2011 Annual Report of the Regional Bird Monitoring Program for the Oil Sands Region

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RAPP
Research on Avian Protection Project

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Executive Summary

In 2011, the provincial department of Alberta Environment obliged industrial operators in the oil sands region to participate in a standardized monitoring program to record the number of birds that flew over, landed on, and died in tailings ponds created by the mining process. Five operators who are responsible for monitoring 48 process-affected water ponds in the region participated in the program. In addition to the process-affected ponds, observers monitored an additional 10 ponds containing freshwater and classified as reference (naturally occurring) or compensation (built to create fish habitat). At each pond, observation of live birds consisted of scan samples of 30 minutes duration (at between one and four stations for large ponds) or 10 minutes (at one station for small ponds). Each scan recorded the number of birds seen flying over, landed on, or heard within 500 m of the monitoring station. Every process-affected pond was monitored once daily. Searches for dead birds were conducted by foot (shorelines) or boat (inaccessible areas) twice weekly. The monitoring program began in mid April 2011 and continued until the end of October.

Among the 58 monitored ponds, a total of 44,687 individuals of 88 species or species groups were detected. Ducks were detected most often, but geese, shorebirds, and gulls were also abundant. Systematic mortality searches logged almost 5000 hours among four active operators and recorded 70 dead birds, most of them ducks. Numerous species of concern were recorded on or near ponds in the oil sands region, but few landed on process-affected water. Only two species of moderate concern, lesser scaup and green-winged teal, were recorded repeatedly on process-affected ponds in groups of a few to 20 individuals. Green-winged teal was the most abundant species (10 individuals) among the birds that could be identified in mortality searches.

Substantial variation in bird detections was apparent among operators. Whereas U of A observers detected an average of over 50 individuals per hour, Imperial, Shell and Suncor clustered around 10 individuals per hour, and CNRL and Syncrude approached zero. Large variation also occurred among operators in the number of individuals recorded for particular species, including several species at risk (e.g., barn swallow, horned grebe, lesser scaup) and particularly common species (e.g., common raven, mallard). Some of these differences might be accounted for by variation in bird presence among sites, but some are undoubtedly caused by unintended inter-observer variation.

In 2011, the migratory seasons were divided arbitrarily into Spring (<July 15) and Fall (>July 14). Shortening the monitoring period by ending earlier in Spring or beginning later in Fall had a lesser effect on the proportion of detections recorded for individuals than for species or species groups. Predictably, rare species showed larger proportionate differences in detections in response to shortened monitoring periods than did common species. Species-specific frequency histograms of detections confirmed that the relative migratory chronology in the oil sands region is consistent with published guides making it possible to tailor monitoring effort in future to the species and periods of maximum interest.

The report concludes with 10 recommendations designed to improve the rigour and comparability of the 2012 monitoring plan. The report is supported by two tables, seven figures, and five appendices. Data were collected by five oil sands operators, two government departments, and numerous individuals associated with the Research on Avian Protection Project at the University of Alberta. Although the U of A team lead the development of this report, all parties contributed to its design and refinement.

Definitions of Terms

Contact	The presence of a bird on a pond. Including birds landed on the pond, diving under the water surface, foraging in the water, mating on the water, and birds on the vegetation on the pond.
Process-affected pond	A tailings pond which is at present or has in the past been used for a storage site for the solid and liquid waste by-products of the bitumen mining process.
Process-affected water	The liquid part of tailings ponds. Most of the time the surface is a combination of water and chemicals used in the mining process to extract bitumen from sand (solvents). Occasionally the liquid tailings include bitumen, which can sit like a mat on the water where it may be blown around by the wind. Under most conditions, bitumen is heavier than water, but adhesion to gases and temperature differentials can cause it to rise to or remain on the surface of the water.
Freshwater pond	Ponds not involved in the waste of the bitumen mining process. These include reservoirs, compensation ponds, and natural lakes.
Reference pond	Freshwater ponds in the oil sands area that were used in the standardized monitoring of birds in the area to survey species that may be found on ponds during migration periods.
Compensation pond	A water-body created by industry and connected to fish-bearing streams to compensate for the presumed loss of fish habitat.
Comparison pond	A pond surveyed by both industry and U of A observers in order to assess inter-observer variation.
Flyover	One or more birds flying over a pond during an observation period. The term may apply to migrating flocks or individuals and can include migratory flights, foraging flights, and predator evasion.
Census	A survey or count of birds at a pond.
Phylogeny	A method of categorizing organisms based on their degree of relatedness, which may be measured by similar form (morphology), genetic similarity, and other characteristics. The phylogeny of birds can be found at:

	http://www.thewildclassroom.com/biodiversity/birds/aviantopics/birdsystematics.html
Metrics	A set of numbers that give information about a particular process or activity (www.dictionary.cambridge.org)
5% Bin	A bin is a specified proportion of a data set. A 5% bin simply means dividing a dataset equally into 20 parts, each of which comprises 5% of the whole data set.
Adaptive Management	A style of resource management that uses an iterative cycle of innovation, monitoring, and adjustment to learn how natural systems function while identifying the best practices to optimize long-term management outcomes.
Deterrent	An instrument stationed beside or on a tailings pond to deter birds. In the oil sands these include both audio deterrents (e.g. propane cannons, phoenix wailers, speaker systems associated with visual deterrents, LRAD speaker systems) and visual deterrents (e.g. human effigies, peregrine effigies, lasers).
Lease site	An area of publicly-owned land that is leased to private interests for a specified period of time for specified purposes and subject to regulatory approval.
Emergent vegetation	Residual vegetation on tailings ponds left during the conversion of low-lying marsh/wetland areas into tailings ponds. Living vegetation in ponds is typically called „emergent" if rises above the water surface (e.g., cattails), but much of the mass of this vegetation, even under natural conditions, is dormant, senescent, dead or decaying. Thus, we do not distinguish between living and dead vegetation of this sort.
Weedy species	Species with high intrinsic rates of reproduction that are known to exploit areas disturbed by humans and their infrastructure. Such species typically increase in abundance dramatically when development occurs in formerly pristine areas. Many native species have this capacity (e.g., crows, ravens, foxes, coyotes).

History of the Program

Waterfowl protection in the mineable oil sands region has a history that directly links to regulatory requirements under Alberta‟s *Environmental Protection and Enhancement Act* (EPEA) and the *Federal Migratory Birds Convention Act*. As early as 1981, bird deterrents were established by individual operators at some sites that contained process-affected water. Since 1999, oil sands mine operators have been required to submit plans pertaining to wildlife management, including a comprehensive bird program to Alberta Environment and Water. Through adaptive management, knowledge and experience, the regulatory requirements have changed over time resulting in the requirement by the provincial regulators for a Waterfowl Protection Plan (note the term "Waterfowl" and "Bird" are used inter-changeably in the context of protection plans). Currently, updated Waterfowl Protection Plans are due at least once per 10 years corresponding to the period of EPEA approval that is issued for each oil sands mine operator.

As a result of a major bird mortality event in the region in 2008, the provincial and federal regulators initiated the development of a regional bird monitoring program (RBMP) for implementation on all oil sands mining sites. The aim of the program was to ensure the availability of comparable data on bird use and mortality among sites and years. These data are essential for evaluating the effectiveness of the Waterfowl Protection Plans as well as the specific and evolving deterrent technologies used in the region. Comparable bird monitoring among sites and years is also necessary to support scientifically-defensible and transparent evaluations of the effects on birds of the oil sands mining industry as a whole.

The development of the RBMP began in 2009 when Alberta Environment and Water and Alberta Sustainable Resource Development (ASRD) conducted site visits at each of the mining operation, recorded numerous characteristics associated with ponds and deterrent systems, and then requested independent evaluation of deterrent practices across the industry. The report, written by Colleen Cassady St. Clair and Robert A. Ronconi, was entitled *Review of Alberta Environment 2009 Compliance Inspection Reports and Avian Deterrence in the Oil Sands Region* and the final version was submitted to Alberta Environment in April 2010. The report contained four sections comprised by a review of the inspection reports, production of a pond inventory with a supporting database of pond and deterrent characteristics, a description of knowledge gaps in avian deterrence, and recommendations.

The final section of the St. Clair and Ronconi 2010 report described the characteristics that should be contained in a monitoring program that could be standardized across the region. Alberta Environment invited Rob Ronconi to expand these recommendations to produce a first draft for a new standardized monitoring plan in late Spring 2010 and that plan was shared with operators in Fall 2010. Operators were reticent to accept this plan because of safety and operational constraints. Subsequent discussion with Alberta Environment produced a compromise solution in which

a. Rob Ronconi was contracted by the Oil Sands Developers Group to develop an integrated regional monitoring program

b. At the invitation of operators, consultation occurred between Rob and both industry operators and Colleen Cassady St. Clair (via a full day meeting on March 1, 2011) to integrate the constraints perceived by industry while supporting the program goals of Alberta Environment, and

c. A revised monitoring protocol entitled *Oil Sands Bird Contact Monitoring Plan for 2011* was produced in time for the Spring Migration Season (draft March 16, 2011; updated April 6, 2011). This revised plan met with the approval of all parties to achieve regulatory needs, operational constraints, and scientific defensibility.

d. Operators proposed and Alberta Environment regulators agreed that Colleen Cassady St. Clair (University of Alberta) would receive, organize, securely store, and analyze the data collected under the standardized monitoring program. This role is complementary to the one Dr. St. Clair serves by leading the *Research in Avian Protection Project*, a research project that stemmed from the creative sentence awarded following the 2008 landing event and subsequent conviction.

In addition to the requirements outlined in *The Oil Sands Bird Contact Monitoring Plan for 2011*, each oil sands mine operator was to comply with existing reporting mechanisms for gathering data regarding observations, injury, and mortality of birds and wildlife. These include immediate, monthly and annual reporting to ASRD as required by the Research and Collection permits obtained by each oil sands mine operator. Alberta Environment and Water requires annual reporting of recoveries and incidental observations through the annual conservation and reclamation reports submitted by each operator, each April.

The report that follows is based on contact and mortality monitoring data submitted monthly by each oil sands mine operator to the University of Alberta database as well as on data gathered by the University of Alberta as part of a research project in cooperation with Imperial Oil and Shell. The University of Alberta was not conducting operational monitoring for any of the operators whose data is presented in this report.

Goals and Objectives

The overall goal of the program as stated in the *Oil Sands Bird Contact Monitoring Plan for 2011* is *"to provide a robust and systematic monitoring program that documents bird interactions with liquid storage facilities at oil sands mining facilities."*

The monitoring program addresses this goal with five specific objectives:

1. *Provide an estimate of bird contacts and mortalities on ponds containing process-affected waters.*

2. *Provide an estimate of bird contacts on ponds containing fresh water.*

3. *Develop a standardized monitoring program for all oil sands mine operations to provide comparable data across ponds, sites, seasons, and years.*

4. *Identify species at risk that have been affected through contact on ponds containing process-affected waters.*

5. *Provide direction on adaptive management for long-term monitoring and bird deterrent programs.*

This report provides information on observed contacts and mortalities at process-affected (Objective 1) and freshwater (Objective 2) ponds, variation in detections among operators and observers (Objective 3) and on species at risk affected through contact with process affected ponds (Objective 4). It will also, through ongoing review, discussion, and consideration of annual results with the regulators and oil sands mine operators, provide direction on adaptive management for long-term monitoring and bird deterrent programs in the region (Objective 5). Some changes to the *Oil Sands Bird Contact Monitoring Plan for 2011* have already been drafted for the 2012 plan and additional refinement is anticipated in the years ahead.

This report is the product of thousands of hours of effort by dozens of individuals who worked cooperatively and transparently to generate the first truly standardized monitoring program of the effects on birds of the mining oil sands industry in Alberta and, potentially, of any comparable industry worldwide.

Methods

Oil Sands Mine Operators

The second-largest mineable oil sands deposit in the world are located in the Athabasca oil sands region in northeastern Alberta, Canada, just north of the city of Fort McMurray. Oil sands mining companies currently operating in the area who participated in the *Oil Sands Bird Contact Monitoring Plan for 2011* included Suncor Energy Inc, Syncrude Canada Ltd, Canadian Natural Resources Limited (CNRL), Shell Albian, and Imperial Oil (Appendix A).

Much variation exists among operators in the length of time over which mining has occurred, the spatial scale of operations, and the technologies employed to both mine the oil sands and store the process-affected water resulting from that process. As a result, there is also tremendous variation in the number and size of process-affected ponds

(Appendix B). In addition, there is variation among operators the deterrent system used to minimize interactions between birds and the process-affected water ponds.

All deterrent systems in the region employ both visual and acoustic deterrents, but the methods by which they are deployed are of two main types. Syncrude and Suncor developed the original deterrent systems, in which acoustic cannons were set to fire continuously at of pre-set, but varying, intervals to produce an approximately-random pattern of sound. In 2003, Shell Albian introduced a new kind of system in which marine radar is used to detect the approach of migrating birds which, in turn, triggers the deployment of both auditory (cannons and peregrine screeches) and visual (peregrine effigy) deterrents. The two newer operators (CNRL and Imperial) each use a radar-based, on-demand system, but their acoustic deterrents are based on long range acoustic devices (LRAD) and their visual deterrents include lasers. Similar systems were introduced to some ponds at Syncrude and Suncor in Fall 2011.

Ponds and Survey Stations

As described in the 2011 monitoring protocol, "both process-affected and freshwater ponds were surveyed for contacts (bird landings) and flyovers. Process-affected water includes tailings and recycle water used for the processing of bitumen extraction, storm water, emergency dump ponds and any other water that may contain harmful or hazardous materials. Trace amounts of various compounds may be found in this water, but it is the residual bitumen that poses the greatest immediate risk to birds through direct contact and potential ingestion and so it is important to minimize the number of birds that come into contact with these ponds.

Process-affected ponds provide potential resting, roosting, nesting and foraging sites for birds, particularly in spring when they offer open water before other local water bodies have thawed. In spring and fall, high volumes of birds pass through this area during migration, and these are the times of greatest potential risk that the birds may land on the ponds."

Freshwater ponds included both reference ponds and compensation ponds. Reference ponds were monitored to better understand what bird species that may be found in the area, and to evaluate what portion of birds in the area are found on process-affected ponds. Compensation ponds are areas where land is set aside and a human-made pond is created and connected to fish-bearing streams to compensate for the habitat loss to fisheries systems. They incidentally also provide habitat for migrating birds. Imperial‟s Kearl Project and Shell‟s Jackpine Mine each has a Compensation pond.

All process-affected ponds on all oil sands sites were surveyed by their operators. Reference ponds were chosen for their close proximity to operator sites (3 ponds used by U of A) or were contained within lease sites (operator reservoirs or compensation ponds).

The number of survey stations placed at each process-affected water pond was proportional to pond size, and located according to criteria found in Table 5.2 of the *Oil Sands Bird Contact Monitoring Plan for 2011*. Maps of each pond (as of April 15, 2011)

describe the spatial characteristics of deterrents and survey locations (Appendix B). In total, there were 72 stations on process-affected ponds, 10 stations on reference ponds, and 3 stations on compensation ponds (Appendix C).

Pond Inventories

The frequency with which ponds were to be surveyed is described in section 5.1.2 of the *Oil Sands Bird Contact Monitoring Plan for 2011*, and is summarized below.

Survey stations at process-affected ponds were monitored daily, as close as possible to sunrise and/or sunset, splitting survey time and stations between those periods. The order that stations were surveyed (route) and the time of day were alternated among successive days to avoid confounding the timing of surveys with survey locations. Survey stations on freshwater ponds were monitored twice weekly.

Operator-specific monitoring methods

CNRL monitored all process-affected water ponds around its Horizon site daily from April 15th to October 31st. Mortality searches during this period were scheduled to be conducted on all process-affected water ponds twice per week. Horzion‟s Compensation Lake was also monitored but not at the same frequency as had been described in the Monitoring Plan. Most of the bird sightings recorded by CNRL were recorded on the western shore of the Tailings pond while bird monitoring crews were conducting mortality searches. In May, severe wildfires in the area forced the Horizon site to close for almost 3 weeks and the Monitoring Program was suspended over this period. In August, there were errors in data recording on some of the data sheets. To maintain data integrity, these data were not submitted to the U of A and Alberta Environment. The bird monitoring crews were notified of this problem and data was recorded properly for the remainder of the year. In future, CNRL will be using electronic tablets to record data in order to minimize recording errors.

At CRNL, there was some deviation from the protocol in the frequency of mortality searches. Searches of the tailings pond, especially its western side, were impeded by recurrent mechanical problems with the airboats. A misunderstanding by observers meant that dedicated mortality searches were not conducted at the other process-affected water ponds. Because all of these ponds are very small and were visited daily for observations, it is unlikely that bird mortalities there were missed. After notification of this problem in August, mortality searches were conducted twice weekly for the remainder of the year. Incidental observations showed the majority of birds on the Tailings Pond to be on the western shore.[1] All 4 observations points on the Tailings Pond were located on the eastern dyke.

[1] Potential implications of this observation will be explored in the discussion.

Imperial Oil conducted contact monitoring at two freshwater bodies (fisheries compensation lake, and future external tailings area – used as a freshwater storage area in 2011) as outlined in the *Oil Sands Bird Contact Monitoring Plan for 2011*. Contact monitoring surveys were conducted in teams of two, between mid- to late-morning, for between 45 minutes and two hours per survey, two times per week, at a minimum. The reduced effort, in comparison to other operators, was due to the fact that the Kearl Project was under construction, no oil was being produced, and therefore no process-affected ponds were on-site. Preliminary monitoring began in the late summer, 2011.

Shell conducted observations at four tailings ponds on Muskeg River Mine and two tailings ponds at Jackpine Mine. For the first four months of the monitoring program, the standardized monitoring program was conducted by Shell"s bird crew, which was also responsible for hazing birds detected on the ponds. Demands for these two sets of tasks repeatedly exceeded the time available and so Shell hired Hatfield Consultants who began performing observations on August 24, 2011 and continued until October 28, 2011.

Suncor Energy Inc. conducted contact and mortality monitoring as outlined in the Oil Sands Bird Contact Monitoring Plan for 2011. Surveys for bird contact were conducted by single observers, with two individuals working in each morning and evening shift. Contact monitoring began and ended as close as possible to local sunrise and sunset and was evenly spaced between morning and afternoon periods. As per the protocol, the order in which ponds were surveyed changed systematically each day so that the timing of monitoring varied. Although the Plan only required each survey station to be monitored once daily and freshwater ponds to be monitored twice weekly, additional available resources permitted Suncor to survey all survey stations twice daily (including freshwater ponds).[2] Mortality searches were conducted on the surface and shorelines of each pond twice a week by a dedicated crew of 3 individuals. Mortality searches were conducted throughout the day from 07:00-19:00.

Syncrude conducted the bird contact portion of the 2011 monitoring program with a crew of 8 individual bird watchers conducting the observations. On any given day, 4 people conducted observations for10 hours per day. Although these observers worked on their own to survey each process-affected water pond, they gathered at the end of each shift at Syncrude"s reference pond to provide ongoing mentoring and comparison of bird identification. On some occasions, poor road conditions or other safety constraints prevented surveys from being conducted. Extensive forest fires in Spring 2011 resulted in repeated orders by Sustainable Resource Development and Syncrude management for

[2] The implications of this adjustment of the monitoring protocol by Suncor are that (a) there was an opportunity to record approximately twice as many individuals in the course of each season and the entire year, (b) that a broader distribution of observation times is reported, and (c) that measures of sampling effort by approximately twice what would be expected of other operators. No effect of the protocol change is expected on (d) detection rates of birds per hour or per sampling period, (e) the number of species reported, or (f) any measure associated with mortality searches.

the temporary evacuation of non-essential personnel. These missing censuses were compensated for by adding an additional sample in the ensuing week.

Variation in start times by operator and pond, and in detection rates are presented in the results along with the products of the monitoring program. Overall start time by operator and start time per pond by operator are presented in the results.

Mortality Searches

Surveys for bird carcasses were conducted at all process-affected pond surfaces and shorelines twice per week. These surveys were conducted at any time of day, without diverting effort away from the dawn and dusk pond inventories. Additional mortality searches were done as soon as possible (within 2 days) of storm events. Freshwater ponds were not searched for mortalities. Further details on mortality survey methodology can be found in section 5.2 of the Oil Sands Bird Contact Monitoring Plan for 2011. Information on the number of censuses devoted to surveying for dead birds and the rate of detections per hour are presented in the results.

Incidental Observations

In addition to recording bird contacts and mortalities observed during pond inventory monitoring surveys and mortality searches, each oil sands mine operator has policies and procedures in place to facilitate the reporting of incidental observations of birds on process-affected ponds by employees. In addition, operators are obliged to report all incidental detections of dead wildlife, including birds, found on their sites. Currently, mortality records stemming from the incidental detections at ponds or other parts of operator lease sites are not included in this report.

Safety and Operational Constraints

The *Oil Sands Bird Contact Monitoring Plan for 2011* was developed recognizing that oil sands mine operators face several safety and operational constraints not typically encountered when monitoring wildlife in other contexts. The collection of rigorous and comparable data must not compromise safety and operational constraints. Impacts of these constraints in 2011 included:

- Observation could not occur around tailings ponds in low light conditions (i.e. during the twilight and night) when bird landings might be more likely.
- Some ponds and shorelines were inaccessible, which limits detectability of contacts and mortalities.
- The time available (up to 30 min at up to 4 sites) limits detection of birds on very large ponds.
- Ponds were sometimes inaccessible do to unforeseeable events (e.g., fires, road wash outs).

- Severe weather with heavy precipitation sometimes precluded observations or boat-based surveys.
- Dangerous wildlife sometimes precluded access to particular sites.

Results and Discussion

The section headings below address three themes:

1. Descriptive information about ponds and weather that will facilitate interpretation of the results,
2. Results that address objectives from the 2011 monitoring program (above), and
3. Assessments of the effects of the timing of both bird migration and monitoring by people that will contribute to the refinement of the monitoring protocol.

Pond characteristics

In all, 58 ponds were monitored by industry (including their contractors) and University of Alberta observers in Spring and Fall of 2011. This total included 48 monitored ponds on lease sites that contained process-affected water (Appendix C), three references ponds (Poplar Reservoir, Ruth Lake, and Kearl Lake) that were visited only by U of A observers, and seven reference ponds located on lease sites and monitored by industry observers (one per operator plus one additional pond at Suncor and the Kearl External Tailings Area which was a reference pond in 2011). These reference ponds were comprised of built compensation lakes (CNRL, Shell, Imperial) fresh water reservoirs (Syncrude and Suncor) and reclaimed sites (Suncor"s Crane Lake). Three of the ponds (Crane Lake, Kearl Compensation Pond, Shell"s Jackpine tailings pond) were monitored over comparable time periods by both industry and U of A personnel and these are referred to hereafter as comparison ponds.

Weather

2011 was characterized by an exceptionally warm and dry early spring, which resulted in several forest fires in the oil sands region. The late spring and early summer were cool and relatively wet. Late summer and early fall were warmer than average with little precipitation (Appendix D).

Monitoring objectives 1 and 2: Flyovers and contacts of birds at process-affected, reference, and compensation ponds

Among the 58 ponds monitored in 2011, a total of 44,687 individuals of 88 species or species groups were detected (Table 1, Figure 1A). At process-affected ponds, the most abundant species was "Unknown duck" (>6000 individuals) followed by Canada Goose (~4300 individuals).

Within the duck guild and at both pond types, 26,239 individuals were detected representing 31 species or species groups and the majority of these detections were via landings. At process-affected ponds (Figure 1B), geese were the water-associated species detected most often via fly-overs (~2500 individuals), more often recorded than unknown ducks, but the apparent prevalence of this species may stem from inconsistent identification among operators (below). At both pond types, and exempting unknown ducks, mallard, American wigeon, bufflehead, common goldeneye, and unknown scaup comprised the five most abundant species, respectively, each reported with over 1000 detections (Figure 1C).

Like the duck guild, loons and grebes were usually detected as landed birds, particularly red-necked grebes (Figure 1E).

In contrast to ducks, loons and grebes, other species were more often detected as fly-overs. These included the three most abundant goose species (Figure 1D), sandhill cranes (Figure 1J), and five species of gulls (Figure 1F). Raptors and passerines were almost always detected as fly-overs (Figure 1H and 1I). The most abundant of these, excluding unknown, were American kestrels and red-winged blackbirds, respectively.

Shorebirds were most often identified as "unknown sandpiper" or "unknown shorebird," which were approximately equally split between detections via landings and fly-overs (Figure 1G). When shorebirds were identified to species, they had usually landed.

Process-affected ponds

For the process-affected ponds, we separated observations by operator. Again we reported all observations (Tables 1A and 1B) and only those that were water-associated (Tables 1D, 1F, 1H and 1J).

On monitoring forms in 2011, observers were required to record whether or not a bird "landed". This did not require specification of whether the bird landed on the shore of a process-affected pond (likely for shorebirds), on residual pond vegetation (likely for passerines and other land birds) or made contact with the pond surface (likely for waterfowl). If observers did not specify where the bird was in relation to the pond surface, (a common occurrence), we decided if birds were water-associated by their natural history characteristics. If they were found to be water-associated, then their status as "landed" qualified as having made "contact" with the process-affected pond. This information is particularly important for sensitive species such as horned grebe (Suncor), green-winged teal (U of A), lesser scaup (Suncor and U of A), and northern pintail (Suncor), in addition to some species of lesser concern such as mallard (Suncor) and "unknown duck" (mainly Suncor).

Of the approximately 12,000 contacts observed by Suncor, 91% of them were recorded on two small, low-risk process-affected ponds (PAW pond and INK pond) on which resident waterfowl were found throughout the monitoring season.

Reference ponds

To assess the total species complement in the area, U of A observers monitored 6 reference ponds on 2 or more occasions during the 2011 monitoring program. Three sites were monitored twice for species surveys (Kearl Lake, Isidore Lake, and Athabasca River), and three sites were monitored consistently throughout spring and fall migration (Crane Lake, Poplar Reservoir, and Ruth Lake). One of these, Crane Lake, was also monitored by Suncor observers, creating one of the only three comparable ponds where inter-observer variation could be assessed (see Section 5.5, "Variation Among Sites and Observers", below). Syncrude observers monitored their freshwater pond Mildred Lake Reservoir as their reference pond.

Compensation ponds

Compensation ponds were monitored at Kearl (by both Imperial and U of A observers) and Jackpine (U of A only). At these sites, U of A observers made particular effort to record all species observed, including those on the periphery of the pond. These more comprehensive observations may be valuable to the assessment of the sites as compensatory habitat. Owing partly to fewer sites and observation periods at these compensation ponds, many of the species detected at reference and process-affected water ponds were not observed. As more data accumulate, important information will be contained in the differing species compositions of process-affected ponds, reference ponds, and compensation ponds.

Recoveries from Mortality Searches

The number of mortality surveys conducted on process-affected water ponds and the number of hours spent surveying varied dramatically among operators, mainly as a function of the number and size of process-affected water ponds (Appendix B and C, Figure 7A). For the largest operator, Syncrude, the number of hours spent surveying for dead birds exceeded 3000 during which a total of 10 dead birds were recovered. Suncor spent approximately 1500 h conducting mortality surveys and reported 37 dead birds. Shell spent about 200 hours surveying and reported 23 dead birds. CNRL also spent about 200 hours surveying and reported no dead birds. Imperial did not report mortality surveys, presumably because their mine was not yet in production.

By number, "unknown" and "unknown duck" were the most frequently reported mortality type (Figure 7B). The maximum number of individuals recovered for a single species was 10 for the entire 2011 season. A few species of special concern were recovered including green-winged teal (10 individuals), American white pelican (2 individuals), and lesser scaup (2 individuals).

Because of the large variation in the size and number of ponds, mortality counts do not accurately describe potential differences among sites in the vulnerability of birds to mortality. A better measure may be the rate at which dead birds were recovered as a

function of search time, even though there remains potential differences in searching efficacy. Measured as detections per 100 hours of search time, variation among operators ranged from less than one detection (Syncrude) to 12 individuals (Shell; Figure 7C). Mallards were the most readily detected species at Shell (1.8 per 100 hours), but least detected at Syncrude (< 1 per 1000 hours). Clearly, detecting dead birds is an extremely labour-intensive activity.

A portion of the dead birds found on site were not the result of mortality searches, but incidental observations made by other operations individuals. Only Syncrude provided data for these incidental mortalities, which revealed that the 10 birds recovered during mortality searches represented only 33% of all the dead birds found on the lease site. The other 20 dead birds were reported incidentally by site workers, but only one of these was a water-associated bird. Over 60% of the total bird mortalities recorded by Syncrude during the 2011 monitoring season were represented by corvids, which seem to be especially prone to electrocution when they are attracted to mining operations. Understanding the generality of these patterns and the complete context of bird vulnerability will require comparable information on bird mortality from all operators.

Monitoring objective 3: Develop [and refine] a standardized monitoring program … to provide comparable data across ponds, sites, seasons, and years.

Variation in detections

Observation effort was quantified as the number of visits to ponds and the number of hours spent monitoring (Figures 2A and 2B). As expected by the large variation in the number and size of process-affected water ponds, there were dramatic differences among operators in both metrics. Imperial‟s Kearl site reported the longest average observation duration, almost 2 hours, perhaps because its observers targeted mainly the Kearl Compensation pond with few visits in this pre-production year. At the other sites, average visit length was 30 minutes or more, as would be expected from the monitoring protocol. The number of visits made to sites was dramatically higher at Suncor, over 11 000, than at the other sites. Except for Imperial‟s Kearl project, each of the other operators made over 1000 observation visits to ponds.

The proportion of visits with no detections recorded approached 100% at each of CNRL and Syncrude (Figure 2C). That proportion was about 80% at each of Shell and Suncor. Imperial observers saw no birds on less than 30% of their visits and U of A observers detected no birds on only 12% of their visits. A lower proportion of visits without detections would be expected for U of A observers because they monitored a much larger proportion of reference ponds where bird detections were expected and because the two process-affected ponds they monitored, at Shell‟s Jackpine Mine, contained emergent vegetation which attracted birds throughout the season. Similarly, a lower proportion of visits without detection would be expected for Imperial observers, as they were mainly monitoring their compensation pond and a reference pond (future process-affected pond pre-production with no deterrents). Again, it is impossible to know the extent to which

differences in detectability owing to equipment or skill might have contributed to these values because only 3 ponds (Crane Lake, Kearl Compensation pond, Jackpine ETF) were monitored by industry and U of A observers in the same season.

The number of individuals detected in each visit varied among sites as an approximate inverse of the proportion of visits without detections (Figure 2). On average, fewer than one bird was detected per visit by each of CNRL and Syncrude, 3 or 4 by Suncor and Shell, respectively, and about 15 by Imperial. U of A detected an average of 26 individuals per visit. When expressed as detections per hour, U of A observers detected an average of over 50 individuals, Imperial, Shell and Suncor clustered around 10, and CNRL and Syncrude approached zero. All pond types are lumped for each of these sums and rates.

Some of the detections of rare or unexpected species on or over process-affected water were highly concentrated at particular lease sites. Examples of these species in the spring (Table 1C and 1E) include horned grebe (>90% at Suncor), snow goose (100% at Shell), green-winged teal (>70% by U of A), barn swallows (>80% at Suncor), magpies, ravens, and robins (all > 90% at Suncor), and common grackle (>95% at Suncor). Examples of these species in the fall (Table 5) include horned grebe (100% Suncor), trumpeter swan (100% at CNRL), red-necked phalarope (100% U of A), black tern (100% at Suncor), American kestrel (100% at Shell), barn swallow (100% at Suncor), American pipit (>99% at Shell), red-winged blackbird (100% at Suncor), Brewer‟s blackbird (100% at Suncor), common grackle (100% at Suncor), and white-winged crossbill (100% at Shell).

Because lease sites occur over a wide region with substantial differences in topography, vegetation, hydrology, soil types, and pond characteristics, it is difficult to know whether site-specific concentrations in species observations stemmed from actual differences in species distributions or from differences in identification accuracy among observers. For example, both U of A and Shell observers monitored Shell‟s Jackpine Mine site, but U of A observers recorded over 70% of the green-winged teal observations, whereas the Shell observers recorded less than 1% of green-winged teal observations. Abundant floating vegetation at the newly-flooded Jackpine site might explain some of the difference. Nonetheless, inter-observer variation is expected even among highly skilled observers (see information below concerning Objective 3).

At process-affected ponds, the recording and identification of some species that are typically abundant near human infrastructure varied unexpectedly among lease sites (Tables 1C and 1E). For example, common ravens were recorded often only at Shell and Suncor, and both black-billed magpies and red-winged blackbirds only at Suncor. However, all four species are likely to be abundant in the vicinity of ponds. Similarly, over 80% of the mallards reported were recorded at Suncor, but Suncor also reported the highest number of unknown ducks (42%), which makes it difficult to know whether mallards along with other ducks were actually more abundant there or if other species were more likely to be assumed to be mallards at that site.

We examined differences in the three pairs of sites (hereafter „comparison

ponds"), Crane Lake, Jackpine Mine"s External Tailings Facility, and Kearl Compensation pond. Dividing the ponds by type makes it possible to assess inter-observer variation directly (Figure 3) for the ponds that were monitored by both U of A and industry observers. We examined differences in the metrics of detection frequency (number / visit), and detection rate for water-associated birds. At Kearl Compensation Pond, U of A observers recorded around 300 landed water-associated birds whereas industry observers recorded about 600 landed. U of A observers also recorded about 1800 landed water-associated birds at Crane Lake whereas industry observers detected about 8300 landed (Figure 3C). The direction and approximate magnitude of these differences are put into context when detections were expressed as a rate (number of water-associated birds per hour of observation; Figure 3D), U of A detected almost 30 landed birds to industry"s 5 at Kearl Compensation pond, and 75 to industry"s 45 at Crane Lake. At all three sites, U of A detected more water-associated birds per visit than industry observers did with differences ranging from 40% to 60% (Figure 3E). Differences in detections of water-associated birds per hour was qualitatively similar to the pattern of detections per visit: relative to industry observers, U of A rates were almost twice as high at Crane Lake, over twice as high at Jackpine (but almost completely restricted to fly-overs) and almost five times as high at Kearl Compensation pond (Figure 3D). Differences in survey methodology must account for some of these differences.

Beyond the information on inter-observer variation contained in the comparison sites, evidence of unintended variation is provided by the nature of variation in detections. Table 1 provides several examples of unexpected variation among sites that may be caused by inter-observer variation. A few of these differences are summarized below:

- Suncor identified almost all their scaup as lesser or greater but the distinction between the two is notoriously difficult and requires good light and close proximity.
- Syncrude observed 1000 cliff swallows but no other swallow species, making it likely that all swallows were assumed to be cliff swallows. At the same time, the 126 records of barn swallows by Suncor is surprising. Because the latter are a species of special concern, accurate identification is especially important.
- There was dramatic variation among observers in the recording of corvids (see section 5.2, Flyovers and Contacts).

Variation in monitoring start times

As part of *Oil Sands Bird Contact Monitoring Plan for 2011*, operators were encouraged to spread their observations through the periods in which crews were able to access tailings ponds, to target dawn and dusk for observations, and to alternate the order with which they monitored ponds to avoid a systematic confound in detections between site and time. Accordingly, there was substantial breadth to the distribution of start times for all observers (Figure 4A). Among observers, observations by U of A exhibited more spread than those of other observer teams, partly because they sought to quantify differences in detection as a function of time and broke their observation periods into 5 blocks ranging from dawn to dusk. Syncrude observers exhibited the earliest observation periods with the narrowest distribution; virtually all occurred between 500 h and 1200 h.

By contrast, Suncor and CNRL observations exhibited greater spread and many occurred after 1200 h; Shell and Imperial were intermediate. Within operators, average start times varied among ponds by as little as 2 hours (Shell, Syncrude) and by as much as 7 hours (CNRL; Figure 4B).

When examined as a continuous function of time with a smoothing function (i.e. a non-linear, best-fit relationship), there was little evidence that the detections varied as a function of time since sunrise (Figure 5A). At only one site, Suncor, was there evidence of a pronounced peak in detections by hour. This apparent effect may be a consequence of overlap between the first and second observation periods in each day. As described above, Suncor conducted observations at each pond twice each day to make use of the large crew size it had anticipated needing to complete the monitoring program.

The effect of time of day on detections was similar when they were plotted as a rate (Figure 5) with only a slightly higher rate in the period described as late morning for all operators combined. At individual sites, the tendency for detection rate to peak in the late morning was apparent at CNRL, Shell, Syncrude and by U of A observers (Figure 5D). Maximum detection rate was slightly higher in the afternoon at Imperial and in the early morning at Suncor. Variation in detection rates among operators was generally several times greater than differences among time periods within operators. The most pronounced peak in late morning detections was reported by U of A observers (Figure 5E)

Variation in migration chronology and length of the monitoring period

We estimated the effects of shortening the monitoring period in both spring and fall by calculating the number of individuals and species that would have been detected if monitoring had ended on earlier dates (Spring) or begun on later dates (Fall). To do this, we used the actual number of detections before July 15 as the denominator (i.e., 100%) for Spring and the number of detections after July 14th as the denominator in Fall. Then we identified the date on which each of 80, 85, 90, and 95% of individuals and species would have been detected for each season (Table 2). For all calculations, the term species refers also to species groups. The goal of this effort was to support optimization of monitoring duration to maximize detections while minimizing costs. In other words, if these calculations demonstrated that large changes in monitoring duration produced only small changes in the number of species detected, it would be logical to consider shortening the monitoring periods.

The effect of changing monitoring dates generally had a larger effect on the number of species than on the number of individuals detected in both seasons. For example, when the number of individuals was reduced to 80%, the number of species was reduced to 41% and 52% in the spring and fall, respectively (Tables 2A and 2B). However, the pattern was reversed within species, particularly for rare species. This effect is illustrated well for horned grebes; if the dates that achieved 80% of the total detection had been used to end monitoring in Spring and begin it in Fall, the number of horned grebes detected would have been only 57% and 14% of the actual detections for that species in spring and fall, respectively (Table 2C).

To provide a visual representation of migratory timing for each species, we calculated frequency histograms of all detections in the 2011 season (Figure 6). These patterns were similar to those found in field guides and can be used in subsequent years for three purposes. First, they will demonstrate the species that are most likely to exhibit large effects of changes to the timing of monitoring. Second, they could assist in the identification of birds on lease sites by providing a means of assessing the relative probability of seeing similar-looking species on different dates. Third, these histograms, updated annually, will provide a risk profile for the species that are most likely to encounter severe weather in early spring (e.g., canvasback, Barrow's goldeneye, some mallards) or late fall (e.g., common merganser, lesser scaup, bufflehead), which appears to be associated with large landing events by birds in the oil sands and elsewhere.

Monitoring objective 4: Species at Risk

We derived the risk status for each of the species detected during the 2011 monitoring season from federal and provincial listings (Table 1). Federal listings under the Species At Risk Act (SARA) rank from "Endangered" to "Threatened" to "Special Concern." The rusty blackbird and the yellow rail are listed federally under SARA as "Special Concern." The rest of the species in the "some concern" category receive this status from provincial listings, and are all listed as "Sensitive" to human activities or natural events. Alberta rankings range from "At Risk" (of extinction), to "May Be At Risk" (of extinction), to "Sensitive" (to human activities or natural events), to "Secure" (General Status of Alberta Wild Species 2010, unpublished report). The "Sensitive" listing is defined as "Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk" (General Status of Alberta Wild Species 2010, unpublished report).

During spring migration (prior to July 15), we positively identified 99 bird species (Table 1A) in the total sample of 50 ponds, which included process-affected water, reference, and compensation. Twenty of those species are of "some concern," and may have made contact with the pond surface, made contact with the pond shore, made contact with the pond vegetation, flown over the pond, or were identified by sound only. The twenty species of "some concern" include horned grebe (113), American white pelican (3), great blue heron (10), sandhill crane (248), trumpeter swan (2), green-winged teal (410), northern pintail (96), lesser scaup (631), white-winged scoter (8), sora (35), yellow rail (2), upland sandpiper (1), black tern (216), golden eagle (1), bald eagle (3), northern harrier (21), osprey (1), sharp-tailed grouse (1), common yellowthroat (1), rusty blackbird (3; Table 1A).

During fall migration (after July 14), 102 bird species were positively identified (Table 1B). Twenty-one of those species are of "some concern." Horned grebe (222), pied-billed grebe (11), American white pelican (1), American bittern (1), great blue heron (7), sandhill crane (69), trumpeter swan (7), green-winged teal (250) northern pintail (331), lesser scaup (763), white-winged scoter (40), sora (1), black tern (106), golden eagle (1), bald eagle (6), northern harrier (25), Swainson's hawk (1), American kestrel (189),

pileated woodpecker (1), western wood-pewee (12), bay-breasted warbler (1), rusty blackbird (15; Table 1B). All of these species are listed as "Sensitive" in Alberta.

One peregrine falcon was observed by Shell in fall migration (Table 1B) and it was presumably of the subspecies found in Alberta, *P. f. anatum*, which is most at risk nationally. This species was labeled as "high concern" in Table 1B, corresponding to its status as "Threatened" under SARA and "At Risk" in Alberta.

Barn swallow (*Hirundo rustica*), a species of "moderate concern" (Tables 1A and 1B) was recorded with surprisingly high frequency (153 individuals in spring and 339 in Fall). This species is listed as "Threatened" by the Committee for the Status of Endangered Wildlife in Canada (COSEWIC), the federal body that informs species to be listed under SARA (Species at Risk Act, Public Registry). Currently the Barn Swallow has no official listing under SARA, but it is listed in Alberta as "Sensitive" in 2010 (General Status of Alberta Wild Species 2010, unpublished report). Because barn swallows can be confused with tree swallows (above), this sighting should be interpreted cautiously and verified next year.

Whooping cranes (*Grus americana*), which are listed as "Endangered" under SARA and "At Risk" in Alberta and are of particular concern in the oil sands area due to the possibility of contact with process-affected ponds, were not observed at any site in 2011.

Of the species identified at any risk category (level 2 or higher) only green-winged teal and lesser scaup were recorded repeatedly as having landed on process-affected ponds and these species typically occurred in group sizes between 1 and 20 birds.

Monitoring objective 5: Recommendations

Program Implementation

1. **Create and maintain a structured program to assess inter-observer variation.** An ideal way to partition variation to sites and observers would be to have a single observation team travel to each of the sites and conduct observations on the same days as operator-based crews. Data should be collected and recorded with a double-blind method (neither team should know what the other has detected while conducting observations). Comparisons after each observation session is complete would facilitate learning and standardization. This approach was proposed in the automated monitoring prospectus of April 2011, which resulted in invitations by Shell and Imperial to conduct ongoing observations on their lease sites. At least two visits to each of the 5 active operators should be conducted by a single observation team in each of spring and fall migration in 2012. That team could be comprised of U of A, consulting, or industry biologists or a combination. As the monitoring program and its methods are refined in successive years, fewer visits will be necessary to maintain acceptable levels of inter-observer variation.

2. **Create a more extensive training course, including a field component, for all observers contributing to the monitoring program** that is maintained and refined

among years. This standardization is essential to maintaining data quality through time and will allow the monitoring information to inform objectives beyond the protection of birds in the oil sands region.

Data Collection

3. **Enter data electronically in the field** using a database form that has been programmed with drop down menus to standardize place and species names, and to prevent erroneous ranges of values. Use of a common data entry platform will save enormous amounts of time in the entering and grooming of data and support the development of automated self-updating data queries. The form might additionally provide flags for species of special concern so that observers can make extra effort to ensure the accuracy and completeness of the data collected. Hundreds of hours in 2011 were devoted to data entry, data checking, and data correction. Comprehensive field training of effective and accurate use of electronic forms is essential to their success.

4. **Determine the accuracy of mortality searches and develop automated methods for mortality monitoring**. Accuracy could be assessed by measuring the recovery by „blind" observers of a known number of bird carcasses during the 2012 season. We agreed at the January meeting that the current mortality searches should continue for one additional year. Use of the existing protocol would verify the small number of mortalities recorded in the 2011 season and demonstrate the rate at which known deposits are recovered. The design of the double-blind test is beyond the scope of this report, but it should be resolved in time for implementation in both Spring and Fall, 2012. Ideally, it would include at least two deposits of birds from a helicopter per season at each of the operations. Such a test is essential to gain public confidence that estimates of mortality are accurate and that the current method of searching can be reduced. In addition to being labour-intensive, mortality searches that occur by boat also convey significant expense to operators and risk to workers. Automation of mortality monitoring might be supported with HD videography from military-grade, remote-controlled helicopters or high-resolution photography from shore-based stations.

