Hearing Exhibit #006-030
Submitted by Athabasca Chipewyan First Nation

MSES
Management and Solutions in Environmental Science

Memo

To: **Gary Perkins**, Counsel to the Joint Review Panel
File no: **1235**
From: Petr Komers, Sheri Gutsell, Sarah Hechtenthal
cc: **Jenny Biem,** Woodward & Company Barristers & Solicitors
Tel: <phone number removed>
Date: **18 November 2012**

Subject: Secretariat Questions for ACFN Witnesses

Questions for Dr. Komers

Reference: On slide 33 (PDF page) from Dr. Komers's presentation (Exhibit 006-022), there is a graph showing moose population declines. However, we understand that Shell has stated in this proceeding that there is "no data available for moose" (Page 40 of Shell's October 15, 2012 submission, Exhibit 001-070).

1. How were you able to get the ASRD and Suncor moose survey data that is shown on this graph?
   a) Was this data readily available?
   b) Is the data for an area other than the RSA, and if so, is it on a different scale or range that allows for estimating trends on moose density in the RSA?

Responses

1a)

Much of the data used to calculate the red graph on slide 32 (PDF page, assuming that there was a typo in the Secretariat communication as there is no graph on slide 33) from Dr. Komers' presentation (Exhibit 006-022) are readily available on-line on the Alberta Conservation Association website (www.ab-conservation.com). This website contains links to reports detailing Aerial Ungulate Surveys for various Wildlife Management Units (WMUs) for various years. Other data were available through direct correspondence with ASRD regional biologists. Traci Morgan from the Fort McMurray region and Grant Chapman from the Lac LaBiche area were kind enough to provide some of the data via email.

The Suncor data were also readily available on-line. In fact, we have seen the same data tables that we used produced by Golder in other Oil Sands project applications. For your convenience, we attach the Suncor 2008 data tables that were used to calculate the blue graph on slide 32 (see Appendix A below).

1b)

The ASRD data are summarized by WMU because that is the scale at which ASRD conducts its aerial surveys. ASRD data were obtained for the following WMUs: 512, 517, 518, 519, 529, 530, and 531. The year range for the data is 1993 to 2011. All of these WMUs fall within the NE Boreal forest of Alberta and roughly within the Lower Athabasca Region (Map of WMUs: http://albertaregulations.ca/huntingregs/season-wmus.html). These data allow for estimating trends in moose density in the lower Athabasca Region of Alberta rather than specifically in the Shell RSA.

The data we used provide a broader understanding of the general trends in moose populations in the Oil Sands region. These moose population data are complementary to our regional land-cover disturbance analysis shown on slide 25 (Exhibit 006-022). The WMUs we used to calculate the red graph on slide 32 (Exhibit 006-022) are depicted in Appendix B of this memo.

It is notable that the declining trends in population density are evident even when using these relatively rough data sets. Moreover, even though they are from two independent sources, both data sets (from ASRD and Suncor 2008) indicate similarly declining trends.

More detail is required to better understand the trends of moose (and other wildlife) populations in any given regional study area. Wildlife surveys need to be conducted more systematically, broken down in smaller survey blocks, and repeated in consistent time intervals. The need for better regional baseline and monitoring data has been highlighted by several independent review panels, such as the Royal Society of Canada (2010) and the Office of the Auditor General of Canada (2011). A regional data warehouse, accessible to all interested parties, is one of the key elements requested by the panels to facilitate the formulation of informed decisions. Our analysis exemplifies the needs expressed by these panels.

Reference: On November 9, 2012, Dr. Komers referenced Table 14 (Exhibit 001-002B, pdf page 124, or May 2008, EIA Update, Appendix 2, pg 64) in his presentation (006-022, pdf page 12) showing a loss of wetlands occurring from pre-disturbance to closure.

2. Are you aware that Shell expects littoral zones bordering open water in pit lakes, constructed wetlands, depressional areas created by microtopography, and areas surrounding closure drainage features to be revegetated with wetland species and to evolve into functional graminoid marsh (MONG) over time? (001-002B, pdf pg 124 or May 2008, EIA Update, Appendix 2, pg 64)

Responses (by Dr. Gutsell)

2a)

As I am not an expert in wetland ecology, my knowledge of this topic is limited to what I have observed in field surveys for EIAs and on reclamation site tours, and in reports and scientific papers that I have read on this topic. I have not researched wetland ecology or wetland reclamation techniques extensively, but my field work, observations, and expertise in terrestrial ecology informs my conclusions below regarding the reclamation of wetland vegetation types.

I am aware of Shell expectations with respect to wetland vegetation types. It is reasonable to expect that these areas will be re-vegetated with some wetland plant species. However, it is unclear how many and whether native and/or non-native species will re-colonize these areas because to my knowledge there are no studies that have documented the establishment of plant species within such areas in the oil sands region. Given that the soils underlying these areas will be the same (i.e. degraded) stockpiled soils used in terrestrial reclamation, it is reasonable to expect that many of the species to re-establish will be invasive non-native species, with some native wetland species that can tolerate the relatively wet and nutrient-poor soils. This expectation is supported by my observations in field surveys and reclamation site tours of various oil sands operations.

It is not reasonable to expect that littoral zones, constructed wetlands, depressional areas created by microtopography, and area surrounding closure drainage features will evolve into functional graminoid marshes over time. In the boreal forest, a native marsh wetland is one that is periodically inundated by standing or slow-moving water, characterized by an emergent vegetation, including reeds, rushes, sedges, and grasses (Johnson et al. 1995). The Ecosites of Northern Alberta (Beckingham and Archibold 1996) indicates that characteristic species within marshes are dominated by sedges, with lesser amounts of cattails and reed grasses, as well as a variety of other grasses, forbs, and moss. In contrast, marsh-like sites created through reclamation are typically dominated primarily by cattails, with a few other native species and often non-native plant species. Thus, their similarity, in terms of species composition and percent cover of each species, to native marsh wetlands is low.

3. Are you aware of any reclamation techniques available to reclaim non-peatland wetlands?

a) If yes, please describe them.
b) If yes, are you aware of instances where these techniques have been successfully applied?
c) If yes, in your opinion, would these be feasible options for Shell (ecologically and economically) to include as part of the Jackpine Mine Expansion closure landscape?

