Atlantic and Great Lakes
Sea Duck Migration Study

Progress Report
November 2012

A report by the Sea Duck Joint Venture partnership
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Cover photos: Tim Bowman

Sea Duck Joint Venture
Introduction

Most sea ducks breed at northern latitudes and winter in coastal, offshore, and major inland waters including the Great Lakes. Concern about apparent population declines, the impact of hunting, and a lack of understanding of what regulates sea duck populations led to the formation of the Sea Duck Joint Venture (SDJV) in 1999 under the auspices of the North American Waterfowl Management Plan. The SDJV’s mission is to promote the conservation of North American sea ducks through partnerships by providing greater knowledge and understanding for effective management. Since 2001, the SDJV has helped support and coordinate research and monitoring studies to better understand this group of waterfowl that is so poorly understood.

An understanding of the links among breeding, wintering, staging, and molting areas (i.e., population delineation) is essential to understanding sea duck declines and limiting factors, and evaluating potential impacts from development, harvest, and climate change. This information need has been a priority topic for the SDJV. Although much progress has been made in delineating populations of sea ducks in the Pacific and Arctic regions of North America, relatively little had been done in the Atlantic prior to 2009. To address these important information gaps, particularly in the face of increasing demands for hunting and increased interest in offshore energy development, the SDJV launched an ambitious, large-scale satellite telemetry study of sea ducks in the Atlantic Flyway. The SDJV has made this project its highest priority and has committed substantial resources to the project since 2009.

We anticipate that more than 250 transmitters will eventually be deployed in four species: black scoter, surf scoter, white-winged scoter, and long-tailed ducks - all of which are species of high conservation concern (SDJV 2012). Ducks are captured using a variety of techniques, including mist-netting, net-gunning, and night-lighting. Transmitters are surgically implanted in sea ducks and provide location data every few days for up to two years. The study is generating a wealth of detailed information on coastal and marine habitats used by sea ducks throughout the year.

The study is designed to answer several questions, such as:

1. Where do birds from a particular wintering area breed and molt?
2. Where are the most important wintering and staging areas for sea ducks?
3. How much annual variability is there in migration patterns?
4. Do sea ducks return to the same wintering, breeding, molting, and staging areas each year?
5. How should surveys be designed to most effectively monitor sea ducks?

In addition to a lack of basic knowledge about sea duck biology, migration, and habitat use, another compelling reason for this study is to help identify near-shore and offshore areas of the Atlantic coast and Great Lakes where wind power facilities and other developments would have the least impact on sea ducks. Sea ducks often use the same offshore areas where wind farms are proposed for development, prompting concerns about displacement of birds that equates to a loss of habitat, and even collisions with structures. Many offshore wind projects have been proposed, and cumulative effects on sea ducks throughout the flyway need to be considered. Beginning in winter 2011-2012, the Bureau of Ocean Energy Management (BOEM) began a study to investigate this issue in the mid-Atlantic region and has partnered with SDJV to deploy transmitters in surf scoters.

From 2009 to 2012, more than 180 satellite transmitters were deployed on sea ducks along the Atlantic coast and in Lake Ontario. This progress report summarizes information gained through deployment of transmitters up through August 2012, including a few that were deployed prior to 2009.
Additional information about this study can be found at http://seaduckjv.org/atlantic_migration_study.html.

Although the SDJV is facilitating this study via financial support and coordination, there is a growing partnership supporting the project. Current partners include the U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Department of Energy, Bureau of Ocean and Energy Management, Massachusetts Audubon, Ducks Unlimited, Canadian Wildlife Service, Environment Canada Science and Technology Branch, Bird Studies Canada, Long Point Waterfowl, Ontario Ministry of Natural Resources, Ontario Federation of Anglers and Hunters, BioDiversity Research Institute, University of Rhode Island, University of Montreal, New Brunswick Dept of Natural Resources, Rhode Island Dept of Environmental Conservation, Virginia Dept of Game and Fish, Maryland Dept of Natural Resources, Maine Dept of Inland Fisheries and Wildlife, Université du Québec à Montréal, North Carolina Wildlife Resources Commission, and Avery Outdoors. See Appendix I for a summary of partner contributions in 2010-2012. We also want to recognize the contributions of SeaTurtle.org, which is supporting a free mapping platform for data from this study.

Study results, design and deployment plans are periodically reviewed by study partners and a Steering Committee composed of the following SDJV technical team members: Shannon Badzinski (CWS), Tim Bowman (USFWS), Sean Boyd (Environment Canada), Chris Dwyer (USFWS), Grant Gilchrist (Environment Canada), Scott Gilliland (CWS), Christine Lepage (CWS), Dan McAuley (USGS), Jay Osenkowski (Rhode Island DEM), and Emily Silverman (USFWS).

**Study Objectives**

1. Fully describe the annual migration patterns and annual variability for four species of sea ducks (surf scoter, black scoter, white-winged scoter, long-tailed duck) in the Atlantic flyway and Great Lakes.
2. Identify near- and offshore areas of high significance to sea ducks to better inform habitat conservation efforts.
3. Estimate rates of annual site fidelity to wintering, breeding, staging, and molting areas for all four focal species in the Atlantic flyway.
4. Map local movements and estimate length-of-stay during winter, and spring and fall migration, for individual radio-marked ducks in areas proposed for placement of wind turbines along the Atlantic coast and Great Lakes.
5. Provide timely information to facilitate design and interpretation of monitoring surveys, particularly those currently under development. Information includes:
   a. Timing of movements throughout annual cycle, especially during the survey “window” for various ongoing or proposed surveys (e.g., Atlantic Coast Winter Sea Duck Survey, scoter breeding and molting surveys, migration counts at Point Lepreau NB and Avalon NJ)
   b. Identification of key habitat areas and length-of-stay data for sea ducks at staging, molting, and wintering areas such as Chesapeake Bay, Delaware Bay, Nantucket Sound, James Bay, St. Lawrence estuary and gulf, Chaleur Bay and the lower Great Lakes.
   c. Inter-annual site fidelity to specific breeding, molting, staging, and wintering sites.
   d. Annual variation in use and timing of use of breeding, molting, staging, and wintering sites.
   e. Determination or validation of the outer offshore survey boundary and north-south delimiters for the Atlantic Coast Winter Sea Duck Survey currently under development.
The project is conducted at a flyway/population scale to enable inferences at those same scales. By planning a multi-partner large scale effort, we also realize efficiencies due to quantity discounts on transmitters, reduction in travel and logistical expenses (i.e., one big project is more efficient than several smaller projects), and capitalize on related projects currently underway that can provide staff, funding, and logistical support (e.g., BOEM and DOE offshore wind assessments).

**Study Design and Methodology**

The study is focused on four high priority sea duck species in the Atlantic flyway and Great Lakes: black scoter, surf scoter, white-winged scoter, and long-tailed duck. We are striving to capture and mark with satellite transmitters (PTTs) a representative and adequate sample to ensure that effective sample sizes (i.e., those birds/transmitter that actually produce useable data over multiple life stages) are achieved for each species. By **representative** sample, we mean that each species will be sampled throughout its wintering or molting range (in approximate proportion to relative flyway abundance), or at “bottleneck” sites where the bulk of the Atlantic flyway population passes during spring or fall migration.

The question of “what is an adequate sample?” remains unresolved. We initially defined “adequate sample” to be at least 30 birds that survived post-surgery and provided information for at least one full year. A sample size of 30 is consistent with that recommended by Lindberg and Walker (2007) for satellite telemetry studies where two possible outcomes are possible (i.e., birds go to one of two possible areas). However, this study is yielding novel discoveries that are expanding our knowledge of distribution, relative densities, migration paths, and potential structuring of populations. Now, recognizing that initial hypotheses regarding population structure may have been incorrect, partners and the Steering Committee have agreed to take an adaptive approach, whereby an effective sample size of 40 marked birds is achieved, data analyzed, and re-evaluated to determine if additional sampling may be needed to address new hypotheses (e.g., number of outcomes). The SDJV technical team has recommended funding in 2013 for two analytical studies using hypothetical and empirical data sets for sea ducks to provide additional insight in sample size requirements.

To achieve that target sample size, given an estimated 30% post-marking mortality and/or radio failure, it will be necessary to mark approximately 57 individuals per species. Sample sizes for Great Lakes deployments would be in addition to Atlantic coast deployments (i.e., 40 additional long-tailed ducks and up to 40 additional white-winged scoters, if feasible).

Highest priority for marking is adult females, which provide the most unambiguous data on breeding locations, and are the most important cohort for understanding population dynamics. SDJV resources will not be used to mark young (hatch-year) ducks because they are unlikely to breed within one or more years and, therefore, contribute little to our understanding of population delineation, and because young birds marked in previous studies have experienced lower survival.

Birds have been captured using whatever technique works for that species in that particular area. This has included over-water mist nets, net-gunning from a boat, night-lighting, gill-netting, or drive trapping of molting birds (for more information about trapping techniques, see [http://seaduckjv.org/catch/to_catch_a_sea_duck.pdf](http://seaduckjv.org/catch/to_catch_a_sea_duck.pdf)).

Age was determined based on bursa depth, plumage characteristics, or both. For this study (versus for banding reports), we are using the following age designations: **Hatch Year** = less than 12 months old and bursa depth >15mm with immature plumage (e.g., light belly and notched tail feathers); **Second Year** = 12-24 months old and bursa depth >15mm; **After Second Year** = >24 months old and bursa depth <5mm or absent (Mather and Esler 1999, Peterson and Ellarson 1978, Hochbaum 1942). **After Hatch Year**
designation was used to describe a bird that is >1 year old, but for which more definitive age
determination was not possible (i.e., the bird could be second year or older).