5. **Expand species records to include all avian species.** The prevalence of common „weedy" species such as crows, ravens, magpies, robins, and red-winged blackbirds is indicative of other ecological conditions that affect bird communities. Corvids in particular are opportunistic scavengers and their abundance typically increases in human-dominated landscapes. Similarly, observers should be trained to detect species of concern and other species of interest by ear for more comprehensive monitoring of reference ponds. Some species (e.g., Sora) are seldom seen, but they are easily recognized by sound and are likely to colonize compensation ponds as vegetation around them matures. On-going refinements to the data forms should make data entry as consistent and efficient as possible for recording these additional species and contexts. Many changes to the electronic data form have already been made and suggestions for additional changes are welcomed from all users.

Data Inclusion

6. **Add information about incidental mortalities should be included in the annual report of the monitoring program.** Evaluating the danger to birds posed by tailings ponds in this report is based (with one exception by Syncrude) only on the number of mortalities reported from the twice-weekly surveys. Evaluating the utility of this survey as well as the magnitude of its results requires comparison with the number and location of birds recovered incidentally on lease sites. Incidental mortalities should be included in all future monitoring programs. Operators should report the date, time, and specific location of the recovery of all avian recoveries on lease sites.

Data Analysis

7. **Refine the descriptive analyses in the annual report to support comparisons among years.** The descriptive analyses in this report should be assessed and evaluated for their utility in future. Some data summaries might be reduced and others expanded. A pre-defined set of descriptive analyses will improve the efficiency of data collection and report preparation. Coordination with others conducting regional monitoring is desirable. A consistent and well-maintained set of summary data will provide an invaluable resource for industry, government, and concerned citizens. Whereas many of these individuals currently rely mainly on speculation, summary data will foster discussion of avian issues in the oil sands region from a position of shared evidence-based knowledge.

8. **Use refined monitoring data to evaluate deterrent efficacy and efficiency.** In addition to refined descriptive analyses, data should be examined analytically to identify the spatial and temporal variables associated with greater rates of bird visitation. Robust analyses of this type will require greater consistency of data collection than could be achieved this year will be needed to support. Measures of abundance should incorporate detection limitations. With more consistent data, it will be possible to evaluate the efficacy of deterrents as well as their ecological efficiency.

9. **Supplement observational data of landings with consistent and comprehensive information about migratory pressure**. As feared by some industry representatives at the beginning of the 2011 season, it is difficult to quantify the number of birds flying over lease sites, and even ponds, by observation alone. Yet such counts are essential to interpret variation in the number of landed birds and mortalities in process-affected ponds. Radar provides a better means of obtaining this information, if it can be compared among lease sites. As of Spring 2012, every operator uses radar to deploy its deterrents at one or more of its tailings ponds and radar detections of birds should be converted to daily counts of birds and bird flocks (which cannot necessarily be distinguished).

   Conversion of radar records to bird counts is not trivial and existing software for commercial deterrent systems does not do this automatically. Providing this

information could take several forms:

- Operators could work with deterrent system providers to adapt proprietary software for this purpose.
- Operators could store radar files and then apply 3rd party software to the files. The Research on Avian Protection Project (RAPP) uses an open source program, RadR, to convert radar detections to counts. It is a pattern-recognition algorithm tailored to migratory birds and it will support any radar type.
- Operators could invite RAPP researchers to install their own mobile radar on lease sites temporarily and potentially in combination with visits by the standardization teams (above) to count samples of birds at its site. RAPP will be conducting similar counts in the vicinity of lease sites and building a calibration tool using radar records at Shell; a similar calibration tool could be built for other operators.

Data Reporting

10. **Make monitoring information publicly available.** The standardized monitoring program adopted for birds in the oil sands region in 2011 could do much to improve the protection of wildlife and the confidence of the public. These reports should be available on a publicly-accessible data portal in the year of their collection. The section on data analysis (above) described the value of data summaries in this context. However, with refinement, the raw data might also be logged on a public site shortly after collection, as occurs with a number of other environmental monitoring datasets. Because of the novelty of its origin and development, the products of the initial year or two of monitoring could support a publication in the peer-reviewed literature.

Conclusions

The execution of the *Oil Sands Bird Contact Monitoring Plan for 2011* was not without its challenges. Numerous ideas for refinement are contained in the recommendations above and supported by the nature of the results presented. Additional recommendations for the 2012 season are invited from all interested readers for consideration by the team tasked with refining that plan. That team is the same one that created this report; a conglomerate of government, industry, and academic individuals with a common responsibility to protect birds in the oil sands region. Despite their common purpose, the group is too new and too diverse even to have a name. That fact alone describes the most important success of the 2011 monitoring program. In the 30-odd years since industrial operations began in the region, this is the first time that operators have attempted to use a common method for measuring contact with tailings ponds by birds, it is the first time they have shared the results of their observations with one another, and it is the first time they have committed to making the information from the subsequent season even more robust. Concomitant with that procedural change, was a data set that describes a rich assemblage of birds in the oil sands region, landings on process-affected water that number in the thousands, and a total mortality count, stemming from thousands of hours

of searching, that numbers fewer than 100 birds. Additional data will be needed to determine the generality of these results.

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Table 1. Number of individuals counted at ponds by five industry-based monitoring groups and by the University of Alberta (UA). Total detections are differentiated based on whether individuals were observed or heard, seen over the water, or landed or presumed to have landed and include those with location not specified. Observer totals combine detection types. Species name is to the lowest possible taxonomic level. Group reflects a functional organization based on habit rather than phylogeny. Status represents a homogenization of the three species at risk designations used in Canada (see report text); 0=no risk level assigned, 1=no concern, 2=some concern, 3=moderate concern, 4=high concern, blank=unknown species.

This table has 10 panels, labelled from A to J, presenting seasonal surveys by pond type (reference or process-affected or combined) and/or species group (water-associated only or all birds included) as summarized in the table below. Reference ponds include compensation lakes on lease sites as well as natural and semi-natural water-bodies that do not contain process-affected water.

Panel	Species Group	Detection Types	Season	Pond Type
A	All	Observed or heard	Spring	Combined
B	All	Observed or heard	Fall	Combined
C	All	Observed or heard	Spring	Process-affected
D	Water-associated	Observed or heard (In vicinity); Over water (or not specified); Landed	Spring	Process-affected
E	All	Observed or heard	Fall	Process-affected
F	Water-associated	Observed or heard (In vicinity); Over water (or not specified); Landed	Fall	Process-affected
G	All	Observed or heard	Spring	Reference
H	Water-associated	Observed or heard (In vicinity); Over water (or not specified); Landed	Spring	Reference
I	All	Observed or heard	Fall	Reference
J	Water-associated	Observed or heard (In vicinity); Over water (or not specified); Landed	Fall	Reference

A. All species detected at both pond types combined, spring surveys.

				Spring								
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	Unknown [a]	Unknown	other	91	0	91	0	0	41	23	0	27
1	*Gavia immer*	Common Loon	loon/grebe	416	0	416	0	22	0	254	13	127
1	*Gavia pacifica*	Pacific Loon	loon/grebe	2	0	2	0	0	0	2	0	0
	Podicipedidae	Unknown Grebe	loon/grebe	2	0	2	0	0	0	0	2	0
1	*Podiceps grisegena*	Red-necked Grebe	loon/grebe	566	0	566	0	0	0	268	0	298
2	*Podiceps auritus*	Horned Grebe	loon/grebe	113	0	113	0	0	0	98	5	10
1	*Podiceps nigricollis*	Eared Grebe	loon/grebe	9	0	9	0	0	0	0	2	7
2	*Pelecanus erythrorhynchos*	American White Pelican	other	3	0	3	0	0	0	0	2	1
1	*Phalacrocorax auritus*	Double-crested Cormorant	other	1	0	1	0	0	0	0	0	1
	Ardeidae	Unknown Heron	other	1	0	1	0	0	0	0	0	1
2	*Ardea herodias*	Great Blue Heron	other	10	0	10	0	0	0	0	1	9
2	*Grus canadensis*	Sandhill Crane	other	246	2	248	0	1	4	2	0	241
	Cygnus spp.	Unknown Swan	other	5	0	5	0	0	5	0	0	0
2	*Cygnus buccinator*	Trumpeter Swan	other	2	0	2	0	0	0	0	0	2
1	*Chen caerulescens*	Snow Goose	goose	850	0	850	0	0	850	0	0	0
1	*Branta canadensis*	Canada Goose	goose	1996	2	1998	33	348	138	69	0	1410
	Anatinae	Unknown Duck	duck	1763	1	1764	4	103	47	744	305	561
	Anatinae	Unknown Dabbling Duck	duck	26	0	26	0	0	1	0	0	25
1	*Anas platyrhynchos*	Mallard	duck	1374	5	1379	15	69	160	857	34	244
1	*Anas strepera*	Gadwall	duck	58	0	58	0	0	0	51	0	7
2	*Anas crecca*	Green-winged Teal	duck	410	0	410	0	0	2	102	2	304
1	*Anas americana*	American Wigeon	duck	338	1	339	0	5	0	141	18	175
2	*Anas acuta*	Northern Pintail	duck	96	0	96	0	14	53	2	2	25

				Spring								
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Anas clypeata*	Northern Shoveler	duck	276	1	277	0	45	6	94	1	131
1	*Anas discors*	Blue-winged Teal	duck	35	0	35	0	4	0	21	0	10
1	*Oxyura jamaicensis*	Ruddy Duck	duck	57	0	57	0	0	0	34	2	21
	Aythya spp.	Unknown Diving Duck	duck	31	0	31	0	0	0	2	0	29
1	*Aythya valisineria*	Canvasback	duck	423	0	423	0	0	16	165	0	242
1	*Aythya americana*	Redhead	duck	47	0	47	0	0	2	26	0	19
1	*Aythya collaris*	Ring-necked Duck	duck	296	0	296	0	6	0	64	2	224
	Aythya spp.	Unknown Scaup	duck	1134	0	1134	0	0	35	52	6	1041
1	*Aythya marila*	Greater Scaup	duck	144	0	144	0	0	0	141	1	2
2	*Aythya affinis*	Lesser Scaup	duck	631	0	631	0	0	39	320	13	259
	Anatinae	Unknown Eider	duck	2	0	2	0	0	0	2	0	0
	Melanitta spp.	Unknown Scoter	duck	8	1	9	0	0	1	8	0	0
2	*Melanitta fusca*	White-winged Scoter	duck	8	0	8	0	0	0	4	0	4
1	*Melanitta perspicillata*	Surf Scoter	duck	37	0	37	0	0	2	0	3	32
1	*Bucephala islandica*	Barrow's Goldeneye	duck	28	0	28	0	0	0	28	0	0
1	*Bucephala clangula*	Common Goldeneye	duck	968	0	968	12	61	0	788	13	94
1	*Bucephala albeola*	Bufflehead	duck	646	1	647	19	31	1	490	8	98
1	*Mergus merganser*	Common Merganser	duck	11	0	11	0	0	0	0	3	8
1	*Mergus serrator*	Red-breasted Merganser	duck	28	0	28	0	2	0	0	0	26
	Charadriiformes	Unknown Shorebird	shorebird	230	1	231	0	0	0	40	34	157
2	*Porzana carolina*	Sora	shorebird	19	16	35	0	0	0	6	0	29

Spring												
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
2	*Coturnicops noveboracensis*	Yellow Rail	shorebird	1	1	2	0	0	0	0	0	2
1	*Fulica americana*	American Coot	duck	80	1	81	0	0	4	39	0	38
	Charadriinae	Unknown Plover	shorebird	21	1	22	0	0	0	0	0	22
1	*Charadrius vociferus*	Killdeer	shorebird	128	3	131	0	10	7	17	6	91
1	*Pluvialis squatarola*	Black-bellied Plover	shorebird	5	0	5	0	0	0	2	0	3
1	*Pluvialis dominica*	American Golden Plover	shorebird	3	0	3	0	0	0	0	2	1
1	*Tringa melanoleuca*	Greater Yellowlegs	shorebird	15	0	15	0	3	0	4	2	6
1	*Tringa flavipes*	Lesser Yellowlegs	shorebird	116	0	116	0	10	0	32	5	69
	Scolopacinae	Unknown Sandpiper	shorebird	267	0	267	0	1	0	108	0	158
1	*Tringa solitaria*	Solitary Sandpiper	shorebird	5	0	5	0	0	0	1	2	2
1	*Actitis macularius*	Spotted Sandpiper	shorebird	15	0	15	0	0	0	1	5	9
1	*Phalaropus tricolor*	Wilson's Phalarope	shorebird	2	0	2	0	0	0	0	0	2
0	*Limnodromus griseus*	Short-billed Dowitcher	shorebird	6	0	6	0	0	0	0	0	6
1	*Gallinago delicata*	Wilson's Snipe	shorebird	14	1	15	0	0	0	1	0	14
1	*Calidris pusilla*	Semipalmated Sandpiper	shorebird	5	0	5	0	0	0	0	0	5
1	*Calidris minutilla*	Least Sandpiper	shorebird	4	0	4	0	0	1	0	3	0
1	*Calidris bairdii*	Baird's Sandpiper	shorebird	1	0	1	0	0	0	1	0	0
2	*Bartramia longicauda*	Upland Sandpiper	shorebird	1	0	1	0	0	0	0	0	1
	Larinae	Unknown Gull	gull/tern	845	2	847	0	0	14	419	83	331
1	*Leucophaeus pipixcan*	Franklin's Gull	gull/tern	47	0	47	1	0	0	0	30	16

				Spring								
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Chroicocephalus philadelphia*	Bonaparte's Gull	gull/tern	270	1	271	0	30	0	69	0	172
1	*Larus delawarensis*	Ring-billed Gull	gull/tern	13	0	13	0	0	0	0	0	13
0	*Larus argentatus*	Herring Gull	gull/tern	45	0	45	0	0	5	7	15	18
1	*Larus californicus*	California Gull	gull/tern	10	0	10	0	0	0	3	0	7
1	*Sterna hirundo*	Common Tern	gull/tern	106	0	106	0	68	0	15	0	23
2	*Chlidonias niger*	Black Tern	gull/tern	216	0	216	0	0	0	214	0	2
	Raptor [b]	Unknown Raptor	raptor	9	0	9	0	0	0	6	0	3
2	*Aquila chrysaetos*	Golden Eagle	raptor	1	0	1	0	0	0	0	0	1
2	*Haliaeetus leucocephalus*	Bald Eagle	raptor	3	0	3	0	0	0	2	0	1
2	*Circus cyaneus*	Northern Harrier	raptor	20	1	21	0	0	0	1	0	20
1	*Buteo jamaicensis*	Red-tailed Hawk	raptor	5	0	5	0	0	0	5	0	0
2	*Pandion haliaetus*	Osprey	raptor	1	0	1	0	0	0	1	0	0
	Passeriformes [c]	Unknown Passerine	passerine	734	2	736	0	0	0	325	0	411
	Tetraoninae	Unknown Grouse	passerine	1	0	1	0	0	0	1	0	0
2	*Tympanuchus phasianellus*	Sharp-tailed Grouse	passerine	1	0	1	0	0	0	1	0	0
1	*Megaceryle alcyon*	Belted Kingfisher	passerine	3	0	3	0	0	0	0	0	3
1	*Colaptes auratus*	Northern Flicker	passerine	12	0	12	0	0	0	12	0	0
	Tyrannidae	Unknown Flycatcher	passerine	6	0	6	0	0	0	6	0	0
	Hirundininae	Unknown Swallow	passerine	99	0	99	0	0	0	99	0	0
1	*Tachycineta bicolor*	Tree Swallow	passerine	354	2	356	0	0	0	183	0	173
1	*Riparia riparia*	Bank Swallow	passerine	32	0	32	0	0	0	32	0	0
1	*Stelgidopteryx serripennis*	Northern Rough-winged Swallow	passerine	2	0	2	0	0	0	2	0	0

				Spring								
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Petrochelidon pyrrhonota*	Cliff Swallow	passerine	1060	0	1060	0	0	6	0	1053	1
3	*Hirundo rustica*	Barn Swallow	passerine	153	0	153	0	0	0	126	0	27
1	*Cyanocitta cristata*	Blue Jay	passerine	4	0	4	0	0	0	4	0	0
1	*Perisoreus canadensis*	Gray Jay	passerine	4	0	4	0	0	0	0	0	4
1	*Pica hudsonia*	Black-billed Magpie	passerine	27	0	27	0	0	0	26	1	0
1	*Corvus brachyrhynchos*	American Crow	passerine	1	1	2	0	2	0	0	0	0
1	*Corvus corax*	Common Raven	passerine	27	0	27	2	0	0	25	0	0
1	*Poecile atricapillus*	Black-capped Chickadee	passerine	3	0	3	0	0	0	3	0	0
1	*Sialia currucoides*	Mountain Bluebird	passerine	0	1	1	0	0	0	0	0	1
1	*Turdus migratorius*	American Robin	passerine	81	0	81	0	0	0	79	0	2
1	*Bombycilla cedrorum*	Cedar Waxwing	passerine	9	0	9	0	0	0	9	0	0
0	*Sturnus vulgaris*	European Starling	passerine	1	0	1	0	0	0	0	0	1
	Parulidae	Unknown Warbler	passerine	18	0	18	0	0	0	18	0	0
1	*Mniotilta varia*	Black-and-white Warbler	passerine	1	0	1	0	0	0	1	0	0
1	*Setophaga coronata*	Yellow-rumped Warlber	passerine	2	0	2	0	0	0	2	0	0
1	*Setophaga petechia*	Yellow Warbler	passerine	17	2	19	0	0	0	16	0	3
1	*Seiurus aurocapilla*	Ovenbird	passerine	0	1	1	0	0	0	0	0	1
1	*Parkesia noveboracensis*	Northern Waterthrush	passerine	1	1	2	0	0	0	0	1	1
2	*Geothlypis trichas*	Common Yellowthroat	passerine	1	0	1	0	0	0	0	0	1

				Spring								
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	Emberizidae	Unknown Sparrow	passerine	129	0	129	0	0	0	105	1	23
1	*Passerculus sandwichensis*	Savannah Sparrow	passerine	2	0	2	0	0	0	1	0	1
1	*Melospiza melodia*	Song Sparrow	passerine	7	0	7	0	0	0	7	0	0
1	*Spizella pallida*	Clay-colored Sparrow	passerine	1	0	1	0	0	0	0	0	1
1	*Zonotrichia albicollis*	White-throated Sparrow	passerine	2	0	2	0	0	0	0	0	2
1	*Melospiza lincolnii*	Lincoln's Sparrow	passerine	0	1	1	0	0	0	0	0	1
1	*Melospiza georgiana*	Swamp Sparrow	passerine	1	0	1	0	0	0	1	0	0
1	*Plectrophenax nivalis*	Snow Bunting	passerine	33	0	33	0	0	0	0	0	33
	Icteridae	Unknown Blackbird	passerine	103	0	103	0	0	0	103	0	0
1	*Xanthocephalus xanthocephalus*	Yellow-headed Blackbird	passerine	7	0	7	0	0	0	3	0	4
1	*Agelaius phoeniceus*	Red-winged Blackbird	passerine	1536	2	1538	0	0	1	1295	33	209
2	*Euphagus carolinus*	Rusty Blackbird	passerine	3	0	3	0	0	0	0	0	3
1	*Euphagus cyanocephalus*	Brewer's Blackbird	passerine	16	0	16	0	0	0	16	0	0
1	*Molothrus ater*	Brown-headed Cowbird	passerine	2	0	2	0	0	0	2	0	0
1	*Quiscalus quiscula*	Common Grackle	passerine	178	0	178	0	0	0	175	0	3

[a] Unknown had no group or taxonomic information provided.

[b] Raptor includes Accipitridae, Falconinae, and Strigidae.

[c] Passerine includes Passeriformes and passerine-like birds.

B. All species detected at both pond types combined, fall surveys.

				Fall								
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	Unknown [a]	Unknown	other	382	0	382	0	0	169	197	0	16
1	*Gavia immer*	Common Loon	loon/grebe	235	0	235	0	5	0	182	6	42
	Podicipedidae	Unknown Grebe	loon/grebe	3	0	3	0	0	0	0	1	2
1	*Podiceps grisegena*	Red-necked Grebe	loon/grebe	140	0	140	0	5	0	95	0	40
2	*Podiceps auritus*	Horned Grebe	loon/grebe	222	0	222	0	0	0	222	0	0
2	*Podilymbus podiceps*	Pied-billed Grebe	loon/grebe	11	0	11	0	0	0	11	0	0
0	*Tachybaptus dominicus*	Least Grebe	loon/grebe	2	0	2	0	0	0	0	0	2
2	*Pelecanus erythrorhynchos*	American White Pelican	other	1	0	1	0	0	0	0	0	1
1	*Phalacrocorax auritus*	Double-crested Cormorant	other	2	0	2	0	0	2	0	0	0
	Ardeidae	Unknown Heron	other	4	0	4	0	0	0	0	0	4
2	*Botaurus lentiginosus*	American Bittern	other	1	0	1	0	0	1	0	0	0
2	*Ardea herodias*	Great Blue Heron	other	7	0	7	0	2	0	1	3	1
2	*Grus canadensis*	Sandhill Crane	other	69	0	69	0	42	0	0	2	25
1	*Cygnus columbianus*	Tundra Swan	other	2	0	2	0	0	2	0	0	0
2	*Cygnus buccinator*	Trumpeter Swan	other	7	0	7	7	0	0	0	0	0
	Anserinae	Unknown Goose	goose	334	0	334	0	0	230	0	0	104
1	*Anser albifrons*	Greater White-fronted Goose	goose	630	0	630	0	0	600	1	0	29
1	*Chen caerulescens*	Snow Goose	goose	420	0	420	0	0	277	0	0	143
1	*Branta canadensis*	Canada Goose	goose	5651	1	5652	708	565	1517	723	5	2134
	Anatinae	Unknown Duck	duck	6838	3	6841	28	89	16	5856	38	814
	Anatinae	Unknown Dabbling Duck	duck	110	0	110	0	0	0	0	0	110

				Fall								
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Anas platyrhynchos*	Mallard	duck	1702	1	1703	1	14	2	1564	8	114
1	*Anas strepera*	Gadwall	duck	286	0	286	0	0	0	260	0	26
	Anas spp.	Unknown Teal	duck	3	0	3	0	0	0	0	0	3
2	*Anas crecca*	Green-winged Teal	duck	248	2	250	0	0	28	49	0	173
1	*Anas americana*	American Wigeon	duck	2171	0	2171	0	0	0	2128	16	27
2	*Anas acuta*	Northern Pintail	duck	331	0	331	0	6	2	322	0	1
1	*Anas clypeata*	Northern Shoveler	duck	307	0	307	0	26	0	271	4	6
1	*Anas discors*	Blue-winged Teal	duck	161	0	161	0	4	0	144	2	11
1	*Anas cyanoptera*	Cinnamon Teal	duck	4	0	4	0	0	0	4	0	0
1	*Oxyura jamaicensis*	Ruddy Duck	duck	58	0	58	0	0	1	47	0	10
	Aythya spp.	Unknown Diving Duck	duck	454	0	454	0	0	0	13	0	441
1	*Aythya valisineria*	Canvasback	duck	520	0	520	0	0	0	515	0	5
1	*Aythya americana*	Redhead	duck	51	0	51	0	0	0	29	4	18
1	*Aythya collaris*	Ring-necked Duck	duck	283	0	283	0	0	0	102	0	181
	Aythya spp.	Unknown Scaup	duck	393	0	393	0	0	0	0	0	393
1	*Aythya marila*	Greater Scaup	duck	6	0	6	0	0	0	6	0	0
2	*Aythya affinis*	Lesser Scaup	duck	763	0	763	0	0	11	751	1	0
2	*Melanitta fusca*	White-winged Scoter	duck	40	0	40	2	0	0	1	0	37
1	*Melanitta perspicillata*	Surf Scoter	duck	2	0	2	0	0	0	0	0	2
1	*Clangula hyemalis*	Long-tailed Duck	duck	11	0	11	0	0	0	11	0	0
1	*Bucephala clangula*	Common Goldeneye	duck	906	1	907	0	47	0	742	0	118
1	*Bucephala albeola*	Bufflehead	duck	1597	0	1597	0	60	0	1378	0	159
	Mergus spp.	Unknown Merganser	duck	2	0	2	0	0	0	0	0	2

				Fall								
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Mergus merganser*	Common Merganser	duck	12	0	12	0	0	0	0	0	12
1	*Mergus serrator*	Red-breasted Merganser	duck	5	0	5	0	0	0	0	0	5
	Charadriiformes	Unknown Shorebird	shorebird	899	5	904	0	0	55	86	357	406
2	*Porzana carolina*	Sora	shorebird	1	0	1	0	0	0	0	0	1
1	*Fulica americana*	American Coot	duck	2	0	2	0	0	0	2	0	0
	Charadriinae	Unknown Plover	shorebird	13	0	13	0	0	0	0	0	13
1	*Charadrius semipalmatus*	Semipalmated Plover	shorebird	4	0	4	0	0	0	0	0	4
1	*Charadrius vociferus*	Killdeer	shorebird	109	0	109	0	7	38	29	0	35
1	*Pluvialis squatarola*	Black-bellied Plover	shorebird	1	0	1	0	0	0	0	0	1
1	*Pluvialis dominica*	American Golden Plover	shorebird	10	0	10	0	0	10	0	0	0
	Tringa spp.	Unknown Yellowlegs	shorebird	50	0	50	0	0	0	0	0	50
1	*Tringa melanoleuca*	Greater Yellowlegs	shorebird	45	1	46	0	5	0	29	0	12
1	*Tringa flavipes*	Lesser Yellowlegs	shorebird	225	1	226	0	1	0	187	6	32
	Scolopacinae	Unknown Sandpiper	shorebird	1065	2	1067	0	0	29	314	0	724
1	*Tringa solitaria*	Solitary Sandpiper	shorebird	16	0	16	0	0	0	12	4	0
1	*Actitis macularius*	Spotted Sandpiper	shorebird	192	0	192	0	0	0	59	1	132
0	*Tringa incana*	Wandering Tattler	shorebird	1	0	1	0	0	0	0	0	1
	Phalaropodinae	Unknown Phalarope	shorebird	1	0	1	0	0	1	0	0	0
1	*Phalaropus tricolor*	Wilson's Phalarope	shorebird	2	0	2	0	0	0	0	0	2

				Fall								
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Phalaropus lobatus*	Red-necked Phalarope	shorebird	16	0	16	0	0	0	0	0	16
	Scolopacinae	Unknown dowitcher	shorebird	1	0	1	0	0	0	0	0	1
0	*Limnodromus griseus*	Short-billed Dowitcher	shorebird	4	0	4	0	0	2	0	0	2
1	*Gallinago delicata*	Wilson's Snipe	shorebird	5	0	5	0	0	0	0	0	5
1	*Calidris minutilla*	Least Sandpiper	shorebird	10	0	10	0	0	3	1	0	6
1	*Calidris bairdii*	Baird's Sandpiper	shorebird	4	0	4	0	0	0	0	0	4
1	*Calidris melanotos*	Pectoral Sandpiper	shorebird	1	0	1	0	0	0	1	0	0
	Larinae	Unknown Gull	gull/tern	550	3	553	0	0	6	458	38	51
1	*Leucophaeus pipixcan*	Franklin's Gull	gull/tern	15	0	15	0	0	15	0	0	0
1	*Chroicocephalus philadelphia*	Bonaparte's Gull	gull/tern	82	0	82	0	58	0	14	0	10
1	*Larus delawarensis*	Ring-billed Gull	gull/tern	11	0	11	0	0	0	10	0	1
0	*Larus argentatus*	Herring Gull	gull/tern	4	0	4	0	0	0	3	1	0
1	*Larus californicus*	California Gull	gull/tern	50	0	50	0	1	1	35	0	13
	Sterninae	Unknown Tern	gull/tern	1	0	1	0	0	0	0	0	1
1	*Sterna hirundo*	Common Tern	gull/tern	65	0	65	0	46	0	12	1	6
2	*Chlidonias niger*	Black Tern	gull/tern	106	0	106	0	0	0	101	0	5
	Raptor [b]	Unknown Raptor	raptor	20	0	20	0	0	2	2	0	16
2	*Aquila chrysaetos*	Golden Eagle	raptor	1	0	1	0	0	0	1	0	0
2	*Haliaeetus leucocephalus*	Bald Eagle	raptor	5	1	6	0	1	1	2	0	2
2	*Circus cyaneus*	Northern Harrier	raptor	25	0	25	0	0	1	2	0	22
1	*Buteo jamaicensis*	Red-tailed Hawk	raptor	1	0	1	0	1	0	0	0	0
2	*Buteo swainsoni*	Swainson's Hawk	raptor	1	0	1	0	0	0	1	0	0

				Fall								
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Buteo lagopus*	Rough-legged Hawk	raptor	9	0	9	0	0	9	0	0	0
2	*Falco sparverius*	American Kestrel	raptor	188	1	189	0	0	2	187	0	0
0	*Falco columbarius*	Merlin	raptor	1	0	1	0	0	0	0	0	1
4	*Falco peregrinus*	Peregrine Falcon	raptor	1	0	1	0	0	1	0	0	0
	Passeriformes [c]	Unknown Passerine	passerine	1684	2	1686	0	0	18	50	55	1563
	Tetraoninae	Unknown Grouse	passerine	4	0	4	0	0	0	0	0	4
1	*Megaceryle alcyon*	Belted Kingfisher	passerine	1	0	1	0	0	0	1	0	0
1	*Colaptes auratus*	Northern Flicker	passerine	6	0	6	0	0	0	6	0	0
2	*Dryocopus pileatus*	Pileated Woodpecker	passerine	0	1	1	0	0	0	0	0	1
2	*Contopus sordidulus*	Western Wood-Pewee	passerine	12	0	12	0	0	0	12	0	0
1	*Empidonax alnorum*	Alder Flycatcher	passerine	0	1	1	0	0	0	0	0	1
1	*Eremophila alpestris*	Horned Lark	passerine	13	0	13	0	0	13	0	0	0
	Hirundininae	Unknown Swallow	passerine	257	0	257	0	0	3	116	0	138
1	*Tachycineta bicolor*	Tree Swallow	passerine	89	0	89	0	0	0	61	0	28
1	*Riparia riparia*	Bank Swallow	passerine	4	0	4	0	0	0	4	0	0
1	*Petrochelidon pyrrhonota*	Cliff Swallow	passerine	169	1	170	0	0	5	44	0	121
3	*Hirundo rustica*	Barn Swallow	passerine	339	0	339	0	0	0	339	0	0
1	*Cyanocitta cristata*	Blue Jay	passerine	0	1	1	0	0	0	0	0	1
1	*Perisoreus canadensis*	Gray Jay	passerine	5	0	5	0	0	0	0	0	5
1	*Pica hudsonia*	Black-billed Magpie	passerine	56	0	56	0	0	1	51	0	4
1	*Corvus brachyrhynchos*	American Crow	passerine	26	0	26	0	0	18	8	0	0

				Fall								
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Corvus corax*	Common Raven	passerine	492	6	498	0	0	117	380	0	1
1	*Poecile atricapillus*	Black-capped Chickadee	passerine	23	0	23	0	0	0	23	0	0
1	*Cistothorus palustris*	Marsh Wren	passerine	2	0	2	0	0	0	0	0	2
1	*Turdus migratorius*	American Robin	passerine	45	0	45	0	0	0	45	0	0
1	*Anthus rubescens*	American Pipit	passerine	263	0	263	0	0	262	1	0	0
1	*Bombycilla cedrorum*	Cedar Waxwing	passerine	1	0	1	0	0	0	1	0	0
1	*Vireo gilvus*	Warbling Vireo	passerine	1	0	1	0	0	0	1	0	0
2	*Setophaga castanea*	Bay-breasted Warbler	passerine	1	0	1	0	0	0	1	0	0
1	*Setophaga petechia*	Yellow Warbler	passerine	3	0	3	0	0	0	3	0	0
	Emberizidae	Unknown Sparrow	passerine	70	0	70	0	0	0	69	0	1
1	*Passerculus sandwichensis*	Savannah Sparrow	passerine	5	0	5	0	0	5	0	0	0
1	*Melospiza melodia*	Song Sparrow	passerine	18	0	18	0	0	0	18	0	0
1	*Plectrophenax nivalis*	Snow Bunting	passerine	395	0	395	0	0	249	20	0	126
	Icteridae	Unknown Blackbird	passerine	26	0	26	0	0	0	21	0	5
1	*Agelaius phoeniceus*	Red-winged Blackbird	passerine	441	0	441	0	0	30	409	0	2
2	*Euphagus carolinus*	Rusty Blackbird	passerine	15	0	15	0	0	0	0	0	15
1	*Euphagus cyanocephalus*	Brewer's Blackbird	passerine	24	0	24	0	0	0	24	0	0
1	*Quiscalus quiscula*	Common Grackle	passerine	13	0	13	0	0	0	13	0	0
1	*Loxia leucoptera*	White-winged Crossbill	passerine	12	0	12	0	0	12	0	0	0
1	*Pinicola enucleator*	Pine Grosbeak	passerine	3	0	3	0	0	0	0	0	3

				Fall								
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA

[a] Unknown had no group or taxonomic information provided.

[b] Raptor includes Accipitridae, Falconinae, and Strigidae.

[c] Passerine includes Passeriformes and passerine-like birds.

C. All species detected at process-affected ponds, spring surveys.

Spring migrants near process-affected ponds												
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	Unknown [a]	Unknown	other	72	0	72	0	0	41	18	0	13
1	*Gavia immer*	Common Loon	loon/grebe	199	0	199	0	0	0	199	0	0
1	*Gavia pacifica*	Pacific Loon	loon/grebe	2	0	2	0	0	0	2	0	0
	Podicipedidae	Unknown Grebe	loon/grebe	2	0	2	0	0	0	0	2	0
1	*Podiceps grisegena*	Red-necked Grebe	loon/grebe	11	0	11	0	0	0	11	0	0
2	*Podiceps auritus*	Horned Grebe	loon/grebe	93	0	93	0	0	0	86	3	4
1	*Podiceps nigricollis*	Eared Grebe	loon/grebe	7	0	7	0	0	0	0	0	7
2	*Grus canadensis*	Sandhill Crane	other	10	1	11	0	1	4	2	0	4
	Cygnus spp.	Unknown Swan	other	5	0	5	0	0	5	0	0	0
1	*Chen caerulescens*	Snow Goose	goose	850	0	850	0	0	850	0	0	0
1	*Branta canadensis*	Canada Goose	goose	948	2	950	33	143	138	61	0	575
	Anatinae	Unknown Duck	duck	1365	0	1365	4	100	47	554	292	368
	Anatinae	Unknown Dabbling Duck	duck	13	0	13	0	0	1	0	0	12
1	*Anas platyrhynchos*	Mallard	duck	1066	5	1071	15	15	160	792	7	82
1	*Anas strepera*	Gadwall	duck	52	0	52	0	0	0	47	0	5
2	*Anas crecca*	Green-winged Teal	duck	347	0	347	0	0	2	97	0	248
1	*Anas americana*	American Wigeon	duck	70	0	70	0	0	0	41	0	29
2	*Anas acuta*	Northern Pintail	duck	72	0	72	0	0	53	0	0	19
1	*Anas clypeata*	Northern Shoveler	duck	184	1	185	0	1	6	86	0	92
1	*Anas discors*	Blue-winged Teal	duck	28	0	28	0	0	0	20	0	8
1	*Oxyura*	Ruddy Duck	duck	35	0	35	0	0	0	25	0	10

Spring migrants near process-affected ponds												
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	jamaicensis											
	Aythya spp.	Unknown Diving Duck	duck	10	0	10	0	0	0	2	0	8
1	*Aythya valisineria*	Canvasback	duck	44	0	44	0	0	16	26	0	2
1	*Aythya americana*	Redhead	duck	5	0	5	0	0	2	3	0	0
1	*Aythya collaris*	Ring-necked Duck	duck	75	0	75	0	0	0	57	2	16
	Aythya spp.	Unknown Scaup	duck	198	0	198	0	0	35	21	4	138
1	*Aythya marila*	Greater Scaup	duck	115	0	115	0	0	0	115	0	0
2	*Aythya affinis*	Lesser Scaup	duck	364	0	364	0	0	39	181	4	140
	Anatinae	Unknown Eider	duck	2	0	2	0	0	0	2	0	0
	Melanitta spp.	Unknown Scoter	duck	8	1	9	0	0	1	8	0	0
2	*Melanitta fusca*	White-winged Scoter	duck	4	0	4	0	0	0	4	0	0
1	*Melanitta perspicillata*	Surf Scoter	duck	2	0	2	0	0	2	0	0	0
1	*Bucephala islandica*	Barrow's Goldeneye	duck	22	0	22	0	0	0	22	0	0
1	*Bucephala clangula*	Common Goldeneye	duck	733	0	733	12	0	0	718	1	2
1	*Bucephala albeola*	Bufflehead	duck	502	1	503	19	0	1	479	0	4
1	*Mergus merganser*	Common Merganser	duck	2	0	2	0	0	0	0	0	2
1	*Mergus serrator*	Red-breasted Merganser	duck	1	0	1	0	0	0	0	0	1
	Charadriiformes	Unknown Shorebird	shorebird	200	0	200	0	0	0	39	22	139
2	*Porzana carolina*	Sora	shorebird	0	2	2	0	0	0	0	0	2
1	*Fulica americana*	American Coot	duck	11	0	11	0	0	4	0	0	7

Spring migrants near process-affected ponds												
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	Charadriinae	Unknown Plover	shorebird	16	0	16	0	0	0	0	0	16
1	*Charadrius vociferus*	Killdeer	shorebird	51	1	52	0	0	7	17	0	28
1	*Pluvialis squatarola*	Black-bellied Plover	shorebird	2	0	2	0	0	0	2	0	0
1	*Pluvialis dominica*	American Golden Plover	shorebird	3	0	3	0	0	0	0	2	1
1	*Tringa melanoleuca*	Greater Yellowlegs	shorebird	5	0	5	0	0	0	4	0	1
1	*Tringa flavipes*	Lesser Yellowlegs	shorebird	96	0	96	0	10	0	32	0	54
	Scolopacinae	Unknown Sandpiper	shorebird	197	0	197	0	0	0	107	0	90
1	*Tringa solitaria*	Solitary Sandpiper	shorebird	2	0	2	0	0	0	1	0	1
1	*Actitis macularius*	Spotted Sandpiper	shorebird	1	0	1	0	0	0	1	0	0
1	*Phalaropus tricolor*	Wilson's Phalarope	shorebird	2	0	2	0	0	0	0	0	2
0	*Limnodromus griseus*	Short-billed Dowitcher	shorebird	6	0	6	0	0	0	0	0	6
1	*Gallinago delicata*	Wilson's Snipe	shorebird	10	1	11	0	0	0	1	0	10
1	*Calidris pusilla*	Semipalmated Sandpiper	shorebird	5	0	5	0	0	0	0	0	5
1	*Calidris minutilla*	Least Sandpiper	shorebird	1	0	1	0	0	1	0	0	0
1	*Calidris bairdii*	Baird's Sandpiper	shorebird	1	0	1	0	0	0	1	0	0
2	*Bartramia longicauda*	Upland Sandpiper	shorebird	1	0	1	0	0	0	0	0	1
	Larinae	Unknown Gull	gull/tern	557	1	558	0	0	14	339	19	186
1	*Leucophaeus pipixcan*	Franklin's Gull	gull/tern	17	0	17	1	0	0	0	0	16

Spring migrants near process-affected ponds												
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Chroicocephalus philadelphia*	Bonaparte's Gull	gull/tern	76	1	77	0	14	0	30	0	33
1	*Larus delawarensis*	Ring-billed Gull	gull/tern	7	0	7	0	0	0	0	0	7
0	*Larus argentatus*	Herring Gull	gull/tern	14	0	14	0	0	5	7	0	2
1	*Larus californicus*	California Gull	gull/tern	8	0	8	0	0	0	1	0	7
1	*Sterna hirundo*	Common Tern	gull/tern	46	0	46	0	40	0	3	0	3
2	*Chlidonias niger*	Black Tern	gull/tern	13	0	13	0	0	0	11	0	2
	Raptor [b]	Unknown Raptor	raptor	3	0	3	0	0	0	2	0	1
2	*Haliaeetus leucocephalus*	Bald Eagle	raptor	2	0	2	0	0	0	2	0	0
2	*Circus cyaneus*	Northern Harrier	raptor	6	1	7	0	0	0	1	0	6
1	*Buteo jamaicensis*	Red-tailed Hawk	raptor	5	0	5	0	0	0	5	0	0
2	*Pandion haliaetus*	Osprey	raptor	1	0	1	0	0	0	1	0	0
	Passeriformes [c]	Unknown Passerine	passerine	500	1	501	0	0	0	170	0	331
2	*Tympanuchus phasianellus*	Sharp-tailed Grouse	passerine	1	0	1	0	0	0	1	0	0
1	*Colaptes auratus*	Northern Flicker	passerine	7	0	7	0	0	0	7	0	0
	Tyrannidae	Unknown Flycatcher	passerine	6	0	6	0	0	0	6	0	0
	Hirundininae	Unknown Swallow	passerine	96	0	96	0	0	0	96	0	0
1	*Tachycineta bicolor*	Tree Swallow	passerine	131	0	131	0	0	0	57	0	74
1	*Riparia riparia*	Bank Swallow	passerine	16	0	16	0	0	0	16	0	0
1	*Stelgidopteryx serripennis*	Northern Rough-winged Swallow	passerine	2	0	2	0	0	0	2	0	0
1	*Petrochelidon pyrrhonota*	Cliff Swallow	passerine	7	0	7	0	0	6	0	0	1

Spring migrants near process-affected ponds												
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
3	*Hirundo rustica*	Barn Swallow	passerine	151	0	151	0	0	0	126	0	25
1	*Cyanocitta cristata*	Blue Jay	passerine	4	0	4	0	0	0	4	0	0
1	*Pica hudsonia*	Black-billed Magpie	passerine	26	0	26	0	0	0	26	0	0
1	*Corvus corax*	Common Raven	passerine	27	0	27	2	0	0	25	0	0
1	*Turdus migratorius*	American Robin	passerine	19	0	19	0	0	0	19	0	0
1	*Bombycilla cedrorum*	Cedar Waxwing	passerine	9	0	9	0	0	0	9	0	0
	Emberizidae	Unknown Sparrow	passerine	84	0	84	0	0	0	63	0	21
1	*Passerculus sandwichensis*	Savannah Sparrow	passerine	1	0	1	0	0	0	1	0	0
1	*Melospiza melodia*	Song Sparrow	passerine	4	0	4	0	0	0	4	0	0
1	*Melospiza georgiana*	Swamp Sparrow	passerine	1	0	1	0	0	0	1	0	0
1	*Plectrophenax nivalis*	Snow Bunting	passerine	5	0	5	0	0	0	0	0	5
	Icteridae	Unknown Blackbird	passerine	84	0	84	0	0	0	84	0	0
1	*Xanthocephalus xanthocephalus*	Yellow-headed Blackbird	passerine	6	0	6	0	0	0	2	0	4
1	*Agelaius phoeniceus*	Red-winged Blackbird	passerine	477	0	477	0	0	1	395	0	81
2	*Euphagus carolinus*	Rusty Blackbird	passerine	2	0	2	0	0	0	0	0	2
1	*Euphagus cyanocephalus*	Brewer's Blackbird	passerine	14	0	14	0	0	0	14	0	0
1	*Molothrus ater*	Brown-headed	passerine	2	0	2	0	0	0	2	0	0

Spring migrants near process-affected ponds												
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Quiscalus quiscula*	Cowbird Common Grackle	passerine	101	0	101	0	0	0	100	0	1

[a] Unknown had no group or taxonomic information provided.

[b] Raptor includes Accipitridae, Falconinae, and Strigidae.

[c] Passerine includes Passeriformes and passerine-like birds.

