Appendix T – Bird Strike Reports

Contents:

ecoLogical solutions ltd
30 leigh street, po box 180, kāeo 0448
e: [redacted]
w: www.ecologicalsolutions.co.nz

ecoLogical Solutions
Environmental Consultants

Far North Solar Farms Ltd
Level 1 Office, 65 Main Road,
Kumeu, Auckland 0810

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Attention: Richard Homewood

Introduction

Far North Solar Farms Ltd ('FNSF') propose to establish a new solar farm on a site known as 'The Point' located at the head of Lake Benmore in the Mackenzie District, South Canterbury. The proposed development would supply renewable electricity to the New Zealand market and help achieve the country's 100% renewable electricity target by the target date of 2030.

FNSF have been consulting with the Department of Conservation with respect to the proposal, which is described below, since March 2023. These discussions have included specifics about the project and the associated 89ha ecological restoration project, including the location and nature of the proposed restoration plantings, creation of an invertebrate sanctuary and pest control measures to be undertaken across the site.

More recently, the Department has tabled a briefing paper on the potential impact of solar farms on birds generally, and The Point proposal specifically, authored by Dr Colin O'Donnell, Principal Science Advisor. Based on a review of international literature, Dr O'Donnell raises concerns that the solar panels pose a "serious and unresolved risk" to birds due to the potential for collision related mortality and displacement of birds from suitable feeding and breeding habitats. Whilst it is located on farmland, the proposed solar farm site is close to bird habitats on the Tekapo, Ohau and Twizel Rivers and their deltas at the head of Lake Benmore. The bird habitats present are used by birds including nine "threatened" and nine "at risk" species as shown in Table 1.

FNSF engaged Ecological Solutions Ltd to review Dr O'Donnell's briefing paper, and the potential mitigations proposed for The Point solar farm and provide advice with respect to a way forward in light of the concerns raised by Dr O'Donnell.

Summary of the Proposal

The Point solar farm would comprise a 420 MW solar farm over an area of 670ha of farmland near Twizel in the Mackenzie Basin. The land within the footprint of the proposed development is currently used for dairy grazing and production of baleage. The site includes an area of centre pivot irrigated pasture and a larger area of unirrigated pasture as shown in Figure 1. The site also adjoins part of the Project River Recovery management area which is managed by the Department of Conservation and funded by the electricity companies which make up the Waitaki Hydropower scheme as part of mitigating/offsetting the ecological effects of the hydroelectric power generating schemes in the catchment.

The Point solar farm would use 736,000 panels mounted in rows running north to south. The panels would track from east to west throughout the day. There would be a 4m gap between the rows with a maximum panel height of 2.15 m. The proposal also includes 41 6m long inverters across the site, as well as 25 water tanks, each being approximately 4.5m x 3.5m. One large control room will be built on site (dimensions to be determined). No additional powerlines or power poles/pylons are proposed. The entire site would be enclosed within rabbit and hare-proof fencing.

The Point proposal includes development of an 89ha area of ecological restoration surrounding the solar farm as shown in Figure 1. Restoration of this area would include indigenous plantings as well as long-term weed control and control of mammalian browsers and predators. The Department of Conservation are currently contributing to the development of the Ecological Enhancement Plan to support the establishment and maintenance of this restored area. They are also contributing to the conceptual development of an invertebrate sanctuary to be located within the 89ha restoration area.

Within the farm itself, grazing would continue, but weed control methods around the solar panels are still being developed.

Ecological Context

The Mackenzie Basin is the largest intermontane basin in NZ, formed by deposition following glacial retreat at the end of the last ice age. It is bounded by the main divide to the north and west and contained by Two Thumb, Kirkliston and other mountain ranges to the east. The climate of the area is sub-continental, featuring greater temperature extremes and less rainfall on the basin floors than is typical in New Zealand's mild climate (Espie et al 1984). Although difficult to reconstruct, the vegetation prior to arrival of Māori included small leaved shrubland, kowhai (*Sophora* sp.) and kānuka (*Kunzea* sp.) on deeper soils and river courses and grassland or mat herbs and shrubs on the driest soils (McGlone 2004). Tussock grassland became the main vegetation cover in rain shadow areas east of the main divide as a result of increased fire frequency following the arrival of Māori, particularly in the driest areas (McGlone 2004). Arrival of Europeans led to further modification for pastoralism and degradation of the tussock grasslands (Norton et al 2006). In more recent times intensification for dairy and hydroelectric development has further modified the landscape. Other major land uses within the basin include tourism and aquaculture.

The Point is situated between the riverbed and deltas of the Ohau and Tekapo Rivers and the outflow of Ohau C power station canal at the head of Lake Benmore. This is within the Pukaki Ecological District which lies on fluvoglacial outwash deposits below the outlet of the three main glacial lakes of the Mackenzie Basin (McEwen 1987). The site adjoins riverbed habitats on the Ōhau, Pukaki, Twizel, and Tekapo Rivers which provide breeding and feeding habitat for native birds, particularly braided river specialists. The site is within the river delta where the Ōhau and Tekapo Rivers enter Lake Benmore. The full suite of endemic braided river birds occurs at the delta, including kakī/black stilt (*Himantopus novaezelandiae*), which are an endemic species regarded as 'Threatened-Nationally Critical' (Robertson et al. 2021). Species of conservation concern recorded from the area are listed by conservation threat category in Table 1.