PTTs are surgically implanted in the abdominal cavity of each duck by a qualified veterinarian following
the technique described by Korschgen et al. (1996). We are using 38-50g PTTs with a battery life of at
least 750 hours for large-bodied birds such as scoters, and 26-32 g PTTs with a battery life of at least 400
h for smaller-bodied birds such as long-tailed ducks to alleviate concerns about potential adverse
physiological effects of large transmitters in small ducks (M. Perry, pers. comm.). At the veterinarian’s
discretion, transmitters may be wrapped in a sterile mesh that promotes additional surface area for
adhesion to the body wall, and provides additional anchoring points to stabilize the PTT within the bird
(Fig. 1). PTTs are pressure-proofed to prevent crushing if ducks dive to great depth. Although some
ducks were held more than one day in earlier projects, the current protocol is to hold radio-tagged birds
in captivity for up to 3 hours post-surgery. They are then hydrated sub-dermally, in some cases tube-fed
a formulated elemental diet (Olsen et al. 2010), then released at or near the capture site.

Figure 1. Implantable PTTs for use in sea ducks.

All PTTs have been programmed with duty cycles that represent a compromise between PTT longevity
and frequency of location data, intended to meet multiple objectives. For example, more frequent
location data would better characterize habitats used at relatively small geographic or temporal scales,
whereas less frequent data but greater longevity provides better information on inter-annual site fidelity
and variation in migration patterns. The duty cycle currently in use is 2 hrs ON and 72 hrs OFF (i.e., one
location every 3 days). This should allow PTTs to last at least one year, and possibly up to three years for
the larger units with more battery life. PTTs that last at least one, and ideally two, full annual cycles will
enable an analysis of annual variation in timing of migration, habitat use, and site fidelity. The single
duty cycle also enables “trading” PTTs among project elements as necessary to capitalize on
opportunities to mark additional birds. Exceptions to these duty cycles have been made for partners
who have purchased transmitters to meet specific local objectives that require different (usually more
frequent) duty cycles (e.g., daily movements during winter to evaluate potential conflicts with proposed
offshore wind projects). For example, PTTs deployed in surf scoters as part of the BOEM study use a
duty cycle designed to yield two locations per day to maximize locations during the migratory and
wintering periods, and a less frequent duty cycle during the rest of the year to preserve battery power.

All Argos data are archived at MoveBank (for archival) and at USGS Patuxent WRC for analyses. We
typically use the best location per duty cycle as determined by the Douglas filter (Douglas 2006). Tables
for each species indicate the effective sample size at each deployment location and year. Also reported
are percent lost (known death plus unconfirmed mortality or transmitter failure) for each species. Maps
included in this report exclude transmitters that transmitted less than 60 days (i.e., mortality or
transmitter failure) and, unless otherwise noted, include locations through August 2012 (Fig. 2).
Location data has also been uploaded to widlifetracking.org, a free service that hosts animal tracking projects and updates maps (on a fairly coarse scale) of individual birds daily with new location data.

Seasonal migration and distribution maps were created using the following definitions for life stages specific to each species (Table 1). These temporal criteria varied among species due to differences in breeding chronology and overall migration patterns.

Table 1. Life stage criteria used to analyze seasonal migration and distribution data for four sea duck species (black scoter: BLSC; surf scoter: SUSC; white-winged scoter: WWSC; and long-tailed duck: LTDU).

<table>
<thead>
<tr>
<th></th>
<th>BLSC</th>
<th>SUSC</th>
<th>WWSC</th>
<th>LTDU Atlantic</th>
<th>LTDU Great Lakes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeding</td>
<td>Stay for &gt;= 14 days</td>
<td>Stay for &gt;= 14 days</td>
<td>Stay for &gt;= 14 days</td>
<td>Stay for &gt;= 14 days</td>
<td>Stay for &gt;= 14 days</td>
</tr>
<tr>
<td></td>
<td>Arrive between May and June</td>
<td>Arrive between late May and June</td>
<td>Arrive between May and June</td>
<td>Arrive between late May and June</td>
<td>Arrive between May and June</td>
</tr>
<tr>
<td>Wintering</td>
<td>Arrive between October and November</td>
<td>Depart between August and October</td>
<td>Arrive between October and November</td>
<td>Depart between August and October</td>
<td>Arrive between October and November</td>
</tr>
<tr>
<td></td>
<td>Month of fix is January or February</td>
<td>Month of fix is November, December, March or April AND distance between consecutive movements are &lt;=50km.</td>
<td>Month of fix is January or February</td>
<td>Month of fix is November, December, March or April AND distance between consecutive movements are &lt;=50km.</td>
<td>Month of fix is November to late April or May AND distance between consecutive movements are &lt;=50km.</td>
</tr>
<tr>
<td>Wintering</td>
<td>Arrive between October and November</td>
<td>Depart late March early April</td>
<td>Arrive between October and November</td>
<td>Depart late March early April</td>
<td>Arrive between October and November</td>
</tr>
<tr>
<td></td>
<td>Month of fix is January or February</td>
<td>Month of fix is November, December, March or April AND distance between consecutive movements are &lt;=50km.</td>
<td>Month of fix is January or February</td>
<td>Month of fix is November, December, March or April AND distance between consecutive movements are &lt;=50km.</td>
<td>Month of fix is November to late April or May AND distance between consecutive movements are &lt;=50km.</td>
</tr>
<tr>
<td>Staging</td>
<td>Not identified</td>
<td>Along migration bird stays in same location for &gt;= 15 days.</td>
<td>Along migration bird stays in same location for &gt;= 10 days.</td>
<td>Along migration bird stays in same location for &gt;= 15 days.</td>
<td>Along migration bird stays in same location for &gt;= 7 days.</td>
</tr>
</tbody>
</table>

In a few instances, migration maps include multiple paths for individual birds that were tracked in more than one year. We realize that this essentially constitutes pseudo-replication and places additional weight on a few individuals. However, we did not feel that that was a significant detraction from the results and to expedite distribution of this report, have left those multiple tracks in maps. We will...
restrict display to only one track per bird in future reports. Note, however, that sample sizes noted in figures and tables may be in slight disagreement because of this.

Capture events also provide opportunities for collection of tissue samples for analyses of genetics, stable isotopes, contaminants, and disease screening. Tissue sample collection kits and SOPs are distributed to partners prior to each capture event.

Figure 2. Geographic extent of locations determined from satellite telemetry of sea ducks marked along the Atlantic coast and Great Lakes (BLSC: Black Scoter, LTDU: Long-tailed Duck, SUSC: Surf Scoter, WWSC: White-winged scoter). Points represent the best location per duty cycle. Locations are cumulative through August 2012 (all birds, all species).
Species Summaries

Black Scoters

Capture Site: Chaleur Bay, New Brunswick/Quebec, Canada

Chaleur Bay, a coastal area on the border of New Brunswick and Quebec, is the major spring stop-over site for migrating black scoters in eastern North America. It is thought that most of the eastern North American population of black scoters stage here for 2-3 weeks before continuing their northward migration to the breeding grounds. Black scoters were captured with the use of floating mist nets in 2009 and 2010, although several were captured by night-lighting in earlier years (2001-05).

Several transmitters were deployed in black scoters in Rhode Island in December 2010 for a different but complementary study; these data are included in the analyses.

In addition to the main objectives of the study (i.e., population delineation and habitat use) this element of the study also sought to identify molting areas for male Black Scoters, and quantify molting site fidelity to help evaluate a monitoring survey of molting scoters in James and Hudson Bays, currently under development.

Lead investigators: Scott Gilliland, Keith McAloney, Jean-Pierre Savard (Environment Canada) and Matthew C. Perry (USGS Patuxent Wildlife Research Center), Scott McWilliams (University Rhode Island), Jay Osenkowski (RI DEM)

Partners involved in the work at this site: Environment Canada (Canadian Wildlife Service & Science and Technology); USFWS; USGS PWRC; NB-DNR; Rhode Island DEM; University of Rhode Island.

Results and discussion:

One hundred and seventeen black scoters (63 females and 54 males) have been implanted with satellite transmitters as part of this project, although not all have provided useful information due to transmitter failure and/or bird mortality (Tables 2 and 3). Survival of radio-tagged black scoters was relatively high, with about 90% of the bird/radios surviving the first 60 days after release. Ninety-five percent of the 2009 tagged birds that survived the initial release period remained active for the 1.2 year potential life expectancy of the radio. Radio failure or bird mortality rates were higher for the tagged birds released
in 2010 with about 85% radios remaining active to 1.2 years. Longevity of the birds tagged in spring in 2010 was similar to those tagged in spring 2009 with 94% surviving the initial release period and 50% were still transmitting in November 2012 (2.5 years). However, survival of the birds tagged during winter 2010 was low with 33% failing in the first 45 days and only three tags lasting longer than 1.2 years.

### Table 2. Numbers of Black Scoters Marked by Site, Year, and Sex.

<table>
<thead>
<tr>
<th>Category</th>
<th>Chaleur Bay, NB/QC Apr-May</th>
<th>NB/QC Mar RI Dec</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>2002  2003  2004  2009  2010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Total</td>
<td>12    7   4    0    40</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>Female Total</td>
<td>1     4    5    18   26</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>13    11   9    18   66</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td>Male Died¹</td>
<td>0     1    0    0    0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Female Died¹</td>
<td>0     0    0    0    0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Male Lost²</td>
<td>0     5    1    0    7</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Female Lost²</td>
<td>0     4    1    1    2</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Total: Male Died or Lost</td>
<td>0   6    1    0    7</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Total: Female Died or Lost</td>
<td>0  4    1    1    2</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Total Died or Lost</td>
<td>0     10   2    1    9</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>% Male Died or Lost</td>
<td>0%   86%  25%</td>
<td></td>
<td>18%   22%</td>
</tr>
<tr>
<td>% Female Died or Lost</td>
<td>0%  100% 20%</td>
<td></td>
<td>6%    8%</td>
</tr>
<tr>
<td>% Total Died or Lost</td>
<td>0%  91%  22%</td>
<td></td>
<td>6%    14%</td>
</tr>
</tbody>
</table>

¹ Mortality indicated by transmitter temperature equaling ambient temperature or mortality flag triggered during initial 60 days

² Transmitter stopped due either to malfunction or unconfirmed mortality during initial 60 days
TABLE 3. NUMBERS OF BLACK SCOTERS USED FOR ANALYSIS BY SEASON AND SEX.

