

**Devils Pulpit Pacific Highway Upgrade  
Compensatory Habitat Assessment  
Offsets Calculator**



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**Cover Photo:** Mature hollow-bearing trees in the riparian habitat at Bungawalbin (D. Rohweder)

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# 1. Introduction

Benchmark Environmental Management (BEM) assessed the suitability of Lot 21 (DP755601) and Lot 2 (DP 1112483) Myall Creek Road Bungawalbin as an offset for the Devils Pulpit Pacific Highway Upgrade (BEM 2012). The assessment concluded “The subject land compares favourably with the selection criteria for offset lands as stipulated in the Pacific Highway Upgrade Devils Pulpit Biodiversity Offsets Strategy. The subject land has many features that make it suitable for acquisition as part of a compensatory habitat package for the upgrade project or other RMS projects in the Northern Rivers Bioregion....” (BEM 2012).

After evaluating the subject property the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) concluded that the offset sites does not meet *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* Approval condition 7A as it is not of equal or greater quality to the habitat that was removed for the Pacific Highway Upgrade Devils Pulpit. SEWPaC recommended that the departments Offset Assessment Guide (calculator) be used on the proposed site in order to meet the requirements of their Environmental Offsets Policy.

The following report discusses the information used to apply the offsets calculator. Four federally listed threatened fauna species were considered as likely to utilise habitat directly affected by the Devils Pulpit upgrade (Hyder 2010). These are spotted-tailed quoll (*Dasyurus maculatus* subsp *maculatus*), grey-headed flying-fox (*Pteropus poliocephalus*), regent honeyeater (*Anthochaera phrygia*) and swift parrot (*Lathamus discolor*). Each species was assessed using the Threatened Species Habitat feature of the Offsets Calculator.

## 2. Relevant Experience

This report has been prepared by Dr David Rohweder (DR) and Mr Don Owner (DO). The same personnel wrote the Devils Pulpit Compensatory Habitat Assessment and conducted fauna surveys and, in the case of DR, reporting for the Devils Pulpit Environmental Assessment (Hyder 2010). Both DR and DO are familiar with habitats at both the impact and offset sites and the sampling strategy applied at the impact site and discussion of habitat values. Both have also undertaken fauna surveys in the Bungawalbin Creek catchment.

## 3. Background Information

### 3.1 Devils Pulpit Environmental Assessment

Hyder (2010) identified four habitat types within the Devils Pulpit upgrade area and described the main features of these habitats. They also compared the density of Hollow-bearing Trees (HbT) within and adjoining the subject site. Information on habitat was obtained from six sites, three within the alignment and three outside the alignment. Key features of the study area, which included the impact site and adjoining forest, are presence of old growth forest and connectivity between coastal and floodplain landscapes. Forested habitat also contained abundant arboreal and

ground hollows, mistletoe, a seasonal blossom resource (i.e. forest red gum, red ironbark, blackbutt and spotted gum) and abundant wattles. A comparison of arboreal hollow density found that significantly ( $P < 0.01$ ) more HbT were present outside the alignment (7.6/0.5ha) than within (3.6/0.5ha). In addition there were substantially more hollows outside the alignment (17.4/0.5ha) than within (9.8/0.5ha). Whilst no comparison was made for log density the same trend occurred (D. Rohweder pers obs).

Whilst the Devils Pulpit upgrade site contained important habitat values the discussion of habitat by Hyder (2010) was influenced by the presence of old growth forest in Devils Pulpit State Forest, habitat that was not directly affected by the upgrade. Recognising the influence of unaffected habitat on the overall discussion of values is important because it highlights the likelihood that values lost can be miss-interpreted by reading the Environmental Assessment. The nature of highway upgrades necessitates the discussion of habitat values both within and adjoining the impact site as impacts extend beyond the immediate site. When comparing site values between impact and compensation sites the value of adjoining habitat should be separated from that directly affected.

### 3.2 Bungawalbin Site

Key features of the Bungawalbin site are old growth riparian forest with an abundant hollow resource, connectivity between the riparian corridor of Bungawalbin Creek and Bungawalbin Nature Reserve, an abundant seasonal blossom resource (forest red gum, grey ironbark, flooded gum, paperbark) and location within an extensive area of contiguous floodplain forest linked to coastal escarpment in the Richmond Range. Possible inclusion of the Bungawalbin site in the reserve network would provide secure tenure for a large area of land extending from Myrtle Creek in the south to the existing Bungawalbin Nature Reserve. Privately owned land between Physics and Myrtle Creeks is protected by covenants and contributes to the extent of protected land. This large area of lowland floodplain forest contains a variety of habitats and a mixed blossom resource for threatened fauna.

At Bungawalbin, the average number of HbT (13/ha) and arboreal hollows (25/ha) is substantially greater than at Devils Pulpit where average densities of 7.2/ha and 19.6/ha were recorded, including adjoining forest (Table 1). Hyder (2010) do not provide figures on ground hollow density but state that hollow logs were abundant in the Dry Open Forest (DOF) with a shrub understorey and numerous in the DOF with a grassy understorey. At Bungawalbin hollow logs were recorded in three of the four habitat types present. Densities of 4 and 8/ha were recorded in the Grassy DOF and Riparian forest respectively (Table 1).

**Table 1:** Hollow-bearing trees, arboreal hollows and hollow log density at the Bungawalbin site.

Habitat	HbT	Arboreal Hollows	Hollow Logs
Grassy DOF	8/ha	15/ha	4/ha
Shrubby DOF	16/ha	36/ha	0
Swamp Forest <sup>1</sup>	8/ha	14/ha	48/ha
Riparian	20/ha	36/ha	8/ha
Average	13/ha	25.25/ha	20/ha

1. Overestimate as only 1 site sampled.

## 4. Offset Calculator

In applying the offset calculator reference has been made to the Offsets Assessment Guide (SEWPaC 2012). The calculator has been applied to each species separately using the Area of Threatened Species Habitat attribute. This attribute was selected as it best reflects the type of impact and specific details on other features such as birth rate, mortality and abundance is lacking. Tables containing supporting information for each component of the calculator have been included for each species. An extract of the calculator for each species is included in Appendix A. Discussion has been included to substantiate data used in the calculator.