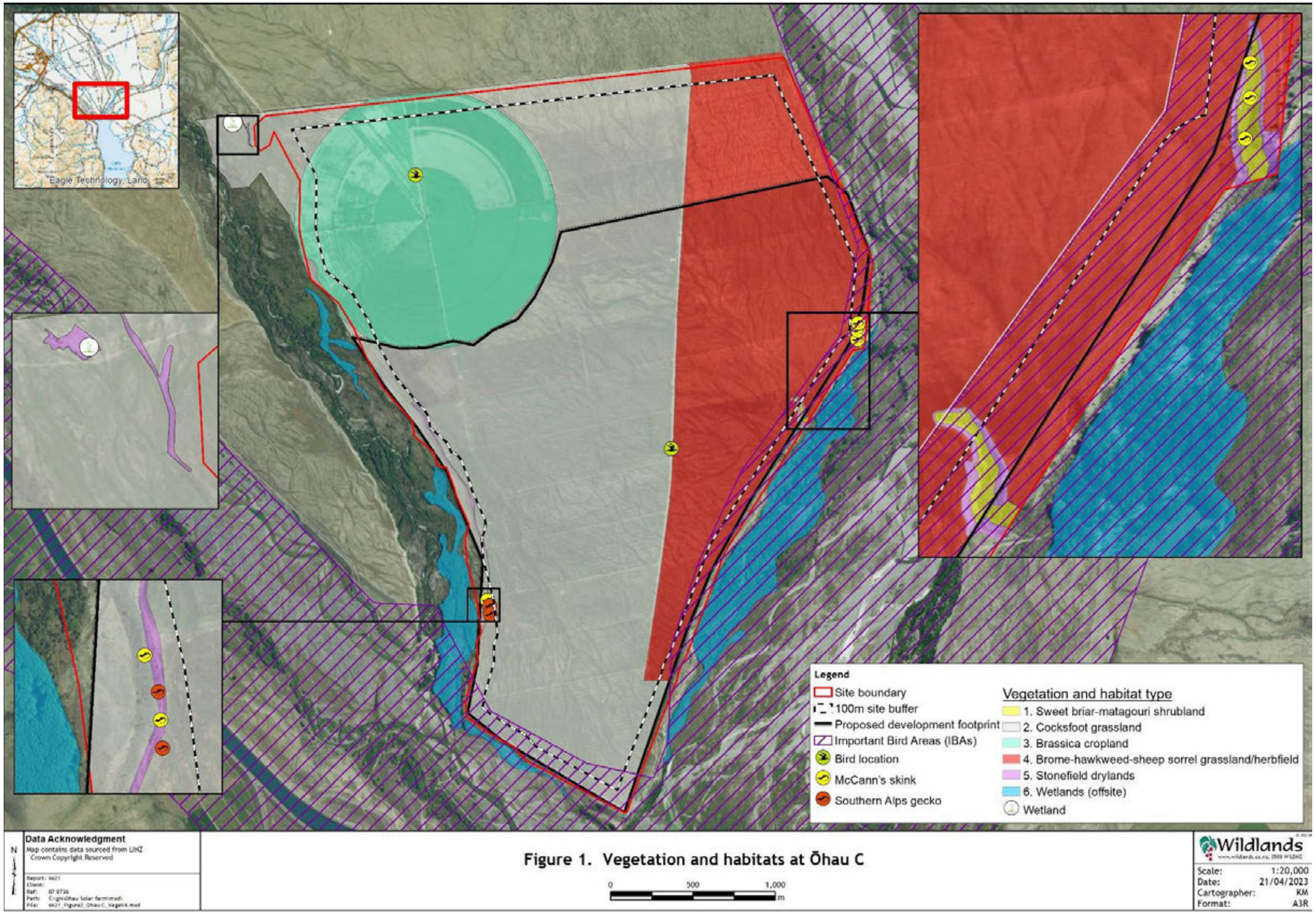


Figure 1: Vegetation and habitats at The Point solar farm (from Wildlands Consultants Limited 2023).

Table 1: Potential for effects on Threatened and At Risk bird species recorded from the vicinity of The Point solar farm, Mackenzie District.

Scientific Name	Common Name	Primary Habitat type	Threat Category	Potential loss of breeding habitat	Potential loss of feeding habitat	Potential for collision	Mortality of similar species overseas	Likely effects after mitigation
Ardea modesta	kōtuku, white heron	Lake, wetland, riverine	Nationally critical			Small	Yes	Less than minor
Botaurus poiciloptilus	matuku – hūrepo, Australasian bittern	Wetland, riverine	Nationally critical			Small	Yes	Benefit?
Himantopus novaezelandiae	kakī, black stilt	Lake, wetland, riverine	Nationally critical			Small	Yes	Benefit?
Chlidonias albostriatus	tara pirohe, black-fronted tern	Lake, wetland, riverine, dryland	Nationally endangered		Small	Small	Yes	Benefit?
Anas superciliosa	pārera, grey duck	Lake, wetland, riverine	Nationally vulnerable			Moderate	Yes	Less than minor
Falco novaeseelandiae	kārearea, New Zealand falcon	Dryland	Nationally vulnerable			Small	Yes	Positive?
Hydroprogne caspia	taranui, Caspian tern	Lake, riverine	Nationally vulnerable			Small	Yes	Less than minor
Podiceps cristatus australis	pūteketeke, Australasian crested grebe	Lake, wetland, riverine	Nationally vulnerable			Moderate	Yes	Less than minor
Anarhynchus frontalis	ngutu parore, wrybill	Riverine	Nationally increasing			Small	Yes	Less than minor
Anthus novaeseelandiae	pīhoihoi, New Zealand pipit	Dryland	Declining	Small	Negligible	Negligible	Yes	Benefit
Charadrius bicinctus	tūturiwhatu, banded dotterel	Riverine, dryland	Declining	Small	Small	Small	Yes	Benefit?
Haemotopus finschi	tōrea, South Island pied oystercatcher	Riverine, dryland	Declining	Small	Small	?	?	Benefit?

Larus bulleri	tarapuka, black-billed gull	Lake, wetland, riverine, dryland	Declining	Small	Small	Yes	Less than minor
Porzana pusilla affinis	koitereke, marsh crake	Wetland, riverine	Declining		Small	Yes	Less than minor
Porzana tabuensis	pūweto, spotless crake	Wetland, riverine	Declining		Small	Yes	Less than minor
Phalacrocorax carbo	māpunga, black shag	Lake, wetland, riverine	Relict		Moderate	Yes	Minor?
Microcarbo melanoleucus	kawaupaka, little shag	Lake, wetland, riverine	Relict		Moderate	Yes	Minor?
Fulica atra	Australian coot	Lake, wetland, riverine	Naturally uncommon		Small	Yes	Less than minor

The ecological and habitat values of the site itself are low under the current management regime, with version 5.0 of the New Zealand Land Cover Database classifying it as 'depleted grassland'[1]. Wildland Consultants Limited (2023) identified five vegetation types within the footprint in descending order of extent as follows: cocksfoot (*Dactylis glomeratus*) grassland, brome-hawkweed-sheep's sorrel grassland/herbfield, brassica cropland, sweet briar-matagouri shrubland and stonefield drylands. Natural vegetation at the site would likely have comprised matagouri shrubland and tussock-grassland (Leathwick 2004).

Avian Mortality due to Solar Farms

Erickson et al. (2005) estimated that between 500 million and >1 billion birds are killed annually in the United States due to anthropogenic sources, including collisions with human-made structures such as vehicles, buildings and windows, power lines, communication towers, wind turbines, electrocutions, oil spills and other contaminants, pesticides, cat predation and commercial fishing by-catch. Loss et al. (2015) estimated annual mortalities more than three times those of Erickson et al. (>3 billion in the United States and >300 million in Canada). Loss et al. (2015) undertook a meta-analysis of studies from the United States and Canada and concluded that collisions with powerlines and communication towers were relatively minor proportions of total avian mortality in both countries, noting that relatively low mortality rates from a particular source can still lead to significant population declines for some species.

