# Draft[1] prospectus for instrument-based monitoring of birds in the oil sands

Colleen Cassady St. Clair, 25 March 2011

With assistance from Rob Ronconi, Jeff Ball, and Tom Habib

**Background**. Recent events have dramatically increased the regulatory and public scrutiny of avian monitoring in the oil sands region. To address these needs, Alberta Environment obliged industry to develop and implement a new observation-based, standardized monitoring protocol. Industry representatives gathered on March 1 to discuss this protocol with Rob Ronconi, whom they had hired to draft it, and myself. We compared the practices now employed by each operator and Rob drafted a new protocol which received tentative approval by provincial regulators on 21 March 2011.

To supplement this required program, I propose to develop radar and photographic tools to automate the counting of birds flying over, landing, and dying in the tailings ponds of the oil sands region. After a period of refinement, these tools are expected to reduce the cost and increase both the accuracy of monitoring and its consistency among seasons, operators, and pond types. Such instrument-based monitoring is likely to become standard practice in the future because it can overcome most of the difficulties associated with observation-based monitoring:

- Waterfowl migrate primarily at night when they are almost impossible to observe directly.
- Bird activity on the ponds peaks at sunrise and sunset, which are times that pose operational difficulties for direct observation.
- Large ponds are difficult to census accurately, even with spotting scopes and trained observers.
- Direct observation is time consuming, expensive, and prone to high rates of inter-observer variation, which limits the comparisons that can be made among times of day, seasons, ponds, and sites.

In addition to the immediate goal of producing standardized monitoring information, development of an instrument-based monitoring program will support subsequent experimentation, innovation, and adaptive management of avian

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[1] This is a working document intended to generate discussion and refine information to support more specific and conventional proposals. With appropriate interest from industry, the contents of this prospectus will form the basis of a CRD application to NSERC which could reduce the cost to industry of supporting this research by up to 66%. None of the proposed methodology of this document are yet finalized, but I have tried to provide enough information for operators to assess collaborative opportunities and immediate camera needs.

deterrents and their deployment consistent with the directives of the court order stemming from R. vs. Syncrude. [2]

**Goal**. Identify tools to automate the identification and counting of birds flying over, landing on, and dying in the tailings ponds of the oil sands region.

**Scope**. I invite each oil sands operator to participate in a 3 year research project that I will lead and support. Participation in this research project is voluntary and is not a regulatory set out by Alberta Environment. The research is conceptually related to the court-ordered Research on Avian Protection Project (RAPP), which emphasizes innovation in deterrence and deployment as a means of identifying best practices for the future.

Because of its independent and voluntary nature, the Instrument-based Monitoring Project (IMP) is eligible for matching funding under the NSERC Collaborative Research Development (CRD) program. Any support that operators chose to commit can be matched by NSERC at a rate of 1:2, for the sum of in-kind and cash contributions provided the cash contributions are at least 50% of the total.[3] Several discussions over the last month with representatives of NSERC suggest that the project has a high likelihood of funding success. Industry-provided funds can be matched retroactively by NSERC up to 3 months before the project is submitted. Over the coming 2 months, we will trial and refine the instrument-based monitoring techniques described here and I will submit the application by early June, 2011. Frequent correspondence in the meantime will ensure operators have sufficient information to decide on the level of investment they would like to commit.

**Forms of investment.** Both cash and in-kind support can be matched by NSERC, providing an excellent opportunity to stretch research dollars. Cash contributions could support equipment, assistant salaries, and transportation costs. In-kind contributions could support housing, high-speed internet access and on-site transportation.

Equipment purchased for use at operator sites can be offered as cash contributions only if the equipment remains the property of the University of Alberta. This requirement does not preclude indefinite research collaborations such that the equipment remains available to operators for the duration of the life of the equipment. Radar units, spotting scopes, and binoculars are likely to retain substantial portions of their purchase value by the end of the 3 year project; digital SLR and HD video cameras will retain a relatively small proportion of their purchase value over the same time period.

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[2] Copies of the literature supporting this prospectus are available at the Google site provided by email to those on the distribution list associated with regulation of bird deterrence by Alberta Environment.

[3] Add the website for CRD program

The rules for the CRD program do not permit the use of court-ordered funds as matching funds. However, the court-ordered funds can support work that contributes to the overarching goals of the project, one of which is to complement efforts by industry and government and avoid redundancy of effort. Thus, the methods I recommend below are intended to provide as much cost-efficacy as possible with the remainder of the work that will be done by the research team. For this reason, I include in this document descriptions of the other research we plan although most of this prospectus emphasizes instrument-based monitoring.

