Proposed solar farm – **The Point, Twizel**

Risks to Threatened and At-Risk bird species from construction and ongoing operation

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December 2025

1. Risks to birds from photovoltaic solar farms

Mortality of birds associated with the construction and operation of photovoltaic solar farms (PVSFs) is a recognised problem globally (e.g., Kagan et al. 2014; Walston et al. 2016; Kosciuch et al. 2020, 2021; Chock et al. 2021; Smallwood 2022; Conkling et al. 2023; Diehl et al. 2024; Gómez-Catasús et al. 2024; Yuzyk 2024; Anderson et al. 2025). Injury and mortality of birds appears to be largely associated with collisions with PV panels and their frames, transmission lines, security fencing, and other infrastructure and with increased levels of predation.

2. At-risk bird species at The Point

The proposed solar farm is at one of the busiest known bird flyways in the Mackenzie basin; being located adjacent to numerous breeding sites [redacted] and comprising a complex mosaic of wetlands and braided river breeding habitats, with many breeding sites located within 100m of the proposed solar farm site.

At least 18 Threatened and At-Risk bird species have been recorded on or in the vicinity of the proposed 'The Point' solar farm. These species may be adversely affected by construction and/or ongoing operation of the solar farm (see **Table 1** below).

The species include three 'Nationally Critical' bird species, which are on the brink of extinction (kakī/black stilt, matuku-hūrepo/Australasian bittern and kōtuku/white heron). Also of concern, is the close proximity of the proposed PVSF site to the largest known black-fronted tern (Nationally Endangered) breeding colony in Aotearoa (>7% of national population), which has been subject to intensive conservation management by DOC over the last 15 years. If collisions between solar infrastructure and birds occur, these will likely have a significant impact on population viability and recovery of these threatened species.

It is possible other species might be affected, including non-threatened species. The survey done by the applicant's consultants was short-lived and occurred after the core breeding season of the species mentioned, so they likely underestimated the number of bird species interacting with the site.

My assessment that c.18 species are at risk is based on the recorded mortality of ecologically similar species overseas (Kosciuch et al. 2020; Smallwood 2022; Conkling et al. 2023; Riser-Espinoza et al. 2024). By ecologically similar, I mean the species have similar body shapes and adaptations, look similar, have similar habitat requirements, feed using the same techniques, have similar roosting behaviours and flight behaviours and are mobile across the landscape. For example, several grebe species form a high proportion of waterbirds found dead in the USA (Conkling 2023), and these are similar species to the crested grebe (a characteristic mobile species present on Mackenzie basin lakes in significant numbers). Many long-legged waders collide with PV infrastructure such as American avocets (*Recurvirostra americana*) and greater yellowlegs (*Tringa melanoleuca*), species, which are similar to our long-legged waders such as black stilt, pied stilt and pied oystercatcher. Similar species to our dabbling waterfowl (ducks, teal and black swans) also frequently turn up as fatalities, as do numerous short legged waders – species such as kildeer (*Charadrius vociferus*), snowy plover (*Charadrius nivosus*) and western sandpiper *(Calidris mauri*), which are similar to banded dotterel and wrybill plover. Rails, such as sora (*Porzana carolina) make up the largest waterbird group colliding with solar infrastructure* (Conkling 2023), species near identical in behaviour to marsh crakes and spotless crakes. American species of terns and bittern have also been found dead at PV solar farm sites (see Section 8 below).

3. Specific risks to birds at The Point

Based on the overseas literature, the potential adverse effects on birdlife through construction and operation of the proposed solar farm would be:

a) Deaths and injury of birds, particularly waterbirds, Threatened and At-Risk species, and mobile species, during the construction phase (all species listed in Table 1).
b) Degradation and loss of local feeding and breeding habitats for species resident during the breeding season following construction and land use change (banded dotterel, black-fronted tern, South Island pied oystercatcher, NZ pipit).
c) Long-term, ongoing, deaths and injury of birds, particularly waterbirds, Threatened and At-Risk species, and mobile species, through collisions with solar farm infrastructure (fences and/or cables and transmission lines and/or solar panels) and electrocution phase (all species listed in Table 1).
d) Disturbance of, or abandonment by, resident birds through construction phase and ongoing operation of the PVSF.

Collision risk is likely to vary among different species. However, as there has been no monitoring of bird displacement or mortality associated with PVSFs in New Zealand, it is currently impossible to estimate the scale of adverse effects that may occur at each site and the long-term impact on bird populations.

