2010 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, H. River Gates
U.S. Fish and Wildlife Service, Migratory Bird Management

Stephen Brown
Manomet Center for Conservation Sciences

and

Brett K. Sandercock
Kansas State University

A collaborative project with the
Arctic Landscape Conservation Cooperative

North and West Alaska Cooperative Ecosystem
Studies Unit Agreement #701817K403

9 May 2011

Abstract

To obtain a better understanding of how shorebirds will respond to climate-mediated changes in the Arctic's morphology and ecology, we 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. We established nine field sites across the arctic, from Nome to Hudson Bay, and successfully collected environmental data and bird data at all nine sites. We have compiled all of the data from the first year, and are in the process of revising the protocols and preparing for the second of five proposed field seasons. We held a network meeting to compile data, compare results from the first season, and plan future work. We also established a Memorandum of Understanding among all of the participating organizations to ensure that collaborative data analysis and publication proceed smoothly following completion of the project. We are also conducting and are planning eight additional projects that use the geographically vast and taxonomically rich ASDN to collect data on relevant issues related to climate change, migratory connectivity and avian health.

Citation: Lanctot, R. B., H. R. Gates, S. Brown, and B. K. Sandercock. 2011. 2010 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 Unpublished report by the U.S. Fish and Wildlife Service, Manomet Center for Conservation Sciences and Kansas State University to the Arctic Landscape Conservation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.

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 degree 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 evapotranspiration rates, resulting in a drier landscape, although enhanced cloud cover, which reduces evapotranspiration, may negate this drying trend to some degree (Martin et al. 2009). The longer growing seasons and warmer temperatures are predicted to accelerate ice wedge degradation and accompanying thermokarst pond development, a pattern already observed today 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. This may be particularly true for the millions of shorebirds that use the Arctic Coastal Plain to breed and raise their young between June and September (Johnson and Herter 1989). Predicting how these 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 (Connors et al. 1979, 1981; Connors 1984; Andres 1994). Decoupling of these 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., lemmings) 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). These 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.

Goal and Objectives

To obtain a better understanding of how shorebirds will respond to climate-mediated changes in the Arctic's morphology and ecology, we established a network of sites in 2010. Biologists at these sites, known as the Arctic Shorebird Demographics Network (ASDN), 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 focus 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 shorebirds (e.g., Red and Red-necked Phalaropes); and how summer temperatures and growing season length affects insect emergence and abundance, and how the latter 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 for trying to understand why many shorebird species that breed in the Arctic are declining. These include:

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 dates of nest initiation, habitat use, and species assemblages.

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

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

6) Maximizing the biological capacity of the ASDN by participating in projects that span large geographic and temporal scales, and include a diversity of shorebird species. Potential projects include investigations of 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 International Polar Year ArcticWOLVES 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 1 of this protocol document was completed last May, and a revision of several parts is currently in draft form and being reviewed by the principal investigators. For this report, please refer to the protocol report posted at this ftp site for field methods used in 2010: ftp://ftp.manomet.org/ShorebirdResearch/ASDN/ASDN_protocol_V1_FINAL_22 May2010.pdf.

Results and Discussion

Network Sites Established in 2010

Nine ASDN sites were established in 2010, ranging from Nome in the western part of Alaska to East Bay in northeastern Canada (Fig. 1). One of the sites, Cape Krusenstern, was not fully implemented because the National Park Service did not give us permission to conduct all of the environmental sampling. Other sites did not implement one or two protocols due to personnel shortages or other reasons. Sponsoring organizations and names of the principal investigators at each site are listed in Appendix 1. Several of the sites had graduate students studying either an ASDN objective or a different biological question.

Figure 1. Location of the nine ASDN sites established in 2010.

Database Development and Population

Excel files have been established for the data described below. Most data have GPS locations that will allow it to be georeferenced and available for incorporation into a geodatabase that is web-accessible. A list of all data collected at each ASDN site is presented in Table 1.

- Field camp Metadata: field personnel, plot and sampling locations
- Adult banding records
- Nest records
- Snow cover
- Surface water
- Lemmings: winter nest counts, incidental observations
- Predator counts
- Food resources: terrestrial and aquatic invertebrates
- Weather
- Daily species list

As of 30 April 2011, Jen Jenkins, the Arctic LCC data manager, has established a portal for the ASDN on the NSSI data catalogue. Metadata, geo-referenced locations and raw data on snow cover, surface water, and remote weather stations has been transferred to the NSSI data catalogue. We will continue to provide data to the NSSI portal as database structures within the NSSI becomes available for us to populate.

Shorebird Data

Prior to the start of the field season, principal investigators agreed to focus their studies on key species, called focal species hereafter, that 1) exhibited high site fidelity and thus were good candidates for estimating annual survival; 2) were present at two or more ASDN camps, thereby providing greater confidence in the results; 3) could be located in good numbers allowing reliable estimates of nest success to be made; and 4) were likely to be influenced by climate change scenarios. A full list of species, with genus and species names are provided in Appendix 2. Based on these criteria, we chose our 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 very common or because they were the subject of additional study.

