

Avian Protection Plan



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Avian Protection Plan

AltaLink is Alberta's largest electricity transmission company. We build and operate high voltage transmission lines that move electricity from where it is generated to where it is consumed.

Our transmission system is the vital link that connects people to power.

Since we build transmission structures in the natural environment, we have an obligation and responsibility to preserve the beauty and integrity of wildlife and their habitat. AltaLink is committed to mitigating the impact its operations have on the environment.

AltaLink has an Avian Protection Plan (APP), which is designed to reduce the impact transmission facilities can have on birds. AltaLink was the first Canadian utility to develop an APP.



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About AltaLink

AltaLink operates more than 13,000 kilometres of transmission lines and 300 substations, bringing electricity to homes and businesses throughout Alberta. As with other energy facilities and linear infrastructure, operating and maintaining a transmission system has the potential to affect wildlife, particularly avian (bird) species. Birds are primarily affected by the transmission system through collisions with transmission line wires, electrical contacts and nesting.

At AltaLink, we recognize the concerns about interactions between birds and the transmission system. AltaLink stays up to date on current research as it relates to birds and power lines, assesses potential bird interactions on its existing and planned facilities, and implements mitigation approaches to minimize potential effects on birds.

AltaLink strives to be a leader in bird protection and is committed to improving performance in this area. We employ biologists to conduct field studies to determine potentially sensitive areas for birds and wildlife. Many of our facilities were built prior to the electricity utility industry having an understanding of these effects, and we are working to upgrade areas of our system to minimize effects to birds and other wildlife.



CORPORATE POLICY

At AltaLink, our commitment to managing environmental performance is demonstrated throughout the organization from our core principles and Environmental RESPECT Policy, to the standards, programs and plans we use in our day-to-day work activities.



AltaLink's Environmental Respect Core Principle

Natural resources are essential for the production of energy. We are committed to using these resources wisely and protecting our environment for the benefit of future generations.

What this means for AltaLink: Environmental respect for AltaLink means being committed to delivering long-term, sustainable solutions for our customers. We are relentless in seeking opportunities to improve sustainable practices in all areas of our business.

AltaLink understands the importance of minimizing its impact on Alberta's natural landscapes and its inhabitants, so we strive to balance the effect of our operations on the environment. We have set strict

standards by which to operate our business with respect to our environmental responsibilities, including an Environment Management System.

Our RESPECT principles are:

RESPONSIBILITY

All levels of management are responsible for integrating environmental management programs into business processes in order to measure and improve environmental performance. All employees are responsible and accountable for understanding and incorporating environmental requirements into their daily work activities with the obligation to meet or surpass all environmental legislation, regulations and other applicable requirements.

EFFICIENCY

We will responsibly use natural resources and pursue increased efficiencies that reduce waste and emissions at their source. We will develop sustainable operations and implement environmental projects designed to leave a clean, healthy environment for our children and future generations.

STEWARDSHIP

We will respect our natural resources and take care in balancing the needs of customers with our obligation to future generations. We will seek opportunities to preserve, restore, protect and improve our natural surroundings.

PERFORMANCE

We will set challenging goals and assess our ability to continually improve our environmental performance as we strive to achieve net zero greenhouse gas emissions. Through the strategic management of our assets, we will improve the environment and contribute to our business success.

EVALUATION

We will perform audits to evaluate our environmental compliance and use the results to improve our operations and their impact on the environment.

COMMUNICATION

We will foster open dialogue and informed decision making through communication of environmental information with management, employees and the public. We will work with governments and others in creating responsible environmental laws and regulations reflective of sound public policy.

TRAINING

We will provide the training necessary for our employees to perform their environmental responsibilities. We will encourage and provide opportunities for employees to learn more about the environment and foster an atmosphere of creating cost effective solutions that go beyond compliance.

