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1.0 Introduction

1.1 Inventory Group

Renewable energy is advancing as one of Alberta's fastest growing industries. Although wind and solar energy are clean and renewable energy sources, they can have direct and indirect effects on the avian community such as mortality from collision or predation, displacement from habitat loss and fragmentation, habitat degradation, and disturbance (Government of Alberta 2017a, 2018). Migratory birds may be susceptible to direct mortality associated with renewable energy projects. Therefore, standardized pre-development avian migratory surveys for renewable energy projects are important to inform impacts to migratory birds (Government of Alberta 2017a, 2018).

Migration surveys are completed to predict risk based on migratory bird activity and potential preferred habitats for migratory birds within the proposed renewable energy project and surrounding areas (e.g., wildlife study area). The following bird migration monitoring protocol for renewable energy projects provides a standardized methodology to conduct avian migration surveys (hereafter the 'surveys') for pre-construction stages of wind and solar projects in Alberta. Surveys are conducted during spring and fall migration periods in Alberta, when birds are moving to and from breeding grounds.

This protocol follows the intent and requirements in the Alberta Environment and Parks (AEP) *Wildlife Directive for Alberta Wind Energy Projects* (Government of Alberta 2018) and the AEP *Wildlife Directive for Alberta Solar Energy Projects* (Government of Alberta 2017a) (hereafter Wind Directive and Solar Directive).

1.2 Species Status

Proponents should refer to the Alberta Wild Species General Status Listing – 2015 (Government of Alberta 2017b), or updates thereof, for a listing of migratory species in Alberta that are listed as a species of management concern.

1.3 Biology

Migratory birds differ on when they migrate during the day. Nocturnal migrants complete most of their travel during the night and include mostly songbirds, some shorebirds (plovers and sandpipers) as well as some waterfowl. Diurnal migrants travel mostly during the daylight hours and include waterfowl, swallows, and soaring species that use updrafts from thermal convection or deflection for travel such as hawks, pelicans, and cranes (Lincoln 1935 - revised 1998). However, the groupings of these species to time of day is a loose categorization as many nocturnal migrants

can migrate in the day or vice versa. As the recommended bird migration protocol limits migration surveys to diurnal hours, the overnight flight of nocturnal migrants will not be detected. Therefore, stopover surveys are required in order to detect nocturnal migrants that have landed from their nighttime flight.

Migration pathways will vary by guild and by species. For example, there are four main migration flyways for waterbirds (waterfowl and shorebirds) that follow a north-south direction in North America, and two of which fall within Alberta (central and pacific corridors). La Sorte et al. (2014) found that terrestrial bird migratory corridors differed from waterbirds, with three broad migration flyways, one in the west and two interrelated flyways in the east. Similarly, raptors also have several migration routes, and within Alberta, typically use pathways within the Rocky Mountain corridor, where the east slope of the Rocky Mountains and adjacent Great Plains provide thermals and habitat for soaring raptors. They typically follow pathways during the spring and fall, however, during the fall, raptors can migrate across a broader front (Goodrich and Smith 2008).

Within Alberta, spring migration typically occurs between the months of March and May and fall migration between the months of August and November. Arrival and departure times for migratory birds vary by taxa and some species migrate outside these months. For example, the Ferruginous Hawk (*Buteo regalis*) can begin arriving in Alberta in late-February. Arctic breeding species such as the Snow Goose (*Anser caerulescens*) and Tundra Swan (*Cygnus columbianus*) have been observed migrating through Alberta from early-March to late-May and late-August to late-November, while the Greater White-fronted Goose (*Anser albifrons*) passes through the province over a shorter period from mid-March to mid-May and mid-August to early-November. Duck species start arriving in Alberta early to mid-March and grebes begin arriving in April; both have usually exited the province by mid-November. Migratory passerines typically arrive in Alberta in late April to mid-May and leave by the end of September.[1]

2.0 Survey Standards

2.1 Personnel

Migration surveys must be designed, conducted, and supervised by experienced wildlife biologists as defined in the Solar and Wind Directives (Government of Alberta 2017a, 2018).

