Sea Duck Joint Venture
Annual Project Summary for Endorsed Projects
FY 2013 – (October 1, 2012 to Sept 30, 2013)
Reporting Deadline: September 28, 2013

Project Title: 82. James and Hudson Bays Molting Black Scoter Survey

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Project Description (*issue being addressed, location, general methodology)*:

The primary target species for this survey is the eastern component of the Black Scoter (*Melanitta americana*) population in North America; specifically, adult males (primarily) undergoing remigial moult along the coastlines of James Bay and Hudson Bay. Black Scoters form major concentrations offshore along the coastlines of James / Hudson Bay, most notably along the western James Bay coast of Ontario, where it is suspected that as much as two thirds of the adult male component of the eastern population may gather during summer to undergo feather moult. Previous surveys have shown that western James Bay and Hudson Bay offer critically important molting habitat for eastern Black Scoter. Given the traditional annual use of areas, large numbers and concentrations of individuals and presumed stability of flocks during the flightless period, a survey conducted during the moulting period may provide an ideal opportunity for monitoring the abundance and distribution of the eastern Black Scoter population. This survey also can assist with developing (minimum) population size estimates needed for conservation planning and determining more localized areas within James or Hudson Bay that may be important for birds so present and future threats can be identified and mitigated. Ultimately, it is hoped, that a long–term, ongoing operational survey of moulting Black Scoters at James Bay and Hudson Bay can be established to help inform conservation of Black Scoter (and possibly other sea ducks) by providing data needed to determine population size, track changes in spatial distributions of birds and possibly monitor population trends.

The first aerial, photographic surveys of molting Black Scoter were undertaken by the Canadian Wildlife Service in 1977 and 1991. Those surveys documented large numbers and several areas where bird congregated along the Ontario coastlines of James / Hudson Bay. Those early surveys served as the impetus and foundation for the 2006, 2009 and 2012 surveys and the associated SDJV-sponsored studies that have focused on developing and refining key methodological aspects of the survey (Ross 1983, Ross and Abraham 2006, Ross et al. 2009). Prior to 2013, developmental work has generally focused on establishing standard survey protocols, evaluating results of multiple surveys at various spatial scales to determine among-year and within year variability in counts, assessing technological advancements in photographic equipment, exploring computer-aided enumeration techniques and evaluating possibility of making species and sex-age identifications. Ongoing improvements in digital photography and an increased understanding (based on recent satellite telemetry studies) of chronology, habitat use, seasonal movements and site fidelity of moulting Black Scoters warrants that further refinement and improvements are required for this survey. As a result, additional developmental work was undertaken in 2013 that focused primarily on delineating the geographic extent of the survey area.

During late summer (26 July – 15 August) 2013, we conducted a photographic, aerial survey of molting flocks of scoters found offshore along the James Bay coastline of Quebec and the Hudson Bay coastlines of Quebec, Ontario and Manitoba. Satellite telemetry data suggests that Black Scoters moult within these broad geographic areas, but numbers and specific locales of major concentrations of birds are largely unknown; this information is necessary for delineating the eastern and western limits of a survey area. This survey is conducted at a time when most adult males are thought to have congregated for the remigial molt. Similar to 2012, the survey was conducted using an amphibious, high-winged Quest Kodiak aircraft owned and operated by the USFWS. However, in 2013 a change was made to the aircraft exhaust system that had a major effect on visibility and thus quality and reliability of survey data. Factory/stock exhaust stacks were re-installed on the Kodiak due to safety concerns with continued use of stacks modified to direct hot exhaust below the observer's line of sight to eliminate the resulting blur and distortion. This aircraft was used to locate moulting flocks, which can occur up to 10 km offshore, using a zig-zag search pattern flown at an altitude of approximately 1000 ft above sea level (asl). Daily surveys were conducted around the high tide period and when weather, wind and visibility conditions were favorable. In some areas, information about past locations of satellite-marked Black Scoters using James and Hudson Bays during July and August was

used to modify the search pattern and increased chances of finding flocks of moulting birds. Using this technique we covered nearly the entire area known to date where Black Scoters have been verified or suspected of undergoing remigial molt within James / Hudson Bay. After a flock of birds was located, the aircraft's altitude was reduced to 500 ft asl and flown alongside the flock at a distance no closer than 500 ft at a direction/orientation that optimized light for photography and visual estimation. The photographer, who sat in the right, rear passenger seat, used a digital camera (Nikon D800, 36.3 megapixel FX-format HD-SLR) with image stabilized, telescopic zoom lens (AF-S Nikkor 70-200mm f/2.8G ED VR II) to take multiple, sequential images of each flock. The observer, who sat in the front right passenger seat, visually estimated size/number and species composition of each flock. A GIS-based computer software program, PC Mapper, was used to assist with navigation by displaying map layers of James / Hudson Bays overlaid with locations of satellite-marked scoters. PC Mapper also was used to record and geo-reference both daily flight paths and sound files (MP3) that contained estimated flock sizes.

After daily surveys were completed photographs were downloaded from the camera, the best picture or series of pictures for larger flocks determined and retained for further processing. Sound files also were transcribed and recorded into a database containing estimated species counts as well as the time, latitude and longitude associated with each flock observation. After the entire survey was completed, a comprehensive database was created that included the file name of digital photographs and all associated metadata (including date, time, latitude, longitude, etc), comments on photo quality, comments on reliability of species identification and additional fields for geo-referenced, species-sex-age specific estimated counts (when possible) and photo-based counts. All digital photographs were evaluated to determine which images were of sufficient quality for reliable species and age/sex (brown birds) identification and to the select the best ones to use for manual and computer-aided counts. The computer software ImageJ© was used for photo processing/editing and for counting individual birds in photographs either using the "Cell Counter" feature for manual counts or the "Analyze Particles" feature for more automated, computer-assisted counts.

Objectives *(should identify how the project addresses SDJV priorities*):

The primary overarching goal of this project is to develop and refine the survey methodology to allow for a reliable, effective periodic count of moulting male scoters using James / Hudson Bay that might ultimately serve as an index to the population thereby providing a way to monitor Eastern Population Black Scoter. The main objective in 2013 was to determine an appropriate geographic scope for the survey and secondarily to determine benefits of using higher quality camera equipment than used previously.

Preliminary Results *(include maps, photos, figures/tables as appropriate):*

Data collection and processing

Aerial surveys were flown using an amphibious Quest Kodiak aircraft offshore along the James Bay coastline of Quebec (including the Charlton and Twin Islands, Nunavut) and the Hudson Bay coastlines of Quebec (Cape Jones north to the Nastapoka River north of Umiujaq, Quebec) and the Belcher Islands, Nunavut, Ontario (Sutton River west to the Ontario/Manitoba border) and Manitoba (Manitoba/Ontario border west and north to the Knife River delta north of Churchill, Manitoba). The survey crew consisted of a USFWS Biologist Pilot (S. Earsom) and two CWS Biologists who photographed (F. Bolduc) and located and made visual estimates (S. Badzinski) of flocks. Between 26 July and 15 August 2013, approximately 750 various-sized flocks of molting scoters were observed and photographed (e.g, Plate 1). A subset of photographs was processed and individuals counted from digital images using manual and computer-aided methods (software, ImageJ©) by a contractor between 1 December 2013 and 31 March 2014. In 2013, 39% (240 of 610) of flocks observed were not photographed (mean = 117, median = 50, mode = 25, min = 1, max = 3,335 birds). We used a segmented linear regression to derive an equation describing the relationship between visual estimates and photo counts of the same flocks in order to predict counts more accurately for non-photographed /

counted flocks ($y = x_1 + x_2 + z - 1$, where x_1 [visual estimate < 3,368 birds] = 1.058 ± 0.003, x2 [visual estimate ≥ 3,368 birds] = 6.058 ± 1.389, z = 1.877e+04 ± 50.38e+03; $R^2 = 0.898$, $F_{2, 248} = 738.1$, $P < 0.001$).

Species identification

Contrary to the 2012 survey, species identification during the 2013 survey was difficult because heat and exhaust from the aircraft blurred the front observer's and photographer's field of vision. Because of uncertainties with species identification, particularly at east James Bay and southeast Hudson Bay, 2013 numbers reported throughout include all three species combined (Scoters). The exhaust issue, combined with suboptimal light and sea conditions some days, greatly affected not only direct visual observation of field marks but also photograph quality making reliable species identification, even from digital images, challenging or, in many cases, impossible (Plate 1). This problem also made it impossible to identify or determine any potential benefits derived from using higher quality camera equipment this year. However, based on information obtained from water landings, bird behavior, flock characteristics and photographs of sufficient quality to identify birds/field marks, some general patterns were surmised regarding the geographic distribution of Black Scoter, Surf Scoter and White-winged Scoters within the area surveyed. Black Scoters appeared to be the dominant species at southeast James Bay, principally in the area from the Ontario/Quebec border to the Conn River, as well as along the Ontario and Manitoba coastlines of Hudson Bay (Figure 1 & 2). Species compositions in both of those areas appeared similar to those observed during the 2012 survey of western James Bay. Although some Black Scoters also were observed, Surf Scoters and White-winged Scoters appeared to be much more common and locally abundant at eastern James Bay and particularly in the area north of the Conn River to Cape Jones, as well as at southeast Hudson Bay, including the Belcher Islands. Based on experience and results of the 2012 survey, these presumed species distributions and compositions could be verified during future surveys using an aircraft properly setup for photographic, aerial surveys (i.e., modified exhaust ports, camera port window).