**Objectives**

The core objectives of the instrument-based monitoring program address the limitations described above. Research initiated this spring will be refined over the subsequent 5 migratory seasons to generate a recommended set of best practices to:

- Detect and provide a means of counting birds flying over ponds during all light and weather conditions.
- Monitor the number of birds landing on portions of the ponds to provide an index of the number of landings under a variety of conditions, including low light.
- Count the number of birds dying as a result of exposure to ponds.
- Identify instrument-based tools that offer greater cost-efficacy, accuracy, consistency, and convenience than can be achieved with observation-based monitoring.

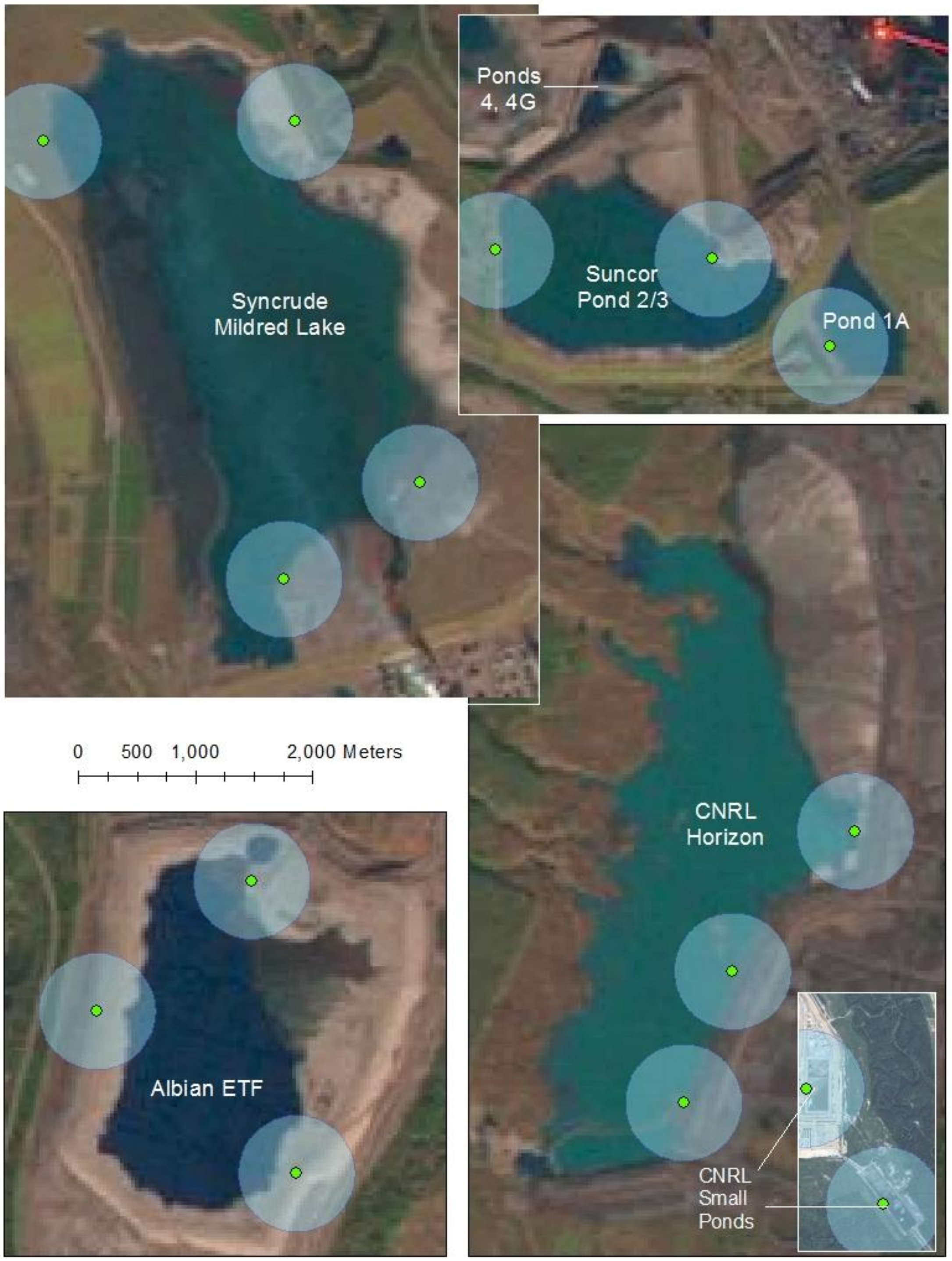
**Protocol.** Since we met on March 1, I have been investigating a variety of techniques for instrument-based monitoring. In this section, I describe only the photographic tools that could replace human observers; radar-based monitoring is described under one of the two research proposals that follow below. The most cost-effective solutions will vary for ponds of different sizes and distances from core facilities. Based on my research to date, I suggest use of the following equipment for each pond size and count type. On the following pages, I provide information about the information this equipment could generate and then make more specific recommendations.