D. Water-associated species detected at process-affected ponds, spring surveys

Status	Species name	Common name	Group	In vicinity	Over pond	Landing	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	Unknown	Unknown	other	72	45	6	0	0	0	6	0	0
1	*Gavia immer*	Common Loon	loon/grebe	199	199	84	0	0	0	84	0	0
1	*Gavia pacifica*	Pacific Loon	loon/grebe	2	2	2	0	0	0	2	0	0
	Podicipedidae	Unknown Grebe	loon/grebe	2	2	2	0	0	0	0	2	0
1	*Podiceps grisegena*	Red-necked Grebe	loon/grebe	11	11	11	0	0	0	11	0	0
2	*Podiceps auritus*	Horned Grebe	loon/grebe	93	93	93	0	0	0	86	3	4
1	*Podiceps nigricollis*	Eared Grebe	loon/grebe	7	7	7	0	0	0	0	0	7
2	*Grus canadensis*	Sandhill Crane	other	11	7	1	0	0	0	1	0	0
	Cygnus spp.	Unknown Swan	other	5	5	0	0	0	0	0	0	0
1	*Chen caerulescens*	Snow Goose	goose	850	850	0	0	0	0	0	0	0
1	*Branta canadensis*	Canada Goose	goose	950	533	85	19	50	5	8	0	3
	Anatinae	Unknown Duck	duck	1365	1307	937	4	100	9	466	212	146
	Anatinae	Unknown Dabbling Duck	duck	13	12	10	0	0	0	0	0	10
1	*Anas platyrhynchos*	Mallard	duck	1071	944	845	15	4	3	760	7	56
1	*Anas strepera*	Gadwall	duck	52	52	52	0	0	0	47	0	5
2	*Anas crecca*	Green-winged Teal	duck	347	346	323	0	0	0	96	0	227

Status	Species name	Common name	Group	In vicinity	Over pond	Landing	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Anas americana*	American Wigeon	duck	70	70	70	0	0	0	41	0	29
2	*Anas acuta*	Northern Pintail	duck	72	22	14	0	0	0	0	0	14
1	*Anas clypeata*	Northern Shoveler	duck	185	184	154	0	0	0	86	0	68
1	*Anas discors*	Blue-winged Teal	duck	28	28	28	0	0	0	20	0	8
1	*Oxyura jamaicensis*	Ruddy Duck	duck	35	35	35	0	0	0	25	0	10
	Aythya spp.	Unknown Diving Duck	duck	10	10	8	0	0	0	0	0	8
1	*Aythya valisineria*	Canvasback	duck	44	32	24	0	0	2	20	0	2
1	*Aythya americana*	Redhead	duck	5	3	3	0	0	0	3	0	0
1	*Aythya collaris*	Ring-necked Duck	duck	75	75	75	0	0	0	57	2	16
	Aythya spp.	Unknown Scaup	duck	198	168	143	0	0	0	21	4	118
1	*Aythya marila*	Greater Scaup	duck	115	115	100	0	0	0	100	0	0
2	*Aythya affinis*	Lesser Scaup	duck	364	329	276	0	0	4	181	4	87
	Anatinae	Unknown Eider	duck	2	2	2	0	0	0	2	0	0
	Melanitta spp.	Unknown Scoter	duck	9	8	8	0	0	0	8	0	0
2	*Melanitta fusca*	White-winged Scoter	duck	4	4	4	0	0	0	4	0	0
1	*Melanitta perspicillata*	Surf Scoter	duck	2	2	0	0	0	0	0	0	0

Status	Species name	Common name	Group	In vicinity	Over pond	Landing	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Bucephala islandica*	Barrow's Goldeneye	duck	22	17	17	0	0	0	17	0	0
1	*Bucephala clangula*	Common Goldeneye	duck	733	733	719	12	0	0	704	1	2
1	*Bucephala albeola*	Bufflehead	duck	503	502	499	19	0	0	477	0	3
1	*Mergus merganser*	Common Merganser	duck	2	2	2	0	0	0	0	0	2
1	*Mergus serrator*	Red-breasted Merganser	duck	1	1	1	0	0	0	0	0	1
	Charadriiformes	Unknown Shorebird	shorebird	200	198	84	0	0	0	39	22	23
2	*Porzana carolina*	Sora	shorebird	2	0	0	0	0	0	0	0	0
1	*Fulica americana*	American Coot	duck	11	7	7	0	0	0	0	0	7
	Charadriinae	Unknown Plover	shorebird	16	16	5	0	0	0	0	0	5
1	*Charadrius vociferus*	Killdeer	shorebird	52	44	31	0	0	0	15	0	16
1	*Pluvialis squatarola*	Black-bellied Plover	shorebird	2	2	2	0	0	0	2	0	0
1	*Pluvialis dominica*	American Golden Plover	shorebird	3	3	3	0	0	0	0	2	1
1	*Tringa melanoleuca*	Greater Yellowlegs	shorebird	5	5	2	0	0	0	1	0	1
1	*Tringa flavipes*	Lesser Yellowlegs	shorebird	96	96	81	0	10	0	30	0	41
	Scolopacinae	Unknown Sandpiper	shorebird	197	197	153	0	0	0	99	0	54

Status	Species name	Common name	Group	In vicinity	Over pond	Landing	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Tringa solitaria*	Solitary Sandpiper	shorebird	2	2	2	0	0	0	1	0	1
1	*Actitis macularius*	Spotted Sandpiper	shorebird	1	1	1	0	0	0	1	0	0
1	*Phalaropus tricolor*	Wilson's Phalarope	shorebird	2	2	2	0	0	0	0	0	2
0	*Limnodromus griseus*	Short-billed Dowitcher	shorebird	6	6	6	0	0	0	0	0	6
1	*Gallinago delicata*	Wilson's Snipe	shorebird	11	10	2	0	0	0	0	0	2
1	*Calidris pusilla*	Semipalmated Sandpiper	shorebird	5	5	4	0	0	0	0	0	4
1	*Calidris minutilla*	Least Sandpiper	shorebird	1	0	0	0	0	0	0	0	0
1	*Calidris bairdii*	Baird's Sandpiper	shorebird	1	1	1	0	0	0	1	0	0
2	*Bartramia longicauda*	Upland Sandpiper	shorebird	1	1	1	0	0	0	0	0	1
	Larinae	Unknown Gull	gull/tern	558	361	132	0	0	1	41	17	73
1	*Leucophaeus pipixcan*	Franklin's Gull	gull/tern	17	17	0	0	0	0	0	0	0
1	*Chroicocephalus philadelphia*	Bonaparte's Gull	gull/tern	77	74	17	0	12	0	1	0	4
1	*Larus delawarensis*	Ring-billed Gull	gull/tern	7	7	1	0	0	0	0	0	1
0	*Larus argentatus*	Herring Gull	gull/tern	14	9	2	0	0	0	0	0	2
1	*Larus californicus*	California Gull	gull/tern	8	8	6	0	0	0	0	0	6
1	*Sterna hirundo*	Common	gull/tern	46	45	41	0	40	0	1	0	0

Status	Species name	Common name	Group	In vicinity	Over pond	Landing	CNRL	Imperial	Shell	Suncor	Syncrude	UA
2	*Chlidonias niger*	Black Tern	gull/tern	13	13	0	0	0	0	0	0	0
2	*Pandion haliaetus*	Osprey	raptor	1	1	0	0	0	0	0	0	0

E. All species detected at process-affected ponds, fall surveys

Fall migrants near process-affected ponds												
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	Unknown [a]	Unknown	other	222	0	222	0	0	169	39	0	14
1	*Gavia immer*	Common Loon	loon/grebe	42	0	42	0	0	0	42	0	0
2	*Podiceps auritus*	Horned Grebe	loon/grebe	217	0	217	0	0	0	217	0	0
2	*Podilymbus podiceps*	Pied-billed Grebe	loon/grebe	1	0	1	0	0	0	1	0	0
1	*Phalacrocorax auritus*	Double-crested Cormorant	other	2	0	2	0	0	2	0	0	0
	Ardeidae	Unknown Heron	other	2	0	2	0	0	0	0	0	2
2	*Botaurus lentiginosus*	American Bittern	other	1	0	1	0	0	1	0	0	0
2	*Grus canadensis*	Sandhill Crane	other	11	0	11	0	9	0	0	2	0
1	*Cygnus columbianus*	Tundra Swan	other	2	0	2	0	0	2	0	0	0
2	*Cygnus buccinator*	Trumpeter Swan	other	7	0	7	7	0	0	0	0	0
	Anserinae	Unknown Goose	goose	284	0	284	0	0	230	0	0	54
1	*Anser albifrons*	Greater White-fronted Goose	goose	601	0	601	0	0	600	1	0	0
1	*Chen caerulescens*	Snow Goose	goose	277	0	277	0	0	277	0	0	0
1	*Branta canadensis*	Canada Goose	goose	3413	0	3413	708	321	1517	518	5	344
	Anatinae	Unknown Duck	duck	896	0	896	28	89	16	683	37	43
	Anatinae	Unknown Dabbling Duck	duck	26	0	26	0	0	0	0	0	26
1	*Anas platyrhynchos*	Mallard	duck	1402	0	1402	1	2	2	1374	7	16
1	*Anas strepera*	Gadwall	duck	176	0	176	0	0	0	176	0	0
2	*Anas crecca*	Green-winged Teal	duck	227	1	228	0	0	28	29	0	171
1	*Anas americana*	American Wigeon	duck	1922	0	1922	0	0	0	1918	4	0
2	*Anas acuta*	Northern Pintail	duck	205	0	205	0	0	2	202	0	1

Fall migrants near process-affected ponds												
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Anas clypeata*	Northern Shoveler	duck	273	0	273	0	23	0	242	4	4
1	*Anas discors*	Blue-winged Teal	duck	115	0	115	0	0	0	113	2	0
1	*Anas cyanoptera*	Cinnamon Teal	duck	4	0	4	0	0	0	4	0	0
1	*Oxyura jamaicensis*	Ruddy Duck	duck	11	0	11	0	0	1	10	0	0
	Aythya spp.	Unknown Diving Duck	duck	3	0	3	0	0	0	2	0	1
1	*Aythya valisineria*	Canvasback	duck	168	0	168	0	0	0	168	0	0
1	*Aythya americana*	Redhead	duck	17	0	17	0	0	0	13	4	0
1	*Aythya collaris*	Ring-necked Duck	duck	102	0	102	0	0	0	102	0	0
1	*Aythya marila*	Greater Scaup	duck	6	0	6	0	0	0	6	0	0
2	*Aythya affinis*	Lesser Scaup	duck	639	0	639	0	0	11	627	1	0
2	*Melanitta fusca*	White-winged Scoter	duck	3	0	3	2	0	0	1	0	0
1	*Bucephala clangula*	Common Goldeneye	duck	696	1	697	0	0	0	697	0	0
1	*Bucephala albeola*	Bufflehead	duck	1059	0	1059	0	0	0	1059	0	0
	Charadriiformes	Unknown Shorebird	shorebird	818	4	822	0	0	55	83	356	328
2	*Porzana carolina*	Sora	shorebird	1	0	1	0	0	0	0	0	1
	Charadriinae	Unknown Plover	shorebird	5	0	5	0	0	0	0	0	5
1	*Charadrius vociferus*	Killdeer	shorebird	88	0	88	0	0	38	29	0	21
1	*Pluvialis squatarola*	Black-bellied Plover	shorebird	1	0	1	0	0	0	0	0	1
1	*Pluvialis dominica*	American Golden Plover	shorebird	10	0	10	0	0	10	0	0	0
	Tringa spp.	Unknown Yellowlegs	shorebird	41	0	41	0	0	0	0	0	41
1	*Tringa*	Greater	shorebird	30	0	30	0	0	0	29	0	1

Fall migrants near process-affected ponds												
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	melanoleuca	Yellowlegs										
1	*Tringa flavipes*	Lesser Yellowlegs	shorebird	212	1	213	0	0	0	187	6	20
	Scolopacinae	Unknown Sandpiper	shorebird	906	1	907	0	0	29	312	0	566
1	*Tringa solitaria*	Solitary Sandpiper	shorebird	15	0	15	0	0	0	11	4	0
1	*Actitis macularius*	Spotted Sandpiper	shorebird	169	0	169	0	0	0	59	0	110
	Phalaropodinae	Unknown Phalarope	shorebird	1	0	1	0	0	1	0	0	0
1	*Phalaropus lobatus*	Red-necked Phalarope	shorebird	16	0	16	0	0	0	0	0	16
	Scolopacinae	Unknown dowitcher	shorebird	1	0	1	0	0	0	0	0	1
0	*Limnodromus griseus*	Short-billed Dowitcher	shorebird	4	0	4	0	0	2	0	0	2
1	*Gallinago delicata*	Wilson's Snipe	shorebird	5	0	5	0	0	0	0	0	5
1	*Calidris minutilla*	Least Sandpiper	shorebird	10	0	10	0	0	3	1	0	6
1	*Calidris bairdii*	Baird's Sandpiper	shorebird	4	0	4	0	0	0	0	0	4
1	*Calidris melanotos*	Pectoral Sandpiper	shorebird	1	0	1	0	0	0	1	0	0
	Larinae	Unknown Gull	gull/tern	521	3	524	0	0	6	454	26	38
1	*Leucophaeus pipixcan*	Franklin's Gull	gull/tern	15	0	15	0	0	15	0	0	0
1	*Chroicocephalus philadelphia*	Bonaparte's Gull	gull/tern	38	0	38	0	24	0	14	0	0
1	*Larus delawarensis*	Ring-billed Gull	gull/tern	10	0	10	0	0	0	10	0	0
0	*Larus argentatus*	Herring Gull	gull/tern	3	0	3	0	0	0	3	0	0
1	*Larus californicus*	California Gull	gull/tern	41	0	41	0	0	1	35	0	5
	Sterninae	Unknown Tern	gull/tern	1	0	1	0	0	0	0	0	1
1	*Sterna hirundo*	Common Tern	gull/tern	12	0	12	0	0	0	12	0	0

Fall migrants near process-affected ponds												
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
2	*Chlidonias niger*	Black Tern	gull/tern	12	0	12	0	0	0	12	0	0
	Raptor [b]	Unknown Raptor	raptor	9	0	9	0	0	2	1	0	6
2	*Aquila chrysaetos*	Golden Eagle	raptor	1	0	1	0	0	0	1	0	0
2	*Haliaeetus leucocephalus*	Bald Eagle	raptor	2	0	2	0	0	1	1	0	0
2	*Circus cyaneus*	Northern Harrier	raptor	9	0	9	0	0	1	2	0	6
1	*Buteo jamaicensis*	Red-tailed Hawk	raptor	1	0	1	0	1	0	0	0	0
2	*Buteo swainsoni*	Swainson's Hawk	raptor	1	0	1	0	0	0	1	0	0
1	*Buteo lagopus*	Rough-legged Hawk	raptor	9	0	9	0	0	9	0	0	0
2	*Falco sparverius*	American Kestrel	raptor	188	1	189	0	0	2	187	0	0
0	*Falco columbarius*	Merlin	raptor	1	0	1	0	0	0	0	0	1
4	*Falco peregrinus*	Peregrine Falcon	raptor	1	0	1	0	0	1	0	0	0
	Passeriformes [c]	Unknown Passerine	passerine	450	1	451	0	0	18	33	55	345
1	*Megaceryle alcyon*	Belted Kingfisher	passerine	1	0	1	0	0	0	1	0	0
2	*Contopus sordidulus*	Western Wood-Pewee	passerine	12	0	12	0	0	0	12	0	0
1	*Eremophila alpestris*	Horned Lark	passerine	13	0	13	0	0	13	0	0	0
	Hirundininae	Unknown Swallow	passerine	162	0	162	0	0	3	116	0	43
1	*Tachycineta bicolor*	Tree Swallow	passerine	71	0	71	0	0	0	55	0	16
1	*Riparia riparia*	Bank Swallow	passerine	4	0	4	0	0	0	4	0	0
1	*Petrochelidon pyrrhonota*	Cliff Swallow	passerine	47	0	47	0	0	5	42	0	0
3	*Hirundo rustica*	Barn Swallow	passerine	339	0	339	0	0	0	339	0	0
1	*Pica hudsonia*	Black-billed Magpie	passerine	50	0	50	0	0	1	49	0	0
1	*Corvus*	American Crow	passerine	26	0	26	0	0	18	8	0	0

Fall migrants near process-affected ponds												
Status	Species name	Common name	Group	Observed	Heard	Total	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	brachyrhynchos											
1	*Corvus corax*	Common Raven	passerine	489	6	495	0	0	117	377	0	1
1	*Turdus migratorius*	American Robin	passerine	2	0	2	0	0	0	2	0	0
1	*Anthus rubescens*	American Pipit	passerine	263	0	263	0	0	262	1	0	0
1	*Bombycilla cedrorum*	Cedar Waxwing	passerine	1	0	1	0	0	0	1	0	0
2	*Setophaga castanea*	Bay-breasted Warbler	passerine	1	0	1	0	0	0	1	0	0
	Emberizidae	Unknown Sparrow	passerine	63	0	63	0	0	0	63	0	0
1	*Passerculus sandwichensis*	Savannah Sparrow	passerine	5	0	5	0	0	5	0	0	0
1	*Melospiza melodia*	Song Sparrow	passerine	12	0	12	0	0	0	12	0	0
1	*Plectrophenax nivalis*	Snow Bunting	passerine	319	0	319	0	0	249	20	0	50
	Icteridae	Unknown Blackbird	passerine	17	0	17	0	0	0	17	0	0
1	*Agelaius phoeniceus*	Red-winged Blackbird	passerine	121	0	121	0	0	30	91	0	0
1	*Euphagus cyanocephalus*	Brewer's Blackbird	passerine	22	0	22	0	0	0	22	0	0
1	*Quiscalus quiscula*	Common Grackle	passerine	13	0	13	0	0	0	13	0	0
1	*Loxia leucoptera*	White-winged Crossbill	passerine	12	0	12	0	0	12	0	0	0

[a] Unknown had no group or taxonomic information provided.

[b] Raptor includes Accipitridae, Falconinae, and Strigidae.

[c] Passerine includes Passeriformes and passerine-like birds.

F. Water-associated species detected at process-affected ponds, fall surveys

Status	Species name	Common name	Group	In vicinity	Over pond	Landing	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	Unknown	Unknown	other	222	52	5	0	0	0	4	0	1
1	*Gavia immer*	Common Loon	loon/grebe	42	42	34	0	0	0	34	0	0
2	*Podiceps auritus*	Horned Grebe	loon/grebe	217	217	65	0	0	0	65	0	0
2	*Podilymbus podiceps*	Pied-billed Grebe	loon/grebe	1	1	1	0	0	0	1	0	0
1	*Phalacrocorax auritus*	Double-crested Cormorant	other	2	1	0	0	0	0	0	0	0
	Ardeidae	Unknown Heron	other	2	2	0	0	0	0	0	0	0
2	*Botaurus lentiginosus*	American Bittern	other	1	0	0	0	0	0	0	0	0
2	*Grus canadensis*	Sandhill Crane	other	11	11	2	0	0	0	0	2	0
1	*Cygnus columbianus*	Tundra Swan	other	2	2	0	0	0	0	0	0	0
2	*Cygnus buccinator*	Trumpeter Swan	other	7	7	0	0	0	0	0	0	0
	Anserinae	Unknown Goose	goose	284	35	0	0	0	0	0	0	0
1	*Anser albifrons*	Greater White-fronted Goose	goose	601	158	1	0	0	0	1	0	0
1	*Chen caerulescens*	Snow Goose	goose	277	196	0	0	0	0	0	0	0
1	*Branta*	Canada	goose	3413	2077	267	0	71	0	191	5	0

Status	Species name	Common name	Group	In vicinity	Over pond	Landing	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	canadensis	Goose										
	Anatinae	Unknown Duck	duck	896	873	643	0	24	0	548	34	37
	Anatinae	Unknown Dabbling Duck	duck	26	26	16	0	0	0	0	0	16
1	*Anas platyrhynchos*	Mallard	duck	1402	1398	1392	0	0	0	1369	7	16
1	*Anas strepera*	Gadwall	duck	176	176	176	0	0	0	176	0	0
2	*Anas crecca*	Green-winged Teal	duck	228	199	190	0	0	0	29	0	161
1	*Anas americana*	American Wigeon	duck	1922	1922	1904	0	0	0	1900	4	0
2	*Anas acuta*	Northern Pintail	duck	205	203	54	0	0	0	53	0	1
1	*Anas clypeata*	Northern Shoveler	duck	273	273	273	0	23	0	242	4	4
1	*Anas discors*	Blue-winged Teal	duck	115	115	115	0	0	0	113	2	0
1	*Anas cyanoptera*	Cinnamon Teal	duck	4	4	4	0	0	0	4	0	0
1	*Oxyura jamaicensis*	Ruddy Duck	duck	11	10	10	0	0	0	10	0	0
	Aythya spp.	Unknown Diving Duck	duck	3	3	3	0	0	0	2	0	1
1	*Aythya valisineria*	Canvasback	duck	168	168	168	0	0	0	168	0	0
1	*Aythya*	Redhead	duck	17	17	16	0	0	0	12	4	0

Status	Species name	Common name	Group	In vicinity	Over pond	Landing	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	americana											
1	*Aythya collaris*	Ring-necked Duck	duck	102	102	102	0	0	0	102	0	0
1	*Aythya marila*	Greater Scaup	duck	6	6	6	0	0	0	6	0	0
2	*Aythya affinis*	Lesser Scaup	duck	639	635	628	0	0	0	627	1	0
2	*Melanitta fusca*	White-winged Scoter	duck	3	3	3	2	0	0	1	0	0
1	*Bucephala clangula*	Common Goldeneye	duck	697	696	673	0	0	0	673	0	0
1	*Bucephala albeola*	Bufflehead	duck	1059	1059	1057	0	0	0	1057	0	0
	Charadriiformes	Unknown Shorebird	shorebird	822	765	417	0	0	0	27	349	41
2	*Porzana carolina*	Sora	shorebird	1	1	1	0	0	0	0	0	1
	Charadriinae	Unknown Plover	shorebird	5	5	5	0	0	0	0	0	5
1	*Charadrius vociferus*	Killdeer	shorebird	88	66	30	0	0	4	12	0	14
1	*Pluvialis squatarola*	Black-bellied Plover	shorebird	1	1	0	0	0	0	0	0	0
1	*Pluvialis dominica*	American Golden Plover	shorebird	10	10	10	0	0	10	0	0	0
	Tringa spp.	Unknown Yellowlegs	shorebird	41	41	41	0	0	0	0	0	41

Status	Species name	Common name	Group	In vicinity	Over pond	Landing	CNRL	Imperial	Shell	Suncor	Syncrude	UA
1	*Tringa melanoleuca*	Greater Yellowlegs	shorebird	30	30	30	0	0	0	29	0	1
1	*Tringa flavipes*	Lesser Yellowlegs	shorebird	213	212	203	0	0	0	179	6	18
	Scolopacinae	Unknown Sandpiper	shorebird	907	892	447	0	0	9	195	0	243
1	*Tringa solitaria*	Solitary Sandpiper	shorebird	15	15	15	0	0	0	11	4	0
1	*Actitis macularius*	Spotted Sandpiper	shorebird	169	168	166	0	0	0	56	0	110
	Phalaropodinae	Unknown Phalarope	shorebird	1	0	0	0	0	0	0	0	0
1	*Phalaropus lobatus*	Red-necked Phalarope	shorebird	16	16	16	0	0	0	0	0	16
	Scolopacinae	Unknown dowitcher	shorebird	1	1	1	0	0	0	0	0	1
0	*Limnodromus griseus*	Short-billed Dowitcher	shorebird	4	2	2	0	0	0	0	0	2
1	*Gallinago delicata*	Wilson's Snipe	shorebird	5	5	2	0	0	0	0	0	2
1	*Calidris minutilla*	Least Sandpiper	shorebird	10	7	4	0	0	0	1	0	3
1	*Calidris bairdii*	Baird's Sandpiper	shorebird	4	4	4	0	0	0	0	0	4
1	*Calidris melanotos*	Pectoral Sandpiper	shorebird	1	1	1	0	0	0	1	0	0
	Larinae	Unknown Gull	gull/tern	524	458	63	0	0	0	8	26	29
1	*Leucophaeus pipixcan*	Franklin's Gull	gull/tern	15	0	0	0	0	0	0	0	0
1	*Chroicocephalus*	Bonaparte's	gull/tern	38	38	27	0	24	0	3	0	0

Status	Species name	Common name	Group	In vicinity	Over pond	Landing	CNRL	Imperial	Shell	Suncor	Syncrude	UA
	philadelphia	Gull										
1	*Larus delawarensis*	Ring-billed Gull	gull/tern	10	8	4	0	0	0	4	0	0
0	*Larus argentatus*	Herring Gull	gull/tern	3	3	0	0	0	0	0	0	0
1	*Larus californicus*	California Gull	gull/tern	41	34	11	0	0	0	6	0	5
	Sterninae	Unknown Tern	gull/tern	1	1	0	0	0	0	0	0	0
1	*Sterna hirundo*	Common Tern	gull/tern	12	12	0	0	0	0	0	0	0
2	*Chlidonias niger*	Black Tern	gull/tern	12	12	1	0	0	0	1	0	0
1	*Megaceryle alcyon*	Belted Kingfisher	passerine	1	1	0	0	0	0	0	0	0

G. All species detected at reference ponds, spring surveys

Spring migrants near reference ponds										
Status	Species name	Common name	Group	Observed	Heard	Total	Imperial	Suncor	Syncrude	UA
	Unknown [a]	Unknown	other	19	0	19	0	5	0	14
1	*Gavia immer*	Common Loon	loon/grebe	217	0	217	22	55	13	127
1	*Podiceps grisegena*	Red-necked Grebe	loon/grebe	555	0	555	0	257	0	298
2	*Podiceps auritus*	Horned Grebe	loon/grebe	20	0	20	0	12	2	6
1	*Podiceps nigricollis*	Eared Grebe	loon/grebe	2	0	2	0	0	2	0
2	*Pelecanus erythrorhynchos*	American White Pelican	other	3	0	3	0	0	2	1
1	*Phalacrocorax auritus*	Double-crested Cormorant	other	1	0	1	0	0	0	1
	Ardeidae	Unknown Heron	other	1	0	1	0	0	0	1
2	*Ardea herodias*	Great Blue Heron	other	10	0	10	0	0	1	9
2	*Grus canadensis*	Sandhill Crane	other	236	1	237	0	0	0	237
2	*Cygnus buccinator*	Trumpeter Swan	other	2	0	2	0	0	0	2
1	*Branta canadensis*	Canada Goose	goose	1048	0	1048	205	8	0	835
	Anatinae	Unknown Duck	duck	398	1	399	3	190	13	193
	Anatinae	Unknown Dabbling Duck	duck	13	0	13	0	0	0	13
1	*Anas platyrhynchos*	Mallard	duck	308	0	308	54	65	27	162
1	*Anas strepera*	Gadwall	duck	6	0	6	0	4	0	2
2	*Anas crecca*	Green-winged Teal	duck	63	0	63	0	5	2	56
1	*Anas americana*	American Wigeon	duck	268	1	269	5	100	18	146
2	*Anas acuta*	Northern Pintail	duck	24	0	24	14	2	2	6
1	*Anas clypeata*	Northern Shoveler	duck	92	0	92	44	8	1	39
1	*Anas discors*	Blue-winged Teal	duck	7	0	7	4	1	0	2
1	*Oxyura jamaicensis*	Ruddy Duck	duck	22	0	22	0	9	2	11
	Aythya spp.	Unknown Diving Duck	duck	21	0	21	0	0	0	21
1	*Aythya valisineria*	Canvasback	duck	379	0	379	0	139	0	240

Spring migrants near reference ponds										
Status	Species name	Common name	Group	Observed	Heard	Total	Imperial	Suncor	Syncrude	UA
1	*Aythya americana*	Redhead	duck	42	0	42	0	23	0	19
1	*Aythya collaris*	Ring-necked Duck	duck	221	0	221	6	7	0	208
	Aythya spp.	Unknown Scaup	duck	936	0	936	0	31	2	903
1	*Aythya marila*	Greater Scaup	duck	29	0	29	0	26	1	2
2	*Aythya affinis*	Lesser Scaup	duck	267	0	267	0	139	9	119
2	*Melanitta fusca*	White-winged Scoter	duck	4	0	4	0	0	0	4
1	*Melanitta perspicillata*	Surf Scoter	duck	35	0	35	0	0	3	32
1	*Bucephala islandica*	Barrow's Goldeneye	duck	6	0	6	0	6	0	0
1	*Bucephala clangula*	Common Goldeneye	duck	235	0	235	61	70	12	92
1	*Bucephala albeola*	Bufflehead	duck	144	0	144	31	11	8	94
1	*Mergus merganser*	Common Merganser	duck	9	0	9	0	0	3	6
1	*Mergus serrator*	Red-breasted Merganser	duck	27	0	27	2	0	0	25
	Charadriiformes	Unknown Shorebird	shorebird	30	1	31	0	1	12	18
2	*Porzana carolina*	Sora	shorebird	19	14	33	0	6	0	27
2	*Coturnicops noveboracensis*	Yellow Rail	shorebird	1	1	2	0	0	0	2
1	*Fulica americana*	American Coot	duck	69	1	70	0	39	0	31
	Charadriinae	Unknown Plover	shorebird	5	1	6	0	0	0	6
1	*Charadrius vociferus*	Killdeer	shorebird	77	2	79	10	0	6	63
1	*Pluvialis squatarola*	Black-bellied Plover	shorebird	3	0	3	0	0	0	3
1	*Tringa melanoleuca*	Greater Yellowlegs	shorebird	10	0	10	3	0	2	5
1	*Tringa flavipes*	Lesser Yellowlegs	shorebird	20	0	20	0	0	5	15
	Scolopacinae	Unknown Sandpiper	shorebird	70	0	70	1	1	0	68
1	*Tringa solitaria*	Solitary Sandpiper	shorebird	3	0	3	0	0	2	1
1	*Actitis macularius*	Spotted Sandpiper	shorebird	14	0	14	0	0	5	9
1	*Gallinago delicata*	Wilson's Snipe	shorebird	4	0	4	0	0	0	4
1	*Calidris minutilla*	Least Sandpiper	shorebird	3	0	3	0	0	3	0

Spring migrants near reference ponds										
Status	Species name	Common name	Group	Observed	Heard	Total	Imperial	Suncor	Syncrude	UA
	Larinae	Unknown Gull	gull/tern	288	1	289	0	80	64	145
1	*Leucophaeus pipixcan*	Franklin's Gull	gull/tern	30	0	30	0	0	30	0
1	*Chroicocephalus philadelphia*	Bonaparte's Gull	gull/tern	194	0	194	16	39	0	139
1	*Larus delawarensis*	Ring-billed Gull	gull/tern	6	0	6	0	0	0	6
0	*Larus argentatus*	Herring Gull	gull/tern	31	0	31	0	0	15	16
1	*Larus californicus*	California Gull	gull/tern	2	0	2	0	2	0	0
1	*Sterna hirundo*	Common Tern	gull/tern	60	0	60	28	12	0	20
2	*Chlidonias niger*	Black Tern	gull/tern	203	0	203	0	203	0	0
	Raptor [b]	Unknown Raptor	raptor	6	0	6	0	4	0	2
2	*Aquila chrysaetos*	Golden Eagle	raptor	1	0	1	0	0	0	1
2	*Haliaeetus leucocephalus*	Bald Eagle	raptor	1	0	1	0	0	0	1
2	*Circus cyaneus*	Northern Harrier	raptor	14	0	14	0	0	0	14
	Passeriformes [c]	Unknown Passerine	passerine	234	1	235	0	155	0	80
	Tetraoninae	Unknown Grouse	passerine	1	0	1	0	1	0	0
1	*Megaceryle alcyon*	Belted Kingfisher	passerine	3	0	3	0	0	0	3
1	*Colaptes auratus*	Northern Flicker	passerine	5	0	5	0	5	0	0
	Hirundininae	Unknown Swallow	passerine	3	0	3	0	3	0	0
1	*Tachycineta bicolor*	Tree Swallow	passerine	223	2	225	0	126	0	99
1	*Riparia riparia*	Bank Swallow	passerine	16	0	16	0	16	0	0
1	*Petrochelidon pyrrhonota*	Cliff Swallow	passerine	1053	0	1053	0	0	1053	0
3	*Hirundo rustica*	Barn Swallow	passerine	2	0	2	0	0	0	2
1	*Perisoreus canadensis*	Gray Jay	passerine	4	0	4	0	0	0	4
1	*Pica hudsonia*	Black-billed Magpie	passerine	1	0	1	0	0	1	0
1	*Corvus brachyrhynchos*	American Crow	passerine	1	1	2	2	0	0	0

Spring migrants near reference ponds										
Status	Species name	Common name	Group	Observed	Heard	Total	Imperial	Suncor	Syncrude	UA
1	*Poecile atricapillus*	Black-capped Chickadee	passerine	3	0	3	0	3	0	0
1	*Sialia currucoides*	Mountain Bluebird	passerine	0	1	1	0	0	0	1
1	*Turdus migratorius*	American Robin	passerine	62	0	62	0	60	0	2
0	*Sturnus vulgaris*	European Starling	passerine	1	0	1	0	0	0	1
	Parulidae	Unknown Warbler	passerine	18	0	18	0	18	0	0
1	*Mniotilta varia*	Black-and-white Warbler	passerine	1	0	1	0	1	0	0
1	*Setophaga coronata*	Yellow-rumped Warlber	passerine	2	0	2	0	2	0	0
1	*Setophaga petechia*	Yellow Warbler	passerine	17	2	19	0	16	0	3
1	*Seiurus aurocapilla*	Ovenbird	passerine	0	1	1	0	0	0	1
1	*Parkesia noveboracensis*	Northern Waterthrush	passerine	1	1	2	0	0	1	1
2	*Geothlypis trichas*	Common Yellowthroat	passerine	1	0	1	0	0	0	1
	Emberizidae	Unknown Sparrow	passerine	45	0	45	0	42	1	2
1	*Passerculus sandwichensis*	Savannah Sparrow	passerine	1	0	1	0	0	0	1
1	*Melospiza melodia*	Song Sparrow	passerine	3	0	3	0	3	0	0
1	*Spizella pallida*	Clay-colored Sparrow	passerine	1	0	1	0	0	0	1
1	*Zonotrichia albicollis*	White-throated Sparrow	passerine	2	0	2	0	0	0	2
1	*Melospiza lincolnii*	Lincoln's Sparrow	passerine	0	1	1	0	0	0	1
1	*Plectrophenax nivalis*	Snow Bunting	passerine	28	0	28	0	0	0	28
	Icteridae	Unknown Blackbird	passerine	19	0	19	0	19	0	0
1	*Xanthocephalus xanthocephalus*	Yellow-headed Blackbird	passerine	1	0	1	0	1	0	0
1	*Agelaius phoeniceus*	Red-winged Blackbird	passerine	1059	2	1061	0	900	33	128
2	*Euphagus carolinus*	Rusty Blackbird	passerine	1	0	1	0	0	0	1
1	*Euphagus*	Brewer's Blackbird	passerine	2	0	2	0	2	0	0

Spring migrants near reference ponds										
Status	Species name	Common name	Group	Observed	Heard	Total	Imperial	Suncor	Syncrude	UA
1	*cyanocephalus Quiscalus quiscula*	Common Grackle	passerine	77	0	77	0	75	0	2

[a] Unknown had no group or taxonomic information provided.

[b] Raptor includes Accipitridae, Falconinae, and Strigidae.

[c] Passerine includes Passeriformes and passerine-like birds.

H. Water-associated species detected at reference ponds, spring surveys

Status	Species name	Common name	Group	In vicinity	Over pond	Landing	Imperial	Suncor	Syncrude	UA
	Unknown	Unknown	other	19	19	4	0	4	0	0
1	*Gavia immer*	Common Loon	loon/grebe	217	217	211	22	55	13	121
1	*Podiceps grisegena*	Red-necked Grebe	loon/grebe	555	555	545	0	249	0	296
2	*Podiceps auritus*	Horned Grebe	loon/grebe	20	20	20	0	12	2	6
1	*Podiceps nigricollis*	Eared Grebe	loon/grebe	2	2	2	0	0	2	0
2	*Pelecanus erythrorhynchos*	American White Pelican	other	3	3	3	0	0	2	1
1	*Phalacrocorax auritus*	Double-crested Cormorant	other	1	1	1	0	0	0	1
	Ardeidae	Unknown Heron	other	1	1	0	0	0	0	0
2	*Ardea herodias*	Great Blue Heron	other	10	9	4	0	0	1	3
2	*Grus canadensis*	Sandhill Crane	other	237	47	32	0	0	0	32
2	*Cygnus buccinator*	Trumpeter Swan	other	2	2	2	0	0	0	2
1	*Branta canadensis*	Canada Goose	goose	1048	1030	518	32	2	0	484
	Anatinae	Unknown Duck	duck	399	393	253	0	181	9	63
	Anatinae	Unknown Dabbling Duck	duck	13	13	0	0	0	0	0

1	*Anas platyrhynchos*	Mallard	duck	308	307	221	6	65	24	126
1	*Anas strepera*	Gadwall	duck	6	6	6	0	4	0	2
2	*Anas crecca*	Green-winged Teal	duck	63	63	59	0	5	2	52
1	*Anas americana*	American Wigeon	duck	269	268	241	5	100	18	118
2	*Anas acuta*	Northern Pintail	duck	24	24	23	14	2	2	5
1	*Anas clypeata*	Northern Shoveler	duck	92	92	91	44	7	1	39
1	*Anas discors*	Blue-winged Teal	duck	7	7	7	4	1	0	2
1	*Oxyura jamaicensis*	Ruddy Duck	duck	22	22	22	0	9	2	11
	Aythya spp.	Unknown Diving Duck	duck	21	21	13	0	0	0	13
1	*Aythya valisineria*	Canvasback	duck	379	379	355	0	134	0	221
1	*Aythya americana*	Redhead	duck	42	42	36	0	23	0	13
1	*Aythya collaris*	Ring-necked Duck	duck	221	221	204	6	7	0	191
	Aythya spp.	Unknown Scaup	duck	936	936	902	0	31	2	869
1	*Aythya marila*	Greater Scaup	duck	29	29	29	0	26	1	2
2	*Aythya affinis*	Lesser Scaup	duck	267	267	263	0	135	9	119
2	*Melanitta fusca*	White-winged Scoter	duck	4	4	4	0	0	0	4
1	*Melanitta perspicillata*	Surf Scoter	duck	35	35	35	0	0	3	32
1	*Bucephala islandica*	Barrow's Goldeneye	duck	6	6	6	0	6	0	0

1	*Bucephala clangula*	Common Goldeneye	duck	235	235	225	59	70	12	84
1	*Bucephala albeola*	Bufflehead	duck	144	144	140	31	11	4	94
1	*Mergus merganser*	Common Merganser	duck	9	9	9	0	0	3	6
1	*Mergus serrator*	Red-breasted Merganser	duck	27	27	27	2	0	0	25
	Charadriiformes	Unknown Shorebird	shorebird	31	29	22	0	1	11	10
2	*Porzana carolina*	Sora	shorebird	33	19	18	0	5	0	13
2	*Coturnicops noveboracensis*	Yellow Rail	shorebird	2	1	1	0	0	0	1
1	*Fulica americana*	American Coot	duck	70	69	69	0	39	0	30
	Charadriinae	Unknown Plover	shorebird	6	5	0	0	0	0	0
1	*Charadrius vociferus*	Killdeer	shorebird	79	62	43	8	0	3	32
1	*Pluvialis squatarola*	Black-bellied Plover	shorebird	3	3	0	0	0	0	0
1	*Tringa melanoleuca*	Greater Yellowlegs	shorebird	10	10	10	3	0	2	5
1	*Tringa flavipes*	Lesser Yellowlegs	shorebird	20	20	18	0	0	5	13
	Scolopacinae	Unknown Sandpiper	shorebird	70	64	58	0	1	0	57
1	*Tringa solitaria*	Solitary Sandpiper	shorebird	3	3	3	0	0	2	1
1	*Actitis macularius*	Spotted Sandpiper	shorebird	14	14	14	0	0	5	9

1	*Gallinago delicata*	Wilson's Snipe	shorebird	4	2	0	0	0	0	0
1	*Calidris minutilla*	Least Sandpiper	shorebird	3	3	3	0	0	3	0
	Larinae	Unknown Gull	gull/tern	289	253	114	0	36	63	15
1	*Leucophaeus pipixcan*	Franklin's Gull	gull/tern	30	30	30	0	0	30	0
1	*Chroicocephalus philadelphia*	Bonaparte's Gull	gull/tern	194	194	113	16	10	0	87
1	*Larus delawarensis*	Ring-billed Gull	gull/tern	6	6	2	0	0	0	2
0	*Larus argentatus*	Herring Gull	gull/tern	31	31	15	0	0	15	0
1	*Larus californicus*	California Gull	gull/tern	2	2	0	0	0	0	0
1	*Sterna hirundo*	Common Tern	gull/tern	60	60	31	19	6	0	6
2	*Chlidonias niger*	Black Tern	gull/tern	203	203	0	0	0	0	0
1	*Megaceryle alcyon*	Belted Kingfisher	passerine	3	3	2	0	0	0	2
1	*Parkesia noveboracensis*	Northern Waterthrush	passerine	2	1	1	0	0	1	0

I. All species detected at reference ponds, fall surveys

Fall migrants near reference ponds										
Status	Species name	Common name	Group	Observed	Heard	Total	Imperial	Suncor	Syncrude	UA
	Unknown [a]	Unknown	other	160	0	160	0	158	0	2
1	Gavia immer	Common Loon	loon/grebe	193	0	193	5	140	6	42
	Podicipedidae	Unknown Grebe	loon/grebe	3	0	3	0	0	1	2
1	Podiceps grisegena	Red-necked Grebe	loon/grebe	140	0	140	5	95	0	40
2	Podiceps auritus	Horned Grebe	loon/grebe	5	0	5	0	5	0	0
2	Podilymbus podiceps	Pied-billed Grebe	loon/grebe	10	0	10	0	10	0	0
0	Tachybaptus dominicus	Least Grebe	loon/grebe	2	0	2	0	0	0	2
2	Pelecanus erythrorhynchos	American White Pelican	other	1	0	1	0	0	0	1
	Ardeidae	Unknown Heron	other	2	0	2	0	0	0	2
2	Ardea herodias	Great Blue Heron	other	7	0	7	2	1	3	1
2	Grus canadensis	Sandhill Crane	other	58	0	58	33	0	0	25
	Anserinae	Unknown Goose	goose	50	0	50	0	0	0	50
1	Anser albifrons	Greater White-fronted Goose	goose	29	0	29	0	0	0	29
1	Chen caerulescens	Snow Goose	goose	143	0	143	0	0	0	143
1	Branta canadensis	Canada Goose	goose	2238	1	2239	244	205	0	1790
	Anatinae	Unknown Duck	duck	5942	3	5945	0	5173	1	771
	Anatinae	Unknown Dabbling Duck	duck	84	0	84	0	0	0	84
1	Anas platyrhynchos	Mallard	duck	300	1	301	12	190	1	98
1	Anas strepera	Gadwall	duck	110	0	110	0	84	0	26
	Anas spp.	Unknown Teal	duck	3	0	3	0	0	0	3
2	Anas crecca	Green-winged Teal	duck	21	1	22	0	20	0	2
1	Anas americana	American Wigeon	duck	249	0	249	0	210	12	27
2	Anas acuta	Northern Pintail	duck	126	0	126	6	120	0	0

Fall migrants near reference ponds										
Status	Species name	Common name	Group	Observed	Heard	Total	Imperial	Suncor	Syncrude	UA
1	Anas clypeata	Northern Shoveler	duck	34	0	34	3	29	0	2
1	Anas discors	Blue-winged Teal	duck	46	0	46	4	31	0	11
1	Oxyura jamaicensis	Ruddy Duck	duck	47	0	47	0	37	0	10
	Aythya spp.	Unknown Diving Duck	duck	451	0	451	0	11	0	440
1	Aythya valisineria	Canvasback	duck	352	0	352	0	347	0	5
1	Aythya americana	Redhead	duck	34	0	34	0	16	0	18
1	Aythya collaris	Ring-necked Duck	duck	181	0	181	0	0	0	181
	Aythya spp.	Unknown Scaup	duck	393	0	393	0	0	0	393
2	Aythya affinis	Lesser Scaup	duck	124	0	124	0	124	0	0
2	Melanitta fusca	White-winged Scoter	duck	37	0	37	0	0	0	37
1	Melanitta perspicillata	Surf Scoter	duck	2	0	2	0	0	0	2
1	Clangula hyemalis	Long-tailed Duck	duck	11	0	11	0	11	0	0
1	Bucephala clangula	Common Goldeneye	duck	210	0	210	47	45	0	118
1	Bucephala albeola	Bufflehead	duck	538	0	538	60	319	0	159
	Mergus spp.	Unknown Merganser	duck	2	0	2	0	0	0	2
1	Mergus merganser	Common Merganser	duck	12	0	12	0	0	0	12
1	Mergus serrator	Red-breasted Merganser	duck	5	0	5	0	0	0	5
	Charadriiformes	Unknown Shorebird	shorebird	81	1	82	0	3	1	78
1	Fulica americana	American Coot	duck	2	0	2	0	2	0	0
	Charadriinae	Unknown Plover	shorebird	8	0	8	0	0	0	8
1	Charadrius semipalmatus	Semipalmated Plover	shorebird	4	0	4	0	0	0	4
1	Charadrius vociferus	Killdeer	shorebird	21	0	21	7	0	0	14
	Tringa spp.	Unknown Yellowlegs	shorebird	9	0	9	0	0	0	9
1	Tringa melanoleuca	Greater Yellowlegs	shorebird	15	1	16	5	0	0	11
1	Tringa flavipes	Lesser Yellowlegs	shorebird	13	0	13	1	0	0	12
	Scolopacinae	Unknown Sandpiper	shorebird	159	1	160	0	2	0	158
1	Tringa solitaria	Solitary Sandpiper	shorebird	1	0	1	0	1	0	0

Fall migrants near reference ponds										
Status	Species name	Common name	Group	Observed	Heard	Total	Imperial	Suncor	Syncrude	UA
1	Actitis macularius	Spotted Sandpiper	shorebird	23	0	23	0	0	1	22
0	Tringa incana	Wandering Tattler	shorebird	1	0	1	0	0	0	1
1	Phalaropus tricolor	Wilson's Phalarope	shorebird	2	0	2	0	0	0	2
	Larinae	Unknown Gull	gull/tern	29	0	29	0	4	12	13
1	Chroicocephalus philadelphia	Bonaparte's Gull	gull/tern	44	0	44	34	0	0	10
1	Larus delawarensis	Ring-billed Gull	gull/tern	1	0	1	0	0	0	1
0	Larus argentatus	Herring Gull	gull/tern	1	0	1	0	0	1	0
1	Larus californicus	California Gull	gull/tern	9	0	9	1	0	0	8
1	Sterna hirundo	Common Tern	gull/tern	53	0	53	46	0	1	6
2	Chlidonias niger	Black Tern	gull/tern	94	0	94	0	89	0	5
	Raptor [b]	Unknown Raptor	raptor	11	0	11	0	1	0	10
2	Haliaeetus leucocephalus	Bald Eagle	raptor	3	1	4	1	1	0	2
2	Circus cyaneus	Northern Harrier	raptor	16	0	16	0	0	0	16
	Passeriformes [c]	Unknown Passerine	passerine	1234	1	1235	0	17	0	1218
	Tetraoninae	Unknown Grouse	passerine	4	0	4	0	0	0	4
1	Colaptes auratus	Northern Flicker	passerine	6	0	6	0	6	0	0
2	Dryocopus pileatus	Pileated Woodpecker	passerine	0	1	1	0	0	0	1
1	Empidonax alnorum	Alder Flycatcher	passerine	0	1	1	0	0	0	1
	Hirundininae	Unknown Swallow	passerine	95	0	95	0	0	0	95
1	Tachycineta bicolor	Tree Swallow	passerine	18	0	18	0	6	0	12
1	Petrochelidon pyrrhonota	Cliff Swallow	passerine	122	1	123	0	2	0	121
1	Cyanocitta cristata	Blue Jay	passerine	0	1	1	0	0	0	1
1	Perisoreus canadensis	Gray Jay	passerine	5	0	5	0	0	0	5
1	Pica hudsonia	Black-billed Magpie	passerine	6	0	6	0	2	0	4
1	Corvus corax	Common Raven	passerine	3	0	3	0	3	0	0
1	Poecile atricapillus	Black-capped	passerine	23	0	23	0	23	0	0

Fall migrants near reference ponds										
Status	Species name	Common name	Group	Observed	Heard	Total	Imperial	Suncor	Syncrude	UA
		Chickadee								
1	Cistothorus palustris	Marsh Wren	passerine	2	0	2	0	0	0	2
1	Turdus migratorius	American Robin	passerine	43	0	43	0	43	0	0
1	Vireo gilvus	Warbling Vireo	passerine	1	0	1	0	1	0	0
1	Setophaga petechia	Yellow Warbler	passerine	3	0	3	0	3	0	0
	Emberizidae	Unknown Sparrow	passerine	7	0	7	0	6	0	1
1	Melospiza melodia	Song Sparrow	passerine	6	0	6	0	6	0	0
1	Plectrophenax nivalis	Snow Bunting	passerine	76	0	76	0	0	0	76
	Icteridae	Unknown Blackbird	passerine	9	0	9	0	4	0	5
1	Agelaius phoeniceus	Red-winged Blackbird	passerine	320	0	320	0	318	0	2
2	Euphagus carolinus	Rusty Blackbird	passerine	15	0	15	0	0	0	15
1	Euphagus cyanocephalus	Brewer's Blackbird	passerine	2	0	2	0	2	0	0
1	Pinicola enucleator	Pine Grosbeak	passerine	3	0	3	0	0	0	3

[a] Unknown had no group or taxonomic information provided.