Most studies investigating the effects of infrastructure such as solar farms and wind farms on birds have estimated mortality via collection of carcasses. One drawback of this method is that often the specific cause of death for birds collected remains unknown (McCrary 1986, Kagan 2014, Walston, 2016, Kosciuch 2020). It is therefore difficult to reliably estimate the proportion of fatalities resulting from impact/collision with panels versus mortality due to other associated facilities at solar farms (such as powerlines) or the proportion of fatalities relative to the background mortality. This is particularly important when comparing mortality across studies or extrapolating beyond the existing literature.

Walston (2016) estimated the annual national avian mortality associated with solar farm facilities in the United States at between 37,800–138,600 birds, whereas Smallwood (2022) estimated >260,000 fatalities per year associated with solar facilities in the State of California alone. These published data suggest that the proportion of human induced avian mortality attributable to solar farms is low – less than 1% of the total annual national mortality in North America. Harrison et al. (2017) concluded, from the limited data available in published and grey literature and based on carcass searches around solar developments in the United Kingdom, that bird collision risk from solar panels was 'very low'. They considered that there was likely to be more of a collision risk to birds presented by infrastructure associated with solar developments, such as overhead power lines, rather than panels themselves.

The majority of the studies Dr O'Donnell reviewed were located in Southern California (McCrary et al. 1986, Kagan et al. 2014, Walston et al. 2016, Smallwood 2022, Conkling et al 2023) or the Southwestern United States, which has a large number of solar farms (Kosciuch et al. 2020, 2021, Lafitte et al 2023). Other studies have been published from South Africa and the United Kingdom, although published literature from geographic areas outside the United States is relatively scarce (see Jarčuška et al. 2024 and Visser et al. 2019). Harrison et al. (2017) could find no peer reviewed experimental scientific evidence relating solely to the ecological impacts of solar developments in the United Kingdom.

[1] https://lris.scinfo.org.nz/layer/104400-lcdb-v50-land-cover-database-version-50-mainland-new-zealand/ accessed 22 June 2024.

Visser et al. (2019) detected eight bird fatalities over three months at a 180ha solar farm in South Africa, but found no definitive evidence of bird collision mortality due to solar panels.

Some studies from the southern United States of America have found waterbirds to be overrepresented in mortalities leading to the development of the 'lake effect hypothesis' (Kagan et al 2014). The lake effect hypothesis can be summarised as follows: water and solar panels are thought to polarize light in a similar way causing birds in flight to confuse large ground-mounted solar arrays for water bodies, which they then attempt to use as places to rest or feed. This can lead to collisions which either result directly in mortality, or cause injury, which increases the risk of predation or other causes of death. To date there is only very limited evidence to support this hypothesis (Kosciuch et al 2021, Conkling et al 2023).

Habitat Values associated with Solar Farms

The available literature suggests that effects of solar farms are variable and likely to be specific to particular locations and the associated suite of bird species.

Jarčuška et al. (2024) investigated the impact of ground-mounted solar parks on species richness, abundance and composition of bird communities in Slovakia (Central Europe), during a single breeding season taking into account pre-construction land cover, elevation and landscape context. They concluded that solar parks supported higher total bird species richness and diversity, and richness and abundance of invertebrate-eaters, and that the abundance of ground-foragers was higher in solar parks developed on grassland than in grassland control plots. Ordination analysis showed that bird communities at solar parks had a different composition than bird communities at similar areas without a solar farm and also had increased overall species diversity.

In contrast, Visser (2019), found that bird species richness and density was lower at the photovoltaic facility they studied in South Africa than in the surrounding untransformed landscape. The species composition also changed, reflecting the loss of shrub/woodland species whose habitats were cleared for farm construction.

Zaplata & Dullau (2022) used time-series data over 16 years from a small (6ha) solar farm created post-mining at Lusatia in Germany alongside a meta-study on birds in solar parks and concluded that bird communities using solar farms changed over time.

Evidence Limitations

The evidence with respect to collision mortality reviewed by Dr O'Donnell is geographically limited and from very different ecological contexts to the Mackenzie Basin, including different habitat types (arid desert or semi-desert versus farmland), different avian communities and species exhibiting different behaviours. While Dr O'Donnell compares what he considers are 'equivalent' species from these (predominantly North American) studies to those present in the Mackenzie Basin, this equivalence in respect to collision risk is impossible to verify since it remains unknown what factors may predispose some species to collision compared to others.

Research into the cause of mortality indicates that collision risk is highly context dependent (Kosciuch et al 2021). The context of The Point is unique and not directly comparable to any of the previous studies we have seen. For solar farms where the infrastructure is not based on an array of photovoltaic panels, comparisons are less valid because causes of mortality could well be unrelated to the panels themselves as described above.

Several of the studies cited by Dr O'Donnell focussed on solar facilities deploying either concentrated central towers (McCrary et al 1986, Kagan et al 2014) or concentrated solar troughs (Kagan et al 2014) rather than the photo-voltaic panels alone proposed for The Point. Concentrated solar power systems generate solar power by using mirrors or lenses to concentrate a large area of sunlight into a receiver. A concentrated central tower, also known as a ‘solar power tower’, 'central tower' or 'heliostat' power plant uses an array of flat, movable mirrors (called heliostats) to focus the sun's rays upon a collector tower. In a parabolic trough system, the sun's energy is concentrated by parabolically curved, trough-shaped reflectors onto a receiver pipe – the heat absorber tube – running approximately a meter above the curved surface of the mirrors. Concentrated solar facilities introduce the additional risk of singeing, which occurs when birds are exposed to high temperatures with concentrated fields, and can lead to mortality (Kagan et al 2014). The mortality rate associated with concentrated solar power sites was between 7 and 21 times higher than at sites using photovoltaic panels (Walston et al 2016). No concentrated infrastructure is proposed at the Point and mortality estimates from these systems are not directly comparable. Furthermore, no additional infrastructure in the form of power lines/pylons is proposed and these are likely to be significant causes of avian mortality independent of any effects due to the solar farm itself.

Most of the research Dr O’Donnell cites occurred at solar facilities which use different technologies to that proposed at The Point. Given the different ecological context and the different infrastructure, Dr O’Donnell’s conclusions cannot be considered reliable with respect to outcomes at The Point.