| | # of birds flying over | # of birds landing | # of birds oiled |
|---|---|---|---|
| Large ponds (> 1.5 $km^2$) | radar | Automatic panning tripod head, telephoto lens, and digital SLR camera | Boat-based surveys supported with HD video and steadying device |
| Small ponds, (< 1.5 $km^2$) | Radar or digital SLR | Digital SLR with adjustable (zoom) lens on time lapse mode or HD video; regular tripod | Shore-based photography with HD video or digital SLR, manual panorama and telephoto lens |
| Very small ponds (< 100 m radius) | HD video camera | HD video camera or digital SLR on time lapse | HD video camera on tripod |

This picture was taken with a 200 m lens shortly after sunrise.  It is 1 km (+/- 20 m) from the camera to the inside bend of the river.

Within a photo editor, it's possible to zoom in enough to count the ducks.  The very high ISO setting on the camera (to accommodate low light) causes pixilation, but not so much that the birds (mallards at the waste water outflow) can't be counted.

This array of images describes actual tailings ponds in the oil sands region. Hypothetical survey stations are depicted as green dots and the blue circles encompass a 500 m radius. I am confident that automated cameras will collect usable data at this distance even in low light conditions, matching the observational protocol. Skilled observers with high quality scopes would be able to see more.



**Photographic equipment recommendations.** If you are prepared to invest in these techniques, I recommend the following models. If purchases are made through the University and the equipment technically belongs to it (notwithstanding the expected indefinite use at the site of operations), it would qualify for matching funding under the NSERC CRD rules.

| **Item** | **Features** | **Estimated Cost**[4] |
|---|---|---|
| Nikon D700 digital SLR camera[5] | Class-leading low-light performance.[6] Built-in time lapse | $2500 |
| Nikon telephoto lens | Manual focus 400 mm lens[7] | $2000 |
| Nikon 28-70 zoom lens | Manual focus 28-70 mm lens | $500 |
| Sony HDR-CX700V HD video camera[8] | Highest light sensitivity in class (upper end consumer model)[9] | $2500 |
| Tripod Stand[10] | Requires security and stability | ?? |

[4] Approximate prices have been provided by McBain Camera, a preferred vendor for the University of Alberta that offers corporate and bulk discounts. Actual discounts will depend on the volume of equipment ordered.

[5] SLR's have the advantage of much greater resolution (14 megapixel) than HD video (2 MP). On time-lapse, they can also monitor over a longer period with equivalent battery use.

[6] Full-sized sensor and superior optics result in better resolution and accurate and reliable auto focus in low-light compared to its closest rival Canon 5D Mark II.

[7] There is some guesswork in this quote, but manual focus lenses – which would be perfectly adequate for this application -- would be ~ 20% of the cost of new auto focus lenses. Availability is a bit uncertain and may require some patience and flexibility.

[8] HD video has the advantage of tracking the movement of actual birds, reducing the potential for double-counting, but it has much lower resolution and light-sensitivity than digital SLR's

[9] Exmor R sensor is repeatedly recognized for its low-light performance. Sony claims the Night Shot mode is capable of capturing images at 0 lux, which is 0.3 to 1.0 lux better than its closest within-class competitors.