### 4.1 Spotted-tailed Quoll

Spotted-tailed quoll have been recorded near the northeast corner of the Bungawalbin site in 2009 and at several locations in the Bungawalbin catchment. A road-killed quoll was recently recorded at the Devils Pulpit site (May 2013) and there are records within 15 km to the north and south (Atlas of NSW Wildlife). The recent record was of a young adult male found dead beside the highway.

Quolls have been reported from a variety of habitats, including dry and moist eucalypt forests and rainforests (Edgar & Belcher 1995). Belcher (2004) notes that the species is dependent on elements of old growth forest such as tree hollows, hollow logs, >50% canopy cover and complex vegetation structure. Prey densities, particularly ground and arboreal mammals, and availability of den sites largely determine habitat use (Belcher & Darrant 2006).

Published information on quoll habitat indicates they prefer structurally complex mature forest (Belcher 2004). Glen and Dickman (2011) suggest that spotted-tailed quolls prefer high elevation forests on productive soils with abundant fallen timber, rocky outcrops and abundant arboreal hollows and abundant arboreal and ground prey. They emphasise the importance of having a large area of habitat where individuals can move freely to breed and disperse and where foxes occur at low density. Hundreds of square kilometres of habitat may be needed to support viable spotted-tailed quoll populations (Glen & Dickman 2011).

Information on prey densities at Bungawalbin and Devils Pulpit is based on field surveys undertaken by the authors for the Devils Pulpit Environmental Assessment and at various times between 1995 and 2005 in the Bungawalbin Catchment. Devils Pulpit has a diverse and abundant arboreal fauna that includes most arboreal mammal species occurring in northern NSW (Hyder 2010). Bungawalbin Nature Reserve has equivalent diversity of arboreal mammals and abundant squirrel gliders (Sharpe 1996). A low abundance of ground mammals was recorded at Devils Pulpit and this finding was supported by camera trap surveys nearby in 2012 (D. Rohweder unpublished data). In contrast, the Bungawalbin site, which is characterised by friable sandy loam, is predicted to have a higher abundance of ground mammals, particularly bandicoots (D. Rohweder pers obs).

Two key points influence the outcome of the offset calculator:

1. The area of habitat, at both sites, that can be considered suitable or potential habitat; and
2. The extent to which quolls would reside and forage within habitat adjoining a major highway.

Neither of the sites contains all habitat attributes that occur in areas with known quoll populations (see Belcher 2004; Glen & Dickman 2011). Quolls inhabiting fragmented coastal environments may occupy larger home ranges and occur at lower densities than reported elsewhere. To survive in coastal habitats quolls would need to utilise a mix of forest types and ages as extensive areas of mature forest do not exist.

There are records of quolls from younger aged stands and the species is noted for raiding chicken coups in agricultural areas adjoining forest (Edgar & Belcher 1995). They have also been recorded in urban areas, such as Urunga on the north coast of NSW, where rabbits are abundant (D. Rohweder pers obs). Quolls will utilise fragmented forest and for that reason the entire Bungawalbin and Devils Pulpit sites have been considered potential habitat and included in the Offsets Calculator.

The Pacific Highway acts as a source of mortality for quolls and there are several records of road struck quolls in northern NSW. Quolls are unlikely to be affected by noise disturbance created by vehicles and they are unlikely to perceive the highway as a barrier to movement. Nonetheless, the highway may act as a population sink for individuals whose home ranges adjoin or overlap it. In the long-term the highway, coupled with clearing and fragmentation may alienate habitat in areas where quolls occur in low abundance. Despite this the entire Devils Pulpit site contains potential quoll habitat, including areas of regrowth north of Devils Pulpit State Forest.

The quality of habitat at Devils Pulpit and Bungawalbin was assessed using information included in the Offsets Assessment Guide (SEWPaC 2012). Assessment results have been tabulated for ease of comparison (Table 2). Devils Pulpit ranked higher than Bungawalbin due to extent of mature forest, adjoins Old Growth Forest, contains more (and better quality) large trunk and branch hollows and more ground hollows, acts as a linkage between coastal and floodplain forests and a linkage with old growth forest. Devils Pulpit is situated in a more fragmented landscape than Bungawalbin which occurs in an extensive area of lowland forest suitable for large home ranges. Both sites would be inhabited by foxes (*Vulpes vulpes*) which would compete with quolls for food.

The Bungawalbin site, whilst containing some important habitat features, such as high diversity of arboreal mammals, abundant squirrel gliders and ground mammals and old growth riparian forest, is dominated by immature vegetation. The hollow resource in the dominant Shrubby and Grassy Dry Open Forest (DOF) habitats consists predominantly of small and medium branch hollows. Fifty percent of hollow trees in the Grassy DOF, which covers 65% of the site, were stags. Many of the hollow logs in DOF are old and rotten and may not provide habitat in the long-term.

Devils Pulpit received a *Quality of Habitat* score of 7 based on moderate ground and arboreal hollow density, high abundance of arboreal prey, landscape position, adjoins old growth forest, lacks evidence that quolls reside on the site, situated in a fragmented landscape where competition with foxes would occur and located beside a source of mortality. The impact calculator determined that the Total Quantum of Impact was 52.5 (Table 3).

