the fixed weather stations have been downloaded from internet sites. All of the climate data for 2010 have been submitted for inclusion in the hydroclimate data archive (Imiq) compiled by the Arctic LCC and North Slope Science Initiative. The remaining data will be archived during the next year.

Shorebird Ecological and Environmental Variables

Preliminary analysis correlating the predictor variables thought to be responsive to climate change and measures of shorebird distribution, ecology, and demography are on-going because data are still being collected. We have italicized areas above where ASDN core or side-projects are on-going.

Table 7: Range and number of predator surveys and small mammal inventory at ASDN sites between 2010 and 2013. Number of collection events is noted in parentheses. no = no data were collected.

Site	Predator Point-Counts	Predator / Lemming Index	Lemming Nest Count	Trapping of Lemmings	Small Mammal Daily Species List
2010					
Nome	2 Jun (1)	no	no	yes[1]	18 May – 12 Jul
Cape Krusenstern	no	no	no	no	--
Barrow	1 Jun – 29 Jul (8)	no	yes	yes[2]	25 May – 30 Jul
Ikpikpuk	17 Jun – 7 Jul (3)	no	yes	no	9 Jun – 13 Jul
Prudhoe Bay	17 Jun – 14 Jul (3)	no	yes	no	7 Jun – 17 Jul
Canning River	6 – 30 June (4)	no	yes	no	5 Jun – 10 Jul
Mackenzie Delta	14 Jun – 2 Jul (3)	no	no	no	10 Jun – 5 Jul
East Bay	20 Jun – 22 Jul (3)	no	yes	no	2 Jun – 25 Jul
Churchill	20 July (1)	no	yes	no	25 May – 2 Aug
2011					
Nome	no	18 May – 21 Jul (60)	yes	yes[1]	18 May – 8 Jul
Cape Krusenstern	no	4 – 28 Jun (9)	yes	no	28 May – 3 Jul
Barrow	2 Jun – 26 Jul (9)	2 Jun – 26 Jul (9)	yes	yes[2]	27 May – 1 Aug
Ikpikpuk	no	5 Jun – 16 Jul (39)	yes	no	4 Jun – 16 Jul
Colville	no	30 May – 13 Jul (45)	yes	no	18 May – 31 Jul
Prudhoe Bay	no	no	no	no	4 Jun – 18 Jul
Canning River	7 Jun (1)	7 Jun – 10 Jul (12)	yes	no	3 Jun – 12 Jul
Mackenzie Delta	no	7 Jun – 7 Jul (17)	no	no	5 Jun – 10 Jul
East Bay	no	no	yes	no	11 Jun – 25 Jul
Churchill	no	9 Jun – 20 Jul (24)	yes	no	26 May – 3 Aug
Bylot Island	no	7 Jun – 16 Aug (35)	yes	yes[3]	5 Jun – 5 Aug
2012					
Nome	no	15 May – 13 Jul (57)	no	yes[1]	13 May – 19 Jul
Cape Krusenstern	no	27 May – 8 Jul (14)	no	no	19 May – 8 Jul
Barrow	4 Jun – 24 Jul (9)	4 Jun – 24 Jul (9)	yes	yes[2]	24 May – 31 Jul
Ikpikpuk	no	6 Jun – 12 Jul (35)	yes	no	5 Jun – 15 Jul
Colville	no	30 May – 15 Jul (42)	yes	no	18 May – 19 Jul
Prudhoe Bay	no	8 Jun – 21 Jul (39)	yes	no	2 Jun – 21 Jul
Canning River	no	5 Jun – 10 Jul (10)	yes	no	3 Jun – 15 Jul
Mackenzie Delta	no	9 Jun – 3 Jul (6)	no	no	5 Jun – 8 Jul
East Bay	no	7 – 15 Jun (9)	yes	no	7 Jun – 23 Jul
Churchill	no	24 Jun – 24 Jul (29)	yes	no	1 Jun – 6 Aug
Bylot Island	no	1 Jun – 20 Aug (40)	yes	yes[3]	1 Jun – 15 Aug
Burnt Point	no	no	yes	no	6 Jun – 18 Jul
Chaun Delta	no	19 Jun – 10 Jul (16)	no	no	16 Jun – 10 Jul
Lower Khatanga	no	17 Jun – 16 Jul (28)	yes	no	no

Site	Predator Point-Counts	Predator / Lemming Index	Lemming Nest Count	Trapping of Lemmings	Small Mammal Daily Species List
2013					
Nome	no	13 May – 9 Jul (50)	no	yes[1]	13 May – 9 Jul
Cape Krusenstern	no	30 May – 4 Jul (20)	No	No	24 May – 9 Jul
Barrow	3 Jun – 16 Jul (8)	3 Jun – 16 Jul (8)	yes	yes[2]	23 May – 29 Aug
Ikpikpuk	no	7 Jun – 13 Jul (33)	yes	no	5 Jun – 15 Jul
Colville	no	30 May – 15 Jul (46)	yes	no	16 May – 16 Jul
Prudhoe Bay	no	2 Jun – 18 Jul (39)	no	no	2 Jun -21 Jul
Canning River	no	4 Jun – 19 Jul (17)	yes	no	2 Jun – 20 Jul
Mackenzie Delta	no	9 Jun – 8 Jul (7)	no	no	6 Jun – 11 Jul
East Bay	no	no	yes	no	7 Jun – 18 Jul
Churchill	no	no	yes	no	1 – 21 Jun
Bylot Island	no	14 Jun – 19 Aug (66)	yes	yes[3]	7 Jun – 21 Aug
Burnt Point	no	no	yes	no	5 Jun – 3 Jul
Chaun Delta	no	7 Jun – 7 Jul (27)	no	no	7 Jun – 7 Jul
Lower Khatanga	no	no	yes	no	no
Igloolik	no	15 Jun – 21 Jul (21)	yes	yes	15 Jun – 21 Jul
Coats Island	no	no	no	no	18 – 28 Jun

[1] Live trapping conducted by ASDN staff.
[2] Trapping of lemmings is being conducted independently of the ASDN by Kaithryn Ott (live-traps; USFWS, Ecological Services) and Denver Holt (snap traps; Owl Research Institute).
[3] Live and snap trapping of lemmings are being conducted independently of the ASDN by Gilles Gauthier's field personnel located at Université Laval, Quebec City, Canada.

Table 8. Sampling period, frequency and method for estimating snow and surface water measurements at each ASDN site between 2010 and 2013.

	Nome	Cape Krusenstern	Barrow	Ikpikpuk	Colville River	Prudhoe Bay	Canning River	Mackenzie Delta	East Bay	Churchill	Bylot Island
2010: snow											
Sampling Period	no	no	30 May – 19 Jun	9 – 29 Jun	n/a	4 – 19 Jun	5 – 30 Jun	No snow present	2 Jun – 25 Jul	no	n/a
Frequency[†]	no	no	2d	3-5d	n/a	3-5d	5d	n/a	1d	no	n/a
Method	no	no	50 m^2	50 m^2	n/a	50 m^2	50 m^2	n/a	Area	no	n/a
Date 50% loss	no	no	12 Jun	Unk[2]	n/a	Unk[3]	15 Jun	n/a	9 Jun	no	n/a
2010: surface water											
Sampling Period	4 Jun – 10 Jul	no	22 Jun – 24 Jul	12 Jun – 3 Jul	n/a	15 Jun – 13 Jul	10 Jun – 7 Jul	no	2 Jun – 25 Jul	no	n/a
High Center polygons	no	no	6	4	n/a	5	10	no	no	no	n/a
Low centered polygons	no	no	6	4	n/a	5	10	no	no	no	n/a
Non-polygonized	no	no	6	4	n/a	5	no	no	no	no	n/a
Pond	8	no	6	4	n/a	5	10	no	no	no	n/a
Tidal inlet	8	no	no	no	n/a	no	no	no	no	no	n/a
General Study area	no	no	no	no	n/a	no	no	no	1	no	n/a
2011: snow and surface water combined											
Sampling Period	20 May – 20 Jul	7 – 20 Jun	29 May – 26 Jul	9 – 29 Jun	20 May – 13 July	3 Jun – 16 Jul	6 Jun – 9 Jul	6 Jun – 6 Jul	15 Jun – 25 Jul	24 May – 28 Jul	18 May – 8 July
Frequency[†]	2d, then 7d	7d	2d, then 7d	3-5d	2d, then 7d	2-4d	5d	1d, then 5d	1d	3d, then 7d	3d
Method	Area	Area	50 m^2	50 m^2	Area	50 m^2	50 m^2	Area	Area	Area	Area
Date 50% loss	20 May	Unk[‡]	14 Jun	Unk[‡]	30 May	Unk[‡]	11 Jun	Unk[‡]	Unk[‡]	Unk[‡]	9 Jun
2012: snow and surface water combined											
Sampling Period	17 May – 13 Jul	20 May – 29 Jun	29 May – 24 Jul	6 June – 12 Jul	19 May – 15 Jul	2 Jun – 15 Jul	5 – 30 Jun	5 Jun – 3 Jul	9 Jun – 21 Jul	6 Jun – 10 Jul	2 – 27 Jun
Frequency[†]	2d, then 7d	variable	2d, then 7d	2d, then 5 d	2d, then 7d	2d, then 7d	2 d, then 5d	7d	1d, then 3,7d	Variable	3d
Method	100 m Area	Area	50 m^2	50 m^2	50 m^2	50 m^2	50 m^2	Area	Area	Area	Area
Date 50% loss	21 May	21 May	8 Jun	Unk[‡]	3 Jun	Unk[‡]	Unk[‡]	Unk[‡]	11-17 Jun	Unk[‡]	10 Jun
2013: snow and surface water combined											
Sampling Period	21 May – 2 July	27 May – 2 Jul	30 May – 16 Jul	7 Jun – 16 Jul	18 May – 9 Jul	2 Jun – 18 Jul	3 Jun – 13 Jul	9 Jun – 7 Jul	9 – 18 Jul	3 Jun – 27 Jul	7 – 20 Jun
Frequency[†]	Variable	2d, then variable	2d, then 7d	7 d	2d, then 7	5-7d	3d, then 7d	7d	1-3d	7d	3d
Method	100 m Area	Area	50 m^2	50 m^2	50 m^2	50 m^2	50 m^2	Area	Area	Area	Area
Date 50% loss	26 May	29 May	2 Jun	Unk[‡]	7 Jun	Unk[‡]	Unk[‡]	Unk[‡]	15 Jun	Unk[‡]	10 Jun
Sampling Period	21 May – 2 July	27 May – 2 Jul	30 May – 16 Jul	7 Jun – 16 Jul	18 May – 9 Jul	2 Jun – 18 Jul	3 Jun – 13 Jul	9 Jun – 7 Jul	9 – 18 Jul	3 Jun – 27 Jul	7 – 20 Jun