Responses (by Dr. Gutsell)

3a)

A non-peatland, or mineral, wetland in the boreal forest (i.e. swamp and marsh) is an area underlain by mineral soil influenced by excess water but which produces little or no peat (Johnson et al. 1995). I am aware of some techniques for reclaiming a limited number of mineral wetland plant <u>species</u>. However, I am not aware of any techniques that are capable of reclaiming mineral wetlands, with their wide variety of plant species. There is an important difference between reclaiming a wetland type and re-establishing some species that may be found within a particular wetland type. In my opinion, if most or all of the species that one might find in a native wetland, for example a marsh, have not been re-established in a reclamation site, then the reclamation site cannot be deemed to be a reclaimed marsh.

The difference between reclaiming a few species and a particular wetland type can be illustrated by looking at the data from the JPME. Out of the 16 wetland types (i.e. peatlands) that will be removed by the project, the number of species per wetland type ranges from 51 to 216, with a mean of 115 species (JPME Terrestrial Report, Appendix L). Unfortunately, there is no data available for mineral wetlands in the JPME because there are none in the pre-disturbance landscape. However, it is well known that wetlands are species rich and therefore for reclamation of these wetlands to be successful, a large number of species must become established.

3b)

Vitt et al. (2011) showed two reclamation techniques that were successful in re-establishing two wetland plant species: 1) transplantation (of the sedge species *Carex aquatilis*) from nearby fen wetlands and 2) planting from rooted cuttings (of the shrub species *Salix lutea*). Each technique was successful for one species and results presented were from two growing seasons. It is unknown if the success of these techniques will continue beyond the two year timeframe of the study. I have also recently observed willow species grown from cuttings successfully established in one of Shell's reclamation research plots. The plots were only approximately 2 years old.

3c)
By the very nature of the technique, transplantation of species from intact wetlands onto reclamation sites may be feasible on a very small scale. Unfortunately, the large-scale removal of plant species from intact wetlands will cause damage to the intact wetland and likely result in an influx of non-native plant species into the disturbed soils.

The technique of planting cuttings is also limited to small scales, as indicated by Shell in their recent CC&R plan (Jack Pine Mine Phase 1 - Integrated CC&R Plan, 2011):
"*Directly placing hardwood cuttings harvested in winter and stored frozen until early spring is a method used primarily for willows, but has been used for aspen and dogwood (Landhäusser et al., 1996). This technique is more appropriate for small reclamation projects and will be used sparingly for the Jackpine Mine in isolated and smaller conditions (for example, wetland edges)*."

4. If Shell successfully constructs non-peatland wetlands as part of the closure landscape, in your opinion, would these areas serve as effective habitat for wetland species?
   a) In your opinion, would species return to this type of reclaimed ecosite?
   b) If yes, in your opinion, how long would it take for the majority of currently present pre-development wetland dependent species to return to the area?

Responses

4 a)

(Note that this response assumes the question refers to plant species in the closure landscape.) As indicated in the response to Question 3 above, there is currently no evidence to show that Shell can successfully construct non-peatland (i.e. mineral) wetlands, with their variety of associated plant species. They may be able to re-establish some wetland plant species; however, as indicated above, the number of plant species that Shell is able to re-establish is far below that found in native wetlands. Based on Dr. Gutsell's observations of reclaimed sites, only a relatively small number of wetland species are able to return to a wet reclaimed site.

Whether or not species return to a reclaimed site depends on a) the quality of the site as a wetland, and b) the source populations of the wildlife species in question. Habitat quality depends a great deal on the vegetation composition of the site. As Dr. Gutsell and I discussed in our submissions, Shell's current reclamation plans do not include planting the necessary diversity of vegetation species that is needed to achieve a vegetation community composition similar to that of pre-disturbance conditions. This is problematic because the re-establishment of a wildlife species is often correlated with the quality of the resources in their habitats. If Shell can concretely demonstrate that pre-disturbance vegetation composition has been achieved for any reclaimed habitat, then we could assume that the reclaimed habitat contains the resources required to serve as effective habitat for the re-colonization of wildlife.

However, re-establishing wildlife is more complicated than just the reclamation of vegetation. Predation and hunting regimes also affect successful re-establishment of wildlife. Land disturbance results in the introduction of invasive predator species such as magpies, coyotes and small predators. Too much human and predator disturbance may keep prey species from returning to an area. Moreover, the surrounding landscape and source populations also play an important role in re-establishing wildlife. The problem we increasingly face in the Oil Sands region is that large regions are being disturbed and large tracts of effective habitat are continually being removed, thus impacting potential source populations on the landscape. In a recent study we found that moose refrain from using small habitat fragments that are isolated from each other and that fragmentation of the landscape makes it difficult for animals to use isolated patches of natural habitat (Stewart and Komers 2012). The lack of successful moose re-establishment on reclaimed sites in the Oil Sands region appears to support our findings.

Therefore, in addition to the successful re-establishment of natural vegetation communities, landscapes that have high connectivity between natural habitat patches, including wetlands (which are naturally interconnected by riparian corridors), and where human access is restricted, are necessary in order to create effective habitat for wildlife re-establishment.

In summary, wetland wildlife species would return to reclaimed wetlands, if a) the wetlands contain the natural diversity of vegetation species, b) the landscape context allows for wildlife to reach and successfully use the wetland resources, and c) the source populations of wetland wildlife species exist in the region.

4b)

For the reasons discussed under 4a), it is not possible to make predictions for successful wildlife re-establishment with any certainty. A great deal of research is still required, and numerous successes need to be demonstrated in Oil Sands reclamation, before we can make an informed decision about whether or not the full complement of wetland wildlife species will re-establish on reclaimed wetlands. With the current lack of available data and knowledge on the subject, I can only offer a professional guess which is that it will be decades after the full re-establishment of vegetation community composition before a full complement of wildlife species will return to any given reclaimed wetland.

Questions for Dr. Gutsell

Reference: On November 9, 2012, Dr. Gutsell presented on reclamation and vegetation diversity (Exhibit 006-022, pdf pg 46-62), referencing Shell's assumption that some species will ingress naturally into reclamation areas through natural dispersion.