<table>
<thead>
<tr>
<th>Season</th>
<th>Number of Birds</th>
<th>Multi-Seasons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
</tr>
<tr>
<td>Wintering</td>
<td>41</td>
<td>40</td>
</tr>
<tr>
<td>Breeding</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>Molting</td>
<td>42</td>
<td>-</td>
</tr>
<tr>
<td>Winter to Breed</td>
<td></td>
<td>27</td>
</tr>
<tr>
<td>Winter to Molt</td>
<td>37</td>
<td>-</td>
</tr>
<tr>
<td>Molt to Winter</td>
<td>38</td>
<td>-</td>
</tr>
<tr>
<td>Breed to Winter</td>
<td></td>
<td>40</td>
</tr>
</tbody>
</table>

Spring migration

Spring migration generally followed a coastal route along the eastern seaboard of the USA and Canada to the spring staging area in Chaleur Bay between NB and QC (Figs. 3 and 4). After departing Chaleur Bay, a small proportion of the birds spent a few days in the St. Lawrence estuary and gulf before flying overland over southern Québec towards their breeding area. Most females moved to James Bay where they staged for 1-2 weeks before continuing to their inland breeding locations in northern Quebec, northern Ontario, northern Manitoba, the Northwest Territories and Nunavut (Fig. 3). Many of the females that traveled to breeding sites in northern Quebec and Labrador (n=8) flew directly to their breeding location from Chaleur Bay (Fig. 3). Most of the males, and some of the females, did not go to breeding sites and flew directly to their molting location in James Bay using a similar overland migration across southern Québec (Fig. 4).
Figure 3. Migration of 27 adult female black scoters from wintering areas to breeding areas, including stopover points during spring migration. Dashed lines between points represent a direct line between consecutive locations, but do not necessarily represent actual migration path.
Breeding areas

The majority of females (~70%) migrated to breeding sites that encompassed an area from the Hudson’s Bay coast of Manitoba west-northwest almost to Great Slave Lake (Figs. 3 and 5). This was surprising as the birds were located well outside the previously documented breeding areas in western Labrador and central Quebec on the Ungava Peninsula, and the Hudson’s Bay Lowlands in Ontario (see Bordage and Savard 1998, Brook et al. 2012). Using the inferred breeding sites, we estimated the approximate breeding range for this population. Their range appears to be divided into two major regions: one covering the Hudson’s Bay Lowlands through part northern Manitoba and eastern NWT, and the second covering northern Quebec and Labrador (Fig. 5).

The 2 hr on 72 hr off duty-cycle used for tags in 2010 allowed us to track birds for up to 2.5 years which has encompassed locations for up to three breeding seasons providing useful information on breeding site fidelity. Twelve females used the same breeding site in 2 successive seasons and 3 females used the same site in 3 successive seasons (average movement between breeding sites was 3.25 km, SD=2.47);
one female moved its breeding site 63 km between years. Only one female may have moved its breeding site in the 19 opportunities to switch locations suggesting the species is highly philopatric.

Figure 5. Breeding locations of 35 adult female black scoters marked during spring migration at Chaleur Bay, New Brunswick/Quebec and Narragansett Bay, Rhode Island

Molting areas

Figure 6 shows four primary moulting areas centered on Western Hudson’s Bay, James Bay, North shore of the Gulf of St. Lawrence and Labrador. Again, the 2 h on 72 h off duty-cycle used for tags in 2010 allowed us to track birds for up to 2.5 years which has encompassed locations for up to three moulting seasons providing useful information on moulting site fidelity. We examined relative use of moulting areas and movements among moulting areas (Fig. 7; for this analysis, James Bay was split into eastern and western areas). Using data from the first year after tag deployment we found 4%, 38%, 35%, 6%, 6% of male Black Scoters moulted in Western Hudson’s Bay, Western James Bay, Eastern James Bay, the Gulf of St. Lawrence and Labrador, respectively.

Black Scoters exhibited some fidelity to moulting areas among years. For example, six of the 15 tagged males that provided moulting locations for three consecutive years used the same moulting area, whereas seven switched areas on at least one occasion. Several birds shifted moulting areas among years. There appears to be strong connectivity between James Bay moulting areas and the Western Hudson’s Bay area (see transition between year 1 and 2, and year 2 and 3, respectively; Fig. 7), and a relatively weak association between the Eastern and Western James Bay moulting areas. There were also direct linkages between the moulting area in the Gulf of St. Lawrence with the Western Hudson’s
Bay and the Eastern James Bay moulting areas. The only site that appears to be isolated was Labrador; however, the tagged birds that used this site only provided data for one year and the sample size may not be adequate to detect transitions from this site.

Figure 6. Location of molting areas for 36 adult male black scoters marked during spring migration at Chaleur Bay, New Brunswick/Quebec and Narragansett Bay Rhode Island.
Figure 7. Number of tagged birds using moult sites, and movements among moult sites for tags that transmitted for two and three years

Fall migration

Many of the males that moulted on James Bay and western Hudson’s, and most females that may have breed or moulted on the Ungava Peninsula or central Canada, staged on James Bay during the fall. When departing the James Bay staging area, most birds took a more westerly route on their southward migration in the fall than they did during spring, with evidence that some birds flew directly overland at night (based on telemetry locations over land at night), from James Bay to the New England coast (Figs. 8 & 9).
Figure 8. Migration of 38 adult male black scoters from breeding/molting areas to wintering areas, including stopover points during fall migration. Dashed lines between points represent a direct line between consecutive locations, but do not necessarily represent actual migration path.
Figure 9. Migration of 40 adult female black scoters from breeding/molting areas to wintering areas, including stopover points during fall migration. Dashed lines between points represent a direct line between consecutive locations, but do not necessarily represent actual migration path.

Wintering areas

The majority of birds staged for a few weeks at various locations along the eastern coast of the USA before arriving at their wintering areas between Nova Scotia and northern Florida (Fig. 10). A detailed analyses of the wintering data has yet to be completed, however preliminary results suggest that there is significant movement of birds during winter both within and among years.
Figure 10. Location of wintering areas for 7 adult male and 27 adult female black scoters marked during spring migration at Chaleur Bay, New Brunswick/Quebec and Narragansett Bay Rhode Island. Points represent the best location per duty cycle. Locations are cumulative through August 2012.

Other important observations

The telemetry data show that James Bay and southwestern Hudson’s Bay are occupied for a large portion of the annual cycle by black scoters. The first birds arrive in James Bay in May and the last birds leave in late November, which suggests that birds use this area as long as it is ice-free. These areas may be very important for nutrient acquisition for breeding, molting and rebuilding energy reserves after breeding. Though no juvenile (hatch-year) birds have been tagged, we suspect productivity of these areas may be important for juvenile black scoters as it is probable that a large portion of the fall flight may forage here before moving south. This marine area would be a good candidate for habitat protection.

Particularly important areas during fall and spring migration along the Atlantic coast include the area around Cape Cod and Nantucket Shoals, Chaleur Bay on the New Brunswick – Quebec border, and the north Shore of the Gulf of St. Lawrence.
Implications for management and conservation:

1. Telemetry data have provided a completely new view of the breeding range for the species, and suggest that a large portion of the eastern population is associated with breeding areas in northern Manitoba, northern Ontario, Nunavut and the Northwest Territories. As a result of this study, this area has been identified as an Area of Continental Significance to North American Ducks, Geese and Swans under NAWMP 2012 Revision. This area has not been covered by traditional waterfowl breeding surveys (see Brook et al. 2012 for survey data for Hudson Bay lowlands), and we recommend that an exploratory survey of the area should be conducted to determine the extent of the breeding area and relative breeding densities for black scoters and other species of waterfowl.

2. New data for male black scoters have identified moulting sites in Western Hudson’s Bay, James Bay, the Gulf of St. Lawrence and Labrador, and has shown that there is some interchange among these sites. This has implications for the development of the James Bay Molting Scoter survey suggesting that the coverage of this survey should include all of James Bay and Western Hudson’s Bay, and possibly the Gulf of St. Lawrence, to adequately represent this population.

3. Data collected so far provide more insight into the origin and composition of molting flocks. It confirms the idea that unpaired males do not go to the breeding areas but fly directly to their molting area. This has important implications for the interpretation of survey data.

4. We also are gathering information on the fall and spring distribution of scoters and the time spent at staging areas. Again, this will help interpret and plan surveys during these periods, as well as assess important habitats for the species, which may eventually lead to habitat protection.

5. Data from the study are being used in several environmental assessments. For example, they are being used in an assessment of a large offshore wind project in Rhode Island, for the design of a radar migration study for a wind turbine project on the isthmus between New Brunswick and Nova Scotia, and in a coastal sensitivity mapping program in South Carolina.

6. The telemetry data have been used for the design and interpretation of the James Bay molt survey and the Atlantic Coast Winter Sea Duck survey.

Recommendations for future work on black scoters:

1. Capture techniques (mostly mist-netting on staging areas) were efficient and do not need to be modified. The effective sample sizes are below the desired target and there may be need to mark additional birds if larger sample sizes are required.

2. Data on black scoters show that the surgery associated with transmitter implantation affects the timing of migration and movements of implanted birds in the year they undergo surgery. Censoring data from the first year may help overcome bias associated with marker effects.
Surf Scoters

**Capture Sites:** Chesapeake Bay, MD/VA, Nain, Labrador, Pamlico Sound, NC, and Narragansett Bay, RI

Surf scoters concentrate during winter along the mid-Atlantic coast, particularly along the Maryland, Delaware, and Virginia coasts, and in Chesapeake and Delaware Bays. Surf scoters were captured and marked during winter in Chesapeake Bay in 2001-05 and 2011-12, as well as on molting areas in Labrador in 2006. Capture techniques included floating mist nets, net gun, night-lighting, and drive-trapping into submerged gill nets (molting birds).