[1] Migration arrival and departure dates are based on the bird observations January – December 1900-2018 in Alberta from: eBird. 2017. eBird: An online database of bird distribution and abundance [web application]. eBird, Cornell Lab of Ornithology, Ithaca, New York. Available: http://www.ebird.org (Accessed: Date [December 20, 2018]).

2.2 Time of Year (Season)

Migration surveys must be conducted during the spring and fall seasons (see Table 1) and within the three different periods within each of the seasons (e.g., early, mid, late-migration) to ensure that migratory data is representative of the wildlife study area.

The seasons and periods vary by natural region due to differences in arrival and departure times of migratory birds within the natural regions. The summary of date ranges for each season and period are summarized in the table below, as defined in the Solar Directive (Table 1) but should also be applied to wind energy projects. **Please note the difference in dates for renewable projects in the early period during the spring season (e.g., the migration period for wind projects is earlier [March 1st] than solar [March 15th]**). This is done in order to document arrival of early migratory raptors, such as the Ferruginous Hawk (Buteo regalis), which may be vulnerable to wind development.

Table 1. Migratory Seasons and Periods within Alberta Natural Regions.

Season	Period	Grassland and Parkland Natural Region	Boreal Forest, Foothills, and Rocky Mountain Natural Regions
Spring	Early	Solar Projects: March 15th – April 15th Wind Projects: March 1st – April 15th	April 1st – April 30th
	Mid	April 1st – April 30th	April 15th – May 15th
	Late	April 15th – May 15th	May 1st – May 30th
Fall	Early	August 15th – September 30th	July 15th – August 15th
	Mid	September 15th – October 30th	August 1st – September 1st
	Late	October 15th – November 30th	August 15th – September 30th

2.3 Time of Day

The time of day when surveys should be conducted for each migration period (Table 1) will vary by survey method and is summarized below. For descriptions of survey methods, refer to Section 3.2 Point Count Survey Methodsand 3.3 Stopover Surveys.

2.3.1 Point Counts

Point count surveys must be completed twice a day for each survey location during the morning and late afternoon/evening time periods in order to document diurnal and potential nocturnal migrants:

1. Morning: The morning surveys must be completed between the period of sunrise and 3 or 4 hours after sunrise. The early morning hours of the survey period (sunrise to 2-3 hours after sunrise) may capture nocturnal migrants when they are landing from their nighttime flight and when they are undertaking morning flight to find stop-over habitat or correct route. The morning surveys may also capture diurnal migrants beginning their migration during the daylight hours.
2. Afternoon/evening: The afternoon/evening surveys must be completed between the period of 3 or 4 hours before sunset. The afternoon hours will capture soaring migrants such as raptors, cranes, and pelicans who utilize thermals that often occur in the warmer afternoon hours. The evening hour surveys may capture waterfowl during their 'foraging flights' as well as nocturnal migrants such as passerines beginning their nighttime flights.

A flexible 3-4 hour interval after sunset and before sunrise has been recommended due to the changes in sunrise and sunset times throughout the seasons. Morning and afternoon/evening surveys must not overlap, and there must be sufficient time to complete stopover counts (see section 2.3.2 Stopover Counts below) between the point count periods.

2.3.2 Stopover Counts

Stopover counts are required to identify locations of preferred migratory birdhabitats in the area not accounted for in the general point counts (e.g., foraging sites) as well as document nocturnal migrants that are resting from overnight flights. Stopover counts will also provide a more reasonable estimate of abundance. Stopover point counts or stopover transect counts must be conducted during the afternoon. The afternoon surveys must be completed between morning and afternoon/evening point count surveys. This survey period will capture migrant birds resting or foraging at stopover sites during the day.

