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Net Positive Impact forecast for the Oyu Tolgoi project

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Summary

This appendix forecasts the theoretical and technical feasibility of the Oyu Tolgoi project achieving a Net Positive Impact (NPI) or No Net Loss (NNL) on biodiversity. Residual losses, which are the losses remaining after the mitigation hierarchy of avoid, minimise and restore has been followed, were estimated for each priority biodiversity value. Biodiversity gains at offset sites were estimated for each priority biodiversity value based on a proposed set of possible offset areas and activities as outlined in Appendix IV Offset Strategy. This does not imply that these offset areas and activities will be undertaken, but does show the approximate area and type of offsets needed to achieve NPI/NNL. Losses and gains were estimated using a metric of Quality Hectares (QH). These methods derive a scientifically defensible offsets ratio based on the gains and losses per hectare, *for each biodiversity value*, a more rigorous and tailored approach than the subjective selection of an overall offset ratio taken by some regulators and companies.

Direct habitat loss was quantified by overlaying infrastructure maps with habitat maps. Indirect habitat loss was based on estimated 'avoidance distances' for species which were predicted to avoid roads and other infrastructure (for example due to disturbance and hunting pressure). These were converted into QH by multiplying the area (ha) by a vegetation quality percentage of 90%. The baseline quality for hunted species was taken as 50% quality and the indirect impacts of illegal hunting was estimated reduce that to 25% quality within 100 km of the mine site (31,000 km^2). It was estimated that mitigation actions might reduce that by 50%, leading to an overall quality of 62.5%, and a loss of 62.5-50% x 31,000 km^2 or 392,000 QH. It is noted that these quality coefficients are estimates based on expert opinion itself based on extremely limited empirical evidence, and therefore require significant refinement as monitoring data becomes available.

Mortality losses due to powerlines and potential gains to offset these impacts were calculated separately: the residual impact for direct mortality from powerline collisions and electrocution was not estimated directly but as a relative value per km (y birds / km). This was used to calculate a length of offset powerlines (outside the project area) over which best-practice mitigation is needed to offset the residual loss (0.6y birds 'gained' / km based on assumption that mitigation prevents 60% of collisions, where 60% is the lower estimates of relevant published studies summarised in Jenkins *et al*. 2010).

Gains were estimated for each priority biodiversity value in 2036 (25 years from now), in QH for the main offset actions of improved rangeland management and control of illegal hunting. Biodiversity gains from rangeland management will be difficult to achieve for social, political, ecological and economic reasons. Therefore calculations were highly conservative for this offset activity in terms of the both the area over which herders are fully supportive and the potential gains per unit area. Hence it was conservatively estimated that rangeland habitat degradation could perhaps be reduced

by half of the increase in plant biomass achieved by the GTZ project (15%; Hess *et al.* 2010), equating to a 7.5% improvement in habitat quality. A conservative estimate is that this might be achieved across a tenth of the total surface area of the landscape. This is equivalent to an overall quality percentage improvement of just 0.75% across the whole offsets landscape. It was estimated that illegal hunting could perhaps be reduced across the proposed Principal Offsets Landscape (28,245 km^2) by a similar level to that achieved by the WWF 'MAPU' project (which experts suggested as 50% reduction in hunting across 75% of landscape). This is equivalent to an overall quality percentage improvement of 18.75% (50%x50%x75%) or 530 QH across the Principal Offsets Landscape.

It is noted that the predicted gains from improved rangeland management are much less than from reduced illegal hunting. There are however essential to generate gains for species and other features which are not hunted.

These are very approximate estimates based on inadequate baseline and lack of comparable data, and should only be used for enabling an order-of-magnitude estimate of NPI feasibility. It is recommended that the Oyu Tolgoi project completes further research to refine these figures, then measures these losses and gains in its ongoing monitoring work, and is precautionary in initiating offset actions across much larger areas than these calculations suggest.

The estimated gain of 0.75% in the habitat quality percentage would equate to an 'offset ratio' of 120x (baseline habitat quality of 0.9/0.0075). The estimated gain of 18.75% in illegal hunting quality percentage would equate to an 'offset ratio' of 2.7x (baseline illegal hunting level of 0.5/0.1875). Another approach would be to compare the area of habitat lost (90 km^2 direct loss and up to 1550 km^2 direct and indirect loss) to the area of the Principal Offset Landscape 28,245 km^2), which gives 'offset ratios' of about 300x and 20x. These could be compared to typical 'offset ratios' in wetter environments (where greater gains per unit area are ecologically feasible) of <10x.

The net positions (gains minus losses) suggest that it is theoretically possible, based on the proposed offset sites and activities, to achieve NPI for the majority of priority biodiversity features (Table 1). The exceptions are the two bustard species, Great Bustard and Houbara Bustard. Consequently additional bustard offsets may be required, such as elsewhere in Mongolia or even on the migratory route outside Mongolia, where they are threatened by hunting. However, as noted in the 'Conclusions and Recommendations' section, there is considerable uncertainty around these figures; until refined through targeted monitoring, they should be treated with caution. Given this uncertainty, the Oyu Tolgoi project should incorporate significant contingency into its offset design.

Table 1. Projected net position (gains minus losses) in 2036 for priority biodiversity features addressed by the offsets strategy (Quality Hectares)