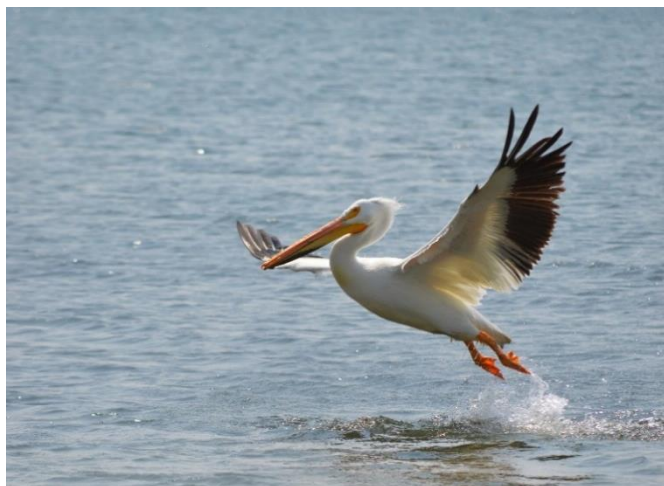
INTRODUCTION

Birds interact with the electric power system in several ways, most notably through collisions, electrical contacts, and nesting. Such interactions can be positive, for example when the electrical infrastructure provides safe nesting or roosting habitat. However they can also be negative, for example when a bird is injured or killed as a result of the interaction. Bird interactions can also create operational and reliability risks as well as health and safety concerns for both the utility and the public and as such, must be managed.

AltaLink has created an Avian Protection Plan (APP) designed to reduce the impact its transmission facilities can have on birds. AltaLink was the first Canadian utility to develop an APP.

Collisions

Injury and mortality can result when birds collide with power lines. Collisions occur most often in areas where a transmission line intersects bird breeding and feeding areas, such as bodies of water or wetlands. Transmission lines are often difficult for birds to see and can sometimes appear invisible due to background or low light conditions. The risk is believed to be highest for waterfowl and water birds who are not able to maneuver quickly around unexpected obstacles.



The American white pelican is a large water bird, native to Alberta. The pelican's large body relative to wing size makes it vulnerable to collisions with power lines.

Electrical Contacts

Birds such as hawks, eagles, owls, osprey and ravens commonly use utility structures and substations for perching, roosting, hunting and nesting. Electrical contacts can occur on distribution structures where the voltage is less than 69 kV (69,000 volts). On these structures, the separation between the energized and grounded components may be smaller than the bird. A bird is at risk of electrocution on a structure if it contacts two energized components or an energized component and a grounded component simultaneously.

Because AltaLink does not operate low voltage power lines under 69 kV, the risk for electrocution on our utility structures is considered low.

In substations however, AltaLink does operate equipment less than 69 kV and there is a risk to birds and other wildlife who interact with this equipment. That interaction can harm or kill the

bird or wildlife species and can also cause power outages. The most common species to be impacted in substations are ravens, crows and great-horned owls.

Nests

Many types of birds nest on, along, and adjacent to electrical infrastructure and the majority of these nests are protected under environmental legislation from disturbance and destruction. Transmission line infrastructure such as power pole structures, telecommunication towers, and substations are some of the most common artificial nest substrates used by raptors such as osprey, and other birds such as crows and ravens. Woodpecker cavity nests are also common in some areas that AltaLink operates. Nests on and in these facilities can result in safety and operational issues for AltaLink if the nest material contacts energized hardware, if excretions build up on insulators, or if a cavity nest compromises the structural integrity of a pole. Other examples of common birds that nest on utility equipment, are barn swallow, western kingbird, American robin, house finch, European starling, and house sparrow.



Example of a nest that has become a safety hazard. The nest is large and the material is contacting energized components of the structure which could lead to a power outage and even a nest fire.

Avian Protection Plan

AltaLink has created an Avian Protection Plan (APP) designed to reduce the impact our transmission facilities can have on birds. AltaLink’s APP was developed based on guidelines established by the Edison Electric Institute’s Avian Power Line Interaction Committee (APLIC) in collaboration with the United States Fish and Wildlife Service (USFWS). AltaLink has been an active member of APLIC since 2008 and strives for continual improvement as part of its commitment to environmental stewardship. AltaLink was the first Canadian utility to develop an APP.