Number and Diversity of Shorebird Nests

A total of 1063 nests belonging to 20 species were located at ASDN sites in 2010 (Table 2). An additional 169 nests were found away from ASDN plots at additional plots monitored strictly for nest survival. Number of nests per species ranged from 1 to 362 (75 off ASDN plots), with the largest number of nests belonging to the ASDN focal species: The number of nests found per ASDN site ranged from 41 to 294.

Table 1. Site activity and data collected by ASDN site in 2010.[a] See subsequent tables for when surveys were conducted and level of effort expended.

Date Type	Nome	Cape Krusenstern	Barrow	Ikpikpuk	Prudhoe Bay	Arctic Refuge	Mackenzie Delta	East Bay	Churchill
Site activity and location									
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									
Metadata- GPS info	X	X	X	X	X	X	X	X	X
Metadata- camp info	X	X	X	X	X	X	X	X	X
Adult banding records	X	X	X	X	X	X	X	X	X
Nest records	X	X	X	X	X	X	X	X	X
Weather	X	0	X	X	X	X	X	X	X
Food Resources collection	X	0	X	X	X	X	X	X	X
Lemming surveys	X	0	X	X	X	X	0	X	0
Predator surveys	X	0	X	X	X	X	X	X	X
Snow melt	0	0	X	X	X	X	0[b]	X	0
Surface water	X	0	X	X	X	X	0	X	0
Daily species list	X	X	X	X	X	X	X	X	X
Pictures of birds captured	X	X	X	X	X	X	X	X	0
Nest notebooks – archive	X	X	X	0	0	X	X	0	0
Banding data- archive	X	X	X	0	0	X	X	0	0

[a] X = collected data, 0= no data, req'd= data request has been sent to PI.
[b] no snow was present upon arrival.

Table 2. Number of nests found at each ASDN site by species in 2010. [a]

Species	Barrow	Cape Krusen-stern	Arctic Refuge	Church ill	East Bay	Ikpik-puk	Macken-zie Delta	Nome	Prudhoe Bay	Grand Total
AMGP	18		3	3		0 (1)	1		0 (2)	25 (3)
BARG						5 (1)				5 (1)
BASA	1		1							2
BBPL			2		12	1 (3)				15 (3)
DUNL	66	21	12	26	3	21 (7)			0 (4)	149 (11)
LBDO	17					4 (2)	4		0 (2)	25 (4)
LESA				8						8
PESA	42		46			17 (17)			11 (21)	116 (38)
REKN					1					1
REPH	73		17		25	15 (14)			2 (7)	132 (21)
RNPH	7	7	29	15		8 (4)	8	24	3 (4)	101 (8)
RUTU			3		28				2	33
SAND			1		1					2
SBDO				12						12
SEPL					7		4			11
SESA	59	17	72			70 (45)	9	30	30 (30)	287 (75)
STSA			4	2			4		0 (5)	10 (5)
WESA	9	10						44		63
WHIM				20			11			31
WRSA	1				33					34
Total	294	55	190	86	110	141 (94)	41	98	48 (75)	1063 (169)

[a] Numbers in parentheses indicate nests found in non-ASDN plots that were monitored for nest survival only (i.e., no banding took place).

Birds Captured

A total of 1,150 shorebirds belonging to 16 species were banded at ASDN sites in 2010 (Table 3). The number of individuals banded per species ranged from 4 to 334, with the largest number banded belonging to the ASDN focal species. The number of birds banded per ASDN site ranged from 33 to 336. From each of these individuals, biometric measurements, body condition, blood, and feathers were collected. Blood and feather samples are archived either at the U.S. Fish and Wildlife Service Office in Anchorage or with the site PI.

Table 3. Number of birds banded at each ASDN site by species in 2010.

Species	Barrow	Cape Krusen-stern	Arctic Refuge	Churc hill	East Bay	Ikpik -puk	Macken zie Delta	Nome	Prudhoe Bay	Total
AMGP	19									19
BARG						6				6
BASA	2		2							4
BBSA									5	5
DUNL	105	30	23	46	1	35			6	246
LBDO	15					8			1	24
PESA	26		39			30			20	115
REPH	61		11		36	18			5	131
RNPH	8	2	19	6		13	6	16	5	75
RUTU			5		21				3	29
SEPL					8		8			16
SESA	85	18	102			50	9	35	35	334
STSA							4			4
WESA	15	11						51		77
WHIM				39			6			45
WRSA					20					20
Total	336	61	201	91	86	160	33	102	80	1,150

Nest Success and Survival

Nests found at ASDN sites were monitored every 3-5 days for survival. Rough estimates of hatching success (# of nests with at least one young hatching) were 55.9% at Barrow (n = 247), 71% (n = 83) at Ikpikpuk, 65.7% (n = 70) at Prudhoe Bay, and 81.1% (n = 143) at the Arctic National Wildlife Refuge in 2010. Additional estimates and corrections to estimates will be available as we continue to proof the data and correct inconsistencies in how field technicians assigned nest fate. We will use Program Mark to estimate nest daily survival rates (DSR) in the future; these DSR will be the currency with which we will evaluate the impact of the many environmental factors being collected.