No = no sampling done; n/a = not applicable since ASDN site was not established

[†] d = day; #d, then #d indicates interval snow was measured and then surface water was measured.

[‡] Unk = Unknown, snow was <50% when field camp was established

Table 8. Continued

	Burnt Point	Chaun Delta	Lower Khatanga	Igloolik	Coats Island
2012: snow and surface water combined					
Sampling Period	No	No	30 May – 14 Jun	n/a	n/a
Frequency†	n/a	n/a	daily	n/a	n/a
Method	n/a	n/a	Area - satellite	n/a	n/a
Date 50% loss	n/a	25 May	4 Jun	n/a	n/a
2013: snow and surface water combined					
Sampling Period	No	No	28 May – 11 Jun	16 Jun – 9 Jul	no
Frequency†	n/a	n/a	Variable	1d, then variable	no
Method	n/a	n/a	Area – satellite	Area	no
Date 50% loss	n/a	Unk‡	2 Jun	19 Jun	no

No = no sampling done; n/a = not applicable since ASDN site was not established

† d = day; #d, then #d indicates interval snow was measured and then surface water was measured.

‡ Unk = Unknown, snow was <50% when field camp was established

Figure 6. Example of a remote weather station deployed at ASDN sites.

Table 9. Dates where weather information was collected at ASDN sites between 2010 and 2013.

	Nome	Cape Krusenstern	Barrow	Ikpikpuk	Colville River	Prudhoe Bay	Canning River	Mackenzie Delta	East Bay	Churchill	Bylot Island
2010											
Sampling Period	16 May – 12 Jul	no	25 May – 31 Jul	10 Jun – 13 Jul	no	4 Jun – 18 Jul	4 Jun – 11 Jul	9 Jun – 7 Jul	3 Jun – 27 Jul	25 May – 2 Aug	n/a
Method	Remote	no	Fixed	Remote	no	Fixed	Remote	Remote	Remote	Fixed	n/a
Interval	1 hr	no	1 hr	1 hr	no	1 hr	1 hr	1 hr	12h	4 hr	n/a
2011											
Sampling Period	16 May – 21 Jul	2 Jun – 4 Jul	1 May – 31 Aug	5 Jun – 16 Jul	10 Jun – 9 Aug	1 Jun – 30 Jul	5 Jun – 13 Jul	7 Jun – 11 Jul	17 Jun – 22 Jul	1 May – 15 Aug	5 Jun – 5 Aug
Method	Remote	Remote	Fixed	Remote	Remote	Fixed	Remote	Remote	Remote	Fixed	Fixed
Interval	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	12h	4 hr	1 hr
2012											
Sampling Period	20 May – 21 Jul	1 May – 27 Jun	1 May – 31 Aug	12 Jun – 16 Jul	19 May – 9 Aug	1 Jun – 1 Jul	5 Jun – 16 Jul	5 Jun – 9 Jul	12 Jun – 27 Jul	1 Jun – 6 Aug	1 Jun – 15 Aug
Method	Remote	Fixed, Remote	Fixed	Remote	Remote	Fixed	Remote	Remote	Remote	Fixed	Fixed
Interval	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr
2013											
Sampling Period	26 May – 13 Jul	2 Jun – 9 Jul	1 May – 31 Aug	5 June to 15 Jul	18 May – 13 Aug	1 May – 31 Aug	3 Jun – 21 Jul	8 Jun – 11 Jul	5 Jun – 25 Jul	1 Jun – 2 Aug	7 Jun – 21 Aug
Method	Remote	Remote	Fixed	Remote	Remote	Fixed	Remote	Remote	Remote	Fixed	Fixed
Interval	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr	1 hr

No = no data collected, n/a = no data available since site not established

Table 9. Continued.

	Burnt Point	Chaun Delta	Lower Khatanga	Igloolik	Coats Island
2012					
Sampling Period	1 May – 30 Aug	18 May – 28 Aug	18 Jun – 16 Jul	n/a	n/a
Method	Fixed	Fixed	Remote	n/a	n/a
Interval	1 hr	3 hr	daily	n/a	n/a
2013					
Sampling Period	1 Jun – 31 Jul	no	21 Jun – 23 Jul	15 Jun – 31 Aug	no
Method	Fixed	no	Remote	Fixed	no
Interval	1 hr	no	Daily	1 hr/variable	no
No = no data collected, n/a = no data available since site not established					

Projects Using ASDN Data

The Network has taken an active role in encouraging projects related to the ecology and conservation of shorebirds that can take advantage of the taxonomic diversity and geographic dispersion of our ASDN sites. Below we provide the project title, lead coordinators, and brief description of each project. For many of these projects, there will be many other ASDN principal investigators involved. Brief project proposals are available for all of these studies.

1) Avian Influenza – U.S. Fish and Wildlife Service, Migratory Bird Management

   To evaluate the presence of H5N1 highly pathogenic avian influenza in shorebirds, four sites in Arctic Alaska collected cloacal swabs from birds in 2010. The four sample sites included Barrow, Ikpikpuk River, Prudhoe Bay and the Canning River. No positive cases of H5N1 influenza were detected from any shorebird. An annual report describing samples obtained was submitted to the US Fish and Wildlife Service in the spring of 2011.

2) Migratory connectivity of Dunlin using geolocators – Stephen Yezerinac, Mount Allison University

   To determine the spatial relationships among important wintering, migration, and breeding areas of Dunlin, a total of 268 light level geolocators were placed on Dunlin at five of the ASDN sites (Cape Krusenstern, Barrow, Ikpikpuk, Canning River, Churchill) and two additional sites outside of the ASDN network (Cold Bay and Yukon Delta, Alaska) in June of 2010. A total of 96 of these devices were retrieved from birds in June 2011. Preliminary analysis of the track lines of these birds has been completed and a manuscript describing the migratory connectivity of the three North American subspecies of Dunlin is in preparation.

3) Migratory connectivity of Semipalmated Sandpiper using stable isotopes – David Mizrahi, New Jersey Audubon

   To determine the spatial relationships among important wintering, migration, and breeding areas of Semipalmated Sandpipers, the 6th primary covert feathers were collected from birds captured at ASDN sites in 2011. Stable isotope values obtained from these feathers will be used to determine if birds breeding in eastern and western Arctic regions use different wintering areas. Preliminary results indicate that nearly two-thirds of the feather samples collected appear to be from French Guiana, despite 70% of all birds observed during aerial surveys being in Suriname. This suggests ASDN birds may be preferentially wintering in French Guiana. Feather samples obtained from two new ASDN sites (Coats Bay and Igloolik) in 2013 have yet to be analyzed. A better understanding of migratory connectivity is badly needed given the recent population declines observed in eastern Canada. Reports to funding agencies are due September 2013 and a manuscript will be ready for submission shortly thereafter.