Abundance and distribution

A total of 215,601 scoters were observed in the areas covered during the 2013 survey (Table 1, Appendix 1). The fewest moulting flocks were observed in northeast James Bay where nearly all 14,921 birds were observed along the Quebec coastline between the Conn River and Cape Jones and only a few hundred scoters were observed far offshore near the Twin Islands (Table 1, Figures 3 & 4). Approximately 35,000 scoters were observed at southeast James Bay, with 22,737 along the Quebec coastline primarily between the Eastmain River and Conn River and another 11,906 observed further offshore near Charlton Island (Table 1, Figure 3). There were about 44,000 scoters observed in southeast Hudson Bay where major moulting concentrations were widely distributed and found mainly along the Quebec coastline in vicinity of Cape Jones and at Long Island Sound, Manitounuk Sound, Lac Guillaume-Delisle and Nastapoka Sound (Table 1, Figure 5). The largest concentrations of molting scoters in southeast Hudson Bay were located at the Belcher Islands where more than approximately 25,000 birds were observed at several of the large inlets, bays and sounds associated with the archipelago (Table 1, Figure 5). Notably, 2013 was the first time the Manitoba coastline of Hudson Bay had ever been explored in search of moulting scoters and it was within that area where the largest moulting concentrations were observed; about 94,000 scoters were discovered in the area between the Kettle River and Mistokokan River (Table 1, Figure 6). However, elsewhere in southeast Hudson Bay flocks of scoters were relatively small and more widely distributed along coastlines of Manitoba and Ontario. Further west and north of the Mistokokan River along the Manitoba coastline, the largest concentration, about 8,000 scoters, was located between Port Nelson and Rupert Creek with smaller flocks numbering in the low hundreds found widely distributed further north toward Churchill and the Knife River Delta (Table 1, Figure 6). Along the Ontario coastline of Hudson Bay, the largest concentration, about 12,000 scoters, was located near the Shagamu River and Shell Brook and smaller concentrations in the 2 - 3 thousand bird range were observed near the Sutton River, Ministik Creek and Pen Islands (Table 1, Figures 7

& 8); tens of thousands of Black Scoters were observed in these areas during the 1977 and 1991 surveys (Table 2).

Survey area delineation

The numerous aerial, photographic surveys of moulting Black Scoters periodically conducted between 1977 and 2012 have shown that large areas of western James Bay, including Akimiski Island, is a major moulting area for (primarily male) Black Scoter. This area previously has been identified for inclusion as part of a core area for version of the survey. There has been discussion recently about whether other areas, such as eastern James Bay, southeastern Hudson Bay and southwestern Hudson Bay, should be included in a fully operational survey. Recent satellite telemetry data suggests that Black Scoters do moult in those areas, but surveys have either never been conducted, have been of limited spatial or one-time coverage, or were flown many years ago in those areas. For example, it was suggested previously that eastern James Bay not be included in an operational survey because relatively few moulting scoters were observed in that area (Cotter et al. 2009). Since that time, a considerable amount of the known and suspected moulting range of eastern Black Scoter (based on satellite telemetry data) has now been investigated and repeat or updated coverage of some areas has just been completed to better inform recommendations regarding methodology, design and geographic scope of an operational survey.

Past surveys of the Ontario coastline of Hudson Bay made during 1977 and 1991 documented widely scattered, but locally abundant concentrations of Black Scoters (primarily adult male) similar in number (~35,000 – 45, 000) to those found in recent years at western James Bay and around Akimiski Island. In 2013, about half as many birds (~ 20,000) were observed along the Ontario coastline of Hudson Bay as compared to preceding surveys, but approximately 94,000 scoters were observed further west in an area never before surveyed along about 175 km of coastline between the Black Duck River and the Mistokokan River (~50 km east of the Nelson River inlet). Notably, this general area was used during the molt period in previous years by several Black Scoters marked with satellite transmitters. Based on the information collected to date, it appears that the Hudson Bay coastlines of Ontario and Manitoba up to the Rupert Creek area (50 km north of Port Nelson, MB), contains a substantial number of moulting scoters and, in addition to western James Bay, should be included as part of the core area for an operational survey. Numbers and flocks of scoters were few and scattered north of Rupert Creek along the Manitoba coastline of Hudson Bay and few satellite marked birds used the area, which suggests it could be excluded from the core area. However, Rupert Creek is closer to the airport in Churchill, MB than to the one in Gillam, MB so for logistical reasons the primary survey area could include the Manitoba coast up to Churchill. The Manitoba coast north of Churchill up to the Manitoba/Nunavut border could be included in a secondary survey area that is periodically surveyed to detect shifts in distribution. The Manitoba (north of Churchill) and Nunavut coastlines of Hudson Bay have never before been surveyed for moulting scoters, but that area warrants investigation because numerous Black Scoters marked with satellite transmitters presumably breed inland from this area.

Before 2013, east James Bay and southeast Hudson Bay (including the Belcher Islands) had been surveyed by Environment Canada only once previously in 2009. Fewer than 5,000 scoters were observed at that time with about equal numbers in southeastern James Bay and around the Belcher Islands – Hudson Bay (Table 2). However, more than 35,000 molting scoters (all three species) were reported by a consultant in 1993 along the northeastern James Bay coast between Riviere au Castor and Cape Jones (Pointe Louis-XIV) (Benoit et al. 1994). The 2009 survey crew did not yet have satellite telemetry data from Black Scoters available to direct them to potential locales within the vast area where moulting scoters might be concentrated. In 2013, we were able to utilize those data which allowed us to locate a substantial number of scoters. Most notably, we observed about 35,000 scoters in southeast James Bay along the Quebec coastline and in the vicinity of Charlton Island, which was similar to numbers recorded at southwest James Bay and Akimiski Island since 2009 and far exceeded numbers in those areas before that time (Table 2). Because the east and west coasts of

James Bay have never been surveyed in the same year, it is unknown if a large proportion of birds observed in west James Bay during 2012 relocated from there (or other major molt areas) and happened to be detected further east in 2013. Certainly Surf Scoters and White-winged Scoters made up some proportion of the birds in southeast James Bay, but a substantial number were suspected to be Black Scoters. As previously noted, future surveys of this area could verify species composition. Regardless, southeast James Bay should be included in a fully operational survey based on the number of scoters observed in 2013 and its proximity to major moulting concentrations at southwest James Bay and Akimiski Island.

Some locales in northeast James Bay and southeast Hudson Bay, particularly the Cape Jones area, Long Island Sound, Lac Guillaume-Delisle and the Belcher Islands, contained substantial concentrations of moulting scoters, but Surf Scoter and White-winged Scoter appeared to be the dominant species. Based on this supposition, and given Black Scoter are the target species, inclusion of northeast James Bay and southeast Hudson Bay as part of the core survey area is not warranted at this time. However, periodic monitoring of this area is warranted because it would provide an opportunity to verify species composition, detect shifts in the Black Scoter moulting range and allow for data to be collected on abundance and distribution of Surf Scoters and White-winged Scoters using those areas. In order to even periodically survey this area, a separate aircraft and survey crew, primarily based out of towns in northern Quebec, would be required due time constraints and the unpredictable weather (i.e., fog, rain, and wind) often associated with James / Hudson Bay and the extensive geographic scope of core survey area.

Project Status ***(e.g., objectives accomplished, encounter any obstacles, plans for the future?)***

This is the most recent developmental aspect of this project and has provided adequate information upon which to make some conclusions regarding the feasibility of this survey becoming operational. The Canadian Wildlife Service – National Scoter Monitoring Strategy Working Group is currently considering this survey as candidate for monitoring monitor eastern population Black Scoter. The final report of this working group should be completed in late 2014. Below is a list summarizing major conclusions and recommendations resulting from all developmental work conducted since 2006.

Conclusions and Recommendations

- This aerial, photographic survey can provide useful information to monitor changes in relative abundance, habitat use and geographic distribution for the male segment of the Eastern Population of Black Scoter moulting at James Bay and Hudson Bay.

- Species and age/sex class can be determined from high quality digital images; if desired, correction factors could be developed from photographs.
    - Adult male black scoters seem to be the dominate (~ 95% of birds) age-sex class observed, at least at south/west James Bay and southwest Hudson Bay.
    - "Brown birds" (females and sub-adult males) occur in relatively small numbers intermixed in flocks of adult males or, in some cases, in separate flocks where they are the dominant class of birds.
    - Both Surf Scoters and White-winged Scoters have been observed at all major moult locales, but evidence to date suggests relatively few typically seem to intermix with Black Scoters (at least at west James Bay and Ontario coastline of Hudson Bay) and most often occur in separate flocks where they tend to be the predominate species.
    - ➢ Additional developmental work is warranted for evaluating and verifying species identification, particularly within major moulting locales at southeast James Bay and Hudson Bay.

- A census-type survey may be justified over one using a sampling approach because under ideal conditions complete coverage of flocks is feasible due to their linear distribution along coastlines.
    - A small number of replicate surveys (n = 3) conducted during 2009 at one major moult site in southwest James Bay (Longridge Point area) showed relatively good agreement between the highest counts (26 July = 38,700 vs. 27 July = 37,700; 4% difference) which were conducted under similar, optimal survey conditions. The largest difference (12%) between the highest and lowest counts (28 July = 34,000) was attributed to the latter survey being conducted during a falling/low tide when feeding/diving tends to increase; supports conducting the survey centered on high tide period and using other standard procedures developed previously.
    - Future developmental work could focus on evaluating the assumption that flock detection probability is close to 1.0. Doing so also would provide more data/larger sample size to assess repeatability of counts and thus determine if the survey can provide reliable data for monitoring population trend.

- Survey timing should coincide with the peak period of wing moult of male Black Scoter.
    - This survey assumes that the moulting male segment of the population is a reliable and representative index for monitoring changes for the entire population.
    - Moult for adult males typically occurs and peaks between late-July and early-August, based on past observations and recent satellite telemetry data (Gilliland et al., Unpublished data).
    - Surveys timed during late August to early September would likely increase the probability of encountering females. Satellite telemetry suggests that during that period females depart breeding areas and relocate to the same areas previously used by moulting males in James Bay and Hudson Bay (Gilliland et al., Unpublished data).

- The geographic scope of an operational survey should be sufficiently extensive to encompass the core of the known moulting range of Black Scoter.
    - Surveys conducted during 2006, 2009 and 2012 of 3 major moulting locales within western James Bay (i.e., SW James Bay, Akimiski Island area, NW James Bay) suggests there can be considerable variation in annual counts at each area.
    - Recent satellite telemetry data suggests a relatively high degree of fidelity to specific moulting sites, but some individuals did use different major moulting locales from year to year (Gilliland et al., Unpublished data).