Daily Species List

All ASDN sites recorded a daily species list; 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 count). In 2011, we plan to continue to collect these data as it provides a good measure of relative abundance, especially for species that fluctuate dramatically in number from year-to-year. A good example of species like this are Snowy Owls (*Bubo scandiacus)* and Pomarine Jaeger (*Stercorarius pomarinus*), which appear to nest only in years with high lemming numbers.

Food Resources

ASDN sites established sampling stations to document aquatic and terrestrial invertebrate phenology and abundance. Each ASDN site established five replicate samples in aquatic habitats, mesic terrestrial habitats, and wet terrestrial habitats. Table 4 shows the dates the sampling plan was implemented at each field site, and Table 5 shows the range of data collection dates at each site. The total numbers of data collection events at each site are shown in Table 6.

Invertebrate samples are currently being assessed to identify species composition, quantify abundance, and obtain estimates of biomass. The Churchill site is inventorying their own samples, and the remaining samples are being analyzed by Bob Wisseman of Aquatic Biology Associates, Inc. He has inventoried all samples from the East Bay site and will complete sample analysis for the remaining ASDN sites during the summer of 2011.

Table 4. Date of food resources trap installations at ASDN sites in 2010.

	Terrestrial		Aquatic
Site	Dry	Mesic	
Nome	1 June	1 June	31 May
Barrow	11 June	17 June	20 June
Ikpikpuk	10 June	10 June	11 June
Prudhoe Bay	9 June	9 June	9, 18, 24 June
Arctic Refuge	10 June	10 June	10 June
Mackenzie Delta	12 June	12 June	12 June
East Bay	20 June	20 June	20 June
Churchill	30 May	30 May	30 May

Table 5. Range and number of food resource data collection events at ASDN sites in 2010. Number of collection events are noted in parentheses.

	Terrestrial		Aquatic
Site	Dry	Mesic	
Nome	4 June – 10 July (13)	4 June – 10 July (13)	4 June – 10 July (13)
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)
Arctic Refuge	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)

Table 6. Total number of food resource samples collected at ASDN sites in 2010.

Site	Terrestrial		Aquatic	
	Dry	Mesic		TOTAL
Nome	65	65	65	195
Barrow	80	70	65	215
Ikpikpuk	55	50	55	160
Prudhoe Bay	50	50	50	150
Arctic Refuge	45	45	45	135
Mackenzie Delta	37	39	39	115
East Bay	54	55	110 [a]	219
Churchill	105	104	105	314
TOTAL	491	478	534	1,503

[a] East Bay collected aquatic samples with both pop-bottle and sweep nets – others used pop.-bottles.

Predator and Alternative Prey Surveys

Avian and mammalian predators were surveyed by conducting point counts weekly throughout the summer at each ASDN site (Table 7). Brown (*Lemmus sibiricus*) and Green-collared (*Cirostonyx groenlandicus*) lemmings, as well as other small mammals, were inventoried by conducting daily opportunistic counts and a single nest count transect shortly after snow melt. The opportunistic data were recorded on daily species lists, and the nest count data are still being summarized.

Table 7: Range and number of predator surveys and lemming nest counts at ASDN sites in 2010. Number of collection events are noted in parentheses.

Site	Predator Point-Counts	Lemming Nest Count	Lemming Daily Species List
Nome	2 Jun (1)	no	18 May – 12 Jul
Barrow	1 Jun – 29 Jul (8)	yes	25 May – 30 Jul
Ikpikpuk	17 Jun – 7 Jul (3)	Yes	9 Jun – 13 Jul
Prudhoe Bay	17 Jun – 14 Jul (3)	yes	7 Jun – 17 Jul
Arctic Refuge	6 – 30 June (4)	yes	5 Jun – 10 Jul
Mackenzie Delta	14 Jun – 2 Jul (3)	no	10 Jun – 5 Jul
East Bay	20 Jun – 22 Jul (3)	yes	2 Jun – 25 Jul
Churchill	20 July (1)	yes	25 May – 2 Aug

Snow and Surface Water

Personnel at five ASDN sites estimated snow cover every 2-5 days until the majority of snow had melted (Table 8). Snow coverage was based on the percentage of ground covered with snow at assigned locations (either 50 m^2 quadrats or general area) within study plots. Surface water was measured by locating three unique sites within each of four habitat types at each ASDN site and measuring water depth (Table 8). Habitat types included the troughs of high-centered polygons, the centers of low-centered polygons, small ponds or waterbodies, and non-polygonized areas. Rebar was used to mark specific locations within each site for repeated measurements. If the site did not have one or more of these habitat types, then a representative habitat type that had water was sampled and described. Water depth was recorded at each site by placing a metric ruler through the water column until it rested on the surface. Water measurements were taken every week to capture changes throughout the summer.