Name	Direct & indirect habitat loss (1000 ha)	Quality of habitat lost (0-1; 1 being highest)	Loss from increased hunting (1000 QH)	Residual loss (1000 QH)	Gain from hunting control (1000 QH)	Gain from rangeland manage-ment (1000 QH)	Predicted overall offset gain (1000 QH)	Net position (1000 QH)	NPI / NNL ?
Mongolian Chesney[1]	9	0.9		8	0	21	21	13	Yes
Asiatic Wild Ass	155	0.5	392	470	530	21	551	59	Yes
Argali	30	0.5	392	407	530	21	551	122	Yes
Goitered Gazelle	130	0.5	392	458	530	21	551	72	Yes
Mongolian Gazelle	76	0.5	392	431	530	21	551	99	Yes
Swan Goose	0								Yes[2]
Ferruginous Duck	0								Yes[2]
Short-toed Snake-eagle	9	0.9		8	0	21	21	13	Yes[2]
Saker Falcon	9	0.9		8	0	21	21	13	Yes[2]
Egyptian Vulture	9	0.9		8	0	21	21	13	Yes[2]
Great Bustard	71	0.9		64	0	21	21	-43	No[2,3]
Houbara Bustard	71	0.9		64	0	21	21	-43	No[2,3]
Relict Gull	0								Yes[2]
Pallas' Sandgrouse	9	0.9		8	0	21	21	13	Yes[2]
Yellow-breasted Bunting	9	0.9		8	0	21	21	13	Yes
Mongolian Ground-Jay	9	0.9		8	0	21	21	13	Yes
Granite Outcrop Floral Communities[4]	0			0	0	0	0	0	Yes
Riverine Elm Trees	0					+[5]	+[5]	+[5]	Yes[6]
Tall Saxaul Forest	+	?	-	+	+	+	+	+	Yes[7]
Eastern Gobi desert-steppe	5.5	0.9		5	0	9	9	4	Yes
Alashan Plateau semi-desert	3.5	0.9		3	0	12	12	9	Yes

[1] Assumed here to represent all 18 'very rare' plants known or predicted from the project area

[2] Assuming mitigation is put in place on all OT powerlines plus an additional >64km of non-OT powerlines

[3] Yes if there is an appropriate additional offset

[4] Even though these are not predicted to be impacted, they are included here since they are a Critical Habitat-qualifying biodiversity value in the area

[5] Offset gains in no. individuals rather than QH; offset gains depend on specific offset site

[6] Yes if the three translocated trees survive; offset gains depend on specific offset site

[7] Yes assuming adequate control of illegal collecting (not quantified)

What is an NPI forecast?

An NPI forecast is a projection of potential biodiversity losses and gains over a period of time in the future (25 years in this case, i.e. 2011-2036), based on current knowledge regarding Oyu Tolgoi project impacts, potential offset activities, characteristics of priority biodiversity features, and background rates of biodiversity loss and threat in the region.

The main purpose of this NPI forecast is to provide an order-of-magnitude answer to the question: '***is it theoretically feasible to achieve a net positive impact on biodiversity, and to meet the requirements of IFC PS6/EBRD PR6 Critical Habitat clauses, at Oyu Tolgoi?'*** In addition, it aims to:

- Provide information to assist with the selection of offset sites and activities, and to determine the appropriate scale of such activities
- Identify data gaps, and outline the additional information needed to be able to carry out a more precise forecast

This is the first attempt to carry out an NPI forecast for Oyu Tolgoi, and several important caveats should be kept in mind. First – this is a *forecast* – it attempts to predict what will happen over the coming years and decades, but it does not guarantee that these things will happen. Importantly it outlines what is theoretically possible; as yet no political consultation on feasibility has been undertaken with Mongolian experts, government and other stakeholders. Second, the calculations presented here are based on a number of assumptions and on supporting information of variable, and often inadequate, quality and quantity. There is very significant uncertainty around a number of key parameters – these are noted in the 'Methods' section (and related Appendices). Third, and perhaps most importantly, although this NPI forecast quantifies Oyu Tolgoi project impacts (including direct, indirect and induced impacts) in a fairly comprehensive way, it does not include (e.g. formally quantify) cumulative impacts from the number of other developments proposed and underway in the region, although some of these are considered in a qualitative way in the 'Results' and 'Conclusions and Recommendations' sections.

Which biodiversity features are included?

Priority biodiversity features included in the NPI forecast include (1) all priority species and ecosystems (i.e., not ecosystem services) for which the area qualifies as Critical Habitat under IFC PS6/EBRD PR6, as well as (2) species and habitats defined as appropriate for inclusion in NPI accounting by Rio Tinto internal guidance. These priority biodiversity features are listed in Table 2, and more details regarding the criteria by which they were selected can be found Appendix 2 Critical Habitat assessment.

Table 2: Biodiversity features included in NPI accounting.

Taxonomic group	Biodiversity feature	Scientific name	Critical Habitat	IUCN Red List status	National Red List status	Status in unit of analysis
Plant (herb)	Mongolian Chesney[1]	*Chesneya/Chesniella mongolica*	Tier 2	-	EN?	Patchily distributed throughout
Mammal (ungulate)	Asiatic Wild Ass	*Equus hemionus*	Tier 1	EN	EN	Nomadic 'resident'
Mammal (ungulate)	Argali	*Ovis ammon*	Tier 2	NT	EN	Localised resident
Mammal (ungulate)	Goitered Gazelle	*Gazella subgutturosa*	Tier 2	VU	VU	Migratory 'resident'
Mammal (ungulate)	Mongolian Gazelle	*Procapra gutturosa*	-	LC	EN	Rare visitor from the east
Migratory Bird	Swan Goose	*Anser cygnoides*	-	VU	NT	Likely a regular migrant over the area
Migratory Bird	Ferruginous Duck	*Aythya nyroca*	-	LC	VU	Likely a regular migrant over the area
Bird	Short-toed Snake-eagle	*Circaetus gallicus*	Tier 2	LC	EN	Breeds
Bird	Saker Falcon	*Falco cherrug*	-	VU	VU	Breeds
Bird	Egyptian Vulture	*Neophron percnopterus*	-	EN	LC	Probably breeds
Migratory Bird	Great Bustard	*Otis tarda*	-	VU	VU	Regular migrant (stops over in the area)
Bird	Houbara Bustard	*Chlamydotis undulata*	-	VU	VU	Breeds
Migratory Bird	Relict Gull	*Larus relictus*	-	VU	EN	Likely a rare migrant over the area
Bird	Pallas' Sandgrouse	*Syrrhaptes paradoxus*	-	LC	LC	Breeds
Bird	Mongolian Ground-jay	*Podoces hendersoni*	-	LC	VU	Breeds
Migratory Bird	Yellow-breasted Bunting	*Emberiza aureola*	-	VU	NT	Likely a regular migrant
Habitat	Granite Outcrop Floral Communities	n/a	-	n/a	n/a	Near Khanbogd
Habitat	Riverine Elm Trees	n/a	-	n/a	n/a	Mostly in Undai riverbed
Habitat	Tall Saxaul Forest	n/a	-	n/a	n/a	Mostly in borefield and depressions
Habitat	Eastern Gobi desert-steppe	n/a	-	n/a	n/a	Major habitat type in the region - widespread
Habitat	Alashan Plateau semi-desert	n/a	-	n/a	n/a	Major habitat type in the region - widespread