APLIC and the USFWS recommend 12 key principles that make up an effective APP:

1. Corporate Policy
2. Training
3. Regulatory Compliance
4. Construction Design Standards
5. Nest Management
6. Avian Reporting System
7. Risk Assessment Methodology
8. Mortality Reduction Measures
9. Avian Enhancement Options
10. Quality Control
11. Public Awareness
12. Key Resources

The following sections discuss each of these principles, outlining AltaLink’s approaches and procedures for mitigating avian interactions with electric transmission facilities. New construction standards for proposed electric infrastructure combined with retrofitting practices for existing infrastructure form the foundation of this APP, while recognizing that the APP is a living program that can be updated, when warranted.



Training

To provide awareness of avian interactions, communicate requirements and responsibilities for environmental protection and to develop required capabilities within the organization, AltaLink provides role-based training to both field and office employees. AltaLink requires employees complete the following training:

Environmental Orientation E-learning: Provides an overview of the Environmental Respect Core Principle and employee responsibilities to incorporate environmental requirements into daily work activities.

Wildlife Protection E-learning: Provides an overview of employee responsibilities and AltaLink's requirements, processes and procedures to protect wildlife and their habitat.

Nesting Behaviour Search E-learning & Field Training:

Provides field based employees with the steps to identify signs of nesting behaviour to protect birds, eggs and their nests.



AltaLink field personnel taking nesting behaviour training.

Regulatory Compliance

Birds in Alberta are protected under both provincial and federal legislation: the *Alberta Wildlife Act*, *Migratory Birds Convention Act*, and the *Species at Risk Act*.

The *Alberta Wildlife Act* and the *Wildlife Regulation* protects Alberta's fish and wildlife resources under the mandate of Alberta Environment and Protected Areas through prohibitions of hunting, possessing, and damaging or destroying nests. As such, before any work begins, an assessment to determine if the activity has the potential to disturb or destroy nests or dens must be completed.

AltaLink must ensure its activities related to the construction, operation and maintenance of electric power lines and associated facilities do not disturb or destroy migratory birds and their nests and eggs.



Swainson's thrush nest in Banff National Park.

Most native bird species in Canada are protected under the *Migratory Birds Convention Act*, through the *Migratory Birds Regulations* and *Migratory Birds Sanctuary Regulations* and are collectively referred to as “migratory birds.” AltaLink must ensure its activities related to the construction, operation and maintenance of electric power lines and associated facilities do not disturb or destroy migratory birds and their nests and eggs.

The *Species at Risk Act* applies to wildlife listed as extirpated, endangered, or threatened on federal land or water and to migratory birds on all lands in Canada. Before any work begins, an assessment is required in most situations to determine if the activity has the potential to affect species at risk.

CONSTRUCTION DESIGN STANDARDS

AltaLink has developed standards, procedures and guidance documents to inform decision making as it relates to avian safety and reducing negative avian interactions with electrical facilities. AltaLink has considered the best practices presented in APLIC’s Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006ⁱ and Mitigating Bird Collisions with Power Lines: The State of the Art in 2012ⁱⁱ in the development of these specifications.



Bird markers being installed by a drone operated robot.

Collisions

When planning new transmission lines, AltaLink considers high risk areas for bird collisions and avoids those areas when possible. When high risk areas cannot be avoided, AltaLink uses marking devices (bird markers) to help increase the visibility of the wires to birds in flight. For existing transmission lines, AltaLink has completed a risk assessment to identify high risk spans for collisions, and installs bird markers in those areas as part of its Capital Replacement and Upgrades program.



The Power Line Sentry marker is a reflective device that provides visibility of the wires at any angle of approach, even at night.

AltaLink has had a Bird Collision Monitoring Program in place since 2006. Since that time, AltaLink has monitored more than 55 sites to varying extents throughout the seasons, but primarily in spring and fall to correspond with seasonal bird migration. Data has been collected at unmarked sites (sites without bird markers) as well as marked sites. Because of the longevity of the program, data exists at some sites for pre-marking as well as post-marking (Figure 1). The results at these sites show a decreasing trend of collisions, post-marking.