1. In your opinion, if Shell's current plans for re-vegetation are followed, how long will it take for species diversity equal to pre-disturbance levels to re-establish through the natural ingress of species?

Response

1)

It is unknown if and when the diversity of species equal to pre-disturbance levels will ever re-establish through the natural ingress of species; however, based on available data, it is unlikely that this will occur. The main challenge with the re-establishment of many native plant species is that they cannot tolerate the altered conditions of soils that are spread back onto reclamation sites. The topsoil spread within reclamation sites is very different from the nutrient- and moisture-rich areas of exposed mineral soil or humus found within burned stands in the first few years after fire. This is primarily because reclamation topsoils are usually stored in stockpiles for long periods, from months to years. Stockpiling soils for long periods causes significant changes in many of the soil's biological, chemical, and physical characteristics that are important to plant re-establishment. When stockpiled soils are spread back onto reclamation sites, many of the nutrients are lost after several weeks through leeching and denitrification because few plants are immediately available to take it up (Johnson and Williamson 1994). An additional problem is that during mound construction and consolidation that occurs during soil storage, soils become compacted, which causes increases in bulk density and a deterioration of the soil structure. All of these changes in soil quality mean that once these degraded stockpiled soils are spread back onto reclamation sites, very few native plant species are able to naturally re-establish. Plant species that can naturally re-establish within these soils are those that can tolerate the relatively poor condition of these soils, and it is the non-native, invasive species that often have these characteristics. Shell believes that the characteristics of reclamation soil will improve over time, which may be the case to some extent. However, I have not seen evidence of reclamation soils that have regained the biological, chemical, and physical properties similar to natural soils.

2. Are you aware of any specific species dispersal mechanisms that could aid the ingress of local species to Shell's reclaimed lands?

Response

2)

I am aware of three dispersal mechanisms of plant species in the boreal forest and these include the transport of seeds by wind, water, and animals. Some seeds are carried by wind or water and may land on reclamation sites and germinate. Some seeds are consumed by animals and remain intact; when feces with intact seeds are deposited within reclamation sites, the seeds may germinate. Some plant species have seeds that are covered by mucus, spines, barbs, or hooks that attach to the bodies of animals. When these animals enter reclaimed sites and the seeds fall off, these seeds may germinate.

3. How would you expect potential dispersal barriers, such as fragmentation of habitat, to impact diversity on Shell's reclaimed lands?
a) Would natural barriers to species dispersal such as rivers impact species dispersal into the Jackpine Mine Expansion area following reclamation?
b) If yes, please identify any specific locations based on the Shell Jackpine Mine Expansion closure plan (001-015A, pdf page 24, or May 2011, Submission of Information to the Joint Review Panel, pg 19) you would foresee as barriers to dispersal.

Response

3a)

Fragmentation of habitat may affect plant species that rely on the wind dispersal of their seeds and the effect will depend on the size of landscape that is disturbed. Each plant species has a wind dispersal curve that indicates the distance that their seeds can travel and typically this curve has a negative slope, with most seeds falling close to the plant that produced it, and increasingly fewer seeds falling as distance from the parent plant increases. Unfortunately, I am not aware of any published studies that have examined the dispersal curve of the many boreal forest plant species, although I have not researched this topic specifically. It would take some time to investigate and beyond the timeframe I have been given to answer to this question. I am aware of dispersal curves for boreal forest tree species and those curves indicate that most seeds fall within the first few hundred metres of the parent tree and some are able to travel up to one or two kilometres. Given the large size of the Shell JPME, over 12,000 ha, it is likely that many areas within the disturbed area will be outside of the wind dispersal distance of many plant species.

Dispersal by water depends on the distance a parent plant is to flowing water and whether this water travels into reclamation sites. I have not examined the extent of land clearing that includes flowing water bodies and do not know how many species rely on water dispersal of their seeds, so I cannot comment further on the effects of the project on plant species that rely on water dispersal of their seeds.

Plant species that rely on animal dispersal of their seeds may also be limited by fragmentation and the large area of disturbance. The animal dispersing the seeds must travel to the reclaimed area in order to deposit seeds. Therefore, if habitat is not yet available for animals to travel into, then fragmentation will affect the dispersal of these plant species. Unfortunately, I cannot be more specific on the extent of these effects as I have not investigated this topic.

3b)

It is difficult to answer this question because of the many unknown variables discussed above. Generally, the areas beyond the first 500 hundred metres from the edge of the disturbed area (where native plant species are found) will have significant limitations to the natural dispersal of seeds.

Questions for Sarah Hechtenthal

1. Are there any studies or findings relating to birds that survive landings in tailings ponds? What do we know of their fate after they leave for either winter or summer breeding grounds?

   a) In particular, is there information that addresses how oilings may affect reproductive success on the breeding grounds?

   b) Would you agree with the statement from Timoney and Ronconi (2010; submitted by Shell as evidence, 001-070JJ, p.573) that "mortality rates of oiled birds are unknown"?

Responses

1. **Are there any studies or findings relating to birds that survive landings in tailings ponds?**

In my research to date I have not come across any published studies that have investigated post-contamination survival rates for birds that come into contact with tailings ponds at oilsands mines in Alberta. This lack of available data regarding mortality rates and long-term survival is a critical knowledge gap and impedes Shell's ability to accurately assess impacts to migratory birds as a result of hazards posed by existing and proposed tailings ponds.

There are, however, numerous studies from other regions relating to birds that are exposed to contaminated waterbodies. Some of these studies investigate acute effects, and others longer-term effects of exposure to contaminants in migratory bird habitat (see Jenssen 1994 and Smith et al. 2007 for reviews). The majority of the research on short- and long-term survival rates is based on data collected from oil spills, natural oil seepages, oil field wastepits, and leaks into fresh- and saltwater environments. Studies have used radio-telemetry to monitor whether contaminated birds survive and return to normal biological function, and to assess the status of populations using various demographic models. As a result, there is now an extensive body of knowledge on the subject of lethal and sub-lethal impacts from exposure to various contaminants (reviewed in Leighton 1993, Stephenson 1997, Trail 2006), and potential impacts to population dynamics (see Henkel et al. 2012; Iverson and Esler 2010).