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern; NE = Not Evaluated

A number of species believed by expert opinion to not occur in the relevant units of analysis have been excluded. Additionally, species and ecosystems that occur marginally in the units of analysis and are not believed to be impacted by the project (Ephemeral Lakes and Pools, Snow Leopard, Long-eared Jerboa and Mongolian Accentor) have been excluded. 'Granite outcrop floral communities' are not predicted to be impacted, but are a Critical Habitat-qualifying feature and – owing to stakeholder concerns – are thus

[1] An umbrella species for 18 poorly known possibly threatened plants which may possibly occur in the project area. These are all considered, on present knowledge, to have similar impacts and mitigation/offset measures and so are represented here by this one species.

precautionarily included in the offsets strategy. Other plants listed as Very Rare in the national *Law on Natural Plants* may occur in the Oyu Tolgoi project area, but are considered to be sufficiently represented here by Mongolian Chesney (cf. discussion in Appendix 3 *Biodiversity Impacts and Mitigation Actions* 3.3).

Which impacts are included?

Impacts were included in the NPI forecast calculations if they were considered significant and certain or relatively likely to occur. The main impact types included were:

- Direct habitat loss
- Indirect habitat loss (due to avoidance of infrastructure by animals)
- Direct mortality (from collision with vehicles and from collision with, and electrocution by, power lines)
- Indirect mortality (from increased hunting and collecting facilitated by increased numbers of people in the area and by increased access)

Losses resulting from all of these impact types were quantified. However, the project also has a number of possible impacts that are understood to be of low likelihood but potentially very high consequence to biodiversity. These include hydrological risks such as those outlined in Appendix 3 Biodiversity Impacts. These low likelihood/high consequence risks are considered in a qualitative way in the 'Results' and 'Conclusions and Recommendations' sections but are not formally included in the NPI forecast calculations.

A detailed consideration of project risks and impacts on the priority biodiversity features can be found in Appendix 3 Biodiversity Impacts.

Which offset sites are considered for the purposes of this NPI forecast?

The Oyu Tolgoi project is in the process of selecting appropriate offset sites; further details of the site screening process are given in Appendix 4 Offsets Strategy. However, for the purposes of carrying out this NPI forecast it was necessary to select a particular set of sites in order to calculate the magnitude of potential biodiversity gains, and to determine whether or not NPI is theoretically achievable based on offsets of the scale currently being considered. It should be noted that this does not imply that this particular set of sites is recommended over any other site or combination of sites, nor that any stakeholder discussion has yet taken place on the feasibility or appropriateness of these sites. Recommendations on site selection and the criteria upon which this should be based are given in Appendix 4 Offsets Strategy.

Calculations of gains were carried out based on the assumption that the following sites would be taken forward as offsets:

- Bayan-Ovoo soum (excluding the SPA)
- Khatanbulag soum (excluding the SPA)
- Khuvsgul soum

The Small Gobi (A and B) SPAs were excluded from offset gain calculations because many stakeholders consider that existing protected areas cannot be considered as offsets because they do not meet additionality criteria (although this is not a universally held view). Nonetheless, it is noted that the Oyu Tolgoi project is committed to carrying out conservation actions in the Small Gobi SPA (most of which are likely to be similar to those outlined for offsets here) and that to some extent this provides a 'contingency' for offsets.

Main offset activities to achieve NPI

The main offset actions that could be employed to achieve a Net Positive Impact on priority biodiversity features are:

- Control of illegal hunting and collecting
- Improved rangeland management
- Infrastructure mitigation

These offset actions cover most of the threats to priority biodiversity features. Sheehy *et al*. (2010) note that Asiatic Wild Ass (and presumably other priority biodiversity features) are also threatened by habitat change, which is driven largely by climate change and is impracticable to address at a local level. The residual impacts and key actions for each feature are summarised in Table 3. Further details of these offset activities are given in Appendix 4 Offsets Strategy.

Table 3: Residual impacts and key actions required for each relevant priority biodiversity value

Priority biodiversity feature	**Key residual impacts**	**Key offset actions**
Eastern Gobi desert-steppe	Habitat loss	Improve rangeland management
Alashan Plateau semi-desert	Habitat loss	Improve rangeland management
Mongolian Chesney	Habitat loss	Improve rangeland management
Asiatic Wild Ass	Increased mortality from hunting; habitat loss	Control illegal hunting; infrastructure mitigation; rangeland management
Argali	Increased mortality from hunting; habitat loss	Control illegal hunting; rangeland management
Goitered Gazelle	Increased mortality from hunting; habitat loss	Control illegal hunting; infrastructure mitigation; rangeland management
Mongolian Gazelle	Increased mortality from hunting; habitat loss	Control illegal hunting; infrastructure mitigation; rangeland management
Swan Goose	Increased mortality from collisions	Infrastructure mitigation
Ferruginous Duck	Increased mortality from collisions	Infrastructure mitigation
Short-toed Snake-eagle	Habitat loss; increased mortality from electrocutions	Rangeland management; infrastructure mitigation
Saker Falcon	Increased mortality from collecting and electrocutions; habitat loss	Control illegal hunting; infrastructure mitigation; rangeland management
Egyptian Vulture	Habitat loss; increased mortality from electrocutions	Rangeland management; infrastructure mitigation
Great Bustard	Increased mortality from hunting and collisions; habitat loss	Rangeland management; control illegal hunting; infrastructure mitigation
Houbara Bustard	Habitat loss; increased mortality from hunting and collisions	Rangeland management; control illegal hunting; infrastructure mitigation
Relict Gull	Increased mortality from collisions	Infrastructure mitigation
Pallas' Sandgrouse	Habitat loss; increased mortality from collisions	Infrastructure mitigation
Mongolian Ground-Jay	Habitat loss	Rangeland management
Yellow-breasted Bunting	Habitat loss	Rangeland management
Granite Outcrop Floral Communities	None	n/a
Riverine Elm Trees	Habitat loss; increased collecting	Rangeland management; collecting control
Tall Saxaul Forest	Habitat loss; increased collecting	Rangeland management; collecting control