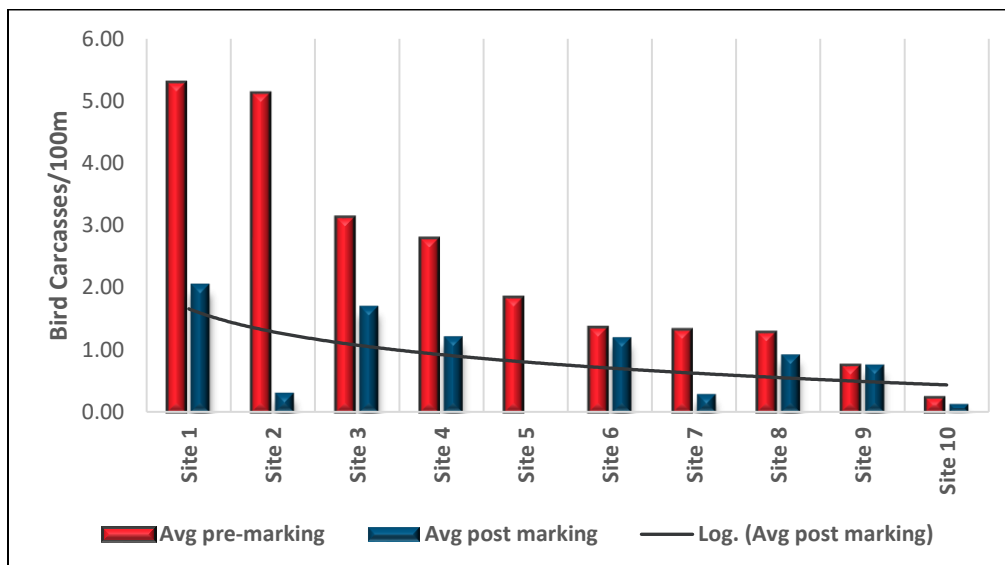


Figure 1. Average bird carcasses/100 m at sites prior to marking (red), after marking (blue). There is a trend of decreased collisions post marking.

Electrical Contacts

Electrocution can occur when a bird contacts electrical equipment either phase-to-phase or phase-to-ground. The separation between energized and/or grounded components influences the risk of electrocution.

There is both a horizontal and vertical risk for avian electrocution:

- Horizontal Risk – When the horizontal clearance, or separation between the bird and the energized and grounded equipment, is less than the wrist-to-wrist (flesh-to-flesh) distance of a bird’s wingspan.
- Vertical Risk – When the vertical clearance is less than a bird’s length from head-to-foot (flesh-to-flesh).







Representative birds showing wrist-to-wrist and head-to-foot distance. An electrical contact is possible when the fleshy parts of a bird (e.g. the wrists) contact two energized and/or grounded parts simultaneously.

Transmission Line Structure Design

AltaLink provides adequate separation or insulation between energized and grounded components for all new transmission line structures. When performing rebuild and maintenance work, AltaLink ensures potential electrocution risks are minimized. Requirements are based on APLIC’s (2006) suggested practices and are determined based on presence of eagle habitat, voltage, structure materials, and insulator array. Table 1 summarizes new construction and existing facility requirements for clearances for the voltages AltaLink operates.

Table 1: New construction and existing facility requirements for clearances for the voltages AltaLink operates

Voltage	Structure Type	Example Photo	New Construction Requirement	Existing Facilities Requirement
69 kV	All types		Must meet avian safe clearances recommended in APLIC (2006). If the clearances are not able to be achieved through design, then other mitigations, such as insulation (e.g., cover-up), are used.	High risk structures are upgraded through AltaLink’s Capital Replacement and Upgrade program. For all other structures not considered high risk, AltaLink may upgrade if avian electrocution risk is suspected.
138 kV	Tangent Linepost Structures		Avian safe clearances are required on 138 kV tangent linepost structures within bald and golden eagle ranges unless a qualified environmental professional deems the area as unsuitable habitat. If clearances are not obtainable, other mitigations, such as insulation, can be used.	For rebuilds and structure replacements, AltaLink will upgrade structures through design. Other mitigations such as insulation are used if clearances are not obtainable.
138 kV	All other types		The majority of 138 kV structure types are considered avian safe.	AltaLink personnel will conduct investigations to determine appropriate mitigation should electrocution risk be suspected on any structures.
240 kV – 500 kV	All types		All 240 kV and above structures are considered avian safe.	AltaLink personnel will conduct investigations to determine appropriate mitigation should electrocution risk be suspected on any structures.