Overall, these studies have shown that there are numerous variables that determine survival rates of contaminated birds including type of contaminant, amount and length of exposure, climate conditions, affected species, time of year, etc. This continues to be an active area of research.

1a) What do we know of their fate after they leave for either winter or summer breeding grounds? In particular, is there information that addresses how oilings may affect reproductive success on the breeding grounds?

There is a large body of literature on how sub-lethal exposure to various contaminants, but particularly oil, impact not only survival, but also reproductive success in birds (reviewed by Albers

1983, Leighton 1993, Hoffman and Easton 1981, Walton et al. 1997, Valando et al. 2005, Finch et al. 2011). For migratory birds, contaminants encountered in nonbreeding habitats, i.e. stopover sites on their way to breeding grounds, have been shown to affect reproductive success (reviewed in Harrison et al. 2011). Reduced reproductive success occurs through a number of pathways including mortality and developmental defects in embryos via direct contact of contaminants with eggshells, sub-lethal toxicological effects in adults and chicks, metabolic effects, and behavioural changes (Henkel et al. 2012). This, combined with effects causing mortality, can lead to population declines (see Figure 1).

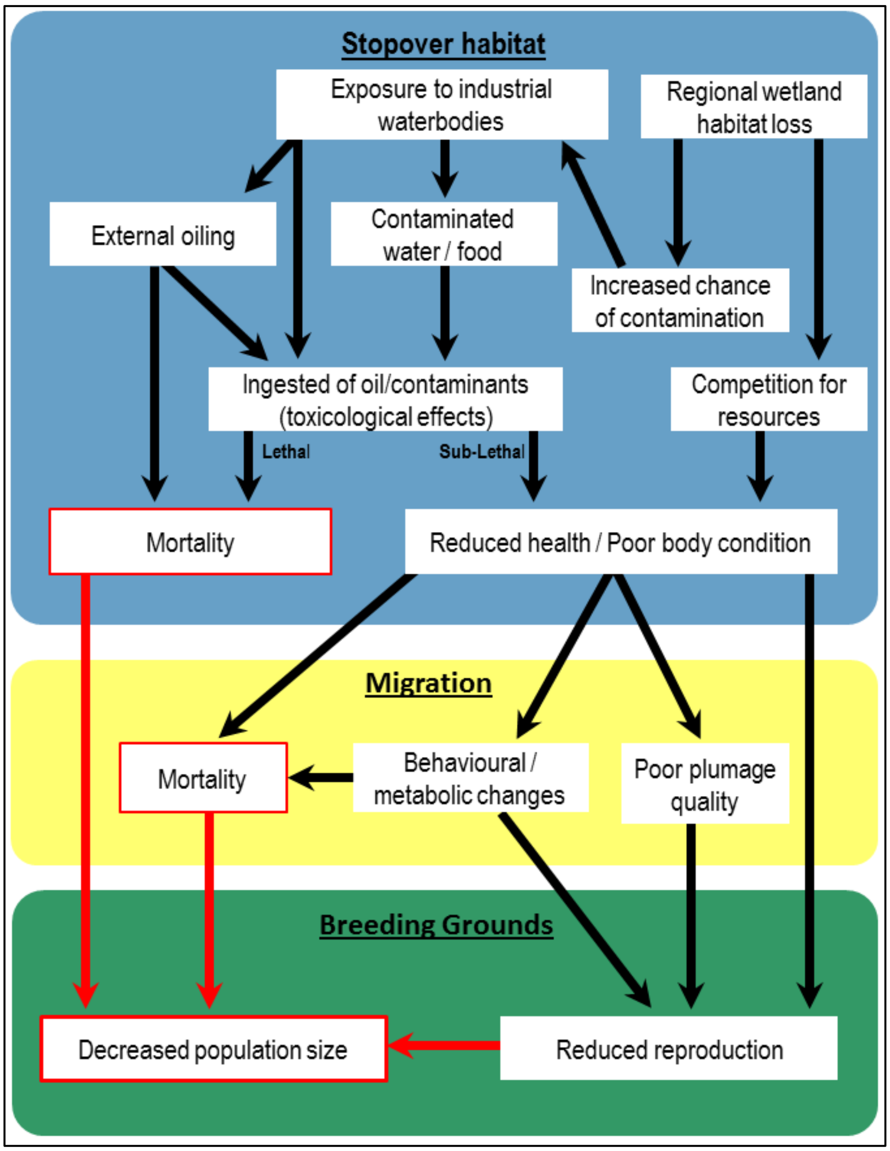


Figure 1 – Contamination pathways and potential carryover effects for migratory birds at each stage of migration to breeding grounds (modified from Henkel et al. 2012).

Understanding factors that can influence reproductive success and population health of a species is critical in assessing the risks associated with anthropogenically caused mortality (incidental take). Vulnerability to population-level effects differs between species because of different life-history parameters that affect population growth rates (e.g. clutch size, survival of young, adult survival, and age structure). Therefore, the potential for population-level effects resulting from a reduced reproductive rate and/or incidental take needs to be assessed using appropriate parameters for the bird species or group in question (Iverson and Esler 2010).

Additionally, a total population estimate for the bird species or group in question must be considered in order to accurately assess impacts and risks associated with increased mortality and decreased reproduction. For example, in the Alberta oilsands, it is largely migratory waterfowl (ducks, swans, geese), waterbirds (herons, grebes, loons) and shorebirds that are most at risk of making contact with industrial waterbodies and becoming contaminated. By contrast, it is largely migratory landbirds (songbirds) that are at risk of being impacted by building strikes and cats. Estimates for total number of birds in each of these groups breeding in North America's boreal forest are shown in Table 1.

Table 1 – Estimated total breeding populations of birds in the North American boreal forest separated by group (data from Wells and Blancher, 2011).

Bird Group	Estimated Breeding Population
Landbirds	1,600,000,000
Shorebirds	7,000,000
Waterbirds & Waterfowl	40,000,000

Table 1 indicates that, with an estimated breeding population of 1.6 billion, landbirds are the most numerous group of migratory bird breeding in the boreal forest. Whereas the total combined estimated breeding population for shorebirds, waterbirds and waterfowl is less than 50 million. Therefore, comparing the risks associated with mortality for landbirds with that of waterbirds, and vice versa, is not appropriate because the causes of mortality differ, and because the potential for population-level effects differs.