Methods

1.1 General methods

The Net Positive Impact forecast for biodiversity at Oyu Tolgoi was carried out according to the following steps, as recommended in Rio Tinto's internal guidance on biodiversity accounting:

1. Select which biodiversity features to include in NPI accounting
2. Select a metric or metrics
3. Decide over which time period to measure losses and gains
4. Quantify residual losses once the mitigation hierarchy has been followed
5. Quantify gains generated through offsets
6. Determine whether Net Positive Impact may be achieved

1. Select which biodiversity to include in NPI accounting

- Biodiversity is complex - it is not possible to quantify all of its aspects.
- Consequently it is necessary to select which biodiversity features to measure. This should be done based on clear and consistent criteria, with stakeholder input where necessary.
- The selected features should be good 'surrogates' - they should capture a wide range of the biodiversity values at a site, including any biodiversity regarded as a conservation priority.
- Typically it is appropriate to measures losses and gains in *habitats* and *priority species*, using globally-accepted methods (e.g. IUCN Red List) to determine priority.

2. Select a metric or metrics

- There is no single globally-accepted metric for measuring losses and gains in biodiversity, in contrast to carbon offsetting, where Carbon Dioxide Equivalents (CDE) provide a globally consistent metric. This presents a challenge for measuring Net Positive Impact.
- The best choice of metric will depend in part on the biodiversity features selected in Step 1. For example, losses and gains of habitat may be measured in hectares, losses and gains of a priority species may be measured in number of individuals.
- The most commonly-used metrics globally are based on *extent and condition (or quality) of habitat*. Rio Tinto's Quality Hectares metric follows this model.
- Condition (or quality) can be measured in many different ways; the appropriate choice depends on the context. There are a number of well-established methods for measuring condition.

3. Decide which time period over which to measure losses and gains

- *Retrospective no net loss analysis* - measuring losses and gains from a point in the past (e.g. date of establishment of a company, site or project) to the present date, to determine whether no net loss has been achieved.
- *No net loss forecast* - forecasting losses and gains from the present date to a point in the future (e.g. project closure, or a stakeholder- or regulator-imposed deadline), for example to determine whether planned mitigation and offset measures are sufficient to deliver no net loss.

4. Quantify residual losses once the mitigation hierarchy has been followed

- Following the mitigation hierarchy means that a company ahould first avoid and minimise impacts wherever possible. Post-impact, biodiversity should be rehabilitated and restored. Offsets should be used to compensate for the residual impacts.
- In practice, because restoration and rehabilitation often happens many years in the future whereas offsets need to be implemented immediately, it is necessary to forecast the gains that can reasonable be achieved through restoration and rehabilitation in order to determine the size of offset required.
- To measure the full impact of a project, indirect/secondary impacts should be considered as well as direct impacts. However, these are often difficult to quantify.

5. Quantify gains generated through offsets

- Measurable gains can be generated by improving the *quality* of biodiversity and / or by increasing the *quantity* of biodiversity in relative or absolute terms (e.g. stopping deforestation in an area where there would otherwise have been rapid loss, or creating a species-rich wetland on intensive arable farmland).

6. Determine whether no net loss has been achieved

- No net loss is achieved when gains from offsets outweigh residual losses (after the mitigation hierarchy has been followed).
- Third-party verification (e.g. through an appropriate stakeholder process) is desirable.

As discussed in Section 2 above, biodiversity features included in the NPI forecast include (1) all priority species and ecosystems for which the area qualifies as Critical Habitat under IFC PS6/EBRD PR6, as well as (2) species and habitats defined as appropriate for inclusion in NPI accounting by Rio Tinto internal guidance, and are listed in Table 2. The main metric used was Quality Hectares (QH)[2]. Additionally, for certain features, losses and gains were quantified in number of individuals, or in the case of mortality from electrocution/collision with powerlines, using a bespoke method that is described fully in the sections below. The time period selected was 25 years, i.e. 2011-2036. Rio Tinto business units located in 'Very High' or 'High' biodiversity value contexts should at a minimum meet Net Positive Impact by closure, and should aim to be NPI positive as early in mine life as possible and ideally throughout operations (Rio Tinto unpubl. memo. 2011). Consequently 25 years was seen as an appropriate time period for NPI forecasting, as Oyu Tolgoi is a long-term project, and offset planning should take a long-term perspective, but forecasting losses and gains over periods longer than a few decades involves very significant uncertainty. Steps 4, 5 and 6 (quantify losses and gains and determine whether or not NPI may be achieved) are described below.

1.2 Estimating biodiversity losses

Losses resulting from the following impact types were quantified following the approach described below:

- Direct habitat loss
- Indirect habitat loss (due to avoidance of infrastructure by animals)
- Direct mortality (from collision with, and electrocution by, power lines)
- Indirect mortality (from increased hunting facilitated by increased numbers of people in the area and by increased access)

Direct habitat loss was quantified for all priority biodiversity features by overlaying infrastructure maps (e.g. mine site, road, airport, borefield/pipeline) with habitat maps. For most priority species, impacts due to direct habitat loss were initially calculated in hectares assuming that the species occurs at even densities throughout the habitat type(s) from which it is known. A next step would be to adjust these losses (and gains) based on distribution maps from national red list assessments. One feature for which this assumption may be particularly problematic is the Mongolian Chesney (and other threatened plants) – very little is known about the ecology and distribution of this species within the study area, and it is possible that this species is patchily distributed

[2] Quality Hectares are Rio Tinto's standard metric for tracking progress towards the NPI target at the global and site level. A wide range of biodiversity values, including threatened species, rare habitats or non-timber forest products, may be expressed in terms of their quantity and quality. This is expressed as an "Area x Quality" metric, referred to here as Quality Hectares (QH). For example, 100 hectares of forest in pristine condition would count as 100 Quality Hectares (100 ha x 100% quality = 100 QH), whereas 100 hectares of fairly degraded forest at 40% 'optimum quality' would be expressed as 40 Quality Hectares (100 ha x 40% quality = 40 QH).

and over-represented in the areas of direct impact (cf Appendix 3 Biodiversity Impacts). For one priority feature, Riverine Elm Trees, losses were calculated in terms of number of individuals.