Potential Risks Identified at The Point

Dr O’Donnell lists 18 threatened or at-risk native birds which he considers could be affected by the solar development at The Point. These species are listed in Table 1. The key habitat features for avifauna in the area are the braided riverbed, wetlands, river delta and lake habitats. All of these are outside the proposed solar farm site, but well within flying/commuting distance for birds using the area and birds may move across The Point between suitable habitats, although the extent to which this occurs and when (daily, seasonally or annually) has not been defined.

Dr O’Donnell identifies four potential risks that the proposed solar farm development at the Point poses to birds using the site for breeding and feeding and/or using the airspace above as a flyway between habitats including:

1. Displacement of birds from the site during construction (a temporary effect).
2. Displacement of birds from the site during operation (a permanent, or at least ongoing effect).
3. The potential for increased injury and mortality due to collision with solar panels (i.e. effects due to the lake hypothesis and flyover risk, an ongoing/permanent effect).
4. Mortality as a result of electrocution (an ongoing/permanent effect).

Each of these matters is considered in more detail below.

Displacement of Birds from the Site during Construction

The site itself offers low value habitat for most of the 18 species listed in Table 1. In terms of breeding habitat, only three species pīhoihoi (New Zealand pipit), tūturiwhatu (banded dotterel) and tōrea (South Island pied oystercatcher) may use the habitats present within the site for breeding, although this has not been confirmed. A further six species tarapirohe (black-fronted tern), pīhoihoi (New Zealand pipit), tōrea (South Island pied oystercatcher), tarapuka (black-billed gull) and kārearea (New Zealand falcon) may use the area for feeding, although the extent to which they are reliant on the area also remains unknown. We note that there is abundant similar habitat nearby and that this would mitigate effects due to the temporary displacement of birds during construction. Given the large size of the site, and therefore the likely lengthy construction period, an avian management plan is proposed to manage birds using the site to reduce these effects (Wildland Consultants Limited 2023).

Pīhoihoi (New Zealand pipit) use rough open areas of different kinds including tussock grasslands, shrublands, wetland edges and coastal margins as well as farmland for breeding and feeding (Beauchamp 2013). Potential habitat for pipit is abundant in the surrounding landscape. Pipit are not particularly sensitive to disturbance and are common at highly disturbed sites such as mines and land development sites. The current land use means that pipit breeding success at the site would likely be highly compromised by activities such as cropping, mowing and rotational grazing which would be expected to reduce productivity significantly. Provided that the site is managed appropriately during the breeding season to protect adult pipit, eggs and chicks, significant adverse effects on pipit beyond the status quo during construction are unlikely.

Tōrea (South Island pied oystercatcher) breed at inland sites on the South Island including riverbeds and farmland, along with high country grassland (Sagar 2013). Tōrea also feed in those areas. As for pīhoihoi, normal farming activities such as cropping, mowing and livestock grazing would likely reduce existing breeding success from any nesting attempts at the site to near zero due to crushing by machinery or livestock or repeated disturbance leading to adults abandoning the nest. Tōrea are more sensitive to human activities than pipit, but given the extensive amount of similar habitat available nearby, site management to protect adults, eggs and chicks would also reduce the magnitude of effects during construction.

Banded dotterel breed in open areas such as riverbeds, outwash fans, herbfields, beaches and farmland (Pierce 2013). As for the species above, any pre-existing breeding success would most likely be reduced by current management at the site. Banded dotterel commonly attempt to nest at development sites elsewhere where soil disturbance has occurred. Provided that the site is managed appropriately during the breeding season to protect adults, eggs and chicks, significant effects on dotterels during construction beyond the status quo are unlikely.

Black-fronted tern and black-billed gulls are primarily associated with riverbeds but often exploit nearby farmland, particularly when bare soil is exposed by cultivation, for feeding (Bell 2013). The activities at the site may allow these birds to use the site for feeding during construction, but given that they would not be breeding there, adverse effects would be very unlikely.

New Zealand falcon (kārearea) hunt live prey within forest and open habitats such as tussocklands and roughly grazed hill country (Seaton and Hyde 2013). Kārearea may use the area for feeding, but would be very unlikely to breed within the footprint itself, although they may use rocky areas/outcrops within the area proposed for ecological restoration for nesting. Falcon have large home ranges and would not be dependent on the area affected by construction activities. Effects on falcon due to construction are unlikely.

For all of these species except pīhoihoi, the site does not represent a natural habitat type of primary importance. Similar types of rough open habitats, both modified and natural are abundantly available in the surrounding landscape and the existing land use within the site will have reduced the value to these species by making it suboptimal or unsuitable for breeding currently.

Twelve of the species listed in Table 1 (kōtuku (white heron), matuku – hūrepo (bittern), kakī (black stilt), pārera (grey duck), taranui (Caspian tern), pūteketeke (Australasian crested grebe), ngutu parore (wrybill), koitereke (marsh crake), pūweto (spotless crake), māpunga (black shag), kawaupaka (little shag) and Australian coot) are more closely associated with the adjacent lake, wetland or riverine habitats and are unlikely to use the site for feeding or breeding, although they may fly over it when moving between sites or be disturbed by noise or other activities there during construction. For sensitive species, these effects would be mitigated by the distance of their habitats from the activities. We note that a 100m buffer is proposed and this is likely to be sufficient for even the most sensitive species, which may choose to fly around the site, or fly at night or at other times when construction is not occurring, to move between habitats.

Wildland Consultants Limited (2023) considered the effects on avifauna would be 'minor' or 'less than minor' (see Table 7, page 46) given the mitigation actions proposed. We agree with respect to the potential for displacement during construction.

Displacement of Birds from the Site during Operation

Dr O'Donnell discusses the effect of displacement and loss of habitat as an ongoing effect from developing a solar facility at the site. The specific habitat value of the site to indigenous birds in this context remains uncertain, but is most likely low. The fact that birds are present there does not indicate it is of particular high value, even though the species concerned are threatened or at risk. As noted above, current farm management activities such as cropping and mowing would take place during the breeding season for many species and would reduce breeding success of any nests affected to zero and could also kill or disturb adults. Rotational cropping and grazing and other cropping and grazing by large livestock would also affect nest attempts by crushing eggs or disturbing adults such that they abandon the nest. Such ongoing permitted activities suggest the habitats are unlikely to be high value.

It seems likely that developing a solar facility at The Point would further alter the existing anthropogenic habitat modifications and replace the seasonal and annual activities which already render the site low value, rather than result in a complete loss of high value habitat for species during the life of the proposal.