4) Avian malaria of shorebirds – Claudia Ganser (PhD candidate) and Samantha Wisely – Florida State University

   To further understand the role of Arctic-breeding shorebirds in the global transmission cycle of avian malaria, this study's objectives were to 1) estimate avian malaria pathogen prevalence of Arctic-breeding shorebirds, 2) identify haematozoa lineages (strains) to describe the pathogen community in shorebirds, and 3) determine the biogeography of haematozoa to identify hotspots along migratory routes and infer cross-species transmission events across the globe. Analysis of the 2011 samples has been completed; avian malaria prevalence in Arctic-breeding shorebirds was 2.39% (n=10). Two unique *Plasmodium* strains were recovered in Pectoral sandpipers and Semipalmated sandpipers, one *Haemoproteus* strain was recovered from Semipalmated sandpipers and Western Sandpipers. The biogeographic analysis indicated that one *Plasmodium* strain had a narrow geographic range occurring in only 4 countries within two geographic regions (Asia, North America) and an equally narrow host range occurring in only 9 host species, while the other strain had a nearly panglobal distribution occurring across 31 countries within five geographic regions (Africa, Asia, Europe, North America, Oceania). This *Plasmodium* strain had a broad host range, occurring in 106 host species that belong to 5 orders. The *Haemoproteus* strain had a global distribution (occurring in 25 countries) and broad host range of 56 species that belong to 9 orders. Molecular analysis of samples from 2012/2013 is to be completed by the end of the year, and additional samples are planned for collection in 2014.

5) Gut microbiota of shorebirds – Kirsten Grond (PhD student) and Brett Sandercock – Kansas State University

To better understand the relationship between health of migratory birds and their gut microbial communities, this study sought to determine if the diversity and prevalence of microbiota in Arctic-breeding shorebirds varies with migration route, habitats used, and general wintering region of the world. Between 2011 and 2013, 1435 fecal samples of 11 shorebird species were collected at 11 ASDN sites to investigate shorebird gut microbiota in relation to life-history characteristics. Of these fecal samples, 534 samples from 2011 have been sequenced using the Illumina MiSeq next-generation sequencing platform. In addition, gut microbiota of 30 Dunlin and 20 Semipalmated Sandpiper embryos were collected in Barrow, AK, to investigate maternal transfer of microbes during egg formation. Sequences generated from 2011 are currently being classified to bacterial species level, and embryonic samples will be sequenced in the coming months. Sample collection is expected to be concluded in summer 2014, and sequence analyses and publication of results is expected to be concluded in spring 2017.

6) Mercury exposure in shorebirds – David Evers and Iain Stenhouse, Biodiversity Research Institute

To evaluate the risk of mercury exposure across a diversity of shorebird species over a large geographic range, a project was funded in 2011 to sample and test shorebirds for exposure in 2012 and 2013. Shorebirds are predicted to be exposed to mercury through the local food web in concentrations that may impair health and, ultimately, have adverse effects at the population level. Contaminant exposure has already been identified as one of five leading factors that may be limiting shorebird populations (Butler et al. 2004), but the degree to which mercury contamination may be contributing to reduced reproductive success and population declines has not been well studied. Samples are currently being analyzed for this study and a study report is due for later in 2014.

7) Effects of spring phenology on timing of breeding in shorebirds – Kirsty Gurney, University of Alaska Fairbanks; and David Ward and Michael Budde, U.S. Geological Survey

To assess spatial and annual variation in arctic shorebird breeding phenology and to understand how spring phenology affects these patterns, satellite-derived information on spring thaw (i.e., soil temperature) and greening of vegetation (i.e., NDVI) was gathered for participating ASDN sites and related to nest initiation data. We have acquired ASDN nesting data from 12 arctic sites (2010 – 2012), including historical data from 7 sites (1990 – 2009), and the support of ASDN has resulted in a pan-Arctic collaboration with researchers at Zackenberg, Greenland also contributing data for multiple species (1995 – 2011). To index the onset of spring conditions on arctic breeding grounds, we have secured remote sensing data (NDVI and soil temperature) for all relevant sites and years. Analyses are anticipated to begin this summer, with manuscript preparation occurring during fall and winter of 2014.

8) Invertebrate phenology in relation to habitat features and weather - Daniel Rinella, University of Alaska Anchorage

To better understand invertebrate phenology and abundance, statistical models will be developed that relate the timing and duration of (1) aquatic insect emergence and (2) terrestrial insect activity to a suite of climatic and weather predictors. Models will be used to forecast changes in the timing of invertebrate prey availability for arctic-breeding shorebirds and other consumers based on scenarios of future climate change. The investigations of phenology for this project rely on invertebrate, weather, and snow melt data collected at ASDN sites in 2010-2011, as well as project-specific data on pond habitat (e.g., bathymetry) and water temperature data collected in 2011. Over 1500 invertebrate samples were collected in each of 2010 and 2011, and pond habitat and temperature data were collected from 35 ponds in 2011. Additional data were collected in 2012. All 2010 to 2012 terrestrial invertebrate data (wet and dry tundra pitfall traps) are now together in an Access database; nearly all of the aquatic insect emergence data have also been added. All 2010 to 2012 weather data from all camps contributing invertebrate data are also in the database, including data for those sites that used airport weather instead of HOBO weather stations (a fair bit of formatting magic was required to make these compatible). A plan for building the models has been developed and initiated for the terrestrial samples. The terrestrial analysis will be completed in the summer 2014 and a manuscript completed in the fall. Emergence data analysis will take place data after that. Funds for this study were provided independently from the Arctic LCC in 2011. The Arctic LCC grant has been extended through May, 2015.

9) Test of the Phenological Mismatch Hypothesis in Arctic-breeding Shorebirds – Eunbi Kwon (PhD Candidate) and Brett Sandercock, Kansas State University

To test for the potential mismatch between the spring phenology of Arctic shorebirds and their prey invertebrates, seasonal changes in the invertebrate abundance and breeding timing of a total of 3,099 shorebird nests were monitored on the following 10 network sites in 2010-2012: Nome, Cape Krusenstern, Barrow, Ikpikpuk, Colville Delta, Canning River, Prudhoe Bay, Mackenzie Delta, East Bay and Churchill. Collected invertebrate samples are being processed for the last site, and complete dataset for both trophic levels has become available for 7 of the 10 sites. The dates of maximum food requirement for the shorebird chicks (5 days post-hatch) mistimed the dates of peak biomass by -63 ~ 37 days across 7 Arctic sites during 2010-2012. The degree of phenological mismatch varied significantly among years, sites and shorebird species with the year explaining the most of observed variance in the degree of mismatch and followed by site and species. The degree of phenological mismatch was also positively correlated with the latitudes of survey sites. Further analysis is due for better understanding on the geographic and inter-specific variation in the extent of the phenological mismatch and its potential causes.

10) Migratory connectivity of American Golden-Plovers – Jean-François Lamarre (PhD Candidate) and Joël Bêty, Université du Québec à Rimouski

To determine the spatial relationships among important wintering, migration and breeding areas of American Golden-plovers, light-level geolocators were placed on plovers. To date, we have deployed 177 geolocators on plovers and retrieved 19 of them across the 7 sites of the study (USA: Nome, Barrow, Ikpikpuk River; Canada: Caw-Ridge, Churchill, Igloolik, Bylot Island). We plan to deploy over 80 geolocators in 2014 across the sites and retrieve as many as possible. Geolocator data will be analyzed in the fall of 2014, and collectively this information will be used to prepare a paper describing the migratory connectivity of this species.

11) Migratory connectivity of Semipalmated Sandpipers – Stephen Yezerinac, Mount Allison University; Stephen Brown, Manomet Center for Conservation Sciences; David Mizrahi, New Jersey Audubon; and Richard Lanctot, US Fish and Wildlife Service

To determine the spatial relationships among important wintering, migration, and breeding areas of Semipalmated Sandpipers, 194 light level geolocators were be placed on birds at eight ASDN sites (Nome, Cape Krusenstern, Barrow, Ikpikpuk, Canning River, Mackenzie Delta, Coats Island, Igloolik) in the Arctic during the 2013 field season. An additional 30 geolocators were placed on birds at one site in Brazil in 2013. Geolocators will be retrieved in 2014, and light level data will be used to construct migration pathways, and to elucidate important wintering and breeding areas.