In October 2012, CWS conducted an experimental capture event along the north shore of the Gulf of St. Lawrence in Quebec, where apparently a high proportion of surf scoters stop during both spring and fall migrations. This project sought to assess the potential for capture there, and if successful, deploy the PTTs that were “leftover” from other capture sites the previous winter. CWS was able to mark 26 female surf scoters with relative ease, and we are currently following the movements of those birds to see where they settle out this winter. If their winter distribution is similar to distributions observed during aerial surveys over the past 4 years (i.e., it seems to be a representative sample of the population; Silverman et. Al 2012), then the study may shift its strategy for surf scoters to a fall marking effort rather than winter trapping. A decision will be made in December 2012, and results for birds marked during this capture event will be presented in the next progress report.

**Lead investigators:** Alicia M. Berlin, Ronald E. Therrien, and Matthew C. Perry (USGS Patuxent Wildlife Research Center), Scott Gilliland and Christine Lepage (CWS ), Doug Howell (NC DWM), Scott McWilliams (University Rhode Island), Jay Osenkowski (RI DEM)

**Partners involved in the work at this site:** MD DNR, VA DGIF, USFWS, DU, NC DWM , RI DEM, University of Rhode Island, Bureau of Ocean Energy Management, CWS, BioDiversity Research Institute

**Results and discussion:**

A total of 78 surf scoters (57 males, 21 females) have been radio-tagged, with 63 marked on wintering areas and 15 tagged on a molting area in Nain, Labrador (Table 4). On average, we have observed a nearly 30% loss rate (this includes known death, known transmitter failure, and undetermined loss (we refer to this as unconfirmed mortality)) in surf scoters (Table 4), reducing the number of individuals used in analyses (Table 5). There is some evidence for higher loss rates using larger transmitters in 2012 (49-53g in 2012 versus 38-42 g previously; Table 6). There is concern that the larger transmitters may be too
big for surf scoters, especially females, and that switching to a smaller model would be beneficial. Additional deployments of the larger units are planned for this winter under the BOEM element of the study, and a further evaluation will be made next spring.

### TABLE 4. NUMBERS OF SURF SCOTERS MARKED BY SITE, YEAR, AND FATE WITHIN 60 DAYS AFTER RELEASE

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
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<tr>
<td></td>
<td>2001 2002 2004 2005</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>Male Total</td>
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</tr>
<tr>
<td>Female Total</td>
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<td>0 0 0 0</td>
<td>6 7 0 0 0 0</td>
<td>24 19 0 0 0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
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<td>2 24 7 0 0 0</td>
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</tr>
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<tr>
<td>Female Died¹</td>
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<td>0 0 0 0</td>
<td>0 4 0 0 0</td>
<td>5 5 0 0 0</td>
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</tr>
<tr>
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<td>0 0 0 0</td>
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<td>5 5 0 0 0</td>
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</tr>
<tr>
<td>Female Lost²</td>
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<td>0 0 0 0</td>
<td>2 0 0 0 0</td>
<td>2 2 0 0 0</td>
<td></td>
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<tr>
<td>Total: Male Died or Lost</td>
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<td>0 0 0 0</td>
<td>4 4 0 0 0</td>
<td>15 15 0 0 0</td>
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<td>Total: Female Died or Lost</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>2 2 0 0 0</td>
<td>7 7 0 0 0</td>
<td></td>
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<tr>
<td>Total Died or Lost³</td>
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<td>0 0 0 0</td>
<td>6 6 0 0 0</td>
<td>22 22 0 0 0</td>
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<tr>
<td>% Male Died or Lost</td>
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<td>47% 0%</td>
<td>22% 33%</td>
<td>26% 26%</td>
<td></td>
</tr>
<tr>
<td>% Female Died or Lost</td>
<td>20% 0%</td>
<td>33% 57%</td>
<td>33% 33%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Total Died or Lost</td>
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<td>20% 0%</td>
<td>47% 0%</td>
<td>25% 42% 28%</td>
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</tr>
</tbody>
</table>

1 Mortality indicated by transmitter temperature equaling ambient temperature or mortality flag triggered

2 Transmitter stopped due either to malfunction or unconfirmed mortality during initial 60 days
TABLE 5. NUMBERS OF SURF SCOTERS USED FOR ANALYSIS BY SEASON AND SEX.

<table>
<thead>
<tr>
<th>Season</th>
<th>Number of Birds</th>
<th>Multi-Seasons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
</tr>
<tr>
<td>Wintering</td>
<td>43</td>
<td>18</td>
</tr>
<tr>
<td>Breeding</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Molting</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>Winter to Breed</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Winter to Molt</td>
<td>28</td>
<td>0</td>
</tr>
<tr>
<td>Molt to Winter</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>Breed to Winter</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

TABLE 6. BIRD MORTALITY OR TRANSMITTER FAILURE FOR CHESAPEAKE BAY SURF SCOTERS, BY TRANSMITTER SIZE, PRIOR TO 60 DAYS AFTER RELEASE FOR 2011 AND 2012 SEASONS

<table>
<thead>
<tr>
<th>Transmitter Size</th>
<th>Dead or PTT failure(^1)</th>
<th>n</th>
<th>Confirmed Dead(^2)</th>
<th>n</th>
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<tbody>
<tr>
<td>38-42 g PTTs</td>
<td>16 Males 19%</td>
<td>3</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>4 Female 50%</td>
<td>2</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Total 25%</td>
<td>5</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>49-53 g PTTs</td>
<td>14 Male 36%</td>
<td>5</td>
<td>36%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>9 Female 44%</td>
<td>4</td>
<td>44%</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Total 43%</td>
<td>9</td>
<td>43%</td>
<td>9</td>
</tr>
</tbody>
</table>

\(^1\) Death indicated by transmitter temperature or failed transmitter during initial 60 days

\(^2\) Death indicated by transmitter temperature equaling ambient temperature or mortality flag triggered during initial 60 days

Spring migration

Spring migration for surf scoters followed a coastal route up the eastern seaboard of the USA and Canada with key stopover and staging areas including Nantucket Shoals, Northumberland Strait, Restigouche River, and St. Lawrence Estuary (Figs. 11 and 12). One notable exception was a male that migrated north through the Great Lakes (in two consecutive years) to a suspected breeding area in Nunavut instead of following the Atlantic coast northward (Fig. 13). Most females moved to their inland breeding locations in the boreal zone of Quebec and Labrador (Fig. 11), with the exception of one female that, after departing spring staging areas, flew overland over southern Québec towards her breeding area in Nunavut; this was the only female surf scoter that apparently bred west of Hudson Bay.
Figure 11. Spring migration routes for 12 adult female surf scoters marked during winter in Chesapeake Bay, MD, Pamlico Sound, NC and Narragansett Bay, RI. Dashed lines between points represent a direct line between consecutive locations, but do not necessarily represent actual migration path.
Figure 12. Spring migration routes for 28 adult male surf scoters marked during winter in Chesapeake Bay, MD/VA, Pamlico Sound, NC, and Narragansett Bay, RI. Dashed lines between points represent a direct line between consecutive locations, but do not necessarily represent actual migration path.
Atlantic and Great Lakes Sea Duck Migration Study
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November 29, 2012

Figure 13. Migration route for male surf scoter #102361 over a two-year period showing how closely it followed the same migration path. The molting location varied by 58.5 kilometers and the winter area by 56 kilometers. The bird molted on a different island in the Belcher Islands and wintered in Chesapeake Bay only in one year, and wintered in both Chesapeake Bay and Delaware Bay the following year.

Breeding areas

Our sample (n = 12) of marked adult female surf scoters indicates that surf scoters apparently breed in the boreal zone of Quebec, Labrador, and Nunavut (Fig. 11). Breeding surveys completed in Quebec and Nunavut have indicated breeding surf scoters in these areas, but other known breeding areas (e.g., Hudson Bay lowlands, Brook et al. 2012) are not represented in this small sample of marked birds. Two females provided breeding locations in two year; both exhibited strong site fidelity to their breeding areas with only an average 0.5 km difference in their site selection.

Molting areas

Surf scoters molted along the eastern coast of southern Hudson Bay and in James Bay, as well as along the Labrador coast and in the St. Lawrence Estuary in Quebec (Fig. 14). Southern James Bay and the Belcher Islands appear to be key areas for molting male surf scoters. The 10 males that provided data on molt location in two years exhibited significant variation (3.3 – 1367.8 km) in their molting locations between years.
During fall, surf scoters departed molting areas to converge on the St. Lawrence and then either stopped over on the Nantucket Shoals area before migrating further south to the wintering areas where they were originally caught or presumably migrating directly from St. Lawrence to the wintering areas (Figs. 15 and 16). Figure 17 focuses on this key staging area of St. Lawrence Estuary and Northampton Strait, and suggests that Northampton Strait is used more during spring migration than during fall migration, whereas the St. Lawrence Estuary is heavily used during fall migration. This observation prompted a recent (October 2012) capture effort there in this key staging area (highly successful; will be covered in next report). It also appears that the Nantucket Shoals area is another area used more intensively during fall migration than during spring migration. The one individual that migrated north through the

Figure 14. Molting areas (kernel density) for 28 adult male surf scoters marked during winter along the Atlantic coast.

**Fall migration**

During fall, surf scoters departed molting areas to converge on the St. Lawrence and then either stopped over on the Nantucket Shoals area before migrating further south to the wintering areas where they were originally caught or presumably migrating directly from St. Lawrence to the wintering areas (Figs. 15 and 16). Figure 17 focuses on this key staging area of St. Lawrence Estuary and Northampton Strait, and suggests that Northampton Strait is used more during spring migration than during fall migration, whereas the St. Lawrence Estuary is heavily used during fall migration. This observation prompted a recent (October 2012) capture effort there in this key staging area (highly successful; will be covered in next report). It also appears that the Nantucket Shoals area is another area used more intensively during fall migration than during spring migration. The one individual that migrated north through the
Great Lakes molted in the James Bay and then, interestingly enough, migrated south through the St. Lawrence Estuary back to the Chesapeake Bay. This male has transmitted for two migrations now and during both cycles he traveled the same routes (Fig. 13).

