Project Title: Feasibility Assessment of Monitoring the Eastern Black Scoter Population through Aerial Surveys of Moulting Flocks in James Bay

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Project Description: The Eastern population of the Black Scoter (*Melanitta nigra*) has been identified by the Sea Duck Monitoring Working Group of the Sea Duck Joint Venture as having a high relative conservation priority. To address this, high priority has been assigned to the development of an effective survey to monitor population trend using counts of moulting Black Scoters that gather each summer in James Bay and lower Hudson Bay. These are thought to represent the bulk of the eastern population of the species which breeds in northern Quebec, northern Ontario, and possibly further west. Given the perceived stability of these flocks during the flightless period, this situation provides a likely opportunity for population monitoring given the number of birds present. Such concentrations have not been found on the wintering grounds (Bordage and Savard 1995).

Establishing an operational monitoring survey of moulting scoters requires development of a standardized methodology. Ross (1983, 1994) undertook the initial surveys in 1977 and 1991, using primarily photographic techniques and these lay the groundwork for the present effort to examine factors affecting the survey. New technology, such as the use of digital imaging, needs to be assessed as it could greatly decrease processing time by facilitating computerized counting.

This report summarizes results from SDJV-sponsored survey activities in James Bay in 2006 and 2009. Surveys were also attempted in 2008 but were unsuccessful due to bad weather and ensuing logistical problems.

Objectives: To collect information required to assess feasibility of and, if appropriate, develop a standard operating procedure for a regularly undertaken, operational survey of moulting Black Scoter concentrations in James and Hudson Bays to provide an index of population trend for the eastern population. Specific aspects of this work include:

a) Comparing numbers and size of the moulting scoter flocks among the survey sectors over the various years to determine the general stability in abundance and distribution. Examining the distribution of moulting flocks to establish whether a complete census is feasible or whether some form of sampling must be implemented. Determining flying time needed for appropriate coverage.

b) Determining the influence of the survey aircraft on scoter behaviour

c) Photographing the flocks using both film and digital imaging equipment and determine the best method.

d) Examining the effects of survey conditions including time of day, tide, sea state, and cloud cover on flock configuration and detectability.

e) Determining age/sex ratios and the presence of other species.

f) Assessing feasibility of visual estimates.

Procedures:

In 2006, the survey work was undertaken by K. Ross and K. Abraham from July 30 to August 2. All offshore areas from the Ontario-Quebec border in southeast James Bay to Cape Henrietta Maria in northwest James Bay, including Akimiski Island, were flown using a Cessna 337 aircraft. The coast was divided into 3 major sectors occupied by scoters: Southern James Bay – Moose River to Cockispenny Point; Akimiski Island which is further subdivided into the southern and eastern shores; northern James Bay – Ekwan Point to Hook Point. All sectors of the coast were covered at least once with the southern Akimiski Island shore being flown twice and the southern James Bay coast around Longridge Point receiving 7 surveys. During the flights, Ross estimated all flocks visually while Abraham photographed on film (Nikon F-80 SLR camera with Ektachrome 200 Professional slide film) as many of the flocks as possible. Survey conditions are described in Table 1. Images of all flocks successfully photographed were projected and flock size determined by marking individual birds and counting them directly. Where larger flocks required multiple images, these were projected and marked, then oriented to accommodate the overlap and taped together prior to counting.

In 2009, the survey was carried out by K. Ross and R. Cotter from July 25 to 31, again using a Cessna 337 aircraft. All sectors were completely covered except the far northern part of the northern James Bay sector where a small portion had to be missed due to fog (see Figure 1 and 2). Multiple coverages were only undertaken in the southern James Bay sector (4 flights). Survey conditions are presented in Table 2. Weather was generally more inclement than in 2006 and flying was not possible on 2 days and was limited on two others. In this year, Ross estimated the flock sizes while Cotter photographed them using a digital SLR camera (Nikon D200). Images were downloaded and printed for counting, again by marking off individuals during the enumerating process. Larger flocks were counted after taping together multiple images.

For both years, the relationship between estimates and the actual counts of flocks was determined through linear regression. For 2006 data, we determined from visual inspection that there appeared to be a hinge point at approximately the 140-bird flock size. For flock sizes >140 we used maximum likelihood linear regression with an intercept to estimate coefficients of a relationship between photo count and visual estimates (Figure 5). In 2009, we ran a similar regression but without an intercept and included all the data (Figure 6). Such comparative data were available for 28 flocks in 2006 and 114 flocks in 2009. The resulting equation was rearranged to derive an estimate of the flock size for visual estimates without a corresponding photo. For the 2006 data, the model was used to correct all estimate values over 250 birds; the lower estimates were not adjusted as the model tended to give nonsensical values including negative ones. For the 2009 data, the model was used to correct all estimates under 3500; larger flocks were all counted from images and thus did not need correction. The final survey dataset for each year was composed of actual flock counts from images and corrected estimates where no direct counts were available.