Figure 2 shows results from replicate samples of surface water depth measurement at Barrow for the entire summer by habitat type. Note there was a rain event on 16 July 2010 that led to an increase in surface water depth. All snow and surface water data have been uploaded into the NSSI data catalogue.

In 2011, we will continue to measure surface water from ponds but will no longer measure water in other habitat types. The pond measurements will be done according to protocols provided by Dan Rinella at the University of Alaska Anchorage. We will also institute a new sampling protocol to obtain surface water measurements over a larger sampling area of each ASDN site. Here, relative surface cover will be quantified by randomly or systematically selecting at least ten 50- m^2 quadrats within each ASDN's study area and visually estimating the percentage of snow, water and land (bare or vegetated) within the quadrat to the nearest 5 to 10%, totaling 100%.

Table 8. Sampling period, frequency and distribution of sampling among habitat types for snow and surface water measurements at each ASDN site in 2010.

	ASDN site[1]						
	Barrow	Arctic Refuge	Ikpikpuk	Nome	Prudhoe Bay	Mackenzie Delta	East Bay
Snow							
Sampling Period	30 May – 19 Jun	5 – 30 Jun	9 – 29 Jun	No	4 – 19 Jun	No snow present	2 Jun – 25 Jul
Frequency	2 d	5 d	3-5 d	n/a	3-5 d	n/a	1 d
Method	$50\ m^2$	$50\ m^2$	$50\ m^2$	n/a	$50\ m^2$	n/a	Area
Date 50% loss	12 Jun	15 Jun	Unk[2]	n/a	Unk[3]	n/a	9 Jun
Surface Water							
Sampling Period	22 Jun – 24 Jul	10 Jun – 7 Jul	12 Jun – 3 Jul	4 Jun – 10 Jul	15 Jun – 13 Jul	No	2 Jun – 25 Jul
High Center polygons	6	10	4		5		
Low centered polygons	6	10	4		5		
Non-polygonized	6		4		5		
Pond	6	10	4	8	5		
Tidal inlet				8			
General Study area							1

1 No = no sampling done; n/a = not applicable
2 Snow was <50% by 9 June when field camp was established.
3 Snow was <50% by 6 June when field camp was established.