Substations



Substation with Greenjacket™ covers installed.

To protect birds in substations, AltaLink uses a variety of innovative solutions including custom-fitted covers to prevent contact between birds and energized electrical equipment. The Greenjacket™ product is a long-term solution to wildlife-caused outages in substations and is AltaLink's preferred cover type. AltaLink was the first company to use this product and was instrumental in the development and testing of the product. Greenjacket™ is installed on specific low voltage substation equipment where

electrocutions are known to occur, for example on breaker bushings, pipe bus, underground connections and switch bases. It works by providing a barrier between wildlife and dangerous energized electrical equipment. It has a high dielectric rating, meaning it can sustain an electric field but does not conduct electric current. Historically, wildlife-caused power outages have accounted for approximately 20 per cent of all outages in substations. AltaLink began using Greenjacket™ in 2003 and since then, has outfitted more than 100 substations with the cover-up, which has reduced electrocutions by as much as 95 per cent in certain stations where electrocutions were common.

Wildlife cover-ups are installed in substations to prevent or significantly reduce wildlife-caused outages on specific types of equipment. Cover-ups are required for all new substation construction and when adding equipment to existing substations. Existing substations are prioritized annually to be outfitted with cover-ups as part of AltaLink's Capital Replacement and Upgrades program. Prioritization is based on customer risk, outage history and past incidents.

NEST MANAGEMENT

Depending on the species, location, time of year, and status, nests may be protected under the *Species at Risk Act*, *Migratory Birds Convention Act*, or the *Alberta Wildlife Act*. Pre-disturbance assessment surveys are used to determine nesting activity within or in proximity to a proposed activity area in order to meet regulatory requirements.



AltaLink personnel conducting a nesting behaviour search during low risk activities.

For high risk activities occurring in suitable habitat during the nesting season for migratory birds (April 15 to August 25), surveys must be completed by a qualified environmental professional. For low risk activities occurring on existing AltaLink facilities during nesting season, trained personnel may complete nesting behaviour searches as needed. Nest sites are documented and setback buffers or restricted activity periods are implemented during relevant development phases, where applicable. Surveys are valid for seven days.

Nesting can still occur before or after the general nesting season and therefore any occupied nests discovered within or in proximity to a work area are treated with the same protection irrespective of the time of year.

Nests in Substations

Numerous types of birds use substation equipment as well as the graveled substrate for breeding and nesting. Substation personnel are trained to identify signs of nesting birds within the vicinity of their work area and ensure they are not disturbed by work activities. Prior to entering a substation, all personnel are required to call into a notification system through which any site restrictions are communicated, including nest setbacks. For the discovery of new or suspected nests (e.g. behavioural cues such as alarm calling, and carrying nesting material or food), AltaLink environment personnel will work with field staff and contractors to identify species, nest status, develop setback distances, and identify the expected date the restriction(s) will be lifted.



American robin nest discovered by a field technician during a routine site check.

Nests on Transmission Line Structures and Telecommunication Towers

Raptor species (e.g. hawks, eagles, owls, osprey) and corvids (e.g. crows, ravens) are known to build stick nests on transmission line structures and telecommunication towers. These nests are typically

accommodated unless the nest poses a threat to the reliability or safety of the power system, for example, if it becomes too large and can contact energized equipment. Upon discovery, each



Transmission structure with nest deterrents installed. An osprey nest was successfully relocated from the structure and installed on the artificial nesting platform shown here.