**Table 2:** Habitat quality scores for spotted-tailed quolls at Devils Pulpit and Bungawalbin sites.

Attribute	Devils Pulpit		Bungawalbin	
	Score	Rationale	Score	Rationale
Structure & condition of vegetation	3	Contains mature trees (in areas); site affected by wildfire in early 2000's; large woody debris present; site previously logged or cleared; cleared areas consist of regrowth.	2	Mature vegetation in riparian zone; remnant mature trees throughout floodplain forest; stags dominant hollow trees in floodplain forest; floodplain dominated by 20-30 year old regrowth.
Diversity of relevant habitat species		High diversity of arboreal mammal species (7 of 8 locally occurring species), which are an important prey resource in northern NSW (Glen & Dickman 2011); population of greater glider, an important prey species (Glen & Dickman 2011; Belcher <i>et al.</i> 2006); low abundance of medium-sized ground mammals; three habitat types present.		High diversity of arboreal mammal species (7 of 8 locally occurring species), including greater glider; moderate abundance of medium ground mammals including bandicoots, an important prey species (Glen & Dickman 2006a); four habitat types present.
Relevant habitat features present		Adjoins Old Growth Forest with abundant arboreal and ground hollows; contains mature forest with large trunk and branch hollows; high arboreal mammal diversity & abundance; low-moderate ground fauna; abundance of arboreal and ground hollows and arboreal & ground mammals priority habitat features elsewhere (Glen & Dickman 2006a & b; Glen & Dickman 2011; Belcher & Darrant 2006); abundance of arboreal mammals less than recorded in high quality habitat elsewhere in northern NSW (Glen & Dickman 2006a & 2011).		Old Growth Forest with abundant arboreal and ground hollows in riparian habitat; extensive area of immature floodplain forest with arboreal and ground hollows; high arboreal mammal diversity; moderate arboreal and ground mammal abundance; presence of drainage lines which have been important elsewhere (Belcher & Darrant 2006); variety of niches for arboreal mammals; abundance of arboreal mammals less than recorded in high quality habitat elsewhere in northern NSW.
Connectivity with other habitat	3	Forms one of four modelled regional corridors (Scotts 2003) linking coastal forests in Bundjalung NP to floodplain forests in the Bungawalbin Creek catchment.; Devils site is major public land connection; Two linkages to north between Tabbimoble SF and Tabbimoble Swamp NR and one to south through Mororo SF.	2	Situated between protected private & public land extending from Myrtle Creek in south to Bungawalbin NR; links with Bungawalbin and Physics Creek riparian corridors; situated within a large area (Bungawalbin Floodplain) of contiguous forest, comprising State Forest, National Park and Private Land.
Importance of site to species population		Knowledge on quoll populations in locality is lacking, which means it is difficult to make definitive statement on importance; local knowledge, literature and Atlas records suggest species is uncommon in locality; site predicted to be of low importance to species given lack of records, nearby threats (highway) and presence of similar landscape connects nearby; presence of adjoining old growth forest increases importance.		Knowledge on quoll populations in locality is lacking, which means it is difficult to make definitive statement on importance; local knowledge, literature and Atlas records suggest species is uncommon in locality; site predicted to be of low importance to species; predicted to be used for foraging, dispersal and movement during breeding season; denning in riparian zone.
Threats on or near site		Road strike associated with Pacific Highway; noise disturbance; frequent fires; foxes; forestry operation.		Land clearing; agriculture; private native forestry; fire frequency; foxes.
Presence of species on site	1	Recent record of road-killed male; predicted to occur; records within 15km	1	Recorded at northeast corner of site in 2009
Density of species on site		Density predicted to be low; no known resident population.		No records on-site; density predicted to be low.
Role of site population in regard to species population		No known site population; site probably acts as dispersal habitat or movement habitat during breeding season (recent record of male during breeding season supports this); may form part of a large block of habitat used occasionally.		No known site population; site probably acts as dispersal habitat or movement habitat during breeding season; may form part of a large block of habitat used occasionally.



**Table 3:** Impact Calculator – spotted-tailed quoll.

Attribute	Answer Provided	Explanation
Protected matter attribute	Area of threatened species habitat	“Area of habitat” best reflects impact and details on other features are lacking.
Area of habitat	75ha	Area of forest affected by proposal – Table 1.1 BEM (2012).
Quality of habitat	7	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site was awarded: 3 pts for Condition (refer Table 2); 3 pts for context (refer Table 2); 1 pt for stocking (refer Table 2).
Total quantum of impact	52.5	

The decision framework for the offset calculator is summarised in Table 4 and an extract from the calculator is presented in Appendix A. *Time over which loss is averted* was set at the maximum allowed of 20 years. Roads and Maritime Services (RMS) has advised that the subject site could be transferred to the National Parks and Wildlife Service (NPWS) for inclusion in existing conservation reserves. Discussions have already been held between NPWS and RMS on this issue. If transferred to the NPWS *Time over which loss is averted* will extend beyond 20 years

*Time until ecological benefit* was set at 5 years to reflect the more gradual nature of change associated with hollow log development. The accepted paradigm is that conservation reserves provide better conservation outcomes than private ownership, although time is required for forest to mature and structure to improve. In this case the alternate scenario is private ownership and management based on the lands zoning, which is RU1 – Primary Production (Table 4). For a wide-ranging species like spotted-tailed quoll the expansion in size of conservation reserves will have benefits (Meffe & Carroll 1994), particularly in lowland areas where reserves are less common.

The entire site contains potential habitat for spotted-tailed quoll and therefore 386ha was used as the *Starting Area*. The site received a score of 5 for *Start Quality*, based on: presence of mature riparian forest, moderate arboreal hollow density across the site and high density in riparian forest, moderate density of ground hollows, predicted high diversity and abundance of arboreal and ground mammals, linkage between riparian corridor and Bungawalbin Nature Reserve and location within a large area of contiguous forest. The site received 1 point for stocking rate as there is no evidence that quolls inhabit the site permanently. The score of 5 is conservative when compared with the ranking provided for the Devils Pulpit site.