Research into the impact of solar facilities to date has primarily focussed on direct mortality, whereas the impacts on avian communities or biodiversity more generally are less well understood (but see Harrison et al (2017) and Latiffe et al (2013) respectively). The available evidence indicates that effects on diversity and abundance can be positive (Jarčuška et al. 2024) or negative (Visser et al 2019) depending on the ecological context of the site, particularly land use prior to development as a solar facility. The positive responses reported in Slovakia by Jarčuška et al. (2024) were associated with development of preexisting farmland, whereas clearance of natural landcover in South Africa resulted in negative effect (Visser et al. 2019). Management practices within the solar facility also influence the habitat value of the solar facilities to birds (Harrison et al 2017).

The proposed development would alter some characteristics of the available habitats, for example the solar panel arrays would decrease the existing openness and create shaded microclimates, adding (artificial) structure and complexity. This may be favourable for some species, including exotic species. Harrison et al. (2017) concluded that solar facilities favoured mid-successional bird communities which prefer herbaceous and shrubland vegetation similar to the stature and partial openness of solar arrays, although it should be noted that they studied a very small solar farm (6ha). Shrubland vegetation was formerly more widespread within the Pukaki Ecological District (McGlone 2004). The anthropogenic habitat created by the solar farm may therefore more closely resemble the site's natural habitats in some ways than the current land use.

Based on the international research undertaken to date that we could locate, the value of solar farms as habitat is likely to vary depending on the location, the pre-existing land use and the avian community present. Solar farms can provide an anthropogenic habitat type of value to birds (Jarčuška et al. 2024, Zaplata & Dullau 2022), but they have also been shown to cause adult mortality and support reduced bird populations and diversity (Visser et al 2019).

The bird guilds associated with the solar facility habitat in Slovakia were predominantly insectivores and ground-foragers (Jarčuška et al. 2024). Species found to benefit most were mostly insectivorous passerines including Black redstart (*Phoenicurus ochruros*), European stonechat (*Saxicola rubicola*), white wagtail (*Motacilla alba*) and Eurasian tree sparrow (*Passer montanus*) (Jarčuška et al. 2024). Similar functional guilds present at The Point are represented by pīhoihoi (pipit), tūturiwhatu (banded dotterel), and perhaps tarapuka (black-billed gull), tōrea (South Island pied oystercatcher) and tarapirohe (black-fronted tern). These species would primarily feed on invertebrates at the site and pipit, banded dotterel and tōrea are largely ground foragers, but whether they are 'equivalent' to the European birds above remains unknown.

The area affected by The Point proposal is already highly modified habitat and unlikely to be of particular value to birds except as an occasional feeding/loafing area (except for pīhoihoi which may breed there). We note that the proposed 89ha environmental enhancement/restoration associated with the development could increase the habitat values for birds surrounding the site, and this is expected to result in a net gain for avifauna and total biodiversity overall.

Wildland Consultants Limited (2023) considered the effects on avifauna would be 'minor' or 'less than minor' (see Table 7, page 46) given the mitigation actions proposed. We agree with respect to the potential for displacement during operation.

Mortality Associated with Solar Panel Collision

Given the threatened and at risk status of the species present near The Point, additional mortality could be sufficient to cause a population decline for one or more of the species present. Having said that, as described above, most of the species present, including the species of most concern, are not using the habitats within the footprint directly and would be most at risk if they collided with panels resulting in injury or death. Wildland Consultants Limited (2023) have proposed monitoring of the solar farm be undertaken after the construction phase and during the lifetime of the solar farm, to assess whether mortality due to bird strike actually occurs, although the specifics of this monitoring have not yet been provided.

Dr O'Donnell states 'It has long been recognised that mortality of birds through collisions with solar farms, electrocution, and secondary predation of injured or stunned birds is a serious impact of operating solar farms (e.g. McCrary et al. 1986; Kagan et al. 2014; Walston et al. 2016; Jeal et al. 2019; Kosciuch et al. 2020, 2021; Penniman & Duffy 2021; Conkling et al. 2023)' and then extrapolates that to New Zealand by adding "collisions with solar panels pose a serious and unresolved risk, especially to mobile wetland species, and because of the relatively high proportion of threatened bird species at some proposed solar farm sites." We note that bird mortalities at solar farms are not necessarily due to collisions with solar panels and that there are a number of reasons why studies from overseas would not be directly applicable to the New Zealand situation, or The Point proposal specifically. These reasons include the pre-existing highly modified habitats where solar farms have been located, the type of infrastructure installed and the specific bird communities and species present.

International studies have confirmed that impact mortality can occur at solar farms, however there is substantial uncertainty about the severity of the issue, particularly at the population level, and particularly at sites which do not use light concentrating infrastructure. Some authors have considered the risk of solar facilities to be low (Harrison et al 2017), particularly in relation to overall mortality resulting from anthropogenic causes which appears to be at least an order of magnitude larger than mortalities due to solar farms in the United States (Walston et al 2016). Given the highly threatened status of several of the species of interest at The Point, any additional mortality could have population level effects, but in our view, Dr O'Donnell may have overstated that risk without sufficient evidence, particularly given the proposed ecological enhancements which also remain to be quantified.

On the basis of North American research, it would appear that the relative risk of solar farms is low when compared to other human caused mortality. Because of the lack of local data, the level of risk to New Zealand birds posed by solar panel arrays alone is difficult to determine with confidence. Contextualizing mortality from solar farms with other anthropogenic causes of mortality cannot inform absolute risk, since the relative importance of these other mortalities remains unconfirmed in New Zealand too.

Structures which cause mortality overseas (building windows, roads, power plants, power lines, communication towers and wind farms) are common in the New Zealand landscape and may be important for some populations (e.g. North Island weka near State Highway 2 (Bramley 1996)), yet they are not known or suspected to be a driver of population declines in threatened or at risk native species more generally (O'Donnell et al. 2016, Sanders & Maloney 2002). Rather introduced mammals and loss/modification of habitat have been implicated in most population declines where the agent(s) of decline have been identified (Innes et al 2010).

High voltage transmission lines are present across the site at the Point and the adjacent riverbed of the Tekapo River near its delta. Transmission lines also run alongside the lower Ohau River and Lake Ruataniwha to the Ohau A substation. Fatalities at electrical infrastructures, including New Zealand falcon and other threatened native species, have been recorded in New Zealand (Fox & Wyn 2010, Kross 2014), but are not generally considered to have population level effects. Based on international research, these types of structures are likely to cause much greater bird mortality than solar panels, and are already present at the site and/or nearby and in the surrounding landscape yet are not considered a serious risk, nor a driver of population declines of the species identified as being at risk.