Figure 15. Fall migration routes for 22 adult male surf scoters from molting areas to wintering areas. Dashed lines between points represent a direct line between consecutive locations, but do not necessarily represent actual migration path.
Figure 16. Fall migration routes for 6 adult female surf scoters from breeding areas to wintering areas. Dashed lines between points represent a direct line between consecutive locations, but do not necessarily represent actual migration path.
Wintering areas

On average, both sexes of surf scoters exhibited strong site fidelity to wintering grounds (avg 84 km difference between years). The heavily used wintering areas in Figure 18 are the areas of deployment, Chesapeake Bay, Pamlico Sound, and Narragansett Bay, so we expect bird use to be concentrated in those areas, but note that the Delaware Bay and Long Island Sound were also used during winter by surf scoters. There were short movements to and from these locations from each nearby deployment location. For example, one male surf scoter marked in Tangier Sound, Chesapeake Bay, moved to Delaware Bay and stayed for one duty cycle (at most 6 days) and then returned to the Chesapeake Bay.
Figure 18. Location of wintering areas for 61 surf scoters (43 males, 18 females) marked in 2001-06 and 2010-12 during winter in Chesapeake Bay, MD/VA, Pamlico Sound, NC, and Narragansett Bay, RI, and on the molting area in Nain, Labrador in 2006. Points represent the best location per duty cycle.
Other observations

1. Scoters appear to exhibit strong site fidelity to wintering and staging areas, but more data are needed to better quantify the degree of fidelity.
2. Timing of migration appears to vary little among years.

Implications for management and conservation:

1. These data are being used by USFWS and BOEM to create a “risk” map of sea duck distributions to better inform the siting of offshore wind power projects.
2. Northampton Strait and St. Lawrence Estuary both appear to be key bottleneck areas for surf scoters during spring and fall migration, respectively, and warrant habitat conservation efforts.
3. The timing and use of these key stopover areas could be linked to management of aquaculture farms in those areas.
4. Birds migrating through Northampton Strait could be impacted by the algal bloom die-offs that are occurring in the Gulf of Maine.

Recommendations for future work on surf scoters:

1. Consider using smaller transmitters to reduce mortality.
2. Investigate the potential for changing deployment tactics for SUSC, from marking on wintering areas to marking on staging area in St. Lawrence estuary.
3. If continuing with winter deployments, strive to mark proportionately throughout the flyway, as determined by winter surveys. Currently under-sampled areas include Nantucket/Cape Cod, Pamlico Sound, NC, and Delaware Bay.
4. Explore alternative technologies using the captive colony at PWRC to reduce mortality of marked birds.
White-winged Scoters

**Capture Sites**: Forestville, St. Lawrence Estuary, Quebec, Canada; Merrimack River, Salisbury (MA), Sco Bay, Scarborough (ME), and Newport, RI

Although the sampling design for this study calls for marking a representative sample of each target species throughout their range, initial attempts to capture white-winged scoters on winter range have been difficult due to low densities of birds and lack of knowledge about where these birds occur, particularly during winter. The capture effort in the St. Lawrence estuary (SLE) was intended to provide additional information about distribution, although it was recognized that any inference would apply only to the population of white-winged scoters that molt in this area. The hope is to find a way to mark a representative sample during winter.

Forestville, Quebec is a known molting area for thousands of surf and white-winged scoters; it is also used by 10,000-40,000 scoters each spring and fall for staging. In August 2010, 16 male and 3 female white-winged scoters were caught by driving birds into a submerged gill net, and fitted with satellite transmitters.

In August 2012, a new capture effort was conducted at the Forestville molting site by Environment Canada. Seventeen adult white-winged scoters (12 males and 5 females) were marked with transmitters and results for these birds should appear in the 2013 report.

White-winged scoters have proven difficult to capture on wintering areas due to smaller overall abundance and restricted distribution. During the winter 2010-2011, the following birds were implanted: three hatch-year white-winged scoters (two males and one female) in Massachusetts, one adult male in Massachusetts and another adult male in Rhode Island.

**Lead investigators**: Quebec: Jean-Pierre L. Savard, Christine Lepage and Scott Gilliland (Environment Canada); New England coast: Lucas Savoy (BioDiversity Research Institute), Scott McWilliams (University Rhode Island), Jay Osenkowski (RI DEM)

**Partners involved in the work at this site**: Quebec: Canadian Wildlife Service, EC; Science and technology, EC; University of Quebec in Montreal (UQAM), University of Montreal (UdM); USFWS. New England coast: USFWS, Maine Dept Inland Fisheries and Wildlife, RI DEM, University of Rhode Island
Results and discussion

Forestville, Quebec birds - In 2010, 19 white-winged scoters were implanted with transmitters at the Forestville molting site. Five transmitters failed before the fall migration, one failed after the bird reached the wintering areas, one failed during winter, and one the following spring. Therefore, results for the first complete year are from 11 birds, while the second complete year provides insights for 10 birds. As of October 2012, the 10 transmitters were still active and hopefully will provide data on fidelity to wintering areas. These data suggest that birds molting at a given molting location originate from several wintering populations and have different migration patterns.

New England coast birds - Of the five white-winged scoters marked during the winter 2010-2011, two of the three hatch-year birds marked in Massachusetts and the adult male from Maine died shortly after implantation. However, the hatch-year female implanted in Massachusetts and the adult male from Rhode Island both survived and will likely provide insights for more than two years.

### TABLE 7. NUMBERS OF WHITE-WINGED SCOTERS MARKED BY SITE, YEAR.

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<thead>
<tr>
<th>Category</th>
<th>QC Aug RI Dec 2010</th>
<th>MA Dec And ME March 2011</th>
<th>Total</th>
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<td>20</td>
</tr>
<tr>
<td>Female Total</td>
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</tr>
<tr>
<td>Total</td>
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<td>24</td>
</tr>
<tr>
<td>Male Died¹</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Female Died¹</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Male Lost²</td>
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<td>Female Lost²</td>
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<td>% Total Died or Lost</td>
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<td>75%</td>
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¹ Mortality indicated by transmitter temperature equaling ambient temperature or mortality flag triggered during initial 60 days
² Transmitter stopped either due to malfunction or unconfirmed mortality during initial 60 days
### TABLE 8. NUMBERS OF WHITE-WINGED SCOTERS USED FOR ANALYSIS BY SEASON AND SEX.

<table>
<thead>
<tr>
<th>Season</th>
<th>Number of Birds</th>
<th>Multi-Seasons</th>
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<td>0</td>
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<td>10</td>
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<td>Breed to Winter</td>
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<td>3</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

### Fall Migration

Of the 14 birds that undertook the 2010 fall migration (Forestville birds), nine birds may have flown overland across the Gaspé Peninsula towards the Atlantic coast. Three birds migrated south via Prince Edward Island: one wintered in Newfoundland, one in the Long Island area, and one transmitter failed before reaching the wintering area. One bird migrated westward along the St. Lawrence to the Great Lakes where it wintered.

Data from the second year (2011; n=11) confirm that birds are generally faithful to their migration pattern (Fig. 19). Like the 2010 fall migration, two birds used the Prince Edward Island as a fall staging areas before heading either south (New England States) or east (Newfoundland) (Fig. 20). The bird that migrated westward to the Great Lakes in 2010 did the same in 2011.

One male had a particularly interesting fall migration pattern, identical for 2010 and 2011. This bird left its fall staging area in St. Lawrence Estuary in late October, briefly stopped on the Massachusetts coast in early November, then went to Lake Ontario for one or two months (7 Nov-8 Jan 2010; 3-29 Nov 2011) and finally ended up in the Long Island area for the rest of the winter (8 Jan-17 March 2010; 9 Dec-20 Mar 2011).
Figure 19. Southbound (fall/winter) migration pattern during 2011 and 2012 for adult male white-winged scoters marked during molt at St. Lawrence Estuary, Quebec (2011, n=10; 9 males from Forestville and 1 male from RI). Dashed lines between points represent a direct line between consecutive locations, but do not necessarily represent the actual migration path.
Figure 20. Spring and fall staging areas for 13 white-winged scoters marked in St. Lawrence Estuary. Note: use of St. Lawrence Estuary is heavy because birds were marked there. Points represent the best location per duty cycle.

**Wintering areas**

From the 12 birds for which we have two full wintering season (2010-2011 and 2011-2012), all but one showed strong wintering site fidelity, returning to the same wintering area the two years. The exception is the female caught on wintering grounds in Massachusetts: she spent winter 2011-12 in Nova Scotia.

Nine birds wintered from Boston, Massachusetts, to the Long Island area, New York (Fig. 21): two males wintered in the Boston area; three males wintered in the Cape Cod—Nantucket Island—Martha’s Vineyard area; and four birds wintered in the Long Island area (two males and two females). A few birds changed locations during winter: for example, one male wintered near Nantucket Island from November to January then moved to Long Island (Feb to mid-March), returning again to Nantucket (mid-March to mid-May), and only in 2011. One female moved from Newburyport, MA (Dec and Jan) to Belfast, ME (Feb to mid-Apr).

Of the three birds that did not winter along the New England coast, one male overwintered in Lake Ontario (moving from the northeast side to the southwest side of the lake during winter), one male
spent the winter not far from Stephenville, on the west coast of Newfoundland, and one female wintered at the southern end of Nova Scotia.

Birds spent 3-6 months at the same wintering site, mostly from early November to late March. One bird even spent seven months in the Nantucket area, from Oct 12 to May 12, 2012.

Spring migration

For the 2011 season, of the nine birds that wintered on the New England coast, four went to Chaleur Bay before going to the SLE during spring, four apparently flew overland directly to the St. Lawrence and one flew to Lake Ontario before following the St. Lawrence back to its molting site; this bird did the same stop on the Lake Ontario during fall migration; see Fall migration section above (Fig. 22). The bird that wintered on Lake Ontario also followed the St. Lawrence eastward in the spring. The bird that wintered in Newfoundland went to the North Shore of the St. Lawrence and followed it back to its molting location. One female flew from her wintering grounds in Massachusetts and Maine to the Northumberland Strait, where she stayed to molt and stage during fall.
Breeding areas

The 2011 breeding season gave no probable indication for breeding areas, because all but one Forestville birds returned directly to 2010 molting sites in the SLE. The two females did not go in the interior to breed, likely because they were still subadult at that time. Only one case could refer to possible breeding: one male flew from the Estuary at the end of May to reach an interior site by the northeast coast of James Bay, an already known breeding area (Lepage and Savard, In prep.), staying there possibly from 30 May to 30 June. He then left for western James Bay in early July. The two New England birds (one male, one female) did not go to breeding grounds during the first breeding season following their implantation; the male flew to the SLE where he stayed three months, and the female flew to the Northumberland Strait where she spent summer and fall.