Using a species-specific context for risk assessment becomes especially critical when dealing with Species at Risk, where even small impacts to survival and reproductive rates can have population-level effects. Federally listed Species at Risk (COSEWIC and SARA) do migrate over the Alberta oil sands including: Peregrine falcon (Falco peregrinus), Whooping cranes (Grus americana), Yellow rails (Coturnicops noveboracensis), Horned grebes (Podiceps auritus), Red knots (Calidris canutus), Common nighthawks (Chordeiles minor), Rusty blackbirds (Euphagus carolinus), Barn swallows (Hirundo rustic) and Canada warblers (Wilsonia canadensis). At least five of these species were detected during a single year of surveys conducted in the Alberta oil sands region (St. Clair et al. 2012).

1b) Would you agree with the statement from Timoney and Ronconi (2010; submitted by Shell as evidence, 001-070JJ, p.573) that "mortality rates of oiled birds are unknown"?

In the context of the sentence from which this quote was taken, yes I would agree. In the Alberta oilsands, total mortality rates (direct and indirect) for birds that come into direct contact with bitumen have yet to be quantified. Similarly, mortality rates for birds that come into direct contact with contaminants in industrial waterbodies (not just bitumen) have yet to be quantified.

However, mortality rates for oiled birds have been the focus of intensive studies over the past 30 years. Because it is well documented that the numbers of oiled wildlife observed and recovered at contamination events are often much lower than actual numbers of wildlife affected, USFWS commonly uses mathematical models to estimate actual wildlife mortality (Ford et al. 1987, 1996, 2001, 2009; Page et al. 1990; Hampton et al. 2002, 2003). The Beached Bird Model was one of the first models developed to estimate the total potential number of oiled birds and partitions them among possible fates (see Ford et al. 1987). Numerous other models have since been developed including the Oiled Seabird Mortality Model (OSMM) which has been widely used and applied internationally (Wiese and Robertson 2004). The accuracy of these models is tested and verified using data collected from contamination events (Page et al. 1990, Hampton et al. 2003, Ford et al. 2009).

An example of this type of model from an inland scenario is a wildlife impact assessment conducted in California for a mining company that discharges hypersaline wastewater containing various chemicals, including oil, into ponds that cover over 4 km^2. USFWS started an investigation into on-going mortality of migratory birds in these ponds. Species affected included grebes, loons, ducks, and other birds that are attracted to open waterbodies. In this case, the model derived a total mortality multiplier of 2.86; that is, that the total number of dead birds was estimated to be 2.86 times higher than the number dead birds found at the site (see Hampton et al. 2002). The model allowed for the calculation of an annual rate of morality of 486 birds/year at this facility.

Overall, these models assist in reducing the uncertainty in mortality estimates and allows for quantitative estimates to be incorporated into an assessment of impact. Similarly, Timoney and Ronconi (2010) were the first researchers in Alberta to attempt to address the uncertainty that exists in mortality rates in the oilsands and based their mortality estimates on recent and systematically collected data (published and unpublished) from the Shell Muskeg River Mine tailings pond.

Literature Cited

Albers, P. H. 1983. Effects of oil on avian reproduction: a review and discussion. The Effects of Oil on Birds: Physiological Research, Clinical Applications & Rehabilitation, 78-97

Beckingham, J.D. and Archibold, J.H. 1996. Field Guide to Ecosites of Northern Alberta. Canadian Forest Service, Northwest Region, Northern Forestry Centre.

Finch, B.E., M. Wooten, K, J., and P.N. Smith. 2011. Embryotoxicity of weathered crude oil from the Gulf of Mexico in mallard ducks (*Anas platyrhynchos*). Environmental Toxicity and Chemistry 30 (8): 1885-1891.

Ford, R. G., Page, G.W., and Carter, H.R. 1987. Estimating mortality of seabirds from oils spills. In: Proceedings of the 1987 Oil Spill Conference, American Petroleum Institute, Washington, D.C. pp. 547-551.

Ford, R.G., M.L. Bonnell, D.H. Varoujean, G.W. Page, H.R. Carter, B.E. Sharp, D. Heinemann, and J.L. Casey. 1996. Total direct mortality of seabirds from the Exxon Valdez oil spill. Pp. 684-711 *In* Rice, S.D., R.B. Spies, D.A. Wolfe, and B.A. Wright, eds. Exxon Valdez Oil Spill Symposium proceedings. Am. Fisheries Soc. Symp. 18.

Ford, R. G., Himes Boor, G.K., and Caylor Ward, J. 2001. Seabird mortality resulting from the M/V New Carissa oil spill incident February and March 1999 – Final Report. Report prepared for US Fish and Wildlife Service, Oregon Fish and Wildlife Office, Portland, OR.

Ford, R. G., Casey, J. L., & Williams, W. A. 2009. Acute seabird and waterfowl mortality resulting from the M/V Cosco Busan oil spill, November 7, 2007. Report prepared for California Department of Fish and Game Office of Spill Prevention and Response, Sacramento, CA.

Hampton, S., Yamamoto, J., and D. Racine. 2002. Assessment of natural resource injuries to birds at Searles Lake 1998-2001. Report prepared for California Department of Fish and Game, San Bernardino County, CA.

Hampton, S., Ford, R.G., Carter, H.R., Abraham, C. & Humple, D. 2003. Chronic oiling and seabird mortality from the sunken vessel S.S. Jacob Luckenbach in Central California. Marine Ornithology 31: 35-41.

Harrison, X.A, Blount I.D., Inger, R., Norris, D.R., and S. Bearhop. 2011. Carry-over effects as drivers of fitness differences in animals. Journal of Animal Ecology 80:4-18.

Henkel, J.R, Sigel, B.J, and C.M. Taylor. 2012. Large-scale impacts of the Deepwater Horizon Oil Spill: Can local disturbance affect distant ecosystems through migratory shorebirds? BioScience 62(7):676-685.

Hoffman, D.J, and W. C. Eastin Jr. 1981. Effects of industrial effluents, heavy metals, and organic solvents on mallard embryo development. Toxicology Letters, 9:35-40.