The 10% *Risk of Loss* is a conservative figure based on the likelihood that clearing, fragmentation and modification of habitat would occur if the property was privately owned. The assessment assumes a potential loss of 38.6ha through application of Routine Agricultural Management Activities (RAMA) under provision of the *Native Vegetation (NV) Act 2003*. Direct evidence that clearing would occur is unnecessary as these activities are standard practice on rural land in NSW. Although the site is presently privately owned a change of ownership would lead to increased impact as new owners seek to exploit an investment. The figure of 10% is conservative as parts of the site consist of vegetation that has regrown since 1 January 1990 and could be cleared under the *NV Act*. BEM (2012) suggest that a substantial part of the site consists of vegetation that is 30-40 years old. The

site would also be a candidate for Private Native Forestry (PNF) given the occurrence of noted timber species such as grey gum (*Eucalyptus propinqua*) and grey ironbark (*E. siderophloia*). PNF would result in clearing and fragmentation and if combined with agriculture could lead to substantial habitat decline.

The application of RAMA could cause: increased fire frequency with resultant loss of stags and hollow logs, clearing of fence lines, clearing for stockyards and around infrastructure and clearing for tracks. The above provisions would result in clearing, fragmentation and reduced quality of some important habitat features, particularly in floodplain habitat. Despite the likelihood of clearing it is unlikely that site values would be completely lost. The conclusion that habitat quality for spotted-tailed quoll would improve if the site was purchased by RMS and added to the reserve network follows accepted opinion about the benefits of conservation reserves for biodiversity (see Lindenmayer & Burgman 2005).

Improvements in habitat quality would occur over time as forest matures and vegetation becomes more structurally complex. Likely temporal changes in habitat quality that would benefit quolls include higher abundance of arboreal and ground hollows and development of a more complex and diverse ground and shrub layer. Increased hollow abundance will provide more den sites for quolls and arboreal prey, whilst a more complex ground layer will benefit terrestrial prey species.

The *Risk of Loss with Offset* has been set at 5% and reflects the negative impact that could occur due to wildfire, which would reduce hollow abundance in the floodplain habitats and increase the time for site improvement. The site is well situated to manage fire as the creeks provide natural fire breaks to the south and east. Fire has been excluded from the site for 20-30 years (BEM 2012).

The outcome of the assessment is that the site offsets approximately 134% of the impact and therefore satisfies the minimum (90%) direct offset requirement.

**Table 4:** Offset calculator – Spotted-tailed Quoll.

Attribute	Answer Provided	Explanation
Protected matter attribute	Area of threatened species habitat	
Time over which loss is averted	20 years	Proposed to transfer site to NSW NPWS for inclusion in reserve network. Site would be protected in perpetuity if this occurs.
Time until ecological benefit	5 years	Adopts the accepted paradigm that conservation reserves provide the highest level of protection and threats associated with private ownership (logging, fire-wood collection, private native forestry, spread of weeds, grazing, clearing) will cease immediately; f 5 year timeframe reflects time required for initial signs of habitat improvement to develop.
Start area	386ha	Area of the subject site that contains potential quoll habitat.
Start quality	5	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site awarded: 2 pts for condition (high HbT density in riparian forest; low-mod HbT in floodplain forest, moderate arboreal and ground mammal density <sup>1</sup> , high prey diversity <sup>2</sup> , moderate ground hollow density in riparian forest); 2 pts for Context (linkage between riparian corridor of Bungawalbin Ck & Bungawalbin NR, situated in large area of suitable habitat); 1pt for Stocking (no evidence that quolls reside on-site, one record at northeast corner).
Risk of loss (%) without offset	10%	Site zoned RU1 (Primary production) in Richmond Valley LEP; Activities permitted without consent include extensive agriculture, forestry, home occupations, horticulture & viticulture; <i>Native Vegetation Act 2003</i> allows Routine Agriculture Management Activities (RAMA) without approval, including clearing for fences, dams, stockyards, roads, collection of firewood, creation of fire-breaks (under protection of property provision) & clearing of regrowth since 1 January 1990;
Future area without offset	347.4ha	Calculator generated figure (starting area – 10%)
Future quality without offset	4	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site awarded: 1pt for Condition (reduced abundance of hollows in floodplain due to clearing & fires; reduced ground prey due to grazing and fragmentation); 2pt for Context (increased fragmentation but would not reduce connectivity, increased threat level); 1pt for Stocking (reduced stocking rate as less prey, ground and arboreal hollows). Decrease in stocking is not sufficient to warrant 0 score.
Risk of loss with offset	5%	Proposed inclusion of site in reserve network would ensure forest matures & enable development of additional arboreal hollows, development of more ground hollows through decay & improved vegetation structure as forest matures; chance that site could be affected by wildfire with negative impacts on ground and arboreal hollows and forest structure; site is well-situated to manage fire.
Future area with offset	347.4ha	No change in area.
Future quality with offset	6	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site awarded: 3pt for Condition (ongoing arboreal hollow formation as trees mature; increased ground hollows due to decay, improved fire management and gradual loss of stags; increased arboreal mammal density as forest matures and develops a more stable structure; moderate ground prey density); 2pt for Context (ensure long-term connectivity between nature reserves and riparian corridor along Bungawalbin Creek, increase size of protected land in locality, long-term reduction in threat from fire, gradual improvement in key habitat features, control of foxes); 1pt for Stocking (increased stocking rate as prey population stabilises and ground and arboreal hollows develop).
Raw gain	scores of 38.6 & 2	Calculator generated figures. 32.8 = 10% gained by avoiding potential clearing; 2 = quality gain by avoiding threats associated with private ownership.
Confidence in result	95%	The ability to predict change in habitat quality of reserved land verses private ownership is high and our approach follows the widely accepted principle that conservation reserves protect and enhance biodiversity values more than private ownership (Lindenmayer & Burgman 2005). Confidence has not been set at 100% as there is some chance that the site could be affected by fire and pest species even if included in the reserve network.