Indirect habitat loss was estimated for a subset of the priority features (i.e. large mammals and certain bird species that exhibit behaviour of avoiding roads and other infrastructure, owing to the fact that they are hunted by humans). Avoidance distances were derived from the literature and from expert consultation[3].

The residual impact and offset requirement for direct mortality from powerline collisions and electrocution was estimated as follows: On a precautionary basis, it was assumed that if best-practice mitigation is implemented, bird strikes can be reduced by 60% (lower estimates of relevant published studies summarised in Jenkins *et al*. 2010). Given impacts of 'y' per km, and a 95 km-long transmission line, this means residual impacts are reduced to 95*0.4*y = 38y. To offset these impacts requires similar mitigation to be put in place over another, previously unmitigated, length of power line of 'z' km in the range of these priority biodiversity features such that z*0.6*y=38y, i.e. z=38/0.6[4], thus mitigation over an additional 64 km.

To convert losses calculated in hectares into Quality Hectares, two different methods were used, depending on what the key determinant of habitat quality was for the particular biodiversity feature in question. For the majority of priority features (e.g. habitat types, birds, reptiles, plants), habitat quality was estimated based on vegetation condition, i.e. degree of degradation (mainly caused by grazing pressure). Vegetation condition was assessed in five categories (very good, good, moderate, poor, very poor) based on Oyu Tolgoi reports and other literature, and 'quality percentages' were derived as shown in Table 4. Vegetation in areas selected was precautionarily assessed to currently be in very good condition; there is relatively little information available, and that which is available is conflicting, so it was most appropriate to take a precautionary approach.

Table 4: Quality multipliers for vegetation condition

[3] Many priority biodiversity features are predicted to avoid areas close to project infrastructure and activities. Such avoidance is not complete and total: for example, avoidance may be 100% within several metres of a road, 50% within 500 m, 25% within 1 km, etc. Avoidance distances depend on factors such as noise, dust, local topography and vegetation, and hunting pressure. At the Oyu Tolgoi project site, background hunting pressure is the strongest driver of avoidance, especially for Asiatic Wild Ass and other ungulates avoiding vehicles and people. Avoidance distances are likely to be higher during construction, when noise and dust pollution will be greatest, and animals have not yet habituated to the infrastructure. Some data on avoidance distances may be possible to obtain empirically (e.g. by aerial surveys) and monitoring. For example, Asiatic Wild Ass in the southern Gobi region are estimated to avoid areas within 5 km of vehicles (P. Kaczensky *in litt.* 2011). However, given likely habituation to static infrastructure, it has been necessary to infer and extrapolate avoidance distances. For example, impacts have been demonstrated up to 1,600 m for Great Bustard (Lane *et al.* 2001; López-Jamar 2010; Raab 2011) and Reindeer have shown reduced population effects up to 17 km from similar infrastructure where historically hunted (Benítez-López *et al.* 2009). Provisional estimates of avoidance distances are given in Appendix 3 Biodiversity Impacts section II.2.

[4] Rounded up to the nearest km.

Vegetation condition	% of 'optimal quality'	Quality Percentage
Very good	80-100%	90%
Good	60-80%	70%
Moderate	40-60%	50%
Poor	20-40%	30%
Very poor	0-20%	10%

For large mammals, the key determinant of habitat condition is hunting pressure[5]. In a similar way, this was estimated in five categories (Very High, High, Medium, Low, Negligible) and quality percentages were derived. Current habitat quality for large mammals was estimated to be moderate (quality percentage of 50%); this is based on scant data and better information is needed.

Indirect mortality from increased hunting facilitated by increased numbers of people in the area and by increased access was estimated as follows: It was estimated that the unmitigated impact of a project of the scale of Oyu Tolgoi would be that the hunting rate doubles within a 100 km radius of growth pole (equivalent to a reduction in habitat quality from 50% to 25%, assuming a linear relationship between hunting pressure and the quality percentage across 31,000 km^2). The resulting loss would be c.785,000 QH for each of the priority hunted mammals. It was further assumed that the project would put best-practice mitigation in place to minimise secondary impacts such as increased hunting, but that this would only be partially successful (it was estimated that mitigation would be 50% successful, hence a quality percentage of 25% + 50%x75% = 62.5%). Consequently the loss from indirect mortality from increased hunting was estimated at c.392,500 QH (62.5%-50% x31,000 km^2). This estimate is essentially based on expert opinion and educated guesswork rather than empirical evidence - better information from field studies is needed to provide a more secure estimate in future. This is particularly necessary given that these kind of impacts are potentially the largest in magnitude of all the project's impacts on priority mammal species.

1.3 Counter-factual situation

To be precautionary, losses and offsets gains were estimated against a static baseline, meaning that there is assumed to be no acceleration in development in the southern Gobi region and concomitant increased impacts on biodiversity. An alternative counterfactual situation of greatly accelerated growth related to additional mines (although acknowledged by the project to be more realistic) was not used as this would be difficult to quantify, assume ineffective mitigation and be non-precautionary. Furthermore, there is experience that stakeholders are unlikely to accept large background rates of loss as the baseline against which losses and gains are measured (Temple *et al.* 2011). An estimate of predicted future growth could be factored into the NPI forecast based on the best opinion of regional planning experts. The project's success in addressing cumulative regional impacts would need to be factored into this estimate. The current assumption of no accelerated impacts is therefore precautionary but subject to revision.