- A primary survey area should be established that encompasses the core of the Black Scoter moulting range; this area should be surveyed completely at regular intervals (e.g., every 3 - 4 years). The majority of moulting flocks are located within ~ 10 km of coastlines. Based on evidence to date, the primary/core area should include:
    1. The Hudson Bay coastline of Manitoba from Churchill, MB south and east continuing along the Ontario coastline to Cape Henrietta Maria;
    2. The James Bay coastlines of Ontario and Quebec between Cape Henrietta Maria south and east to the Conn River, including Akimiski Island and Charlton Island.
- "Secondary survey areas" could be established adjacent to the primary area to detect shifts in the moulting range; the area could be completely surveyed periodically (e.g., every second time). Based on evidence to date, this area should include:
    1. The Quebec coastline of James Bay north of the Conn River to Cape Jones, along the Quebec coastline from Cape Jones to the north end of the Nastapoka Sound (based on satellite telemetry data, this area encompasses the northern most suspected moulting locales of Black Scoters using east Hudson Bay);

2. The Belcher Islands, Nunavut (based on the large number of scoters (presumed mainly Surf and White-winged Scoter), observed in 2013 and its proximity to other suspected Black Scoter moulting locales).
3. The Manitoba coastline of Hudson Bay from Churchill north to the Manitoba/Nunavut border. Based on satellite telemetry data, this area encompasses the northern most suspected moulting locales of Black Scoters using west Hudson Bay (Gilliland et al., Unpublished data).

➢ Future developmental work should include a reconnaissance survey of the Hudson Bay coast north of the Manitoba/Nunavut border because that area has never been investigated and it is close / adjacent to areas where satellite-marked females were located during the summer breeding season (Gilliland et al., Unpublished data).

- A high-winged twin-engine, or single-engine amphibious, aircraft are the best platform.
  - Specific aircraft to consider include: Cessna 337, Rockwell Aero-Commander, De Havilland Twin Otter, Partenavia P68 or Quest Kodiak [USFWS].
  - High-winged aircraft offer good visibility, twin-engine and amphibious qualities offer a degree of safety.
  - Aircraft with extended fuel/range capacity is preferable for work in the far north.
  - An appropriate aircraft equipped with a camera port window is recommended for optimal picture quality. Having a camera port on both sides of the aircraft is preferable and offers most flexibility; having one on the pilot's side makes it easier for positioning the aircraft to photograph scoter flocks most effectively.
  - The heat and exhaust plume emitted from some aircraft can adversely affect observer visibility and photograph quality; the use of such aircraft is not recommended (e.g., Quest Kodiak with stock, versus modified, exhaust ports).

- Conduct the survey using previously developed, standardized survey protocols and, to the greatest extent possible, under optimal survey conditions.
  - Optimal time is approximate 4 hour period centered on a high tide event (birds feed less & groups coalesce = easier to find) and during mid-day (~ 0900 hrs – 1600 hrs EDT (birds feed less & avoids low angle of sun, minimizes glare);
  - Optimal environmental conditions are minimal wind, calm seas, no rain/fog, and high, thin overcast sky (bright conditions with minimal glare from the sun); offer excellent visibility of flocks, plus ideal conditions for photography;
  - Employ a zig-zag search pattern to increase visibility/detection of distant flocks and effectively cover the survey area (may extend up to 10 km or more offshore);
  - Optimal altitude to search for and locate flocks is approximately 1000 ft asl;
  - Optimal height/distance from birds that minimizes avoidance behaviour (and is best for photography) is 500 ft above and at least 500 ft off to the side of flocks.

- Obtain the highest quality pictures possible of moulting scoter flocks.
  - Use the highest resolution digital SLR camera (≥ 20 mega pixels) and highest quality image-stabilized, telephoto (70 – 200mm) lens possible to obtain bright, sharp images best suited for counting birds and identifying species/age/sex.
  - The aircraft should be no closer than 500 ft and banked at the steepest (yet safest) angle possible to offer the best overhead view of a flock and orientated in a way to provide favorable light conditions for photographing flocks (i.e., minimal sun glare and front-lit subjects).
  - Take numerous pictures of the same flock in its entirety using the continuous shoot setting of the camera to increase the probability of getting at least one good quality picture.

    - Continuous shooting is necessary for taking overlapping pictures of large or long, linear shaped flocks if it is not able to be captured in a single frame.

- Photograph-based counts should be used whenever possible to determine the actual number of birds in flocks due to considerable variability in observer ability to accurately estimate flock sizes.
    - The most efficient, yet accurate, method of counting individuals in photographs should be used (i.e., manual or computer-aided counts) depending on image quality and flock size.
    - Visual estimates (photo-corrected for observer bias) of flocks can be used to determine the number of individuals when photographs were not taken or they were unsuitable to count.
    - The free, computer software ImageJ© has a feature called "cell counter" that can be used to manually mark and count birds in digital images displayed on a computer monitor; it also allows several different classes of objects (e.g., species, age-sex classes, etc) to be tallied and recorded during a single counting session.
    - Manual counts of individuals in digital photographs can be time consuming, but required when image quality is relatively poor and can be just as fast (sometimes faster) than using computer-aided/automated methods for relatively smaller flocks (e.g., 1 – 100 birds).
    - The ImageJ© software has feature called "analyze particles" that can be used for automated counts (Plate 2). This feature can record relatively, fast and accurate counts of individuals (within about 1% of manual counts of same flocks), particularly when relatively high quality images are used (i.e., sharp, clear, bright and good contrast of dark birds on light background). Time savings are most pronounced for counts of relatively large flocks.

- Logistical planning is an important aspect of aerial surveys conducted in the far north in remote locations, a few key considerations are:
    1. Two survey crews, consisting of a pilot, observer and photographer, should be used to cover the entire primary (core) survey area;
        - One survey crew could base out of Moosonee, and possibly Attawapiskat, and under ideal weather conditions should be able to complete the survey in 8 days (note: advance arrangements for bulk Jet A fuel could be made with Air Creebec at the Moosonee and Attawapiskat airports).
        - A second survey crew could base out of Peawanuck, Ontario and Gillam, Manitoba and under ideal weather conditions should be able to complete the survey in 7 days. Bulk fuel is available at Peawanuck (via OMNR) and Gillam airports, but drum Jet A fuel would need to be cached at the airport in Fort Severn, Ontario.
    2. A third survey crew would be required to cover the secondary survey area at northeast James Bay and southeast Hudson Bay. This crew would base out of Moosonee, Ontario, Radisson, Quebec, Kuujjuarapik, Quebec and Sanikiluaq, Nunavut - Belcher Islands. Bulk Jet A fuel is available at airports in each of these communities (note: advance arrangements for bulk Jet A fuel can be made with the Kuujjaurapik and Sanikiluaq airports; bulk Jet A fuel is readily available at the Radisson/LaGrande airport).
        - The secondary survey area along the Manitoba coastline of Hudson Bay could be surveyed in 2 additional days by the crew covering the core area in southwest Hudson Bay. Bulk fuel is available at the airport in Churchill, Manitoba.
    3. An authorization is required to fly over eastern James / Hudson Bay. Permission must be sought from the Nunavik Marine Region Wildlife Board (Inuit; www.nmrwb.ca) and the Eeyou Marine Region Board (Cree) well in advance of the survey.
    4. Approximate costs to conduct surveys of various sections of the James Bay and Hudson Bay coasts are included in Appendices 2 & 3.

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Project Funding Sources (US$). Complete only if funded by SDJV in FY13; this is used to document: 1) how SDJV-appropriated funds are matched, and 2) how much partner resources are going into sea duck work. You may Include approximate dollar value of in-kind contributions in costs. Add rows as needed for additional partners.

SDJV (USFWS) Contribution	Other U.S. federal contributions	U.S. non-federal contributions	Canadian federal contributions	Canadian non-federal contributions	Source of funding (name of agency or organization)
28,500					USFWS (Contract aircraft & pilot)
			41,000		CWS (salary, travel equipment & fuel)
			5,000		OMNR (accommodation, fuel caching)

Total Expenditures by Category (SDJV plus all partner contributions; US$). Complete only if project was funded by SDJV in FY13; total dollar amounts should match those in previous table.

ACTIVITY	BREEDING	MOLTING	MIGRATION	WINTERING	TOTAL
Banding (include only if this was a major element of study)					
Surveys (include only if this was a major element of study)		74,500			
Research					