The 2012 breeding season brought insights on breeding sites (Fig. 23). The two Forestville females apparently went to breeding areas in the Northwest Territories (NWT), one on Great Bear Lake and one in the eastern part of Great Slave Lake. The first female arrived at her breeding site on 28 June, with departure date on 24 September, suggesting molting on-site, possibly following breeding and brood rearing, although this is impossible to determine with certainty. The second female arrived at her
breeding site a month earlier, on 28 May, and stayed there until 6 August. She moved to the western Hudson Bay coast (18-21 Aug), to the James Bay coast (28 Aug), and then to the SLE to molt (3 Sept-29 Oct) after that. The New England female likely bred at an interior site in Quebec, about 10 km east of the northeast coast of James Bay (Fig. 23). She stayed there at least from 2 June through 5 July.

Of the nine males transmitting during summer 2012, four went in the interior and five went directly to their molting site in the SLE (Fig. 22). There are four possible cases of males going to breeding areas: one male stayed southeast of the Great Slave Lake (NWT) from 26 May to 16 June; two went to the north-central lowlands of Manitoba from 30 May to 17 June; and from 9 to 23 June, respectively, one stayed in the lowlands at the northwest corner of Ontario from 9 to 28 June. Finally, one male went to the interior along the eastern Hudson Bay coast in Northern Quebec but did not stay long enough at the same site (near Little Whale River, 5 June; near Minto Lake 14 June; near Boniface River, 19 June; north of Inukjuak, 29 June) to suggest he was possibly accompanying a breeding female.

Figure 23. 2012 northbound (spring) migration pattern of three adult female white-winged scoters. Dashed lines between points represent a direct line between consecutive locations, but do not necessarily represent the actual migration path.
Molting areas

In 2011, nine Forestville birds returned to the same SLE molting location or within 30 km of it (including the two subadult females). However, two males changed drastically their molting location (Fig. 22). One molted in James Bay (8 July to 9 Aug), 1100 km northwest from Forestville and the other one on the Labrador coast (15 July to 4 Oct), 870 km northeast from Forestville. The male from New England went molting in the SLE and the female molted in the Northumberland Strait.

In 2012, the molting portrait changed, likely because some birds went to breeding areas (Fig. 22). Of the five males that did not go to breeding areas, three stayed in the SLE to molt, for a third season in a row. One of the males molted on the south shore of SLE. The two other unpaired males changed molting locations: one molted on the northeastern side of James Bay, and the other one along the eastern Hudson Bay coast. The four males that likely went to breeding areas selected molting sites different from those they used in 2010 and 2011: one along the southern coast of the Belcher Islands (Hudson Bay), one along the northeastern coast of Akimiski Island (James Bay), one by Charlton Island (James Bay), and one in northern Manitoba lowlands. The male that was on the eastern Hudson coast in Northern Quebec during June likely molted north of Inukjuak (29 June-August). Of the three females, only one likely molted on her breeding site (Great Bear Lake, NWT; stayed there from 28 June until 24 Sept); one left her NWT breeding site in late August to molt in Forestville, more than 3000 km southeast; and one likely molted on the northeastern James Bay coast (12 July-August), not far from her believed breeding ground.

Birds that did not go to breeding areas (likely unpaired adult males and subadults) and that staged and molted in the SLE, stayed as long as five months in the area (from early June to late Oct), until their departure for their wintering areas.

Other observations

Most inferences about white-winged scoters presented here come from the subsample of birds from the SLE molting site, and therefore may not be representative of the Eastern population as a whole. According to the Atlantic Coast Wintering Sea Duck Survey, the 2009-2011 mean estimate for white-winged scoters is 43 900 ± 8 300 birds (±SE) (Silverman et al. 2012). On the Lower Great Lakes, estimates of wintering white-winged scoters are ~1000 individuals (Petrie et al. 2006). Therefore, the Forestville molting population of white-winged scoters, which is estimated at about 5000 individuals (Lepage and Savard, In Prep), would only represent about 10% of the Eastern population. However, birds from the SLE molting sites originate from several wintering populations and indisputably provide insights into the distribution and migration patterns of the species in the eastern portion of its range.

Telemetry data show that the St. Lawrence Estuary is used by white-winged scoters for a large portion of their annual cycle: 1) during spring migration, 2) as a summer staging area for birds not going to breeding areas (likely unpaired birds and subadults), 3) as a molting area for males (adult and subadult) and females (higher proportion of subadult), 4) during fall migration and fall staging. Some birds use this area for as long as 5 months (from early June to late Oct). Therefore this marine area would be a good candidate for habitat protection.

Alternative molting sites include Labrador coast, eastern Hudson Bay coast, James Bay and Akimiski Island, Belcher Islands, northern lowlands of Manitoba.

Only one of the seven birds that went to a breeding location returned to molt molt in the SLE, the others molted closer to their apparent breeding location. For example, the four males that went to breeding areas in central Canada (NWT, north-central Manitoba and northwest corner of Ontario) went to
northern molting sites (Belcher Islands, Akimiski Island, Charlton Island, and northern Manitoba) rather than returning to the SLE.

Wintering sites (Boston area, Cape Cod—Nantucket Island—Martha’s Vineyard area, Long Island area and Lake Ontario) have been used by marked birds for up to seven months (early Nov to May), making these areas good candidates for habitat protection.

According to the Atlantic coast wintering sea duck survey, 94% of White-winged scoters are present in the Cape Cod-Long Island sound stratum (Silverman et al. 2012); of the Forestville implanted birds that went on the Atlantic coast (8 of 10; one male wintered on Lake Ontario, and one along the western Newfoundland coast), 75% wintered in this stratum (25% wintered in the Maine to Boston stratum).

White-winged scoters appear to exhibit strong site fidelity to wintering and staging areas, although fidelity to molting areas seems quite variable. Two of nine Forestville males changed molting site radically the second year. Breeding birds (birds going to a breeding location) may be more likely to change molting sites than non-breeding birds. From nine Forestville birds for which we have three years of data for molting sites, only three males returned assiduously to the same molting site during the three years (likely three unpaired males but adult at the time of implantation).

White-winged scoters were implanted during the 2010 molt (Forestville birds) and wintering period (New England birds), but no birds went to breeding areas during the 2011 season (n=13), except maybe one case. One reason is that implanted subadult females were probably still immature and non-breeding during the 2011 breeding season. There is also a possibility that the surgery may have affected the pairing process the following winter, which would need to be investigated further.

For the Forestville birds, the distance between molting and wintering areas averaged 877 km (n = 12; range = 645-1052) in 2010, 988 km (n = 11; range = 645-1866) in 2011, and 1945 km (n = 7; range = 645-4262) in 2012. The latest departure date from wintering sites averaged 12 April in 2011 (n = 12; range = 5 March-30 May) and 12 April as well in 2012 but with a different range (n = 9; range = 17 April-30 April). Based on migration pattern and timing, we suspect that three males and two females were paired when they went to a breeding location and unpaired when they went to their previous molting site. Birds that were apparently paired departed wintering areas on the Great Lakes or the Atlantic coast sooner than when apparently unpaired (Table 9).

Table 9. Date of last signal from the Atlantic coast or the Great Lakes during spring in relation to pairing status (2011 not paired; 2012 paired; F = Female; M = Male)

<table>
<thead>
<tr>
<th>Bird</th>
<th>2011: Not paired</th>
<th>2012: Paired</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-39120</td>
<td>22-Jun</td>
<td>14-May</td>
</tr>
<tr>
<td>F-39158</td>
<td>23-May</td>
<td>12-May</td>
</tr>
<tr>
<td>M-39274</td>
<td>24-May</td>
<td>16-Apr</td>
</tr>
<tr>
<td>M-39768</td>
<td>28-May</td>
<td>18-May</td>
</tr>
<tr>
<td>M-39116</td>
<td>17-Apr</td>
<td>13-May</td>
</tr>
</tbody>
</table>
M-39116 went to the St. Lawrence through the Maritimes when unpaired in 2011 and reached its molting area in the St. Lawrence on 6 June whereas in 2012, when paired, it flew directly from the Atlantic coast to its breeding location and reached its molting location in James Bay on 5 July.

**Implications for management and conservation:**

1. If two separate populations exist in North America (western wintering birds and eastern wintering birds) then they should be managed separately.
2. Telemetry data suggest that a large portion of the eastern wintering population is associated with breeding areas in northwestern Ontario, northern Manitoba and the Northwest Territories. Surprisingly, no birds have bred in northern Québec (a known breeding area for this species) so far, arguing a need for further sampling out of the current sampling scheme.
3. Data collected confirms the idea that unpaired males do not go to breeding areas but fly directly to their molting area (based on the 2012 season [n=3], not the 2011 [n=11] which could reflect a potential transmitter effect). This has important implications for the interpretation of survey data.
4. Data suggest that birds molting at a given molting location originate from several wintering populations and have different migration patterns.
5. We are gathering important data on the location and the time spent at each different period (e.g. spring migration, staging areas, molting, wintering).
   a. This will greatly help interpret and plan surveys during these periods (e.g. survey of wintering sea ducks along the Atlantic coast).
   b. This will permit to eventually assess the importance of each site and initiate protective measure if needed, particularly considering that these males (and likely subadult females) spend from 4 to 6 months at their molting, fall staging and wintering locations.