2.4 Weather/Conditions

Migration surveys must be completed under weather conditions that allow for visual detection of the birds within the survey point (i.e., unlimited distance from the surveyor in all directions) or the

indefinite column of airspace above the survey area. Surveys must not be conducted in rainfall (or snow) that is beyond very light or that is continuous as these factors greatly affect migration intensity (Erni et al. 2002) and movement behaviour (D'Entremont 2015). Very light rainfall is defined as scattered drops that do not completely wet a surface (Government of Canada 2018). This definition can also be applied to light snowfall when in the field.

Surveys must be conducted when wind speeds are 35 km/hr or less (Beaufort Scale level 5). If wind is affecting bird flight or is decreasing detectability, surveys must be stopped.

Weather conditions must be recorded at each survey point as follows:

- Air temperature
- Wind speed
- Wind direction
- Percentage of cloud cover
- Precipitation type and amount (if applicable)

2.5 Survey Effort

Survey effort must maximize the spatial and temporal coverage of the project area. A minimum requirement of three survey rounds must be completed for each season (spring and fall) for a minimum of one year (as per the Directives). A required one survey must be completed in each survey period within a season (refer to section 2.2 Time of Year (Season)Season)). Survey must be spaced at least 10 days apart. Surveys for a season must be completed within the same calendar year. For example, if spring migration surveys began in 2020, then all three rounds must be completed in 2020. Spring and fall migration surveys can occur in different years however, they must occur in consecutive years (e.g. fall 2019 and spring 2020) (Table 2). For information regarding survey point placement and the number of survey points required, refer to section 4.0 Methods for Specific Industries.

Table 2. Example of a Grassland Spring and Fall Migration Survey Program over multiple years.

Period	Fall Migration Option A	Spring Migration	Fall Migration Option B
Early	September 9th, 2019	March 25th, 2020	September 9th, 2020
Mid	September 30th, 2019	April 15th, 2020	September 30th, 2020

Late	October 21st, 2019	May 6th, 2020	October 21st, 2020

To account for difficulty assessing migration activity due to annual weather changes tAEP-WM recommends increasing survey efforts to a minimum of two surveys within each survey period (early, mid, and late-migration), resulting in six survey rounds. Projects that exercise this best practice of two surveys within each survey period must space the surveys a minimum of 5 days apart within the same survey period. This additional survey effort would help to provide a more accurate representation of migratory and stopover activity within the wildlife study area to be used by AEP-WM in their Renewable Energy Risk Assessment.

3.0 Survey Protocols

Migration surveys are made up of two survey parts:

1. Point Counts: a standardized survey, using fixed pre-determined point counts, to identify general migratory bird activity and use in the project area and surrounding wildlife study area during fall and spring migration.

2. Stopover Counts: a standardized survey using point count or transect methodology to document migratory bird use of the project area and surrounding wildlife study area as stopover sites throughout fall and spring migration.

Both the point counts and stopover counts are required as part of the pre-assessment Bird Migration Surveys to the meet the requirements of the Wind and Solar Directives. Surveys must be planned in a way that allows for an adequate spatial distribution of survey points, while at the same time capturing various habitat types, allowing for a representative determination of migratory pathways and staging areas across the project area and wildlife study area.

Methods for completing the surveys may differ between Natural Region and for different renewable industries. This protocol has been designed to identify general methods with slight adaptations based on the habitat in the project area. It is the responsibility of the proponent or survey user to ensure that they are following the correct methods for their project area.

3.1 Bird Counting Techniques

Different counting techniques can be used to determine the number of birds observed during surveys. For small flocks or larger flocks that are stationary, a total count of individuals can be completed which is the most accurate counting technique (Gregory et al. 2004). For larger flocks that are moving or in flight, it is often difficult to count all individuals and a counting technique to

estimate flock size can be used such as the block counting method. This involves extrapolating an estimate of flock size based on a smaller proportion or "block" of the flock such as 10, 20, 50, or 100 birds (Gregory et al. 2004, Urfi 2004). The block method works well for same species flocks (Urfi 2004), but may need to be modified for mixed flocks in which smaller proportions for each species (e.g., 2, 5, 10) needs to be estimated to extrapolate flock size or simply each individual for each species is to be counted. Surveyors must clearly identify method(s) used.