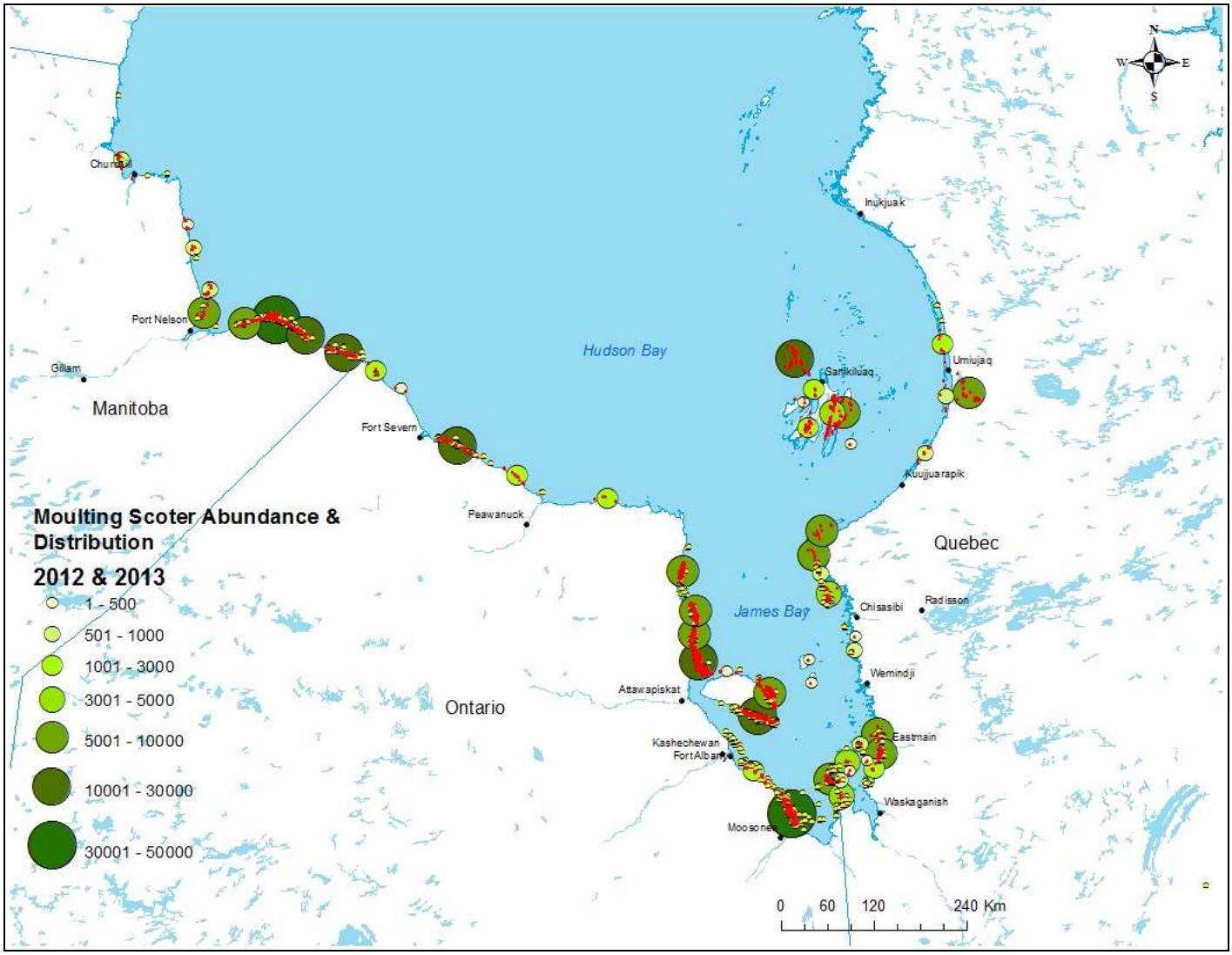

Figure 1. Abundance and geographic distribution of moulting scoters observed during aerial, photographic surveys conducted between late-July and mid-August 2012 and 2013 at James Bay and Hudson Bay. Green circles represent summed abundances of birds in areas where numerous moulting flocks (red circles) of scoters were concentrated. Yellow circles are locations used by Black Scoters implanted with satellite transmitters during the molt period in July and August 2009 – 2012; locations were included to show the suspected extent of the moulting range of the species in relation to direct observation of locations and abundances of scoters recorded during aerial surveys.

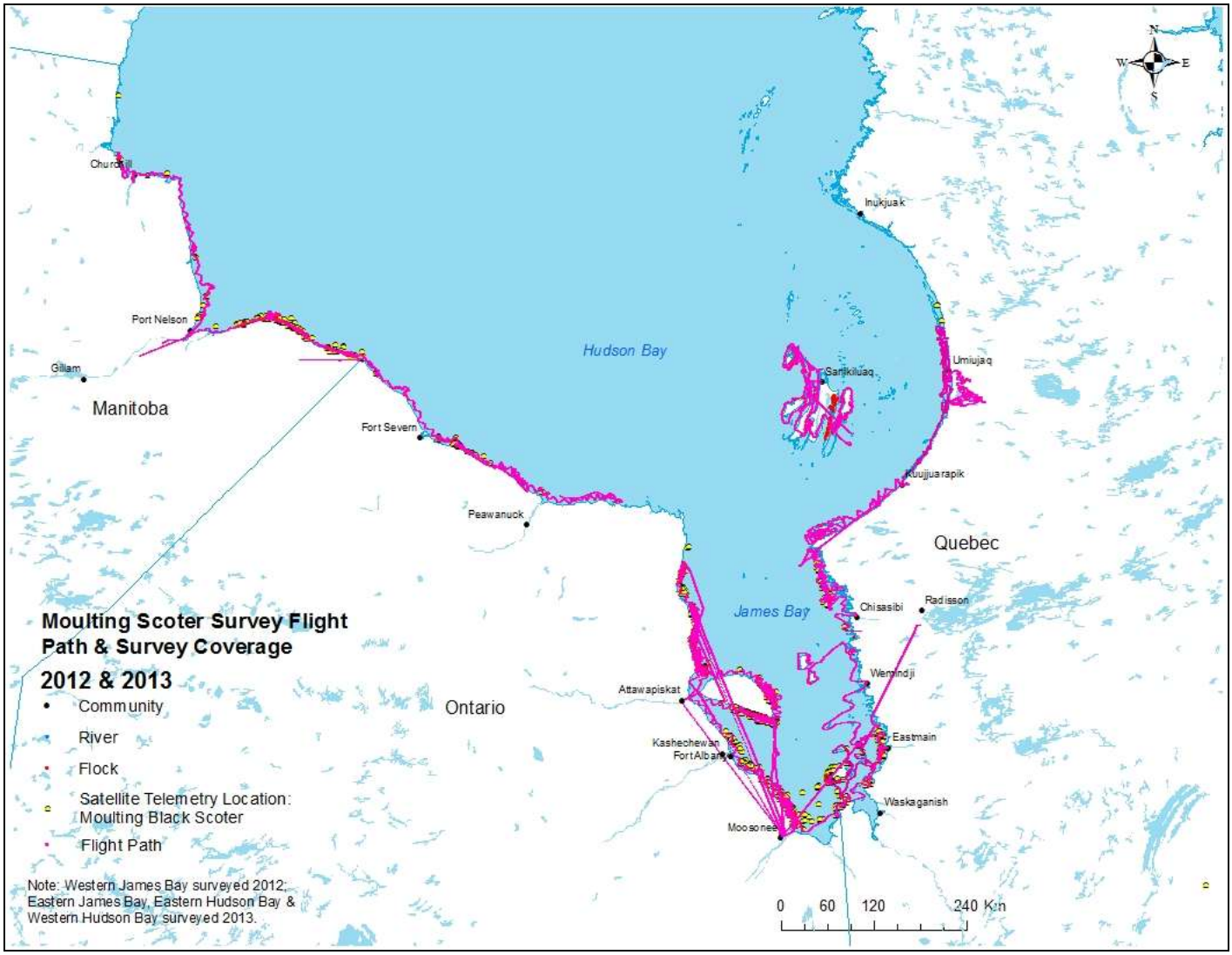

Figure 2. Flight paths and areas covered during the Moulting Scoter Survey in 2012 and 2013. Note: the area around Cape Henrietta Maria in Ontario is difficult to survey due to often foggy conditions and also has not been surveyed any time before 2012.

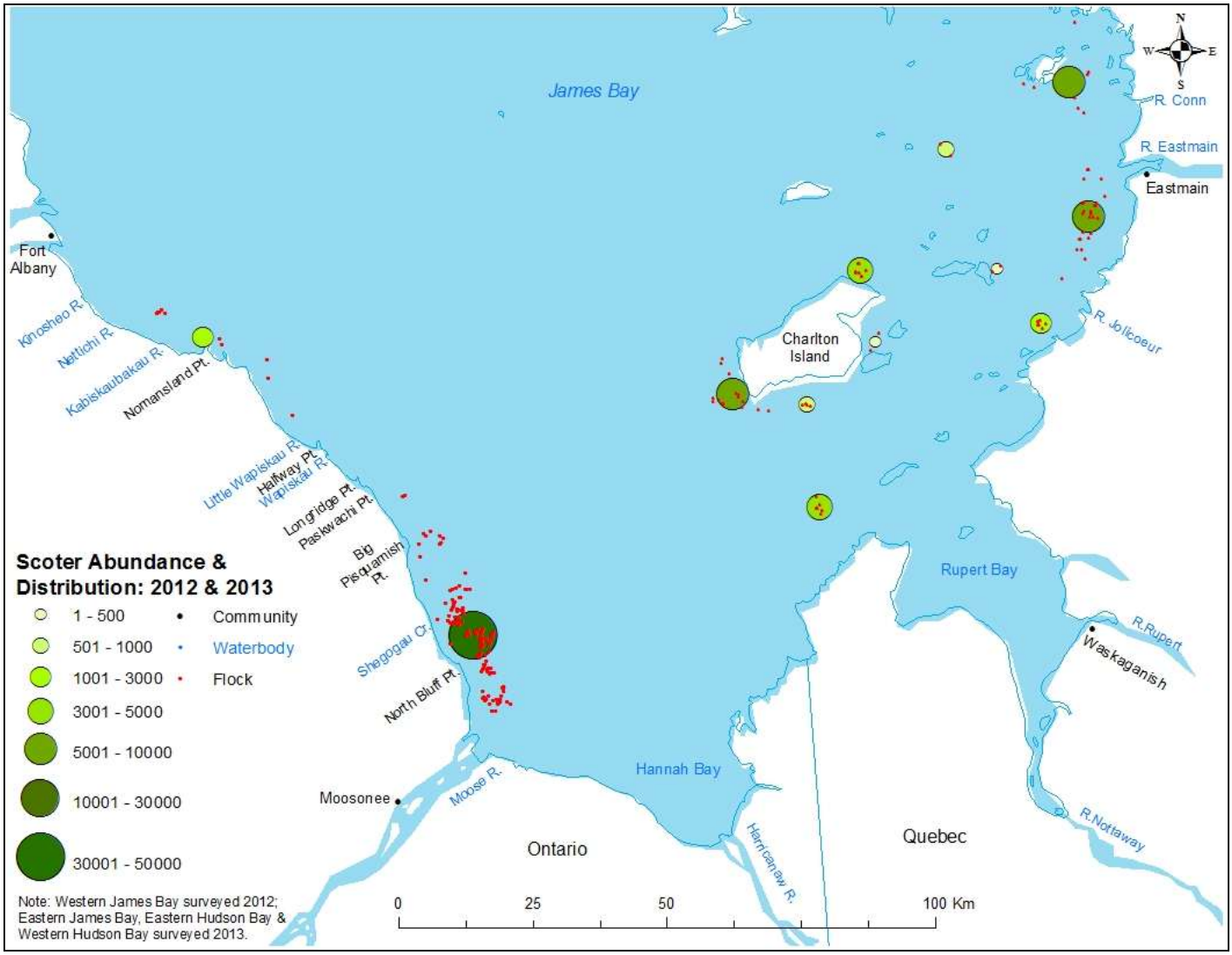

Figure 3. Abundance and geographic distribution of moulting scoters observed during aerial, photographic surveys conducted between late-July and mid-August 2012 and 2013 at south James Bay in the vicinity of Moosonee, Ontario and Waskaganish and Eastmain, Quebec. Green circles represent summed abundances of birds in areas where numerous moulting flocks (red circles) of scoters were concentrated.