In addition, we only have available the limited reporting on adverse effects from a few published studies from overseas. These studies indicate that adverse effects are real and potentially significant for Threatened and At-Risk species and therefore need to be avoided. Given circumstances (e.g., habitat use patterns, risk profiles) may be different in New Zealand, it is challenging to determine the level to which we can infer effects. In the absence of New Zealand data, I consider a precautionary approach to consenting PVSFs in areas with high usage by Threatened and At-Risk bird species is needed.

This precaution should be extended to cumulative effects of the several solar farms currently being proposed for development. If one solar farm was consented and its effects were closely studied for short and long-term impacts, there would be more confidence that additional solar farms could be safely added if these results were negligible. However, there are several solar farms seeking consent at the same time in this area of particularly high importance for these threatened species. If effects are significant from one solar farm, the simultaneous construction of several solar farms could lead to unsustainable impacts on these threatened bird populations.

4. Bird species recorded dead or injured at PVSFs overseas

Members of almost all bird families have been recorded dead at PV facilities. Conkling et al. (2023), who summarised mortality reports from six PVSFs in southern California, recorded 130 species dead at the PV facilities over five years. Similarly, Smallwood (2022) recorded 134 species fatalities from 11 PV facilities (also in California) over seven years, giving a combined list of over156 species. In addition, many species identifications were recorded as unknown, largely because the remains had been scavenged or were otherwise beyond recognition due to infrequent monitoring. The largest bird groups recorded were passerines (perching birds, 49% of species) and water-associated species (34%) (Smallwood 2022).

Of interest in the context of New Zealand was the diverse range of aquatic bird species recorded as fatalities, sometimes in disproportionately high numbers (Kosciuch et al. 2020; Diehl et al. 2024; Anderson et al. 2025). Waterbird fatalities in California included all major waterbird families, including waterfowl, grebes, rails, plovers and dotterels, gulls and terns, stilts and avocets, sandpipers, loons, herons, spoonbills and ibis, pelicans and shags (Conkling et al. 2023). All but two of these families have indigenous breeding populations in New Zealand and have representatives that occur in the vicinity of The Point that occupy similar ecological niches to those overseas fatalities (see Section 2 above). In addition, facultative wetland species, such as swallows, kingfishers, water-associated birds of prey (harriers) and passerines associated with water (pipits) were also among fatalities recorded (Kosciuch et al. 2020; Smallwood 2022).

5. Causes of bird death or injury at PVSFs overseas

While birds interact with solar farm infrastructure and associated habitats without death or injury occurring, and likely often fly over without incident, a proportion are killed, injured, or stranded (Kosciuch et al. 2021). The causes of death associated with PVSF infrastructure are diverse and include impact trauma, predation trauma, and electrocution. Because of the diversity of birds recorded as fatalities, it is likely that they collide or interact with solar infrastructure in a range of ways. While diving species may crash into a panel at force, most birds likely land on, or collide with the panels or panel mountings, at a range of speeds and some get stranded by them (e.g., grebes and coots can only take off from water). Some may be injured during softer landings and either starve or are eaten by predators. Some may still be able to fly, so fly off site before dying. It is also plausible that birds accidentally collide when disturbed or in low visibility and low light situations.

6. How many birds are killed by PVSFs?

Few authors have attempted to estimate the total number of birds killed at PVSFs, although there is no doubt that numbers vary considerably from site to site. In the most recent study, Smallwood (2022) extrapolated from mortality rates at 11 PVSFs and calculated average annual fatalities of 11.61 (95% CI = 8.37–17.56) birds/MW/yr, which extrapolated to 141,811 (95% CI = 102,227–214,593) bird fatalities in 2019 (across 1,948 MW of facilities) and 125,921 (95% CI = 81,346–292,225) in 2020 (12,220 MW of facilities) for PVSFs in the State of California.

7. Mechanisms explaining why collisions occur

It is unknown why birds collide with PVSFs, especially migratory and water birds. There are some obvious causes that contribute to deaths at solar farms, such as birds randomly colliding with infrastructure in high traffic rate areas when they arrive at, or leave, the site or if they are disturbed; or if birds are attracted to lighting at night and colliding; or birds being electrocuted on uninsulated wiring. The latter two effects can easily be mitigated by have no lighting or low, downward facing lighting, and by insulating electrical wiring and placing cables underground.