3.2 Point Count Survey Methods

As defined by the North American Breeding Bird Survey "a point count is a tally of all birds detected by sight and sound by a single observer located at a fixed position during a specified period of time" (USGS Patuxent Wildlife Research Center and Canadian Wildlife Service 2018). Point count methods may vary by Natural Regions and the methodologies are summarized below.

3.2.1 Grassland and Parkland Natural Regions

1. Survey points must be spaced a minimum of 1000 m apart and placed at vantage points that allow for the most undisturbed view of the entire survey area. Surveys must be planned in a way that allows for an adequate spatial distribution of survey points, while at the same time capturing various habitat types.
2. Each survey point location must be recorded in UTM NAD 83; Zone 11 or 12.
3. Surveys can be conducted from roads so long as there is proper coverage of the area (see section 4.0 Methods for Specific Industries for details). Traffic noise can decrease detection during surveys (Breeden et al. 2008), therefore, if the survey is conducted from a road, traffic must be at low volume and frequency.
4. The order of when each point is surveyed must vary for each survey round to ensure that an unbiased representation of migration activity within the wildlife study area is documented.
5. Vehicles must be turned off during the survey and counts should begin immediately when the surveyor reaches the survey point (Ralph et al. 1995).
6. At each survey point, a minimum 20-minute passive survey must be conducted, where the surveyor continuously scans the entire point count area (unlimited distance) and the indefinite column of air space above. As the column of air space is indefinite, all birds, no matter the flight height, must be recorded.
7. During the 20-minute minimum survey, all birds documented must be recorded to the lowest taxonomic category (e.g., species, family, etc.) within survey point. Results must be recorded in the following distance classes, within 400 m of the surveyor, between 400m-800m, or beyond 800 m (Table 3). Due to the survey radius being unlimited, the likelihood of double counting birds between two different survey points may be greater than limited

survey radius counts. Therefore, the surveyor must be aware of this and minimize double counting as much as possible.

Table 3. Migration Point Count Distances Classes

Distance Class	Description
0 – 400 m	Birds observed within 400 m (inclusive) of the surveyor.
400 – 800 m	Birds observed over 400 m and within 800 m of the surveyor.
> 800 m	Birds observed beyond 800 m (exclusive) of the surveyor.

8. For each observation, the number observed (an observation can be greater than 1 individual), species and size of flock (e.g., > 2 birds of the same species) must be documented.
9. Spatial information for each observation must be recorded, including but not limited to, closest distance class to the surveyor, location from the surveyor when first observed (cardinal direction), and direction of flight during observation.
10. The behavior of each bird observation must also be noted (e.g., staging, migratory flight, hunting, perched, foraging, etc.) in order to evaluate bird use of the wildlife study area.
11. Incidental observations which is defined as observations made outside of the survey period time (e.g., before or after the survey was completed) must also be recorded with the same detail as above.

3.2.2 Boreal Forest, Foothills, and Rocky Mountain Natural Regions

1. Survey points must be spaced a minimum of 1000 m apart and placed at vantage points that allow for the most undisturbed view of the entire survey radius. Surveys must be planned in a way that allows for an adequate spatial distribution of survey points, while at the same time capturing various habitat types. Due to the higher likelihood of visual barriers (e.g., topography and forest) expected within these regions, surveyors may have to incorporate openings in ground cover and utilize elevated areas which may lead to more random placement of points.
2. Each survey point location must be recorded in UTM NAD 83; Zone 11 or 12.
3. Surveys can be conducted from roads so long as there is proper coverage of the area (see section 4.0 Methods for Specific Industries for details). Traffic noise can decrease detection during surveys (Breeden et al. 2008), therefore, if the survey is conducted from a road, traffic must be at low volume and frequency.