[10] Workable and durable tripod stations may be fashioned on site. For example, oil drums filled with water would provide a sturdy wind-proof base to which a tripod could be secured. Tripod heads should have marked radians so that the precise camera position can be recreated in successive visits.

| | | |
|---|---|---|
| Tripod - Manfrotto 190XPROB | Sturdy aluminum construction; 2 needed @ $200 | $400 |
| Manfrotto 804RC2 tripod head | 3-way head capable of quick and precise independent adjustment; 1 needed with gigapan (below); 2 without | $100 |
| Gigapan tripod head[11] | Automatically takes a series of photos to support subsequent stitching of images | $1000 |
| Steady-shot video device | Glide cam 2000 pro[12] | $400 |
| Waterproof cases | One for each of SLR and HD video @ $100 | $200 |
| Software[13] | To automate video-editing | $250 |
| Labour[14] | Undergraduate student (per set of cameras) | $1650 |
| Server space | Presumed to be an in-kind provision for data back-up | $0 |
| **Total** | | **$11 500** |

**Power and memory logistics.**

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[11] The Gigapan Epic Pro can be set to take a series of images at high magnification that are later stitched together to generate a single image that is ideal for counting landed birds or birds in the air at specific times.  A time lapse function permits repeated samples of the same viewscape.  Visit http://gigapan.org/ to see examples of composite panoramas from around the world.

[12] Jerky video is hard to watch and interpret.  If video is shot in a boat or while walking, a counterweighted steadying device is essential.  The glidecam pro is one of the most popular of these devices. http://www.glidecam.com/product-2000-pro.php

[13] Open-source software will be used whenever possible.  Purchased video-editing software may be needed to automate video processing.

[14] In addition to the labour needed to place and maintain cameras, labour is needed to store and analyze the data they will produce.  For every 4 monitoring set ups, I estimate that 3 months of full time work @ $2200 / month will be needed, assuming that approximately 12 h of images are collected per camera per day.

- Gigapan Epic Pro – the rechargeable battery is capable of capturing 1000+ images. Recharging can be done while the battery is in the unit or in the included external battery charger.

- Sony HDR-CX700V with 96GB embedded Flash memory, can record and store up to 40 hours of high-definition video footage (HD LP mode; 8 hours in HD PS mode). The included rechargeable battery (NP-FV50) allows approximately 2 hours of HD recording. This battery can be upgraded (NP-FV100) to > 8 hours of recording. Batteries can be charged in the camera during operation. The optional external battery charger (AC-VQV10) simultaneously recharges two batteries more quickly than charging in the camera.

- Nikon D700 DSLR **–** battery and memory card consumption are not limiting factors. The built-in lithium ion battery is capable of 1000 images/charge. The compact flash card will hold 1000s of images (depending on compression ratio). Convenience will be increased by purchasing additional batteries and memory cards which can be carried to the camera site and swapped in a few minutes.

**Suggested number of units**. To maximize the opportunity to test equipment without committing resources prematurely, I suggest purchasing one to four sets of the camera packages outlined above in this first year. The number would depend on operation size, the number of simultaneous crews at the operation, and the speed with which transitioning to instrument-based monitoring is desired. Ideally, each simultaneous work crew would have a complete set for their use. I expect that instrument-based monitoring with capabilities comparable to observation-based monitoring will be possible and demonstrable at some ponds by the end of the spring 2011 migration period.

Retaining the ability to commit similar resources in years 2 and 3 would allow for ongoing refinement of techniques while gradually equipping each operator with the total number of cameras needed for the transition to instrument-based monitoring at each of the current observation monitoring stations by year 3.

**NB**: Even if fly-over, landing, and oiling information could be automated for every monitoring station during each morning and evening, staff would still need to visit the cameras daily to change memory cards and batteries and ensure correct camera placement. Rapid development of larger storage cards and solar powered batteries may reduce this frequency in future.

**Additional equipment suggestions.** Rob Ronconi's monitoring protocol of 16 March 2011 recommended use of spotting scopes, binoculars and range finders for observation-based monitoring. To reduce labour costs and inter-observer variability, I recommend the following items. Equivalent equipment from other manufacturers will suffice. Equipment of dramatically lower quality will introduce substantial variation among operators.

| Item | Features | Estimated Cost |
|---|---|---|
| Quality spotting scope – Zeiss Victory Diascope 85 T* FL with 20-75X Zoom[15] | Superior optics offer class-leading low-light performance. Highest zoom power available. Waterproof and anti-fog construction. | $3400.00 |
| Scope tripod - Manfrotto 190XPROB w/ 804RC2 head | Sturdy aluminum construction with 3-way head capable of quick and precise independent adjustment | $260.00 |
| Integrated range finder and binoculars - Bushnell 10 x 42 Fusion 1600 ARC Rangefinder Binocular[16] | Line of sight accuracy to 1450 m. Pin-point targeting option for small objects. Inclinometer and horizontal distance estimator for flocks in flight. | $860.00 |
| Samsung Galaxy data entry platform | | |

**Implementation Schedule and Support.** Ideally, camera maintenance can occur once per day when the observational visit occurs. Because of the random stratification of visiting times, this means that cameras would ideally need to function for up to 24 hours to capture both dawn and dusk periods.