[5] And disturbance (increased avoidance of humans and infrastructure), which is a problem because of hunting pressure.

1.4 Projecting possible biodiversity gains

The main offset actions that would be employed to achieve a Net Positive Impact on priority biodiversity features include the following:

- Control of illegal hunting
- Improved rangeland management
- Infrastructure mitigation (reducing collision with, and electrocution by, power lines)

The predicted offset gains need to be estimated in order to make a forecast for achieving Net Positive Impact. Gains are measured in the same units as losses, and are largely a product of offset area and incremental improvement in quality (hunting, rangeland and infrastructure).

The key parameters enabling quantification of quality improvements are:

- By what percentage can the Oyu Tolgoi project decrease the rate of illegal hunting?
- By what percentage can the Oyu Tolgoi project reduce the degree of habitat degradation?

As indicated in the previous sections on offset actions, these parameters are very poorly-known and require much more research. However, it is important to indicate their likely scale in order to assess the feasibility of achieving Net Positive Impact. The overall rate of illegal hunting could perhaps be reduced by a similar level to that achieved by the WWF 'MAPU' project. The impact of this project on the baseline rate of hunting has not been quantified but the reviewers concluded that "illegal hunting has strongly declined" (Breitenmoser *et al.* 2006). For the purpose of enabling an order-of-magnitude estimate of Net Positive Impact feasibility, this report solicited expert opinion and precautionarily suggests that an appropriate offset action could achieve a 50% improvement in illegal hunting over 75% of the area in which it worked (i.e. hunting would be reduced to 50% x 75% of 2011 levels). In practice, a 'strong decline' might turn out to be greater in magnitude than this precautionary estimate, but for the purposes of offset planning it is appropriate to be cautious. An alternative guesstimate is that effective control of illegal hunting would allow the populations of Asiatic Wild Ass and similar species to increase by c.10% / year (D. Sheehy *in litt.* 2011).

Quantified reviews are unavailable for any projects that have aimed to improve rangeland management, except for the GTZ project which had a primary aim of improving herder income but also included improvement of rangeland management as an action. This achieved c.15% relative increase in plant biomass (Hess *et al.* 2010). However, herders in the offset areas may be less interested in participating in a project whose primary aim is wild animal conservation. Offset actions could be undertaken over a relatively small area at a similarly intense rate to the GTZ project, or over similar areas to the control of illegal hunting but at a lesser intensity than the GTZ project. For the purpose of enabling an order-of-magnitude estimate of Net Positive Impact feasibility, this report suggests that an appropriate offset action could achieve a 15% improvement in plant biomass, which might equate to a 7.5% improvement in habitat quality.

These figures are very approximate estimates based on very inadequate baseline and comparable data, and should not be used as anything other than the purpose of enabling an order-of-magnitude estimate of Net Positive Impact feasibility. Further research into improving the accuracy of these estimates is needed. It is also recommended that the project is precautionary in initiating actions across much larger areas than calculations may suggest, and invests in accurate measurements of baselines and offset gains which will enable much more accurate estimates. It is also noted that the final outcome should be measured in gains in population size of priority biodiversity features, in addition to the rate of illegal hunting or rangeland improvement.

1.4.1 Gains from the control of illegal hunting

Potential gains from the control of illegal hunting were projected for the priority large mammal species, assuming that offset actions would be implemented throughout the offset area[6]. As detailed above, it was assumed that the hunting rate could be reduced to 50% of 2011 levels across 75% of the landscape; assuming a linear relationship between hunting rate and quality percentage this would be equivalent to an improvement in habitat quality from 50% to 68.75% (= no change (50% quality) in 25% area + doubled quality (75%) in 75% area) or an overall gain of 18.75% (50% gain x50% quality x75% area) Details of the kind of activities that would need to be put in place to achieve this are given in Appendix 4 Offset Strategy.

1.4.2 Gains from improved rangeland management

Potential gains from improved rangeland management were projected for all non-mammal priority features (with the exception of Riverine Elm Trees, Granite Outcrop Floral Communities and Tall Saxaul Forest, to which this management is not specifically targeted, though it may have some benefits). It was assumed that an improvement of quality of 7.5% could be achieved in the areas of focused management intervention (assumed to be 10% of the total offset area for the purposes of these calculations[7]; this is a precautionary assumption made on the grounds that the total offset area considered for the purposes of this NPI forecast is very large and it may not be feasible to successfully implement improved rangeland management across this whole very large area rangeland). Details of the kind of activities that would need to be put in place to achieve this are given in Appendix 4 Offset Strategy. It should be noted that measuring and monitoring success will be challenging in the non-equilibrium ecosystems found in the project area and offset sites.

1.4.3 Gains from infrastructure mitigation

The method for calculating residual impact and offset requirement for direct mortality from powerline collisions and electrocution was given in the previous section. Details of

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[6] Calculated here based on the area of Bayan-Ovoo soum (excluding the SPA), Khatanbulag soum (excluding the SPA) and Khuvsgul soum; this does not imply that these areas have been selected as offset sites, the purpose of the calculation is simply to determine whether offsets of sufficient scale and appropriate type are available to be able to potentially meet NPI.

[7] Calculated here based on the area of Bayan-Ovoo soum (excluding the SPA), Khatanbulag soum (excluding the SPA) and Khuvsgul soum; this does not imply that these areas have been selected as offset sites, the purpose of the calculation is simply to determine whether offsets of sufficient scale and appropriate type are available to be able to potentially meet NPI.

the kind of activities that would need to be put in place are given in Appendix 4 Offset Strategy.

Feature-specific actions may be necessary for some priority features such as Riverine Elm Trees. Three individuals were under the project's direct footprint and have been translocated; the NPI forecast assumes that this translocation is successful and, if not, that any residual loss is compensated for by propagating trees in the OT nursery and planting them out with appropriate medium-term care to ensure successful establishment. Details of other gains from feature-specific activities are given in the Appendices.