4. The order of when each point is surveyed must vary for each survey round to ensure that an unbiased representation of migration activity within the wildlife study area is documented.
5. Vehicles must be turned off during the survey and counts should begin immediately when the surveyor reaches the survey point (Ralph et al. 1995).
6. At each survey point, a minimum 20-minute passive survey must be conducted, where the surveyor continuously scans the entire point count area (unlimited distance) and the indefinite column of air space above. As the column of air space is indefinite, all birds, no matter the flight height, must be recorded. If line of sight is significantly reduced because of topography and/or tree cover, additional survey points must be added to ensure adequate coverage of the project area (See section 4.1 Wind and Solar Energy Development Surveys for number of survey points required). Survey point placement and survey radius must be clearly defined by the assessor.
7. During the 20-minute minimum survey, all birds documented must be recorded to the lowest taxonomic category (e.g., species, family, etc.) within survey point. Due to potential limited visibility from topography and trees in the regions, distance classes are reduced. Results must be recorded in the following distance classes, within 200 m of the surveyor, between 200m-500m, or beyond 500 m (Table 4). Due to the survey radius being unlimited, the likelihood of double counting birds may be greater than limited survey radius counts. Therefore, the surveyor must be aware of this and minimize double counting as much as possible.

Table 4. Migration Point Count Distances Classes

Distance Class	Description
0 – 200 m	Birds observed within 200 m (inclusive) of the surveyor.
200 – 500 m	Birds observed over 200 m and within 500 m of the surveyor.
> 500 m	Birds observed beyond 500 m (exclusive) of the surveyor.

8. For each observation, the number observed (an observation can be greater than 1 individual), species and size of flock (e.g., > 2 birds of the same species) must be documented.
9. Spatial information for each observation must be recorded, including but not limited to, closest distance class to the surveyor, location from the surveyor when first observed (cardinal direction) and direction of flight during observation.
10. The behavior of each bird observation must also be noted (e.g., staging, flying, perched, foraging, etc.) in order to evaluate bird use of the wildlife study area.

11. Incidental observations which is defined as observations made outside of the survey period time (e.g., before or after the survey was completed) must also be recorded with the same detail as above.

3.3 Stopover Surveys

In general, stopover habitats are areas where birds rest and feed along their migratory route to their breeding and wintering grounds. Stopover habitat can include staging areas which have abundant food resources that are important for migrating birds. Renewable energy projects risk impacting these habitats if not sited properly, which can lead to an increased risk of direct mortality or may lead to avoidance of these habitats. Therefore, in addition to point count surveys, surveys of potential stopover locations not adequately covered by the point count surveys are required. Stopover surveys must follow the below methodology:

1. A desktop assessment must be undertaken prior to the initiation of migration surveys to identify potential stopover locations (i.e. large wetlands, lakes, reservoirs, IBAs) within the wildlife study area (i.e., Project area + 1000 m as per the Solar and Wind Directives).
2. Additionally, areas within the wildlife study area that are documented with high stopover/staging abundance during field visits must be revisited throughout the migration seasons during each survey round.
3. Stopover surveys in the wildlife study area may vary by habitat type primarily due to visibility limitations.
    a. Open habitats (e.g., prairies, wetlands): a stopover point count must be conducted at potential stopover locations (identified during desktop assessment) as well as identified stopover habitats (identified during field visits) with a survey distance that covers the entire stopover habitat (e.g., only survey waterfowl in wetland or staging field) and a survey length that ensures an accurate count at these habitats. A GPS location should be taken at the surveyor's location, and the distance and bearing to the approximate centroid of each stopover habitat should be estimated. The species, number of individuals, activity (e.g., foraging, resting), and the time spent at the survey point must be recorded.
    b. Closed habitats (e.g. heavily treed): a stopover fixed-width transect must be conducted to sample a portion of the closed habitats within the project area. Due to the limitations of visibility, transect width should be 200 m across, where birds within 100 m of the transect center on either side must be recorded. Transects should be no less than 500 m long but can vary in length due to project size. Transects can be placed along roads and trails for ease of access. If the survey is to be completed by vehicle, the surveyor must stop frequently (approximately every 100 m) and conduct a 5 min survey. In addition, transects can also be broken into segments if different habitats are traversed (Environment Canada 2007). The species, number of individuals, cardinal direction from surveyor, distance from

surveyor, activity (e.g., foraging, resting, etc.), and total survey time along the transect must be recorded. It is recommended that the distance from surveyor be an approximate value rather than a distance class.