Iverson, S.A and D. Esler. 2010. Harlequin Duck population injury and recovery dynamics following the 1989 Exxon Valdez oil spill. Ecological Applications, 20 (7): 1993-2006.

Jenssen, B. M. 1994. Review article: Effects of oil pollution, chemically treated oil, and cleaning on thermal balance of birds. Environmental Pollution, 86(2), 207-215.

Johnson, D.B. and Williamson, J.C. 1994. Conservation of mineral nitrogen in restored soils at opencast coal mine sites: I. Results from field studies of nitrogen transformations following restoration. European Journal of Soil Science 45: 311-317.

Landhäusser, S.M., K.J. Stadt, and V.J. Lieffers. 1996. Competition between Calamagrostis canadensis and three replacement species at different densities and times of seeding. *Journal of Applied Ecology* 33: 1517-1526.

Leighton, F.A. 1993. The toxicity of petroleum oils to birds. Environmental Reviews. 1: 92-103.

Office of the Auditor General of Canada 2011: The Commissioner's Perspective: Chapter 2 - Assessing Cumulative Environmental Effects of Oil Sands Projects. Report of the Commissioner of the Environment and Sustainable Development to the House of Commons. 16pp.

Page, G.W., Carter, H.R. and R.G. Ford. 1990. Numbers of seabirds killed or debilitated in the 1986 Apex Houston oil spill in central California. Studies in Avian Biology 14:164-174.

Royal Society of Canada Expert Panel (RSC) 2010. Environmental and Health Impacts of Canada's Oil Sands Industry.

Smith, P. N., Cobb, G. P., Godard-Codding, C., Hoff, D., McMurry, S. T., Rainwater, T. R., & Reynolds, K. D. 2007. Contaminant exposure in terrestrial vertebrates. Environmental Pollution, 150(1), 41-64.

St. Clair, C.C., T. Habib, S. Loots, J, Ball, and C. McCallum. 2012. 2011 Annual Report of the Regional Bird Monitoring Program for the Oil Sands Region. Department of Biological Sciences, University of Alberta, Edmonton, Alberta.

Stephenson, R. 1997. Effects of oil and other surface-active organic pollutants on aquatic birds. Environmental Conservation 24(2):121-129.

Stewart, A. and P.E. Komers. 2012. Testing the Ideal Free Distribution Hypothesis: Moose Response to Changes in Habitat Amount. *ISRN Ecology*. Article ID 945209, doi:10.5402/2012/945209. pdf available at: http://www.isrn.com/journals/ecology/aip/.

Trail, P. W. 2006. Avian mortality at oil pits in the United States: a review of the problem and efforts for its solution. Environmental management, 38(4), 532-544.

Velando, A., Alvarez, D., Mourino, J., Arcos, F., and A. Barros. 2005. Population trends and reproductive success of the European shag *Phalacrocorax aristotelis* on the Iberian peninsula following the Prestige oil spill. Journal of Ornithology 146 (2): 116-120.

Vitt, D.H., R.K. Wiederb, B. Xua, M. Kaskiea, and S. Koropchaka 2011. Peatland establishment on mineral soils: Effects of water level, amendments, and species after two growing seasons. *Ecological Engineering* 37: 354–363

Walton, P., C.M.R. Turner, G. Austin, M.D. Burns, and P. Monaghan. 1997. Sub-lethal effects of an oil pollution incident on breeding kittiwakes *Rissa tridactyla*. Marine Ecology Progress Series 155:261-268.

Wells, J.V. and P.J. Blancher. 2011. Global role for sustaining bird populations, Pp 7-22 In J.V Wells (editor). Boreal Birds of North America: a hemispheric view of their conservation links and significance. Studies in Avian Biology (no. 41), University of California Press, Berkley, CA.

Wiese, F.K. and G.J. Robertson. 2004. Assessing seabird mortality from chronic oil discharges at sea. Journal of Wildlife Management 68: 627-638.

APPENDIX A

Suncor 2008 Data Table Used to Calculate the Moose Population Trend based on Suncor Data

OIL SANDS

Suncor Energy Inc.
Oil Sands
P.O. Box 4001
Fort McMurray, Alberta T9H 3E3
Website: www.suncor.com

March 6, 2008
HAND DELIVERED

Mr. Stephen Smith
Executive Manager, Fort McMurray Oil Sands Branch
Energy Resources Conservation Board
2nd Floor, Provincial Building
9915 Franklin Avenue
Fort McMurray, AB T9H 2K4

Mr. Kem Singh
Regional Approvals Manager, Northern Region
Alberta Environment
111 Twin Atria Building
4999-98 Avenue
Edmonton, AB T6B 2X3

Dear Sirs:

Re: Application for Suncor Mine Dump 9

Suncor Energy Inc. (Suncor) applies to the Energy Resources Conservation Board (ERCB) and Alberta Environment (AENV) in this combined application comprising the Project Description (Volume 1) and the Environmental Assessment (EA) Report (Volume 2) for approval of Mine Dump 9 (MD9).

Suncor applies to the ERCB pursuant to Sections 10 and 13 of the *Oil Sands Conservation Act* (OSCA) to amend Approval 8535 (as amended) as follows:

- Approval of the scheme to expand mining operations as described in this application, including:
  - the development and operation of the MD9 as described in this application; and
  - alteration of the currently approved reclamation plan to include MD9.

Suncor also submits the MD9 EA Report to the Director of Environmental Assessment, Alberta Environment pursuant to Section 50 of the *Environmental Protection and Enhancement Act* (EPEA). Suncor requests confirmation from the Director to the ERCB that the report is complete as required pursuant to Section 53 of EPEA.

Suncor seeks approval from AENV to modify the existing Fort McMurray oil sands operations and reclamation plan as proposed in the application. Accordingly, Suncor applies pursuant to Sections 66 and 70 of EPEA to amend Approval 94-02-00 (as amended).

Suncor also seeks approval from AENV pursuant to sections 36 and 49 of the *Water Act* for activities with respect to the collection, impoundment and diversion of surface and groundwater during the construction, operation and reclamation of MD9 and the southern portion of the existing mining operations area.

This combined application has been developed to combine all information required under the OSCA, EPEA and WA into one document to facilitate and expedite the regulatory review of the project.