AltaLink aims to accommodate bird nests whenever possible. If there is a nest in a dangerous location, AltaLink may relocate it to a safer location in consultation with the appropriate regulatory agency.

nest is considered on a case-by-case basis and depending on the species and time of year, AltaLink may recommend accommodating the nest, relocating it to an artificial nest platform, relocating it to a safer location on the structure, or removing it with no further mitigation. When a nest is relocated or removed from a structure, deterrents may be installed to prevent re-nesting attempts.

Woodpeckers can also damage the structural integrity of a power pole when they create large nest cavities in the pole. In this situation AltaLink obtains federal permits that allow for the pole to be replaced. Unless there is an urgent threat to human safety, this work is done at a time when the cavity is not active with adult birds or young present.

Artificial Nesting Platforms

Nests can be placed on stand-alone artificial nesting platforms or on an extension built on an existing structure. Artificial nesting platforms are installed for the purpose of reducing a reliability or safety hazard and are not installed to create new habitat.

Use of Nest and Perch Deterrents

Nest and perch deterrents are used to protect the conductors and insulators from bird droppings and to discourage nesting in a specific location. AltaLink recommends using caution when using perch deterrents on power line structures as they may create nesting opportunities, depending on the deterrent design, making it easier for birds to build a nest there. In trials conducted by Dwyer and Doloughan (2014)ⁱⁱⁱ where perch deterrents were proactively installed as an attempt to keep birds off structures completely, perching still occurred although the duration of perching was reduced. The use of perch deterrents as a perch and nest management tool are considered on a site-specific basis.

INCIDENT REPORTING AND MANAGEMENT SYSTEM

Documenting and tracking bird mortalities and injuries can help identify problem areas, assist in planning retrofits, and support budget allocation.

AltaLink reports, tracks and analyzes trends of all known avian injuries and mortalities. AltaLink has established incident reporting standards for employees and contractors. A wildlife injury and mortality reporting form is submitted within 24 hours of discovery and the incident is classified and entered into AltaLink's incident database.

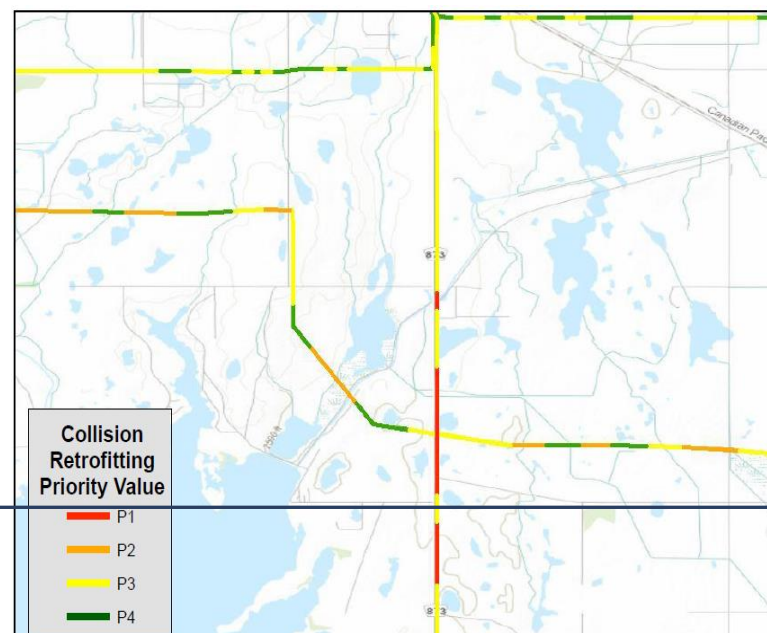
Any avian-related electrical contacts that cause power interruptions are recorded in an outage-specific database. This data is managed through AltaLink's Disturbance Analysis group and is used to track outage trends and support mitigation recommendations.

RISK ASSESSMENT

Risk assessment is an integral component of an APP because it allows the organization to reduce avian mortality cost-effectively by focusing efforts on areas of greatest risk. AltaLink conducted three independent risk assessments between 2006 and 2017 to address the aspects of collision with wires, electrocution on structures, and electrocution in substations.