Results:

Flock Distribution and Abundance

Survey results by sector are presented in Tables 1, 2, and 3. In the last table, results from earlier surveys (Ross 1983, 1994) are also included for comparative purposes. Figures 1, 2, 3, and 4 illustrate the actual locations of the photographed flocks within the sectors in 2006 and 2009. It is clear from all of these that the offshore area around Akimiski Island is an important moulting area not previously recognized. It also shows that numbers in the various sectors can be quite variable although total counts of the whole coast may be less so. Numbers using the northern James Bay sector were relatively stable compared to those using the southern James Bay sector which showed very high numbers in 2009, almost 3 times larger than any previous count there. Around Akimiski Island, the southern shore counts were reasonable consistent in 2006 and 2009 while those along the eastern shore were very different. In this case, this was likely due to the very late pack ice along the eastern shore in 2009 which reduced habitat availability and may have caused birds to move elsewhere to moult. Overall, 17140 more birds were seen in 2009 than in 2006.

As in the earlier surveys, the moulting flocks were distributed in a fairly linear manner along the coast no more than 10 km offshore or less. This facilitated surveys as the aircraft could move in a fairly straight, stepping-stone pattern and did not have to circle excessively to cover all flocks. Complete coverage of the flocks is feasible and the use of a sampling approach should not be necessary.

Effects of Survey Aircraft on Flock Behaviour

Passes were made over the flocks at various heights to determine the extent of avoidance diving which was characterized as increasing diving activity as the aircraft approaches the flock. Below 300 feet asl, level of diving activity by the birds was quite noticeable being evident to a greater or lesser extent. This diving appeared to be characterized by more splashing than the routine feeding dives. At 500 feet, there was no evidence of this activity; moreover, this also proved to be an optimal height for photographing the flocks as it generated good image sizes of the birds without using an excessive telephoto setting which would degrade image sharpness. As well, this height permitted observation of the other flocks nearby to facilitate planning the survey route for optimal coverage.

Comparison of Film vs. Digital Imaging

The initial survey (1977) employed a medium-format film camera (Hasselblad 500EL) whose images were projected using a photographic enlarger for counting purposes. The image quality was excellent although the camera was cumbersome and required an assistant loading film backs during the survey. The 1991 and 2006 surveys used 35mm film cameras (Olympus OM-2 and Nikon F80 respectively). An assistant was not required for this equipment. Image quality, while not quite as good as that of the Hasselblad, was more than adequate for the purpose. A slide projector was used to project the images for counting on paper taped to a wall. This was an awkward process and difficult for technicians to do for extended periods of time.

In 2006, a digital camera was tried on the survey. This was a fixed lens digicam (Panasonic DMC-F27) with an extended zoom, image stabilization and electronic viewfinder. It proved totally unsuitable as the viewfinder did not have adequate resolution for one to see the flocks. No useful images were taken. In 2009, a Nikon D200 with an 18-200mm image-stabilized lens was employed very successfully; the camera was interfaced with a GPS allowing all images to be georeferenced. Images, which were of excellent quality, could be printed and analyzed at one's desk comfortably and efficiently.

Detectability and Environmental Conditions

Replicate surveys show considerable variability in counts.

a. In 2006, the southern Akimiski shore was surveyed twice, two days apart (Table 1). Numbers were highest on the first count which was carried out under ideal survey conditions: high overcast – bright but little glare; moderate winds; shallow waves; rising tide in its upper reaches. The second survey took place under less optimal conditions including bright sunlight with attendant glare, high winds with a heavy chop on the sea, and a falling half tide. Birds would likely be more difficult to see given glare and the very choppy sea state. As well, the wind may have assisted in breaking up the flocks into smaller groups which could have been more easily missed. Lastly there is also the likelihood that the scoters may have been more actively feeding then as the tide was at a lower level and falling, thus reducing the availability of birds for detection.
b. In 2006, the southern James Bay Sector around Longridge Point was surveyed 7 times. The two highest counts (# 2 and 3) were associated with very good conditions: overcast with no glare, light to moderate winds, and rising half tide or higher. The highest count (# 3) took place on the rising ¾ tide when the flocks had coalesced into only 2 groups. The lowest count (# 6) was carried out under very windy conditions and late in the day when low sun angle caused extreme glare. Possible explanations for the

intermediate counts are as follows: Surveys 1, 4, and 5 – tide in lower range when feeding likely most active; Survey 7 – birds more dispersed for unknown reasons and some flocks possibly missed.

c. In 2009, the southern James Bay sector was surveyed 4 times. The two highest counts (Surveys 2 and 3) were associated with rising tides in the upper range. The highest count (Survey 3) had the lowest number of flocks, thus maximum coalescing of flocks. Survey 4 which had a slightly lower count than Survey 2 took place on a falling, lower range tide although otherwise conditions were very good, suggesting that feeding activity may have affected counts. Survey 1 was incomplete as the combination of glare, mist patches and choppy sea state combined to make finding the flocks difficult and photographing them ineffective.