Correspondence regarding this application should be directed to:

Doug Johnson, Manager Environmental Assessment
Suncor Energy Inc., Oil Sands
P.O. Box 4001
Fort McMurray, Alberta, T9H 3E3
Telephone: (780) 743-6806
Fax: (780) 790-7287
E-Mail: dcjohnson@suncor.com

Sincerely,

SUNCOR ENERGY INC

<original signed by>

Doug Johnson
Manager, Environmental Assessment

APPENDIX 8-IV

HISTORIC WILDLIFE SURVEY RESULTS IN THE OIL SANDS REGION PLUS MILLENNIUM MINE DUMP 9 RESULTS

Table 8-IV-1 Moose Aerial Survey Results Within the Oil Sands Region

Year	Project	Results (individuals/km² unless otherwise noted)	Habitat	Reference
1969 to 1985	Alberta Environment	0.21 to 0.54	n/a	Gunderson and Rippin (1981) cited in BP Resources et al. (1985)
1973	Alberta Environment	0.50	n/a	Bibaud and Archer (1973)
1975 to 1976	Syncrude Lease 17	0.23	preferred tall shrub, deciduous and avoided mixedwood in early winter; preferred tall shrub and avoided coniferous in late winter	Penner (1976)
1977	AOSERP[(a)]	0.03 in muskeg 0.23 in aspen 0.27 in river bottom	n/a	Cook and Jacobsen (1978)
1977 to 1978	AOSERP	0.26 in March 0.28 in December 0.19 in February	n/a	Hauge and Keith (1981) as reported in Conor Pacific (1998)
1978	Syncrude	0.10	n/a	Hauge and Keith (1981)
1978 to 1979	Esso	0.14 to 0.18	n/a	Esso (1979)
1978 to 1981	Alberta Environment	0.25 to 0.34	n/a	Gunderson and Rippin (1981) cited in BP Resources (1985)
1979 to 1980	Syncrude	0.13 in December 0.23 in February	December most in mixedwood, black spruce-muskeg and shrub February most in deciduous and mixedwood	Westworth (1980)
1980	Canstar Project 80	0.10 in December	most in riparian shrub and black spruce-muskeg	Skinner and Westworth (1981)
1981	Dome Petroleum Ltd	0.17	n/a	Roe (1984) cited in Suncor (1995)
1981 to 1982	Canstar Lease	0.33 in early winter 0.32 in late winter	most in mixedwood, aspen and willow wetlands in early winter most in willow wetlands, mixedwood, black spruce and aspen in late winter	Westworth and Brusnyk (1982)
1983	AOSTRA	0.18 in February	n/a	Green (1983) as reported in Conor Pacific (1998)
1985	Alberta Environment	0.52	n/a	Penner and Ealey, cited in Suncor (1995)
1986	OSLO[(b)]	0.11 in early winter 0.07 in late winter	n/a	Salter and Duncan (1986)
1991	Esso Resources Ltd.	0.14	n/a	Brusnyk et al. (1991) cited in Esso (1997)
1992 to 1993	Alberta Environment	0.10	n/a	AENV, Fish and Wildlife Division, cited in Esso (1997)
1995	Solv-Ex	0.01 in March	n/a	Bovar-Concord Environmental (1995)
1995	Syncrude Aurora North	0.10 in January	most in black spruce-tamarack	Westworth, Brusnyk and Associates (1996b)

Table 8-IV-1 Moose Aerial Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (individuals/km^2 unless otherwise noted)	Habitat	Reference
1996	Suncor Mine, Lease 23 and Steepbank Mine	0.20 in February 0.32 in December	preferred closed deciduous, closed mixedwood and avoided closed jack pine, closed white spruce, mixed coniferous, black spruce, wetlands shrub complex and disturbed habitat in February; avoided closed jack pine, closed white spruce and mixed coniferous in December	Westworth, Brusnyk and Associates (1996a)
1996	Steepbank Study Area	0.24 in February 0.24 in December	preferred closed deciduous, closed mixedwood and avoided closed jack pine, closed white spruce, mixed coniferous, black spruce, wetlands shrub complex and disturbed habitat in February avoided closed jack pine, closed white spruce and mixed coniferous in December	Westworth, Brusnyk and Associates (1996a)
1998	Suncor Firebag Project	0.2 in February	most in FTNN	Suncor (2000)
1999	Mobil Lease 36	0.22 in February	most in FONS, FTNN and FT/STNN	Golder (1999b)
1999 to 2000	Petro-Canada MacKay River	0.37 in December 0.17 in February	found mostly in d1	AXYS (2000a)
2000	Canadian Natural PAW Project	0.07	n/a	Canadian Natural (2000)
2000	PanCanadian Christina Lake Thermal Project Study Area	0.04 in late winter	three in BTNN and two in FTNN	Golder (2000c)
2000	TrueNorth Fort Hills Oil Sands Project	0.22 in mid winter 0.25 in late winter	only in d1, b1 and disturbed in mid winter most in d1 and d2 in late winter	Golder (2000d)
2000	OPTI Long Lake Project	0.20 in January 0.28 in March	most observations in FTNN and BTNN	OPTI (2000)
2001	Rio Alto Kirby Project	0.08 in February	two moose observed in FTNN	Rio Alto (2002)
2001	Petro-Canada Meadow Creek Project	0.21 in February	most observations in FTNN, d2 and e1	Petro-Canada (2001)
2001	Shell Jackpine Mine – Phase 1	0.21	most observations in FTNN, h1, SONS and d2	Golder (2002c)
2001	Canadian Natural Horizon Project	0.15	most observations in d1, d2 and e1	Canadian Natural (2002)
2002	Petro-Canada Meadow Creek Aerial Ungulate Survey	0.10 in February	observed in BTNN, SONS, FTNN, d1, d2 and d3 ecosite phases/wetlands types	Golder (2002b)

Table 8-IV-1 Moose Aerial Survey Results Within the Oil Sands Region (continued)