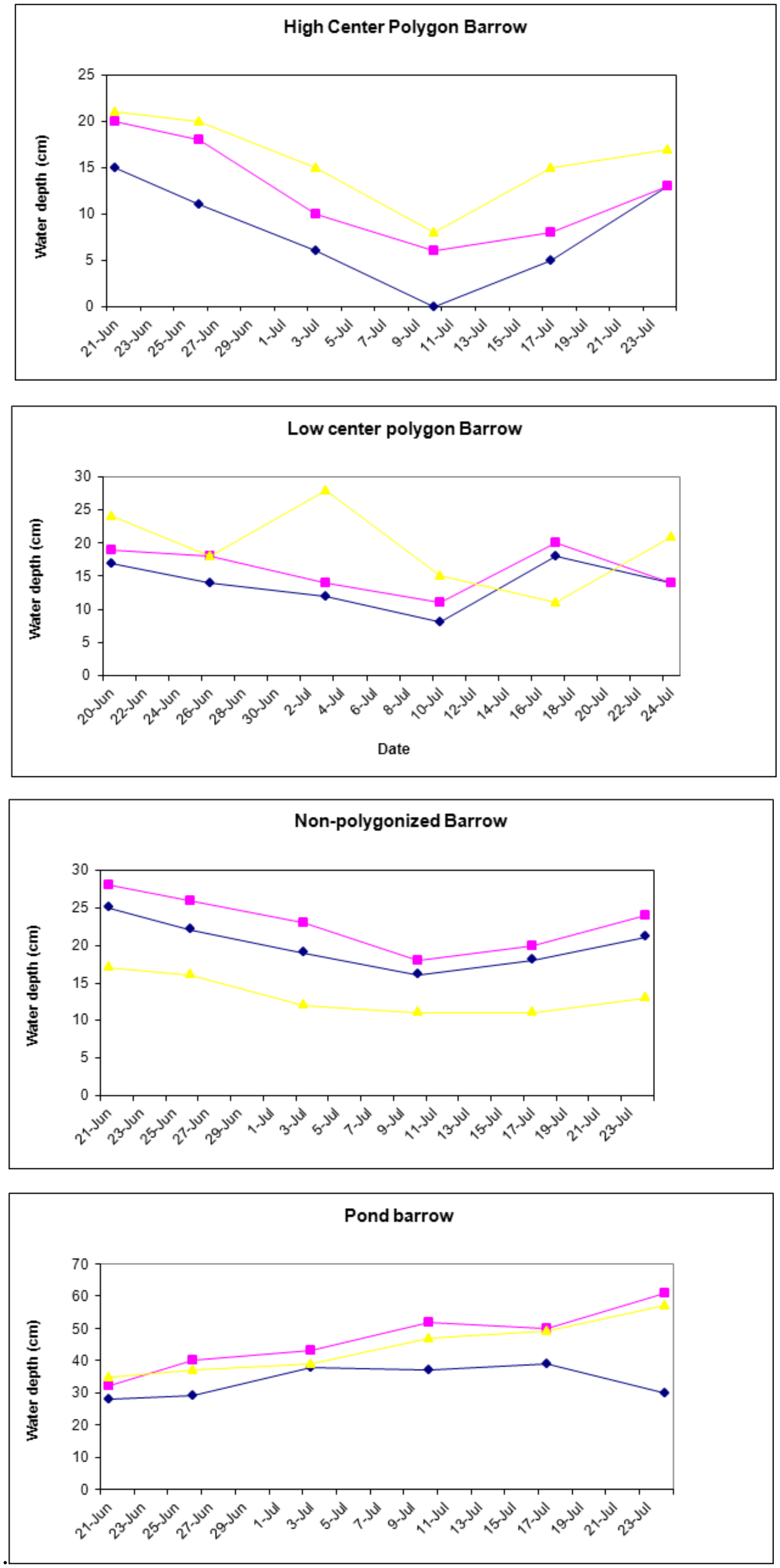

Figure 2. Results of water depth monitoring at four habitat types at Barrow in 2010. Each line represents a different site.

Weather

Remote weather stations (Fig. 3) were deployed at all ASDN sites except Barrow and Prudhoe Bay, which had access to a nearby permanent weather station operated by another agency. Data collected included measurements at 1-hr intervals of air temperature, relative humidity, wind speed and direction. The exception to this is data collected at 4-hr intervals at Churchill and daily at East Bay. In addition, field crews measured precipitation (snow, rain) manually using rain/snow gauges. Similar data from the permanent weather stations have been downloaded from internet sites. Dates during which weather data were collected are depicted in Table 9. All the weather data have been uploaded in the NSSI data catalogue.

Figure 3. Example of a remote weather station deployed at ASDN sites.

Table 9. Dates within which weather information was collected at ASDN sites. No weather information was collected at Cape Krusenstern but local weather could be retrieved from Kotzebue that is about 35 kilometers away.

	Nome	Barrow	Ikpikpuk	Prudhoe Bay	Arctic Refuge	Mackenzie Delta	East Bay	Churchill
Dates	16 May – 12 Jul	25 May – 31 Jul	10 Jun – 13 Jul	4 Jun – 18 Jul	4 Jun – 11 Jul	9 Jun – 7 Jul	3 Jun – 27 Jul	25 May – 2 Aug

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 have not yet been compiled because data is still being collected.

Additional Projects

The Network has taken a very active role in encouraging additional projects related to the ecology and conservation of shorebirds that can take advantage of the geographic dispersion of our ASDN sites. We were able to establish two projects in 2010, four in 2011, and two more that may occur in 2012 pending funding. Below we provide the project title, key collaborator, and brief description of each project.

1) Avian Influenza – Kim Trust

Four sites in Alaska collected cloacal swabs from birds captured for analysis of H5N1 highly pathogenic avian influenza in 2010. These sites included Barrow, Ikpikpuk River, Prudhoe Bay and the Arctic Refuge. To our knowledge, no positive cases were detected from any shorebird.

2) Migratory connectivity of Dunlin using geolocators – Stephen Yezerinac
   A total of 268 light level geolocators were placed on Dunlin at five of the ASDN sites (Cape Krusenstern, Barrow, Ikpikpuk, Canningand two additional sites (Cold Bay and Yukon Delta, Alaska) in June of 2010. These devices when retrieved from birds in June 2011 will allow us to determine the migratory routes, stopover sites and wintering grounds of three subspecies of Dunlin.

3) Semipalmated Sandpiper stable isotope project – David Mizrahi
   Feathers collected from Semipalmated Sandpipers at breeding sites will be linked with stable isotope values obtained from birds sampled at different wintering grounds, allowing breeding and wintering sites of particular populations to be connected. This approach allows information on migratory connectivity to be learned – something not possible via geolocators or satellite transmitters due to the small size of this species. This project will begin in 2011.

4) Avian disease sampling – Samantha Wisely, Debbie Buehler, Jorge Santo Domingo
   Funds were acquired from the US Fish and Wildlife Service's Avian Health program to conduct a disease assessment of shorebird species that are captured at the ASDN sites in 2011. Emphasis will be to document the present and past exposure of avian malaria, gastrointestinal bacteria, and variability in immune genes and immune gene expression. Because arctic-breeding shorebirds migrate to different latitudes to winter, use different habitats while migrating and wintering, and use different migratory routes, they are an especially good group of birds to investigate how disease prevalence varies with these factors. In doing so, we can also gain a better understanding of how disease may contribute to the recently documented declines in shorebird species.