[b] Raptor includes Accipitridae, Falconinae, and Strigidae.

[c] Passerine includes Passeriformes and passerine-like birds.

J. Water-associated species detected at reference ponds, fall surveys

Status	Species name	Common name	Group	In vicinity	Over pond	Landing	Imperial	Suncor	Syncrude	UA
	Unknown	Unknown	other	160	160	159	0	158	0	1
1	*Gavia immer*	Common Loon	loon/grebe	193	193	143	5	90	6	42
	Podicipedidae	Unknown Grebe	loon/grebe	3	3	3	0	0	1	2
1	*Podiceps grisegena*	Red-necked Grebe	loon/grebe	140	140	140	5	95	0	40
2	*Podiceps auritus*	Horned Grebe	loon/grebe	5	5	5	0	5	0	0
2	*Podilymbus podiceps*	Pied-billed Grebe	loon/grebe	10	10	7	0	7	0	0
0	*Tachybaptus dominicus*	Least Grebe	loon/grebe	2	2	2	0	0	0	2
2	*Pelecanus erythrorhynchos*	American White Pelican	other	1	1	0	0	0	0	0
	Ardeidae	Unknown Heron	other	2	2	2	0	0	0	2
2	*Ardea herodias*	Great Blue Heron	other	7	5	4	0	0	3	1
2	*Grus canadensis*	Sandhill Crane	other	58	32	32	30	0	0	2
	Anserinae	Unknown Goose	goose	50	50	0	0	0	0	0
1	*Anser albifrons*	Greater White-fronted Goose	goose	29	3	3	0	0	0	3
1	*Chen caerulescens*	Snow Goose	goose	143	143	0	0	0	0	0
1	*Branta canadensis*	Canada Goose	goose	2239	2222	840	95	45	0	700

	Anatinae	Unknown Duck	duck	5945	5939	5839	0	5104	0	735
	Anatinae	Unknown Dabbling Duck	duck	84	84	80	0	0	0	80
1	*Anas platyrhynchos*	Mallard	duck	301	300	251	12	168	1	70
1	*Anas strepera*	Gadwall	duck	110	110	110	0	84	0	26
	Anas spp.	Unknown Teal	duck	3	3	3	0	0	0	3
2	*Anas crecca*	Green-winged Teal	duck	22	21	21	0	20	0	1
1	*Anas americana*	American Wigeon	duck	249	249	248	0	210	12	26
2	*Anas acuta*	Northern Pintail	duck	126	126	126	6	120	0	0
1	*Anas clypeata*	Northern Shoveler	duck	34	34	34	3	29	0	2
1	*Anas discors*	Blue-winged Teal	duck	46	46	46	4	31	0	11
1	*Oxyura jamaicensis*	Ruddy Duck	duck	47	47	47	0	37	0	10
	Aythya spp.	Unknown Diving Duck	duck	451	451	448	0	11	0	437
1	*Aythya valisineria*	Canvasback	duck	352	352	351	0	347	0	4
1	*Aythya americana*	Redhead	duck	34	34	34	0	16	0	18
1	*Aythya collaris*	Ring-necked Duck	duck	181	181	181	0	0	0	181
	Aythya spp.	Unknown Scaup	duck	393	393	393	0	0	0	393
2	*Aythya affinis*	Lesser Scaup	duck	124	124	124	0	124	0	0

2	*Melanitta fusca*	White-winged Scoter	duck	37	37	37	0	0	0	37
1	*Melanitta perspicillata*	Surf Scoter	duck	2	2	2	0	0	0	2
1	*Clangula hyemalis*	Long-tailed Duck	duck	11	11	0	0	0	0	0
1	*Bucephala clangula*	Common Goldeneye	duck	210	210	210	47	45	0	118
1	*Bucephala albeola*	Bufflehead	duck	538	538	533	60	317	0	156
	Mergus spp.	Unknown Merganser	duck	2	2	2	0	0	0	2
1	*Mergus merganser*	Common Merganser	duck	12	12	12	0	0	0	12
1	*Mergus serrator*	Red-breasted Merganser	duck	5	5	5	0	0	0	5
	Charadriiformes	Unknown Shorebird	shorebird	82	78	9	0	0	0	9
1	*Fulica americana*	American Coot	duck	2	2	2	0	2	0	0
	Charadriinae	Unknown Plover	shorebird	8	8	7	0	0	0	7
1	*Charadrius semipalmatus*	Semipalmated Plover	shorebird	4	4	2	0	0	0	2
1	*Charadrius vociferus*	Killdeer	shorebird	21	17	15	3	0	0	12
	Tringa spp.	Unknown Yellowlegs	shorebird	9	9	9	0	0	0	9
1	*Tringa melanoleuca*	Greater Yellowlegs	shorebird	16	15	15	5	0	0	10
1	*Tringa flavipes*	Lesser Yellowlegs	shorebird	13	13	13	1	0	0	12

	Scolopacinae	Unknown Sandpiper	shorebird	160	157	51	0	2	0	49
1	*Tringa solitaria*	Solitary Sandpiper	shorebird	1	1	1	0	1	0	0
1	*Actitis macularius*	Spotted Sandpiper	shorebird	23	23	23	0	0	1	22
0	*Tringa incana*	Wandering Tattler	shorebird	1	1	1	0	0	0	1
1	*Phalaropus tricolor*	Wilson's Phalarope	shorebird	2	2	2	0	0	0	2
	Larinae	Unknown Gull	gull/tern	29	27	16	0	1	12	3
1	*Chroicocephalus philadelphia*	Bonaparte's Gull	gull/tern	44	44	44	34	0	0	10
1	*Larus delawarensis*	Ring-billed Gull	gull/tern	1	1	1	0	0	0	1
0	*Larus argentatus*	Herring Gull	gull/tern	1	1	1	0	0	1	0
1	*Larus californicus*	California Gull	gull/tern	9	9	9	1	0	0	8
1	*Sterna hirundo*	Common Tern	gull/tern	53	51	45	44	0	1	0
2	*Chlidonias niger*	Black Tern	gull/tern	94	94	17	0	17	0	0
1	*Empidonax alnorum*	Alder Flycatcher	passerine	1	0	0	0	0	0	0

Table 2. Effects of monitoring duration on the detection of individuals and species (which, hereafter, includes species groups) of water-associated birds relative to the detections that occurred with the actual end date of July 14 in Spring and the start date of July 15 in Fall. The purpose of these calculations is to identify the optimal dates on which intensive monitoring should end and begin in the spring and fall, respectively. Each panel is based on the same four thresholds of 95, 90, 85, and 80 for the percentage of detections attributable to either individuals or species relative to the complete sample.

A. Dates on which each of four percentage thresholds (95, 90, 85, 80) is reached relative to the total detections of 15,719 individuals and 70 species in Spring.

B. Dates on which each of four percentage thresholds (95, 90, 85, 80) is reached relative to the total detections of 28,968 individuals and 79 species.

C. Species-specific percentage detections that would have been achieved on the stop dates (Spring) and start dates (Fall) that corresponded to each of the four thresholds for the entire sample for each of Spring (Panel A) and Fall (Panel B).

D. Dates on which spring monitoring could end and fall monitoring could begin in order to detect each of four thresholds of percent detections of individuals within species relative to the same thresholds for detecting species for each of Spring and Fall. The actual percentages achieved for the percent of species detected with the combined criteria are given in parentheses. For example, if spring migration monitoring stopped on July 6 in 2011, over 80% of the individuals would have been detected for 59 / 70 (84.3%) of the species in the total sample.

A. Effects of shortening spring migration monitoring

Spring				
Monitoring category	End date	Day of year	% birds counted	% species >95%
100%	14/07/2011	195	100	100
95%	10/07/2011	191	95.4	72.9
90%	07/07/2011	188	91.1	67.1
85%	03/07/2011	184	85.7	54.3
80%	28/06/2011	179	80.5	41.4

B. Effects of shortening fall migration monitoring

	Fall			
Monitoring category	End date	Day of year	% birds counted	% species >95%
100%	15/07/2011	196	100	100
95%	21/07/2011	202	95.1	76.0
90%	24/07/2011	205	90.3	65.8
85%	31/07/2011	212	85.2	57.0
80%	05/08/2011	217	80.2	51.9

C. Effects on individual species of shortening monitoring

	Spring				Fall			
Common name	95%	90%	85%	80%	95%	90%	85%	80%
American Coot			91.4	91.4				
American Widgeon			90.3	87.0		93.0	88.5	86.5
Black Tern		75.5	73.6	59.3	92.5	34.0	0.9	0.9
Blue-winged Teal		94.3	94.3	94.3			91.9	87.6
Bonaparte's Gull				88.9	67.1	42.7	42.7	34.1
Bufflehead	90.3	79.9	67.4	58.9	90.0	84.1	77.8	65.2
California Gull	80.0	80.0	30.0	10.0	94.0	92.0	92.0	58.0
Canada Goose			90.1	87.4				94.7
Canvasback					84.2	73.5	57.9	53.3

	Spring				Fall			
Common name	95%	90%	85%	80%	95%	90%	85%	80%
Common Goldeneye	89.6	80.5	63.5	51.0	76.0	66.4	49.9	47.4
Common Loon			92.5	88.2	88.1	79.1	71.1	67.2
Common Merganser		81.8	63.6	63.6				
Common Tern	89.6	33.0	17.9	12.3			7.7	7.7
Eared Grebe			77.8	77.8				
Gadwall				29.3	93.0	92.7	91.6	79.4
Great Blue Heron			70.0	40.0	71.4	57.1	0.0	0.0
Greater Scaup				66.7				
Greater Yellowlegs			93.3	53.3			89.1	84.8
Green-winged Teal	92.9	90.2	81.0	73.2	84.0	70.8	63.2	54.4
Herring Gull				84.4				
Horned Grebe	87.6	79.6	69.0	56.6	93.7	21.2	16.2	14.0
Killdeer	87.0	81.7	75.6	71.0	93.6	87.2	79.8	62.4
Least Sandpiper							40.0	40.0
Lesser Scaup	89.1	87.0	84.6	70.4	86.8	81.5	75.2	74.0
Lesser Yellowlegs	87.9	74.1	68.1	62.9	89.4	81.9	65.9	54.0
Mallard	92.9	84.5	74.6	68.1	88.1	82.9	71.9	61.8
Northern Pintail						49.2	40.5	29.3
Northern Shoveler			88.4	87.4			82.1	72.6
Redhead	93.6	93.6	93.6	93.6				80.4
Red-necked Grebe		93.5	91.0	87.8	74.3	60.7	23.6	22.9

	Spring				Fall			
Common name	95%	90%	85%	80%	95%	90%	85%	80%
Ring-billed Gull							63.6	9.1
Ring-necked Duck							79.9	79.9
Ruddy Duck				52.6		86.2	74.1	51.7
Sandhill Crane	89.1	88.7	77.4	77.4		87.0	87.0	56.5
Short-billed Dowitcher	16.7	0.0	0.0	0.0	75.0	75.0	75.0	75.0
Solitary Sandpiper				80.0	87.5	87.5	81.2	31.2
Spotted Sandpiper	93.3	93.3	66.7	53.3			72.9	60.9
Unknown	74.7	74.7	71.4	70.3		94.8	89.5	86.4
Unknown Dabbling Duck	61.5	61.5	61.5	61.5		90.9	90.9	90.9
Unknown Diving Duck	93.5	93.5	93.5	93.5				
Unknown Duck		91.2	88.7	87.0				92.8
Unknown Gull			92.1	90.4		92.6	88.8	73.6
Unknown Plover				86.4				
Unknown Sandpiper	77.5	77.2	74.5	64.8	87.1	68.0	65.6	49.7
Unknown Scoter				88.9				
Unknown Shorebird	88.3	85.7	74.5	73.2		92.3	89.3	77.3
Unknown Yellowlegs								52.0
Wilson's Snipe				73.3				

D. Dates from combined thresholds for reducing monitoring

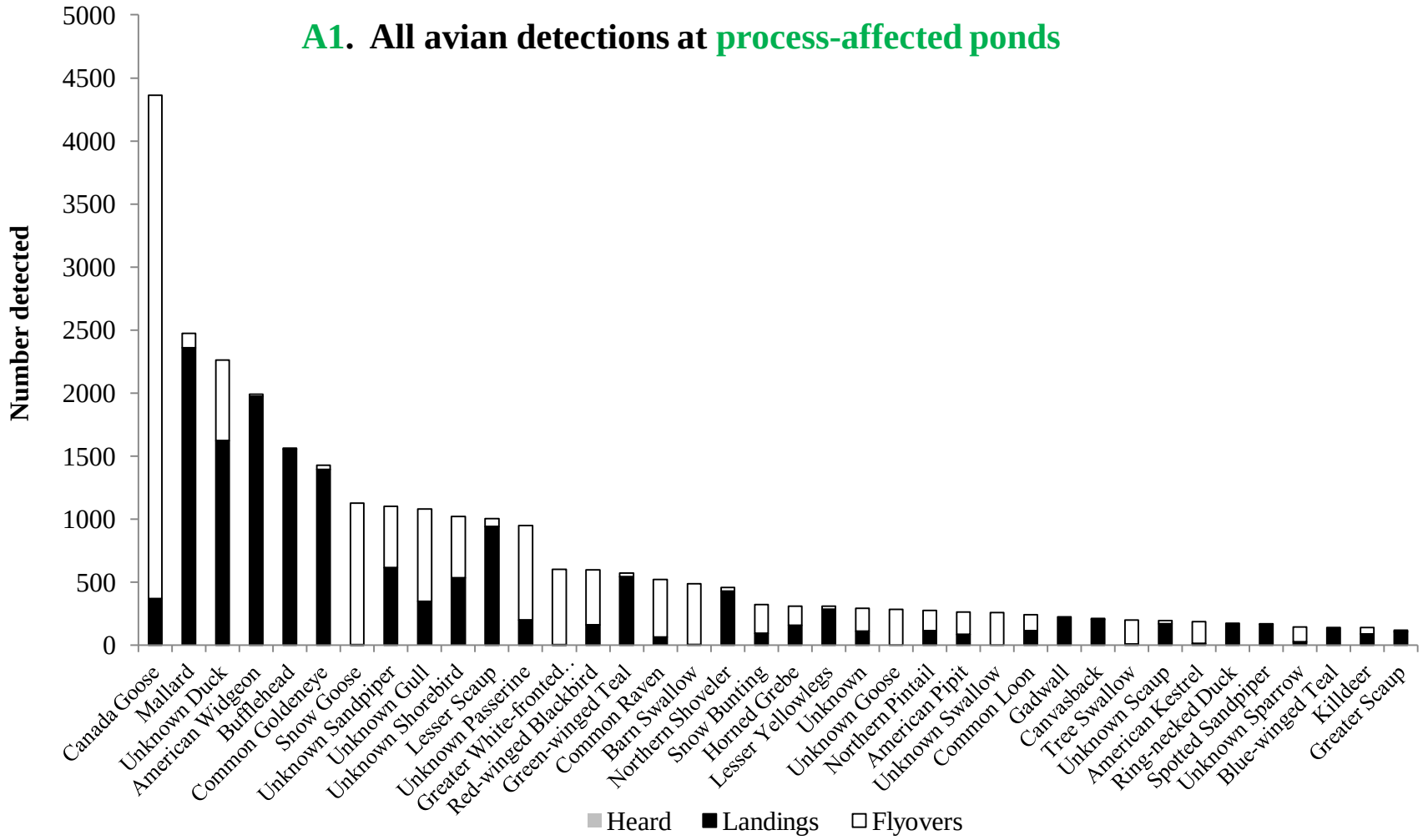
Spring	% species			
% individuals/species	95	90	85	80
95	13 July (97.1)	13 July (97.1)	13 July (97.1)	12 July (82.8)
90	13 July (97.1)	12 July (92.9)	11 July (87.1)	10 July (81.4)
85	13 July (97.1)	10 July (92.9)	9 July (88.6)	7 July (81.4)
80	12 July (95.7)	8 July (91.4)	7 July (88.6)	6 July (84.3)

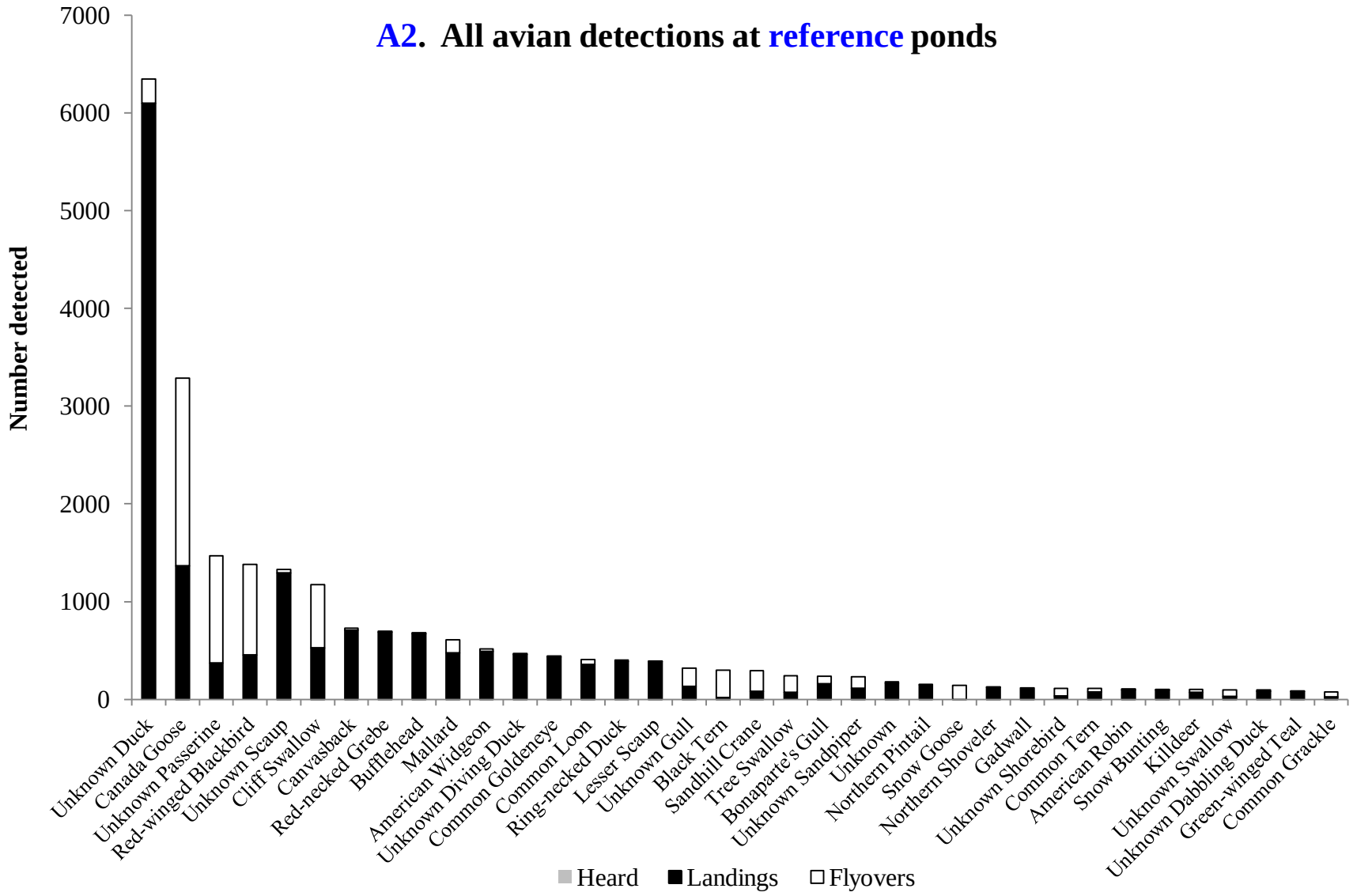
Fall	% species			
% individuals/species	95	90	85	80
95	16 July (96.2)	17 July (92.4)	19 July (87.3)	20 July (83.5)
90	17 July (96.2)	19 July (92.4)	20 July (89.9)	21 July (83.5)
85	19 July (97.5)	21 July (91.1)	21 July (91.1)	23 July (81.0)
80	20 July (96.2)	21 July (93.7)	23 July (86.1)	25 July (81.0)

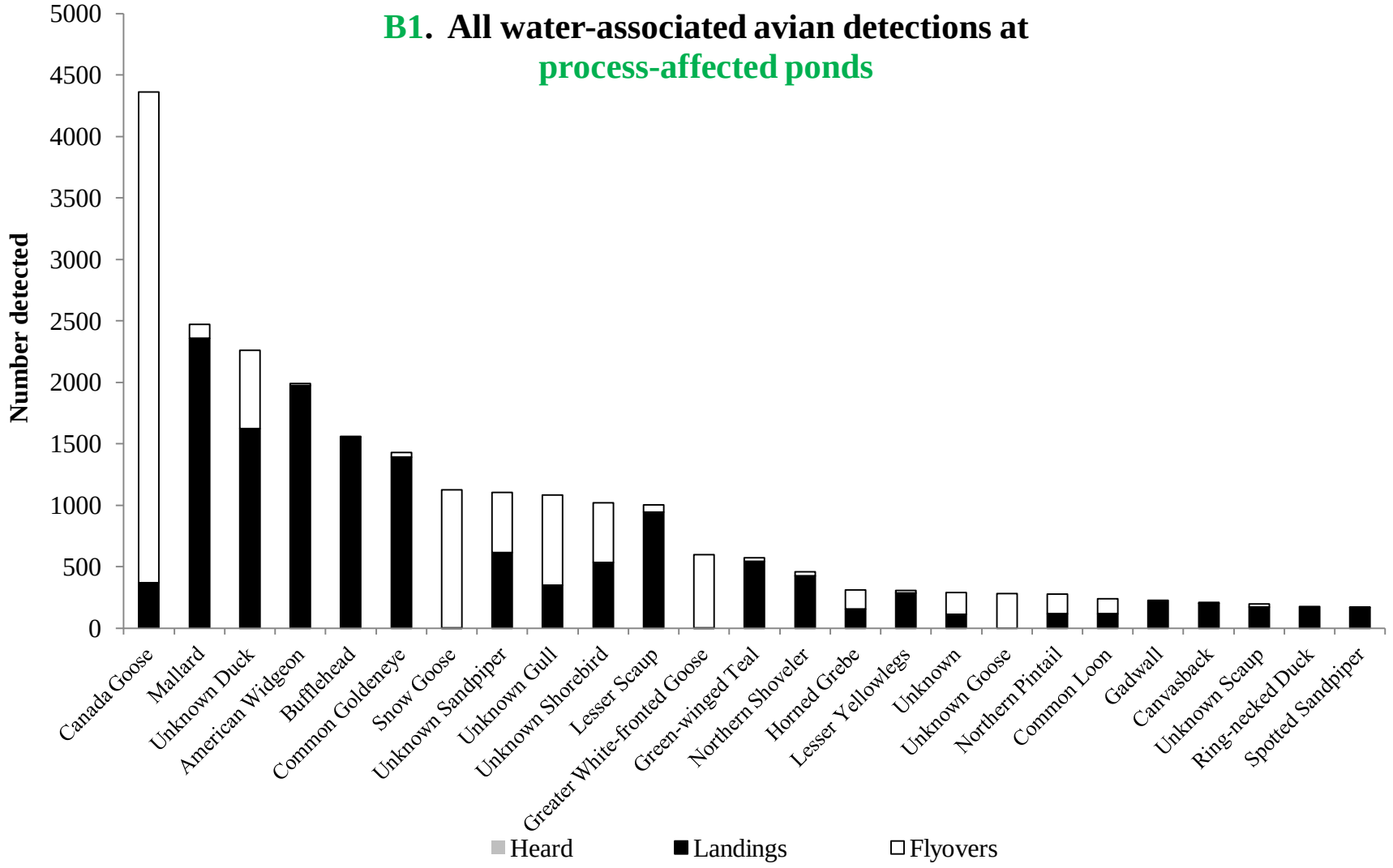
Figure 1. Rank abundance graphs of the most common species or species groups that comprised a minimum of 95% of all recorded landings, flyovers or individuals heard in a given group of birds in the oil sands region recorded by 5 oil sands operators and UofA researchers. The remaining 5% or fewer of the individuals were detected too infrequently to merit comparison by abundance.

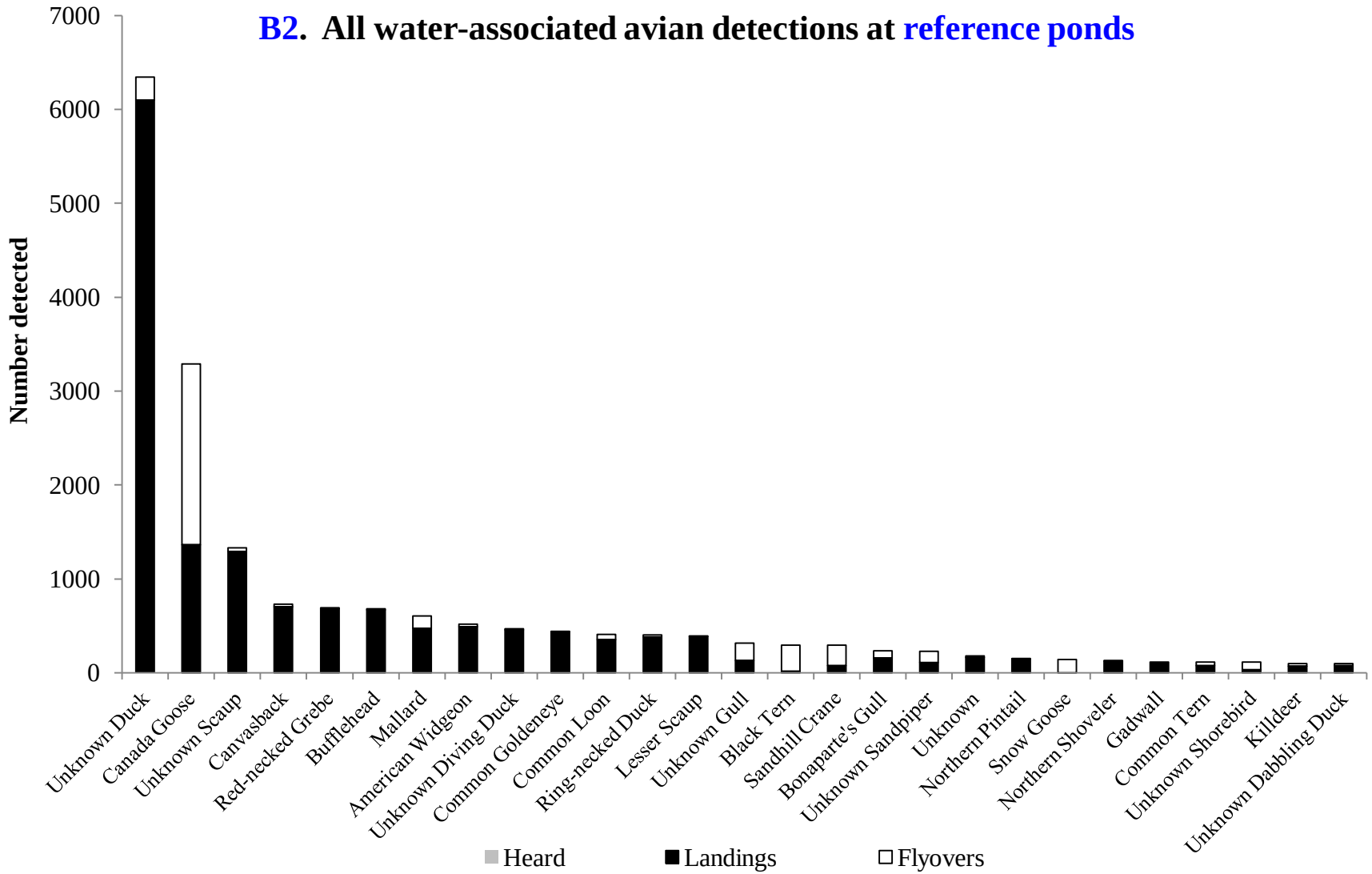
Each set of panels (labelled A – K) below describes a different set of species or species groups. Within each set of panels (e.g., A), there are two figures. The first describes abundance at process-affected ponds and the second describes abundance at reference ponds. Reference ponds include compensation lakes on lease sites as well as natural and semi-natural water-bodies that do not contain process-affected water. Abundance is the estimated or actual counts of individuals that are summed at each site for the entire spring and fall migratory seasons of 2011. The table below provides sample sizes for each set of species or species groups.

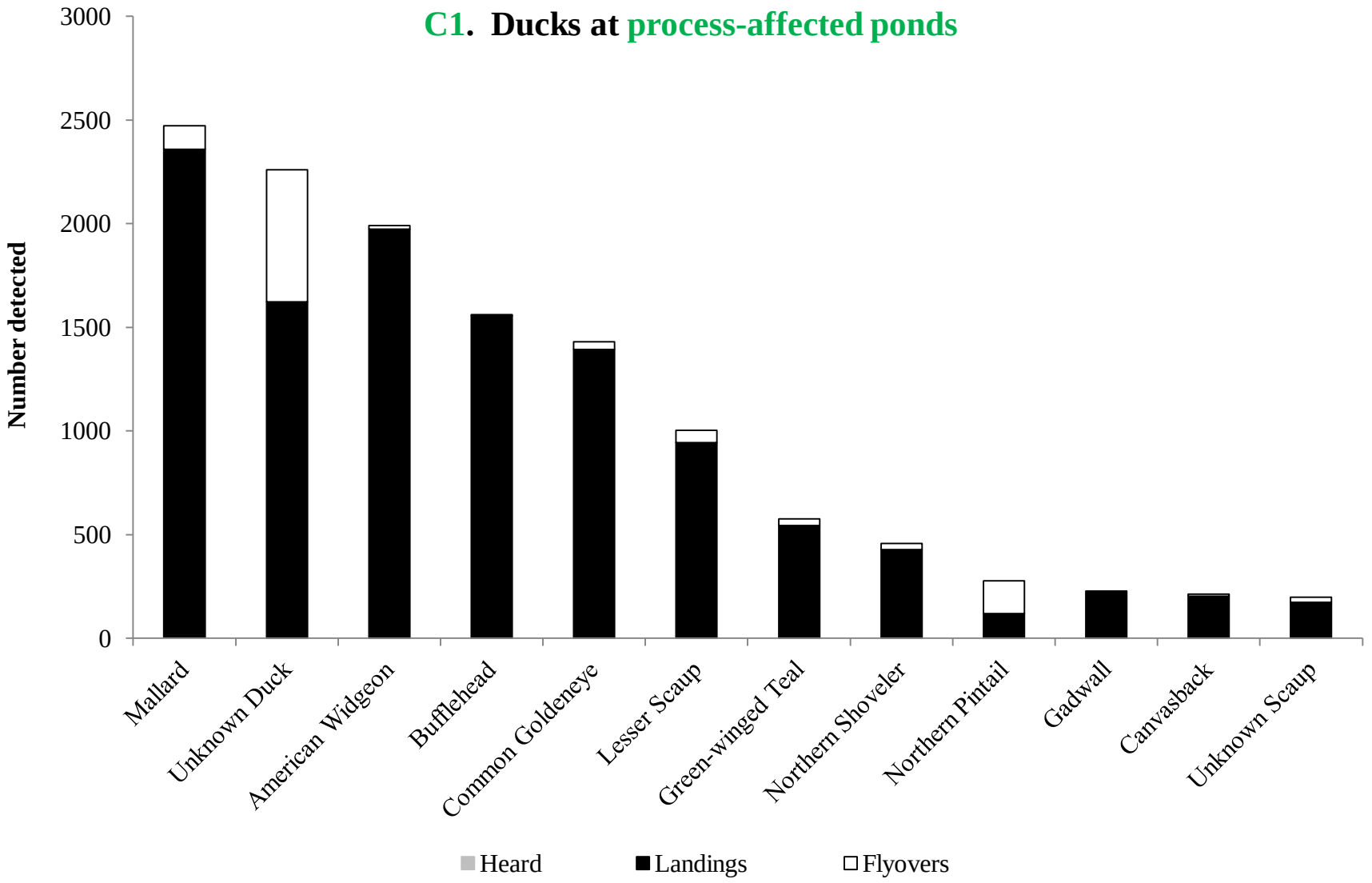
Panel	Species / Species Group	Process-affected ponds			Reference ponds		
		%	Individuals	Species/Groups	%	Individuals	Species/Groups
A	All avian detections	95.4	29,464	124	95.3	24,734	118
B	All water-associated birds	95.3	24,919	81	95.2	19,776	74
C	Ducks	95.3	13,290	28	95.1	12,949	28
D	Geese	95.5	6,375	4	97.7	3,509	4
E	Loons and Grebes	96.0	574	7	96.3	1,147	7
F	Gulls and Terns	95.7	1,396	9	95.4	1,046	8
G	Shorebirds	95.7	2,947	23	96.3	618	17
H	Raptors	96.3	241	11	98.1	53	4
I	Passerines	95.2	4,306	34	95.8	4,911	43
J	Other	96.4	335	8	98.0	501	7

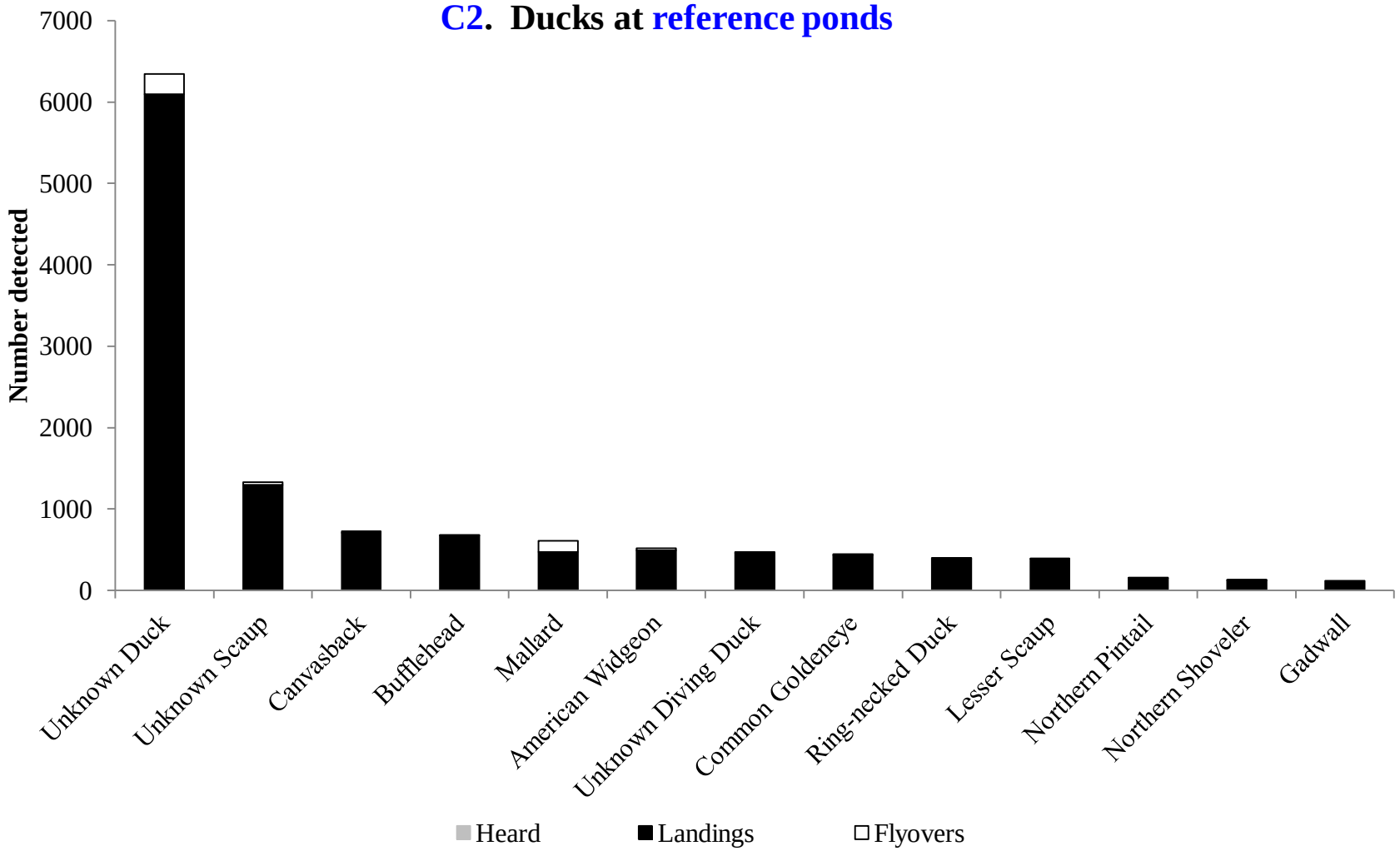

A1. All avian detections at process-affected ponds
Number detected
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Canada Goose
Mallard
Unknown Duck
American Widgeon
Bufflehead
Common Goldeneye
Snow Goose
Unknown Sandpiper
Unknown Gull
Unknown Shorebird
Lesser Scaup
Unknown Passerine
Greater White-fronted…
Red-winged Blackbird
Green-winged Teal
Common Raven
Barn Swallow
Northern Shoveler
Snow Bunting
Horned Grebe
Lesser Yellowlegs
Unknown
Unknown Goose
Northern Pintail
American Pipit
Unknown Swallow
Common Loon
Gadwall
Canvasback
Tree Swallow
Unknown Scaup
American Kestrel
Ring-necked Duck
Spotted Sandpiper
Unknown Sparrow
Blue-winged Teal
Killdeer
Greater Scaup
Heard
Landings
Flyovers