Year	Project	Results (individuals/km² unless otherwise noted)	Habitat	Reference
2003	Petro-Canada Meadow Creek Aerial Caribou Survey	0.13 in February	observed in d3, g1, BTNN, SONS, and WONN ecosite phase/wetlands types	Golder (2003a)
2002	Suncor South Tailings Pond Project	0.1	observed in b3 and FTNN	Golder (2003c)
2002	Devon-Jackfish Project	0.16	most observations in closed aspen forest	Devon Canada (2004)
2003	EnCana-Christina Lake Thermal Project	0.09	observed in d2 and FONS	Golder (2004)
2004	MEG Energy	0.07	observed within d1, d2, BTNN and FONS	MEG (2005)
2004	Suncor Voyageur	0.10 0.05	observed in b3 observed in FTNN	Golder (2005h)
2004 to 2005	Primrose East Expansion	0.05	observed in d1, d2, BTNN, and FONS	Canadian Natural (2006)
2006	Devon – Jackfish 2 Project	0.16	observed in burn area, aspen forest, mixedwood forest, treed bog, treed fen, tall shrub, and open jack pine forest	Devon Canada (2006)
2006	Suncor Voyageur South	0.25	observed in d1, FTNN, cutblocks, BTNN, FONS	Suncor (2007)
2006	EnCana Christina Lake Expansion	0.06	observed in FTNN, FONS	Non-published data
2007	Canadian Natural Kirby	no observations	n/a	Non-published data
2007	Shell Jackpine Expansion and Pierre River Mining Areas	0.22 n/a	observed in BUu, BTNN, CC, d1, d2, FTNN, FONG n/a	Non-published data
2007	Suncor Millennium MD-9	0.03	observed in d2, BTNN, FTNN	Present study

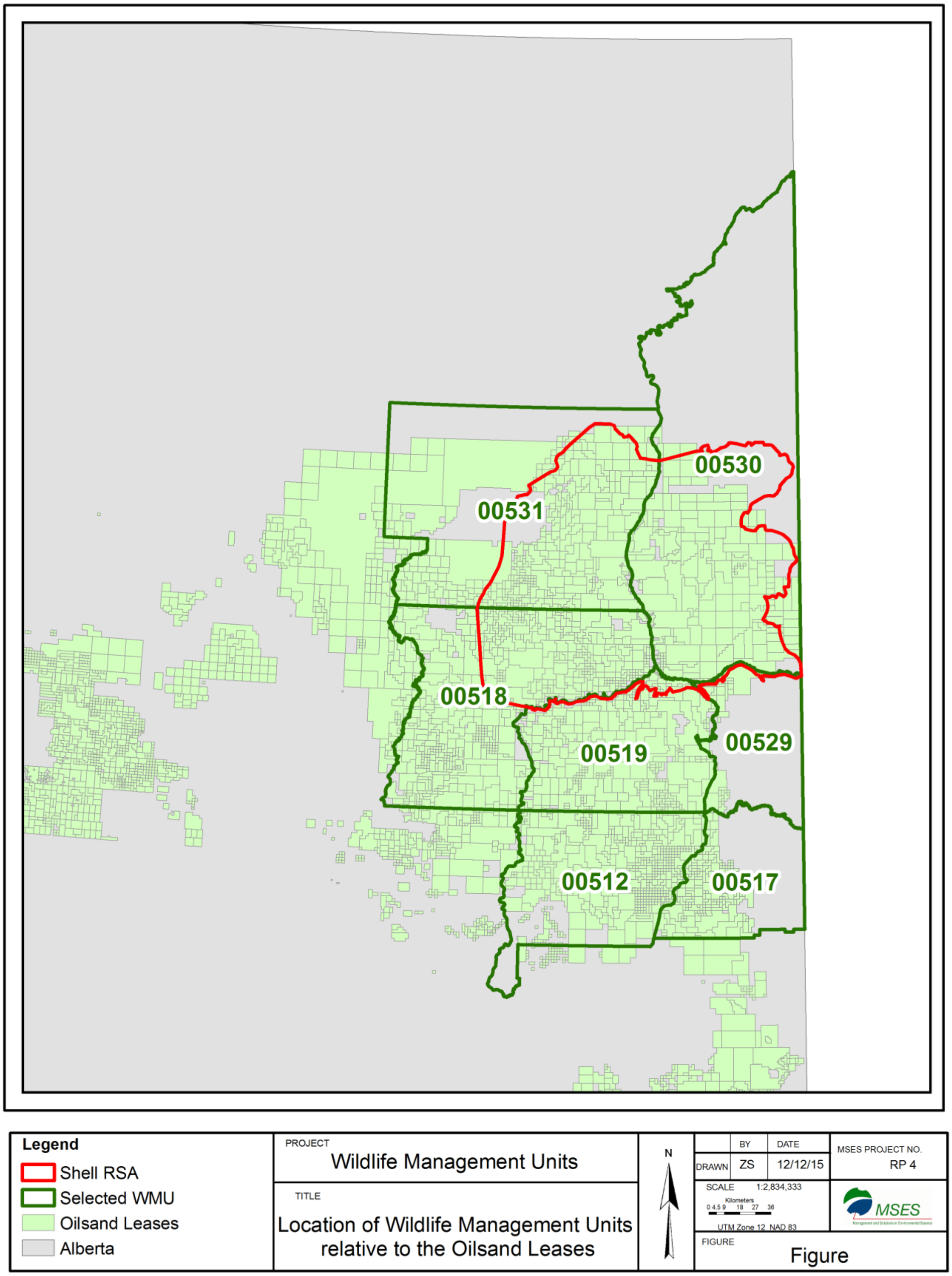
(a) AOSERP = Alberta Oil Sands Environmental Research Program.

(b) OSLO = Other Six Lease Owners.

n/a = Not applicable.

APPENDIX B

Location of Wildlife Management Units Used to Calculate the Moose Population Trend based on ASRD Data Relative to the Oil Sands Leases


00530
00531
00518
00519
00529
00512
00517
Legend
Shell RSA
Selected WMU
Oilsand Leases
Alberta
PROJECT
Wildlife Management Units
TITLE
Location of Wildlife Management Units relative to the Oilsand Leases
N
BY
DATE
DRAWN
ZS
12/12/15
MSES PROJECT NO.
RP 4
SCALE
1:2,834,333
Kilometers
UTM Zone 12 NAD 83
FIGURE
Figure
MSES