5) NDVI and nest initiation – David Ward
   To ascertain the feasibility of using satellite-derived values of NDVI – a measure of vegetation green-up – as an indicator of arrival and nest initiation, we are providing nest initiation data to correlate with NDVI values. This study is on-going.

6) Invertebrate phenology and pond characteristics - Mac Butler and Daniel Rinnella
   In an effort to better understand invertebrate phenology and abundance, investigators at ASDN sites will collect water temperature, bathometry and other data at ponds where aquatic insects are being sampled. These data will be used with our aquatic insect data to develop models predicting insect emergence and abundance. Funds for this study was provided by the Arctic LCC in 2011.

7) Ice out monitoring – Chris Arp
   ASDN investigators agreed to collaborate on a National Fish and Wildlife Foundation proposal to deploy a sensor network that will provide information on the range of variation in ice-out timing among six classes of water bodies across six regions during the spring / summer of 2012. Intensive ice-decay sensor systems will monitor water temperature beneath the water's surface and snow depth and heat flux above the surface. These data will be used to develop a

physically-based model of ice decay that will be able to predict how a changing climate may affect ice conditions on a variety of lakes throughout the cold seasons.

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

We have collected feather and blood samples from captured individuals 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

In conjunction with the Alaska Bird Conference in November 2010, principal investigators met in person or by teleconference to discuss data collection and protocols related to conducting field work in 2010. Protocols were revised and data collection techniques were reviewed to ensure consistency in data collection methods. We also learned of issues faced by individual ASDN site leaders that prohibited them from conducting various field tasks. This "face time" was critical for obtaining buy in from all site leads and allowing us to move forward in 2011. 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 of 2011. This document will guide the interactions of the partners, and ensure that collaborative data analysis and publication proceed smoothly following completion of the project.

As of this writing, we have generated the following reports / publications (numbered sequentially and specified as being products of the ASDN) from work associated with the Arctic Shorebird Demographics Network. These items are.

1. 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.
2. Sandercock, B.K. 2010. There's no place like Nome for professor researching migrant shorebirds. News release, Kansas State University.
3. 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(3): 173–178.
4. Franks, S., R.D. Norris, K.T. Kyser, G. Fernandez, B. Schwarz, R. Carmona, M.A. Colwell, J. Correa Sandoval, A. Dondua, H.R. Gates, B. Haase, D.J. Hodkinson, A. Jimenez, R.B. Lanctot, B. Ortego, B.K. Sandercock, F. Sanders, J.Y. Takekawa, N. Warnock, R.C. Ydenberg, and D.B. Lank. (in prep). Range-wide patterns of migratory connectivity in the Western Sandpiper. *Ecography.*

Other Reports and Publications (does not include an exhaustive list from all ASDN sites)

Governali, F.C., H.R. Gates, R. B. Lanctot, and R.T. Holmes. (submitted) Egg volume can be accurately and efficiently estimated from linear dimensions of eggs for arctic-breeding shorebirds. *Journal of Field Ornithology.*

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.

Relevance to Arctic LCC conservation goals:

The Arctic Shorebird Demographics Network (the Network) is a geographically broad, multi-partner strategy that has the full support of the US Fish and Wildlife Service, U.S. Geological Survey, the Canadian Wildlife Service, Environment Canada, academia, and many non-governmental conservation organizations (including Manomet, Inc.). This 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;
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; and
6) provide the beginning of a much larger international Shorebird Demographics Network (SDJ) proposed to collect demographic data across multiple Service regions to identify sensitive life cycle stages that may indicate when and where shorebird species are most vulnerable.

Fund expenditures

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.

The Future

Funding from the Arctic LCC has allowed us 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. The ASDN has continued to expand in 2011. We have raised funds to expand the Cape Krusenstern site and convinced investigators at Bylot Island to join the ASDN in 2011. The U.S. Geological Survey (David Ward) also added a site at the Colville River, Alaska, in 2011. Unfortunately, due to budget reductions or delays in funding within many federal programs we were unable to raise sufficient funds to continue operating the Prudhoe Bay site in 2011. We hope to restart this site in 2012.

The ASDN steering committee continues to seek funds from many locations to pay for general ASDN costs, including NFWF (successful in 2010, pending in 2011), Neotropical Migratory Bird Conservation Program (successful in 2011), and the Alaska Department of Fish and Game (successful in 2010, failed in 2011). We have also submitted a proposal to the Western Arctic LCC to expand the ASDN to the Yukon Delta National Wildlife Refuge and to partially support the Nome and Cape Krusenstern sites in 2012. Principal investigators from each site (Appendix 1) fund most of the costs of their sites and collectively acquire funds from many different locations, both public and private (see some of those listed below). Most recently, we were approached by the National Science Foundation to submit a Research Coordination Network proposal within the "Science, Engineering and Education for Sustainability track". Successful funding from this proposal will help pay for PIs to meet periodically, to pay salary for ASDN site managers to proof and submit data, and other coordination expenses. Finally, we hope that the Arctic LCC will continue to fund this ambitious 5-year study that has already shown great progress in a very short period of time.