**Recommendations for future work on white-winged Scoters:**

1. Increase effective sample size of PTTs for both females and males. If possible, capture and implant white-winged scoters with satellite transmitters at the most important wintering locations to better ensure a representative sample of the Eastern population (according to the Atlantic coast wintering sea duck survey, 94% of individuals are present in the Cape Cod-Long Island Sound stratum; Silverman et al. 2012).
2. Determine relative densities of birds at the identified breeding, molting and wintering locations.
3. If capture on wintering areas is not possible, and capture at molting sites is the only option, then capture of birds at different molting sites may prove adequate because:
   a. Capture techniques for molting birds are efficient and do not need to be modified.
   b. Differences in the proportion of females captured each year during molt indicate that the number of molting females captured could be increased by capturing birds later in August.
   c. Implanting adult females at molting sites may be a good strategy as it would provide good data the following spring in terms of migration timing. Data also indicate that molting sites include birds from several wintering areas.
   d. Logistically, capture is much easier at molting sites than at staging or wintering areas, and would be possible to implant large number of birds.
   e. To ensure the marked sample is representative of the flyway population, then it would be important to locate and mark birds at additional molting sites throughout the range.
Long-tailed Ducks

**Capture Sites:** Nantucket, MA, Cape Cod, MA, Chesapeake Bay, MD & VA, and Lake Ontario, Canada

According to the sea duck surveys reported by Silverman et al. 2012, the Cape Cod/Nantucket and Chesapeake Bay areas are the most important wintering areas for long-tailed ducks along the Atlantic Coast, therefore, these areas were chosen as capture areas. Long-tailed ducks also overwinter at the Great Lakes, primarily in Lake Ontario, and numbers of wintering long-tailed ducks have increased there in recent years (Petrie and Schummer 2002). Long-tailed ducks have been marked with satellite transmitters at all three areas as part of an effort to mark a geographically representative sample throughout the flyway.

Capture and marking efforts in Lake Ontario dovetail with research by one graduate student (Philip Wilson) project at the University of Western Ontario that is focused on evaluating use of Lake Ontario waters by long-tailed ducks as it relates to potential offshore wind energy development. There, long-tailed ducks were captured during winters 2010-2011 and 2011-2012 using overwater mist-nets and a modified lift-net technique.

Long-tailed ducks were captured at Nantucket, MA in 2007-09, Cape Cod, MA in 2010, and Chesapeake Bay, MD/VA in 2010-12 by night-lighting.

**Lead investigators for MA & MD:** Alicia M. Berlin, Ronald E. Therrien, and Matthew C. Perry (USGS Patuxent Wildlife Research Center)

**Lead investigators for Lake Ontario:** Shannon Badzinski (CWS), Scott Petrie (Long Point), and Phil Wilson (University of Western Ontario)

**Partners involved in the work at MA & MD:** MD DNR, VA DGIF, USFWS, DU, Massachusetts Audubon Society

**Partners involved in the work at Lake Ontario:** University of Western Ontario, USFWS, USGS Patuxent Wildlife Research Center, Toronto Zoo, Ontario Ministry of Natural Resources, Ontario Federation of Anglers and Hunters

**Results and discussion:**

Mortality of long-tailed ducks post-release has been moderate to high at all sites, thereby reducing overall effective sample size. For example, about 42% of birds either died or stopped transmitting data within approximately the first 60 days after implantation and release (Table 10).
Currently it is not clear why Long-tailed Duck post-release survival is low, but may be related to a combination of factors including predation by gulls or other aerial predators soon after release, weather- or temperature-related stresses, loss of waterproofing and subsequent hypothermia due to handling stress, diminished body condition during late winter, behavioral effects on diving/feeding activity or other size/weight-related issues related to the transmitters. The following results are based on two assumptions: 1) that the ducks are not impacted by the transmitters and 2) that despite a small sample size the information provided on their migrational pathways are representative of the population. In deference to these assumptions, to date there are 19 (12M: 7F) birds that have transmitted for 1.5 years, thereby, providing multi-year data (Table 11). These results show that the ducks exhibited similar pathways each year; therefore, we feel that any transmitter/surgery effects may be minimal once birds have survived the immediate post-surgical period (Fig. 24).

**TABLE 10. NUMBERS OF LONG-TAILED DUCKS MARKED BY SITE, YEAR, AND SEX.**

<table>
<thead>
<tr>
<th>Category</th>
<th>Cape Cod Area Mar-Apr</th>
<th>MA &amp; MD Mar GL Dec</th>
<th>Chesapeake Bay Feb-Apr Great lakes Dec-mar</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2007</td>
<td>2008</td>
<td>2009</td>
<td>2010</td>
</tr>
<tr>
<td>Male Total</td>
<td>6</td>
<td>9</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Female Total</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9</strong></td>
<td><strong>11</strong></td>
<td><strong>10</strong></td>
<td><strong>20</strong></td>
</tr>
<tr>
<td>Male Died¹</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Female Died¹</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Male Lost²</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Female Lost²</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Total: Male Died or Lost</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Total: Female Died or Lost</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total Died or Lost</strong></td>
<td><strong>4</strong></td>
<td><strong>6</strong></td>
<td><strong>4</strong></td>
<td><strong>8</strong></td>
</tr>
<tr>
<td>% Male Died or Lost</td>
<td>50%</td>
<td>56%</td>
<td>75%</td>
<td>33%</td>
</tr>
<tr>
<td>% Female Died or Lost</td>
<td>33%</td>
<td>50%</td>
<td>17%</td>
<td>50%</td>
</tr>
<tr>
<td>% Total Died or Lost</td>
<td>44%</td>
<td>55%</td>
<td>40%</td>
<td>40%</td>
</tr>
</tbody>
</table>

¹ Mortality indicated by transmitter temperature equaling ambient temperature or mortality flag triggered during initial 60 days
² Transmitter stopped due either to malfunction or unconfirmed mortality during initial 60 days
TABLE 11. NUMBERS OF LONG-TAILED DUCKS FOR ANALYSIS BY SEASON, AND SEX.

<table>
<thead>
<tr>
<th>Season</th>
<th>Number of Birds</th>
<th>Multi-Seasons</th>
<th>Ave KM&lt;sup&gt;1&lt;/sup&gt;</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td>Total</td>
<td>Two Seasons</td>
</tr>
<tr>
<td>Wintering</td>
<td>32</td>
<td>46</td>
<td>78</td>
<td>19</td>
</tr>
<tr>
<td>Breeding</td>
<td>0</td>
<td>28</td>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>Molting</td>
<td>17</td>
<td>0</td>
<td>17</td>
<td>5</td>
</tr>
<tr>
<td>Winter to Breed</td>
<td>0</td>
<td>28</td>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td>Winter to Molt</td>
<td>18</td>
<td>0</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>Molt to Winter</td>
<td>11</td>
<td>0</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>Breed to Winter</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

<sup>1</sup> Average distance in kilometers between successive years
Figure 24. Number of days between release and 16 October 2012 that Long-tailed ducks captured at Lake Ontario survived / transmitted data after being implanted with satellite transmitters.
Spring migration

The majority of the ducks tracked from Cape Cod/Nantucket area departed in mid-April (3-12 April) and passed through the Northampton Strait and either stopped over in the St. Lawrence Estuary or Chaleur Bay before departing to breeding/molting areas (Figs. 25 and 26). One exception was one female that stayed in the Gulf of Maine before migrating on to breeding areas. All males and females, with three exceptions, migrated across Quebec to the Hudson Bay area, and onto the breeding/molting grounds. The remaining three birds traveled directly north to the breeding/molting areas in northern Quebec. Minor stops of only a few hours were made in various areas of Quebec as they flew across. In contrast, ducks deployed in the Chesapeake Bay departed early to mid-April and migrated, with one exception, to Lake Erie as a stopover area before moving on to the breeding/molting areas. This exceptional female traveled north to a small lake just outside Pittsfield, New York and then migrated to Lake Erie before traveling north to the breeding areas. In addition, ducks deployed on Lake Ontario departed late April to mid/late May (19 Apr – 25 May); some birds (10F: 2M) staged at Lake Huron, to a large extent Georgian Bay, prior to traveling further north where they along with the other birds from Lake Ontario spent time staging at James Bay and Hudson Bay.

Figure 25. Spring migration patterns for 28 adult female long-tailed ducks marked during winter along the Atlantic coast and on Lake Ontario. Dashed lines between points represent a direct line between consecutive locations, but do not necessarily represent actual migration path.
Breeding areas

Twenty eight females arrived on breeding grounds in June and breeding ranges for long-tailed ducks appeared to spread from tundra regions of northeastern Manitoba, southeastern Northwest Territories, and Nunavut (including Southampton and Baffin Islands) east to northern Quebec (Figs. 25 and 27). Females marked at Chesapeake Bay appeared to nest further north in Nunavut than the Great Lakes females, which mostly nested in the lower tundra regions of northeastern Manitoba, southern Nunavut, and southeastern Northwest Territories. However, a few Great Lakes birds traveled further north and northeast with one bird settling into the Melville Sound area of north-central Nunavut, whereas several others ended their migration further south and east in Nunavut, most in the vicinity of Southampton Island. The Cape Cod/Nantucket females also nested in northern Nunavut and in northern Quebec.
Figure 27. Breeding areas for 28 adult female long-tailed ducks marked during winter along the Atlantic coast and on Lake Ontario.

**Molting area**

Although the sample size is small, long-tailed ducks appear to exhibit strong site fidelity to molting areas (50.4 km between years). Satellite telemetry data suggest there may be an important molting area for male Long-tailed Ducks in the vicinity of the Adelaide Peninsula and King William Island - Nunavut. Fewer numbers of males were presumed to have molted at other locales including Prince of Wales Island - Nunavut, northwestern and southwestern Baffin Island Foxe Basin near north end of Southampton Island, and the Puvirnituq region in Quebec (Fig. 28). There seems to be no apparent pattern in use of molting areas between birds marked on Great Lakes or Atlantic coast.
Fall migration

All long-tailed ducks departed breeding or molting areas in September and October (Figs. 29 and 30). Hudson Bay, particularly the vicinity of the Belcher Islands, appears to be a key stopover area for many of the marked long-tailed ducks on their fall migration to wintering areas. Ducks usually stayed anywhere from 10 days to 2 months at the Belcher Islands before departing to wintering areas. Birds marked at Chesapeake Bay returned to Lake Erie/Lake Ontario before returning over land to Chesapeake Bay in November. Most of the Cape Cod/Nantucket ducks flew directly back to the wintering area from the Belchers, arriving in November. One exception was a female that migrated from the Belcher Islands to Lake Ontario and then returned to Cape Cod/Nantucket wintering area. A few ducks stopped over in the St. Lawrence Estuary before returning to the Nantucket area. The majority of the Ontario ducks have returned to winter in Lake Ontario, but one male did move to Short Beach Island east of Brooklyn, NY. This male stayed in that area from 10 January to 14 March before returning to Lake Ontario (please note that this duck does not show up on figure due to this duck making these movements after August 2012 when maps were created).
Figure 29. Fall migration patterns for five adult female long-tailed ducks marked during winter along the Atlantic coast and on Lake Ontario. Dashed lines between points represent a direct line between consecutive locations, but do not necessarily represent actual migration path.
Figure 30. Fall migration patterns for adult 11 male long-tailed ducks marked during winter along the Atlantic coast and on Lake Ontario. Dashed lines between points represent a direct line between consecutive locations, but do not necessarily represent actual migration path.