To assist with the implementation and inevitable trouble-shooting of the instrument-based protocol, I propose to have a two-member research team visit each of the participating operators for two mornings on a regular rotation. By working actively with operators, we will develop a first-hand understanding of site characteristics and constraints and be available to tutor operator employees and contractors on equipment as needed. Simultaneously, operator employees could identify and help trouble shoot logistical constraints. I believe there would be much mutual benefit to this sharing of expertise by both parties.

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[15] Further product details available here: http://www.zeiss.com/c1256bcf0020be5f/ContentsFrame/7ef3e5ae85c42b85852571d50048b2b5

[16] Quality binoculars and a separate range finder would also function fine. For the combination, further product details available here: http://bushnell.com/products/rangefinders/Fusion-1600-arc/

To calibrate the instrument-based monitoring with direct observation at the same time periods, dawn and dusk, when landings are most likely, I will designate one or more reference sites in the vicinity of each operator where it will be possible for our research team to conduct these early morning and late evening observations. Our 2-member teams will travel with a light-weight trailer so that they can sleep at the reference sites and avoid travel time between dusk and dawn observations.

A tentative schedule would look like this: The researchers will travel to the site in the late afternoon, set up for the night, conduct the dusk observations, sleep, conduct the dawn observations and then make their way to the operator gate where I hope they could be met by one of your employees and escorted to the bird team. They'll spend the rest of the morning with your team(s) conducting whatever is their regular rotation with them. After lunch, our team will travel to the next evening's site and take some time off to accommodate this split shift. It would be ideal if they could have access to hot showers and meals at your camps when that is convenient. We'll need to discuss the best logistics for this. I will visit at least once during April and twice in May for a few days each time. I will also arrange for visits by experts in photography and radar. In this way, I hope to provide each operator with sufficient resources to begin implementing an instrument-based system by the end of spring migration. More detailed protocols will follow when we've identified the equipment each operator will use.

Although I plan to have two teams of 2 in the field, the second team (of students) is not able to start until May and then will require some training time. With these constraints, I provide a potential list of reference sites and an example of a visitation schedule that would let our researchers visit each of the operators 5 times during the migration period. Adjustments may be needed that would reduce the number of visits and it is unlikely that we could achieve more than this number if all operators participate.

Operators, I would especially appreciate your suggestions for reference sites and adjustments to this schedule. The following table describes a potential schedule for the two research teams.

**Tentative schedule for visitation** to operators by research teams during the spring migration period. This schedule addresses monitoring alone and does not include toxicology or radar support (below).

| | Team 1 | | Team 2 | |
|---|---|---|---|---|
| Nights on site | Operator | Reference[17] | Operator | Reference |
| April 18-19 | Training | | Exams | Exams |
| April 20-21 | CNRL | Compensation pond | Exams | Exams |
| April 22-23 | Shell | Jack Pine | Exams | Exams |
| April 24-25 | Imperial | Kearl | Exams | Exams |
| April 26 | Day off | | Exams | Exams |
| April 27-28 | Syncrude | Poplar Res | Exams | Exams |
| April 29-30 | Suncor | Crane Lake | Exams | Exams |
| May 1-2 | Students arrive | | Training (students) | |
| May 3-4 | CNRL | Compensation pond | Shell | Jack Pine |
| May 5-6 | Imperial | Kearl | Syncrude | Poplar Res. |
| May 7-8 | Day off | - | Suncor | Crane Lake |
| May 9-10 | CNRL | Compensation | Day off | - |
| May 11-12 | Shell | Jack Pine | Imperial | Kearl |
| May 13-14 | Syncrude | Poplar Res | Suncor | Crane Lake |
| May 15-16 | Day off | - | CNRL | Compensation |
| May 17-18 | Shell | Jack Pine | Day off | - |
| May 19-20 | Imperial | Kearl | Syncrude | Poplar |
| May 21-22 | Suncor | Crane | CNRL | Compensation |
| May 23-24 | Day off | - | Shell | Jack Pine |
| May 25-26 | Imperial | Kearl | Day off | - |
| May 27-28 | Syncrude | Poplar Res | Suncor | Crane Lake |

[17] The sites for reference lakes are tentative and we would especially welcome your suggestions.