Determining age/sex ratio and presence of other species

As in previous surveys, low passes (under 100 feet asl) were made over various flocks to determine whether adult female and/or subadult birds were present. In most cases, none were observed although the occasional flock may have had as many as 2% brown scoters. Actual sex and age of these birds of course could not be determined.

Similarly, flocks were checked for the presence of other species of scoters but in no case were these found mixed in with the Black Scoters. Occasionally small groups of Surf Scoters (*Melanitta perspicillata*) were observed, usually less than 10 birds at a time and always separate from the Black Scoter flocks.

Feasibility of Visual Estimation

As noted in the procedures section, visual estimate were assessed by comparing these with known flock sizes as determined from film or digital images. Results presented graphically in Figures 5 and 6 reveal that the degree of bias differed substantially between 2006 and 2009. In 2006, the senior author overestimated flock size consistently (by 71% overall) in contrast to 2009 when he tended to underestimate slightly (by 2% overall). It should be noted that these analyses took place after the survey in 2009 and so the earlier results did not have a training influence on the later ones.

Equations:

2006 flock size estimate (>250) = (visual count – 137.9887) / 1.5005
2009 flock size estimate = visual count / 0.9251

Conclusions and Recommendations:

1. The recent surveys showed that the Akimiski Island offshore area holds important numbers of moulting Black Scoters along with the already known northern and southern James Bay shore sectors. Distribution of the flocks among these sectors differed substantially between 2006 and 2009 and may reflect a shift in environmental conditions, particularly the unseasonably large

amount of ice present in some sectors in 2009. This suggests that any operational survey must be extensive in order to accommodate these shifts within the overall survey area. This also underlines the importance of the planned satellite telemetry study in determining the schedule and pattern of use of these sectors. In further support of this approach, a reconnaissance survey is needed along the western Hudson Bay shore to assess numbers of moulters present there and whether there is a need for the operational survey to be extended to cover those flocks. Similarly, the telemetry study may reveal if there is any interchange between the James Bay and western Hudson Bay moulting groups.

2. Aircraft flight time requirements for survey coverage of the western James Bay moulting area by sector are as follows:

a. Southern James Bay – 1.5 hours
b. Akimiski Island: south shore – 2.5 hours: eastern shore – 2.5 hours. Note that these two subsectors should be surveyed separately as their points in the tidal cycle differ by almost 180^0.
c. Northern James Bay – 4.5 hours. This requires that the survey aircraft have long-range fuel tanks giving it a safe range of at least 5 hours plus a reserve.

All flights were based out of Moosonee which has bulk fuel (avgas and jet fuel). Rest stops can be made at Attawapiskat but fuel is not available there unless specifically cached at considerable expense. Because of the offshore nature of the work, a twin-engined, high-winged aircraft is required. Suitable types are the Cessna 337, Rockwell Aero-Commander, De Havilland Twin Otter and Partenavia P68.

3. Surveys should be undertaken at an altitude of 500 feet asl. The pilot should bank over the flock to permit photographs to be taken from as close to a vertical position as possible for the smaller, rounder flocks. For long flocks requiring multiple images, a line along the long axis of the flock should be followed. It should be sufficiently close to the flock to allow for photos from as steep an angle as possible.

4. The use of a high-quality digital single-lens reflex camera has proven very successful for gathering excellent images for analysis. Image stabilization, built into either the camera or the lens, is also highly recommended. This equipment simplifies field work as it eliminates reloading activities and information such as time of photo and location can be recorded automatically with each image. As well, quality of images can be checked easily in the field on a laptop computer and all files backed up to maximize data security. Analysis of the image is also facilitated as they can be easily magnified and printed. Counting can be carried out at one’s desk and does not require cumbersome or complicated equipment. Automated counting is also a possibility that should be further investigated. R. Brook has successfully applied a freeware counting program available to him

(ImageJ) to some high quality images from the 2009 survey. Limitations of this application need to be investigated.

5. Issues relating to the detectability of the scoters have been investigated through the use of multiple surveys. While the number of replicates is not sufficient for a detailed statistical analysis, there are some tendencies in the results that are worth noting.

a. Numbers tend to be higher when surveys are undertaken during periods of higher tidal range. This may be due to more birds resting and less feeding, thus fewer being underwater. The scoters also seem to form larger, denser flocks at this time which may facilitate counting.

b. Viewing conditions and sea state also likely affect results. High, thin overcast which limits glare, and calm conditions are ideal. Glare, particularly that due to low sun angle combined with choppy wave conditions, can make the flocks very difficult to see. Moreover, photographing the flock under this combination of conditions can be impossible as flocks tend to become virtually invisible as the aircraft flies over them, either because of blinding glare or a disruptive, shadowing effect caused by the waves.

c. Time of day may have an effect. Ross (1983) indicated that feeding activity appeared to subside towards mid-day reducing the proportion of birds underwater during a survey. The interrelationship of time and tide on the foraging activity of the birds needs to be better understood. As a good general practise, surveys should be undertaken between 0900 hrs and 1600 hrs EDT to eliminate sun angle effects and benefit from potentially increased resting activity of the birds.