4. Stopover points and stopover transects must be surveyed at least once per survey round.
5. Stopover surveys must be conducted under suitable weather conditions during the seasons, periods, and times defined in section 2.0 Survey Standards. The time and weather conditions (temperature, wind speed, wind direction, cloud cover, precipitation) for each survey location must be recorded.
6. Data collected from the stopover surveys must be incorporated into migration survey reporting.

4.0 Methods for Specific Industries

4.1 Wind and Solar Energy Development Surveys

A minimum of three migration survey points for point counts are required for the first 1,999 ha of the project area. As per the Directives, the project area is defined as the entire area within the boundary of the proposed project which includes all associated infrastructure. Extra points must be added accordingly based on the size of the project area, project spread, and habitat types present. Generally, one migration point count must be added for every 2000 ha of overall project area. See Table 5 for the minimum number of point count survey locations required based on project area size. Additional points will be required if multiple habitats types are present or if the project is spread out over a large area or in multiple parcels. For example, a project area with many habitat types will require a greater number of point counts than a project with a lower number of habitat types; and a project that is spread out in several disconnected parcels of land will require a greater number of point counts than a project that is one contiguous parcel. It is important that the survey radius of the point counts cover a large proportion of the project area, as well as all habitat types within 1000 m of the project boundary (i.e., wildlife study area).

Table 5. Minimum Number of Point Count Survey Locations Required Based on the Size of the Solar or Wind Project Area.*

Project Area Size (ha)	Base Number of Points	Additional Points Required Due to Project Size	Total Minimum Number of Point Count Locations
< 2000	3	0	3
2,000 – 3,999	3	1	4

4,000 – 5,999	3	2	5
6,000 – 7,999	3	3	6
8,000 – 9,999	3	4	7
10,000 – 11,999	3	5	8
12,000 – 13,999	3	6	9
14,000 – 15,999	3	7	10

* This guide is only for point count surveys. Additional points are required for stopover counts.

There is no minimum number of points counts or transects for stopover counts. However, there must be adequate coverage of potential and confirmed stopover sites across wildlife study area.

5.0 Required Analysis

All bird observations made exclusively at survey points during designated survey times for point counts and stopover counts (excluding incidental observations) must be presented as the number of birds observed per minute (see below). The birds observed per minute must be calculated separately for point counts and stopover counts.

$$x = total\ number\ of\ individual\ birds\ observed \div total\ survey\ time\ (minutes)$$

In addition, abundance and number of flocks (i.e., greater than 2 individuals) must be summarized by location, species and by the following bird guilds[2]:

1. Passerines: sparrow, warbler, blackbird, jay, lark, longspur, pipit, hummingbird, nighthawk, woodpecker
2. Birds of Prey: owl, hawk, falcon, eagle, vulture
3. Grouse and Allies: grouse, partridge, pheasant, turkey, ptarmigan
4. Waterfowl: swan, goose, duck,
5. Obligate Waterbirds[3] (solar projects only – for wind projects obligate waterbirds can be included with waterfowl): grebe, loon, diving duck (Family Anatininae)
6. Shorebirds/waterbirds: sandpiper, heron, crane, egret, coot, rail, gull, phalarope, cormorant, pelican.

[2] The bird guilds are loose categorizations based on behaviour and taxonomy of the birds.
[3] For the purpose of this protocol, an obligate waterbird is defined as a bird that relies on water to reach the speed required for flight takeoff.

7. Others: crow, raven, magpie, dove, pigeon.

All observations recorded for the migration surveys (point counts, stopover counts, and incidental sightings) must be submitted to the Fish and Wildlife Management Information System (FWMIS) using the AEP-WM Submission Template.

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