Acknowledgements

This report represents 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 techs whose names are not mentioned. We thank them all for being willing to work in a collaborative nature to address very large scale questions. 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, Selawek National Wildlife Refuge, Migratory Bird Management, and Avian Influenza programs, as well as the National Fish and Wildlife Foundation and the Neotropical Migratory Bird Conservation Program), Manomet Center for Conservation Sciences, Indian and Northern Affairs 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), Liz Claiborne / Art Ortenberg Foundation, Bureau of Land Management, the Alaska Department of Fish and Game, and the National Science Foundation. This is report # 5 of the Arctic Shorebird Demographics Network.

Literature Cited

Alaska Migratory Bird Co-management Council. 2003. 2003 harvest regulations – final rule. <http://alaska.fws. gov/ambcc/History.htm>.

Andres, B.A. 1994. Coastal zone use by postbreeding shorebirds in northern Alaska. Journal of Wildlife Management 558:206 –213.

Auerbach, N.A., M.D. Walker, and D.A. Walker. 1997. Effects of roadside disturbance on substrate and vegetation properties in Arctic tundra. Ecological Applications 7:218–235.

Connors, P.G., J.P. Myers, and F.A. Pitelka. 1979. Seasonal habitat use by Arctic Alaskan shorebirds. Studies in Avian Biology 2:101–111.

Connors, P.G., C.S. Connors, and K.G. Smith. 1981. Shorebird littoral zone ecology of the Alaska Beaufort Coast. Final Report of Principal Investigators, Outer Continental Shelf Environment Assessment Program, National Oceanic and Atmospheric Administration 23:297– 396.

Connors, P.G. 1984. Ecology of shorebirds in the Alaskan Beaufort littoral zone. In: Barnes, R., Shell, D.M., and Ramirez, E., eds. The Alaskan Beaufort Sea: Ecosystems and environments. New York: Academic Press. 403– 416.

Day, R.H. 1998. Predator populations and predation intensity on tundra-nesting birds in relation to human development. Unpubl. ms. Available at Alaska Biological Resources Inc., P.O. Box 80410, Fairbanks, Alaska 99708-0410.

Eberhardt, L.E., R.A. Garrott, and W.C. Hanson. 1983. Den use by arctic foxes in northern Alaska. Journal of Mammalogy 64:97–102.

Gilders, M.A., and M.A. Cronin. 2000. North Slope oil field development. In: Truett, J.C., and Johnson, S.R., eds. The natural history of an Arctic oil field. San Diego: Academic Press. 15–33.

Ims R.A., and E. Fuglei. 2005. Trophic interaction cycles in tundra ecosystems and the impact of climate change. Bioscience 55: 311-322.

Johnson, S.R. and D.R. Herter. 1989. The birds of the Beaufort Sea. Anchorage: British Petroleum Exploration (Alaska), Inc.

Kausrud, K.L., A. Mysterud, H. Steen, J.O. Vik, E. Østbye, B. Cazelles, E. Framstad, A.M. Eikeset, I. Mysterud, T. Solhøy, and N.C. Stenseth. 2008. Linking climate change to lemming cycles. Nature 456: 93-98.

Klaassen, M., Å. Lindström, H. Meltofte, and T. PIERSMA. 2001. Arctic waders are not capital breeders. Nature 419:794.

Liebezeit, J.R., P.A. Smith, R.B. Lanctot, C. Gratto-Trevor, H. Schekkerman, D. Tracy, J.A. R. Robinson, H. Meltofte, S. Kendall, R.J. Rodrigues, J.A. Morse, and B.J. McCaffery. 2007. Determining incubation stage of shorebird eggs using the flotation method: species-specific and generalized regression models. Condor 109:32-47.

Liebezeit, J.R., S.J. Kendall, S. Brown, C.B. Johnson, P. Martin, T.L. McDonald, D.C. Payer, C.L. Rea, B. Streever, A.M. Wildman, and S. Zack. 2009. Influence of human development and predators on nest survival of tundra birds, Arctic Coastal Plain, Alaska. Ecological Applications 19:1628-1644.

Martin, P.D., J.L. Jenkins, F.J. Adams, M. Torre Jorgenson, A.C. Matz, D.C. Payer, P.E. Reynolds, A.C. Tidwell, and J.R. Zelenak. 2009. Wildlife response to environmental Arctic change: Predicting future habitats of Arctic Alaska. Report of the Wildlife Response to Environmental Arctic Change (WildREACH): Predicting Future Habitats of Arctic Alaska Workshop, 17-18 November 2008. Fairbanks, Alaska: U.S. Fish and Wildlife Service. 138 pages.

MacLean, S.F. 1980. The detritus-based ecosystem. In: Brown, J., Miller, P.C., Tieszen, L.L., and Bunnell, L.F., eds. An Arctic ecosystem: The coastal tundra at Barrow, Alaska. U.S. International Biome Program Synthesis Series 12. Stroudsburg: Dowden, Hutchinson, and Ross, Inc. 411– 457.