6. All surveys to date of the moulting Black Scoters flocks have indicated that they are comprised almost totally of adult males. Very small numbers of brown-plumaged birds, either females or subadult males, were seen in some flocks. There is little benefit in trying to develop correction factors for this tiny component. We did not detect other species in the moulting flocks.

7. Visual estimation was used extensively in the 2006 and 2009 surveys in contrast to the earlier surveys in 1977 and 1991 which were largely based on photographs. Analysis of the relationship between estimates and actual counts from images showed that correction factors differed considerably between years. Given this result, one must conclude that photographic methods should be employed to the greatest extent possible and that visual estimation should be limited to smaller flocks not easily accommodated along the flight line of the survey. A sample of flocks in that general size range should be photographed and estimated in order to develop a year-specific correction factor.

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References:

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Table 1. Results, timing, and environmental conditions for surveys of moulting Black Scoter flocks in western James Bay in 2006.

Sector*	Survey Number	Total Count	Number of Flocks	Maximum Flock Size	Date	Start Time (EDT)	Tidal Conditions		Environmental Conditions		Comments
							Level (% of high tide)	Direction	Cloud Cover	Wind Direction and Speed (knots)	
SJB	1	7570	7	5772	July 30	12:30	0	Slack	Clear	SW-<5	
	2	9642	14	3906	July 30	15:30	50	Rising	Overcast	SW-10	
	3	9813	2	8905	July 30	17:30	75	Rising	Overcast	SW-10	Some glare
	4	6662	7	3440	July 31	11:00	35	Falling	Overcast	Calm	
	5	5730	4	4240	August 1	13:30	25	Falling	Clear	NW-15+	
	6	3640	4	2000	August 1	19:30	100	Slack	Clear	NW-15+	Strong glare, heavy chop
	7	7186	17	1574	August 2	9:00	75	Falling	Clear	W-5	Some glare
SAK	1	15976	55	1307	July 30	16:20	65	Rising	Overcast	SW-10	
	2	13019	105	574	August 1	10:30	50	Falling	Scattered	NW-20	Moderate glare and chop
EAK	1	17094	42	2685	July 31	11:40	35	Falling	Overcast	SE-<5	
NJB	1	46569	137	3107	July 31	15:00	65	Falling	Overcast	SE-10	

* SJB - Southern James Bay; SAK - South shore of Akimiski Iskand; EAK - Eastern shore of Akimiski Island; NJB - Northern James Bay.

Table 2. Results, timing, and environmental conditions for surveys of moulting Black Scoter flocks in western James Bay in 2009

Sector*	Survey Number	Total Count	Number of Flocks	Maximum Flock Size	Date	Start Time (EDT)	Tidal Conditions		Environmental Conditions		Comments
							Level (% of high tide)	Direction	Cloud Cover	Wind Direction and Speed (knots)	
SJB	1	6593†	7	2702	July 25	15:00	50	Rising	Broken	SE-10	Glare, mist, choppy sea
	2	38219	63	3243	July 26	16:30	75	Rising	Overcast	E-10	Some drizzle
	3	44665	39	7388	July 27	16:00	65	Rising	Broken	E-10	Some glare
	4	36767	51	3567	July 28	10:45	35	Falling	Clear	E-10	Some glare-low sun
SAK	1	18221	66	1615	July 26	9:40	35	Falling	Overcast	SW-10	Moderately choppy sea
EAK	1	3603	20	541	July 26	11:00	75	Rising	Clear	Calm	
NJB	1	40106††	116	1297	July 31	13:00	65	Rising	Overcast	W-20	Flat light at end

* SJB - Southern James Bay; SAK - Shore shore of Akimiski Iskand; EAK - Eastern shore of Akimiski Island; NJB - Northern James Bay.

† Incomplete count - survey discontinued due to bad conditions

†† Incomplete count - some of far northern coast missed due to fog

Table 3. Summary results of all surveys of moulting Black Scoters in western James Bay

Sector	Year			
	1977	1991	2006	2009
Northern James Bay	42600	37640	46570	40110*
Akimiski Island	NS	NS	33080	21820
southern shore	---	---	(15980)	(18220)
eastern shore	---	---	(17100)	(3600)
Southern James Bay	2400	16320	9810	44670

* incomplete count

Figure 1. Overall distribution of georeferenced moulting Black Scoter flocks along the coasts of western James Bay as determined during surveys in 2006 and 2009. Note that not all flocks seen were georeferenced in any year.