12) Do migratory shorebirds disperse Moss (Bryophyta) diaspores? – Lily Lewis (PhD Candidate) and Chris Elphick, University of Connecticut

To test the hypothesis that long-distance dispersal of moss is occurring by transport on migratory shorebirds, personnel collected breast feather samples from shorebirds captured throughout the ASDN network in 2013. Prior support for this hypothesis had been based simply on correlations between migratory bird flyways and species distributions. We have screened the feathers of transequatorial migrant shorebirds, and provide the empiric evidence of migrant birds harboring unspecialized bryophyte diaspores in their migratory plumage. A manuscript describing the results is under review with the journal of *Ecology*, and will be presented at the upcoming *Frontiers of Botany 2014* conference. This project has provided formative research opportunities to three undergraduate students, two of which have been awarded competitive grants from the University of Connecticut to support their contributions to the project.

13) Variation in shorebird nest predation across the North American Arctic – Paul Smith, Smith and Associates Ecological Research Ltd., and Joe Liebezeit, Wildlife Conservation Society

To better understand geographic patterns in shorebird nest survival, variation in nest survival will be related to shorebird nest density, predator abundance, lemming abundance, and other environmental variables (such as timing of snow melt or mean June temperature). This study will use data from the first four years of the ASDN operation (2010-2013 field seasons). Nest data from most ASDN sites have been collated and analysis is beginning now, with plans for submission of a manuscript to a peer-reviewed journal by February 2015.

14) Arctic shorebird settlement patterns – Sarah Saalfeld and Richard Lanctot, U.S. Fish and Wildlife Service

Shorebirds appear to use conservative and opportunistic settlement strategies to exploit the unpredictable Arctic environment. However, no study has used long-term data from intensively marked populations of shorebirds from multiple sites to systematically assess whether these two settlement strategies exist and if species consistently follow one strategy or another through time. Furthermore, no study has evaluated the environmental and social factors influencing how individual birds settle. This study, proposed in spring 2013, will use data collected at ASDN sites over the five year study period to investigate how shorebird nest density relates to invertebrate amount and dependability, abundance of predators and alternative prey, timing of snow melt and vegetation green-up, prior reproductive success of shorebirds in an area, and social cues.

15) Global distribution and drivers of breeding wader population declines – Tatsuya Amano, University of Cambridge, Tamás Székely and Sergio Ancona, University of Bath; and Hélène Deleu and William J. Sutherland, University of Cambridge.

There is thus an urgent need to assess the global pattern of change – where are species declining and where are they stable or increasing? This should also help understand the drivers of declines. Data on wader population counts have been collected thoroughly across the globe and over an extensive period of time within the framework of several continental-scale surveys. Many of the ASDN sites are also contributing data to this analysis, which was only recently introduced to the group. Specifically, this project will assess the spatial distribution of population changes in breeding wader species at the global scale, it will identify areas showing population declines across species, and explore drivers explaining spatial patterns. Data from a wide range of wader breeding sites will be collected between April and June 2014, and analysis and paper writing is projected to be completed by February 2015.

16) Distribution of Arctic invertebrates – Bob Wisseman, Aquatic Biology Associates, Inc. and partners in systematic zoology who are invertebrate specialists.

A request was made to summarize and publish information collected from ASDN sites on the distribution and abundance of species within the Trichoptera (caddisflies), Plecoptera (stoneflies), Ephemeroptera (mayflies or shadflies), and Diptera (true flies) orders. These publications would involve researchers from a number of different universities across the United States. During the past year, two additional requests have been made. Joe Bowden at the University of California San Diego has obtained the spiders collected by the ASDN and is investigating how spider diversity and abundance varies across the Arctic in relation to glaciation and other factors. Kelly Miller at the University of New Mexico has requested the ability to archive predacious diving beetles (Coleoptera, Dytiscidae) at the Museum of Southwestern Biology.

17) Using feathers to measure stress in wintering shorebirds and relating this to breeding success – Megan Boldenow (PhD Candidate), Sasha Kitaysky and Abby Powell, University of Alaska Fairbanks.

A pilot study is currently being conducted to evaluate how useful winter-grown feathers might be in discerning long-term stress experienced by shorebirds on the winter grounds. The investigators will focus on Semipalmated Sandpipers since a large collection of feathers have been archived for them, they have three breeding populations that are experiencing different levels of population change, and there is additional information on winter location being gathered from these birds using geolocators and stable isotopes. The investigators will first check to see if corticosterone levels in feathers varies with winter location and then evaluate how feather corticosterone relates to nest initiation, and clutch size and volume.

18) Feather and blood collection for stable isotope and genetic investigations

We have collected feather and blood samples from captured individuals between 2010 and 2013 for future studies on migratory connectivity (via stable isotopes), and population genetics and phylogeography. To date, feathers have been or are planned to be used from Dunlin and Semipalmated Sandpipers, and we anticipate future use of these tissues as funds become available and new principal investigators become interested.

Other Accomplishments

Principal investigators met in person or by teleconference to discuss data collection and protocols related to conducting field work during the Alaska Bird Conference in November 2010, the Western Hemisphere Shorebird Group meeting in August 2011, the North American Ornithological Congress in August 2012, and the 5th Western Hemisphere Shorebird Group meeting in September 2013. We have also held regular teleconference calls outside of these meetings to discuss protocols and data collection techniques so as to ensure standardization and consistency in quality data collection. We also learned of issues faced by individual ASDN site leaders that prohibited them from conducting various field tasks during these meetings. This “face time” was critical for obtaining buy-in from all site leads and allowing us to make progress towards our goals. Based on discussions at this meeting, we established a comprehensive Memorandum of Understanding (MOU) among all of the organizational partners sponsoring a field site. The MOU was signed by all parties in March 2011. This document guides the interactions of the partners, and ensures that collaborative data analysis and publication proceed smoothly following completion of the project. We have also developed a standardized side-project MOU that discusses the roles and responsibilities of side project principal investigators and ASDN network leaders.

As of this writing, we have generated the following publications, reports, popular articles, and presentations from work associated with data collected at all or particular sites within the Arctic Shorebird Demographics Network between 2010 and now. Items are listed chronologically and by author within each topic.

Peer-reviewed Publications

Clark, N. A., C. D. T. Minton, J. W. Fox, K. Gosbell, R. B. Lanctot, R. R. Porter, and S. Yezerinac. 2010. The use of light-level geolocators to study wader movements. *Wader Study Group Bull.* 117: 173–178.

Franks, S., D.R. Norris, T.K. Kyser, G. Fernández, B. Schwarz, R. Carmona, M.A. Colwell, J. Correa Sandoval, A. Dondua, H.R. Gates, B. Haase, D.J. Hodkinson, A. Jiménez, R.B. Lanctot, B. Ortego, B.K. Sandercock, F. Sanders, J.Y. Takekawa, N. Warnock, R.C. Ydenberg, and D.B. Lank. 2012. Range-wide patterns of migratory connectivity in the Western Sandpiper *Calidris mauri*. *Journal of Avian Biology* 43:1-13.

Governali, F.C., H.R. Gates, R. B. Lanctot, and R.T. Holmes. 2012. Egg volume can be accurately and efficiently estimated from linear dimensions of eggs for arctic-breeding shorebirds. *Wader Study Group Bulletin* 119:46-51.

Liebezeit, J.R., E. Rowland, M. Cross, and S. Zack. 2012. Assessing Climate Change Vulnerability of Breeding Birds in Arctic Alaska. A report prepared for the Arctic Landscape Conservation Cooperative. Wildlife Conservation Society, North America Program, Bozeman, MT., 167pp.

Smith, P.A., C. L. Gratto-Trevor, B.T. Collins, S. D. Fellows, R.B. Lanctot, J. Liebezeit, B. McCaffery, D. Tracy, J. Rausch, S. Kendall, S. Zack and H. R Gates. 2012. Trends in abundance of Semipalmated Sandpipers: Evidence from the Arctic. *Waterbirds 35:106-119.*

Bolduc, E., N. Casajus, P. Legagneux, L. McKinnon, H.G. Gilchrist, M. Leung, R.I.G. Morrison, D. Reid,P.A. Smith, C.M. Buddle, and J. Bêty. 2013. Terrestrial arthropod abundance and phenology in the Canadian Arctic: modeling resource availability for arctic-nesting insectivorous birds. *Canadian Entomologist* 145:1-16.

Klima, J., Ballantyne, K., Perz, J., Johnson, A.S., Jackson, J.A., Lamarre, J-F., McKinnon, L. 2013. North

American longevity records for American Golden-Plover *Pluvialis dominica* and Whimbrel *Numenius phaeopus* from Churchill, Manitoba, Canada. *Wader Study Group Bulletin* 120(2):1-2.