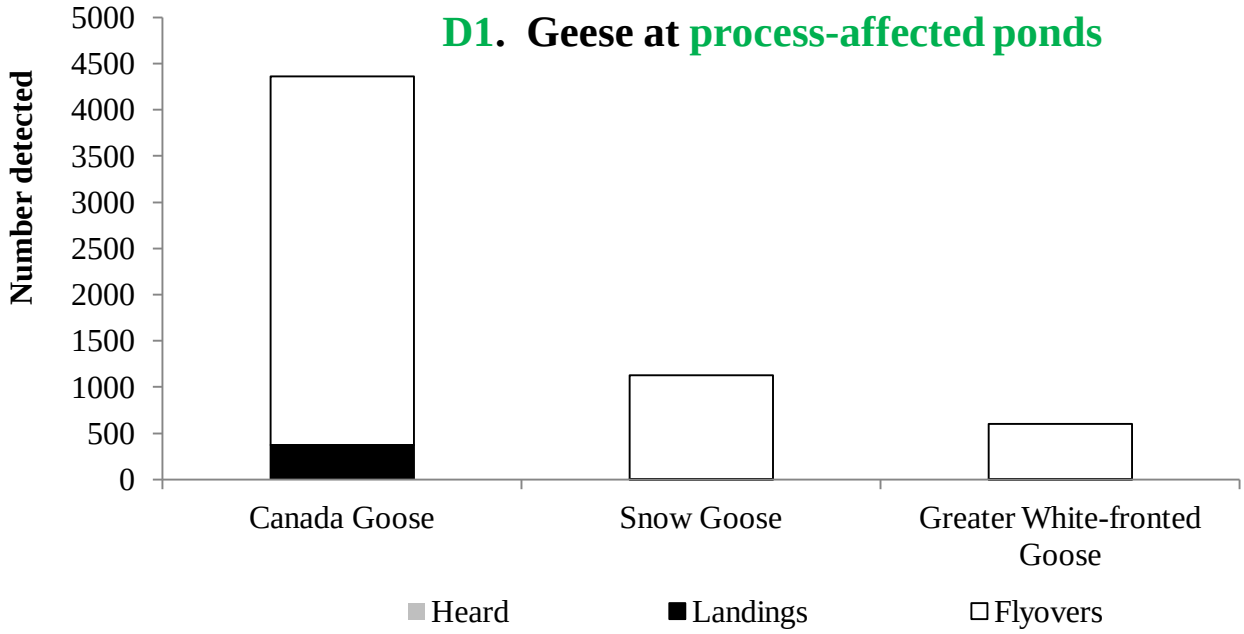

A2. All avian detections at reference ponds
Number detected
7000
6000
5000
4000
3000
2000
1000
0
Unknown Duck
Canada Goose
Unknown Passerine
Red-winged Blackbird
Unknown Scaup
Cliff Swallow
Canvasback
Red-necked Grebe
Bufflehead
Mallard
American Widgeon
Unknown Diving Duck
Common Goldeneye
Common Loon
Ring-necked Duck
Lesser Scaup
Unknown Gull
Black Tern
Sandhill Crane
Tree Swallow
Bonaparte's Gull
Unknown Sandpiper
Unknown
Northern Pintail
Snow Goose
Northern Shoveler
Gadwall
Unknown Shorebird
Common Tern
American Robin
Snow Bunting
Killdeer
Unknown Swallow
Unknown Dabbling Duck
Green-winged Teal
Common Grackle
Heard
Landings
Flyovers

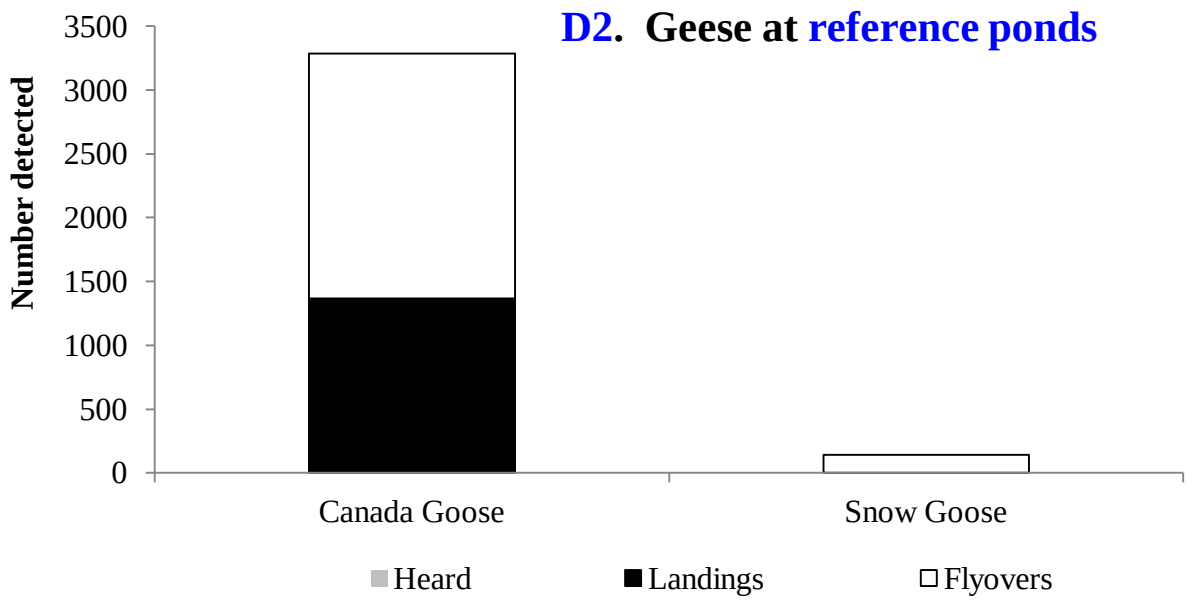

B1. All water-associated avian detections at process-affected ponds
Number detected
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Canada Goose
Mallard
Unknown Duck
American Widgeon
Bufflehead
Common Goldeneye
Snow Goose
Unknown Sandpiper
Unknown Gull
Unknown Shorebird
Lesser Scaup
Greater White-fronted Goose
Green-winged Teal
Northern Shoveler
Horned Grebe
Lesser Yellowlegs
Unknown
Unknown Goose
Northern Pintail
Common Loon
Gadwall
Canvasback
Unknown Scaup
Ring-necked Duck
Spotted Sandpiper
Heard
Landings
Flyovers

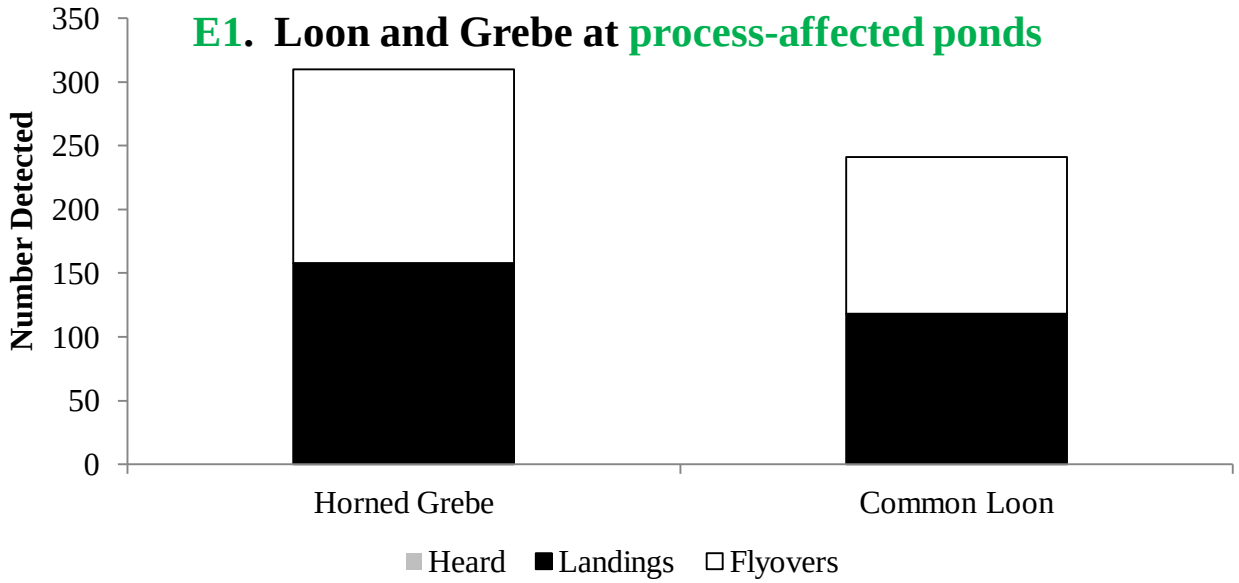

B2. All water-associated avian detections at reference ponds
Number detected
7000
6000
5000
4000
3000
2000
1000
0
Unknown Duck
Canada Goose
Unknown Scaup
Canvasback
Red-necked Grebe
Bufflehead
Mallard
American Widgeon
Unknown Diving Duck
Common Goldeneye
Common Loon
Ring-necked Duck
Lesser Scaup
Unknown Gull
Black Tern
Sandhill Crane
Bonaparte's Gull
Unknown Sandpiper
Unknown
Northern Pintail
Snow Goose
Northern Shoveler
Gadwall
Common Tern
Unknown Shorebird
Killdeer
Unknown Dabbling Duck
Heard
Landings
Flyovers


C1. Ducks at process-affected ponds
Number detected
3000
2500
2000
1500
1000
500
0
Mallard
Unknown Duck
American Widgeon
Bufflehead
Common Goldeneye
Lesser Scaup
Green-winged Teal
Northern Shoveler
Northern Pintail
Gadwall
Canvasback
Unknown Scaup
Heard
Landings
Flyovers

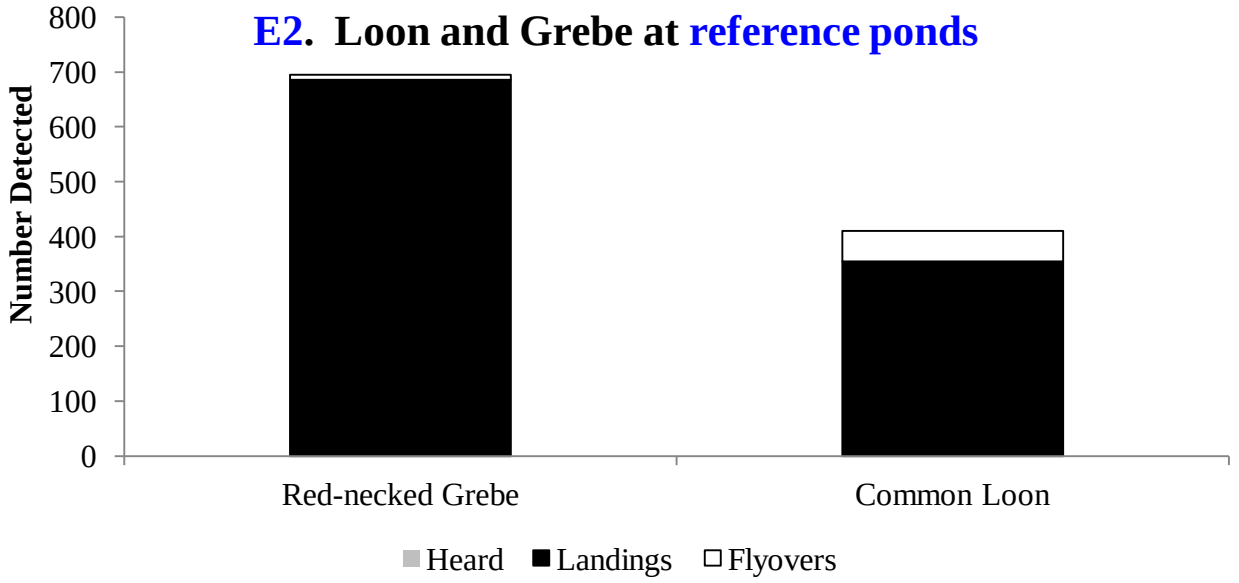

C2. Ducks at reference ponds
Number detected
7000
6000
5000
4000
3000
2000
1000
0
Unknown Duck
Unknown Scaup
Canvasback
Bufflehead
Mallard
American Widgeon
Unknown Diving Duck
Common Goldeneye
Ring-necked Duck
Lesser Scaup
Northern Pintail
Northern Shoveler
Gadwall
Heard
Landings
Flyovers

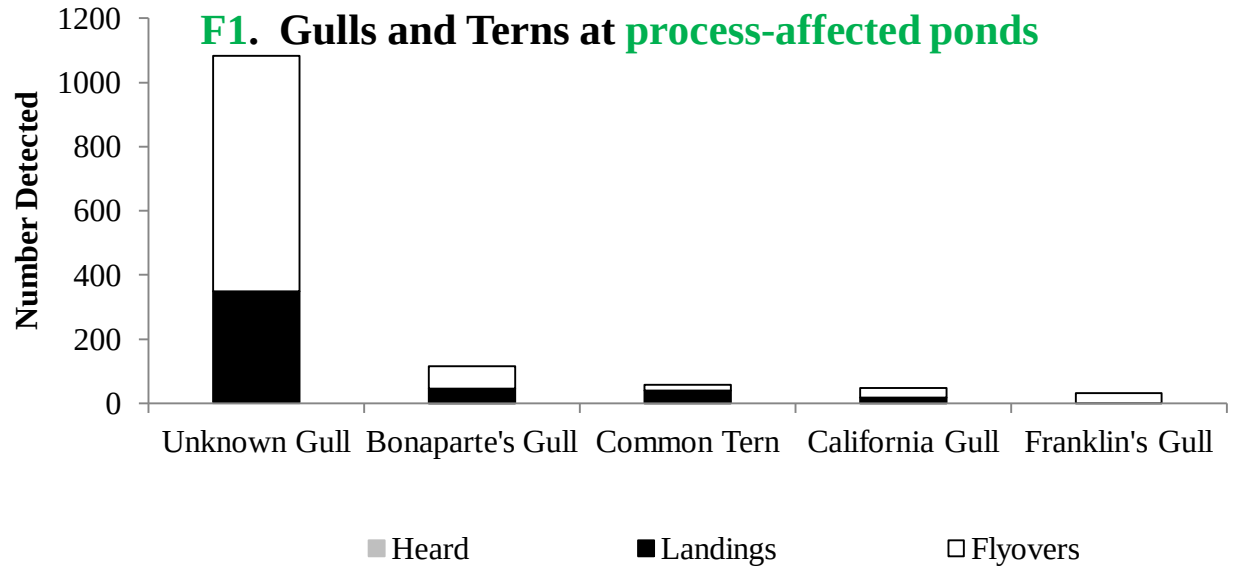

D1. Geese at process-affected ponds
Number detected
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Canada Goose
Snow Goose
Greater White-fronted Goose
Heard
Landings
Flyovers

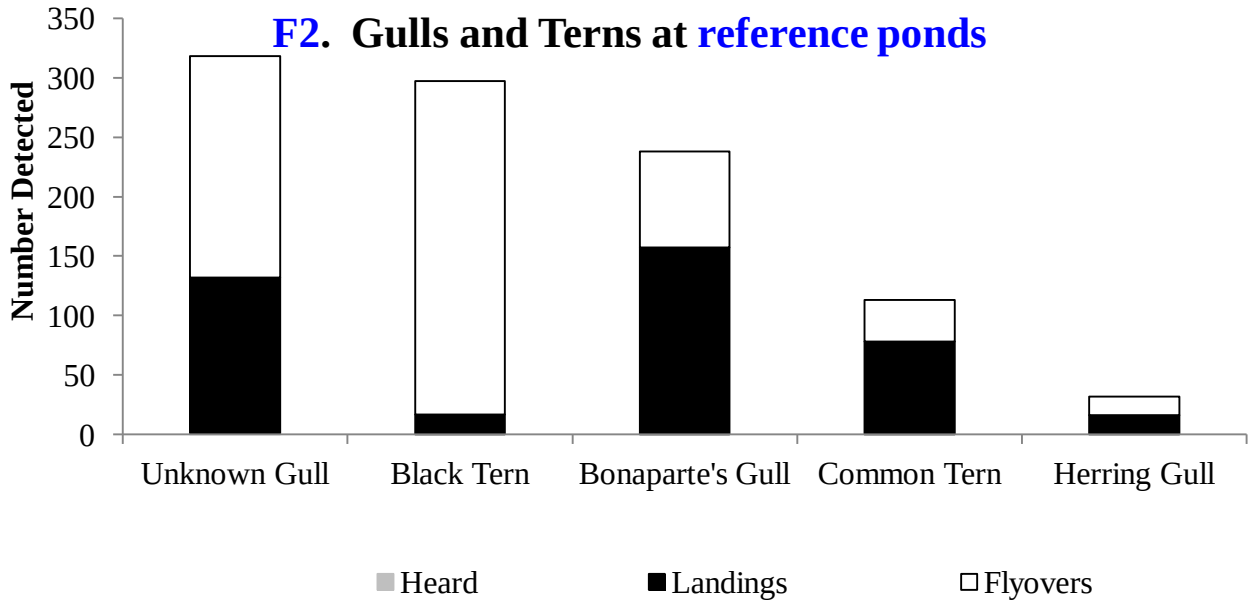

D2. Geese at reference ponds
Number detected
3500
3000
2500
2000
1500
1000
500
0
Canada Goose
Snow Goose
Heard
Landings
Flyovers

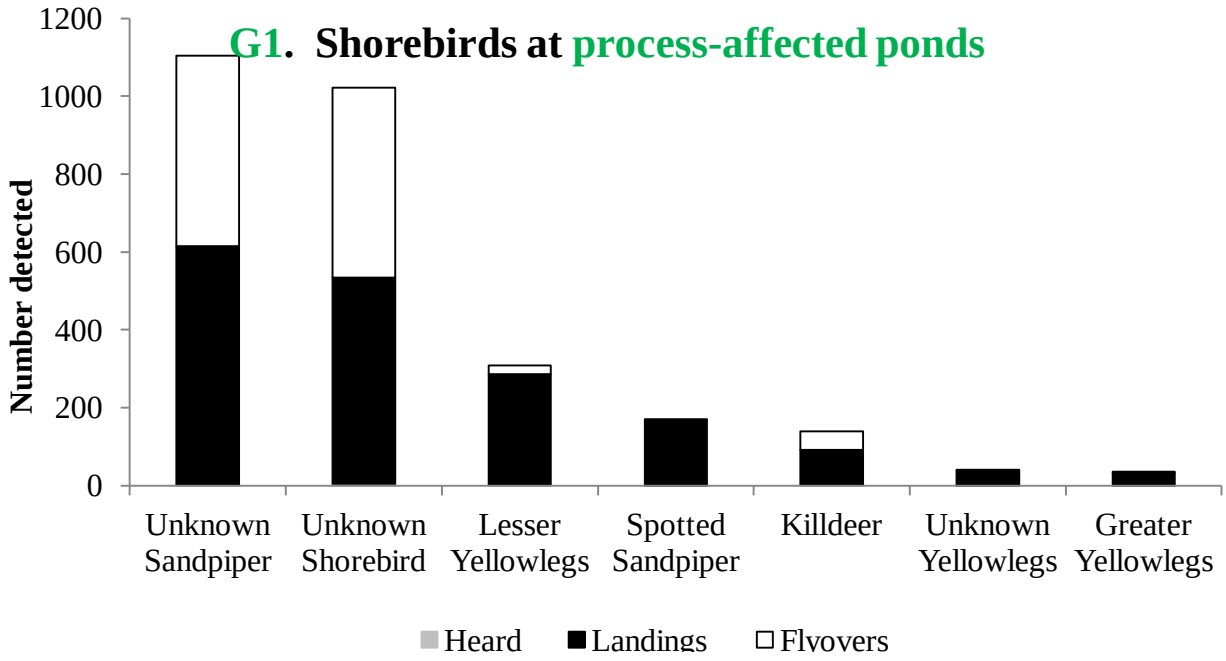

E1. Loon and Grebe at process-affected ponds
Number Detected
350
300
250
200
150
100
50
0
Horned Grebe
Common Loon
Heard
Landings
Flyovers

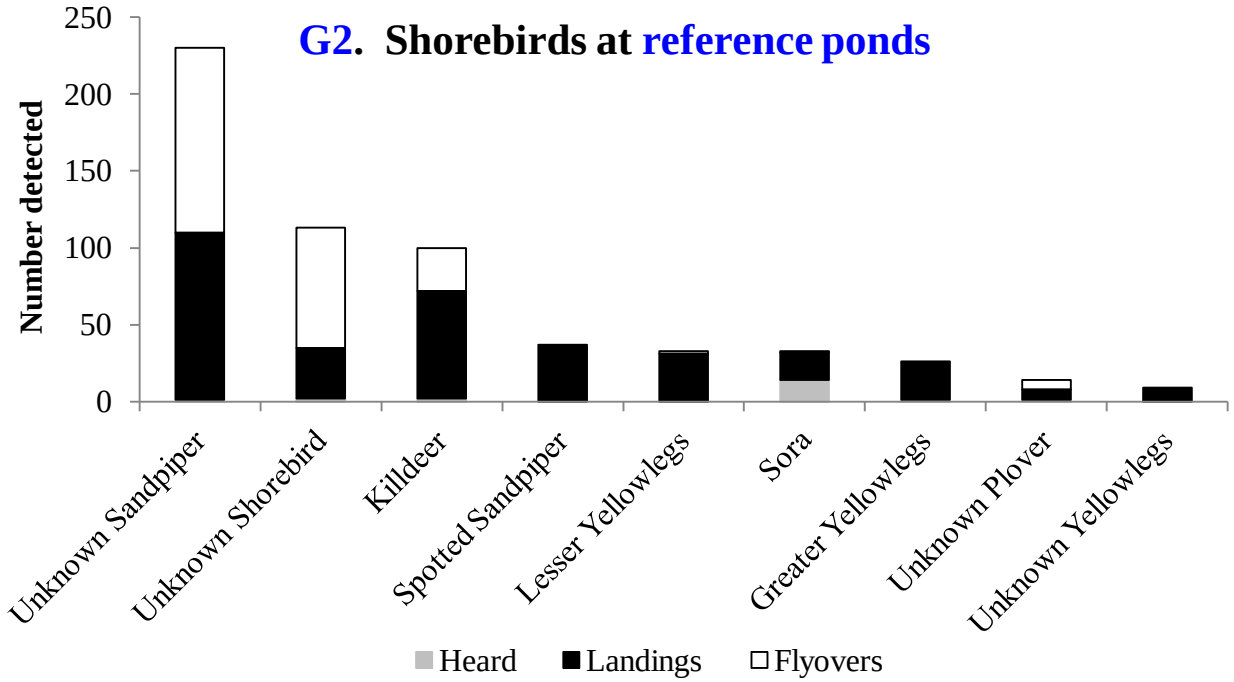
.

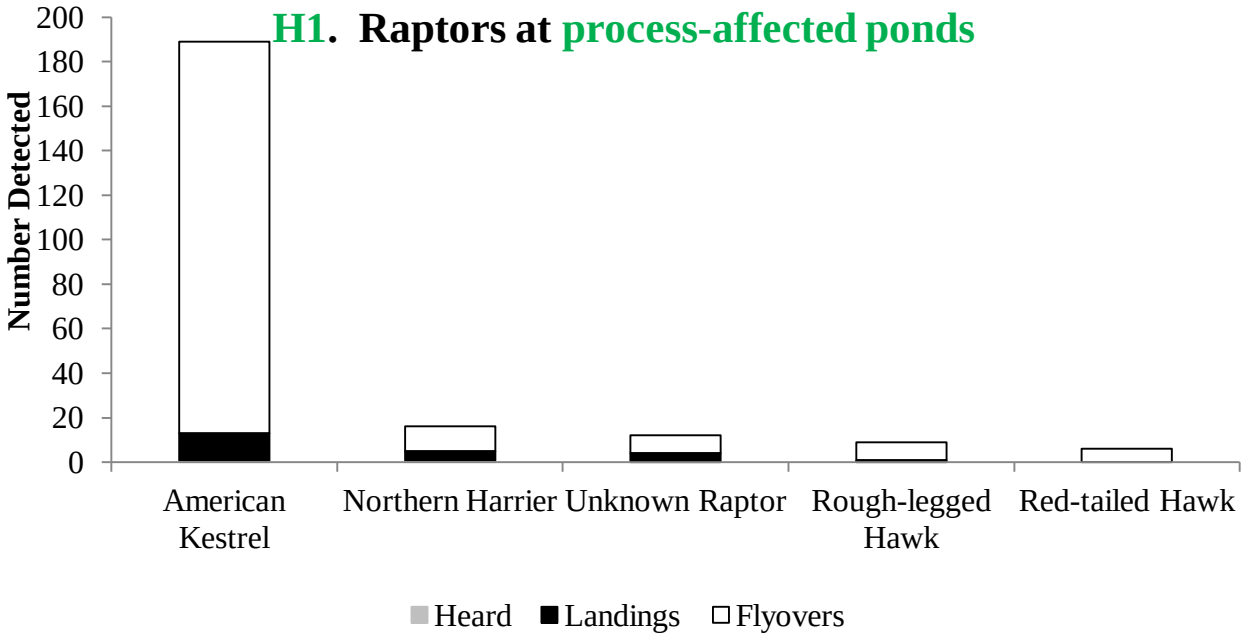

E2. Loon and Grebe at reference ponds
Number Detected
800
700
600
500
400
300
200
100
0
Red-necked Grebe
Common Loon
Heard
Landings
Flyovers

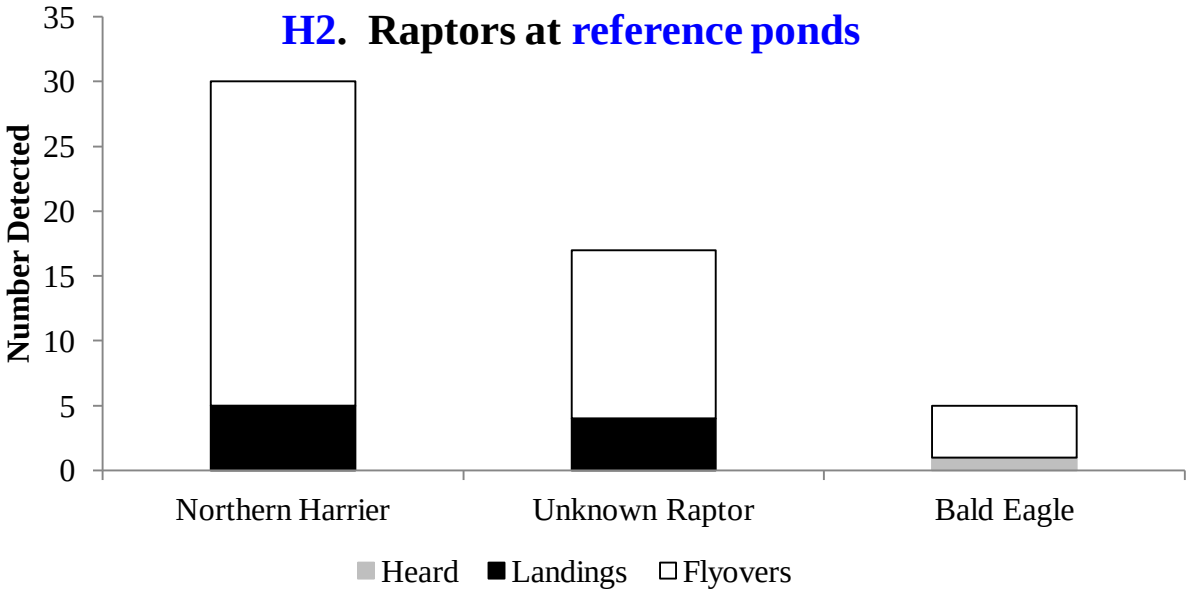

F1. Gulls and Terns at process-affected ponds
Number Detected
1200
1000
800
600
400
200
0
Unknown Gull
Bonaparte's Gull
Common Tern
California Gull
Franklin's Gull
Heard
Landings
Flyovers

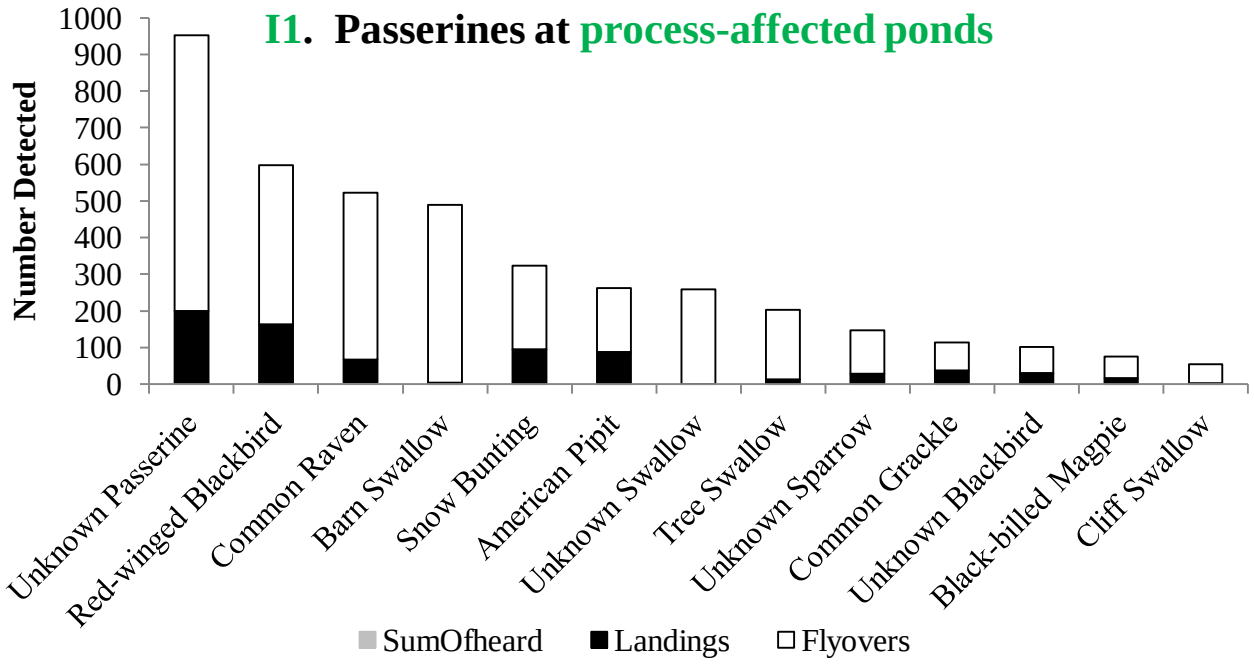

F2. Gulls and Terns at reference ponds
Number Detected
350
300
250
200
150
100
50
0
Unknown Gull
Black Tern
Bonaparte's Gull
Common Tern
Herring Gull
Heard
Landings
Flyovers

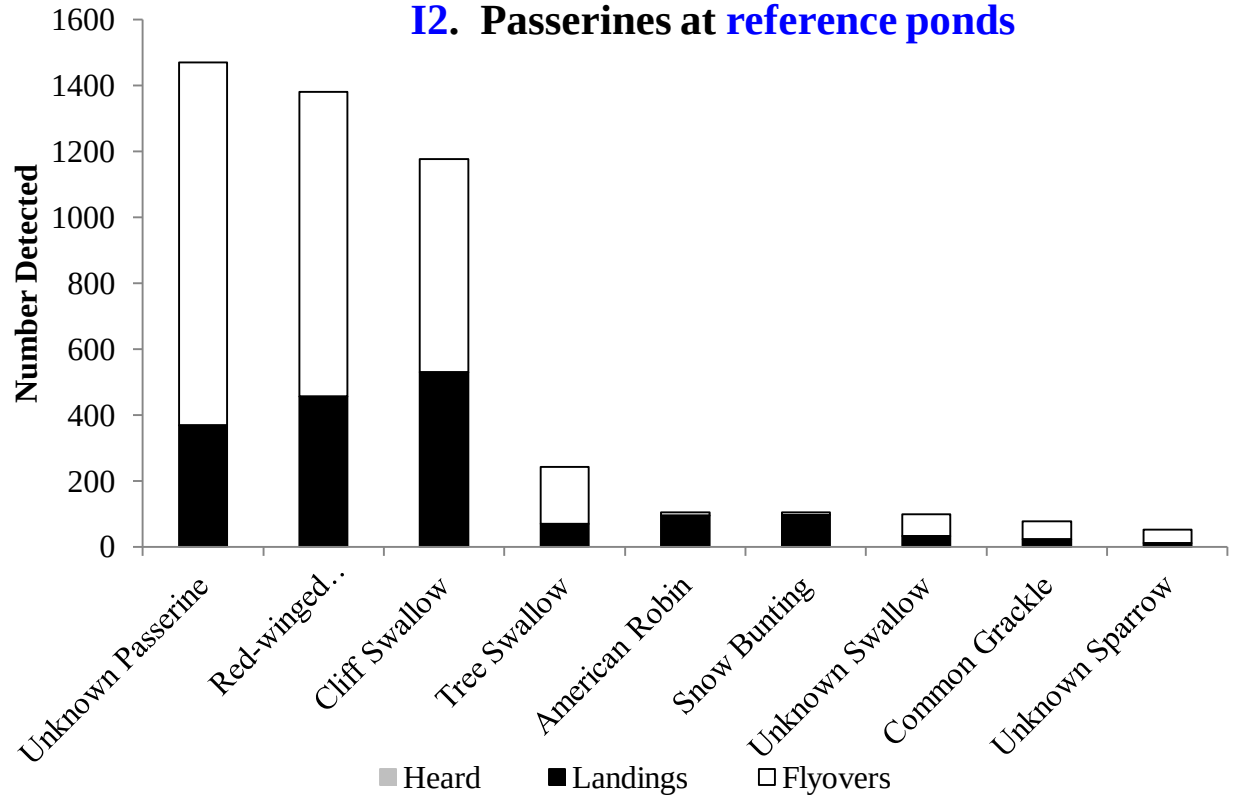

G1. Shorebirds at process-affected ponds
Number detected
1200
1000
800
600
400
200
0
Unknown Sandpiper
Unknown Shorebird
Lesser Yellowlegs
Spotted Sandpiper
Killdeer
Unknown Yellowlegs
Greater Yellowlegs
Heard
Landings
Flyovers

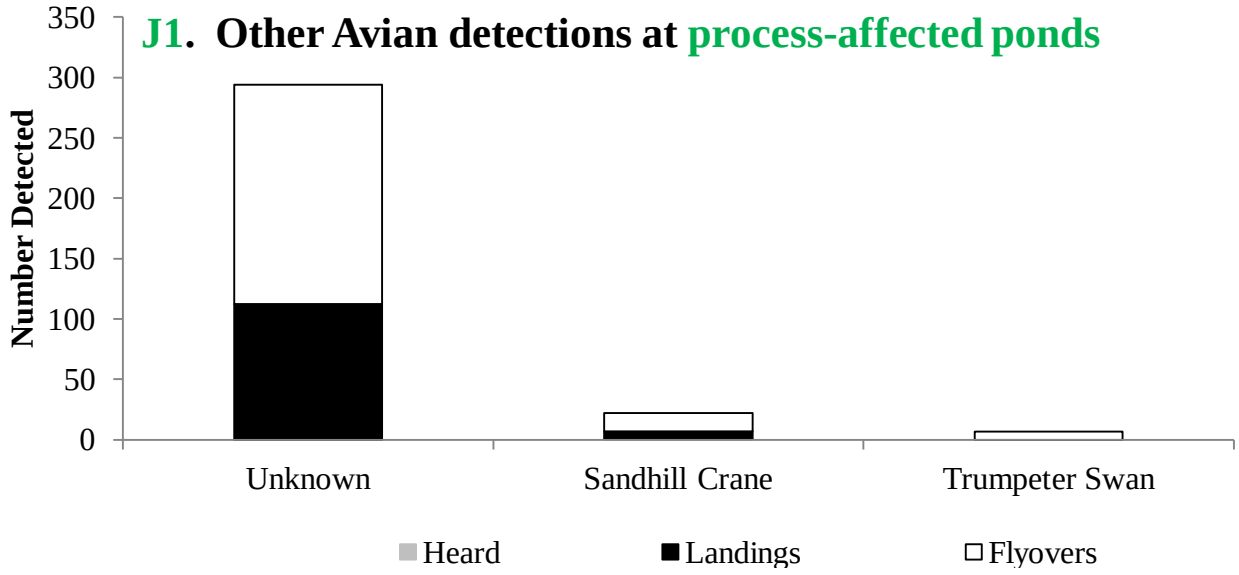

G2. Shorebirds at reference ponds
Number detected
250
200
150
100
50
0
Unknown Sandpiper
Unknown Shorebird
Killdeer
Spotted Sandpiper
Lesser Yellowlegs
Sora
Greater Yellowlegs
Unknown Plover
Unknown Yellowlegs
Heard
Landings
Flyovers


H1. Raptors at process-affected ponds
Number Detected
200
180
160
140
120
100
80
60
40
20
0
American Kestrel
Northern Harrier
Unknown Raptor
Rough-legged Hawk
Red-tailed Hawk
Heard
Landings
Flyovers


H2. Raptors at reference ponds
Number Detected
35
30
25
20
15
10
5
0
Northern Harrier
Unknown Raptor
Bald Eagle
Heard
Landings
Flyovers


I1. Passerines at process-affected ponds
Number Detected
1000
900
800
700
600
500
400
300
200
100
0
Unknown Passerine
Red-winged Blackbird
Common Raven
Barn Swallow
Snow Bunting
American Pipit
Unknown Swallow
Tree Swallow
Unknown Sparrow
Common Grackle
Unknown Blackbird
Black-billed Magpie
Cliff Swallow
SumOfheard
Landings
Flyovers


I2. Passerines at reference ponds
Number Detected
1600
1400
1200
1000
800
600
400
200
0
Unknown Passerine
Red-winged…
Cliff Swallow
Tree Swallow
American Robin
Snow Bunting
Unknown Swallow
Common Grackle
Unknown Sparrow
Heard
Landings
Flyovers


J1. Other Avian detections at process-affected ponds
Number Detected
350
300
250
200
150
100
50
0
Unknown
Sandhill Crane
Trumpeter Swan
Heard
Landings
Flyovers

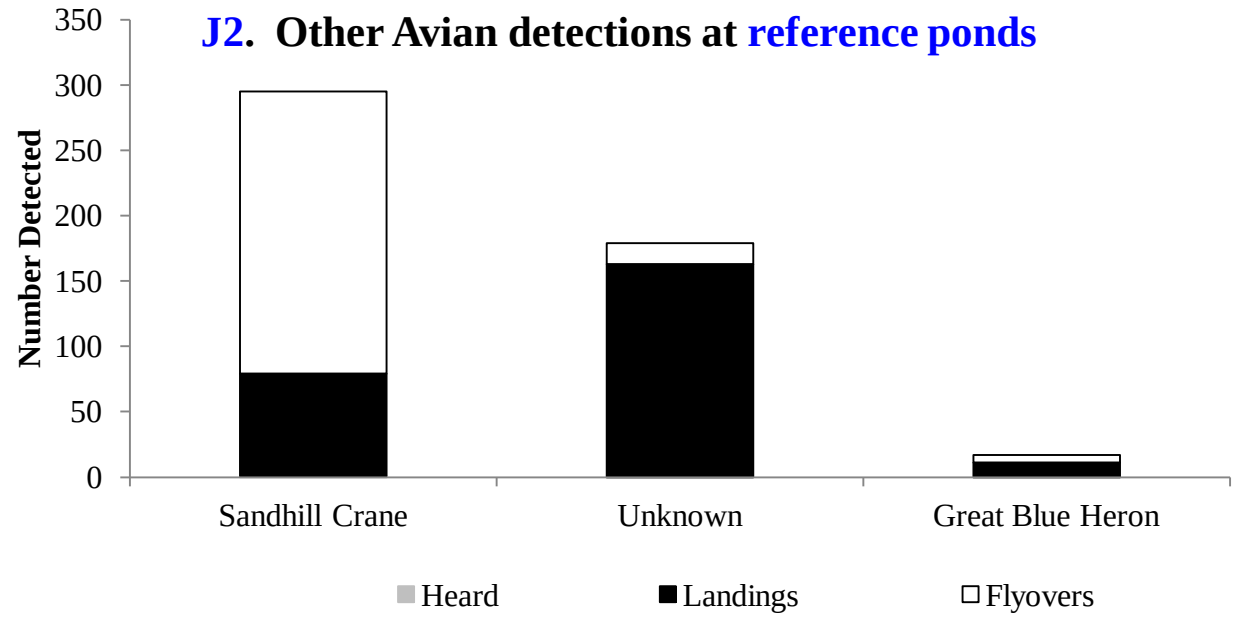

J2. Other Avian detections at reference ponds
Number Detected
350
300
250
200
150
100
50
0
Sandhill Crane
Unknown
Great Blue Heron
Heard
Landings
Flyovers

Figure 2. Observation effort. Due to small sample sizes, white bars on graphs may be seen as flat black lines on top of gray boxes.

A. Total number of pond visits by observer and pond type.

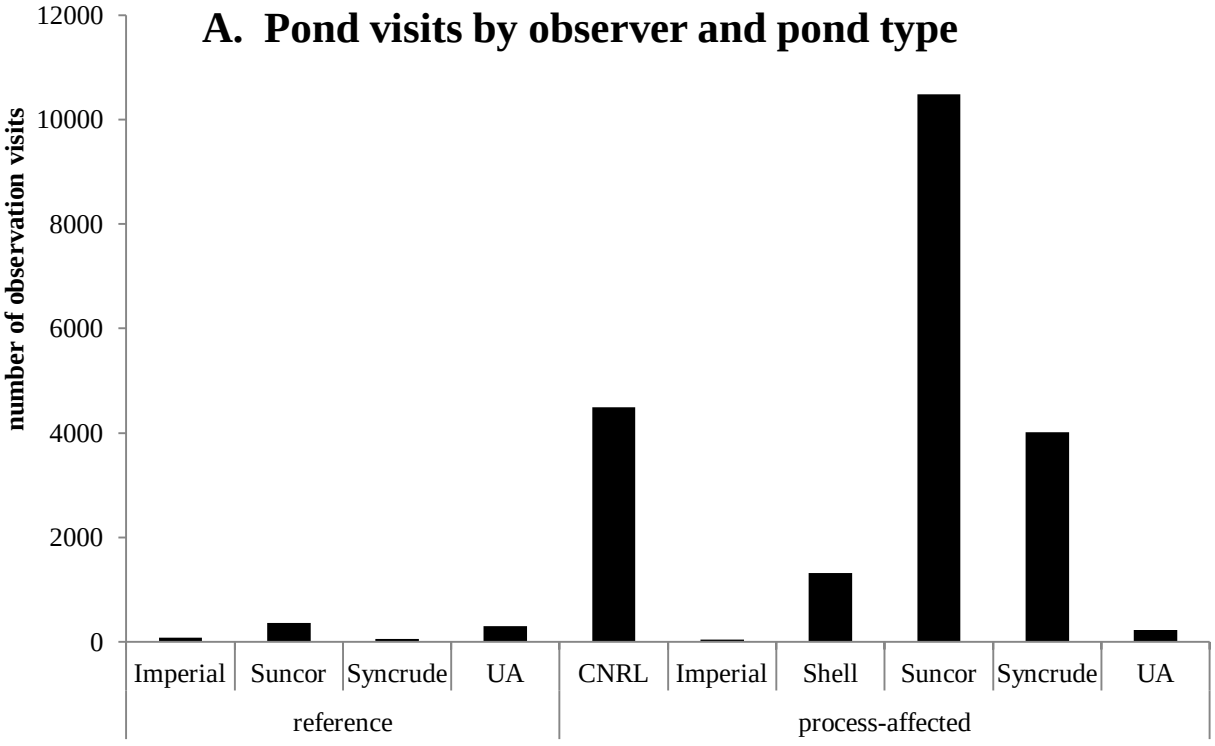
B. Average observation length per visit by observer and pond type.

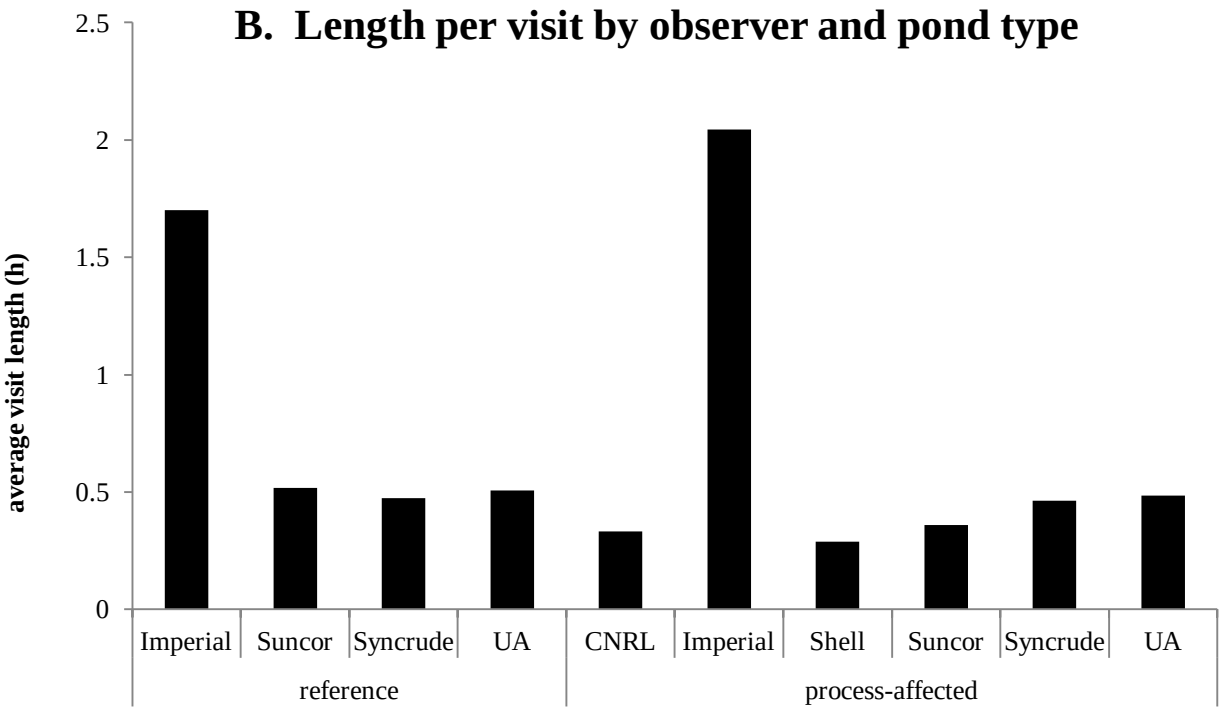
C. Proportion of visits with no detections (black bars) and additional visits with no detections of water-associated birds (grey bars) and no detections of water-associated birds at ponds (or not specified; white bars) by operator and pond type.