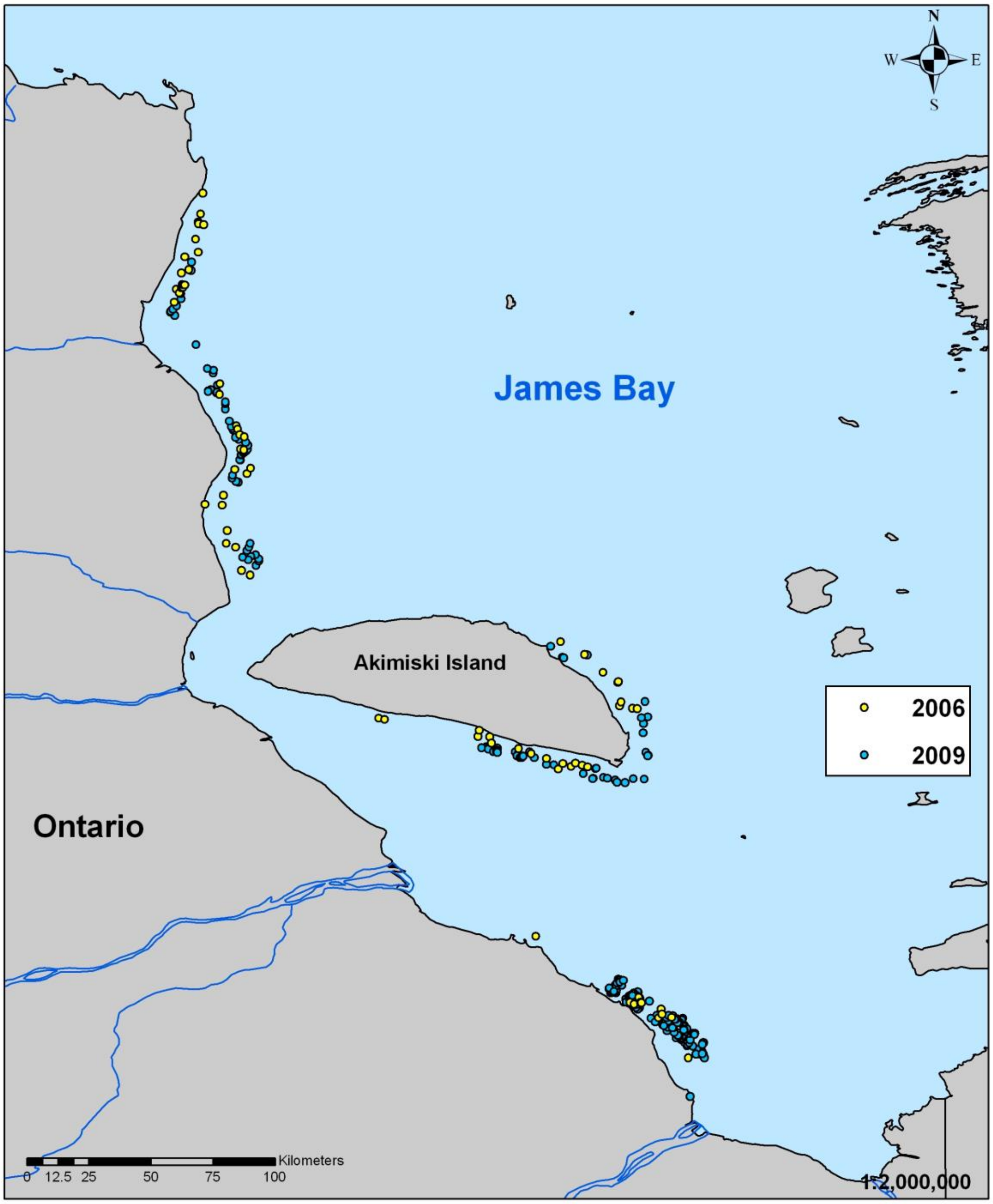

Figure 2. Detailed distribution of moulting Black Scoter flocks in the Northern James Bay survey sector. Note that the northern most record for 2009 was at the limit of the survey that year due to fog.