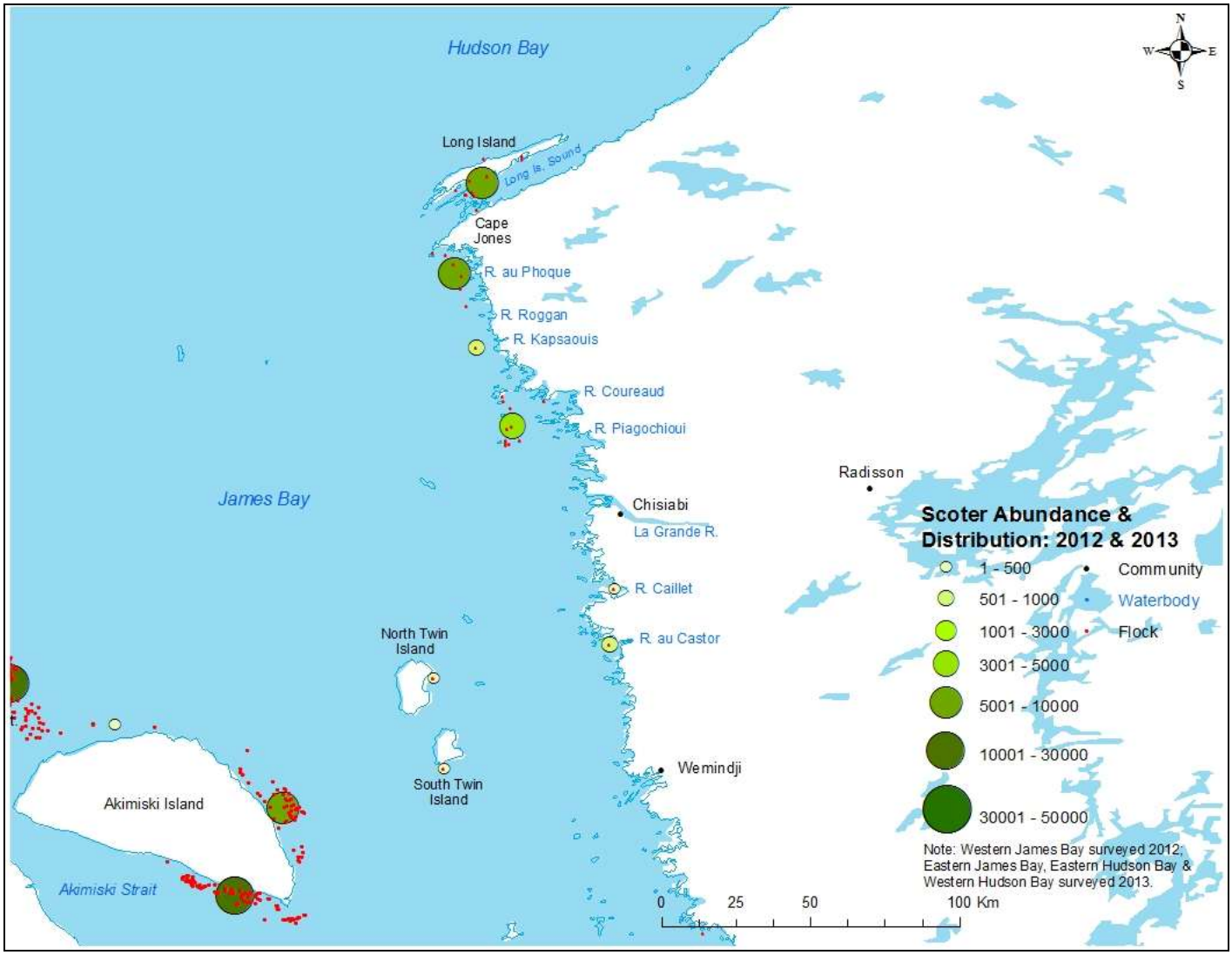

Figure 4. Abundance and geographic distribution of moulting scoters observed during aerial, photographic surveys conducted between late-July and mid-August 2012 and 2013 at northeast James Bay in the vicinity of Wemindji and Chisiabi, Quebec. Green circles represent summed abundances of birds in areas where numerous moulting flocks (red circles) of scoters were concentrated.

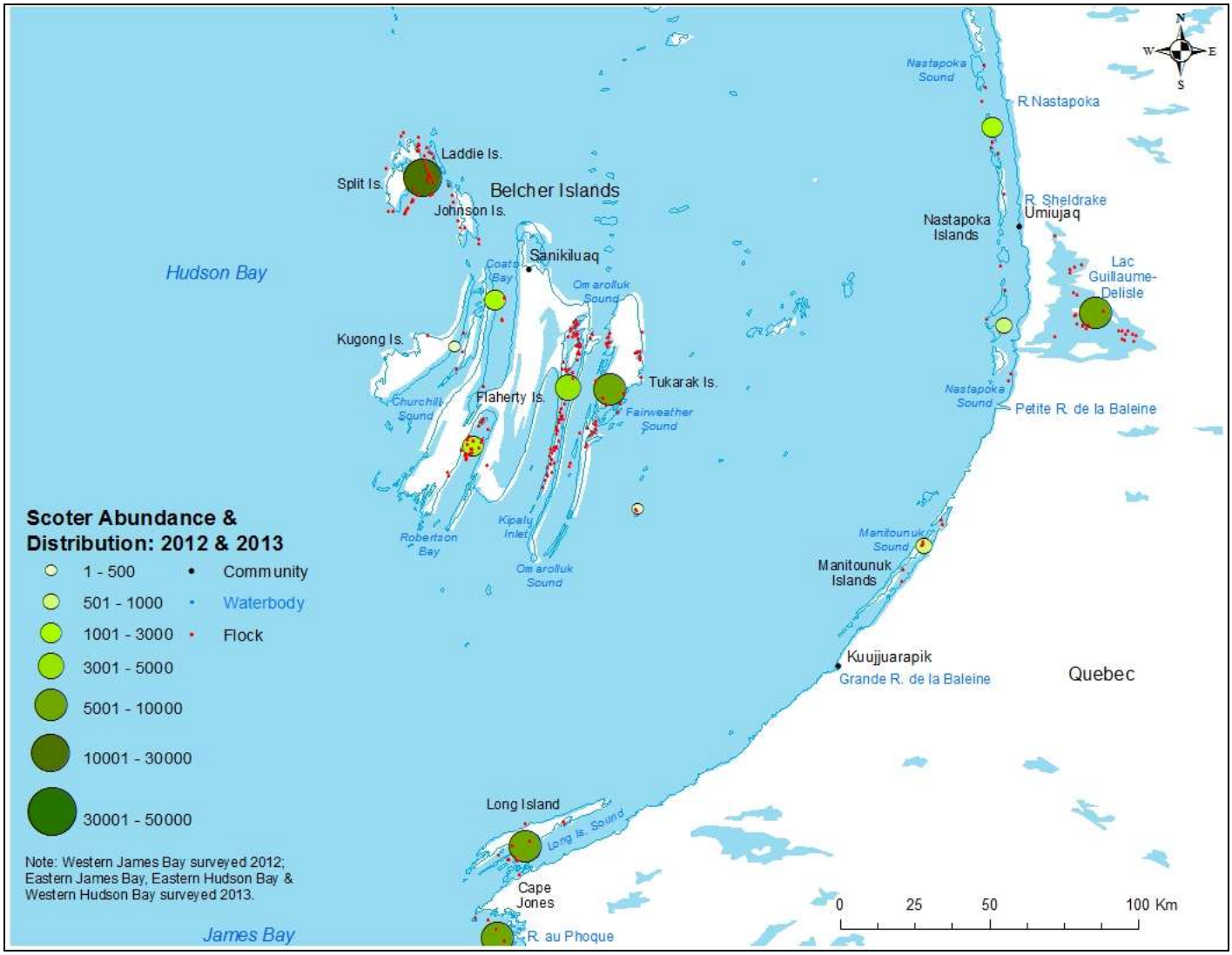

Figure 5. Abundance and geographic distribution of moulting scoters observed during aerial, photographic surveys conducted between late-July and mid-August 2012 and 2013 at southeast Hudson Bay in the vicinity of Kuujjuarapik and Umiujaq, Quebec and Sanikiluaq – Belcher Islands, Nunavut. Green circles represent summed abundances of birds in areas where numerous moulting flocks (red circles) of scoters were concentrated.