Lounsberry, Z.T., J.B. Almeida, T. Grace, R.B. Lanctot, J. Liebezeit, B.K. Sandercock, K.M. Strum, S. Zack, and S. M. Wisely. 2013. Range-wide conservation genetics of Buff-breasted Sandpipers (*Tryngites subruficollis*). *Auk* 130:429-439.

McCloskey, M., S.R. Robinson,P.A. Smith, and M.R. Forbes. 2013. Mercury concentrations in the eggs of four Canadian arctic-breeding shorebirds not predicted based on their population statuses. *SpringerPlus* 2: 567.

McKinnon, L., E. Nol, and C. Juillet. 2013. Arctic-nesting birds find physiological relief in the face of trophic contraints. *Nature Scientific Reports* 3(1816).

Porter, R. andP.A. Smith. 2013. Using auxiliary data to improve the accuracy of solar geolocation. *Wader Study Group Bulletin* 120: 147-159.

Saalfeld, S.T., B.K. Hill, and R.B. Lanctot. 2013. Shorebird responses to construction and operation of a landfill on the Arctic Coastal Plain. *Condor* 115:1-13.

Yezerinac, S., R.B. Lanctot, S. Talbot, and G. Sage. 2013. Social and genetic mating system of American Golden-Plovers. *Condor* 115:808-815.

Dickie, M.,P.A. Smith, H.G. Gilchrist. Accepted. Does survey timing impact shorebird estimates at East Bay, Nunavut? *Waterbirds*.

Doll, A.C., R.B. Lanctot, C.A. Stricker, S. Yezerinac, and M.B. Wunder. (in review) A novel approach to estimate isotopic turnover rates and arctic arrival dates in wild Dunlin. *Evolutionary Applications.*

English, W.B., D. Schamel, D.M. Tracy, D.F. Westneat, and D.B. Lank. (in review). Sex ratio varies with egg investment in the red-necked phalarope (*Phalaropus lobatus*). *Behavioral Ecology and Sociobiology*.

Liebezeit, J.R., K. E. B. Gurney, M. Budde, S. Zack, and D. Ward. (in review). Phenological advancement in arctic species: relative importance of snow melt and ecological factors. *Polar Biology*.

Miller, M.P., S.M. Haig, T.D. Mullins, L. Ruan, B. Casler, A. Dondua, H.R. Gates, J. M. Johnson, S. Kendall, P.S. Tomkovich, D. Tracy, O.P. Valchuk, and R.B. Lanctot. (in review). Intercontinental genetic structure and gene flow in Dunlin (*Calidris alpina*), a natural vector of avian influenza. *Ecological Applications.*

Ramey, A., J. Reed, J. Schmutz, T. Fondell, B. Meixell, J. Hupp, Jerry, D. Ward, J. Terenzi, and C. Ely. In Review. Prevalence, transmission, and genetic diversity of blood parasites infecting tundra-nesting geese in Alaska. *Canadian Journal of Zoology*.

Saalfeld, S.T. and R.B. Lanctot. (in review) Conservative and opportunistic settlement strategies in Arctic-breeding shorebirds. *Auk*.

Gauthier, G., J. Bêty, J., M.-C. Cadieux, P. Legagneux, M. Doiron, C. Chevalier, S. Lai, A. Tarroux, and D. Berteaux. 2013. Long-term monitoring at multiple trophic levels reveals heterogeneity in responses to climate change in the Canadian Arctic tundra. *Philosophical Transactions B.* 368:20120482.

Bêty, J., Graham-Sauvé, M., Legagneux, P., Cadieux, M.-C., Gauthier, G. 2014. Fading indirect effects in a warming arctic tundra. *Current Zoology* 60: 189-202.

Legagneux, P., G. Gauthier, N. Lecomte, N.M. Schmidt, D. Reid, M.-C. Cadieux, D. Berteaux, J. Bêty, C.J. Krebs, R.A. Ims, N.G. Yoccoz, R.I.G. Morrison, S.J. Leroux, M. Loreau, and D. Gravel. 2014. Arctic ecosystem structure and functioning shaped by climate and herbivore body size. *Nature Climate Change* 4:379-383.

Therrien J.-F., Gauthier G., Korpimäki, E. and Bêty J. 2014. Predation pressure imposed by avian predators suggests summer limitation of small mammal populations in the Canadian Arctic. *Ecology* 95:56–67.

Reports:

Gates, H.R., R.B. Lanctot, J. Liebezeit, and P. Smith. 2010. Arctic Shorebird Demographics Network Breeding Camp Protocol, version 1, May 2010. Unpubl. paper by U.S. Fish and Wildlife Service, Anchorage, Alaska.

Gates, H.R., R.B. Lanctot, J.R. Leibezeit, and P. Smith. 2010. Arctic Shorebird Demographic Network breeding season protocol. Unpubl. Report by U.S. Fish and Wildlife Service, Anchorage, Alaska.

Lanctot, R.B. 2010. Avian influenza sampling of shorebirds at Barrow and Cape Krusenstern, Alaska -2010. Unpubl. report for U.S. Fish and Wildlife Service, Anchorage, Alaska.

Lanctot, R.B., and H. R. Gates. 2010. Cape Krusenstern Shorebird Breeding Ecology Study. Investigator's Annual Report. National Park Service.

Liebezeit, J.R. and S. Zack. 2010. Nesting success and nest predators of tundra-nesting birds on the Ikpikpuk River, NE planning area National Petroleum Reserve - Alaska – 2010 annual report. A report prepared by the Wildlife Conservation Society for the Bureau of Land Management, Alaska Department of Fish and Game and other interested parties. Available for download at http://www.wcsnorthamerica.org/tabid/3645/Default.aspx.

Liebezeit, J.R. and S. Zack. 2010. Nesting success and nest predators of tundra-nesting birds in the Prudhoe Bay Oilfield, Long-term Monitoring – 2010 annual report. A report prepared by the Wildlife Conservation Society for the Bureau of Land Management, Alaska Department of Fish and Game, BP Exporation, Alaska, Inc., and other interested parties. Available for download at http://www.wcsnorthamerica.org/tabid/3645/Default.aspx.

Arctic Shorebird Demographics Network Protocol Subcommittee. 2011. Arctic Shorebird Demographics Network Breeding Camp Protocol, version 2, May 2011. Unpubl. paper by U.S. Fish and Wildlife Service and Manomet Center for Conservation Sciences.

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Wisely, S.M., Ganser, C. 2011. Avian malaria surveillance in Arctic breeding Shorebirds. Ongoing or new studies of Alaska shorebirds annual summary compilation, Alaskan Shorebird Group. U.S. Fish and Wildlife Service.

Environment Canada. 2012. Bird Conservation Strategy for Bird Conservation Region 3 in the Prairie and Northern CWS Region: Arctic Plains and Mountains. Canadian Wildlife Service, Environment Canada. Yellowknife, Northwest Territories. 87 pp. + appendices.

Gates, H.R., R.B. Lanctot, and S. Yezerinac. 2012. Migratory connectivity of Dunlin breeding at Cape Krusenstern National Monument. Murie Science and Learning Center Fellowship Report to the National Park Service.

Gates, H. R., R. B. Lanctot, J. R. Liebezeit, P. A. Smith, and B. L. Hill 2012. Arctic Shorebird Demographics Network Breeding Camp Protocol, Version 3, April 2012. Unpubl. paper by U.S. Fish and Wildlife Service and Manomet Center for Conservation Sciences.

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Ward, D. and J. Hupp. 2012. Influence of Forage Phenology on Timing of Avian Reproduction and Juvenile Growth on the Colville River Delta, 2011-12. Progress Report. USGS, Alaska Science Center, Anchorage.

Wisely, S.M, Ganser, C. 2012. Avian malaria surveillance in Arctic breeding Shorebirds. Annual Summary, Alaskan Shorebird Group. U.S. Fish and Wildlife Service.

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Boldenow, M.B., R.B. Lanctot, A.N. Powell, H.R. Gates, and S.C. Brown. 2013. Breeding ecology of shorebirds and survey of other birds at Cape Krusenstern National Monument, Alaska. In: Annual Summary Compilation: New or ongoing studies, Alaska Shorebird Group.

Boldenow, M.B., A.N. Powell, and R.B. Lanctot. 2013. Cape Krusenstern Shorebird Breeding Ecology Study.