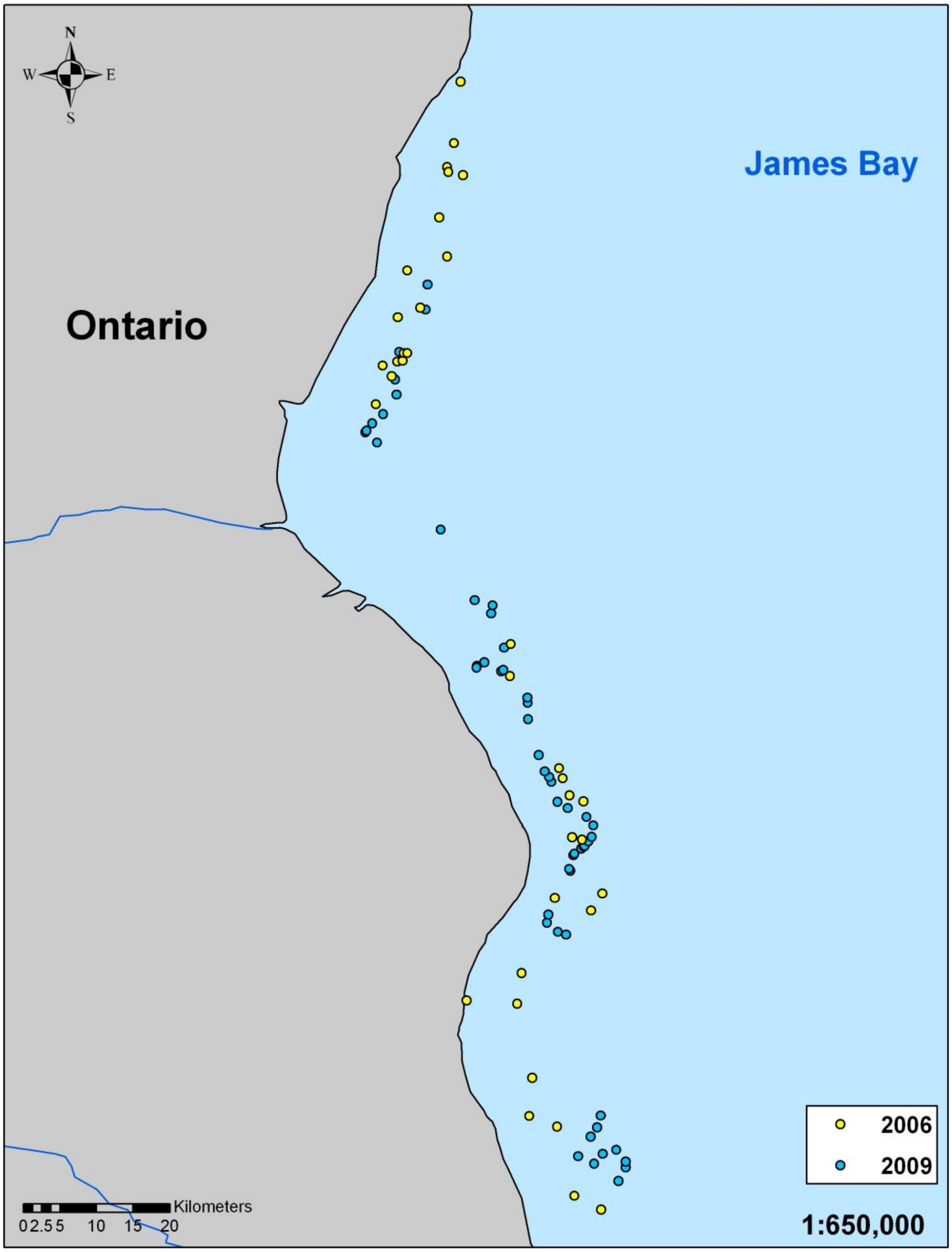

Figure 3. Detailed distribution of georeferenced moulting Black Scoter flocks in the Akimiski Island survey sector.