**Wintering areas**

Both males and females exhibited strong site fidelity to wintering areas with an average between-year difference of 26.6 km. Figure 31 shows the wintering areas used up to September 1, 2012. Notice the point around New York, which represents the one Lake Ontario duck that migrated there for a brief time in March before returning to Lake Ontario. Also note that there are few locations between the two winter deployment locations of Chesapeake Bay and Nantucket/Cape Cod. However, based on surveys completed by Silverman et al. (2012) there are long-tailed ducks wintering off the coast of New Jersey and in Delaware Bay. Additional winter marking efforts should focus on under-sampled areas including Delaware Bay and coastal New Jersey to determine what staging, breeding, and molting areas they use.
Figure 31. Location of wintering areas for 78 long-tailed ducks (32 males, 46 females) marked in 2007-2010 at Nantucket/Cape Cod, MA, Chesapeake Bay, MD/VA, and Lake Ontario, Canada. Points cumulative up to September 1, 2012 (i.e., all years, all birds)
**Other observations**

1. The distribution of long-tailed ducks in the Nantucket wintering area is driven by the high densities of amphipods.
2. For the 19 ducks that we have multiple years worth of tracking (including Nantucket deployments) the timing of migration is consistent, with 19 ducks departing and arriving at the wintering areas within three days of the year before.
3. For the two females and five males that returned to breeding and molting areas respectively there was a fair amount of variation in site selection for breeding areas (156.4 km), but not as much variation in molting site selection (50.4 km)(Table 11, Fig. 32).

![Multi-season migration patterns for three adult long-tailed ducks. Female #40695 was marked in the Cape Cod area during winter and followed a similar path both years migrating to the breeding area. Male #40777 was also marked in the Cape Cod area and contains two full years of spring and fall migrations. Male #40901 was marked in Chesapeake Bay and contains 1.5 years of data with both spring migrations occurring via the Great Lakes following a similar path.](image-url)
Implications for management and conservation:

1. If Cape Cod/Nantucket and Chesapeake Bay wintering populations are truly segregated, then consideration should be given to evaluating limiting factors, including hunting, for each of these two wintering populations.

2. Potential for offshore wind power development in the Great Lakes could impact distribution of long-tailed ducks at a critical stopover area and major wintering area.

3. Changes in salinity gradients in marine areas near the Belcher Islands (related to hydro power development in Quebec) may influence benthic communities and could impact habitat quality and use by long-tailed ducks (and other sea ducks) that molt there.

4. As with other species key staging areas including Northampton Strait, Chaleur Bay, Belcher Islands, and St. Lawrence Estuary may warrant special management or protection.

Recommendations for future work on long-tailed ducks:

1. Focus deployment of transmitters in under-sampled wintering areas (Delaware Bay, New Jersey coastline, and Nantucket/Cape Cod) to better ensure that the sample is geographically representative of the population.

2. Choose birds for implantation that appear to be in the relatively best possible body condition to increase their probability of survival. For those caught in the Chesapeake Bay, the ducks caught later in winter were in the best body condition compared to birds caught earlier in winter.

3. Test newer technologies, such as 5-12 g solar powered backpack transmitters, on captive long-tailed ducks to reduce mortality caused by the invasive surgical technique currently used. If it works this would reduce the handling time, the need for anesthesia, and reduce additional weight of transmitter.

Outreach Efforts and Presentations

A project web page has been created on the SDJV website, [http://seaduckjv.org/atlantic_migration_study.html](http://seaduckjv.org/atlantic_migration_study.html). The web page includes some general outreach products, and links to maps for all species and all elements of this study, including individual bird maps that are updated daily by seaturtle.org. The site also contains important information for partners, including the most updated study plan, SOPs, equipment lists, generic data recording forms, trapping techniques, and project task lists.

Oral presentations related to this study, presented at the 4th International Sea Duck Conference in Seward, Alaska (abstracts available at [http://seaduckjv.org/](http://seaduckjv.org/)):


**Posters related to this study, presented at the 4th International Sea Duck Conference in Seward, Alaska (abstracts available at [http://seaduckjv.org/](http://seaduckjv.org/)):**

Gilliland, Scott G. and Sean Boyd. Tradeoffs in duty cycles for satellite tracking programs for sea ducks.


**Other presentations or products related to this study:**

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<th>Title or Topic of Product</th>
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<td>Spatial and temporal distribution, abundance and flight ecology of birds in inshore and offshore waters of RI</td>
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<td>Marine Bird Cooperative Meeting</td>
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### Wintering ecology of sea ducks in southern New England in relation to potential offshore wind facilities

- **Researchers:** Kris Winiarski, Trocki, Paton, Osenkowski, McWilliams, Loring
- **Conference:** 5th North American Ornithological Conference
- **Date:** Aug 2012

### Developing a framework to monitor sea ducks for offshore wind developments

- **Researchers:** Scott McWilliams, Peter Paton
- **Conference:** 5th North American Ornithological Conference
- **Date:** Aug 2012

### Atlantic and Great Lakes Sea Duck Migration Study

- **Researchers:** Alicia Berlin, R. Therrien, Olsen, Osenton, S. Therrien, and McBride
- **Conference:** Microwave Telemetry Avian and Marine Tracking Conference
- **Date:** March 2012

### Research on Wintering Waterfowl on Chesapeake Bay: What we have learned and where we are headed

- **Researchers:** Alicia Berlin
- **Conference:** Virginia Ducks Unlimited Convention
- **Date:** Feb 2012

### Phenology and Habitat Use of Scoters along the southern New England Continental Shelf

- **Researchers:** Pam Loring
- **Conference:** MS thesis, University of Rhode Island
- **Date:** 2012

## Synopsis

The study is yielding results that are both interesting and will be useful for management purposes. The study is greatly improving our understanding of migration patterns and range affiliations for sea ducks in eastern North America. Some of the more notable results include:

1. Documentation of a previously unknown major breeding area for black scoters west of Hudson Bay and in Hudson Bay lowlands.
2. Emerging evidence of two potentially separate wintering populations of long-tailed ducks, one wintering primarily off the coast of Nantucket, MA and another wintering in Chesapeake Bay, MD.
3. High annual fidelity of black scoters to a molting area in James Bay; used by a high proportion of molting males, and some females.
4. Further documentation of Chaleur Bay and St. Lawrence Estuary as staging areas for high proportions of all species marked so far.
5. Lake Erie may be a key staging area for long-tailed ducks wintering in Chesapeake Bay.
6. Belcher Islands in Hudson Bay appears to be a key stopover for surf scoters and long-tailed ducks during fall.

Capture and marking efforts have been highly successful for black scoters, and most objectives have largely been met for this species. The focus has now shifted to the other three species (surf and white-winged scoters, and long-tailed ducks). Efforts to trap these other species of sea ducks along the mid-Atlantic coast fell short of objectives in 2010-11 and again in 2012, and mortality of marked birds was high. We do not fully understand the reasons for these shortfalls. Mortality of marked birds remains higher than we would like, and calls into question how representative the behavior of surviving birds are relative to unmarked wild birds. Similarly, the strength and accuracy of inferences should be viewed with some caution due to possible transmitter effects.

The SDJV has asked the Harvest Management and Habitat Conservation subcommittees for more explicit guidance about what level of detail (i.e., geographic scale) and precision is necessary to address questions related to harvest management and habitat conservation. Re-evaluation of overall study objectives and sampling plan, including required sample sizes, will continue before and after the each trapping season.

Currently, the plan for 2013 is to 1) mark additional long-tailed ducks in Lake Ontario; 2) conduct a pilot capture effort for white-winged scoters in Lake Ontario; 3) mark white-winged scoters at a wintering area near Boston (Revere Beach); 4) conduct a reconnaissance survey and evaluation of logistics for a future capture event in the Nantucket/Cape Cod area; and 5) re-evaluate the deployment strategy (wintering versus staging area) for surf scoters once the birds marked in Quebec in October 2012 settle out on wintering areas.

Capture events are providing biologists an unprecedented opportunity to collect tissues samples that can be used to examine relationships among populations based on genetics and stable isotopes, screen for diseases, and determine contaminant loads (e.g., mercury). Some of these samples have already been analyzed (e.g., mercury; Savoy et al. 2011), other samples are being archived for future analyses.

The partnership is growing, and in 2012 a significant new partnership was formed with the Bureau of Ocean Energy Management (BOEM) to deploy additional transmitters in surf scoters along the mid-Atlantic coast (North Carolina, Chesapeake Bay, and Delaware Bay) to better evaluate habitat use and potential risk associated with development of offshore wind energy projects. These two projects have overlapping objectives and are complementary. The SDJV and BOEM have similar needs for data management and synthesis and are jointly seeking a long-term (3-4 yrs) solution to database management and GIS-related support for the SDJV and BOEM sea duck and sea bird telemetry projects.

For more information on this project please visit: http://seaduckjv.org/atlantic_migration_study.html
Appendix I. Summary of SDJV and partner contributions ($1000s) to the Atlantic and Great Lakes Sea Duck Migration Study, 2010 and 2011.

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Note: Included in SDJV total for 2012 are some Argos costs for future years.
Literature Cited