## 4.2 Grey-headed Flying-fox

Grey-headed Flying-fox is listed as vulnerable on the *EPBC Act* and has an annual probability of extinction of 0.2%. The impact calculator determined that the Total Quantum of Impact for grey-headed flying-fox was 45 (Table 5). The impact site was deemed to have a *Quality of Habitat* score of 6 based on the presence of a seasonal blossom resource, forms part of contiguous habitat between coastal plain and floodplain and presence of foraging resource (Table 5). The site does not contain suitable habitat for a flying-fox camp and is small in area comprising only a minor component of the Bundjalung/Bungawalbin lowland eucalypt forest.

**Table 5:** Impact Calculator – Grey-headed Flying-fox

Attribute	Answer Provided	Explanation
Protected matter attribute	Area of threatened species habitat	“Area of habitat” best reflects impact and details on other features are lacking.
Area of habitat	75ha	Area of forest affected by proposal – Table 1.1 BEM (2012).
Quality of habitat	6	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site was awarded: 2 pts for Condition (seasonal blossom resource (eucalypts & melaleuca), no suitable camp habitat); 2 pts for context (forms part of east-west linkage - coastal plain to escarpment, part of Bundjalung/Bungawalbin lowland eucalypt forest); 2 pt for stocking (not recorded but likely to occur, nearby camp at Iluka, abundant when eucalypts in blossom, site forms part of larger habitat and would have a small contribution to local abundance).
Total quantum of impact	45.0	

The Bungawalbin site received a *Quality of Habitat* score of 7 based on the area of suitable foraging habitat, presence of fruit and blossom, suitable camp habitat along Bungawalbin and Physics Creeks, high likelihood of use, ability to support many individuals when blossom is available and location in an extensive area of contiguous forest (Table 6). The *Risk of Loss* was set at 10% based on the same reasons discussed for spotted-tailed quoll. Whilst flying-foxes would not be affected by lower abundance of ground and arboreal hollows clearing would remove foraging habitat and fires and grazing would reduce recruitment and canopy density. Future *Quality without Offset* was set at 6 due mainly to the smaller area of foraging habitat and less recruitment of food plants. The loss of 10% may not have a substantial effect on habitat quality, however, our assessment follows the accepted paradigm that habitat loss and agriculture reduce habitat quality for threatened fauna (Sivertsen 1995; Lindenmayer & Burgman 2005).

Future habitat quality without the offset would decrease due to the high potential for clearing, grazing and altered burning practices. Once again a conservative approach has been adopted and the main impact from private ownership would be reduced condition through agriculture and private native forestry.

The outcome of the assessment is that the site offsets approximately 271% of the impact on grey-headed flying-fox and therefore satisfies the minimum (90%) direct offset requirement.

**Table 6:** Offset calculator – Grey-headed Flying-fox.

Attribute	Answer Provided	Explanation
Protected matter attribute	Area of threatened species habitat	
Time over which loss is averted	20 years	Proposed to transfer site to NSW NPWS for inclusion in reserve network. Site would be protected in perpetuity if this occurs.
Time until ecological benefit	0 years	Adopts the accepted paradigm that conservation reserves provide the highest level of protection and threats associated with private ownership (logging, fire-wood collection, spread of weeds, grazing, clearing) will cease immediately.
Start area	386ha	Area of the subject site that contains potential grey-headed flying-fox habitat (see BEM 2012).
Start quality	7	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site awarded: 3 pts for condition (seasonal blossom resource; mix of food plants; potential camp habitat on creek; source of fruit); 2 pts for Context (lowland eucalypt forest linkage between riparian corridor of Bungawalbin Ck & Bungawalbin NR, large area of suitable habitat); 2pts for Stocking (high likelihood that the species would use the site; area of suitable foraging habitat indicates that several individuals would use the site).
Risk of loss (%) without offset	10%	Site zoned RU1 (Primary production) in Richmond Valley LEP; Activities permitted without consent include extensive agriculture, forestry, home occupations, horticulture & viticulture; <i>Native Vegetation Act 2003</i> allows Routine Agriculture Management Activities (RAMA) without approval, including clearing for fences, dams, stockyards, roads, collection of firewood, creation of fire-breaks (under protection of property provision) & clearing of regrowth since 1 January 1990;
Future area without offset	347.4ha	Calculator generated figure (starting area – 10%)
Future quality without offset	5	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site awarded: 2pts for Condition (reduced abundance of blossom due to clearing & fires); 2pts for Context (increased fragmentation but would not reduce connectivity, increased threat level from agriculture & forestry); 1pts for Stocking (reduced stocking rate due to smaller forest area; fewer mature trees).
Risk of loss with offset	0%	Proposed inclusion in reserve network would ensure forest matures & enable development of blossom and fruit resource and improved vegetation structure as forest matures.
Future area with offset	386ha	No change in area.
Future quality with offset	8	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site awarded: 3pts for Condition (improving blossom abundance as vegetation matures; increased variety of blossom as forest matures); 3pts for Context (ensure long-term connectivity with riparian corridor and provide permanent linkage to nature reserve, long-term reduction in threat level; increase size of protected land in locality by linking Nature Reserve to conservation properties (i.e. properties with conservation covenants sold by the Conservation trust) on the south side of Physics Creek); 2pts for Stocking (increased stocking rate as forest matures; ensures that a large area of mixed hardwood forest on floodplain is available for foraging in the long-term).
Raw gain	scores of 36.64 & 2	Calculator generated figures. 36.64 = 10% gained by avoiding potential clearing; 2 = quality gain by avoiding threats associated with private ownership.
Confidence in result	95%	The ability to predict change in habitat quality of reserved land verses private ownership is high and our approach follows the widely accepted principle that conservation reserves protect and enhance biodiversity values more than private ownership (Lindenmayer & Burgman 2005). Confidence has not been set at 100% as there is some chance that the site could be affected by fire and pest species even if included in the reserve network.