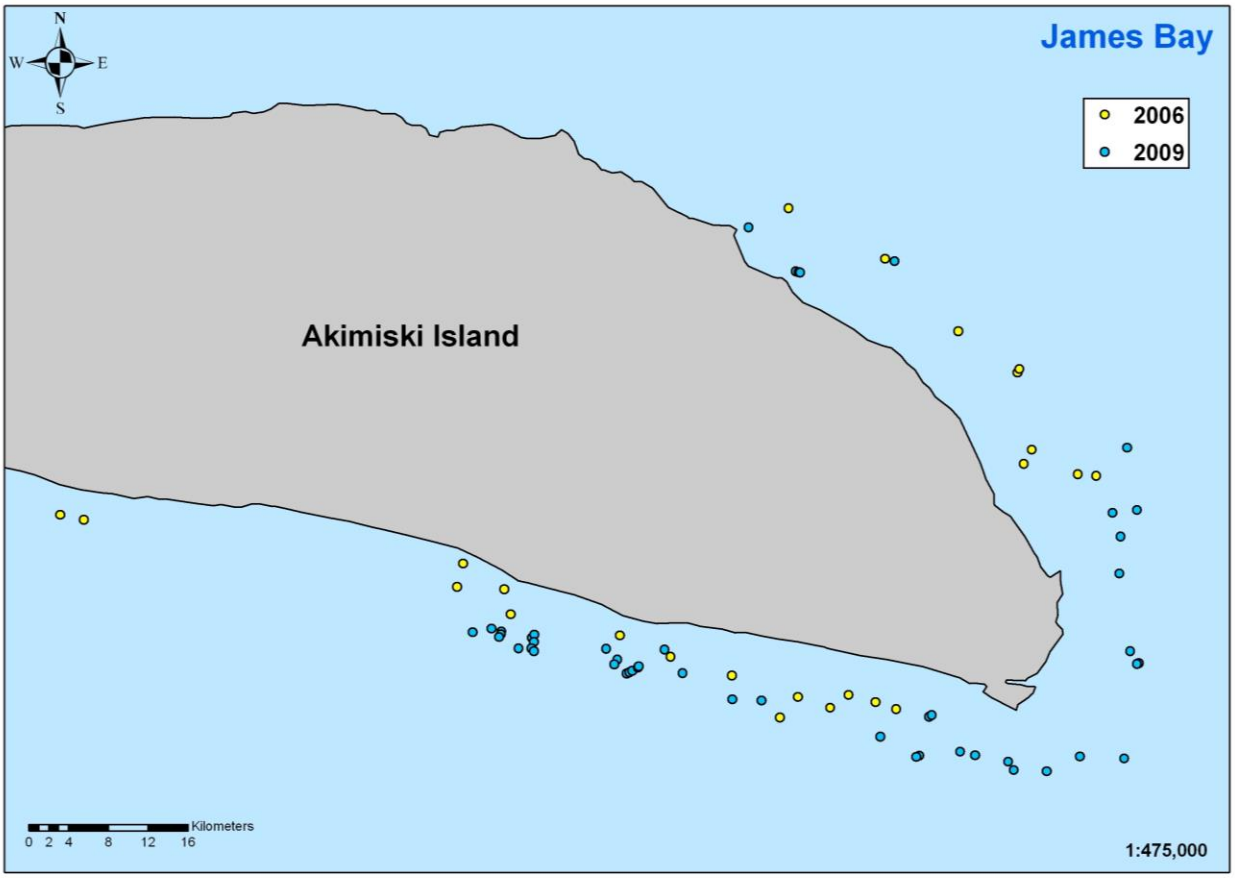

Figure 4. Detailed distribution of the georeferenced moulting Black Scoter flocks in the Southern James Bay survey sector. Note that there were multiple surveys in each year and so flocks may have been georeferenced more that once.