Investigator's Annual Report. National Park Service.
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Lanctot, R.B., H.R. Gates, S. Brown and B.K. Sandercock. 2013. 2011 progress report: Using a network of sites to evaluate how climate-mediated changes in the Arctic ecosystem are affecting shorebird distribution, ecology and demography. Unpublished report by the U.S. Fish and Wildlife Service, Manomet Center for Conservation Sciences and Kansas State University to the Arctic Landscape Conservation Cooperative. U.S. Fish and Wildlife Service, Anchorage, AK.
Lanctot, R.B., K. Grond, J.W. Santo Domingo, and B.K. Sandercock. 2013. Phylogenetic analysis of microbiota inhabiting the gut of shorebirds using high throughput genetic sequencing techniques. Unpubl. report to the national U.S. Fish and Wildlife Service's Avian Health and Disease Program.
Wisely, S.M, Ganser, C. 2013. Biogeography of Transmission Dynamics for a Vector-borne pathogen recently found in Arctic-breeding Shorebirds. Avian Health and Disease Progress Report, Alaskan Shorebird Group. U.S. Fish and Wildlife Service.
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Hupp, J., D. Ward, T. Donnelly, and K. Hogrefe. 2014. Banding of Lesser Snow Geese and Black Brant on the Colville River Delta, Alaska 2011-2013. Progress Report. USGS, Alaska Science Center, Anchorage.
Sandercock, B.K., and Kwon, E. 2014 Annual project report: effects of environmental change on Arctic-breeding shorebirds. National Science Foundation.

Popular Articles:

Sandercock, B.K. 2010. There's no place like Nome for professor researching migrant shorebirds. News release, Kansas State University.
Lanctot, R.B. 2012. Dunlin gives (almost) all for shorebird research and conservation. Tattler 24:10-11.

Presentations at Meetings

Brown, S., R.B. Lanctot, and B. Sandercock. 2009. Arctic shorebird demographics network. 15th Annual Alaska Shorebird Group Meeting, Anchorage, Alaska.
Brown, S., R.B. Lanctot, and B. Sandercock. 2010. Arctic Shorebird Demographics Network: overview and current status. 13th Alaska Bird Conference, Anchorage, Alaska.
Lanctot, R.B., S. Brown and B.K. Sandercock. 2010. Arctic Shorebird Demographic Network: understanding the mechanisms behind shorebird declines. 25th International Ornithological Congress. Campos do Jordão, SP, Brazil.
Lanctot, R.B.,S. Brown and B.K. Sandercock. 2010. Arctic shorebird demographic network: understanding the mechanisms behind shorebird declines. Joint Meeting of the American Ornithologists' Union (128th), Cooper Ornithological Society (80th), and the Society of Canadian Ornithologists (30th). San Diego, California.
Bêty, J. 2011. Arctic birds highly scrutinized: global change and recent discoveries. Society of Canadian Ornithologist, University of Moncton, New Brunswick, Canada
Bêty, J. 2011. Ecology and evolution of arctic migrants. Animal Migration Symposium, Royal Swedish Academy of Sciences and Wenner-Gren Foundations, Sweden.
Brown, S., R.B. Lanctot, H.R. Gates, and B. Sandercock. 2011. Arctic Shorebird Demographics Network. 17th Annual Alaska Shorebird Group Meeting, Anchorage, Alaska.
Brown, S., R.B. Lanctot, and B. Sandercock. 2011. The Arctic Shorebird Demographics Network: Understanding the mechanisms behind shorebird declines. 4th Western Hemisphere Shorebird Group, Vancouver, British Columbia.
Doll, A., M. Wunder, R.B. Lanctot, and C. Stricker. 2011. Estimating arrival times of Arctic-breeding Dunlin

using stable isotopes. 4th Western Hemisphere Shorebird Group, Vancouver, British Columbia.
Kwon, E., and Sandercock, B.K. 2011. Population dynamics of arctic-breeding shorebirds under environmental change. Invited talk. Ewha Women's University, Seoul, Korea. December 22, 2011.
Kwon, E., and Sandercock, B.K. 2011. Age-specific demography and population dynamics of the Western Sandpiper (*Calidris mauri*). 4th Western Hemisphere Shorebird Group Meeting. Vancouver, Canada. August 11-15, 2011.
Kwon, E., and Sandercock, B.K. 2011. Changes in breeding phenology of arctic-breeding shorebirds: comparative study over two decades. KOS 2011 Fall Meeting. Great Bend, KS. USA. September 30-October 2, 2011.
Kwon, E., and Sandercock, B.K. 2011. Age-specific Demography and Population Dynamics of the Western Sandpiper (*Calidris mauri*). Division of Biology, BioForum. Manhattan, KS. March 5, 2011.
Kwon, E., and Sandercock, B.K. 2011. Age-specific Demography and Population Dynamics of the Western Sandpiper (*Calidris mauri*). AFO/COS/WOS 2011 Meeting. Kearney, NE. March 9-13, 2011. (poster)
Wunder, W., R.B. Lanctot, C. Stricker, L. Wassenaar, B. Casler, A. Dey, P. Doherty, A. Dondua, S. Drovetski, D. Edwards, R. Gates, B. Hill, O. Lane, J. Liebezeit, D. Poppe, B. Schwarz, P. Tomkovich, D. Tracy, O. Valchuk, and S. Zack. 2011. Using stable isotopes in primary feathers to classify Dunlin subspecies. 4th Western Hemisphere Shorebird Group, Vancouver, British Columbia.
Cunningham, J., D. Kesler, and R.B. Lanctot. 2012. Effects of experience on male and female breeding habitat selection in Arctic-breeding shorebirds. 5th North American Ornithological Conference, Vancouver, British Columbia.
Doll, A., M. Wunder, R.B. Lanctot, and C. Stricker. 2012. Estimating temporal movements of a migratory species using stable carbon isotopes. 8th International Conference on Applications of Stable Isotope Techniques to Ecological Studies, Brest, France.
English, W.B. and D.B. Lank. 2012. Mr Mom: egg size and incubation in red-necked phalaropes. Pacific Ecology and Evolution Retreat, Bamfield, British Columbia.
Gates, H,R., S. Brown, R.B. Lanctot, and B. Sandercock. 2012. The Arctic Shorebird Demographics Network: Understanding causes of shorebird declines. 14th Alaska Bird Conference, Anchorage, Alaska.
Gates, H.R., S. Brown, R.B. Lanctot, and B. Sandercock. 2012. The Arctic Shorebird Demographics Network: Understanding causes of shorebird declines. 5th North American Ornithological Conference, Vancouver, British Columbia.
Kwon, E., and Sandercock, B.K. 2012. Age-specific demography and population dynamics of the Western Sandpiper (*Calidris mauri*). Kansas Ornithological Society 2012 Fall Meeting. Winfield, Kansas. September 28-30, 2012.
Kwon, E., and Sandercock, B.K. 2012. Changes in breeding phenology of arctic-breeding shorebirds: comparative study over two decades. 5th North American Ornithological Conference. Vancouver, BC, Canada. August 14-18, 2012.
Kwon, E., and Sandercock, B.K. 2012. Changes in breeding phenology of arctic-breeding shorebirds: comparative study over two decades. 2012 Kansas Natural Resource Conference. Wichita, KS. January 26-27, 2012.
Lanctot, R.B. 2012. What happens when you remove a top predator (Arctic Fox) from an Arctic ecosystem? Findings from a 9-year shorebird study at Barrow, Alaska. 20th Kachemak Bay Shorebird Festival, Homer, Alaska.
Lanctot, R.B., S. Saalfeld, B. Hill, R. Gates, A. Taylor, J. Cunningham, A. Doll, and M. Budde. 2012. What happens when you remove an Arctic Fox from a tundra ecosystem? 14th Alaska Bird Conference, Anchorage, Alaska.
Lanctot, R.B., S. Saalfeld, B. Hill, R. Gates, A. Taylor, J. Cunningham, A. Doll, and M. Budde. 2012. What happens when you remove an apex predator from an Arctic ecosystem? Findings from a 9-year study at Barrow, Alaska. 5th North American Ornithological Conference, Vancouver, British Columbia.
McKinnon, L., Jehl, J., Picotin, M., Juillet, C., Bolduc, E. Bêty, J and E. Nol. 2012. Assessing the sensitivity of arctic-nesting shorebirds to climate induced changes in insect phenology. From Action to Knowledge, International Polar Year (IPY) 2012, Montréal, QC.

McKinnon, L. and E. Nol. 2012. Optimizing shorebird breeding phenology in a changing arctic environment. North American Ornithological Conference, Vancouver, BC.

Saalfeld, S., R.B. Lanctot, S. Brown, and B. Hill. 2012. Shorebird response to construction and operation of the North Slope Borough Landfill in Barrow, Alaska. 14th Alaska Bird Conference, Anchorage, Alaska.

Yezerinac, S., R.B. Lanctot, S. Brown, B. Casler, D. Fifield, R. Gates, B. Hill, S. Kendall, J. Liebezeit, L. McKinnon, and E. Nol. 2012. Connecting Dunlin breeding sites with migratory stopover and wintering locations using light-level geolocation.5th North American Ornithological Conference, Vancouver, British Columbia.