**Post-migration brain-storming session.** To capture the good ideas that I know will be generated by everyone associated with instrument-based monitoring this spring, I would like to organize a meeting day with a wrap-up bar-b-que once the main migration season has passed. I would like take a leading role in facilitating the research-oriented feedback of this function, but I welcome your shared leadership, and ideas for timing, format, goals and venue. May 30 or 31st are logical dates for this.

**Invitation to participate in additional research projects.**

In addition to the instrument-based monitoring program, we anticipate above, I will work with collaborators to initiate two research projects this summer and have imagined a third, which is provided as partial context for the second. The projects involve innovations with radar, assessments of the toxicity caused by short-term exposure of birds to process-affected water, and mechanical methods for removing small amounts of bitumen to create safe landing zones. Of these, only objective 1 of the radar project is logically associated with the instrument-based monitoring described above. Nonetheless, all three are likely to be part of the longer term solutions for avian protection in the oil sands region and all three would depend on collaboration with operators for realistic experimentation.

I have approximated some of the costs of these projects here, but more discussion with collaborators is needed to refine these estimates. I include these descriptions now mainly to initiate dialogue with interested operators.

**1. Development of a comparable, photo-integrated, open-source radar program** in collaboration with **Phil Taylor,** Acadia University, Nova Scotia

Phil and his colleagues have used radar to monitor bird populations for many years and have developed an open-source software program (RadR; Taylor et al. 2010) that permits the recording, analysis, and replay of data collected by small marine radars. To support the necessary data storage, these researchers have also developed an open-source digitizing card by modifying a GNU radio board. Both products have been tested on several other projects and have reached a working stage of development although ongoing refinements will continue.

In addition to software and hardware development, Phil's team has addressed the mathematical problem of translating the multiple hits on a radar produced by a moving bird to a single trajectory. Accurate translation of hits to trajectories is essential to understanding the responses of birds to deterrents, identifying birds that land, and generating accurate counts of birds that fly over lease sites. This mathematical solution can be enhanced with better estimates of the azimuth and timestamp for individual pulses from the radar beam. In turn, the accuracy of these estimates are dependent on the nature of the radar's antenna and the flexibility and configuration of the digitizing card described above. For counts of birds flying overhead, a simple, open-array antenna mounted in a vertical position would be best; for the trajectory information a tilting, parabolic dish antenna would be needed.

Phil expects that future developments with FM radar will provide a low-cost, open source, system that is suitable for use at multiple sites within an oil sands lease. Within this three year project, Phil believes it would be possible to integrate radar and infra-red photography to record and identify birds flying over or landing at ponds even in complete darkness. Subsequent proposals will develop theses idea further.

**Objectives of the radar project**.

1. Identify the number of birds (as opposed to hits) that pass over each lease with a method that can be standardized and compared across sites.
2. Develop a method for accurately detecting landings using radar.
3. Integrate infra-red automated photography with radar to make it possible to identify bird species that fly over and landing on tailings ponds at night.
4. Develop an inexpensive radar that can be powered with marine batteries and solar panels for use in remote sites.
5. Assist operators in the development of skills and software to manage, describe, interpret, and compare information generated by their radar systems.

These goals would be tackled in the order in which they are outlined above. For the spring migration season, only objective number 1 is practical. Some development of objective 2 is possible this spring with full functionality expected for the fall migration 2011. Development of objectives 3 and 4 would begin this year, but would not be expected to be operational before the completion of the 3 year project.

Installation of 2 or more radars this spring with an open-array antenna would make it possible to create baseline information on the number of birds passing over each site. By making these units mobile with the provision of a trailer, they could be set up temporarily in the vicinity of each of the operators' own radar units and used to identify which forms of information can be shared among systems.

More specific methods will require further discussion.