One common theory that may explain why aquatic birds collide with, or land on or near, PV panels is the ‘lake effect’ hypothesis (Kagan et al. 2014). Because solar panels are known to polarise light reflected from their surface, like bodies of water, the hypothesis implies that birds in flight perceive solar PV panel arrays as water bodies, reorient and descend toward those facilities, and in some cases either collide with the panels or other infrastructure, or are unable to take off again from the ground (Kosciuch et al.

2021; Diehl et al. 2024). However, the literature is equivocal on this hypothesis, and many questions create uncertainty about the mechanisms causing mortality (Kosciuch et al. 2020; Gómez-Catasús et al. 2024).

Alternatively, more complex mechanisms may be at play that involve how birds perceive the polarised and/or ultraviolet light and how this varies in time or space depending on their approach angles, the angles of the PV panels, and the angle of the sun or moon. Mobile species use polarised light for orientation and navigation and use it to calibrate magnetic compasses, so birds may become disorientated, especially in low light at dawn or dusk (Helbig & Wiltschko 1989; Phillips & Moore 1992; Muheim et al. 2016). Polarised imagery of the two types of solar panels commonly used in large solar installations, showed that they polarize both visible and ultraviolet light that mimics natural water bodies from a range of angles, elevations, and distances that local and migrating birds would realistically experience. Taken together, the experimental results and the analysis of polarisation from solar panels provide evidence that supports a new behavioural mechanism by which many species of birds could be attracted to, or disoriented by, solar panels (Diehl et al. 2024).

8. Risk profiles for threatened species using The Point

The applicants do not appear to have adequately assessed the relative use of the area by Threatened and At-Risk species by which we could judge the relative use and importance of the area. The applicant's ecological assessment suggested that low numbers of banded dotterel, black-fronted tern, South Island pied oystercatcher, NZ pipit use the site directly. These species are likely to be displaced following construction because their feeding and breeding habitat will disappear following the development.

Of concern is the collision risk of birds that frequently fly over the site while moving among other habitats or during migration, which does not seem to have been considered. Most species that are at risk from this proposal are waterbirds that are highly mobile, moving across the landscape frequently, especially during periods of low light or at night. DOC has limited tracking data available for three of the most threatened species that use the area. These data highlight the high frequencies of overflights of the site and therefore the potential risks to the 18 Threatened and At-Risk species traversing the area (see Figures 1 – 6 below).

8.1 Kakī / black stilt

Kakī only breed in the Mackenzie Basin where the wild population only numbers 141 adults with a current breeding population of 28 productive pairs (4/6/2025). Kakī have been individually colour banded since 1984 so that the locations and survival of birds could be monitored over time. 389 individuals (9,224 sightings) have been recorded within 1 km of the proposed solar farms in the Mackenzie basin (Figure 1) with records of 173 banded kakī (3874 locations) within 1-km of the proposed 'The Point' solar farm

(Figure 2). Van Heezik et al. (2009) commonly recorded hundreds of movements among wetlands across the Mackenzie basin over a two-year period.

The Figures indicate:

a) Kakī occur frequently in the vicinity of the proposed solar farm.
b) Kakī are highly mobile throughout the Mackenzie Basin.
c) Birds occurring near the proposed solar farm include birds that breed throughout the Mackenzie basin, so the solar farm could potentially influence the breeding birds in other parts of the basin.
d) Although we don't know which flight paths kakī take among all these locations, it is fair to assume that birds will be flying over proposed solar farm site and therefore would be at risk of collisions.

Wading birds (similar ecologically to kakī) were recording colliding with PVSFs at a rate of 0.055 bird/MW/yr in California by Smallwood (2022).

8.2 Black fronted tern

The national population of black-fronted terns is thought to number up to c.10,000 birds in 2010 (O'Donnell & Hoare 2011). However, given colonies were generally declining at rates of 5 – 15% per annum, that figure may be lower now.

Tern species, which included the black tern *Chlidonias niger* (similar ecologically to black-fronted terns) were recording colliding at a rate of 0.023 birds/MW /yr in California by Smallwood (2022).

The proposed Point solar farm is located what may be the most significant site for black-fronted terns nationally. It is on a major flyway between a breeding colony on the [redacted] where birds roost at night. In addition, birds generally feed regularly across this dryland landscape. The Ōhau breeding colony is by far the largest known and harbours >7% of the national population of black-fronted terns. This colony is also managed intensively by DOC using predator control.