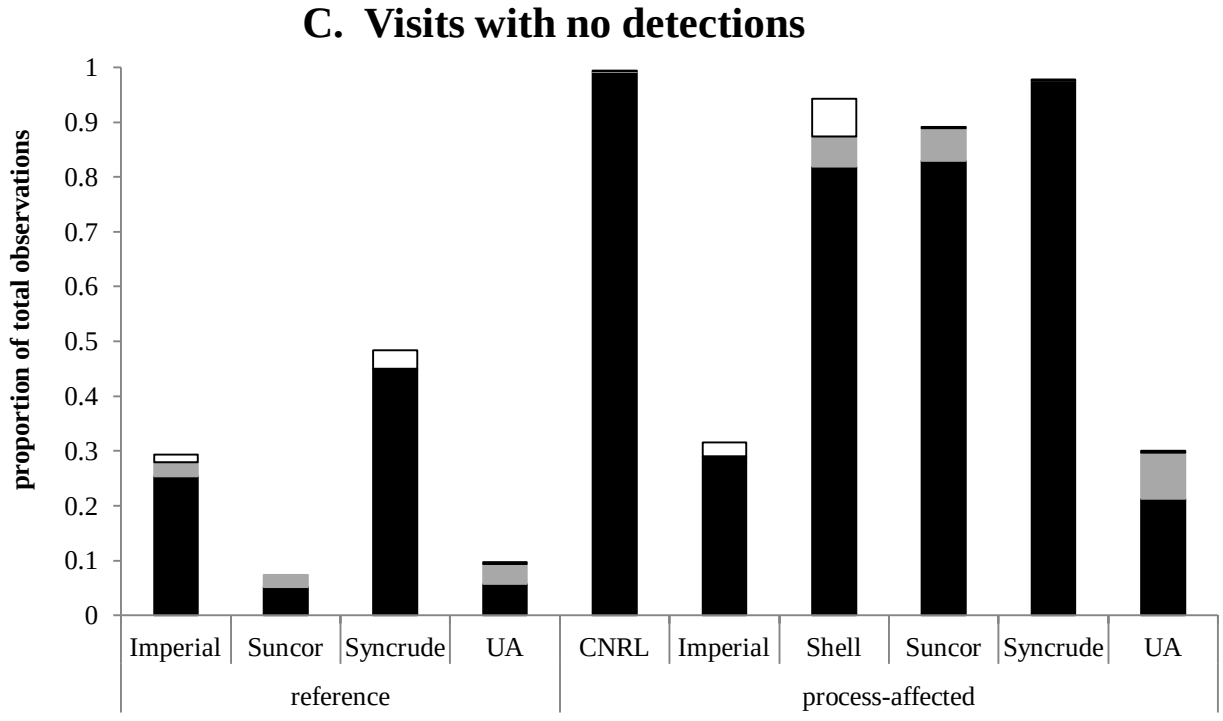
D. Total number of water-associated birds detected per visit that landed (black bars), flew overhead (grey bars), or were heard (white bars) at ponds (or not specified) by operator and pond type.

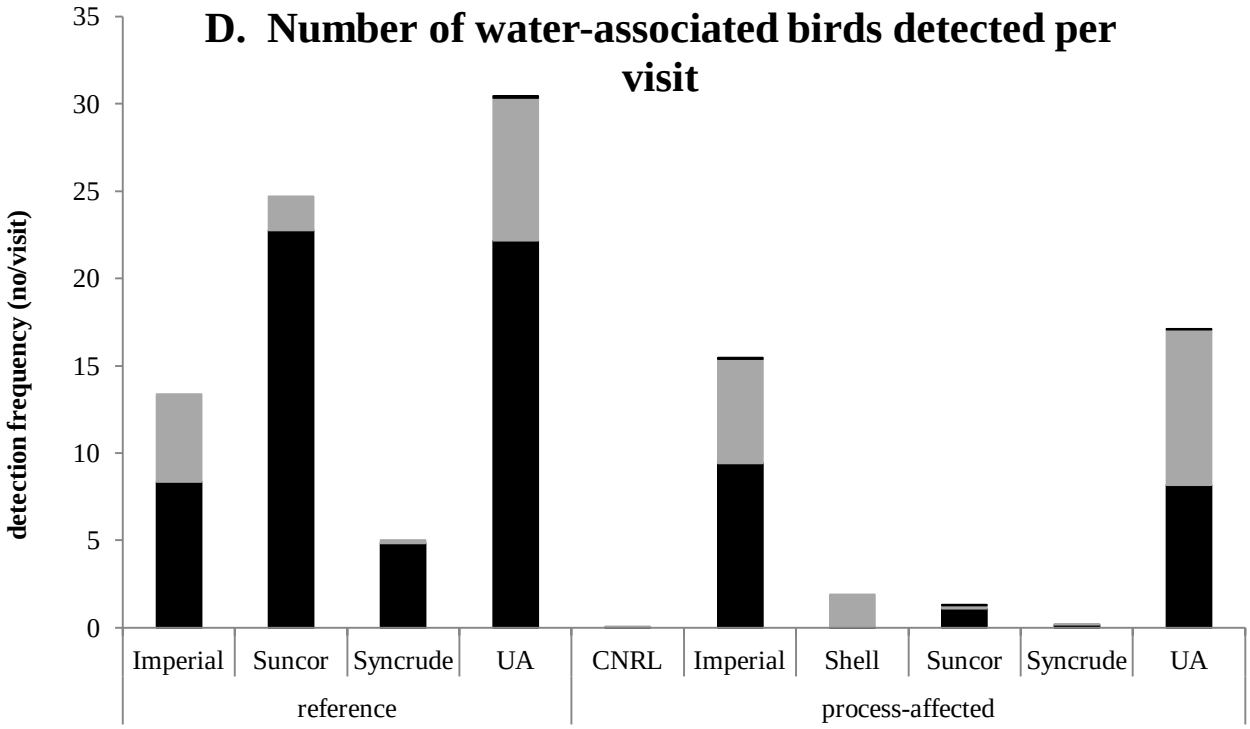
E. Total number of water-associated birds detected that landed (black bars), flew overhead (grey bars), or were heard (white bars) at ponds (or not specified) by operator and pond type.

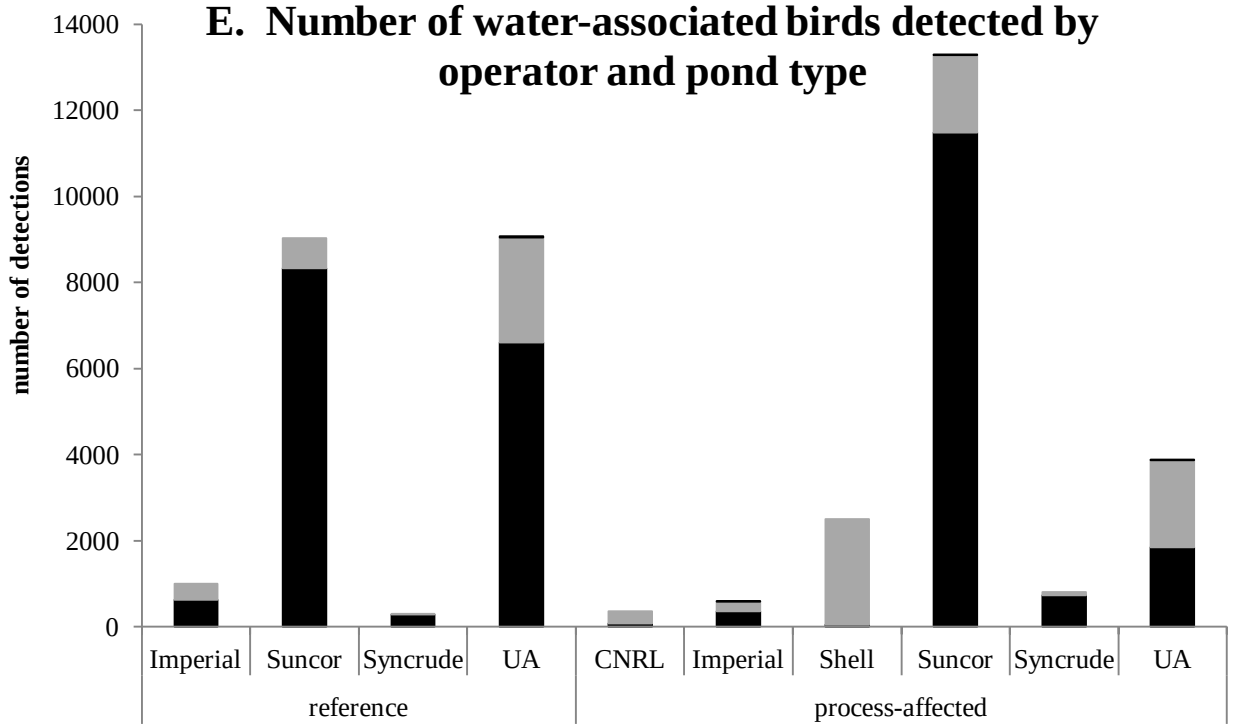
F. Number of detections of water-associated birds per hour that landed (black bars), flew overhead (grey bars), or were heard (white bars) at ponds (or not specified) by operator and pond type.




B. Length per visit by observer and pond type
average visit length (h)
2.5
2
1.5
1
0.5
0
Imperial
Suncor
Syncrude
UA
CNRL
Imperial
Shell
Suncor
Syncrude
UA
reference
process-affected


C. Visits with no detections
proportion of total observations
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Imperial
Suncor
Syncrude
UA
CNRL
Imperial
Shell
Suncor
Syncrude
UA
reference
process-affected


D. Number of water-associated birds detected per visit
detection frequency (no/visit)
35
30
25
20
15
10
5
0
Imperial
Suncor
Syncrude
UA
CNRL
Imperial
Shell
Suncor
Syncrude
UA
reference
process-affected


E. Number of water-associated birds detected by operator and pond type
number of detections
14000
12000
10000
8000
6000
4000
2000
0
Imperial
Suncor
Syncrude
UA
CNRL
Imperial
Shell
Suncor
Syncrude
UA
reference
process-affected

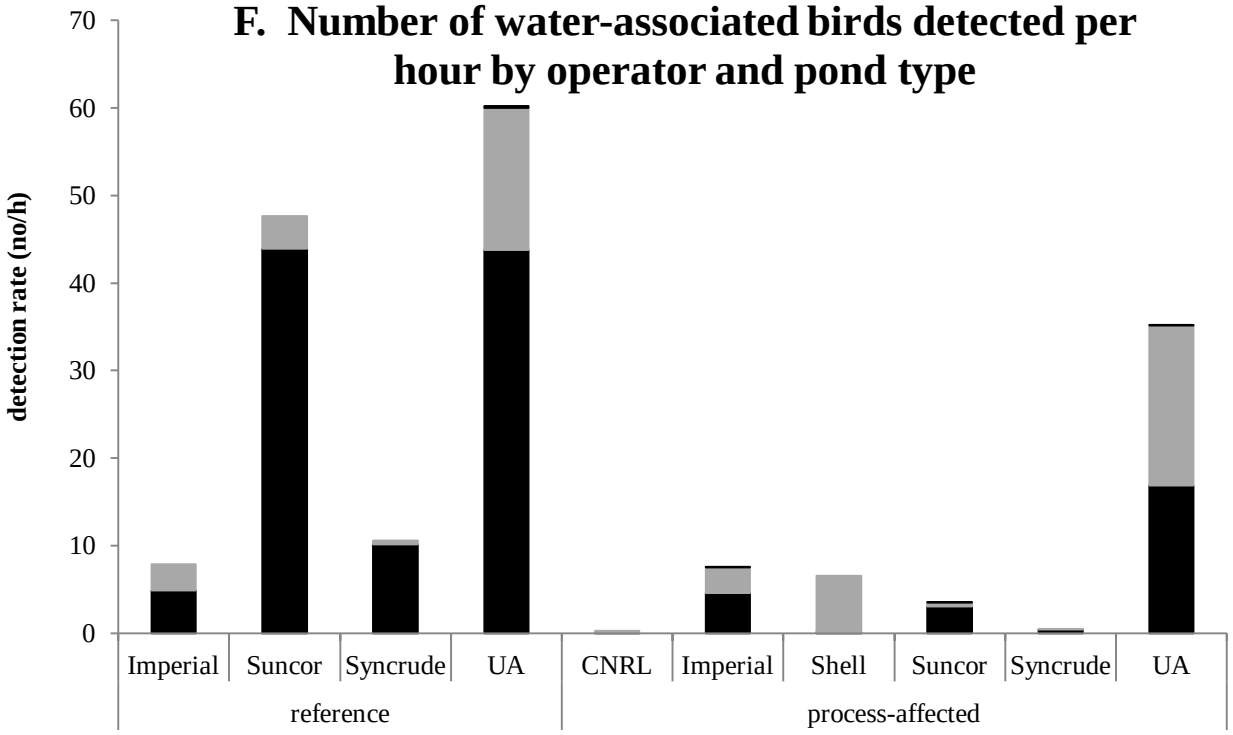

F. Number of water-associated birds detected per hour by operator and pond type
detection rate (no/h)
70
60
50
40
30
20
10
0
Imperial
Suncor
Syncrude
UA
CNRL
Imperial
Shell
Suncor
Syncrude
UA
reference
process-affected

Figure 3. Observation effort and detection frequency on comparison ponds. UA: University of Alberta.

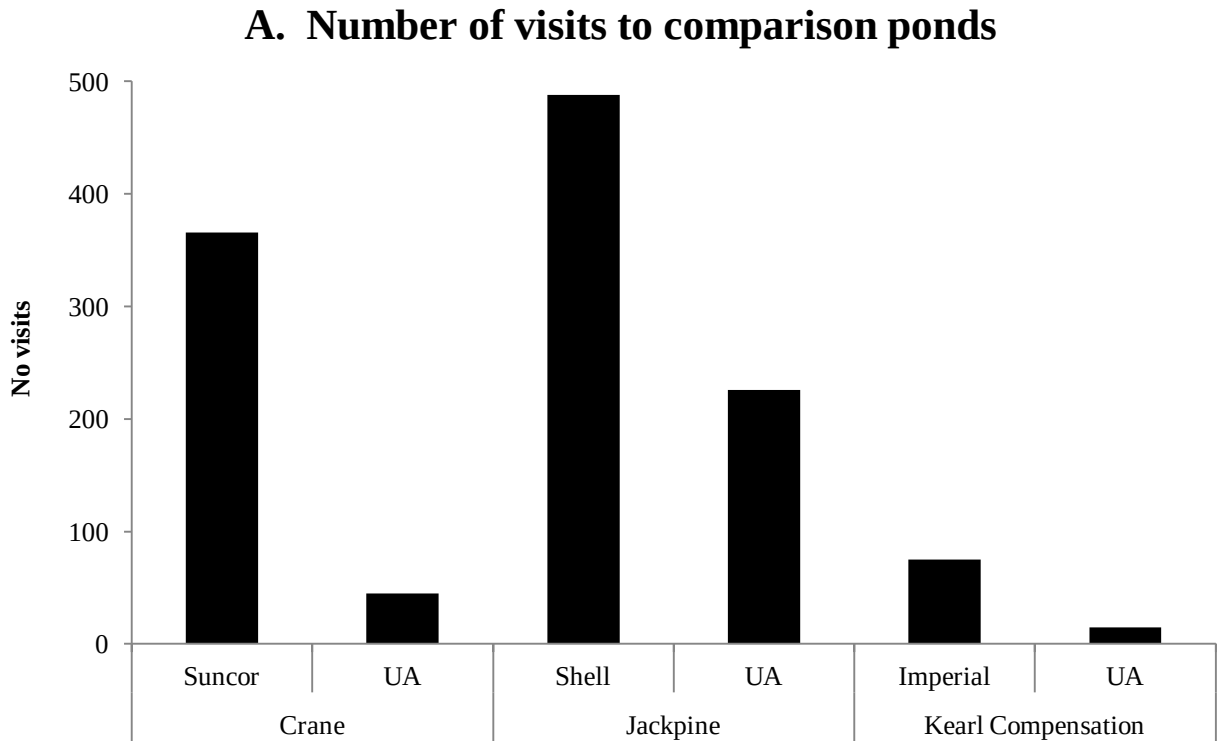
A. Number of visits to comparison ponds by operators and UA.

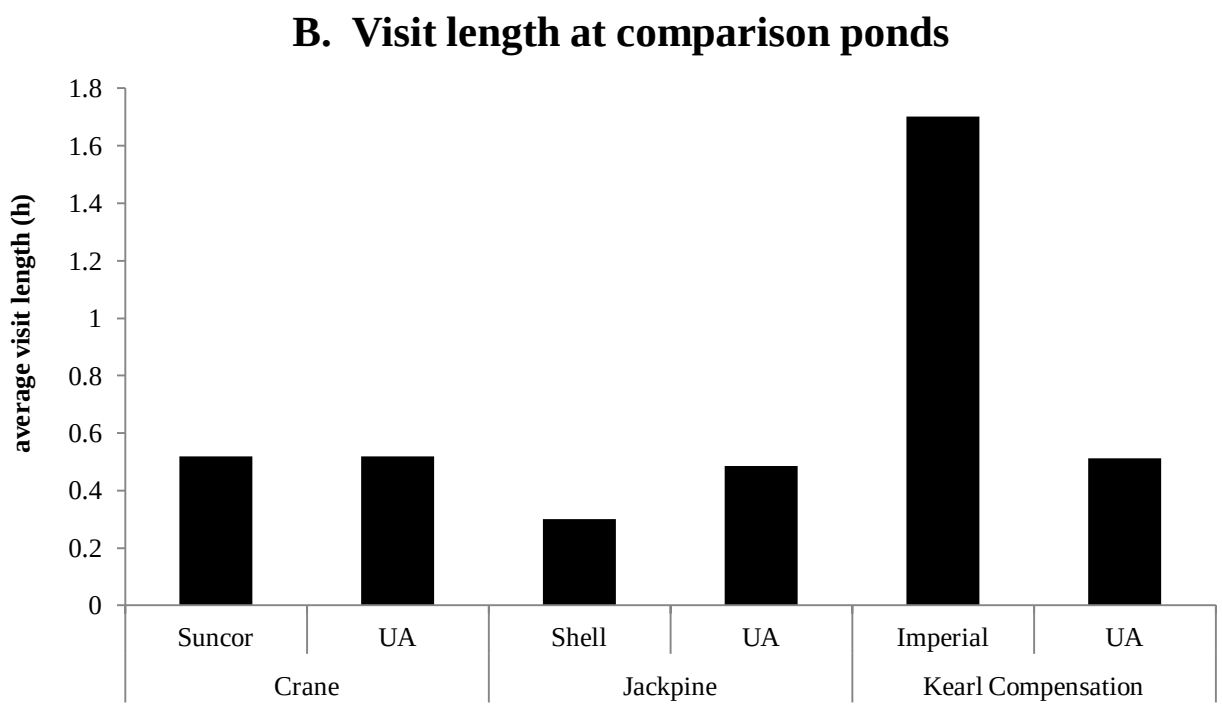
B. Average visit length at comparison ponds by operators and UA.

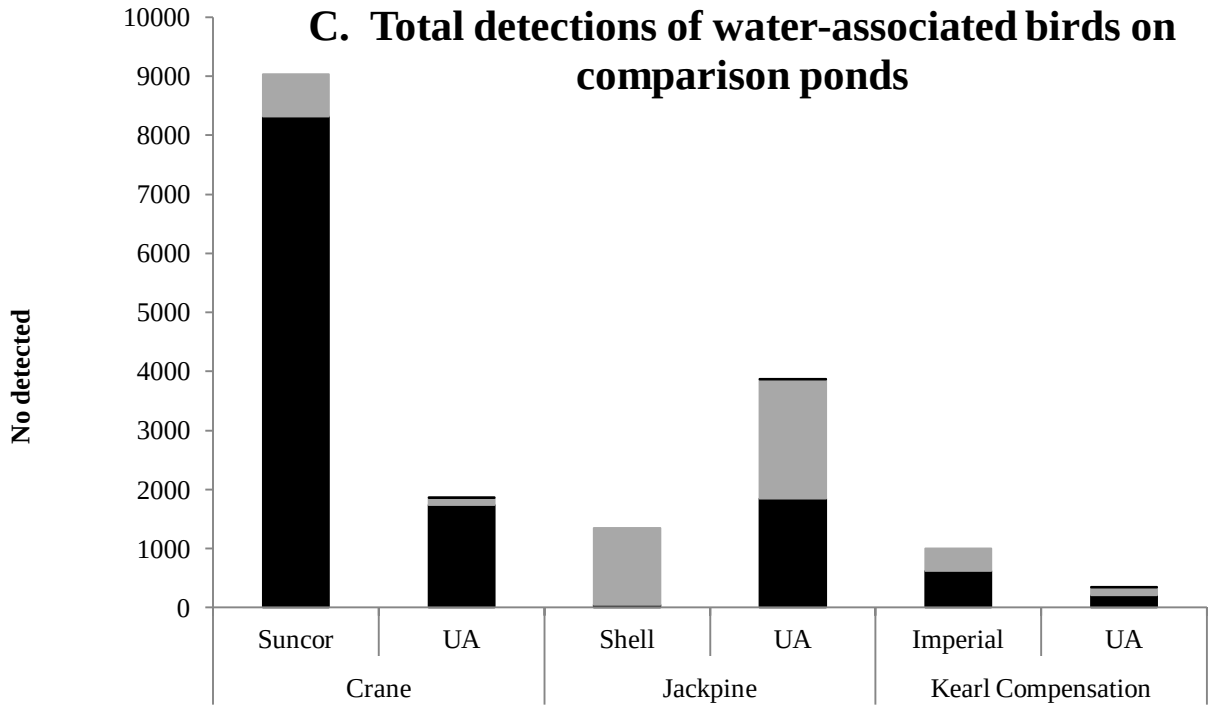
C. Number of detections of water-associated birds that landed (black bar), flew overhead (grey bar), were heard (white bar), or not specified, at comparison ponds by operators and UA.

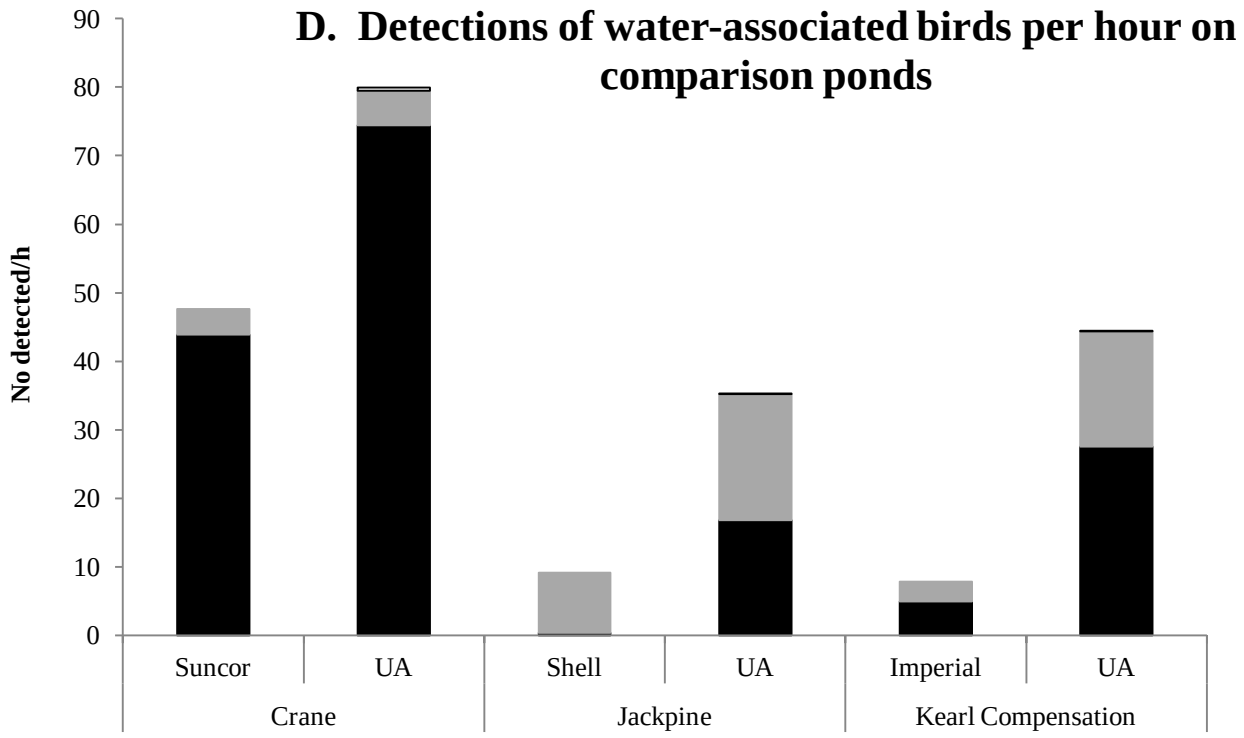
D. Number of detections of water-associated birds per hour on or over water that landed (black bar), flew overhead (grey bar), were heard (white bar), or not specified, at comparison ponds by operators and UA.

E. Number of detections of water-associated birds per visit that landed (black bar), flew overhead (grey bar), were heard (white bar), or not specified, at comparison ponds by operators and UA.




B. Visit length at comparison ponds
average visit length (h)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Suncor
UA
Shell
UA
Imperial
UA
Crane
Jackpine
Kearl Compensation


C. Total detections of water-associated birds on comparison ponds
No detected
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Suncor
UA
Shell
UA
Imperial
UA
Crane
Jackpine
Kearl Compensation


D. Detections of water-associated birds per hour on comparison ponds
No detected/h
90
80
70
60
50
40
30
20
10
0
Suncor
UA
Shell
UA
Imperial
UA
Crane
Jackpine
Kearl Compensation

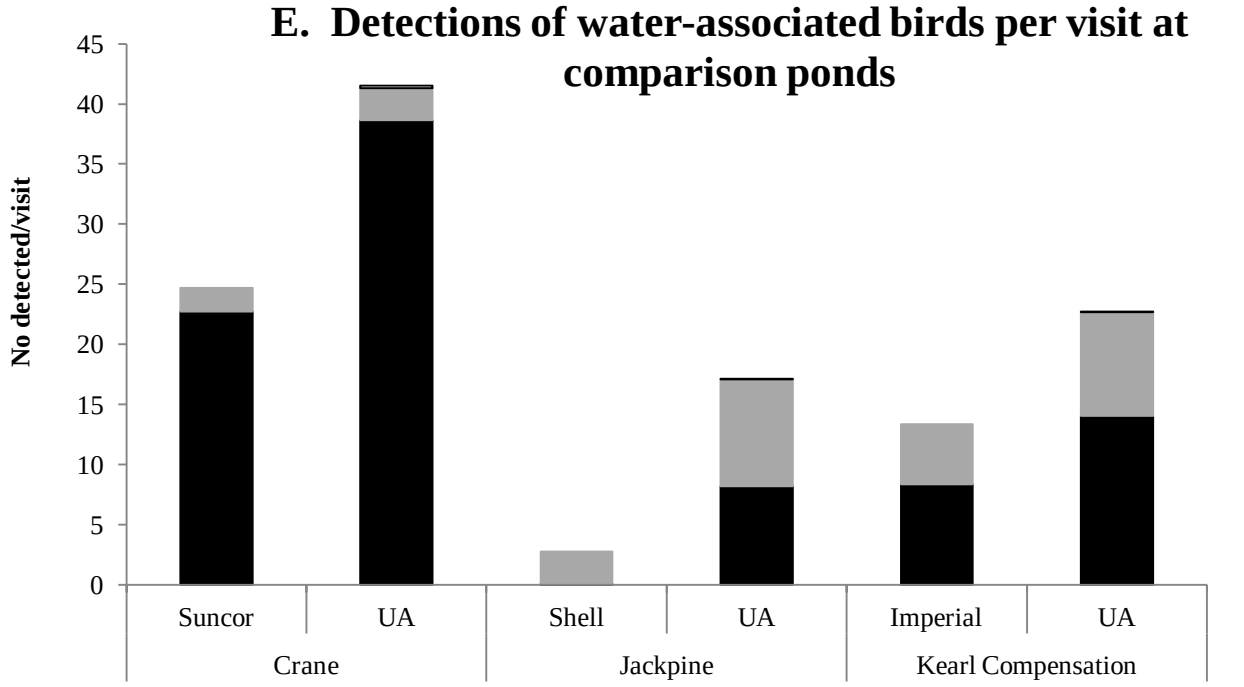
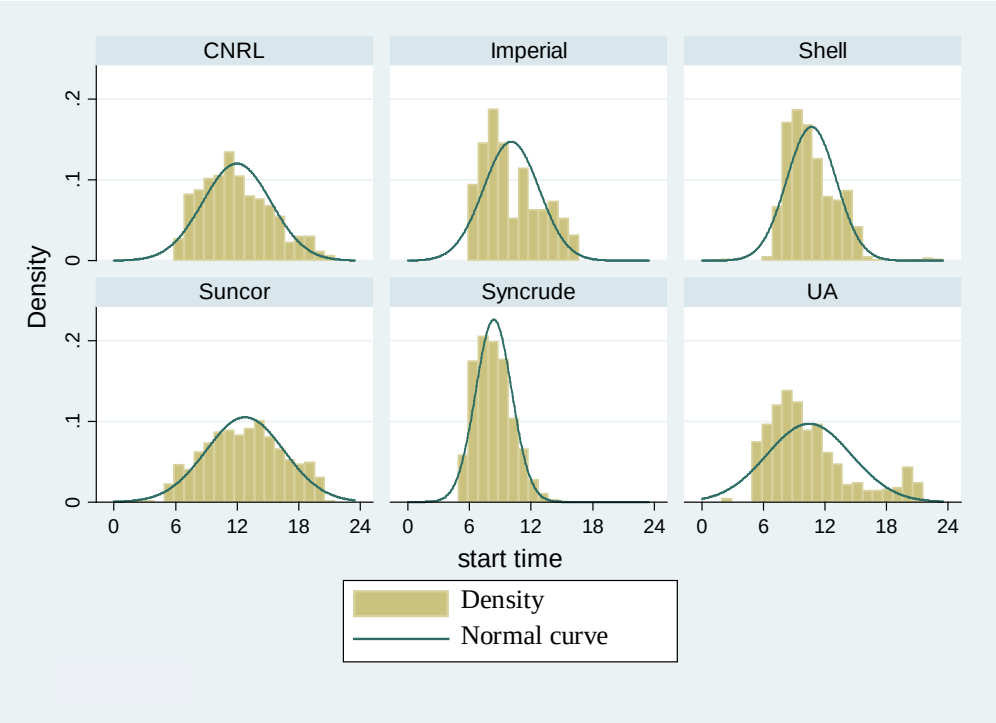

E. Detections of water-associated birds per visit at comparison ponds
No detected/visit
45
40
35
30
25
20
15
10
5
0
Suncor
UA
Shell
UA
Imperial
UA
Crane
Jackpine
Kearl Compensation

Figure 4. Distribution of observation start times within and among operators.

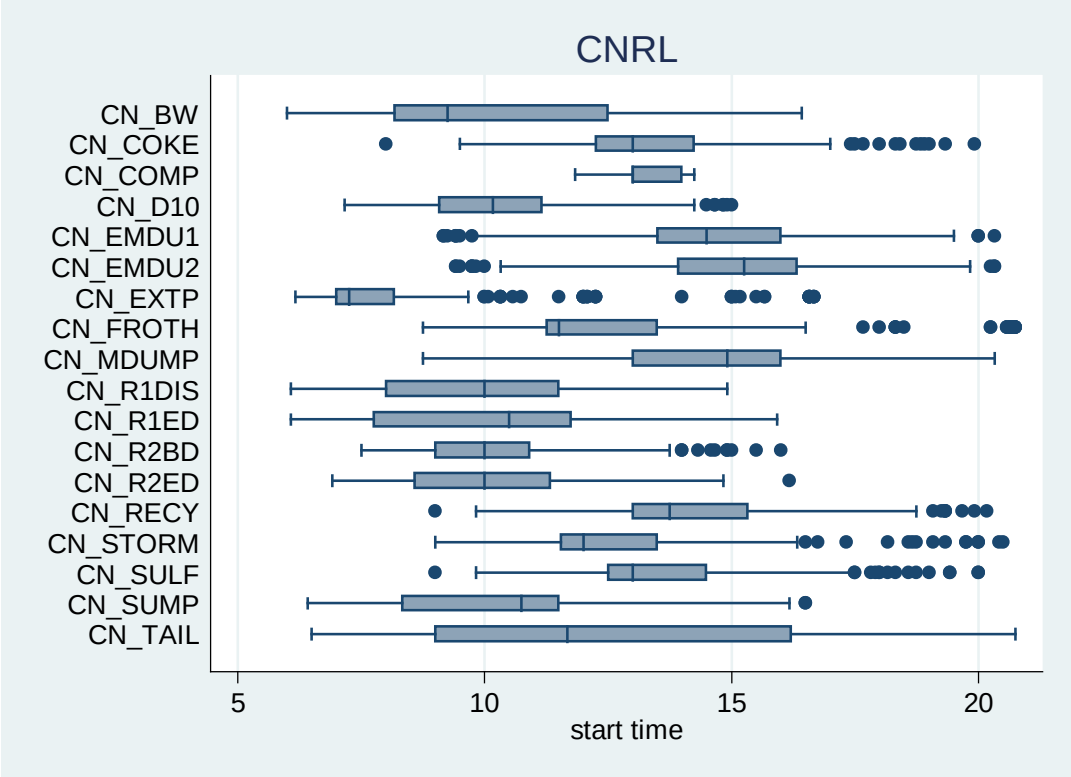
A. Density distribution of observation start times by operator with an overlaid normal curve.

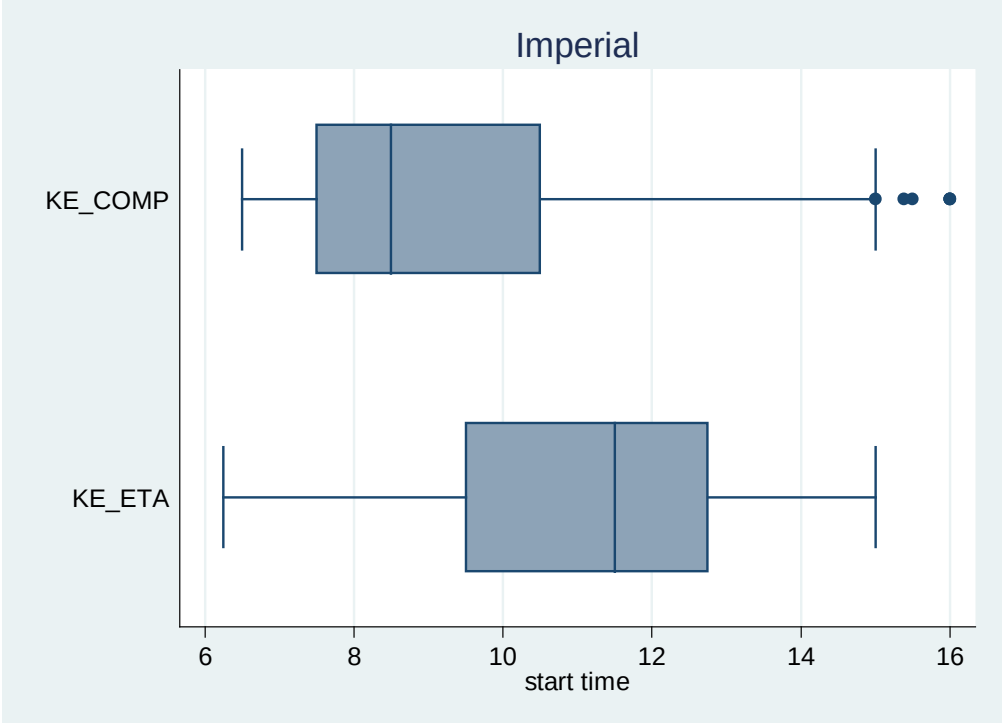
B. Distribution of observation start times per pond for each operator. For each plot, the blue box represents 50% of the data (25th to 75th percentile). The vertical line within the box is the median value (50 of observations are above and 50% are below). The lines attached to either end of the box represent 90% of the data (5th to 95% percentile). The dots are the remaining (outlier) values.

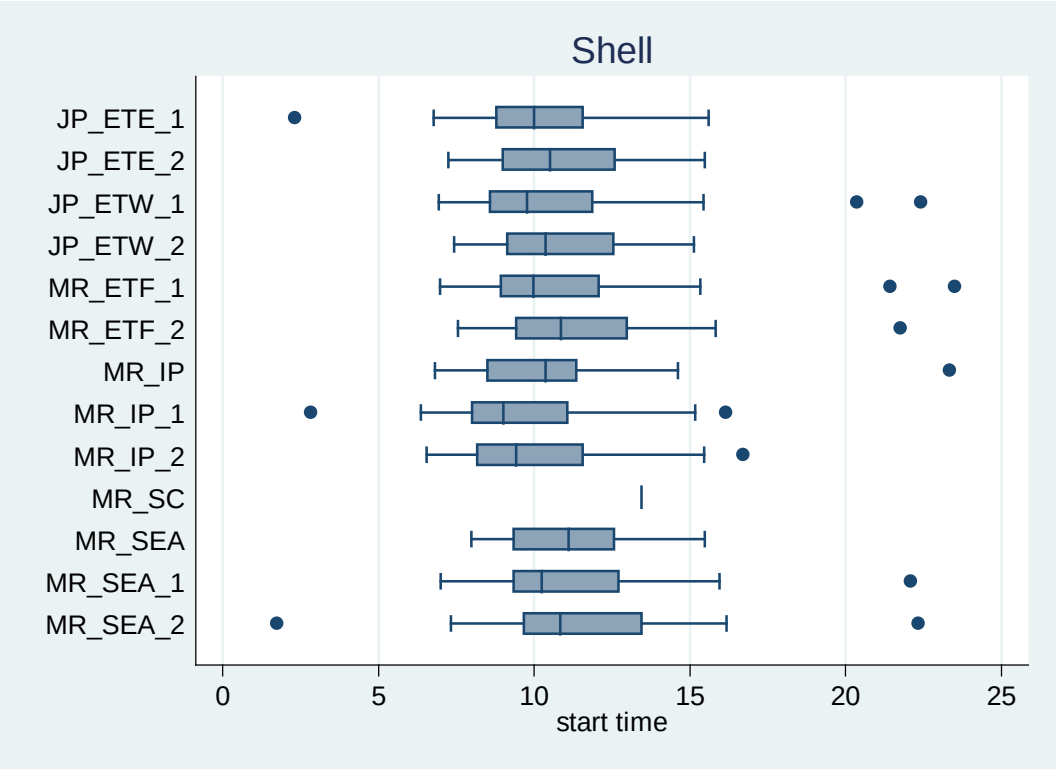
A. Distribution of start times by operator

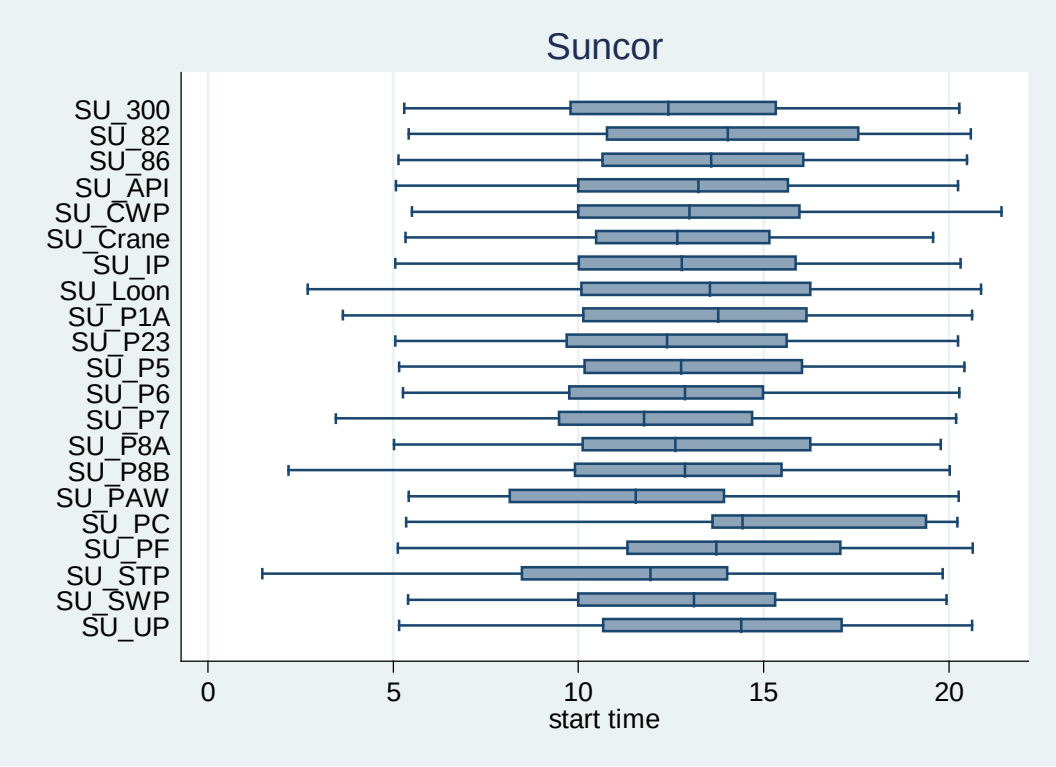


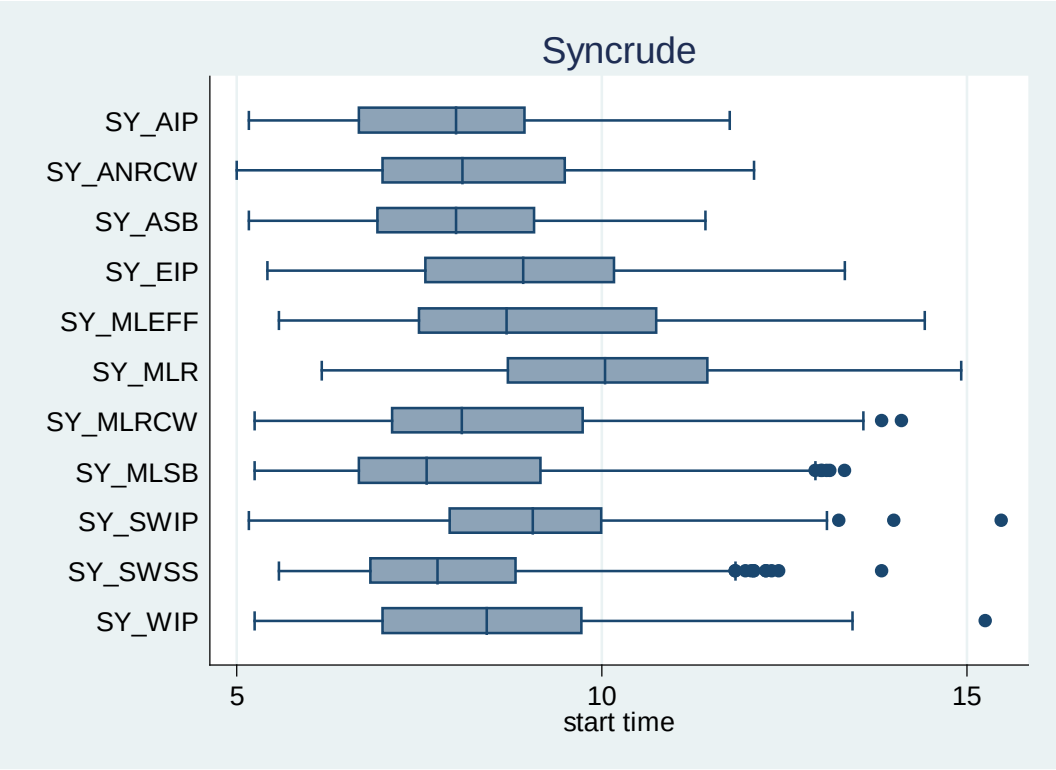
B. Distribution of start times per pond by operator






Shell
JP_ETE_1
JP_ETE_2
JP_ETW_1
JP_ETW_2
MR_ETF_1
MR_ETF_2
MR_IP
MR_IP_1
MR_IP_2
MR_SC
MR_SEA
MR_SEA_1
MR_SEA_2
0
5
10
15
20
25
start time


Suncor
SU_300
SU_82
SU_86
SU_API
SU_CWP
SU_Crane
SU_IP
SU_Loon
SU_P1A
SU_P23
SU_P5
SU_P6
SU_P7
SU_P8A
SU_P8B
SU_PAW
SU_PC
SU_PF
SU_STP
SU_SWP
SU_UP
0
5
10
15
20
start time


Syncrude
SY_AIP
SY_ANRCW
SY_ASB
SY_EIP
SY_MLEFF
SY_MLR
SY_MLRCW
SY_MLSB
SY_SWIP
SY_SWSS
SY_WIP
5
10
15
start time

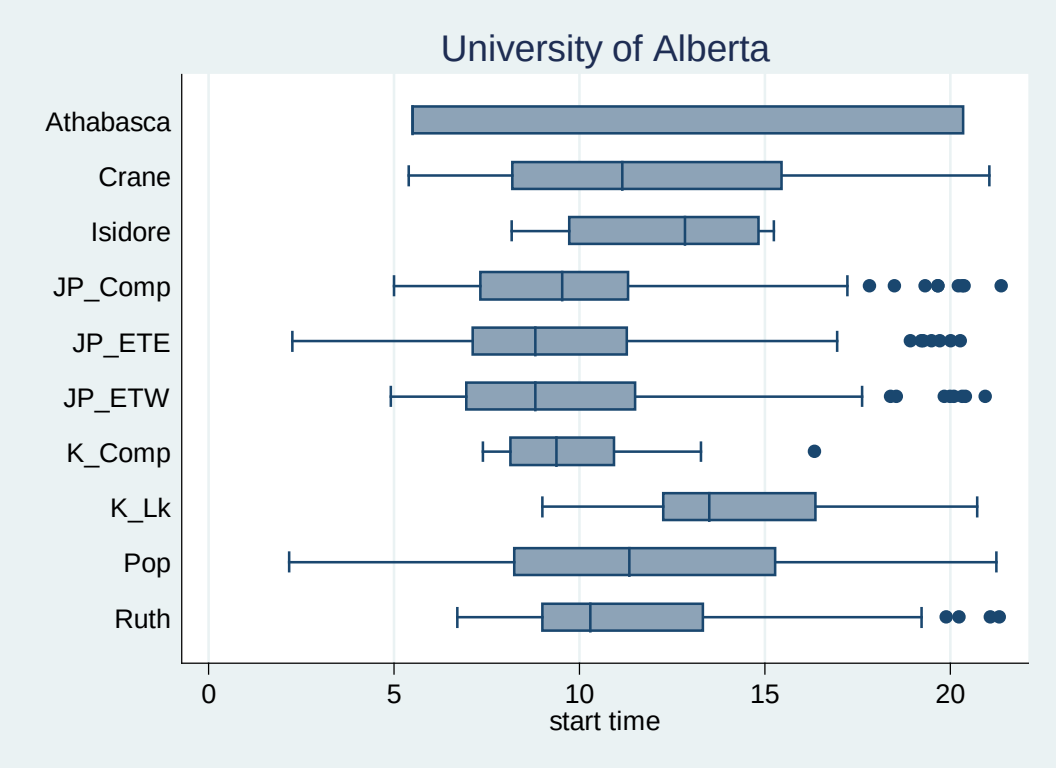

University of Alberta
Athabasca
Crane
Isidore
JP_Comp
JP_ETE
JP_ETW
K_Comp
K_Lk
Pop
Ruth
0
5
10
15
20
start time

Figure 5. Detection rates (birds per hour or observation period) for each operator. Detections are restricted to water-associated birds.