Bêty, J. 2013. Arctic birds under the spotlight. Hawk Mountain Sanctuary, Pennsylvania.

Brown, S., R.B. Lanctot, and B.K. Sandercock. 2013. Arctic Shorebird Demographics Network: Overview and preliminary report. 5th Western Hemisphere Shorebird Group, Santa Marta, Colombia.

Cunningham, J.A., D.C. Kesler, and R.B. Lanctot. 2013. Habitat and social factors influence nest site selection in Arctic-breeding shorebirds. 5th Western Hemisphere Shorebird Group, Santa Marta, Colombia.

Cunningham, J.A., D.C. Kesler, and R.B. Lanctot. 2013. Habitat and social factors influence nest site selection in Arctic-breeding shorebirds. Joint Meeting of American Ornithologists' Union and Cooper Ornithological Society. Chicago, Illinois.

English, W.B., B.K. Sandercock, and D.B. Lank. 2013. Weather and the consequences of extended incubation in a uniparental arctic-breeding shorebird, the red-necked phalarope (*Phalaropus lobatus*).Western Hemisphere Shorebird Group Meeting, Santa Marta Colombia.

English, W.B., D. Schamel, D.M. Tracy, D.F. Westneat, and D.B. Lank. 2013. Unexpected sex-biased egg allocation in the red-necked phalarope (*Phalaropus lobatus*). Western Hemisphere Shorebird Group Meeting, Santa Marta Colombia.

English, W.B., B.K. Sandercock, and D.B. Lank. 2013. Incubate or eat: patterns in differential nest attentiveness by red-necked phalaropes. Pacific Seabird Group Meeting, Portland Oregon.

Ganser, C. and S.M. Wisely. 2013. Avian malaria of Arctic-breeding shorebirds and their global transmission patterns. 5th Western Hemisphere Shorebird Group Meeting. Santa Marta, Colombia.

Ganser, C. and S.M. Wisely. 2013. Biogeography of transmission dynamics for vector-borne pathogens recently found in Artic-breeding shorebirds.62nd International Conference of the Wildlife Disease Association. Knoxville, Tennessee.

Ganser, C., K. Schroeder, A.J. Gregory, L.M. Hunt, L.B. McNew, B.K. Sandercock, and S.M. Wisely. 2013. Molecular epidemiology of avian malaria of sympatric nesting grounds in the Midwest. 6th International Biogeography Conference. Miami, Florida.

Hupp, J., D. Ward, T. Donnelly, and K. Hogrefe. 2013. Comparative Reproductive Success of Arctic Geese in Northern Alaska. Wildlife Society Conference, Anchorage AK.

Koloski, L.R., and E. Nol. 2013. Philopatry and area tenacity in a breeding population of Dunlin (*Calidris alpina hudsonia*) in Churchill, Manitoba. 5th Western Hemisphere Shorebird Group, Santa Marta, Colombia.

Kwon, E., D. Lank, and B.K. Sandercock. 2013. Changes in breeding phenology and reproductive success of long-distance migratory shorebirds. Division of Biology BioForum. Manhattan, KS.

Kwon, E., D.B. Lank, R.B. Lanctot, S. Brown, and B.K. Sandercock. 2013. Temporal gradient of prey availability and shorebird breeding phenology in the Arctic. 5th Western Hemisphere Shorebird Group, Santa Marta, Colombia.

Kwon, E., and B.K. Sandercock. 2013. Tracking annual movement of long-distance migratory sandpipers using light logging geolocator. Ecology of Animal Migration – International PhD course. Lund, Sweden.

Lamarre, J.-F., Bêty, J., Gauthier, G., 2013. Predator-mediated interactions between shorebirds and colony-nesting snow geese on Bylot Island, Nunavut. 5th Western Hemisphere Shorebird Group Meeting, Santa Marta, Columbia.

Lanctot, R.B. and P. Smith (co-convenors of symposium). 2013. Understanding factors affecting shorebird population size in the Arctic. 5th Western Hemisphere Shorebird Group, Santa Marta, Colombia.

Perkins, M., L. Eggert, N. Basu, I. Stenhouse, J. Bety, J.F. Lamarre, R. Gates, and D. Evers. 2013. Evaluating blood and feather mercury concentrations for multiple Arctic shorebird species across a large spatial scale. 11th International Conference of Mercury as a Global Pollutant, Edinburgh, Scotland.

Perkins, M., L. Ferguson, R.B. Lanctot, I.J. Stenhouse, D.C. Evers, N. Basu, J. Bety, S. Brown, R. Gates, S. Kendall, J.F. Lamarre, J. Liebezeit, and B. Sandercock. 2013. Quantifying mercury exposure for multiple shorebird species across the North American Arctic using blood and feather samples. 34th Society of Environmental Toxicology and Chemistry North America meeting, Nashville, Tennessee.

Saalfeld, S.T. and R.B. Lanctot. 2013. Conservative and opportunistic settlement strategies in Arctic-breeding shorebirds. 19th Annual Alaska Shorebird Group Meeting, Anchorage, Alaska.

Smith, P.A. 2013. Variable nest survival in arctic shorebirds: ecological and conservation implications. Biology Dept., Carleton University, Ottawa, ON.

Smith, P.A. 2013. Variable nest survival in arctic shorebirds: ecological and conservation implications. Biology Dept., Trent University, Peterborough, ON.

Taylor, A.R., R.B. Lanctot, and R.T. Holmes. 2013. A 60-year evaluation of shorebird response to environmental change at Barrow, Alaska. 5th Western Hemisphere Shorebird Group, Santa Marta, Colombia.

Kwon, E., D. Lank, R.B. Lanctot, S. Brown, and B.K. Sandercock. 2014 Temporal gradient of prey availability and shorebird breeding phenology in the Arctic. Division of Biology BioForum. Manhattan, Kansas.

Smith, P.A. 2014. Status and conservation of Arctic shorebirds". National Wildlife Research Centre, Ottawa, Ontario.

Smith, P.A. and J. Rausch. 2014. Bird research and monitoring in Nunavut: methods and applications. Seminar presented to the meeting of all Nunavut Area Co-management Committees, Iqaluit, NU.

Smith, P.A. 2014. Status and conservation of Arctic shorebirds. Pacific Wildlife Research Centre, Delta, British Columbia.

Relevance to Arctic LCC conservation goals:

The Arctic Shorebird Demographics Network (the Network) is a geographically broad, multi-partner strategy that on-going support from the U.S. Fish and Wildlife Service, U.S. Geological Survey, the Canadian Wildlife Service, Environment Canada, academic partners, and many non-governmental conservation organizations (including Manomet, Inc.). Our study meets several stated objectives within the Arctic Landscape Conservation Cooperative Development and Operations Plan (draft plan December 2009). Specifically, it:

1) has a broad geographic scope that is focused on the Arctic;
2) currently includes a host of partners, including State and Federal Agencies and NGOs, as well as universities;
3) focuses on measuring habitat availability and quality; as well as priority migratory shorebirds that occupy a predominant role in the Arctic environment;
4) will improve our fundamental understanding of ecological changes by providing an inventory of surface water, insects, climate conditions, predators, alternative prey, and shorebird ecology; and
5) will build science capacity, by leveraging funds acquired elsewhere to operate the ASDN, and by doing so, complement the priority science needs identified by the WildREACH workshop.

Fund Expenditures

Funding from the Arctic LCC allowed the ASDN to become a reality in 2010. These funds were critical for successful completion of protocols and data collection, and provided a small boost to many sites that allowed them to start-up in 2010 and continue in 2011. Funds were used to equip sites with necessary equipment (e.g., weather stations, nest traps, invertebrate sampling materials), to hire and supervise field technicians collecting data to meet Arctic LCC specific-objectives at field sites, to pay for invertebrate analysis, and to hire a logistical coordinator that has developed protocols and collated the data from 2010 and 2011. A follow-up grant from the Arctic LCC in 2012 provided funds to cover analyses of invertebrates samples collected in 2012.

The ASDN steering committee continues to seek funds from many locations to pay for general ASDN costs. Seed funding from the Arctic LLC was vital in allowing us to prepare competitive grants proposals that were successfully funded by a series of different sponsors, including NFWF (successful in 2010-2013), Neotropical Migratory Bird Conservation Program of the U.S. Fish and Wildlife Service (successful in 2010-2013), and the Alaska Department of Fish and Game (successful in 2010, failed in 2011). We also submitted a proposal to the National Science Foundation's Research Coordination Network grant program in October 2011 that was declined. During July 2012, a proposal was submitted to the U.S. Fish and Wildlife Service's Survey, Monitoring, and Assessment program to hire a 3-year post-doctoral research associate to help with data analyses. Our project was ranked number one in the nation and subsequently funded. Emily Weiser was hired as a new post-doctoral research associate and began work on 1 April 2014. Principal investigators from each site (Appendix 1) fund most of the costs of their sites and collectively acquire funds from many funding agencies, both public and private (see list below). Overall, the seed funding provided by the Arctic LCC has been leveraged by at least 10:1.