Results

The results of the NPI forecast suggest that, based on an offset programme including the sites and activities detailed above and in Appendix 4 Offsets Stratgey, it may be theoretically possible to achieve NPI on the majority of priority biodiversity features (Table 5). The exceptions are Great Bustard and Houbara Bustard. Consequently additional bustard offsets may be required outside Mongolia (e.g. on migratory route, where the species are threatened by hunting). However, as noted in the 'Conclusions and Recommendations' section, there is considerable uncertainty around these figures, and they should be treated with caution. For example, it is possible that the net impact would be negative rather than positive, even if all of the offset measures recommended in 'Potential offset sites and actions for the Oyu Tolgoi project' are implemented.

Table 5. Projected net position (i.e. losses plus gains) in 2036 for relevant priority biodiversity features

Name	Net position (QH) excluding secondary impacts (increased hunting)	Net position (QH) for priority mammals including secondary impacts (increased hunting)	Is NPI forecast to be achieved for this feature?
Mongolian Chesney	13,000		Yes
Asiatic Wild Ass	452,000	59,000	Yes
Argali	515,000	122,000	Yes
Goitered Gazelle	465,000	72,000	Yes
Mongolian Gazelle	491,000	99,000	Yes
Swan Goose			Yes[1]
Ferruginous Duck			Yes[1]
Short-toed Snake-eagle	13,000		Yes[1]
Saker Falcon	13,000		Yes[1]
Egyptian Vulture	13,000		Yes[1]
Great Bustard	-43,000		No[1,2]
Houbara Bustard	-43,000		No[1,2]
Relict Gull			Yes[1]
Pallas' Sandgrouse	13,000		Yes[1]
Yellow-breasted Bunting	13,000		Yes
Mongolian Ground-Jay	13,000		Yes
Riverine Elm Trees			Yes
Granite Outcrop Floral Communities	0		Yes (NNL)
Tall Saxaul Forest	0		Yes
Eastern Gobi desert-steppe	4,000		Yes
Alashan Plateau semi-desert	9,000		Yes

[1] Assuming mitigation is put in place on all OT powerlines plus an additional >64km of non-OT powerlines
[2] Yes if there is an appropriate additional offset

Detailed results are presented in the Appendices. Note that there will be a time lag during which the project is NPI negative because losses will occur immediately (indeed some significant impacts have already occurred) whereas gains in a number of features may take some years to accrue. Consequently offset actions should be implemented as soon as possible in order to minimise this period of temporal loss, which may be significant for the viability of some priority features (e.g. threatened species).

Conclusions and recommendations

This section starts by setting out a number of key caveats that should be born in mind when interpreting this NPI forecast.

First, this NPI forecast quantifies Oyu Tolgoi project impacts (including direct, indirect and induced impacts) in a fairly comprehensive way, but it does not include (e.g. formally quantify) cumulative impacts from the number of other developments proposed and underway in the region. This approach is in line with the requirements of Rio Tinto's biodiversity policy and IFC/EBRD, which require operations to offset their own impacts, keeping in mind the broader regional context (including cumulative impacts) when considering offset viability. However, particularly in the case of the southern Gobi region, there is a significant risk that even if the Oyu Tolgoi project does the 'right thing', following the mitigation hierarchy and implementing mitigation and offset activities of a type and scale commensurate with project impacts, Net Positive Impact may not be achieved. In other words, there is a significant risk that mitigation and offset activities may fail owing to the actions of others that are outside Oyu Tolgoi's control. This presents a reputational risk to OT, Rio Tinto, and its lenders. A resultant recommendation is that Oyu Tolgoi and its lenders should consider how they can use their influence to drive improved biodiversity performance for other non-Rio businesses (and across all sectors, including both private and public) in the region.

Second, the project has a number of uncertainties that are understood to be of low likelihood but potentially very high consequence to biodiversity, including hydrological impacts such as those outlined in the summary and full Biodiversity Management Plans. These low likelihood/high consequence risks are not appropriate for inclusion in the NPI forecast calculations. Moreover, little information is available to be able to quantify the potential impacts that might occur. All that can be said is that impacts (and hence additional offset requirements) would potentially be large, and consequently these low likelihood/high consequence risks should be further investigated and monitored as recommended in Appendix 3 Biodiversity Impacts.

Third, as is clear from the 'Methods' section, the results of the NPI forecast are critically dependent upon a number of different technical assumptions and input parameters, many of which have been estimated based on minimal evidence (typically because little or no information is available), and which consequently are associated with a high level of uncertainty. Further research needs to be done as part of the ongoing monitoring, and the NPI forecast can be iteratively improved and refined as better information becomes available.

Finally, the ambitious nature of such a novel approach in Mongolia should be stressed. Based on the findings of this NPI forecast, offset activities on a very large scale would be required to give reasonable confidence of achieving a net positive impact on biodiversity. The political feasibility of implementing such measures has yet to be ascertained. Political consultation on the feasibility of the offset actions required to theoretically achieve NPI is the next step required.

The following recommendations can be made:

- Additional bustard offsets may be required outside Mongolia (e.g. on wintering grounds and migratory route, where the species are threatened by hunting)
- Oyu Tolgoi and its lenders should consider how they can use their influence to drive improved biodiversity performance for other non-Rio businesses (and across all sectors, including both private and public) in the region, in order to manage cumulative impacts
- Low likelihood/high consequence risks (e.g. hydrology) should be further investigated and monitored, and offsets for these should be implemented if monitoring indicates that impacts are occurring. Further research is needed to determine whether offsets would be feasible.
- Some of the information upon which this NPI forecast is based is very weak, and additional research would need to be done to provide a forecast with higher confidence and less uncertainty