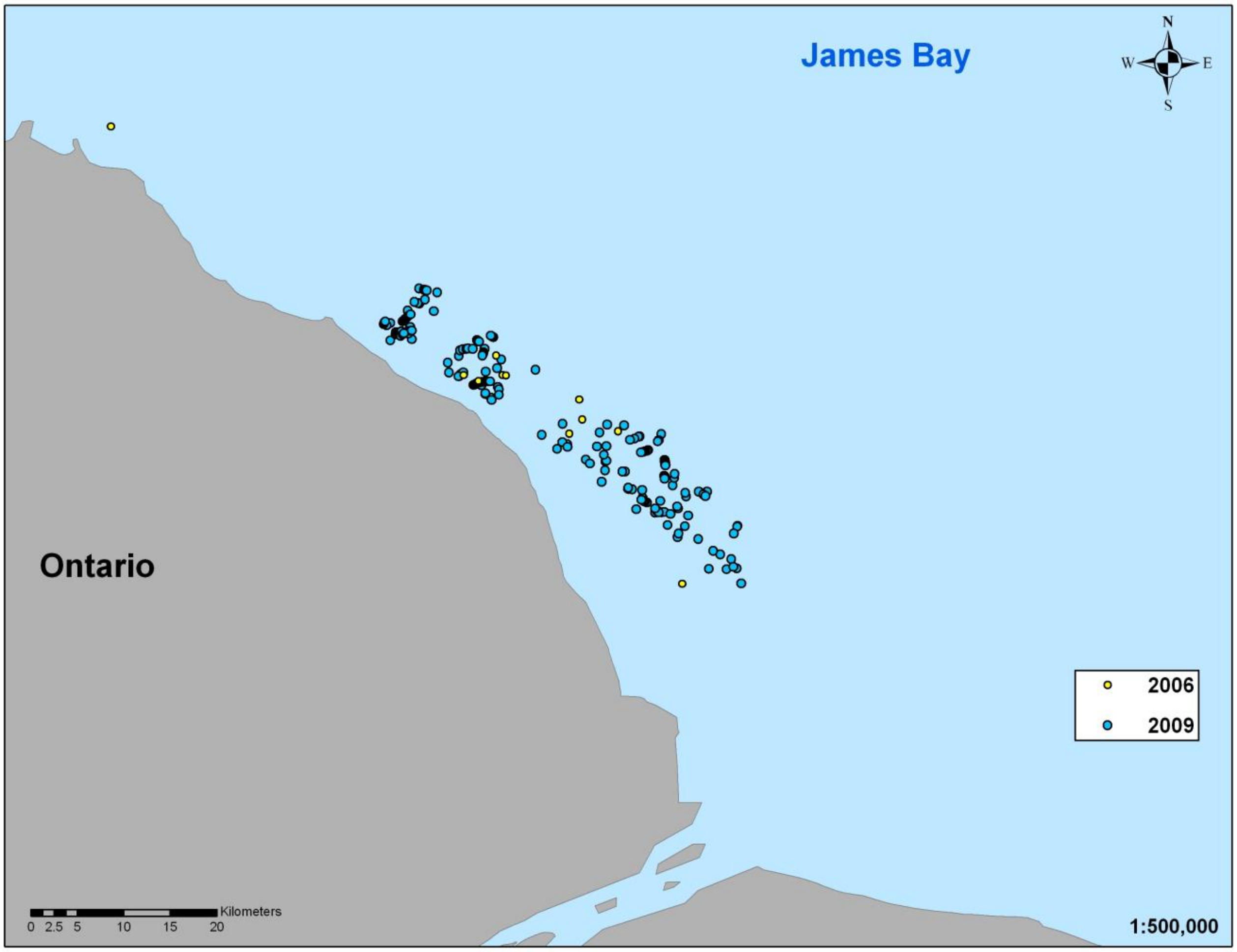

Figure 5. Corrected visual estimates with 95% confidence limits (black boxes and bars) resulting from linear regression equation (upper [red] line: see text) of the relationship between photo counts and visual estimates (red diamonds).

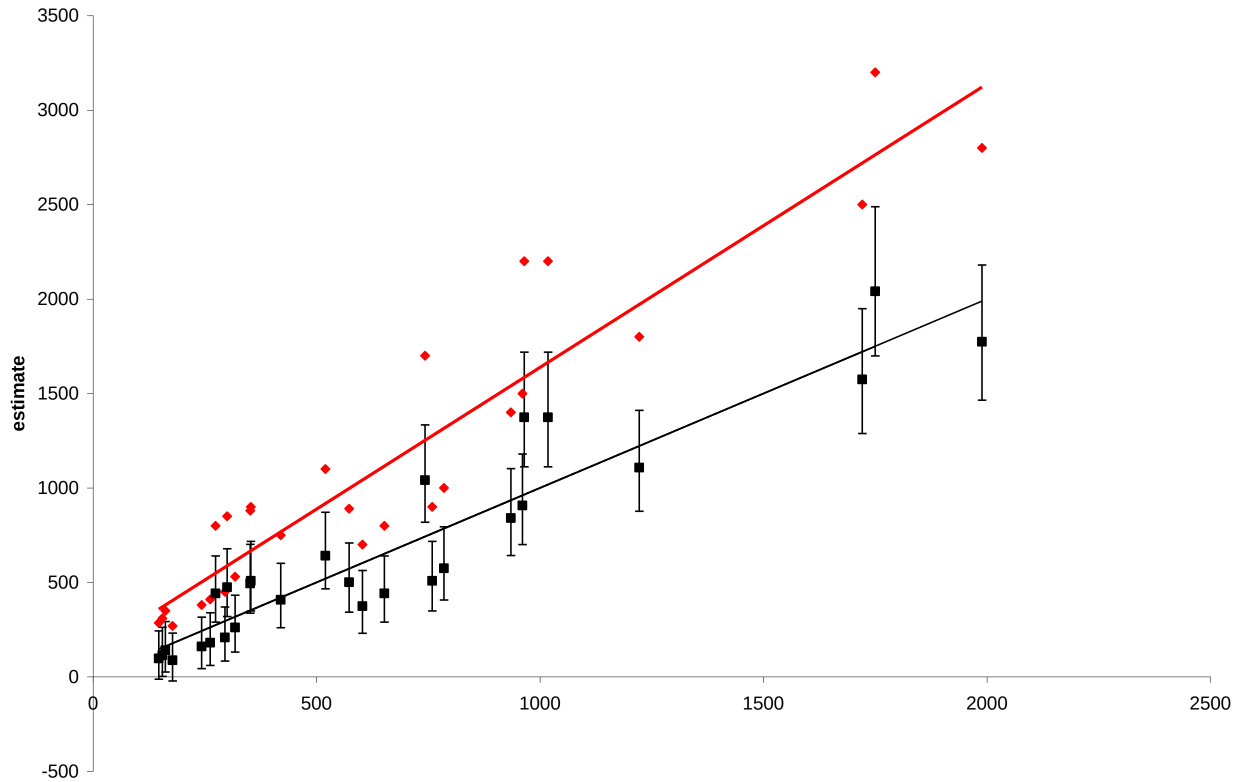

Figure 6. Corrected visual estimates with 95% confidence limits (red boxes and bars) resulting from linear regression equation (lower [red] line: see text) of the relationship between photo counts and visual estimates (black diamonds).