The Future

The ASDN expanded from 9 to 11 sites in 2011. We raised new funds to expand field efforts at the Cape Krusenstern site, and new investigators at Bylot Island and the Colville River joined the ASDN in 2011. Due to budget reductions and delays in funding within many federal programs we were unable to raise sufficient funds to continue operating the Prudhoe Bay site at full capacity in 2011. The ASDN network has continued to grow in 2012. Two new sites were added in Russia (Chaun River Delta and Lower Khatanga River) and one site was added in Canada (Burnt Point). Last, two new sites joined the ASDN in 2013; including Igloolik and Coats Island in Nunavut, Canada.

One of our most impressive achievements is the number of network projects that have developed due to the collection of data over many species over a large geographic area. The 18 projects listed above will surely increase as people think of new and creative ways to use the data being collected and the samples being archived.

We are currently exploring new ways to continue the ASDN beyond the initial 5-year study. Possibilities include focusing on migratory connectivity, and goose foraging and impacts to shorebirds.

Acknowledgements

Our progress report summarizes field work conducted by many individuals from many different organizations. Appendix 1 lists the principal investigators and students working at each ASDN site. Within each of these sites, there were a number of additional field technicians whose names are not mentioned. We thank them all for being willing to work in a collaborative nature to address very large scale questions. Thanks to River Gates and Ian Davies who helped collate data and construct tables for the report. Besides the Arctic LCC funding, which necessitated this report, field crews were supported by the U.S. Fish and Wildlife Service (including the Arctic National

Wildlife Refuge, Selawik National Wildlife Refuge, Migratory Bird Management, and Avian Influenza programs); Manomet Center for Conservation Sciences; the National Fish and Wildlife Foundation; the Neotropical Migratory Bird Conservation Act; U.S. Geological Survey, Alaska Science Center's Changing Arctic Ecosystem Initiative; National Park Service, Cape Krusenstern National Monument and a Murie Science and Learning Center grant to River Gates; Bureau of Land Management; ArcticNet; Department of Indian Affairs and Northern Development Canada, Cumulative Impacts Monitoring Program and Arctic Research Infrastructure Fund; Environment Canada, Canadian Wildlife Service & Science and Technology Branch; Natural Resources Canada, Polar Continental Shelf Program; Natural Sciences and Engineering Research Council of Canada (Discovery Grant, Northern Supplement, International Polar Year, graduate student scholarships), EnviroNorth Program (Canada); National Science Foundation (Office of Polar Programs, and Doctoral Dissertation Improvement Grant to Nathan Senner); the Alaska Department of Fish and Game; FQRNT (Quebec); University of Alaska Fairbanks; Université du Québec à Rimouski, Cornell University Graduate School Mellon Grant (Nathan Senner); Churchill Northern Studies Centre; American Ornithologists' Union; Liz Claiborne / Art Ortenberg Foundation; Faucett Family Foundation; and Athena Foundation.

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Appendix 1. Sponsoring organization(s), names of principal investigators, and graduate students for ASDN sites established between 2010 and 2013.

ASDN Site	Institution	Principal Investigator	Graduate Students
Active sites in 2010			
Nome, Alaska, USA	Simon Fraser University, Kansas State University	David Lank, Brett Sandercock	Eunbi Kwon, Willow English
Cape Krusenstern, Alaska, USA	U.S. Fish and Wildlife Service, Migratory Bird Management	Richard Lanctot (formerly River Gates)	Megan Boldenow
Barrow, Alaska, USA	U.S. Fish and Wildlife Service, Migratory Bird Management	Richard Lanctot, Sarah Saalfeld	Andy Doll, Jenny Cunningham, Kirsten Grond
Ikpikpuk River, Alaska, USA	Wildlife Conservation Society	Martin Robard, Rebecca Bentzen (formerly Joe Liebezeit and Steve Zack)	
Prudhoe Bay, Alaska, USA	Wildlife Conservation Society	Martin Robard, Rebecca Bentzen (formerly Joe Liebezeit and Steve Zack)	
Canning River, Alaska, USA	U.S. Fish and Wildlife Service, Arctic NWR; Manomet Center for Conservation Sciences;	David Payer, Stephen Brown (formerly Steve Kendall)	
Mackenzie Delta, Northwest Territories, Canada	Environment Canada	Jennie Rausch, Paul Woodard (formerly Lisa Pirie)	
East Bay, Nunavut, Canada	Environment Canada, Smith and Associates Ecological Research Ltd	Grant Gilchrist, Paul Smith	
Churchill, Manitoba, Canada	Trent University, Cornell University	Erica Nol (formerly Laura McKinnon	Nathan Senner, Laura Koloski
New in 2011			
Bylot Island, Nunavut, Canada	University of Quebec at Rimouski	Joël Bêty	Jean-François Lamarre
Colville River Delta, Alaska, USA	U.S. Geological Survey, Alaska Science Center	David Ward	
Reduced in 2011			
Prudhoe Bay, Alaska, USA	Wildlife Conservation Society	Martin Robards, Rebecca Bentzen (formerly Joe Liebezeit and Steve Zack)	
New in 2012			
Burntpoint, Ontario	Ontario Ministry of Natural Resources	Rod Brook, Ken Abraham	
Chaun River Delta, Russia	Ornithology Institute of Biological Problems of the North, Wildlife Conservation Society	Diana Solovyeva, Martin Robards, Rebecca Bentzen	

Appendix 1 Continued.

ASDN Site	Institution	Principal Investigator	Graduate Students
New in 2013			
Lower Khatanga River, Taimyr, Russia	Lomonosov Moscow State University	Mikhail Soloviev	
Coats Island, Nunavut, Canada	Environment Canada, Manomet Center for Conservation Sciences	Paul Smith, Stephen Brown	
Igloolik, Nunavut, Canada	Université de Moncton, Moncton, NB	Nicolas Lecomte, Marie-Andree Giroux	

Appendix 2. Species whose nests were located or were banded at ASDN sites between 2010 and 2013. Listed alphabetically by common name to match other tables.

Common Name	Genus Species	4-letter acronym
American Golden-Plover	*Pluvialis dominica*	AMGP
Bar-tailed Godwit	*Limosa lapponica*	BTGO
Black-bellied Plover	*Pluvialis squatarola*	BBPL
Black Turnstone	*Arenaira melanocephala*	BLTU
Broad-billed Sandpiper	*Calidris falcinellus*	BBIS
Buff-breasted Sandpiper	*Calidris subruficollis*	BBSA
Common-ringed Plover	*Charadrius hiaticula*	CRPL
Common Snipe	*Gallinago gallinago*	COSN
Common-ringed Plover	*Charadrius hiaticula*	CRPL
Curlew Sandpiper	*Calidris ferruginea*	CUSA
Dunlin	*Calidris alpina*	DUNL
Hudsonian Godwit	*Limosa hudsonica*	HUGO
Killdeer	*Charadrius vociferus*	KILL
Least Sandpiper	*Calidris minutilla*	LESA
Lesser Yellowlegs	*Tringa flavipes*	LEYE
Little Stint	*Calidris minuta*	LIST
Long-billed Dowitcher	*Limnodromus scolopaceus*	LBDO
Pacific Golden-Plover	*Pluvialis fulva*	PAGP
Pectoral Sandpiper	*Calidris melanotos*	PESA
Red Knot	*Calidris canutus*	REKN
Red Phalarope	*Phalaropus fulicaria*	REPH
Red-necked Phalarope	*Phalaropus lobatus*	RNPH
Ruddy Turnstone	*Arenaria interpres*	RUTU
Ruff	*Philomachus pugnax*	RUFF
Sanderling	*Calidris alba*	SAND
Semipalmated Plover	*Charadrius semipalmatus*	SEPL
Semipalmated Sandpiper	*Calidris pusilla*	SESA
Short-billed Dowitcher	*Limnodromus griseus*	SBDO
Spotted Redshank	*Tringa erythropus*	SPRE
Sharp-tailed Sandpiper	*Calidris himantopus*	SPTS
Stilt Sandpiper	*Calidris himantopus*	STSA
Temminck's Stint	*Calidris temminckii*	TEST
Western Sandpiper	*Calidris mauri*	WESA
Whimbrel	*Numenius phaeopus*	WHIM
White-rumped Sandpiper	*Calidris fuscicollis*	WRSA
Wilson's Snipe	*Gallinago delicata*	WISN
Wood Sandpiper	*Tringa glareola*	WOSA