The reason why birds collide with solar panels remains unknown. The 'lake hypothesis' if true, means that solar farms could potentially attract birds from beyond the site boundaries, or those in the airspace above, particularly waterfowl. This hypothesis has not been convincingly tested. Whilst in some cases waterbirds are over represented in mortalities (Kagan et al. 2014), there is very limited empirical evidence which confirms that mobile waterfowl are more at risk than other birds. The species most frequently occurring as mortalities in Southern California were very common birds with passerines being the most affected group (Kosciuch et al 2020).

Studies suggest that while the lake hypothesis might explain some mortalities (Kagan et al. 2014), most of the mortality at solar facilities is of birds that do not associate with water (Kosciuch et al 2021). An alternative hypothesis is that collision mortality is incidental, with birds being killed approximately in proportion to their relative abundance in the environment. Incidental collisions, particularly with clear or reflective smooth surfaces can be significant. Collision with clear and reflective sheet glass and plastic is a major killer of birds, with Klem (2009) estimating 1 billion birds may die per year in the United States from collisions of this type alone. Birds are unable to detect the presence of these materials and collide with them while attempting to fly to what they perceive through the translucence or in the reflection.

If the lake hypothesis was a strong driver of bird collisions at solar farms, mortality could be expected to occur more frequently than by incidental collision alone. This isn't readily apparent in the available data, since solar farms rank far below other causes of incidental bird collision mortality (Walston et al 2016).

On the basis of existing evidence, the risk of mortality for birds using the surrounding habitat due to the proposal would appear to be low, but given the conservation status of the birds present, further research and detailed monitoring would be appropriate.

Mortality as a Result of Electrocution

Another potential risk at The Point identified by Dr O'Donnell is electrocution. Although electrocution can be a major cause of mortality where exposed live cabling exists (Loss et al 2015), this does not form part of the proposal and is not expected to contribute to avian mortality at The Point.

We consider it unlikely that birds would die from electrocution at The Point.

Mitigation of Collision Risk

As stated above, given the conservation status of the birds present, detailed monitoring at The Point is appropriate to confirm the level of effects on the species of concern using the habitats nearby. Such monitoring is only helpful if potential mitigation actions exist or could be developed quickly, which could address any effect identified in the event that mitigation is required. Dr O'Donnell discusses potential mitigation measures, stating that "there is no simple fix to prevent bird collisions." Most of the solutions he suggests address the lake hypothesis, although this has not been confirmed as a significant, or even the main, cause of collisions to date. Mitigation measures would aim to increase the visibility/distinguishability of panels to birds and decrease the risk of bird collision. Potential actions to mitigate the risk of avian collision and mortality include anti-reflective coatings (Brown 2020, Dong et al 2018, Shanmugam et al. 2020) and decals and UV-reflective panels (Klem 2009, Klem & Saenger 2013, Ocampo-Peñuela 2016, Mitrus & Zbyryt 2018, Riggs et al 2023). Potential mitigation measures which have been adopted elsewhere are discussed below

Non-Reflective Panels

Panel reflectiveness could cause bird collision by causing mis-identification of the panels as either water, or reflected surroundings in accordance with the lake hypothesis (Brown 2020). A polished silicon surface can reflect more than 35% of light, increasing to 100% at low angle of incidence (Dong et al 2018). Recent advances in anti-reflective coatings have achieved average transmittance as high as 99.7% in the wavelength span of visible light (Shanmugam et al. 2020). Research into the effectiveness of antireflective coatings at reducing bird collision mortality is needed, however if the lake hypothesis is confirmed, this approach would likely reduce effects since it addresses the most likely cause of birds mistaking the panels for water.

Patterned and UV-reflected film coatings

Evenly spaced decals and white, black or UV-reflective and absorbent patterns have been shown to reduce frequency of bird collision when applied to windows (Klem 2009, Klem & Saenger 2013, Ocampo-Peñuela 2016). White markers (5x5 cm "feather friendly" dots) on glass panel bus stations markers reduced impacts by 65% (Riggs et al 2023). A film of vertical, thick black stripes applied to clear acrylic noise barriers along European roads resulted in a 17-fold reduction in individual collisions compared to un-treated sections (Mitrus & Zbyryt 2018). The effectiveness of this approach has yet to be proven in the context of a solar farm, but may prove helpful.

Design Elements

The design of The Point allows for wide spaces of up to 4m between the arrays of panels. This spacing will mean only approximately one third of the site will actually be covered by panels. This spacing is expected to be sufficiently wide to break up any visual uniformity from above that could potentially cause a 'lake effect' to occur. This approach has proven successful for deterring aquatic insects from being attracted to panels (Horvath et al. 2010). It is possible to programme the arrays to rest in a vertical position overnight thereby further reducing any reflective profile for nocturnal birds.

Deterrents

Bird deterrents have been effectively deployed in a range of situations including vineyards, solar farms and buildings. There is some evidence that laser-based deterrents have been effective at solar farms, where bird fouling has been an issue. The AVIX Autonomic Mark II laser system has been used for this role in industrial settings. The laser works as a visual deterrent, rather than a hot laser which might burn on contact, instead emitting a beam of green light which projects onto a surface and moves. The laser system causes birds to avoid the beam as they perceive it to be a threat, deterring them from landing or roosting on the objects covered by the laser. The lasers can be programmed to move at different speeds and cover different areas meaning habituation by local birds to the beam is reduced.

This approach was used on 2.2ha roof top solar system in Tortona, Italy, to deter perching and roosting seagulls and reduce fouling of the panels which decreased their efficiency. After deployment, bird presence on the area covered by the system was reduced by 85%. The same system was also used to deter seagulls and ducks from landing or perching on a 1.2ha floating solar farm facility in Berkshire, England (also to prevent fouling). The system was active from sunrise to sunset and found to reduce bird activity by 75%. The system in Berkshire covered an area of two square kilometres (200ha). In a local context, the AVIX Autonomic Mark II laser system has been used on the Edgar Centre in Dunedin. The laser was installed in September 2021 where it successfully keeps gulls off a large roof and prevents them becoming a pest there.

Strategic design and placement of multiple units would be required to ensure effective coverage over an area as large as The Point. However, used in conjunction with other mitigation methods, the laser system could provide effective mitigation measures to help effectively mitigate collision risk.