Thirty-six of 39 black-fronted terns tracked from the Ōhau colony between 6 November 2020 and 28 February 2022 were recorded flying frequently over The Point or within 1 km of it (3,445 fixes) (Figure 3). Most tern movements over The Point are at night, and during periods of low light around dusk and dawn (Figure 4), a period when birds could conceivably be disorientated by the solar panels (see above).

We know that >500 birds roost each night at [redacted] from different nesting colonies from [redacted] at least. This figure is likely a large underestimate, because most birds are active at the site in the middle of the night when observers cannot count them (Gray 2024). The terns using major roost sites like this begin to arrive at dusk and continue to arrive after dark into the small hours of the morning. Departures start before dawn and continue until approximately an hour after it gets light. Most terns arrive and depart roost sites in flocks of 3-30 birds, but there are some pairs and individuals and also some flocks of up to 50. Therefore, it is reasonable to assume that movement data from tracking single birds is likely to indicate there are multiple birds flying to/from the roost on that path at that time (Gray 2024).

8.3 Matuku-hūrepo/Australasian bittern

The national population of Australasian bittern numbers perhaps 500 breeding birds (Robertson et al. 2021, NZTCS data files). DOC's database contains 106 records of bittern from the Mackenzie Basin, which includes many sightings around [redacted] (Figure 5) and elsewhere in the Mackenze Basin (Figure 6) (O'Donnell & Robertson 2016). Bittern are highly mobile among networks of wetlands and most fly at dawn or dusk or at night, making their detection challenging (Williams 2024).

Bittern species (similar ecologically to matuku) were recording colliding at a rate of 0.017birds/MW /yr in California by Smallwood (2022).

Figures 5 & 6 indicate:

a) Bittern occur frequently in the vicinity of the proposed solar farm.
b) They are widespread throughout the Mackenzie Basin.
c) Birds occurring near the proposed solar farm conceivably include birds that occur elsewhere in the Mackenzie basin and beyond, based on mobility of birds from tracking studies conducted elsewhere in the country (e.g., Williams 2024).
d) Although we don't know which flight paths bittern take among all these locations, it is fair to assume that birds will be flying over proposed solar farm site and therefore would be at risk of collisions.

9. How to avoid, remedy, mitigate or compensate for risks

Given the very high value of the general area for birdlife, the potentially high (yet unquantified) impacts of collisions with infrastructure, and the uncertainty about the effectiveness of potential mitigation, the precautionary approach would be best applied to this proposal, as the only way to avoid potentially significant impacts on Threatened and At-Risk species would be not to construct the solar farm at this location.

Alternatively, is to try an adaptive management approach with staged construction of one solar farm. For example, build a small part of it (say 10%), fully document its effects, and then either proceed with construction of another small stage (e.g., another 10%), or abandon all projects in the vicinity, if things negative effects are detected and unsustainable. However, even this approach could have a profound adverse impact on populations of these threatened species if collision rates with solar infrastructure are significant.

Global best practice for siting solar farms, including from the IUCN and Birdlife International, suggests that a primary guideline is not to place such infrastructure near sensitive habitats (e.g., Jenkins et al. 2015; Bennun et al. 2021; SolarPower Europe 2022; Lightsource bp 2023; Jobson et al. 2024).

Unfortunately, I have not come across any tested methods, and effectiveness for mitigating risks of bird collisions with solar infrastructure, especially in a NZ context. However, if the project were to be consented, there a several commonsense possibilities to manage *some* of the risks:

1. Place all transmission cables underground to avoid collisions with power lines.
2. Minimise or eliminate bird-attracting lighting at night
3. Insulate all electric connections to avoid electrocuting birds
4. Construct low-security fences to avoid collisions with tall fences.
5. Minimise or avoid installing night lighting (which may attract birds).

This still leaves some potentially high impact residual risks to deal with, largely around collisions with the panels and associated infrastructure.

One approach to dealing with uncertainty is to instigate a rigorous carcase monitoring programme, and if carcases are detected, to then trigger compensation focussed on reversing any impacts - so that over time there is an objective of no net loss in sensitive bird populations. This would require identifying adaptive management methods and/or appropriate compensation activities before construction is consented. It also would require scientifically robust monitoring of bird populations.