A. Total detection rate by operator by observation period relative to sunrise. Observation periods are split into bins of 0.8 h (approximately 50 minutes) to support the creation of frequency histograms. A lowess smoother (a non-linear function that accommodates zero-truncation at sunrise) was fit to these distributions to identify the peak detection periods. One outlier was removed from Suncor (in which there were ~4000 detections in a single hour).

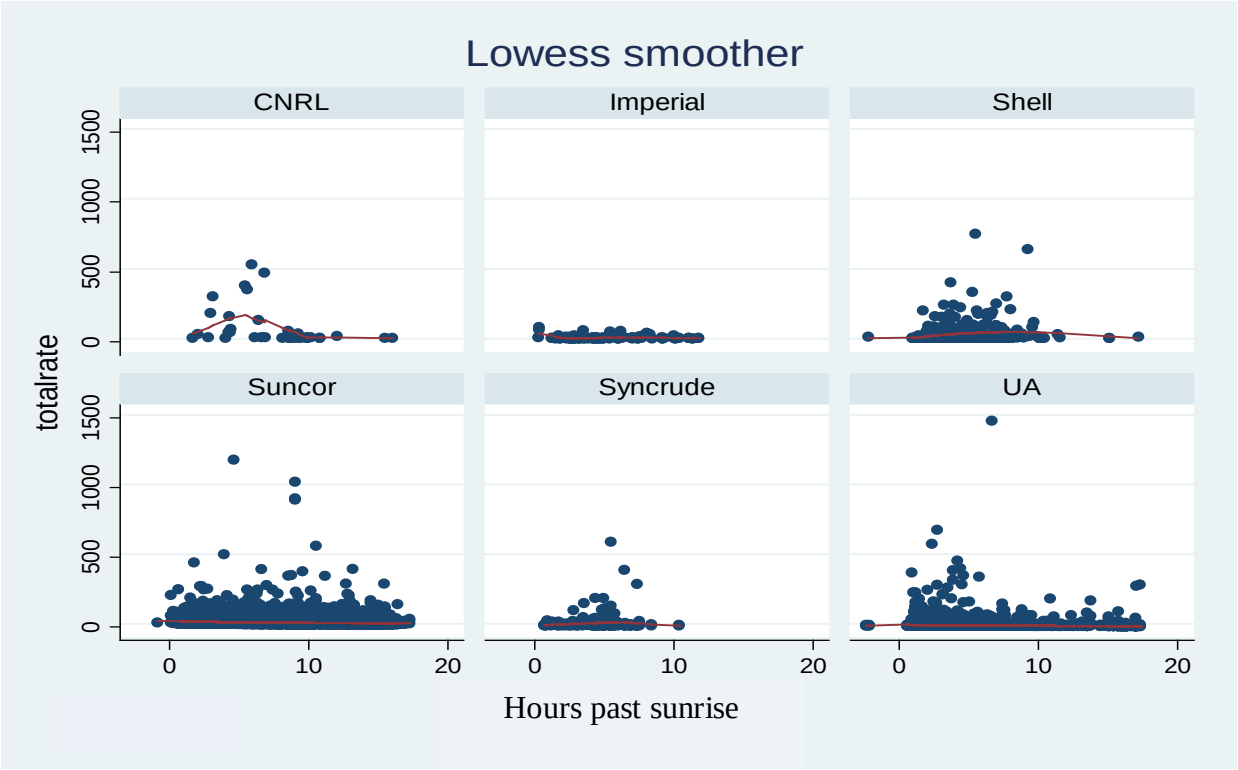
B. Average number of detections per hour (± 95% CI) of all birds by time block.

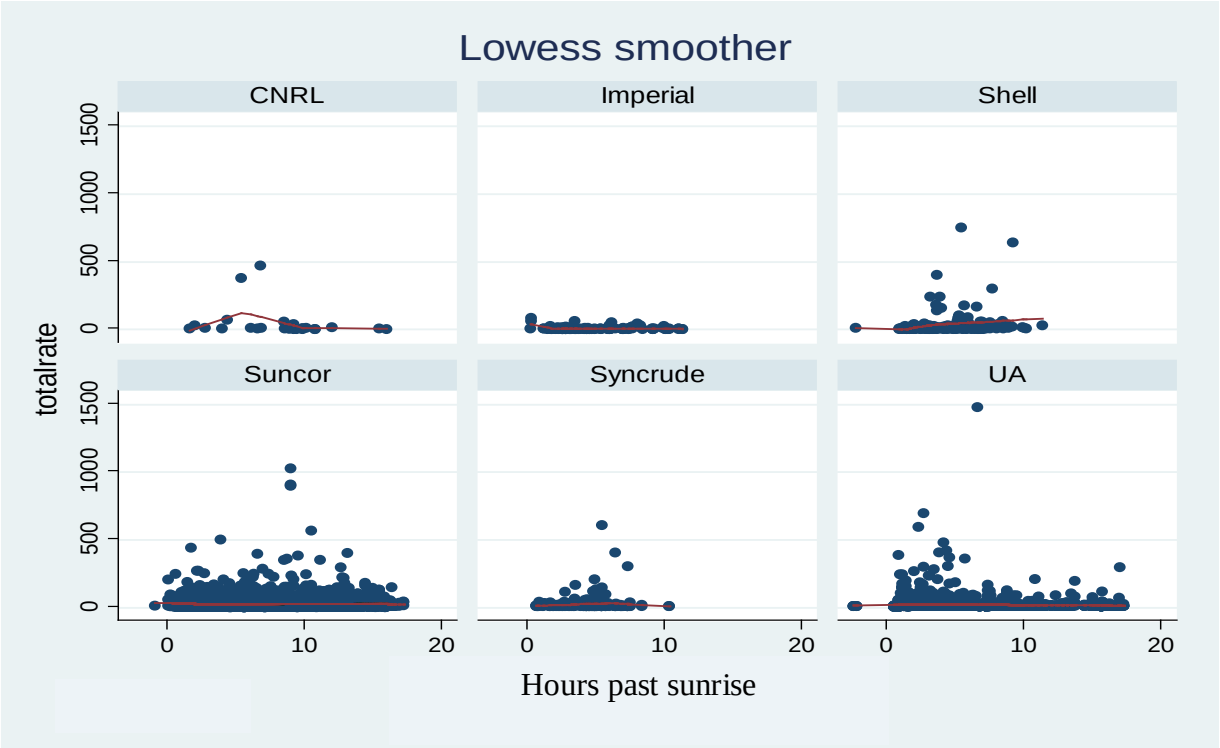
C. Average number of detections per observation period (± 95% CI) of water-associated birds by time block.

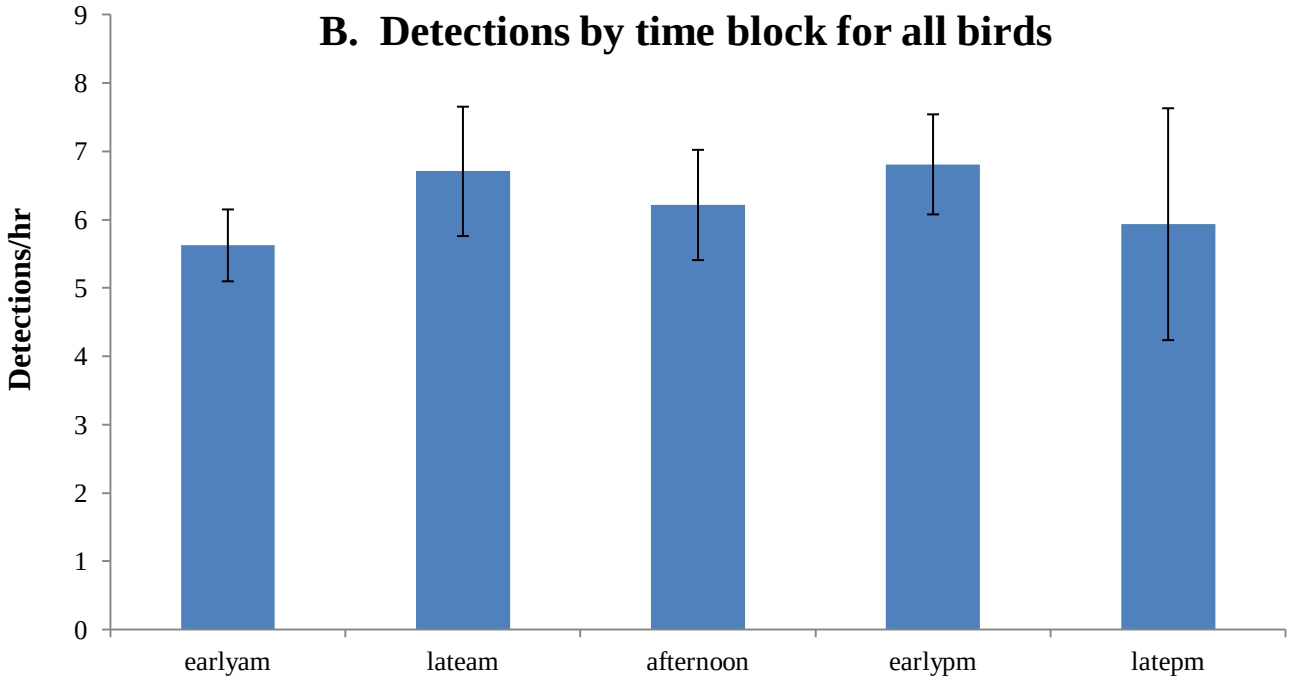
D. Average number of detections per hour (± 95% CI) of all birds by time block and operator.

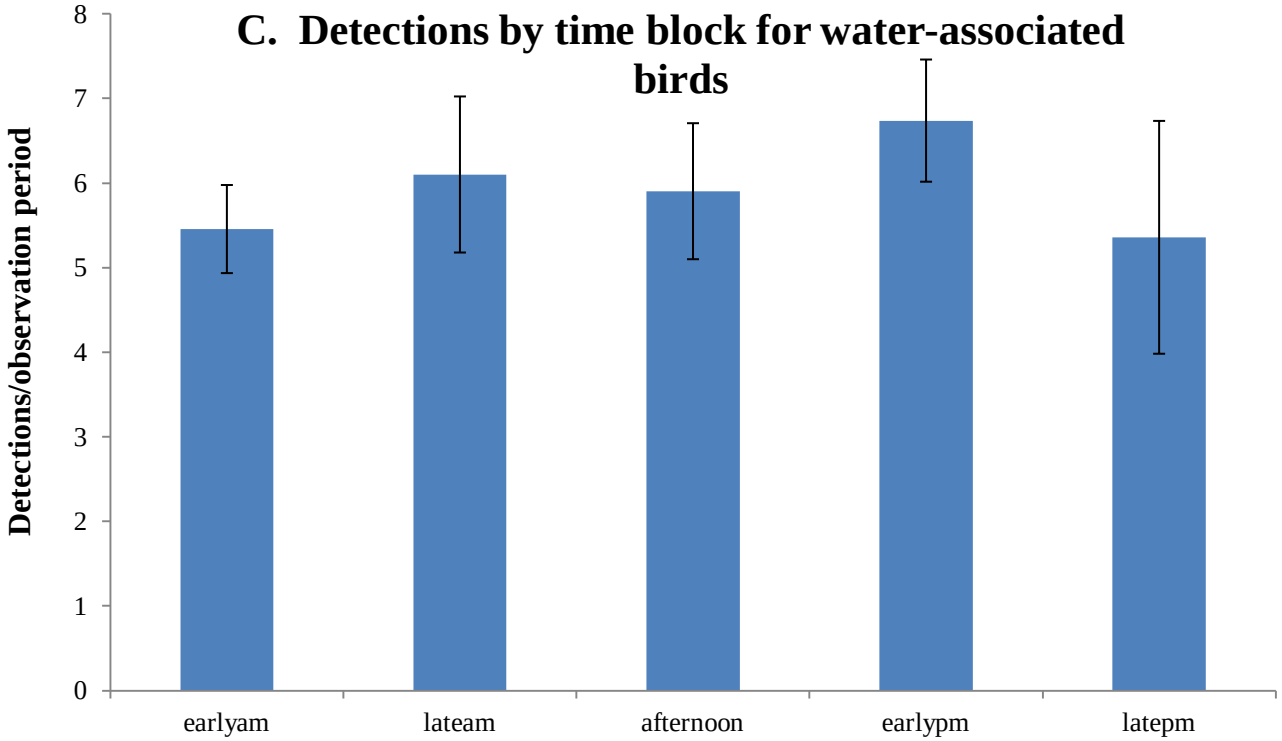
E. Average number of detections per hour (± 95% CI) of water-associated birds by time block and operator.

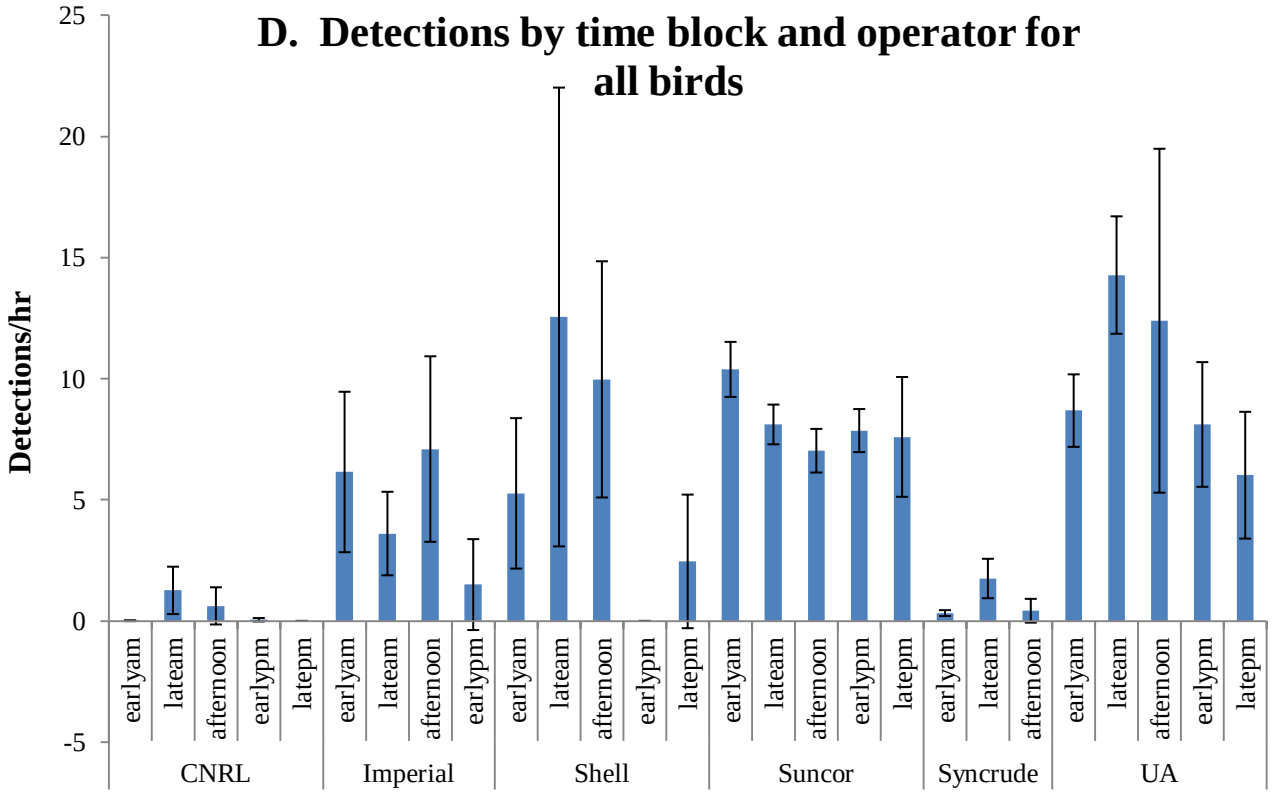
A. Detection rate by operator by relative to sunrise






B. Detections by time block for all birds
Detections/hr
9
8
7
6
5
4
3
2
1
0
earlyam
lateam
afternoon
earlypm
latepm


C. Detections by time block for water-associated birds
Detections/observation period
8
7
6
5
4
3
2
1
0
earlyam
lateam
afternoon
earlypm
latepm


D. Detections by time block and operator for all birds
Detections/hr
25
20
15
10
5
0
-5
earlyam
lateam
afternoon
earlypm
latepm
CNRL
Imperial
Shell
Suncor
Syncrude
UA

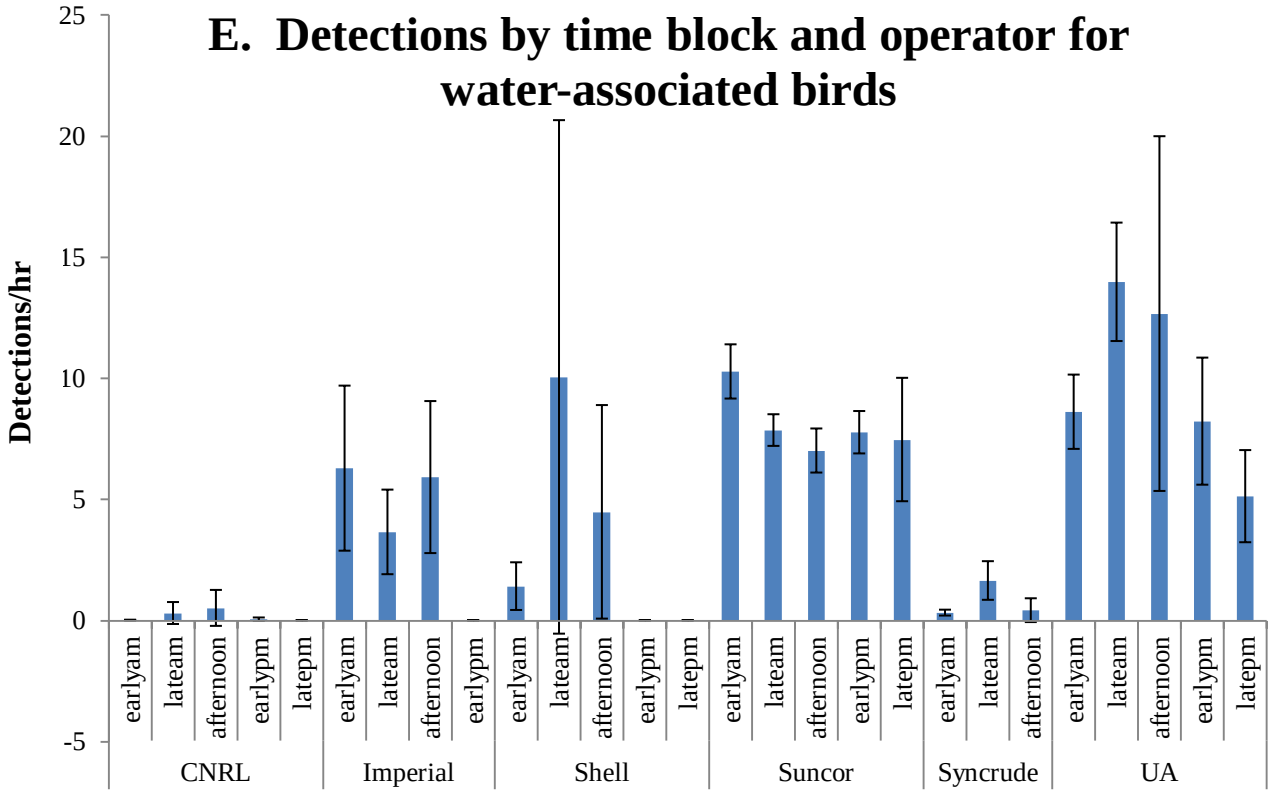
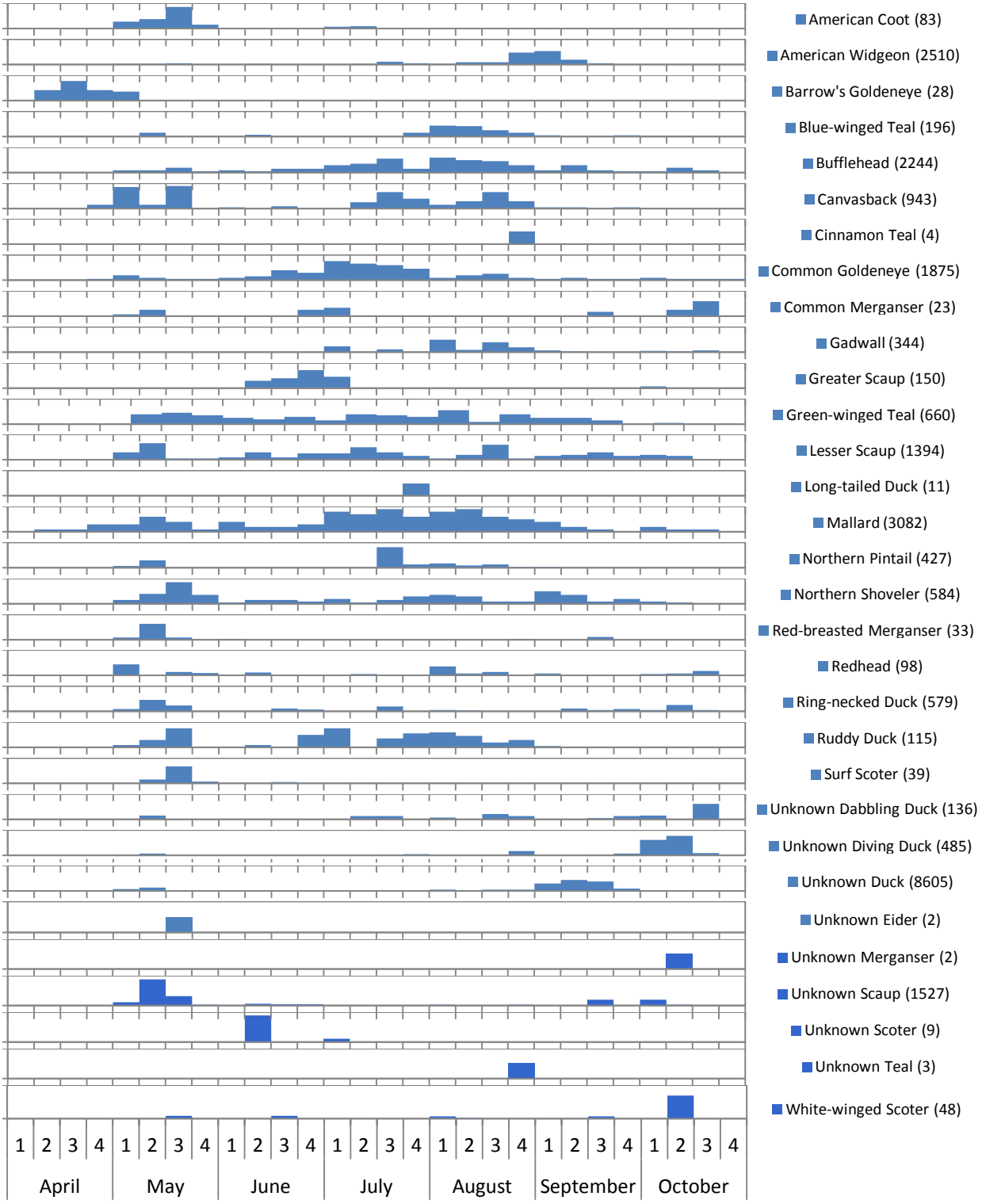
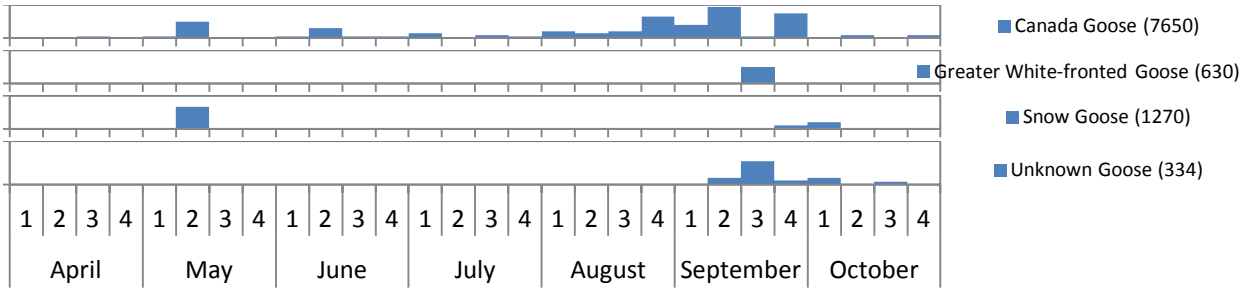

E. Detections by time block and operator for water-associated birds
Detections/hr
25
20
15
10
5
0
-5
earlyam
lateam
afternoon
earlypm
latepm
CNRL
Imperial
Shell
Suncor
Syncrude
UA

Figure 6. Migration chronology for each bird group (panels A – F). Bar height represents relative proportion of each species counted during a given month and week. Species and species group totals are in brackets.

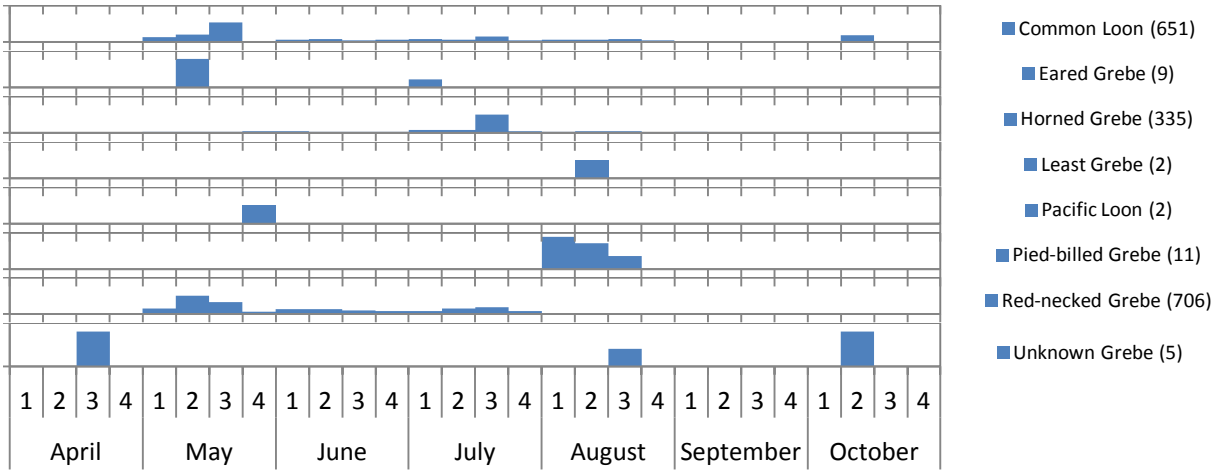
A. Migration chronology of ducks



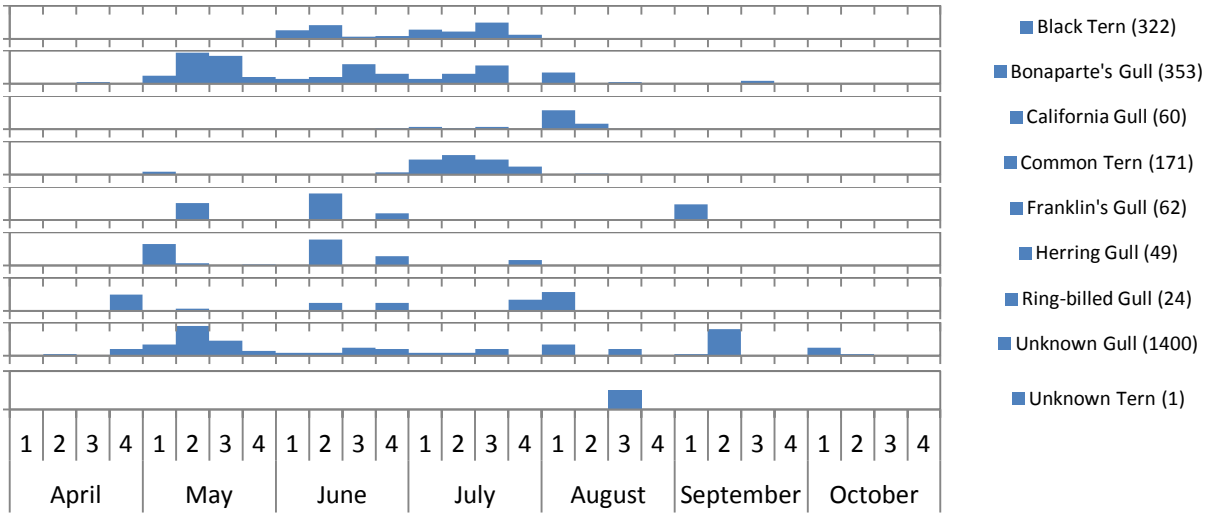
B. Migration chronology of geese



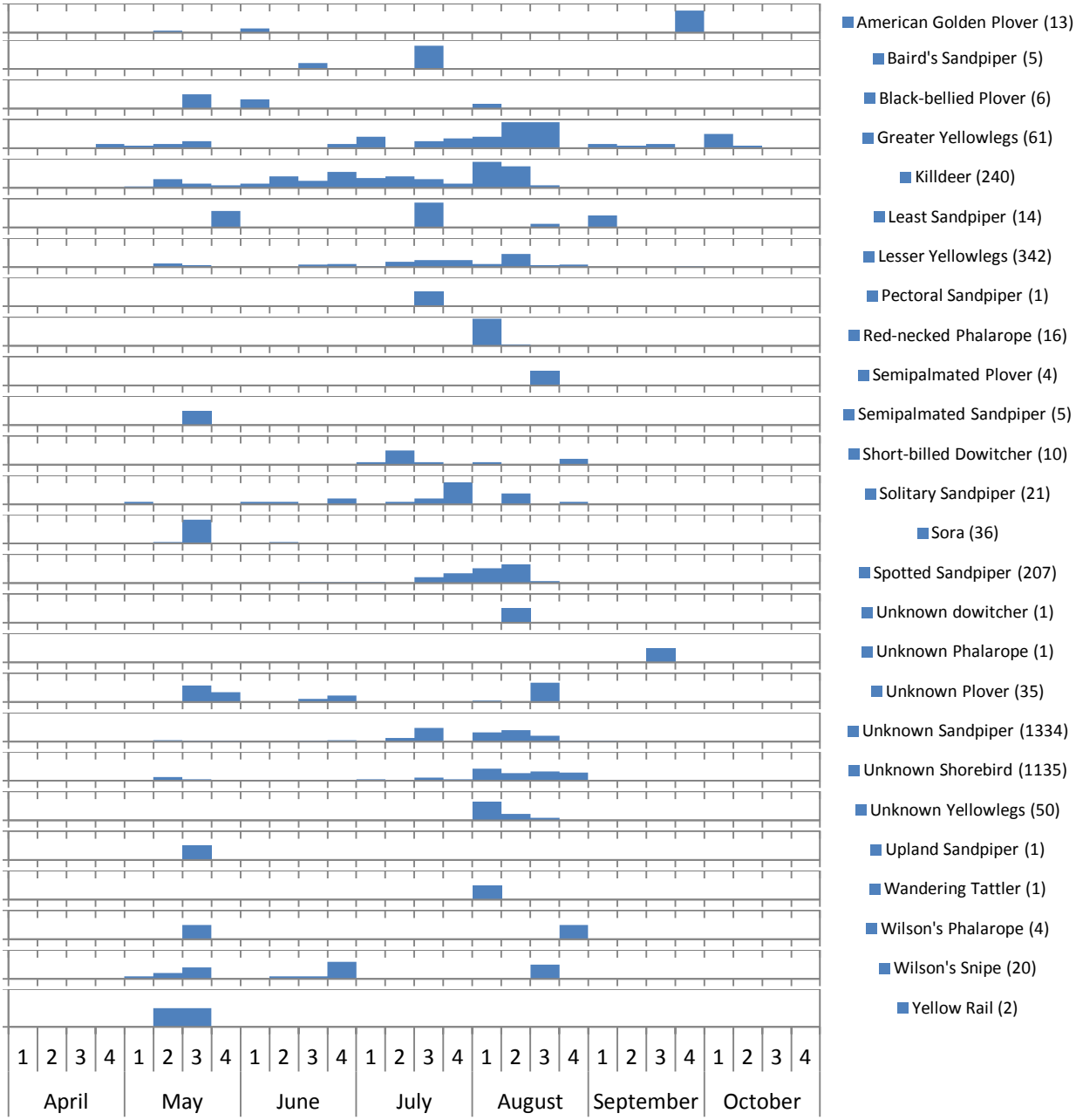
C. Migration chronology of loons and grebes



D. Migration chronology of gulls and terns



E. Migration chronology of shorebirds



F. Migration chronology of other water-associated birds

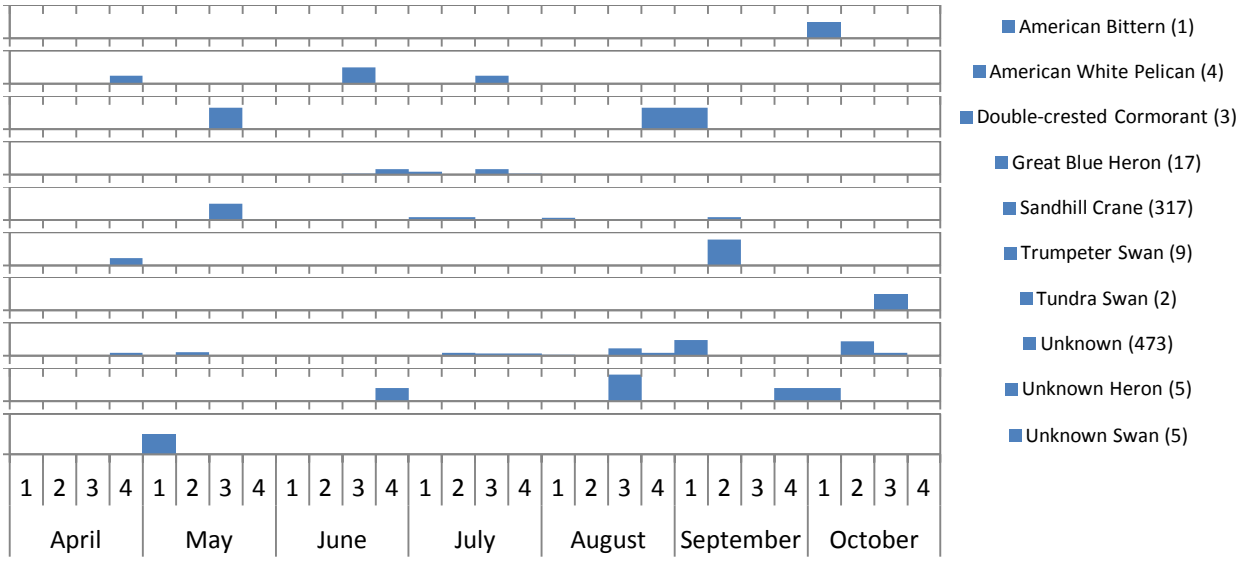


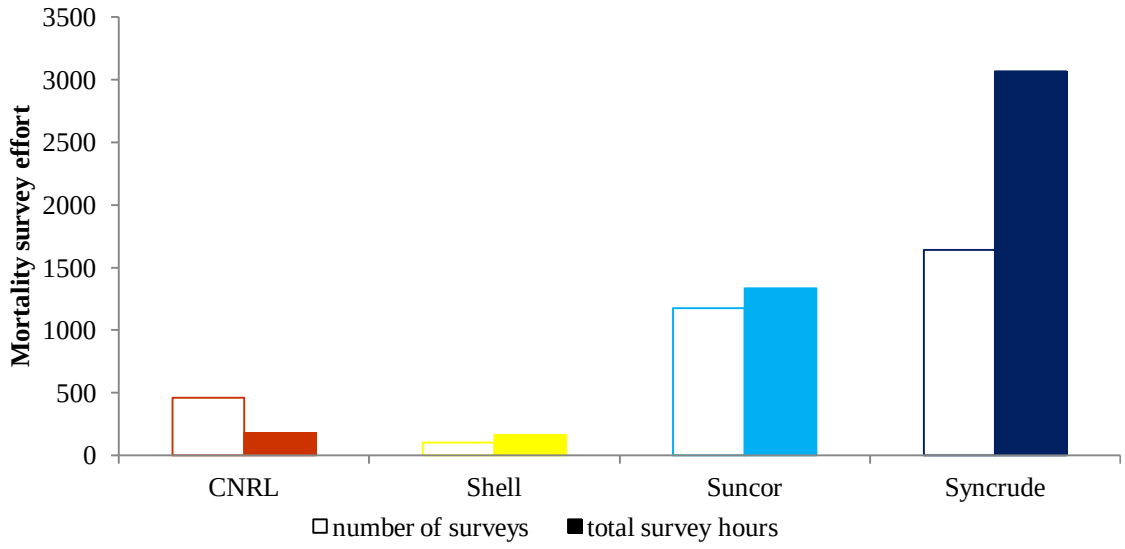
Figure 7. Mortality survey effort and number of dead birds recorded in total and per hour for each of the Oil Sands operators conducting mortality searches on process-affected water ponds in 2011.

A. Number of surveys (open bars) and total hours spent surveying (closed bars) for dead birds by operator. Imperial Oil's Kearl Oil Sands Project was not in production in 2011, had no process-affected ponds, and therefore did not conduct mortality surveys.

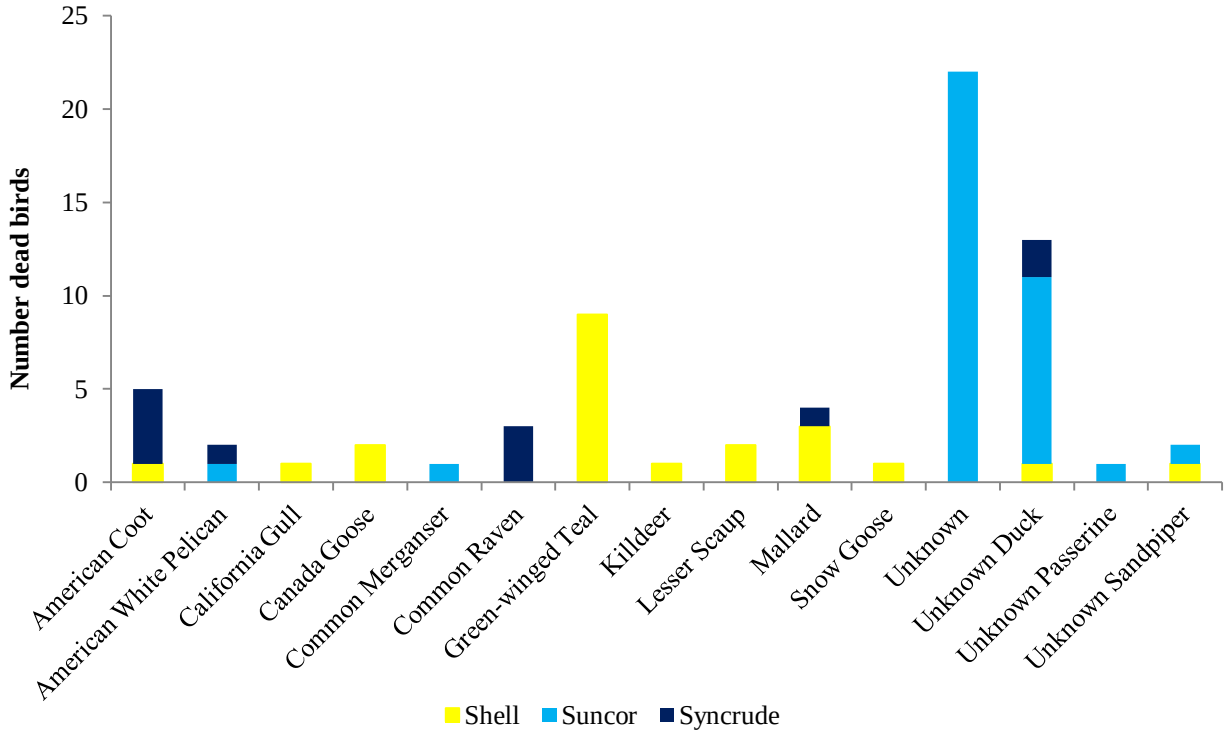
B. Total number of dead birds found by each operator that conducted mortality surveys. CNRL did not report finding any dead birds.