Acoustic bird deterrents utilise digital recordings of meaningful signals such as a distress call or calls of a natural predator that replay at random intervals. The effect is to create a sense of alarm and threat to other nearby birds, so that they avoid the area. Over time, habituation to the noise used can mean this type of deterrent loses effect. Systems have been developed to counter habituation and are used to manage bird control issues experienced at airports, farms and around buildings. Integrum Services have developed an acoustic system in the United Kingdom that continually monitors a site using an advanced microphone system. As a bird approaches an area the system identifies the species by analysing their calls. It then activates an appropriate distress call to scare the bird away. The system can analyse if the bird has left the area and if not, it automatically reactivates. The system can also use other acoustic sounds, visual deterrents or devices such as gas cannons which emit loud bangs and are widely used in horticultural settings in New Zealand.

Some bird species are more responsive to acoustic signals than others, and as such more likely to be discouraged from landing or settling at a site using them. There is only limited information about flight paths of particular species in and around The Point, but this information could be used to inform the location of acoustic, or other deterrent systems to increase effectiveness. Acoustic deterrents typically increase in effectiveness when used in conjunction with laser deterrents, reducing the likelihood of birds becoming habituated to the deterrent systems and any deterrent system used would likely need to be varied and adapted as its effectiveness declined.

The use of bird deterrents would ensure that the habitat becomes unsuitable for all (or at least the majority) of birds, and this would be an increase in the overall level of effect on birds anticipated to date. Depending on their effectiveness and the birds affected, if bird deterrents were deployed, additional mitigation to improve bird habitats nearby might be considered necessary.

If FNSF is granted the relevant resource consents to construct and operate The Point, we recommend that the avian management plan provide for a monitoring programme to be instigated as soon as practicable in order to determine pre- and post-construction bird abundance and use of the site as well as quantify any bird mortality and implement mitigation measures as required to avoid or minimise the mortality of threatened and at risk species if it occurs. This could include orienting the panels vertically at night, increasing the visibility of panels via a combination of anti-reflective coatings, patterned coloured and UV-reflective decals.

Other Effects

Dr O'Donnell has not identified that solar farms elsewhere have affected the oviposition and other behaviours of invertebrates (particularly aquatic invertebrates) which insectivorous birds rely on for food and this could affect local populations (Horvath et al 2010). Given that many of the birds identified in Table 1 feed on aquatic invertebrates in braided rivers, monitoring and addressing any potential effects on these species as required should also be provided for as part of the proposal.

Restoration Proposal

The main agent of decline for New Zealand's native avian fauna, and ground nesting birds of braided rivers in particular, including kakī, is introduced mammalian predators (Keedwell 2001, Innes et al 2010, Cruz 2013). In addition to habitat enhancements in the form of restoration planting and weed control, FNSF proposes to undertake extensive pest control at The Point and surrounding areas. This has the potential to increase the survivorship of birds there, particularly those nesting or roosting on or near the ground. Restoration of the indigenous shrubland and tussock grassland would restore the natural vegetation type now effectively absent from the lower basin and would represent a significant habitat gain, particularly for the threatened and at risk invertebrates which occur in the vicinity, provided that they can colonise these new habitats. Although the position with respect to net biodiversity has not been modelled as part of the proposal (e.g., using the Biodiversity Compensation Model or similar (Baber et al 2021), Wildland Consultants Limited (2023) expect the restoration plantings, predator control and other ecological management actions to result in an overall net gain in biodiversity. The methods proposed are widely accepted and have proven effective elsewhere, including nearby as part of Project River Recovery. The expected ecological benefits can be estimated with a high degree of certainty, whilst any potential negative effects on birds remain highly uncertain, based as they predominantly are on international studies of solar farms deploying different technology in strikingly different ecological contexts. Furthermore, the impacts of solar farms reported in the literature have ranged from positive to negative and there are no New Zealand data yet to inform such an assessment.

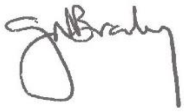
Conclusion

In our view the development of a solar facility at The Point does pose some risk to threatened and at risk birds in the vicinity, however this risk has been overstated by Dr O'Donnell. We do not consider that the displacement of birds from suitable feeding and breeding habitats either during construction or operation would be significant in this instance for the reasons set out above. The risk of electrocution is also negligible for this proposal. The potential for collision related mortality remains unknown and the level of risk that this presents to the birds living in the area remains uncertain because no directly comparable situation has been studied to date. This risk is expected to be smaller than that posed by other structures already present at the site and in the surrounding landscape such as powerlines, roads/vehicles, fences and buildings. Furthermore, some of the risk associated with collision mortality associated with the proposal can be resolved via mitigation actions which have proved effective elsewhere to reduce the likelihood that birds will collide with the solar panels.

The existing low value of the habitat is a relevant consideration when assessing the effects, and the proposal to restore 89ha of land surrounding the site is appropriate and more than likely to result in ecological gain. Given the threatened status of the species present, our view is that the deployment of appropriate mitigations, comprehensive monitoring and adaptive management to refine bird management at the site as required are appropriate to avoid population level effects.

We trust that this advice is sufficient for your purposes. Please don't hesitate to contact us if we can be of further assistance.

Ngā tauwhirotanga o te wā



Dr Gary Bramley
Ecologist

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Far North Solar Farms Ltd

Level 1 Office, 65 Main Road,

Kumeu, Auckland 0810

30 June 2024

Attention: Richard Homewood

Potential effects of The Point Solar Farm on birds

I offer a peer review of the advice of G. Bramley from EcoLogical Solutions Ltd on the effect of the proposed 670 ha PV solar farm at The Point, Mackenzie District. I have read the AEE by Wildlands Ltd, the Department of Conservation initial paper by C. O'Donnell and numerous published scientific papers and reports on the subject. I am familiar with all the bird species involved and have undertaken bird research in the general area. In general, I concur with the content and conclusions of the letter from Dr Bramley.

When determining and evaluating potential effects, context is important. There will be effects and in order to evaluate their importance, it is helpful to know what are the effects relative to the current situation and relative to the final situation with planned mitigation and compensation. Also how likely is the effect, given what is known about the behaviour of birds in different situations.

Most authors list four potential effects and I will deal with the context of these in turn.

1 Displacement and loss of feeding and breeding habitat associated with construction.

Pipit will likely feed and breed on the site. They will not be in the areas of long grass or crops referred to in the AEE, but a small number will be present. Having worked on SIPO (South Island pied oystercatcher) in inland Canterbury, most breed on or adjacent to braided river flats but a very small number do use farmland. For those birds, the most common cause of death was being cultivated (Sagar et al. 2000). Given that the site is used for hay and some cropping, it is not an ideal site for SIPO. A small number may use the site. Banded dotterel use short grass paddocks associated with sheep so the sites current use is not likely to support many pairs. Black fronted terns may use the area for feeding although they tend to use areas of wetter ground so like the black billed gulls, there will only be particular times when they would feed on the site.