The following list of equipment and support is an initial estimate of the resources needed to support the radar component of the project. I will spend court ordered funds on this project, but welcome collaboration from operators interested in this component.

| Item | Features | Cost |
|---|---|---|
| Radar | Furuno 1964 BB | $9 000 |
| Open array antenna | 6 or 8 feet, ??? | ??? |
| Tilting parabolic dish antenna | ???? | $14 000 |
| Digitizing card | Open-source card developed for use with RadR software (also open-source)[18] | $2 000 |
| Generator | Needs to be substantial, e.g. 3000 watt[19] | $3 000 |
| Purpose-built stand | Approximation for building | $1 000 |
| Alternative: trailer for mobile use | Trailer would need windows and doors if it is to be used subsequently to house a computer for deterrent deployment. | $5 000 – $20 000 |
| Support for radar development technician | 50% salary for Phil's radar technician for software and hardware development; discussion is needed to identify an appropriate allocation of support among operator, federal and court-ordered funding sources | $30 000 / year |
| Support for radar field technician and site visits | This would support a dedicated, experienced technician for and an assistant for 6 months; again discussion is needed to allocate support from funding sources | $33 000 / year |

[18] See description and supporting peer-reviewed publication at www.radr-project.org

[19] Additional in-kind support would be needed to provide fuel and maintenance salary to fill the generators that power the radar units. One incentive for the development of the inexpensive FM radars is that they require much less power which could be provided by solar panels.

## 2. Assessment of cumulative, but sub-lethal toxicological effects of process-affected water on young ducks

### Background

Alberta has large oil sands deposits and their development is expected to increase rapidly. The process of extracting bitumen generates large, tailings ponds for which there is no currently viable reclamation to pre-extraction condition. These ponds pose a risk to migratory birds, which fly over the area en route to important staging areas only 200 km north in Wood Buffalo National Park. That site attracts hundreds of thousands of birds each year, causing similar numbers to pass through the region each spring and fall.

Birds sometimes land on tailings ponds, particularly during severe weather in the spring or fall. Substantial contact with bitumen is lethal for birds, but birds that land without contacting bitumen typically fly away. It is unknown what longer-term effects this contact has on bird health. Constituents, or OSPM in the tailings water that potentially pose a threat to birds include: unrecovered bitumen, polycyclic aromatic hydrocarbons (PAHs), naphthenic acids, salts, ammonia, and trace metals.

The high molecular weight PAHs that pose the greatest health risks are found primarily in the sediments and are not soluble in water. Some naphthenic acids biodegrade quickly in the environment, however, the refractory fractions may persist for many years. There is evidence that salts interact with naphthenic acids and increase the toxicity effects. Exposure to these chemicals can occur through contact with skin and feathers, drinking or bathing in contaminated water, and consumption of aquatic invertebrates and vegetation.

It is important to know more about non-lethal short-term exposure because it would be much easier to prevent the birds from landing on bitumen than to prevent them from landing anywhere, particularly during severe weather.

### Objectives
Determine the effect of short-term exposure of waterfowl to tailings ponds:
- Probability of contacting bitumen
- Repeated measures of health via blood samples and immune challenges
- Growth rates and fluctuating asymmetry (just an idea)
- Toxicity measures in tissues of sacrificed birds

**Methods** (sample sizes and exposure duration are under continued discussion)

*Husbandry*
- Establish 3 replicate colonies of captive mallards ducklings
- Raise ducklings on reference ponds on the lease sites of oil sands operators

- Provide ducklings with ad libitum duck chow and natural foods
- When ducklings are at least one month old and all risk of snow storms has passed, randomly assign ducklings to control, old and young tailings ponds
- Put the old and young treatments on tailings ponds for 6 h each 7 days. Birds will be contained in an portable floating cage that prevents them from escaping via the water or the air. They will be placed in an area with no visible bitumen on the pond surface.
- Capture the control birds and house them on an adjacent reference pond in a similar manner. Birds must be weighed and blood sampled before and after exposure to ponds.