### 4.3 Swift Parrot

Swift parrots occur in NSW in winter where they are considered nomadic, moving in relation to food availability (Higgins 1999; Forshaw 2002). Movement is predominantly latitudinal and most individuals occur on the east coast of NSW. In northern NSW the species has been recorded in small numbers (Forshaw 2002), although Gosper (1986 & 1992) recorded no individuals during a decade of sampling (1973-1983) in the Richmond River district and Higgins (1999) states that the species is rare north of the Hunter Region. The Atlas of NSW Wildlife does not contain any records of swift parrot within a 10km radius of either site. Forshaw (2002) states that, in northern NSW, numbers and distribution fluctuates between years, possibly in relation to food availability. In northern NSW the species has been reported foraging on swamp mahogany (*E. robusta*) and forest red gum (*E. tereticornis*) in the Coffs Harbour district and is also known to use spotted gum (*Corymbia maculata*) and blackbutt (*E. pilularis*) (Higgins 1999).

Both the Bungawalbin and Devils Pulpit sites contain potential food trees and can be regarded as potential foraging habitat despite the absence of records. Both sites contain known food species. The Bungawalbin site has a greater area of potential habitat, whilst the Devils Pulpit site has more mature trees, which are preferred (Higgins 1999).

Both sites were given a *Quality of Habitat* score of 6 (Table 7 & 8). Both sites are situated in the coastal plain and are connected with large areas of floristically diverse floodplain eucalypt forest that adds to the variety of foraging opportunities available at different times. The Bungawalbin site is better located given the large area of contiguous lowland eucalypt forest. The entire Devils Pulpit site was deemed to contain potential habitat despite the occurrence of vegetation communities that did not contain suitable food species. The compensatory site was reduced to 366.4ha by removing the moist riparian forest (flooded gum-tallowwood-brush-box) which is unsuitable for swift parrots. The paperbark swamp forest was included in the compensatory area as it contains occasional mature forest red gum and swamp mahogany.

**Table 7:** Impact Calculator – Swift Parrot

Attribute	Answer Provided	Explanation
Protected matter attribute	Area of threatened species habitat	"Area of habitat" best reflects impact and details on other features are lacking.
Area of habitat	75ha	Area of forest affected by proposal – Table 1.1 BEM (2012).
Quality of habitat	6	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site was awarded: 3 pts for Condition (small area of mature blackbutt, spotted gum and red gum); 2 pts for Context (situated in coastal plain in known latitudinal movement path; site probably of low importance in a population context; adds to diversity of foraging sites); 1 pt for Stocking (valuable as an occasional foraging resource; use is unpredictable but probably low).
Total quantum of impact	52..5	

**Table 8:** Offset calculator – Swift Parrot.

Attribute	Answer Provided	Explanation
Protected matter attribute	Area of threatened species habitat	
Time over which loss is averted	20 years	Proposed to transfer site to NSW NPWS for inclusion in reserve network. Site would be protected in perpetuity if this occurs.
Time until ecological benefit	0 years	Adopts the accepted paradigm that conservation reserves provide the highest level of protection and threats associated with private ownership (logging, fire-wood collection, spread of weeds, grazing, clearing) will cease immediately.
Start area	366.4ha	Area of the subject site that contains potential swift parrot habitat (see BEM 2012).
Start quality	6	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site awarded: 3 pts for condition (large area of immature red gum with some swamp mahogany; large area of habitat containing a mix of eucalypt species); 2pts for Context (connected to a large area of lowland floodplain forest that contains a mosaic of seasonally available feed tree species); 1pt for Stocking (valuable as an occasional foraging resource; use is unpredictable but probably low).
Risk of loss (%) without offset	10%	Site zoned RU1 (Primary production) in Richmond Valley LEP; Activities permitted without consent include extensive agriculture, forestry, home occupations, horticulture & viticulture; <i>Native Vegetation Act 2003</i> allows Routine Agriculture Management Activities (RAMA) without approval, including clearing for fences, dams, stockyards, roads, collection of firewood, creation of fire-breaks (under protection of property provision) & clearing of regrowth since 1 January 1990;
Future area without offset	329.8ha	Calculator generated figure (starting area – 10%)
Future quality without offset	5	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site awarded: 2pts for Condition (reduced abundance of blossom, particularly red gum, due to clearing & fires); 2pts for Context (increased fragmentation of lowland floodplain forest; but no effect on connectivity, increased threat level from agriculture & forestry); 1pt for Stocking (reduced stocking rate due to smaller forest area; decrease not sufficient to warrant a lower score than initial stocking rate; site likely to be used sporadically by small number of individuals).
Risk of loss with offset	0%	Proposed inclusion in reserve network would ensure forest matures & enable development of blossom resource; mature trees are also favoured feed trees; improved vegetation structure as forest matures.
Future area with offset	366.4ha	No change in area.
Future quality with offset	7	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site awarded: 3pts for Condition (improving blossom abundance as vegetation matures; increased variety of blossom as forest matures); 3pts for Context (consolidate the area of protected land in the Bungawalbin floodplain, long-term reduction in threat level); 1pt for Stocking (increased stocking rate as forest matures, further consolidates the area of potential foraging habitat within the wintering range).
Raw gain	scores of 32.8 & 2	Calculator generated figures. 32.8 = 10% gained by avoiding potential clearing; 2 = quality gain by avoiding threats associated with private ownership.
Confidence in result	95%	The ability to predict change in habitat quality of reserved land verse private ownership is high and our approach follows the widely accepted principle that conservation reserves protect and enhance biodiversity values more than private ownership (Lindenmayer & Burgman 2005). Confidence has not been set at 100% as there is some chance that the site could be affected by fire and pest species even if included in the reserve network.