Considering Table 1 of O'Donnell's paper, there is no indication of likely numbers of birds affected, only if at least one is. Without the context of relative numbers, readers have no way of judging the significance of the Table. In contrast, Bramley offers a gauge of relative importance.

The other important context is that currently the area has no pest control (although it does adjoin the Project River Recovery area). Introduced mammals are the largest agent of bird death in New Zealand (Innes et al. 2010). Assuming that a bird that currently breeds on the site produces independent young would require evidence. Cats and hedgehogs in addition to mustelids and rats will terminate most breeding efforts at present.

Many birds rapidly habituate to levels of disturbance. Pipit will likely use the site during the construction phase and make use of insects disturbed by construction staff. They will also make use of any new roads put in the area. Other birds including gulls and possibly dotterel will make use of newly exposed ground associated with the cable drains. Fantails and swallow will continue to use the site.

In conclusion, determining disturbance and loss of breeding habitat is relative and can be managed.

2 Continued displacement due to loss of habitats

The presence of solar panels will largely displace the few birds that used the area. Pipit will be an exception and will likely increase. With pest control they should breed successfully as well. New Zealand dotterel have shown they readily take advantage of areas with human activity plus pest control. The largest breeding populations of dotterel known are on the tank farm at Marsden Point and at Auckland Airport. Perhaps some of the other waders may learn to behave similarly.

Given one known issue of PV panels is that they reflect polarised UV light that attracts some insects, it is possible that other birds such as fantails and swallows may increase on site. Good before and after monitoring will demonstrate what these effects may be.

3 Collisions with solar panels, fatalities and injuries

Collisions with panels is the largest unknown. As Drs Bramley and O'Donnell point out, the reason for apparent collision mortalities is poorly understood. International evidence offers details of both negative and positive effects as Dr Bramley's letter records. The suggested "lake effect" would not explain why song birds and other birds that do not land on water should be the most affected. Some are insect feeders and may be attracted to food.

Unfortunately, the majority of evidence comes from the continental Northern Hemisphere where climate forces millions of birds to migrate long distances in spring and autumn. This likely increases the numbers of birds making a one-time pass over a solar farm. In contrast, birds living in the area are more likely to habituate and ignore the panels.

It might seem easy to dismiss the considerable evidence that comes from a large PV facility in a desert environment in western USA suggesting that the birds mistook the panels for water, but results from many places suggest the issue is more complex. Walston et al. (2016)reports that less than 5% of recorded deaths at CVSR in California could be attributed to collisions, the cause of death of the remainder of carcasses found was unknown.

Considering the position of Dr O'Donnell. He provides a list of birds that are in the area, which he implies would be at risk of collision. My personal experience of bittern, wrybill, stilts, crakes, dotterel and herons is that they always land adjacent to water rather than into it. Similarly with black fronted terns, showing that these fly over an area when returning to a dry land roost is not evidence that they will land, especially if most flights are around 10pm.

O'Donnell's paper also reproduces data from CVSR in inland California but fails to provide the context that The Point solar farm is a third the size and is not in an area where millions of birds pass through on long distance migration in autumn. Furthermore, the graph he borrows shows marked increase in deaths in autumn when naïve young birds are migrating.

Once again, O'Donnell's paper provides a very black and white picture of death records. Relative rates would assist the reader and it is interesting that he records that he could find no records of oystercatchers being killed but still puts them in Table 1 under recorded being killed in international studies.

Only future monitoring will assist in deciding outcomes. The AEE suggests that the risk is minor and Dr Bramley concurs. The Natural England review of the impact of solar farms (Harrison et al. 2017) concludes that "evidence suggests that the collision risk presented by solar panels to birds is low but not impossible". I live off the grid with a mere 30 PV panels and have a nearby building with 240m^2 of panels. It is a high bird environment resulting from intensive pest control. Despite years of existence, and nearby wetlands of small size used by many species of shag and duck and commonly used by bittern, the only bird problem we experience is fouling, certainly no deaths or injuries. With intensive pest control, we have no loss or carcases due to predators. In contrast, the windows of our house kill at least 10 birds every year with the greatest number in autumn when many are juveniles.

4 Electrocution

The design has no above ground wires so this is irrelevant at the Point. Currently existing power pylons cross the site so there is no new mortality risk. Indeed, Dr O'Donnell's results show that the terns currently fly over the site with these exposed wires. The Natural England review suggests that losses to overhead lines is greater than from solar arrays.

Mitigation

The current plan is to establish an area of 89ha as a managed nature reserve. In addition, the whole site will be fenced to keep out hares and rabbits, although there is some discussion that this could be a predator proof fence. The whole site will receive pest control for mammals and weeds. Cattle will be removed but sheep will continue to graze the 4m strips between panels. There is suggestion in the AEE that intensive pest control may not be possible over the full 670 ha but this needs revisiting. Where I live, currently over 1000ha is under intensive pest control and there is no reason why the whole 670 ha site cannot receive the same. Given that introduced pests are the greatest source of mortality of New Zealand birds, pest control over the site would more than counter the presumed risks of the solar farm. The pest control must include cats and hedgehogs in addition to those named in the AEE.

Conclusion

Solar farms assist in reducing the threat of global warming which is seen as a threat to New Zealand's birds (Walker et al. 2019). The site is in an area of high ornithological value but there is no good evidence that the PV panels represent a clear risk to the birds. The current situation is dominated by death from invasive species and the proposed design includes mitigation of pest control to minimise this problem. There is excellent evidence that intensive pest control benefits birds, and there is suggested evidence that there may be a collision risk with PV panels. I fully concur with the AEE and Dr Bramley that the overall effect will be minor.

Recommendations

1. Need to ensure there is appropriate detailed data collected on bird usage at least bimonthly before and after construction and operation.
2. An effective mortality monitoring program is installed. This needs to start prior to construction to eliminate potential deaths from existing overhead lines.
3. The suggestion by Drs O'Donnell and Bramley to have panels vertical at night appears sensible.
4. Pest control is best with a predator proof fence but must include control of cats, mustelids, rats and hedgehogs.

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John L Craig

July 2024

GREEN INC

John Craig

PhD ONZM

ECOSYSTEM ARCHITECT

[redacted]