Collisions

For new transmission line projects, avoiding large water bodies is AltaLink's primary mitigation for preventing collisions with its lines. When large water bodies cannot be avoided, AltaLink installs markers to increase the visibility of the lines to birds in flight. For existing transmission



Sample 1 km² subset of the AltaLink bird collision risk model where P1 represents the highest priority area for marking and P4 is the lowest.

lines, AltaLink has completed a risk assessment to help determine which segments are high risk.

AltaLink first developed a risk-based avian collision model in 2006. The risk model identified suspected high risk areas for bird collisions at a large spatial scale focussed on the various regions of the province where AltaLink operates. Then in 2017, AltaLink worked with EDM International^{iv} to update the risk model to a detailed span-by-span level. The risk model assessed 58,958 spans within AltaLink's system and assigned

each a rank for retrofitting from Priority 1 (P1; high-risk), Priority 2 (P2; moderate risk), Priority 3 (P3; low-risk), to Priority 4 (negligible risk). Less than 10% of AltaLink’s system has been identified as high or moderate risk (Figure 2).

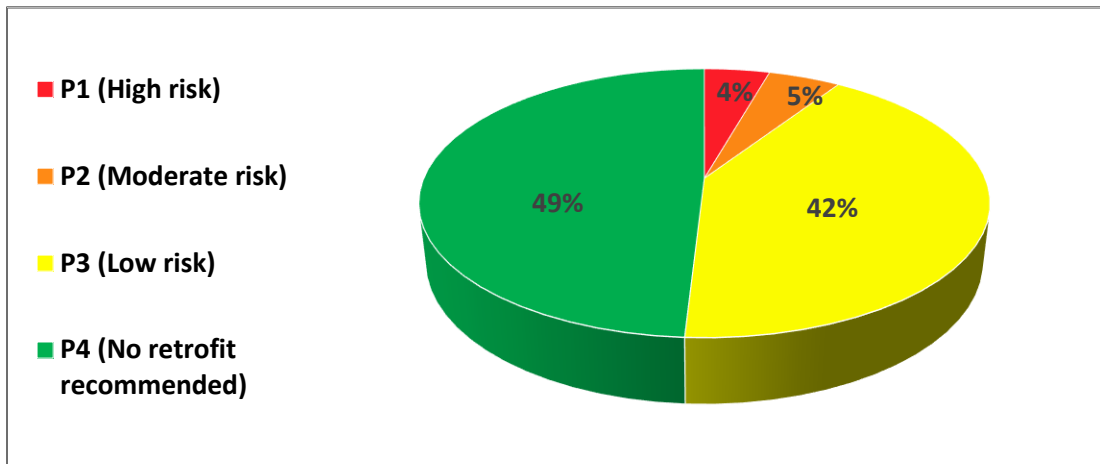


Figure 2. Proportion of AltaLink’s system assessed in the risk model as P1, P2, P3, and P4.

Electrical Contacts

AltaLink does not operate distribution voltage power lines and therefore avian electrocutions on power poles are rare. Birds are typically at risk on distribution poles (i.e. voltages below 69 kV) where the energized and grounded components are closer together, rather than on larger transmission structures that AltaLink operates where they are further apart. However, AltaLink does operate some 69 kV lines. Electrocutions can occur on 69 kV structures with inadequate clearance for raptor protection. AltaLink is in the process of upgrading many 69 kV lines to 138 kV standards where bird-safe clearances are achieved.

In substations, electrocutions typically occur on the low voltage (i.e. 25 kV) side of the substation where there are minimal clearances. Power outages can occur when a bird bridges the gap between energized and/or grounded components in a substation. AltaLink analyzed 20 years of substation outage data to determine which stations have had an un-proportionally high number of bird related incidents. High-risk stations were identified and were retrofitted with Greenjacket™ custom fitted cover-ups. AltaLink continues to review substation outage data annually and approximately five stations are retrofitted every year. All new substations with low voltage equipment are built with cover-ups as a proactive way to prevent wildlife electrocutions.