The risk of loss was set at 10% as for the previous species. This represents a conservative approach as the Red Gum/Swamp Box community, which covers most of the site and contains the largest area of potential foraging habitat, would be most affected by clearing. Floodplain habitat is the most productive grazing land on the site and it stands to reason that it would be targeted for agriculture.

The outcome of the assessment is that the site offsets approximately 181% of the impact on swift parrot and therefore satisfies the minimum (90%) direct offset requirement.

#### 4.4 Regent Honeyeater

Regent Honeyeaters are most common on the western side of the Great Dividing Range where they occupy dry box-ironbark open forests and woodlands. They are known to forage on the nectar of several eucalyptus species including Mugga Ironbark, White Box (*E. albens*), Yellow Box (*E. melliodora*), and Blakely's Red Gum (*E. blakelyi*) (Higgins *et al.* 2001). When blossom is scarce they forage on lerp, honeydew and insects (Oliver 1998; OEH 2013). Regent Honeyeaters are uncommon in coastal northern NSW, although there are records from the Bungawalbin Catchment (Gosper 1986). In coastal areas they are known to favour Swamp Mahogany and Spotted Gum (*Corymbia maculata*) for foraging (Higgins *et al.* 2001; OEH 2013). Other winter flowering eucalypts like forest red gum (*E. tereticornis*) may also be used. Spotted gum was a co-dominant canopy species in part of Devils Pulpit and swamp mahogany occurs as a sub-dominant species in the red gum/swamp box community at the Bungawalbin site.

The area of habitat included in the calculator was adjusted according to the likely occurrence of known feed tree species. The area of habitat removed at Devils Pulpit was 56ha, which included the Blackbutt/Spotted Gum shrubby open forest and the Spotted Gum/Grey Ironbark/Pink Bloodwood open forest. The area of potential habitat at Bungawalbin was 237.7ha which included the red gum communities where swamp mahogany was a sub-dominant canopy species (BEM 2012).

The Devils Pulpit site was awarded a *Quality of Habitat* score of 5 and the quantum of impact was 28 (Table 9). The quality of habitat score considered the area of habitat, its location between floodplain forests in the Bungawalbin catchment and swamp mahogany forest in Bundjalung National Park, predicted low stocking rate, occasional use and abundance of food plants. The Bungawalbin site also received a quality of habitat score of 5 based on the presence of swamp mahogany, the sites location in an area known to be used by the species, predicted low stocking rate and occasional use (Table 10). The Bungawalbin site does contain a larger area of habitat and supports extensive red gum forest which may represent an occasional winter blossom resource. The larger area of habitat at Bungawalbin is offset by a lower density of known feed tree species and the presence of mature trees at Devils Pulpit.

Risk of loss was set at 10% for the same reasons specified in the previous sections. As noted for swift parrot the occurrence of swamp mahogany in the floodplain forest means that habitat feature may experience a higher level of impact and the figure of 10% is conservative.

Under private ownership the Bungawalbin site could be subject to agriculture or private native forestry, the end result being clearing of habitat. Red gum forest may experience a proportionally higher rate of disturbance as it represents better quality agricultural land and is the dominant vegetation community. The extent of clearing and effect on habitat quality will depend on the type



of land use. Even with minor clearing (i.e. 10%) there is likely to be a reduction in habitat quality mainly through removal of feed trees. If purchased by RMS and protected in a conservation reserve habitat quality is predicted to increase as vegetation matures. Habitat quality at Bungawalbin exceeds that at Devils Pulpit due to the greater area of habitat and presence of mature red gums, which are an important winter blossom resource for several species and may be used occasionally by regent honeyeaters.

The outcome of the assessment is that the site offsets approximately 183% of the impact on regent honeyeater and therefore satisfies the minimum (90%) direct offset requirement.

**Table 9:** Impact Calculator – Regent Honeyeater

Attribute	Answer Provided	Explanation
Protected matter attribute	Area of threatened species habitat	“Area of habitat” best reflects impact and details on other features are lacking.
Area of habitat	56ha	Area of forest affected by proposal – based on presence of known feed tree species.
Quality of habitat	5	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site was awarded: 3pts for Condition (small area of mature spotted gum forest); 2pts for Context (situated in coastal plain in area known to occasionally support regent honeyeater; site of low importance in a population context; adds to diversity of foraging sites in known wintering range); 1pt for Stocking (occasional foraging resource; use is unpredictable but probably low; habitat not critical for species survival).
Total quantum of impact	28	