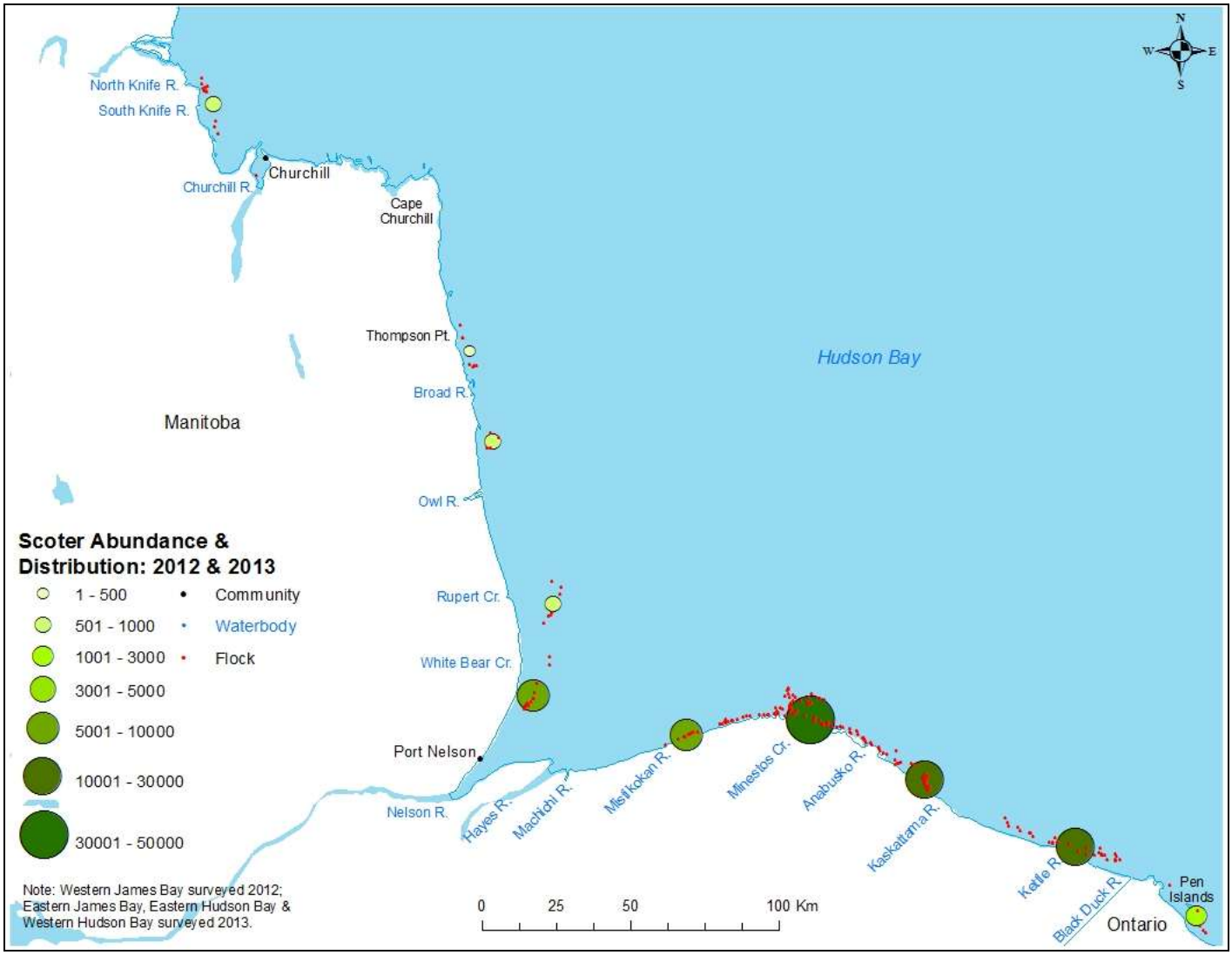

Figure 6. Abundance and geographic distribution of moulting scoters observed during aerial, photographic surveys conducted between late-July and mid-August 2012 and 2013 at southwest Hudson Bay in the vicinity of Port Nelson and Churchill, Manitoba. Green circles represent summed abundances of birds in areas where numerous moulting flocks (red circles) of scoters were concentrated.

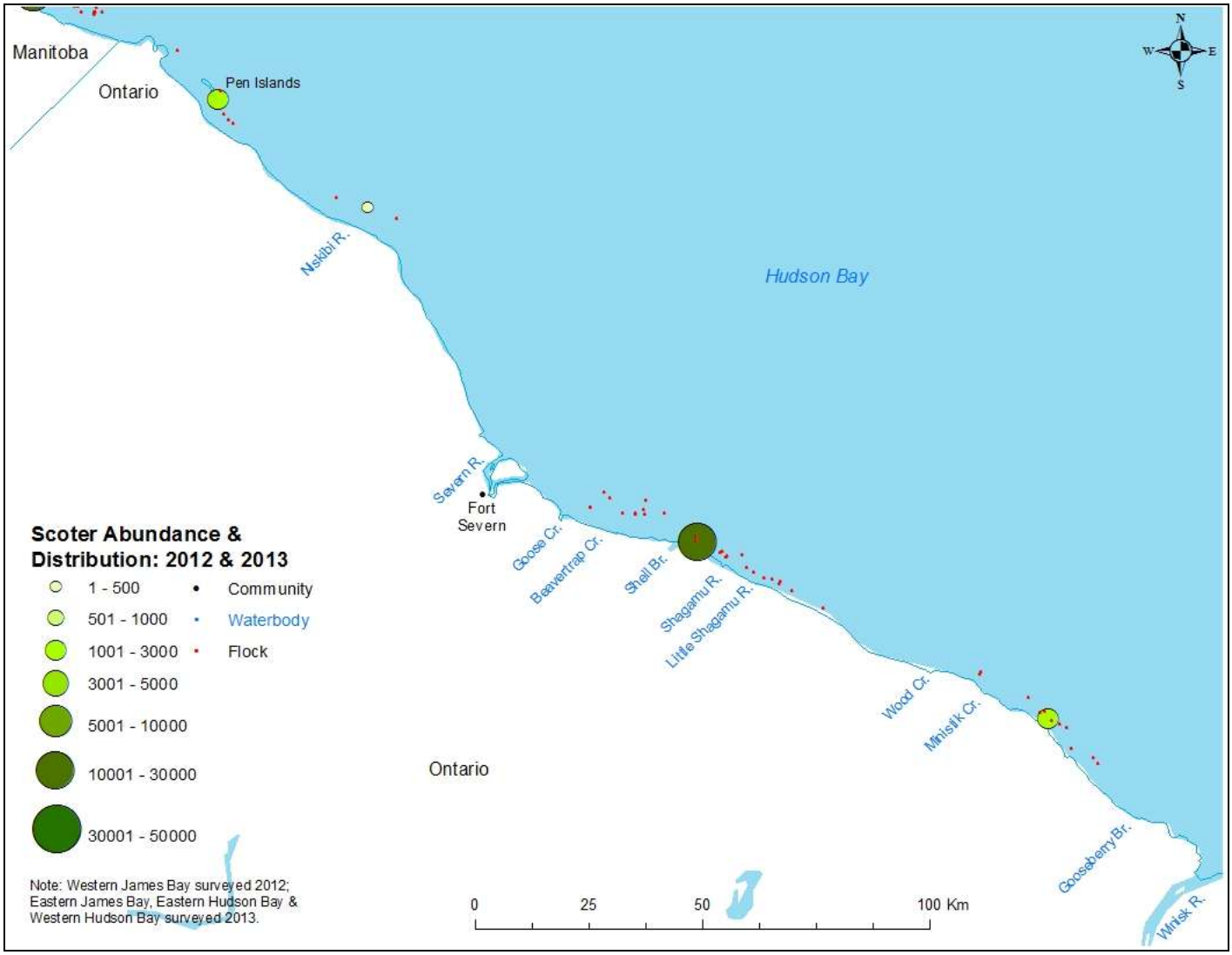

Figure 7. Abundance and geographic distribution of moulting scoters observed during aerial, photographic surveys conducted between late-July and mid-August 2012 and 2013 at southwest Hudson Bay in the vicinity of Fort Severn, Ontario. Green circles represent summed abundances of birds in areas where numerous moulting flocks (red circles) of scoters were concentrated.

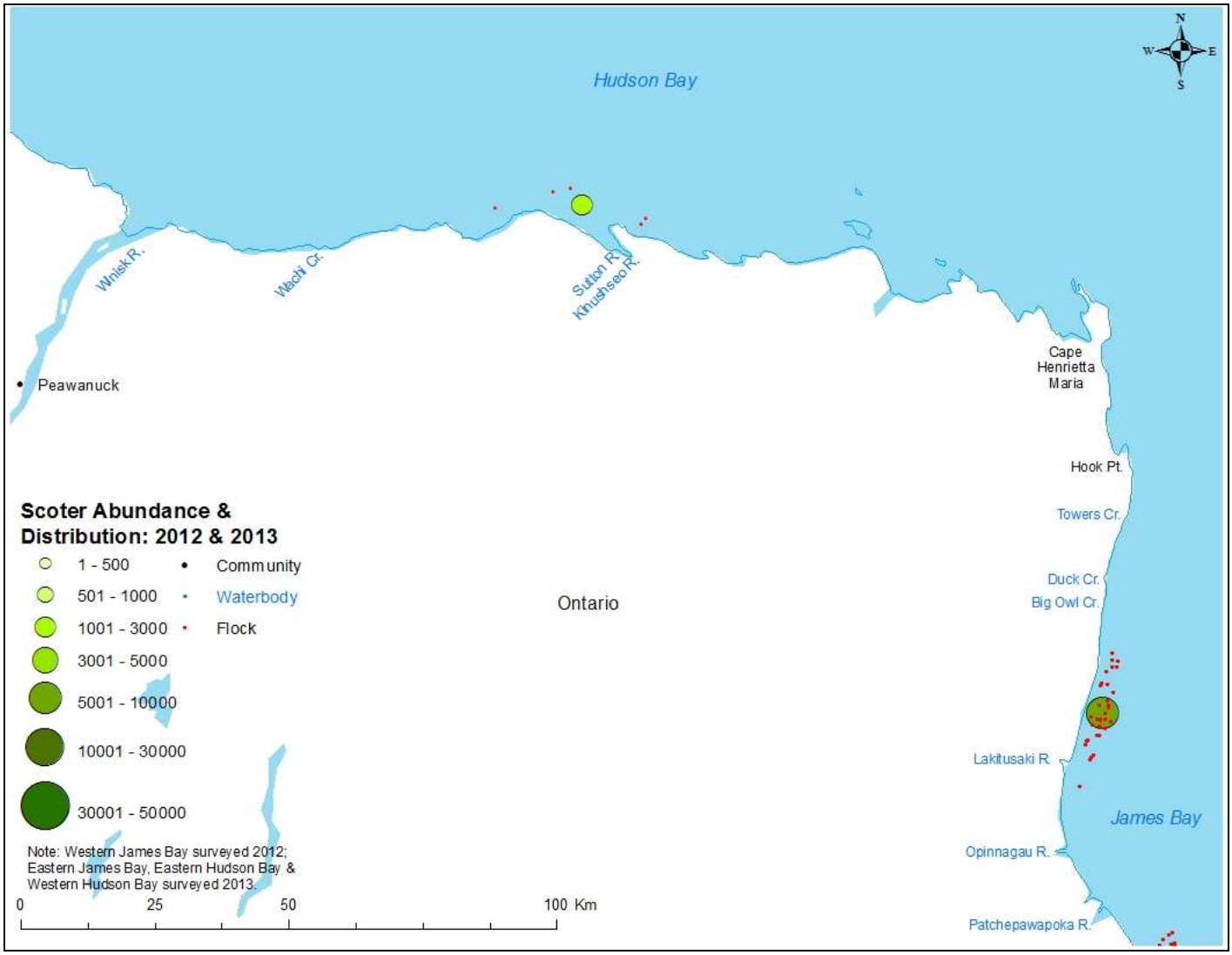

Figure 8. Abundance and geographic distribution of moulting scoters observed during aerial, photographic surveys conducted between late-July and mid-August 2012 and 2013 at northwest James Bay and southwest Hudson Bay in the vicinity of Cape Henrietta Maria and Peawanuck, Ontario. Green circles represent summed abundances of birds in areas where numerous moulting flocks (red circles) of scoters were concentrated.