PUBLIC AWARENESS AND OUTREACH

It is important for AltaLink to communicate with the public and its stakeholders about avian and powerline interactions. AltaLink funds educational programming, participates in public events, discusses and educates its customers on efforts made to minimize avian interactions with electrical facilities, contributes to research and development, and provides donations where appropriate. Select examples of these types of outreach include:



The Birds of Prey Centre and AltaLink biologists provided educational programming at the Blackie School.

- Alberta Conservation Association MULTISAR Program: AltaLink installs artificial nest platforms for the endangered ferruginous hawk and has provided funding for Alberta's Ferruginous Hawk Recovery Plan and Peregrine Camera Program.
- Alberta Birds of Prey Foundation: AltaLink has provided operational funding, and has regularly provided donations to have the Alberta Birds of Prey Foundation attend corporate events and interact with AltaLink employees.
- Ducks Unlimited Canada: AltaLink funded the Wetland Discovery Days school program for two years which impacted more than 2,000 students.
- Rangeland Ecology and Management Fund: AltaLink supports students studying at the University of Alberta through the AltaLink Master's Scholarship in Rangeland Disturbance Ecology with a permanent endowment. The scholarship program funds a master's level student every year undertaking research that supports Alberta's ranchers.

In addition to its public outreach programs, AltaLink is also actively involved in industry working groups including:

- Avian Power Line Interaction Committee (APLIC): APLIC leads the electric utility industry in protecting avian resources while enhancing reliable energy delivery. The committee works in partnership with utilities, resources agencies and the public to develop and provide management options and suggested best practices for mitigating avian electrocutions, collisions, and nesting interactions.
- Alberta Ferruginous Hawk Recovery Team: Provincially appointed and coordinated through Alberta Environment and Protected Areas, the main purpose of the team was to prepare a strategy and action plan to guide the recovery of the endangered ferruginous hawk.

- Electricity Canada (EC) Environmental Policy and Stewardship Committees: EC's mission is to promote a safe, secure, reliable, sustainable and competitively priced supply of electricity essential to Canada's prosperity. EC's Transmission Council works to ensure that federal policy in both Canada and the U.S. creates an environment that will foster the timely development and operation of transmission systems, with a commitment to environmental, worker and public safety best practices. This includes providing economically viable solutions to protect species and their habitats.

QUALITY CONTROL

AltaLink has an integrated Environment, Health and Safety Management System (EHSMS), which conforms with the ISO 14001:2015 and ISO 45001:2018 standards which provide a framework for continual improvement. As part of the EHSMS, AltaLink has established an Environmental RESPECT Index that measures the performance of key environmental programs and initiatives within the company including this APP. The EHSMS drives continual improvement in environmental performance across the organization.



KEY RESOURCES

AltaLink is committed to protecting the environment around its transmission facilities and works closely with communities across its service territory in doing so.

If you want to learn more about what AltaLink does to protect birds, or if you want to report an incident where you believed a bird has been injured or killed on an AltaLink facility, please contact AltaLink's Environment department:

Telephone: 403.267.3400
Toll-Free: 1.866.451.7817
Email: environment@AltaLink.ca

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- ⁱ Avian Power Line Interaction Committee (APLIC). 2006. Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006. Edison Electric Institute, APLIC, and the California Energy Commission. Washington, D.C. and Sacramento, CA.
 - ⁱⁱ Avian Power Line Interaction Committee (APLIC). 2012. Mitigating Bird Collisions with Power Lines: The State of the Art in 2012. Edison Electric Institute, APLIC, and the California Energy Commission. Washington, D.C. and Sacramento, CA.
 - ⁱⁱⁱ Dwyer, J. F., and K. Doloughan. 2014. Testing systems of avian perch deterrents on electric power distribution poles. *Human-Wildlife Interactions* 8:39-55.
 - ^{iv} EDM International, Inc. 2017. Bird Collision Risk Assessment Model: Model Description, Field Verification, and Results. Report prepared for AltaLink, Fort Collins, CO. 78pp.