C. Detection rate (no./hr) of dead birds by each operator that conducted mortality surveys. CNRL did not report finding any dead birds.

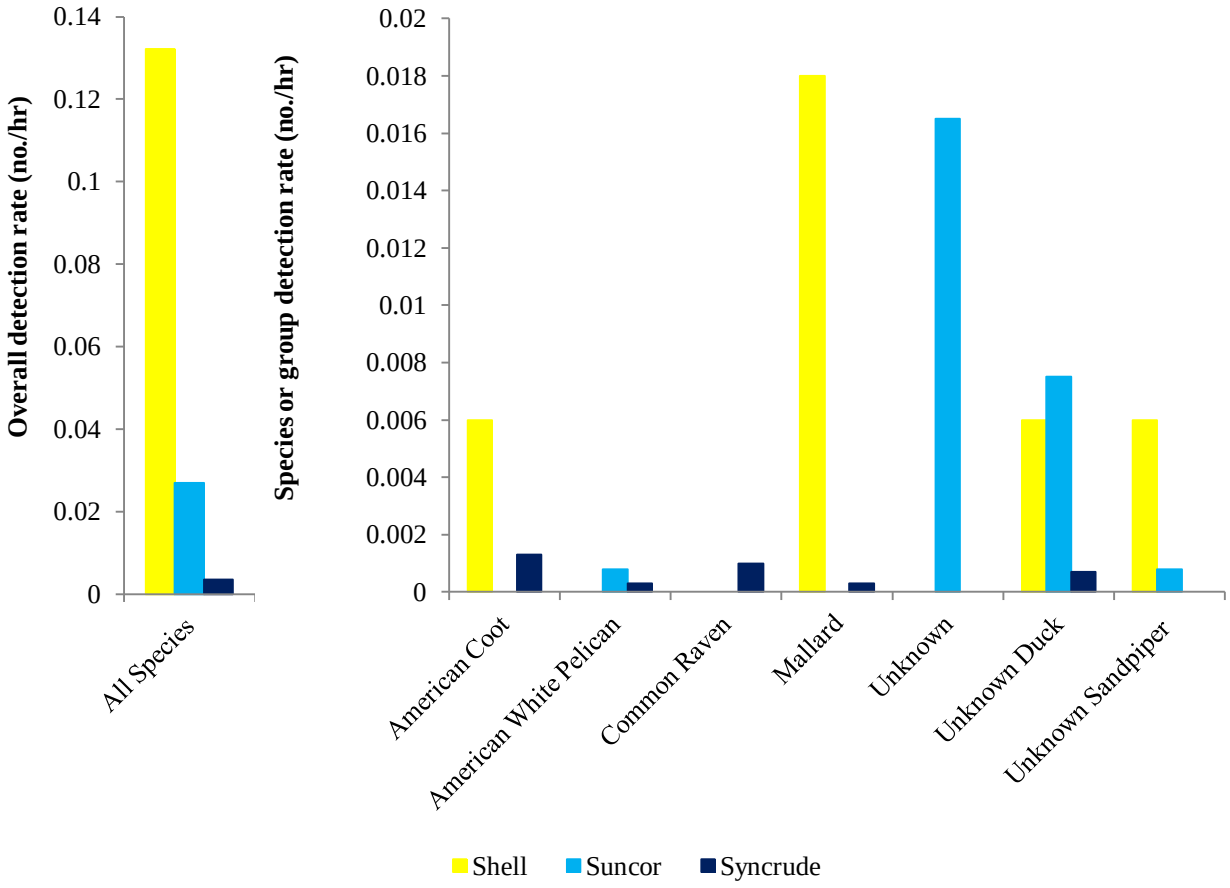
A. Mortality surveys by operator



B. Dead birds found by operator



C. Detection rate of dead birds per hour by operator



Appendices

Appendix A – Regional Map

Regional Map of the Oil Sands Region indicating the location of each operator.

Appendix B – Pond Maps

Operator specific maps of ponds, including deterrent and survey station locations.

Appendix C – Metrics by Pond

Descriptive metrics by pond for each operator.

Appendix D – Weather data

Archived at https://rowan.biology.ualberta.ca/oilsands/?Page=8420

Appendix E – Raw data

Data as submitted by operators and error-checked for consistency and completeness by Colleen and her assistants. This is available in both database (Access) and spreadsheet (Excel) formats.

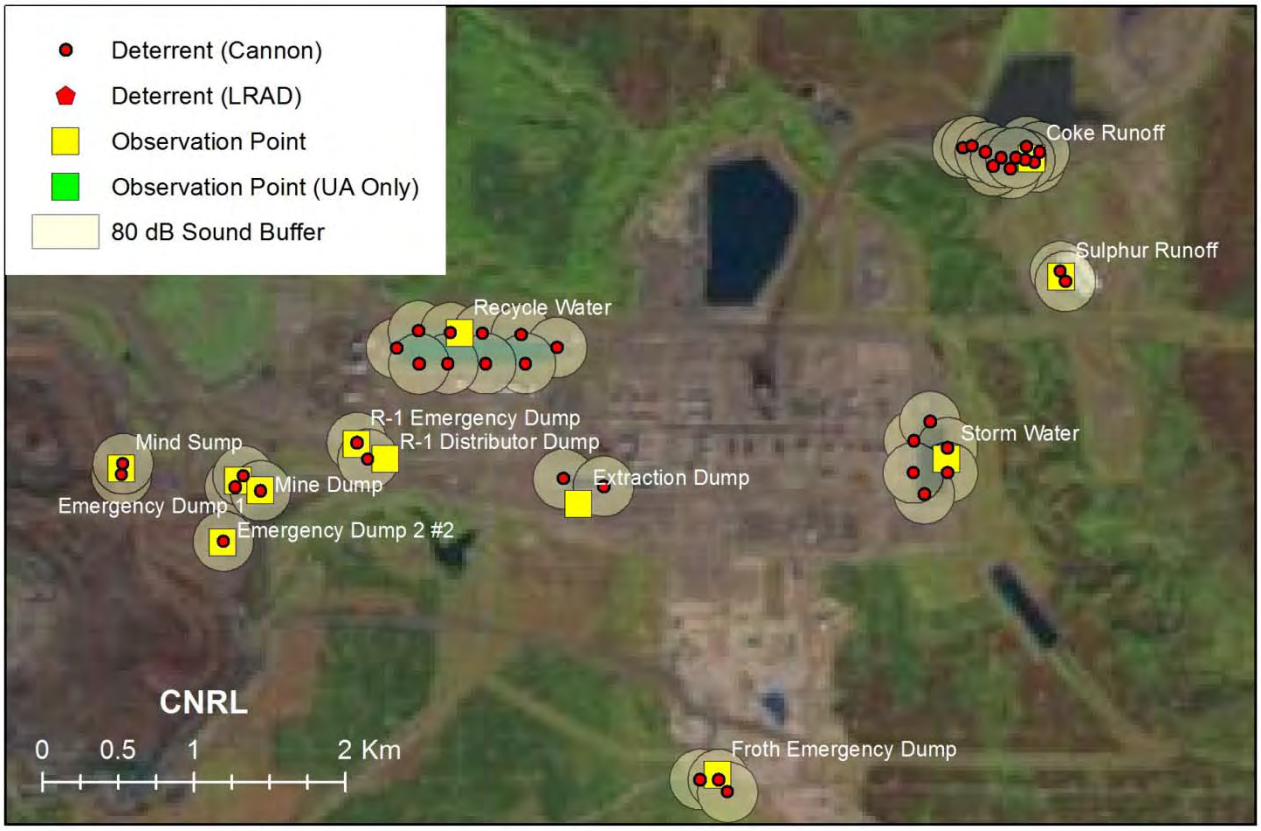
Archived at https://rowan.biology.ualberta.ca/oilsands/?Page=8420

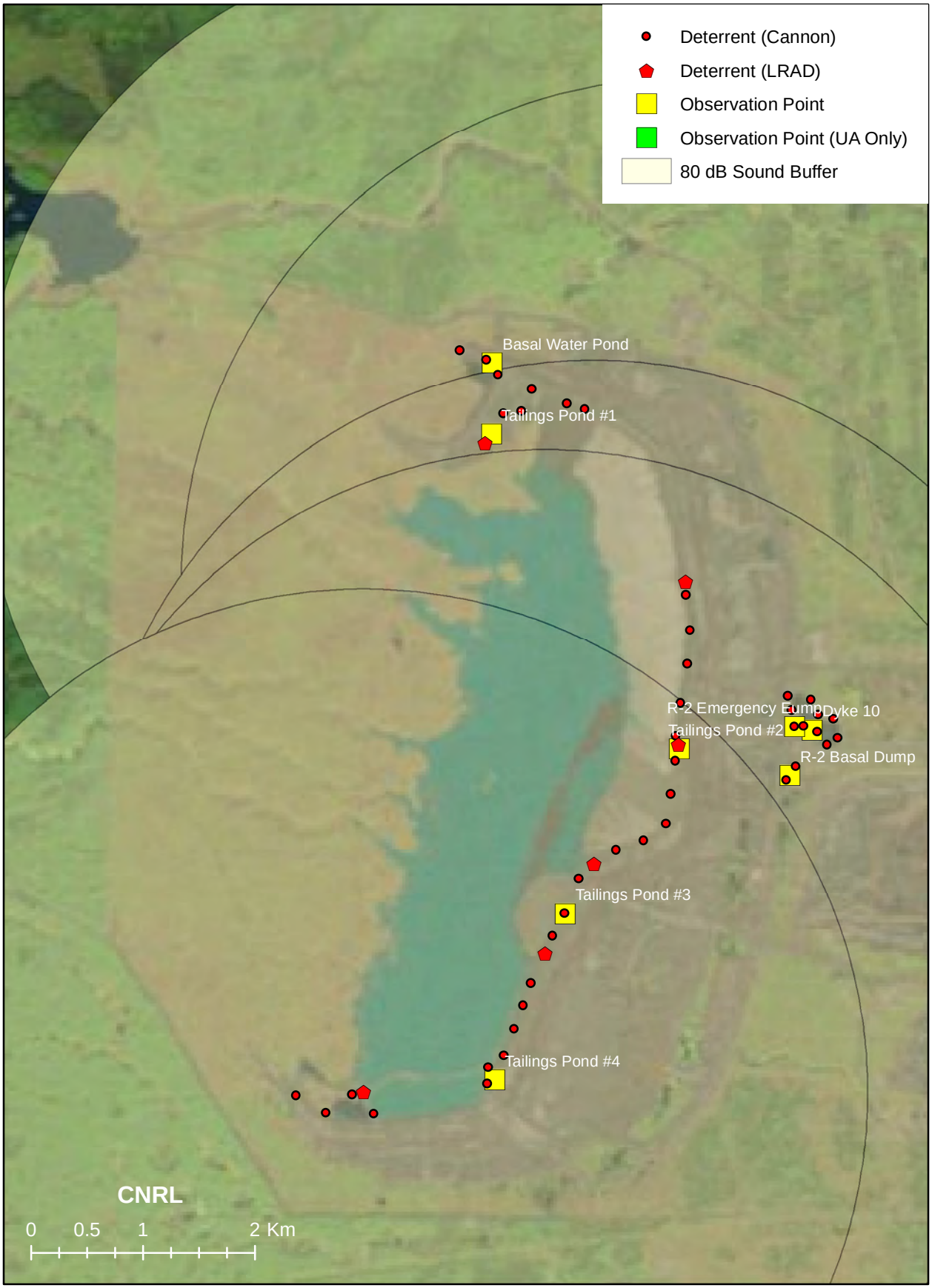
Appendix A – Regional Map. Tailings ponds north of Fort McMurray, AB monitored as part of the Regional Bird Monitoring Program from April 1 – October 31, 2011 by industry and/or University of Alberta personnel. Ponds are colour-coded by operator, with reference ponds (*i.e.* those not containing process-affected water) labelled in italics. The Imperial External Tailings Area, marked with an asterisk, did not contain process-affected water in 2011 because the mine was still in pre-production, but in future years it will contain process-affected water. Note that University of Alberta personnel also monitored some industry ponds. Smaller ponds are indicated by points instead of outlines, and labels for some small ponds have been omitted for clarity. Background imagery is a Landsat 5 composite image captured on September 20, 2011 and obtained from the United States Geological Survey.


Highway 63
McClelland Lake
Imperial
External Tailings Area*
CNRL Compensation Lake
CNRL
Dyke 10
R2 Dump
Tailings Pond
OPP Train 2
Mine Dump
OPP Train 1
Coke Runoff
Sulphur Runoff
Storm Water
Aurora In-Pit
Syncrude (Aurora)
Aurora Settling Basin
Jackpine Compensation Lake
Kearl Compensation Lake
Kearl Lake
Aurora Recycle Water
CIBA Test
Total Joslyn North Mine Future Pond Site
In-Pit
Recycle Water
External Tailings Facility
External Tailings West (TT)
External Tailings East (MFT)
South Extension Area
Seep Collection
Shell
Ft. MacKay
Mildred Lake Settling Basin
Mildred Lake Reservoir
Mildred Lake Effluent
Mildred Lake Recycle Water
Pond 6
Seal Water Pond
Southeast In-Pit
Syncrude (Mildred)
West In-Pit
Pond 5
Pond 4G/4G2
Plant 300
Southwest In-Pit
Pond 2/3
Pond 7
Crane Lake
Pond 1A
Loon Lake (Weir)
Ruth Lake
Plant 86
Suncor
Southwest Sand Storage
Poplar Reservoir
University of Alberta
Pond 8B
Pond 8A
PAW
PAW Pond
South Tailings Pond
0
5
10
20 Km

Appendix B – Pond Maps. Series of maps showing tailings ponds and process-affected water bodies monitored on each oil sands operator's mine site as part of the Regional Bird Monitoring Program. All maps are presented at a 1:50,000 scale. Background imagery is a Landsat 5 composite image captured on September 20, 2011 and obtained from the United States Geological Survey. Observation points are indicated by yellow (industry) or green (University of Alberta) squares. Temporary observation points are labelled with a lowercase "t" following the point number. Industry sites also monitored by UA personnel are indicated with an asterisk. Red dots indicate propane cannons (with or without additional deterrents such as falcon or human effigies), and larger red pentagons indicate LRAD devices. Deterrent locations were provided by each operator based on positions at some point throughout the April 1 - October 31 monitoring season, although some minor movement of deterrents occurred throughout the season.

The effective acoustic radius around each deterrent was based on Golder (2000), which recommended a density of one propane cannon per 13 ha, corresponding to a 200-m radius around each cannon. The 200-m radius of this circle is expected to produce a sound level of 80 dB based on a propane cannon's maximum sound level of 125 dB at the cannon and under ideal conditions (www.zoncannon.com). An LRAD unit is capable of producing 153 dB (www.lradx.com), resulting in a maximum effective (*i.e.* 80 dB) radius of 4500 m under ideal conditions. Because the directionality of each deterrent was not known, we extended the effective radius a full 360° to obtain their effective area. These 80 dB buffers are indicated with translucent yellow circles.

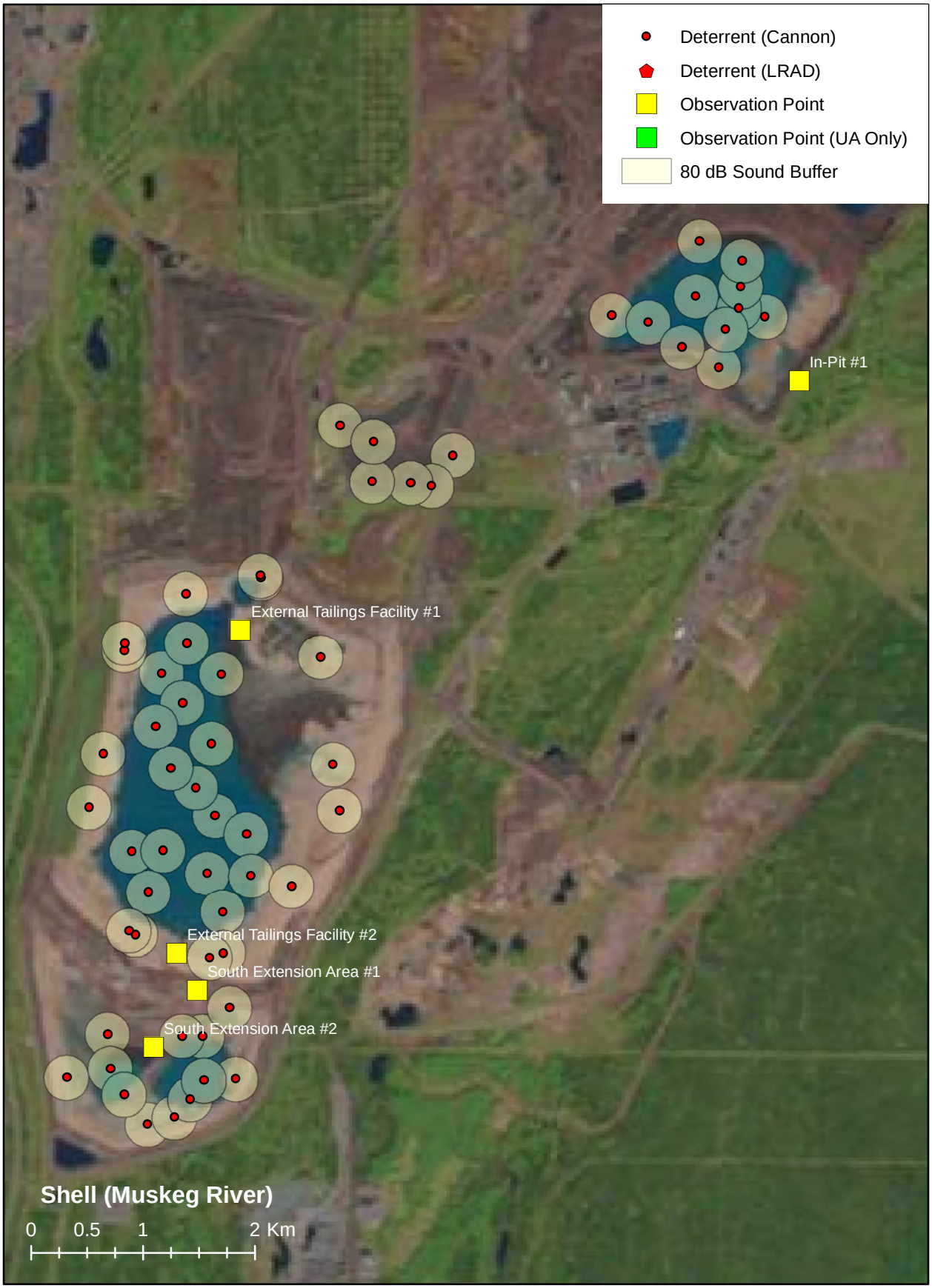



Deterrent (Cannon)
Deterrent (LRAD)
Observation Point
Observation Point (UA Only)
80 dB Sound Buffer
Basal Water Pond
Tailings Pond #1
R-2 Emergency Dump
Dyke 10
Tailings Pond #2
R-2 Basal Dump
Tailings Pond #3
Tailings Pond #4
CNRL
0 0.5 1 2 Km

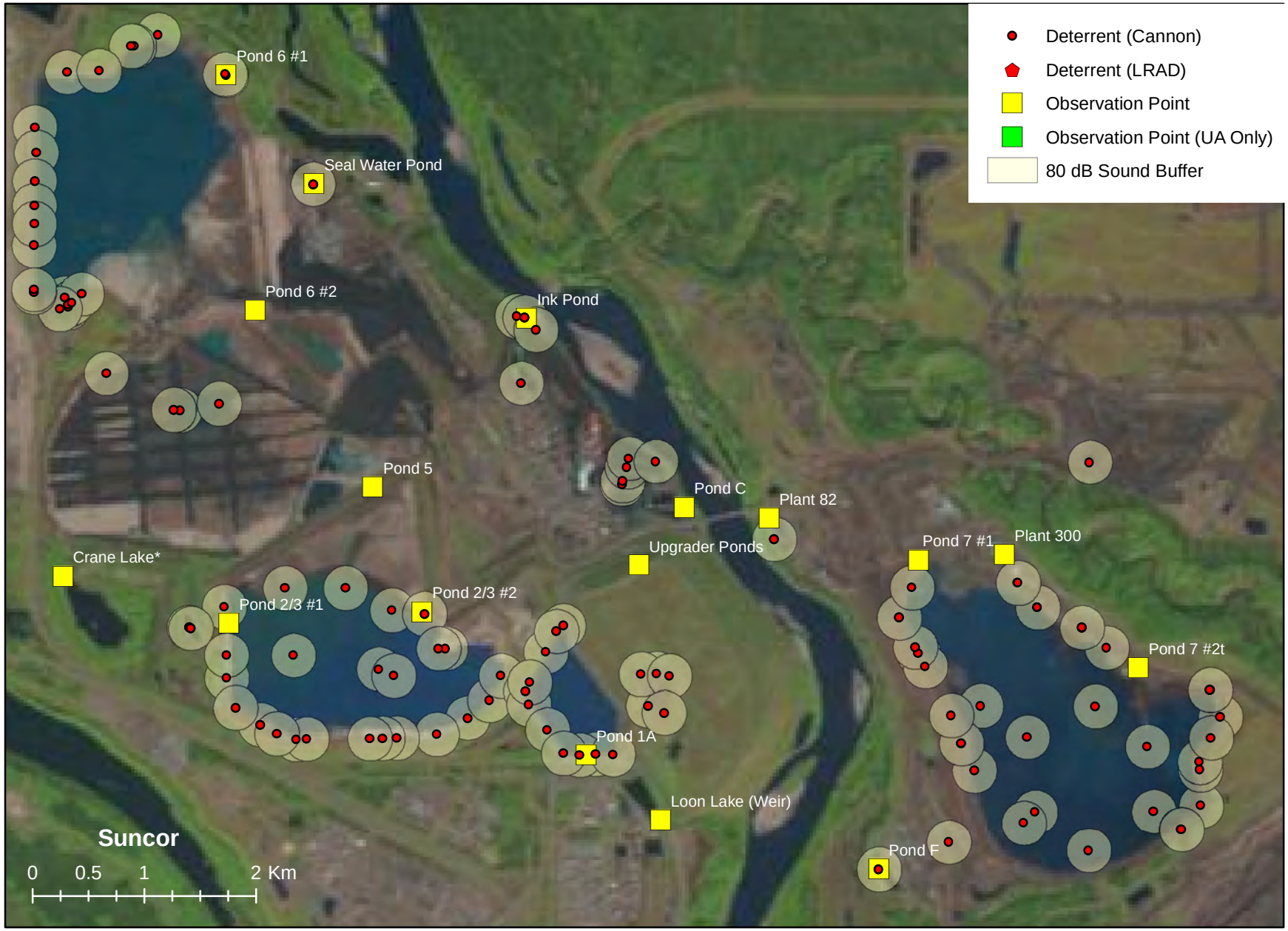

Deterrent (Cannon)
Deterrent (LRAD)
Observation Point
Observation Point (UA Only)
80 dB Sound Buffer
External Tailings Area
Imperial
0 0.5 1 2 Km


Deterrent (Cannon)
Deterrent (LRAD)
Observation Point
Observation Point (UA Only)
80 dB Sound Buffer
Kearl Compensation Lake*
Kearl Lake
Imperial
0 0.5 1 2 Km

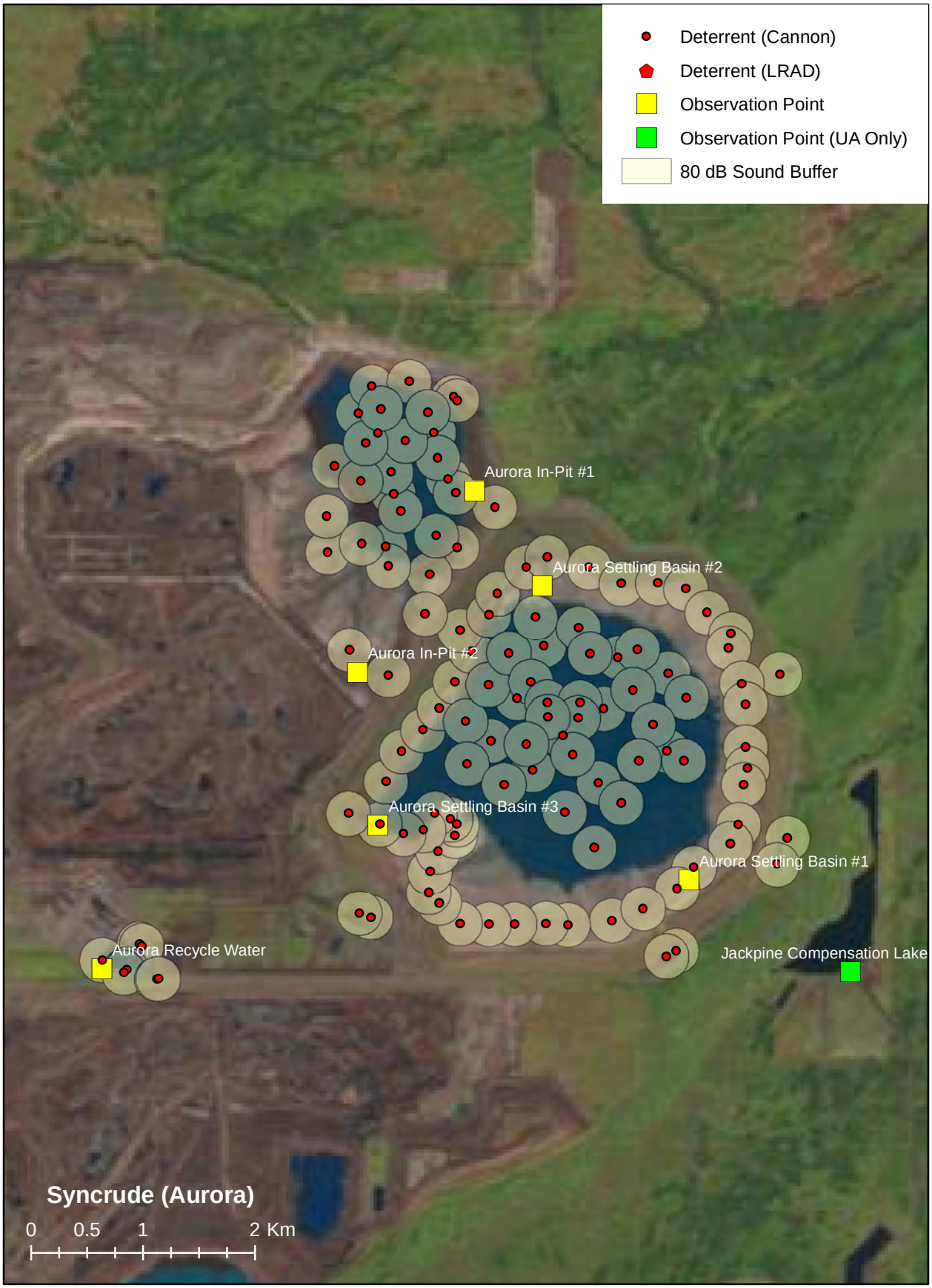

Deterrent (Cannon)
Deterrent (LRAD)
Observation Point
Observation Point (UA Only)
80 dB Sound Buffer
Jackpine Compensation Lake
External Tailings West (TT) #1*
External Tailings East (MFT) #1*
External Tailings West (TT) #2*
External Tailings East (MFT) #2*
Shell (Jackpine)
0 0.5 1 2 Km


Deterrent (Cannon)
Deterrent (LRAD)
Observation Point
Observation Point (UA Only)
80 dB Sound Buffer
In-Pit #1
External Tailings Facility #1
External Tailings Facility #2
South Extension Area #1
South Extension Area #2
Shell (Muskeg River)
0 0.5 1 2 Km

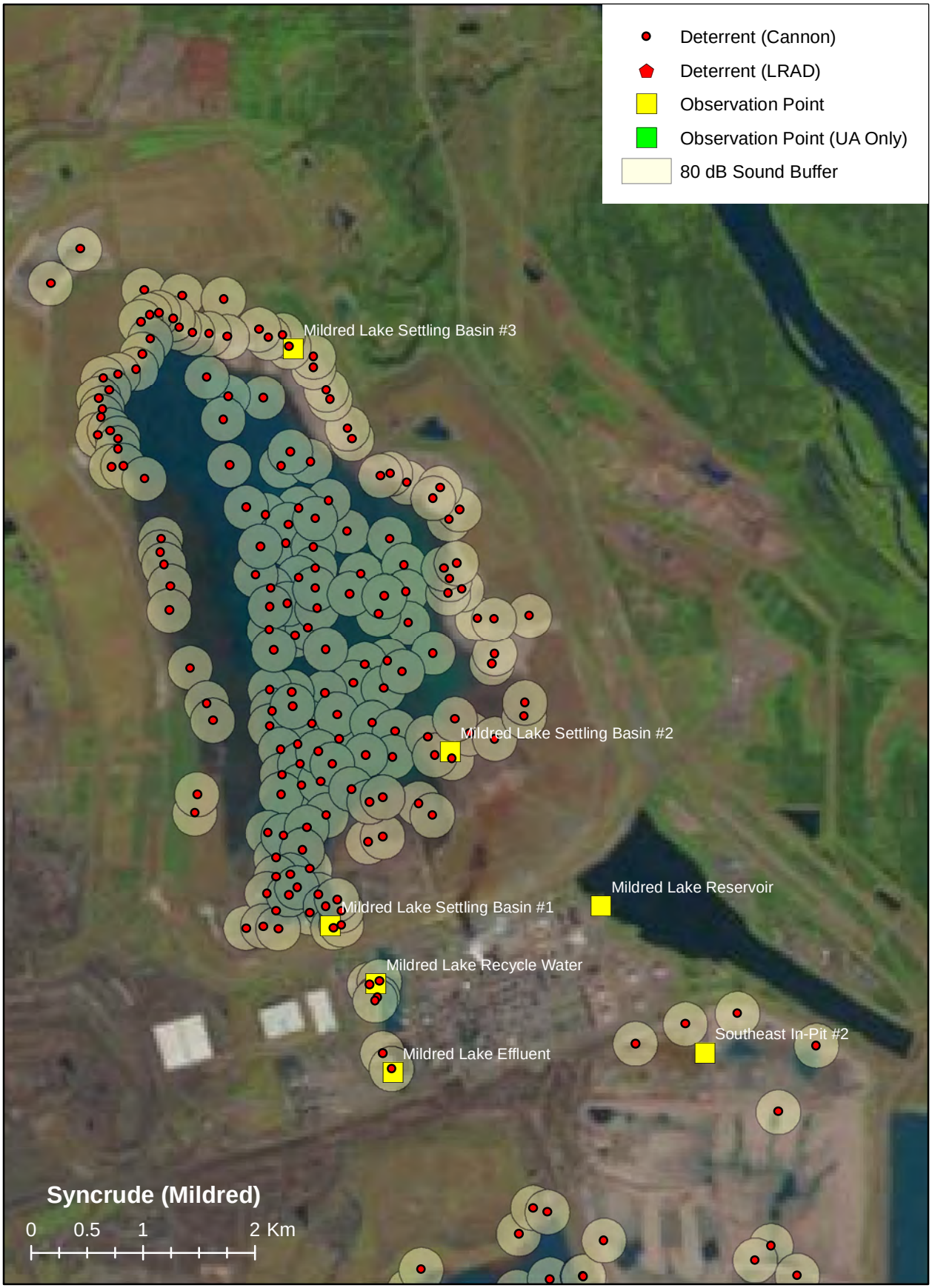

Deterrent (Cannon)
Deterrent (LRAD)
Observation Point
Observation Point (UA Only)
80 dB Sound Buffer
Pond 5
Pond C
Plant 82
Upgrader Ponds
Pond 2/3 #2
Pond 7 #2t
Pond 1A
Loon Lake (Weir)
Pond F
Plant 86
Pond 8B #2
Pond 8A #1
Poplar Reservoir
Suncor
0 0.5 1 2 Km

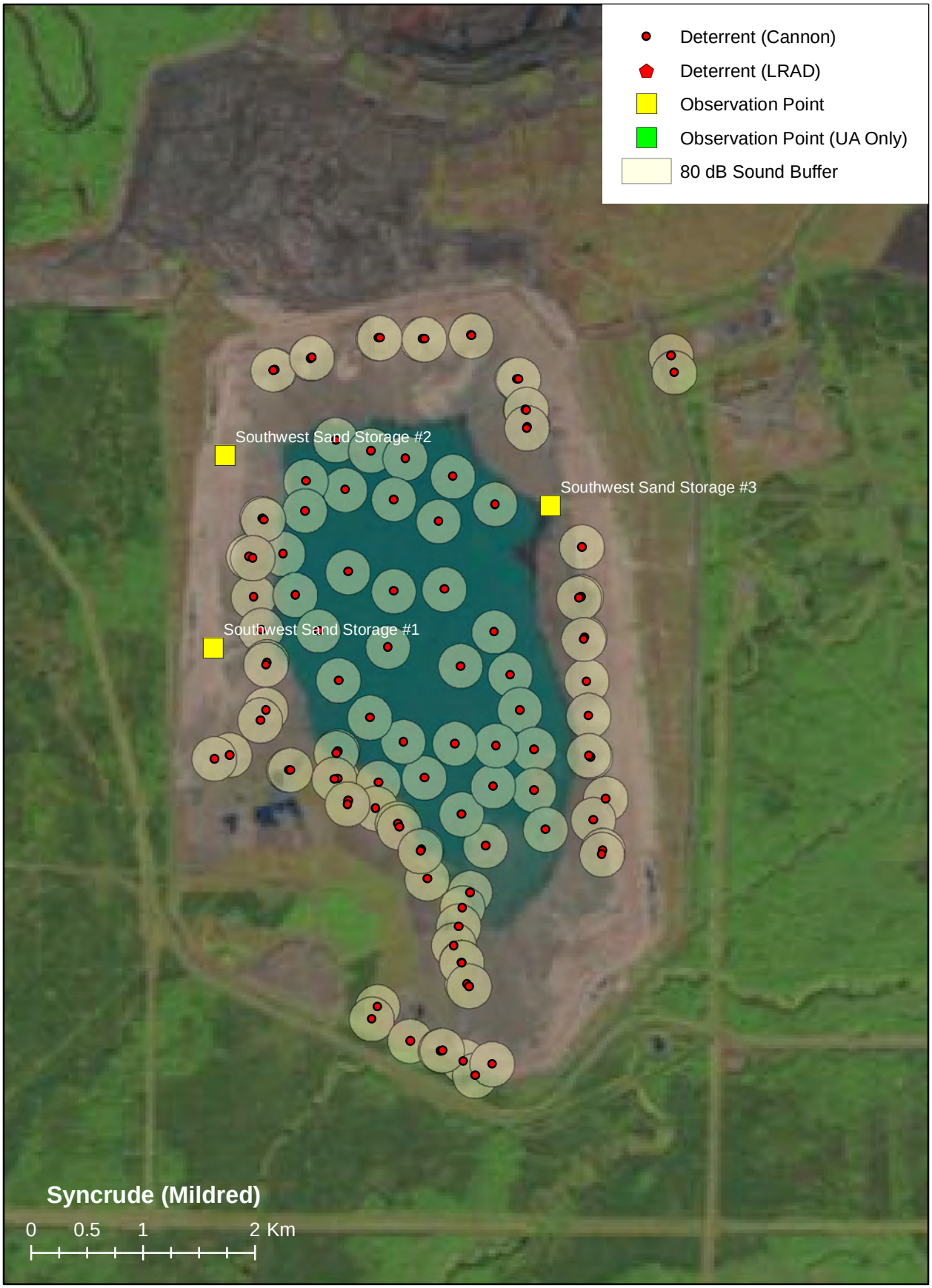

Deterrent (Cannon)
Deterrent (LRAD)
Observation Point
Observation Point (UA Only)
80 dB Sound Buffer
Pond 6 #1
Seal Water Pond
Pond 6 #2
Ink Pond
Pond 5
Pond C
Plant 82
Upgrader Ponds
Crane Lake*
Pond 2/3 #1
Pond 2/3 #2
Pond 1A
Loon Lake (Weir)
Pond 7 #1
Plant 300
Pond 7 #2t
Pond F
Suncor
0 0.5 1 2 Km


Deterrent (Cannon)
Deterrent (LRAD)
Observation Point
Observation Point (UA Only)
80 dB Sound Buffer
Pond 8B #2
Pond 8A #1
Pond 8B #3
South Tailings Pond #3t
Pond 8A #2
Pond 8B #1
South Tailings Pond #1
PAW
South Tailings Pond #2
Suncor
0 0.5 1 2 Km


Deterrent (Cannon)
Deterrent (LRAD)
Observation Point
Observation Point (UA Only)
80 dB Sound Buffer
Aurora In-Pit #1
Aurora Settling Basin #2
Aurora In-Pit #2
Aurora Settling Basin #3
Aurora Settling Basin #1
Aurora Recycle Water
Jackpine Compensation Lake
Syncrude (Aurora)
0 0.5 1 2 Km


Deterrent (Cannon)
Deterrent (LRAD)
Observation Point
Observation Point (UA Only)
80 dB Sound Buffer
Mildred Lake Sett
Mildred Lake Reservoir
Mildred Lake Settling Basin #1
Mildred Lake Recycle Water
Southeast In-Pit #2
Mildred Lake Effluent
West In-Pit #3
Southwest In-Pit #2
West In-Pit #1
Southeast In-Pit #1
West In-Pit #2
Southwest In-Pit #1
Ruth Lake
Syncrude (Mildred)
0 0.5 1 2 Km


Deterrent (Cannon)
Deterrent (LRAD)
Observation Point
Observation Point (UA Only)
80 dB Sound Buffer
Mildred Lake Settling Basin #3
Mildred Lake Settling Basin #2
Mildred Lake Reservoir
Mildred Lake Settling Basin #1
Mildred Lake Recycle Water
Southeast In-Pit #2
Mildred Lake Effluent
Syncrude (Mildred)
0 0.5 1 2 Km


Deterrent (Cannon)
Deterrent (LRAD)
Observation Point
Observation Point (UA Only)
80 dB Sound Buffer
Southwest Sand Storage #2
Southwest Sand Storage #3
Southwest Sand Storage #1
Syncrude (Mildred)
0 0.5 1 2 Km

Appendix C - Pond Metrics

Operator	Water_type	Pond_ID *	Name	Area_km^2	Easting	Northing	Obs Stations
CNRL	Reference	CN_Comp	CNRL Compensation Lake	0.745861	442027	6360903	1
CNRL	Process	CN_TAIL	Tailings Pond	7.61115	445875.1	6355844	4
CNRL	Process	CN_RECY	Recycle Water	0.184758	452940.9	6355738	1
CNRL	Process	CN_STORM	Storm Water	0.076774	455950.8	6355017	1
CNRL	Process	CN_R1DIS	R-1 Distributor Dump	0	452116	6355160	1
CNRL	Process	CN_R1T	R-1 Tailings	0	452273	6355050	1
CNRL	Process	CN_R2D	R2 Dump	0	448576	6356388	1
CNRL	Process	CN_OT2	OPP Train 2	0	451269	6354483	1
CNRL	Process	CN_MDUMP	Mine Dump	0	451457	6354906	1
CNRL	Process	CN_OT1	OPP Train 1	0	451364	6354881	1
CNRL	Process	CN_COKE	Coke Runoff	1	456616	6357069	1
CNRL	Process	CN_SULF	Sulphur Runoff	1	456781	6356212	1
CNRL	Process	CN_FROTH	Froth Emergency Dump	1	453999	6354904	1
CNRL	Process	CN_EXTP	Extraction Dump	1	453643	6354905	1
CNRL	Process	CN_STORM	Storm Water	5	455931	6355065	1
CNRL	Process	CN_RECY	Recycle Water	30	452914	6355776	1
CNRL	Process	CN_D10	Dyke 10	48	448680	6356498	1
Imperial	Reference	KE_ETA	External Tailings Area	2.293047	494603	6363843	1
Imperial	Reference	KE_Comp	Kearl Compensation Lake	0.197059	486900.8	6351834	1
Shell	Process	JP_ETE	External Tailings East (MFT)	3.013419	478927.4	6341912	1
Shell	Process	MR_ETF	External Tailings Facility	3.25849	465581	6342789	2
Shell	Process	JP_ETW	External Tailings West (TT)	1.477893	477239.1	6342139	1
Shell	Process	MR_IP	In-Pit	1.182138	470223.4	6347114	1
Shell	Reference	JP_Comp	Jackpine Compensation Lake	0.428659	476266.6	6350821	1
Shell	Process	MR_SC	Seep Collection	0.06449	464515.2	6339482	0
Shell	Process	MR_SEA	South Extension Area	0.421265	465387.5	6340205	2
Shell	Process	MR_RW	Recycle Water	0.053219	469864	6345885	0
Suncor	Reference	SU_Crane	Crane Lake	0.189683	466659.4	6316698	1
Suncor	Reference	SU_Loon	Loon Lake (Weir 1)	0.057456	471539	6315093	1
Suncor	Process	SU_P1A	Pond 1A	0.48787	470935.4	6315920	1
Suncor	Process	SU_P23	Pond 2/3	2.599843	468919.7	6316314	2
Suncor	Process	SU_P4x	Pond 4G/4G2	0.613666	469063.7	6318396	0

Suncor	Process	SU_P5	Pond 5	1.520046	467126.7	6318280	1
Suncor	Process	SU_P6	Pond 6	2.736265	466922.4	6320688	2
Suncor	Process	SU_P7	Pond 7	4.060592	475329.9	6315613	2
Suncor	Process	SU_P8A	Pond 8A	1.170547	475959.9	6307349	2
Suncor	Process	SU_P8B	Pond 8B	7.0718	477963.5	6307845	3
Suncor	Process	SU_STP	South Tailings Pond	8.431907	479898.7	6303023	3
Suncor	Process	SU_PAW	PAW	13	477836	6304523	1
Suncor	Process		Plant 300	0	474801	6317240	1
Suncor	Process		Seal Water Pond	0	468630	6320552	1
Suncor	Process		Plant 82	0	472696	6317568	1
Suncor	Process		Plant 86	0	474312	6312353	1
Suncor	Process		Pond F	0	473678	6314430	1
Suncor	Process		Ink Pond	0	470531	6319351	1
Suncor	Process		Upgrader Ponds	0	471532	6317144	1
Suncor	Process		Pond C	0	471939	6317659	1
Syncrude	Process	SY_AIP	Aurora In-Pit	1.555211	472200.9	6354808	2
Syncrude	Process	SY_ASB	Aurora Settling Basin	5.000121	473799.8	6352273	3
Syncrude	Reference	SY_MLR	Mildred Lake Reservoir	1.577838	464563.4	6323164	1
Syncrude	Process	SY_MLSB	Mildred Lake Settling Basin	8.294001	460872.9	6326063	3
Syncrude	Process	SY_EIP	Southeast In-Pit	1.183426	465019	6318717	2
Syncrude	Process	SY_SWIP	Southwest In-Pit	2.432795	459230.6	6317426	2
Syncrude	Process	SY_SWSS	Southwest Sand Storage	8.420437	453618.4	6315038	3
Syncrude	Process	SY_WIP	West In-Pit	6.981154	462191.6	6318609	3
Syncrude	Process	SY_ANRCW	Aurora Recycle Water	0.049395	469817.5	6350372	1
Syncrude	Process	SY_MLEFF	Mildred Lake Effluent	0.046416	461763.8	6322012	1
Syncrude	Process	SY_MLRCW	Mildred Lake Recycle Water	0.133867	461686.8	6322564	1
Syncrude	Process	SY_CIBA	CIBA Test	20	472043	6350663	0
UA only	Reference	KE_Lk	Kearl Lake	5.472743	485614.1	6349925	1
UA only	Reference	Pop	Poplar Reservoir	1.092017	469367.8	6309618	1
UA only	Reference	Ruth	Ruth Lake	1.265624	466515.5	6315323	1

48 PA Ponds
10 Reference Ponds
72 Stations on PA Ponds