Table 1. The estimated number and geographic location of moulting flocks and scoters observed at eastern James Bay and Hudson Bay between 26 July and 15 August 2013.

Area	Flocks	Birds
Southeast James Bay - Total	**81**	**34,643**
Quebec Coast - ON/QC border to R. Conn	49	22,737
Charlton Islands, NU	32	11,906
Northeast James Bay - Total	**23**	**14,921**
Quebec Coast – R. Conn to Cape Jones	20	14,699
Twin Islands, NU	3	222
Southeast Hudson Bay - Total	**259**	**43,721**
Quebec coast - Cape Jones to Nastapoka Sound	30	10,660
Lac Guillaume-Delisle, QC	25	7,466
Belcher Islands, NU	204	25,595
Western Hudson Bay - Total	**247**	**122,316**
ON coast - Sutton R. to MB/ON border	49	19,111
MB coast - MB/ON border to Knife R.	198	103,205

Table 2. Summary results of all surveys of molting Black Scoters at James / Hudson Bay.

Survey area	1977	1991	2006	2009	2012	2013
Northern James Bay, ON coast	42,600	37,640	46,570	40,110[a]	46,870[a]	NS
Akimiski Island	NS[b]	NS	33,080	21,820	31,393	NS
South shore	NS	NS	(15,980)	(18,220)	(22,567)	NS
North shore	NS	NS	(17,100)	(3,600)	(8,826)	NS
Southern James Bay, ON coast	2,400	16,320	9,810	44,670	47,106	NS
Eastern James Bay, QC coast	NS	NS	NS	1,605	NS	37,658
Charlton Islands	NS	NS	NS	NS	NS	11,906
Eastern Hudson Bay, QC coast	NS	NS	NS	930	NS	18,126
Belcher Islands	NS	NS	NS	1,796	NS	25,595
Western Hudson Bay, ON coast	43,700	33,570	NS	NS	NS	19,111
Western Hudson Bay, MB coast	NS	NS	NS	NS	NS	103,205

[a]Incomplete count.
[b]NS = No survey conducted.

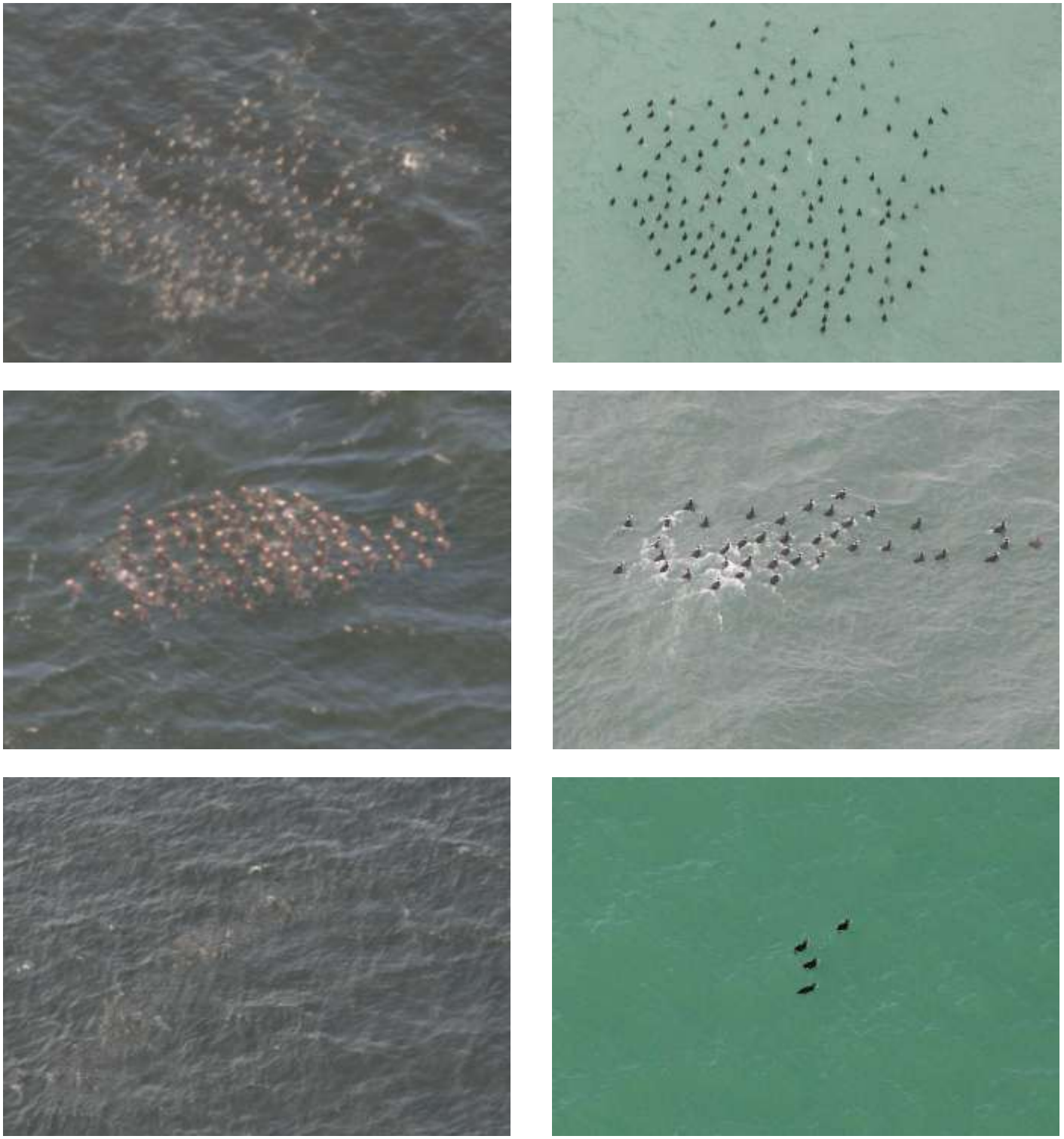

Plate 1. Photographs of Black Scoters (top), Surf Scoters (middle) and White-winged Scoters (bottom) taken during the 2013 (left) and 2012 surveys (right) showing the degree of image quality reduction between years.