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11 Appendices

Appendix 1. Currencies used for measuring biodiversity losses and gains

Name of biodiversity feature	Currency / currencies	Currency notes
Mongolian Chesney	QH	Quality estimated in terms of degree of degradation (mainly caused by grazing pressure)
Asiatic Wild Ass	QH	Quality estimated in terms of hunting pressure
Argali	QH	Quality estimated in terms of hunting pressure
Goitered Gazelle	QH	Quality estimated in terms of hunting pressure
Mongolian Gazelle	QH	Quality estimated in terms of hunting pressure
Swan Goose	Bespoke collision metric	Not affected by habitat loss
Ferruginous Duck	Bespoke collision metric	Not affected by habitat loss
Short-toed Snake-eagle	QH, bespoke collision metric	Quality estimated in terms of degree of degradation (mainly caused by grazing pressure)
Saker Falcon	QH, bespoke collision metric	Quality estimated in terms of degree of degradation (mainly caused by grazing pressure)
Egyptian Vulture	QH, bespoke collision metric	Quality estimated in terms of degree of degradation (mainly caused by grazing pressure)
Great Bustard	QH, bespoke collision metric	Quality estimated in terms of degree of degradation (mainly caused by grazing pressure)
Houbara Bustard	QH, bespoke collision metric	Quality estimated in terms of degree of degradation (mainly caused by grazing pressure)
Relict Gull	Bespoke collision metric	Not affected by habitat loss
Pallas' Sandgrouse	QH, bespoke collision metric	Quality estimated in terms of degree of degradation (mainly caused by grazing pressure)
Yellow-breasted Bunting	QH	Quality estimated in terms of degree of degradation (mainly caused by grazing pressure)
Mongolian Ground-Jay	QH	Quality estimated in terms of degree of degradation (mainly caused by grazing pressure)
Riverine Elm Trees	Number of individuals	Total population within study area is 3-5,000
Granite Outcrop Floral Communities	QH	
Tall Saxaul Forest	QH	
Eastern Gobi desert-steppe	QH	Quality estimated in terms of degree of degradation (mainly caused by grazing pressure)
Alashan Plateau semi-desert	QH	Quality estimated in terms of degree of degradation (mainly caused by grazing pressure)

Appendix 2. Residual losses to relevant priority biodiversity features

Name	Direct habitat loss (1000 ha)	Direct & indirect habitat loss (1000 ha)	Secondary impact of increased hunting from increased human population in the region (1000 QH)	highest)Quality of habitat lost (0-1; 1 being	Quality notes
Mongolian Chesney	9	9		0.9	Habitat is currently in very good condition. Using a 5-category scale, habitat would be in top category (0.8-1; mid-point 0.9)
Asiatic Wild Ass		155 5	392	0.5	Habitat is of moderate quality for mammals (main determinant of quality for mammals is hunting pressure). Using a 5-category scale, judged to be in middle category e.g. Range 0.4-0.6, mid-point = 0.5
Argali		301	392	0.5	
Goitered Gazelle		130 2	392	0.5	
Mongolian Gazelle		763	392	0.5	
Swan Goose					n/a
Ferruginous Duck					n/a
Short-toed Snake-eagle	9	9		0.9	Habitat is currently in very good condition. Using a 5-category scale, habitat would be in top category (0.8-1; mid-point 0.9)
Saker Falcon	9	9		0.9	
Egyptian Vulture	9	9		0.9	
Great Bustard		713		0.9	
Houbara Bustard		713		0.9	
Relict Gull					n/a
Pallas' Sandgrouse	9	9		0.9	Habitat is currently in very good condition. Using a 5-category scale, habitat would be in top category (0.8-1; mid-point 0.9)
Yellow-breasted Bunting	9	9		0.9	
Mongolian Ground-Jay	9	9		0.9	
Riverine Elm Trees					n/a
Granite Outcrop Floral Communities	0	0			n/a
Tall Saxaul Forest		+		?	

Eastern Gobi desert-steppe	5.5	5.5		0.9	Habitat is currently in very good condition. Using a 5-category scale, habitat would be in top category (0.8-1; mid-point 0.9)
Alashan Plateau semi-desert	3.5	3.5		0.9	

Appendix 3. Potential offset gains by 2036

Name	How will gains be achieved?	Offset area (km^2)	Offset gain (1000 QH)	Notes on calculation of gains
Mongolian Chesney	Improved habitat quality is likely to benefit threatened plants	28,245	21	Assumes improvement of quality by 7.5% over 25 years in area of intensive intervention (which is 10% of total offset area).
Asiatic Wild Ass	Reduce hunting rates at the offset sites	28,245	551	Assumes that hunting rate can be improved by 18.75%; combined with habitat gains (2100 QH)
Argali	Reduce hunting rates at the offset sites	28,245	551	
Goitered Gazelle	Reduce hunting rates at the offset sites	28,245	551	
Mongolian Gazelle	Reduce hunting rates at the offset sites	28,245	551	
Swan Goose	Collision mitigation on non-OT power lines			
Ferruginous Duck	Collision mitigation on non-OT power lines			
Short-toed Snake-eagle	Improve habitat quality, collision mitigation on non-OT powerlines	28,245	21	Assumes improvement of quality by 7.5% over 25 years in area of intensive intervention (which is 10% of total offset area).
Saker Falcon	Improve habitat quality, collision mitigation on non-OT powerlines	28,245	21	
Egyptian Vulture	Improve habitat quality, collision mitigation on non-OT powerlines	28,245	21	
Great Bustard	Improve habitat quality, collision mitigation on non-OT powerlines	28,245	21	
Houbara Bustard	Improve habitat quality, collision mitigation on non-OT powerlines	28,245	21	
Relict Gull	Collision mitigation on non-OT power lines			
Pallas' Sandgrouse	Improve habitat quality	28,245	21	Assumes improvement of quality by 7.5% over 25 years in area of intensive intervention (which is 10% of total offset area).
Yellow-breasted Bunting	Improve habitat quality	28,245	21	
Mongolian Ground-Jay	Improve habitat quality	28,245	21	
Riverine Elm Trees	3 trees translocated		+	Assumes translocation is successful; offset gains depend on specific offset site
Granite Outcrop Floral Communities	No certain losses to offset		0	Offset gains depend on specific offset site
Tall Saxaul Forest	No certain losses to offset		+	Assumes adequate control of illegal collecting (not quantified)
Eastern Gobi desert-steppe	Improve habitat quality through improved rangeland management	12,179	9	Assumes improvement of quality by 7.5% over 25 years in area of intensive intervention (which is 10% of total offset area).
Alashan Plateau semi-desert	Improve habitat quality through improved rangeland management	16,066	12	