## The development of the Australian environmental offsets policy: from theory to practice

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**QUANTIFYING CHANGES IN FUTURE RISK OF LOSS**

In order to calculate the value of offsets that seek to place protective legal mechanisms on an area of land or sea, a risk assessment of these areas must be undertaken. The assessment needs to analyse the real and potential threats to the site and the value of a protective mechanism, such as a conservation covenant, in addressing these threats. To calculate this factor in the Guide, a risk of loss percentage is used for both a with-offset and without-offset scenario. The difference between the two risk of loss scores is the benefit the offset provides in averting a future foreseeable loss. Predicting land use change is complex, and there may be a wide range of data that are able to be drawn upon at various landscape scales to indicate development intent of a particular area (Verburg *et al.* 2004). Potential scales and types of data that may be used in assessing the risk of loss to a particular site (Table S1).

The averted loss value of an offset is only contingent on its ability to protect habitat that is under threat. By estimating a future risk of loss based on various risk factors, the Guide is explicit in the value that such protection will provide for maintaining biodiversity. For example, protecting habitat that has a low baseline risk of loss may be more attractive to developers due to the lack of competing land uses, but its contribution to improving the conservation outcomes for a threatened species will be less than what would be delivered by protecting habitat that would otherwise be cleared in the near future. Further to this, the value of a legal protection mechanism is contingent on its ability to abate the potential risk that an offset site faces. Where a protection mechanism (such as a private conservation covenant) is insufficient to remove a key risk (such as a mineral exploration or extraction license), the Guide is explicit in assessing this, with no change in the risk of loss score in both the with-offset and without-offset scenario.

**Table S1** Sources and scale of information for assessing risk of loss in the Offsets Assessment Guide.

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| *Risk factors* | *Data specificity* |
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| Development applications, approvals demonstrating clear development intent of a specific site | Highly site specific |
| Zoning, leases and broad planning instruments that demonstrate possible development intent | Site specific |
| Geophysical, economic or social data that indicates likely impacts on the site | Regional scale |
| Background rates of loss of similar vegetation / ecosystem types | Bioregional / ecosystem distribution scale  |

**SELECTION OF A DISCOUNT RATE TO ACCOUNT FOR SPECIES RISK OF EXTINCTION**

The annual probability of extinctionis an estimate of the average chance that a species or ecological community will be completely lost in the wild each year, given recent rates of decline. Separating the estimated extinction rates for vulnerable, endangered and critically endangered species and ecological communities listed under the EPBC Act acknowledges that the threats facing the protected matters in a higher threat category are at higher risk of extinction over the shorter term. As such, the ecological impacts of time lags between impact and offset delivery are considered relatively greater for a critically endangered species or community than one which is listed as endangered or vulnerable.

Similar to the USA’s Endangered Species Act (US Senate 2002), there are currently no guidelines under the EPBC Act which quantify the probability of extinction for species listed under different threat categories (Regan *et al.* 2013). We therefore adopted the IUCN (2001) criteria for each threatened species category (Table 3), and calculated the annual probability of extinction in the wild *p* taking the geometric mean:

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where *P* is the minimum probability of extinction in *T* years.

The final annual discount rate *r* was found by adding a 0.1% to *p* to account for the risk of catastrophic events such as severe bushfire, flooding and weather events:

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Where there is peer reviewed scientific evidence that a species or ecological community has a different annual probability of extinction to that of its IUCN criteria, then that alternative figure may be used.

**ALTERNATIVE CALCULATIONS FOR ADJUSTED HECTARES CURRENCY**

Because of limited information regarding population viability or specific threats to species, area adjusted for either habitat quality (for fauna species) or vegetation condition (for ecological plant communities) are the most frequently used currencies in the Guide:

$$Adjusted Area=\frac{Actual habitat quality}{Highest possible habitat quality} × Area \left(ha\right)$$

This approach was adopted because it provides a method to define impact as a function of both the physical area and the quality of the habitat it contains, which is defined specifically by the value it holds for a species or community. It is important to note that quality may be contingent on the location of an offset in the landscape relative to the movement and dispersal needs of a species, for example, the prevalence or otherwise of relevant habitat features, and patterns of utilisation of habitat by relevant target species. The importance of such factors depends on the extent to which they are likely to be important for the target matter. Thus, a given site may score highly as habitat for one species, but poorly as habitat for another, depending on the particular species’ requirements.

**Risk of loss**

The risk of loss is used to calculate the value of an offset in averting a future loss. This is achieved through measuring the .risk of loss (*RoL*) in both a with-offset and without-offset scenario. To calculate the expected area of a proposed offset site at end time point *T* (*ARoL*) the future area of the offset ($Area\_{t=T}$) is adjusted according to the risk of loss:

$$ARoL =Area\_{t=T} × (1-RoL)$$

**Confidence**

The confidence adjustment occurs once for most currencies, but for the adjusted area currency, the area and quality components are disaggregated and a different level of confidence may apply to scenarios relating to each:

$$Adjusted Gain in Area =\left(ARoL\_{with offset}-ARoL\_{without offset}\right)× Confidence$$

$$Adjusted Gain in Quality=(Quality\_{with offset} -Quality\_{without offset}) × Confidence$$

**Net present value**

Before calculating the final value of area-based offsets, the Guide utilises the annual probability of extinction *r* to calculate the net present value (*NPV*) for confidence-adjusted habitat improvements and changes in risk of loss. The following equation was used to calculate the NPV of an offset and to allow comparison of future offset benefits with impacts that occur at an earlier point in time:

$$NPV\_{AGArea}=Adjusted Gain in Area \left(1+r\right)^{T}$$

$$NPV\_{AGQuality}=\frac{Adjusted Gain in Quality }{\left(1+r\right)^{T}}$$

Two summed calculations occur against a relative constant in order to calculate the net present value. Firstly the *net present value of adjusted gain in area* is multiplied by the future quality of the offset, as quality is a constant and area remains variable. This is because the effective gain in area as a result of averting some loss from the offset will theoretically be achieved at the final quality score. Similarly*, adjusted gain in quality* is multiplied by future area without offset, as the area remains constant and change in *adjusted quality* is treated as the variable.

The final value of area-based offsets is then determined by calculating the sum of the present value of improvements in quality and changes in risk of loss resulting from the proposed offset. This is calculated based on the following formula:

$NPV\_{final}= \left[\left(\frac{Quality\_{with offset}}{10}\right)×NPV\_{AGArea}\right]+ \left[\left(\frac{NPV\_{AGQuality}}{10}\right)×ARoL\_{without offset}\right]$

**References**

IUCN (2001) IUCN Red List Categories and Criteria: Version 3.1. IUCN, Gland, Switzerland and Cambridge, UK [www document]. URL http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria

Regan, T. J., Taylor, B. L., Thompson, G. G., Cochrane, J. F., Ralls, K., Runge, M. C. & Merrick, R. (2013) Testing decision rules for categorizing species’ extinction risk to help develop quantitative listing criteria for the US Endangered Species Act. *Conservation Biology* **27**: 821-831.

US Senate (2002) Endangered Species Act of 1973. Public Law 93–205, approved Dec 28, 1973, 87 Stat. 884 (as amended through Public Law 107–136, Jan 24, 2002) [www document]. URL http://www.epw.senate.gov/esa73.pdf

Verburg, P. H., Schot, P. P., Dijst, M. J. & Veldkamp, A. (2004) Land use change modelling: current practice and research priorities. *GeoJournal* **61**: 309–324.