*Health measures*

- Blood samples will be collected via jugular or brachial veins at time 0 (after their acclimation period) prior to being put onto experimental sites, and on the same day after every exposure period.
- Blood samples will be processed for hematology and clinical biochemistry evaluation. These tests provide an overall indication of the health of various organs, blood parasite status, etc.). Corticosterone levels will also be measured in the birds after each exposure, which will reflect the stress they experience from short term residence time.
- We will submit samples collected from the ducks, to determine exposure to common bird pathogens (avian influenza, west nile virus, Newcastle disease virus, hematozoan parasites, etc…) during the summer research season. This will give us important background or baseline data about the types of diseases that are occurring naturally in the Oil Sands regions, and will be valuable information in the event of future die-offs, or unexplained deaths of individual birds.
- Feather samples will be collected to provide the material for heavy metal testing.
- Samples will be sent to a veterinary diagnostic laboratory for analyses.
- Once per week, collect morphometric measurements (mass, wing chord, tarsus or foot length, exposed culmen).
    - For bilaterally symmetrical features, measure both sides to derive indices of fluctuating asymmetry (a potential measure of developmental stress).
    - Assess muscle mass and fatty tissue accumulation for indications of body condition.
    - Physical condition, such as injury, disease, and the presence of external parasites will also be recorded during each measurement period.
- After 3 months, sacrifice the birds and take tissue samples (heart, lungs, liver) to measure PAHs and the suite of metals (above) found in OSPM water.
- Results will be analyzed with a generalized linear mixed models. This will allow the lease site to be a random effect and each duckling to be a second random effect in the growth study (equivalent to repeated measures ANOVA)

**Significance**. Much active debate surrounds the issue of pond toxicity to water birds. Although mortality from contact with bitumen appears to be relatively rare, there is little knowledge of the effects of short-term contact with the tailings ponds when birds are able to fly away. Determining whether or not this exposure compromises bird health will make it possible to identify best practices for avian deterrence. If adverse effects from such exposure are low, deterrence strategies are likely to change in future. In particular, safe zones might be created in the middle of ponds by removing bitumen there and intensifying deterrence efforts on the pond perimeters. Such a strategy might be temporary and adopted via flexibility in deterrence deployment during severe weather events.

The **budget** for this project remains under development and will be mainly funded by the court order. The main logistical support needed from operators is access to a site for raising the ducklings (which could double as a reference site for the instrument-based monitoring) and the ability to place ducklings on tailings ponds for the exposure trials.

### 3. Assessment of the potential to create 'safe zones' in the middle of large ponds.

This project is in its imagination-based infancy, but provides some of the impetus for project 2 above. Because it appears that birds simply must land under some weather conditions, no deterrent system is likely to be 100% successful. At such times, adjusting deterrent deployment to encourage landings in specified locations might increase the net protection of birds in the region. These locations would need to be free of bitumen and contain toxin levels that do not harm birds that are exposed to them briefly (#2 above).

Development of safe zones in the interior of large ponds might be achieved by booming and skimming large bitumen mats and using remote-controlled boats towing hair mats to adsorb small amount of residual bitumen. Because mammalian hair adsorbs, but does not absorb oil, it can be washed and reused, reducing the disposal problems of toxic waste. Somewhere in Louisiana, I'm told, 49 warehouses of human hair were collected from hair salons around the world for the gulf oil spill, but never used by BP. They found that the hair booms sunk, but inexpensive and reusable flotation devices (e.g., pool noodles) might prevent this problem. Despite the allure of this idea (at least to me), no development of this project can occur until more is known about the toxicity of process-affected ponds on waterfowl.

**What we need from you.**

1. **Short term.** If we are going to begin implementing instrument-based monitoring immediately – the epiphany of the March 1 meeting – we'll need to have funding for that equipment committed with comparable timing. Each of the equipment tables above indicated a recommended level of support for each participating operator. I can provide additional information to customize equipment to each site and operator needs.

2. **Medium term.** I will develop the NSERC CRD proposal over the coming 2 months and will need to be in regular contact with a representative of each of the operators who would like to participate in the instrument-based monitoring program with potential additional involvement in the other two projects. Over this time period, we will refine
   - the anticipated three year costs of the project,
   - its distinction from both the court-ordered project and the similar research by Phil Taylor for offshore oil platforms,
   - specific project objectives and timelines, and
   - the deliverables that will be provided at the end of the three year period.

   To support these medium term goals, I will need a modest (estimate 5 h / week) time commitment from one representative at each operation for proposal development in addition to the individuals who are participating in the collection of instrument-based monitoring data.

3. **Long term.** By the end of the three year project, we will know the extent to which instrument-based monitoring could be used to replace observation-based monitoring. My expectation is that some modest level of observation-based monitoring will always be desirable to calibrate equipment, experiment with new techniques and trouble-shoot problems. Investment this year in quality monitoring tools and secure cases for them (scopes, binoculars, tripods, tablet computers) will pay off over many subsequent years even if we succeed in making them *almost* redundant.

4. **Always.** Your questions, comments and suggestions are invaluable sources of information that will help us to develop the right tools for the job. I welcome input by any project member at any time.

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**Judit Smits – University of Calgary**

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