Meehan, R.H. 1986. Impact of oilfield development on shorebirds, Prudhoe Bay, Alaska. PhD thesis, University of Colorado, Boulder, Colorado.

National Research Council. 2003. Cumulative environmental effects of oil and gas activities on Alaska's North Slope. Washington, D.C.: National Academies Press.

Schekkerman, H., I. Tulp, and B. Ens. 2003. Conservation of long-distance migratory wader populations: Reproductive consequences of events occurring in distant staging sites. Wader Study Group Bulletin 100:151–156.

Shur, Y., M.T. Jorgenson, and E.R. Pullman. Widespread degradation of ice wedges on the Arctic coastal plain in northern Alaska in response to the recent warmer climate. American Geophysical Union, Fall Meeting 2003, Abstract C11A-05. Available at <http://adsabs.harvard.edu/abs/2003AGUFM.C11A..05S>.

Soloviev M.Y., C.D.T. Minton, P.S. Tomkovich. 2006. Breeding performance of tundra waders in response to rodent abundance and weather from Taimyr to Chukotka, Siberia. In Boere G.C., C.A. Galbraith, and D.A. Stroud (Eds). Waterbirds around the world (p 121-137). The Stationery Office, Edinburgh, UK.

Troy Ecological Research Associates. 1993. Bird use of the Prudhoe Bay oil field. Unpubl. ms. Available at the Alaska Resources Library and Information Services: <http://www.arlis.org>.

U.S. Bureau of Land Management. 2006. 2006 Northwest NPR-A final lease sale results. <http://www.blm.gov/ak/ak940/fluids/images/npra_maps/npra_salemaps/2006npra_nw_saleresultsmap.pdf>.

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

ASDN Site	Sponsoring Organization	Principal Investigator	Graduate Students
Active sites in 2010			
Nome, AK	Simon Fraser University, Kansas State University	David Lank, Brett Sandercock	Sam Franks, Willow English, Toby St. Clair
Cape Krusenstern, AK	U.S. Fish and Wildlife Service, Migratory Bird Management	H. River Gates	
Barrow, AK	U.S. Fish and Wildlife Service, Migratory Bird Management	Richard Lanctot	Brooke Hill, Andy Doll, Jenny Cunningham
Ikpikpuk River, AK	Wildlife Conservation Society	Joe Liebezeit, Steve Zack	
Prudhoe Bay, AK	Wildlife Conservation Society	Joe Liebezeit, Steve Zack	
Arctic Refuge, AK	U.S. Fish and Wildlife Service, Arctic NWR; Manomet Center for Conservation Sciences;	Steve Kendall, Stephen Brown,	
Mackenzie Delta, Northwest Territories	Environment Canada	Lisa Pirie, Jennie Rausch	
East Bay, Nunavut	Environment Canada, Paul Smith Consulting	Grant Gilchrist, Paul Smith	
Churchill, Manitoba	Trent University, Cornell University	Erica Nol, Nathan Senner	Nathan Senner
New sites in 2011			
Bylot Island	University of Quebec at Rimouski	Joël Bêty	Jean-François Lamarre
Colville River Delta	U.S. Geological Survey, Alaska Science Center	David Ward	
Proposed for 2012			
Yukon Delta NWR	U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Cascadia Field Station, and U.S. Fish and Wildlife Service, Migratory Bird Management and Yukon Delta NWR	Audrey Taylor	

Appendix 2. Species whose nests were located or were banded at ASDN sites in 2010.

Common Name	Genus Species	4-letter acronym
Semipalmated Plover	*Charadrius semipalmatus*	SEPL
Black-bellied Plover	*Pluvialis squatarola*	BBPL
American Golden-Plover	*Pluvialis dominica*	AMGP
Bar-tailed Godwit	*Limosa lapponica*	BTGO
Whimbrel	*Numenius phaeopus*	WHIM
Red-necked Phalarope	*Phalaropus lobatus*	RNPH
Red Phalarope	*Phalaropus fulicaria*	REPH
Short-billed Dowitcher	*Limnodromus griseus*	SBDO
Long-billed Dowitcher	*Limnodromus scolopaceus*	LBDO
Ruddy Turnstone	*Arenaria interpres*	RUTU
Dunlin	*Calidris alpina*	DUNL
Red Knot	*Calidris canutus*	REKN
Sanderling	*Calidris alba*	SAND
Semipalmated Sandpiper	*Calidris pusilla*	SESA
Pectoral Sandpiper	*Calidris melanotos*	PESA
Western Sandpiper	*Calidris mauri*	WESA
White-rumped Sandpiper	*Calidris fuscicollis*	WRSA
Baird’s Sandpiper	*Calidris bairdii*	BASA
Stilt Sandpiper	*Calidris himantopus*	STSA
Buff-breasted Sandpiper	*Trygnites subruficollis*	BBSA