Carcase monitoring protocols need careful design by a suitably qualified biostatistician and need to account for the fact that it is unlikely that the entire PVSF can be monitored completely and constantly. Design needs to include determining correction factors to apply to the results – a correction factor for observer effectiveness (i.e. how many carcases do observers detect and how many do they miss?) and a correction factor for carcase persistence (how long does a carcase remain on the ground before it degrades or is scavenged by a mammalian or avian predator?). A further correction is likely needed to account for birds that may collide with infrastructure but then fly or walk off site before dying. Recent research indicates that frequently carcasses are not found (likely because of predation of stunned, injured or killed birds) but imprints on panels can now be swabbed and the eDNA extracted to identify species with high certainty (Gruppi et al 2023; Harrigan et al. 2023).

A second strategy to deal with unresolved residual risks would be to include experimental mitigation techniques that show some promise , although they have never been trialled at solar farms in New Zealand to my knowledge so their effectiveness is unknown. This could include:

a. Bird-friendly-designed site layout and panel arrangement (e.g., greater and/or irregular spacing between panel sets to break up the visual profile of the PVSF from above.

b. Angling individual panel sets to different angles to break the polarised light visual cue from above.
c. Positioning the panels at night in directions away from sources of polarised moonlight.
d. Design and apply bird-sensitive anti-reflective coatings to minimise polarisation and ultraviolet reflectance in the wavelengths birds might find attractive.
e. Investigating and testing a range of bird deterrents.

If this approach were taken, it should require appropriate careful monitoring of the effectiveness of each method.

However, an overall problem is that because the species at risk at this site include Nationally Critical species, if fatalities cannot be prevented from PVSFs, then they could incrementally or solely contribute to species extinction. The lack of any comprehensive study on these interactions in a New Zealand context as well as the lack of clear methods to avoid and mitigate risks to birds means that a conservation precautionary approach is justified in the interim.

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Table 1. Threatened and At-Risk bird species recorded in the vicinity of the proposed 'The Point' solar farm, Twizel. Presence of these species has been confirmed through the applicant's ecological assessment, examination of eBird records (New Zealand - eBird), Robertson et al. (2007) and DOC unpublished databases.

Scientific name	Common name	Primary habitat type	Threat category	Loss of breeding habitat	Loss of feeding habitat	Potential collision	Mortality of equivalent species in overseas studies
Ardea modesta	Kōtuku/white heron	Lake/Wetland/Riverine	Nationally Critical			Y	Y
Botaurus poiciloptilus	Matuku/Australasian bittern	Wetland/Riverine	Nationally Critical			Y	Y
Himantopus novaezelandiae	Kakī/black stilt	Lake/Wetland/Riverine	Nationally Critical			Y	Y
Chlidonias albostriatus	Tarapirohe/black-fronted tern	Lake/Wetland/Riverine/Dryland	Nationally Endangered		Y	Y	Y
Anas superciliosa	Pārera/grey duck	Lake/Wetland/Riverine	Nationally Vulnerable			Y	Y
Falco novaeseelandiae novaeseelandiae	Kārearea/eastern falcon	Dryland	Nationally Vulnerable			Y	Y
Hydroprogne caspia	Taranui/Caspian tern	Lake/Riverine	Nationally Vulnerable			Y	Y
Podiceps cristatus australis	Pūteketeke/Australasian crested grebe	Lake/Wetland/Riverine	Nationally Vulnerable			Y	Y
Anarhynchus frontalis	Ngutu parore/wrybill	Riverine	Nationally Increasing			Y	Y
Anthus novaeseelandiae novaeseelandiae	Pīhoihoi/NZ pipit	Dryland	Declining	Y	Y	Y	Y
Charadrius bicinctus bicinctus	Tūturiwhatu/banded dotterel	Riverine/Dryland	Declining	Y	Y	Y	Y
Haematopus finschi	Tōrea/South Island pied oystercatcher	Riverine/Dryland	Declining	Y	Y	Y	Y
Larus bulleri	Tarāpuka/black-billed gull	Lake/Wetland/Riverine/Dryland	Declining		Y	Y	Y
Porzana pusilla affinis	Koitereke/marsh crake	Wetland/Riverine	Declining			Y	Y
Porzana tabuensis	Pūweto/spotless crake	Wetland/Riverine	Declining			Y	Y
Phalacrocorax carbo	Māpunga/black shag	Lake/Wetland/Riverine	Relict			y	y
Microcarbo melanoleucos	Kawaupaka/little shag	Lake/Wetland/Riverine	Relict			y	y
Fulica atra	Australian coot	Lake/Wetland/Riverine	Naturally uncommon			Y	Y

Figure 1. [redacted]

Figure 2. [redacted]

Figure 3 [redacted]

Figure 4. [redacted]

Figure 5. [redacted]

Figure 6. [redacted]