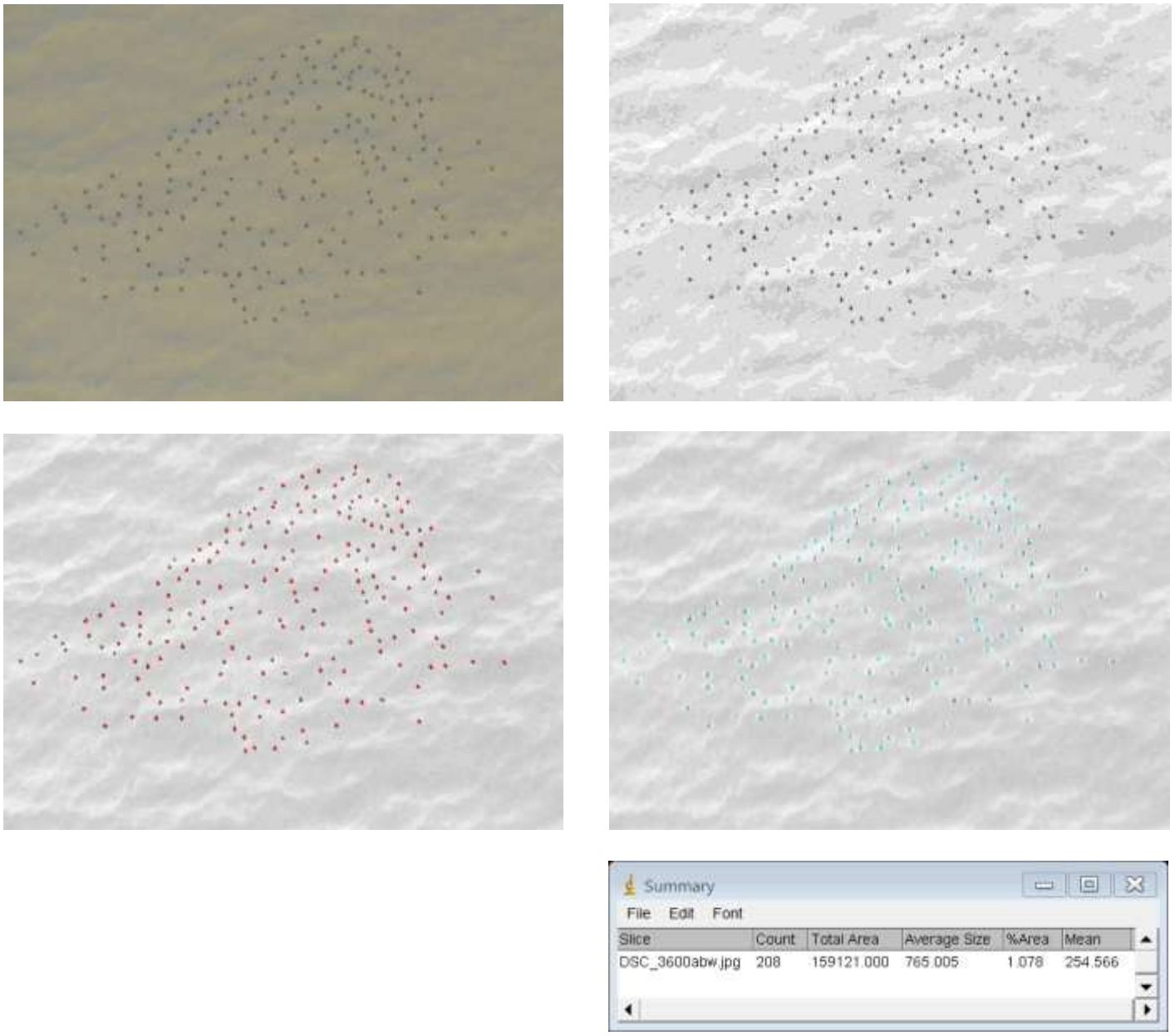

Plate 2. A series of photographs showing the steps for using the ImageJ© computer software for counting individual Black Scoters within digital images (jpeg). The original color jpeg image (top left) is converted to an 8-bit black and white image (top right) to which a color threshold process is applied that highlights the target objects/birds in red (middle left) which can then be identified by the program and counted using the "Analyze Particles" feature producing an image overlay of outlines with number identifiers (middle right) and a summary output table containing the number of birds counted (bottom right).

Appendix 1. Numbers of moulting scoters counted in various areas along the James Bay and Hudson Bay coasts during July and August 2013 (Note: longitude and latitude are average values from all flocks observed in an area).

Area	Longitude	Latitude	Flocks	Number
Southeast James Bay				
Charlton Island, NU - West	-79.6731	51.9171	16	7,115
Charlton Island, NU - South	-79.4741	51.8912	4	619
Charlton Island, NU - Southeast	-79.2759	51.9885	2	499
Charlton Island, NU - Northeast	-79.3022	52.1096	8	3,512
Charlton Island, NU - Shoals	-78.9304	52.0954	2	161
Sub-total			32	11,906
Ministikwatin Penninsula - Shoals	-79.4610	51.7189	6	4,045
Jolicouer River, QC	-78.8223	51.9971	6	1,214
Eastmain River, QC	-78.6694	52.1700	27	7,230
Eastmain River - Shoals	-79.0432	52.3014	2	588
Conn River, QC	-78.6923	52.3970	8	9,660
Sub-total			49	22,737
Total			81	34,643
Northeast James Bay				
Comb River, QC	-79.0065	53.3909	1	820
Castor River - Caillet River, QC	-78.9641	53.5561	1	53
Piagochioui River - Coureaud River, QC	-79.4190	54.0741	11	4,972
Kapsaouis River - Roggan River, QC	-79.5707	54.3129	1	590
Phoque River, QC	-79.6606	54.5417	6	8,264
Sub-total			20	14,699
South Twin Island, NU	-79.8847	53.0524	1	106
North Twin Island, NU	-79.9094	53.3299	2	116
Sub-total			3	222
Total			23	14,921

Appendix 1 (cont.)

Area	Longitude	Latitude	Flocks	Number
Southeast Hudson Bay				
Long Island Sound, QC/NU	-79.4817	54.8101	11	7,622
Manitounuk Sound, QC/NU	-77.2528	55.6074	7	637
Nastapoka Sound - Belanger, Ross & Anderson Islands, QC/NU	-76.7024	56.2419	5	631
Nastapoka Sound - Sheldrake R., Gillies Is., Nastapoka R. & Christie Island, QC/NU	-76.6454	56.8378	7	1,770
Sub-total			30	10,660
Lac Guillaume-Delisle, QC	-76.1977	56.2493	25	7,466
Belcher Islands, NU - Southeast Shoals	-78.7533	55.7974	2	111
Belcher Islands, NU - Amarolluk Sound & Fairweather Sound	-78.8459	56.1621	36	5,260
Belcher Islands, NU - Wellatok Bay & Kipalu Inlet	-79.0727	56.1795	72	4,087
Belcher Islands, NU - Robertson Bay	-79.6063	56.0250	34	1,517
Belcher Islands, NU - Coats Bay	-79.4304	56.4568	7	1,277
Belcher Islands, NU - Churchill Sound	-79.6673	56.3252	4	418
Belcher Islands, NU - North Islands	-79.7696	56.8393	49	12,925
Sub-total			204	25,595
Total			259	43,721
Southwest Hudson Bay				
Sutton River / Kinusheo River, ON	-83.7823	55.3005	5	1,674
Gooseberry Brook - Ministik Creek, ON	-85.6471	55.5724	11	2,684
Little Shagamu R., Shell Brook, Goose Cr., ON	-86.8749	55.9084	26	11,850
Niskibi River, ON	-88.0784	56.5437	2	124
Pen Islands, ON/NU	-88.6282	56.7418	5	2,779
Sub-total			49	19,111
Kettle River, MB	-89.3070	56.9338	33	12,500
Kaskattama River, MB	-90.1568	57.1074	18	10,958
Anabusko River, MB	-90.8110	57.2577	95	64,887
Mistokokan River, MB	-91.4864	57.1811	8	5,912
Nelson River, MB - South	-92.3510	57.2595	14	6,575
Nelson River, MB - North	-92.2869	57.5379	7	541
Owl River - Broad River, MB	-92.7146	58.0033	4	563
Broad River - Thompson Point, MB	-92.8979	58.2637	7	493
Knife-Seal River Delta, MB	-94.5164	58.9085	12	776
Sub-total			198	103,205
Total			247	122,316

Appendix 2. Approximate costs of surveying areas in western James Bay using USFWS Quest Kodiak aircraft under different funding scenarios (e.g., CWS considered partner or not) and fuel payment options (e.g., CWS purchases fuel [dry] vs. USFWS only purchases fuel [wet]).

Day	Destinations / area surveyed	Hours	USFWS wet rate	Partner wet rate	USFWS dry/wet rate	Partner dry/wet rate
1 / 23 Jul	US – Ottawa – Moosonee (M)	6.2	$3,210	$4,080	$3,730	$4,380
2 / 24 Jul	M – SW James Bay (ON/QC border to Nomansland Pt.) – M	5.9	$3,060	$3,880	$3,740	$4,200
3 / 25 Jul	M – Akimiski Is. (S. shore) & SW James Bay (Ft. Albany to Nomansland Pt.) – M	3.9	$2,020	$2,570	$2,470	$2,780
4 / 26 Jul	M – Akimiski Is. (N. shore) – M	4.2	$2,180	$2,760	$2,660	$2,990
5 / 27 Jul	M – Attawapiskat (A) – NW James Bay (Ekwan Pt. to Nowashe Cr.) – A – M	5.2	$2,700	$3,420	$3,290	$3,700
6 / 28 Jul	M – A – NW James Bay (Nowashe Cr. to Cape Henrietta Maria) – A – M	7.0	$3,630	$4,600	$4,430	$4,950
7 / 29 Jul	Moosonee – Ottawa – US	6.2	$3,210	$4,080	$3,730	$4,380
	Total		$20,010	$25,390	$24,050	$27,390

Appendix 3. Approximate costs of surveying areas in eastern James Bay and Hudson Bay using USFWS Quest Kodiak aircraft under different funding scenarios (e.g., CWS considered partner or not) and fuel payment options (e.g., CWS purchases fuel [dry] vs. USFWS only purchases fuel [wet]).

Day	Destinations / area surveyed	Hours	USFWS wet rate	Partner wet rate	USFWS dry/wet rate	Partner dry/wet rate
1 / 25 Jul	US – Ottawa – Moosonee (M)	5.3	$2,750	$3,490	$3,150	$3,720
2 / 26 Jul	M – SE James Bay (ON/QC border to Conn R.) – M	3.0	$1,560	$1,970	$1,900	$2,130
3 / 29 Jul	M – SE James Bay (Charlton Is. & shoals) – M	3.8	$1,970	$2,500	$2,400	$2,700
4 / 30 Jul	M – NE James Bay (Conn R. to Chisiabi) – Radisson (R)	4.4	$2,280	$2,890	$2,790	$3,130
5 / 31 Jul	R – NE James Bay (Chisiabi – Cape Jones) – Kuujjaurapik (K)	4.2	$2,180	$2,760	$2,660	$2,990
6 / 1 Aug	K – SE Hudson Bay (Cape Jones to Great Whale R.) – K	3.6	$1,870	$2,370	$2,280	$2,560
7 / 4 Aug	K – SE Hudson Bay (Great Whale R. to Nastapoka R.) – K	4.1	$2,130	$2,700	$2,600	$2,920
8 / 5 Aug	K – Sanikiluaq (S) – SE Hudson Bay (Belcher Is.) – K	6.4	$3,320	$4,210	$4,050	$4,550
9 / 6 Aug	K – SE Hudson Bay (Lac Guillaume-Delisle) – K	3.5	$1,810	$2,300	$2,220	$2,490
10 / 7 Aug	K – S (Belcher Is.) – Peawanuck (P)	4.5	$2,330	$2,960	$2,850	$3,200
11 / 8 Aug	P – SW Hudson Bay (Cape Hen. Maria to Shell Br.) – P	4.2	$2,180	$2,760	$2,660	$2,990
12 / 13 Aug	P – SW Hudson Bay (Shell Br. to Pen Is.) – F. Severn – Gillam	4.0	$2,070	$2,630	$2,530	$2,840
13 / 14 Aug	Gillam (G) – SW Hudson Bay (Pen Is. to Nelson R.) – G	5.0	$2,590	$3,290	$3,170	$3,560
14 / 15 Aug	G – SW Hudson Bay (Nelson R. to Knife R.) – Churchill (C)	3.7	$1,920	$2,430	$2,340	$2,630
15 / 16 Aug	C – Winnipeg	4.3	$2,230	$2,830	$2,870	$3,200
	Total		$33,190	$42,090	$40,470	$45,610