**Table 10:** Offset calculator – Regent Honeyeater.

Attribute	Answer Provided	Explanation
Protected matter attribute	Area of threatened species habitat	
Time over which loss is averted	20 years	Proposed to transfer site to NSW NPWS for inclusion in reserve network. Site would be protected in perpetuity if this occurs.
Time until ecological benefit	0 years	Adopts the accepted paradigm that conservation reserves provide the highest level of protection and threats associated with private ownership (logging, fire-wood collection, spread of weeds, grazing, clearing) will cease immediately.
Start area	237.7ha	Area of the subject site that contains potential regent honeyeater habitat (see BEM 2012).
Start quality	5	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site awarded: 3pts for condition (large area of immature red gum with some swamp mahogany; large area of habitat containing a mix of eucalypt species); 2pts for Context (connected to a large area of lowland floodplain forest that contains a mosaic of seasonally available feed tree species); 1pt for Stocking (valuable as an occasional foraging resource; use is unpredictable but probably low).
Risk of loss (%) without offset	10%	Site zoned RU1 (Primary production) in Richmond Valley LEP; Activities permitted without consent include extensive agriculture, forestry, home occupations, horticulture & viticulture; <i>Native Vegetation Act 2003</i> allows Routine Agriculture Management Activities (RAMA) without approval, including clearing for fences, dams, stockyards, roads, collection of firewood, creation of fire-breaks (under protection of property provision) & clearing of regrowth since 1 January 1990;
Area without offset	213.9ha	Calculator generated figure (starting area – 10%)
Future quality without offset	4	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site awarded: 1pt for Condition (reduced abundance of blossom due to clearing & fires; floodplain red gum community may experience highest impact); 2pt for Context (increased fragmentation of lowland floodplain forest; limited effect on connectivity for regent honeyeater, increased threat level from agriculture & forestry); 1pt for Stocking (low stocking rate due to low abundance of swamp mahogany; abundant winter flowering red gums; decrease not sufficient to warrant a lower score than initial stocking rate; site likely to be used sporadically by small number of individuals).
Risk of loss with offset	0%	Proposed inclusion of site in reserve network would ensure forest matures; mature trees often preferred for foraging, improved vegetation structure as forest matures.
Future area with offset	237.7ha	No change in area.
Future quality with offset	6	Assessed quality against three criteria, Condition (4pts), Context (3pts) & Stocking (3pts). Site awarded: 3pt for Condition (improving blossom abundance as vegetation matures; stability of resource through conservation; variety of maturing winter flowering eucalypts); 2pt for Context (consolidate the area of protected land in the Bungawalbin floodplain, long-term reduction in threat level; situated in area known to be used will form part of winter foraging habitat); 1pt for Stocking (increased stocking rate as forest matures, further consolidates the area of potential foraging habitat within the wintering range, used by small number of individuals).
Raw gain	scores of 23.77 & 2	Calculator generated figures. 23.77 = 10% gained by avoiding potential clearing; 2 = quality gain by avoiding threats associated with private ownership.
Confidence in result	95%	Ability to predict change in habitat quality of reserved land verse private ownership is high and our approach follows the widely accepted principle that conservation reserves protect and enhance biodiversity values more than private ownership (Lindenmayer & Burgman 2005). Confidence has not been set at 100% as there is some chance that the site could be affected by fire and pest species even if included in the reserve network.

## 5. Conclusion

Application of the Offsets Calculator to the Bungawalbin site shows that the site would be a satisfactory offset for all federally listed species potentially affected by the Devils Pulpit Pacific Highway Upgrade. The most contentious finding relates to spotted-tailed quoll. Our assessment considered the actual condition of habitat affected at Devils Pulpit rather than that discussed by Hyder (2010) which included adjoining habitat, as often occurs in environmental impact assessments. Habitat adjoining the Devils Pulpit upgrade includes old growth blackbutt forest that would be suitable for quolls, however, that habitat was not indicative of what was removed by the upgrade.

Neither of the subject sites support high quality habitat for spotted-tailed quolls. The entire area of Bungawalbin was considered suitable for quolls, although floodplain habitat may be used predominantly for foraging. Given the nature of floodplain forests in north eastern NSW it is impractical to assume that quolls would not use immature or regrowth vegetation that adjoins higher quality mature forest. Whilst the Devils Pulpit site contained mature vegetation and adjoins mature forest this forest type represents a small area of the total habitat required to support a viable population. Consideration of small patches of habitat in isolation for species whose home ranges cover 100's of hectares is inappropriate and ignores published information on habitat use.

At Bungawalbin the riparian forest best satisfies published descriptions of high quality quoll habitat. Quolls may utilise riparian habitat to move through the Bungawalbin floodplain and venture into floodplain forests to forage or disperse.

Coastal forests in northern NSW are used occasionally by swift parrot and regent honeyeater. These forests contribute to the overall viability of these species populations as they occur within the non-breeding (wintering) range but are not regarded as critical to survival. The assessment of habitat quality reflects the overall value of habitat to the survival of the species and habitat quality for both species was in the moderate range. Both sites contain good quality foraging habitat for grey-headed flying-fox but the Bungawalbin site also contains a fruit resource and potential camp habitat on Bungawalbin and Physics Creeks.

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# Appendix A

**Table A1:** Spotted-tailed Quoll

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset	
					Time over which loss is averted (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset	
Area of habitat	Yes	52.50	Adjusted hectares	386	20	Start area (hectares)	386	Risk of loss (%) without offset	10%	Risk of loss (%) with offset	5%	
								Future area without offset (adjusted hectares)	347.4	Future area with offset (adjusted hectares)	386.0	
					Time until ecological benefit	5	Start quality (scale of 0-10)	5	Future quality without offset (scale of 0-10)	4	Future quality with offset (scale of 0-10)	6

Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?
38.60	95%	36.67	28.89	83.34	134.95%	Yes
2.00	95%	1.90	1.90			

**Table A2:** Grey-headed Flying-Fox

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset	
Area of habitat	Yes	45.00	Adjusted hectares	386	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	386	Risk of loss (%) without offset	10%	Risk of loss (%) with offset	0%
									Future area without offset (adjusted hectares)	347.4	Future area with offset (adjusted hectares)	386.0
					Time until ecological benefit	0	Start quality (scale of 0-10)	7	Future quality without offset (scale of 0-10)	5	Future quality with offset (scale of 0-10)	8

Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?
38.60	95%	36.67	28.89	122.12	271.37%	Yes
3.00	95%	2.85	2.85			

**Table A3: Swift Parrot**

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset	
					Time over which loss is averted (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset	
Area of habitat	Yes	45.00	Adjusted hectares	366.4	20	Start area (hectares)	366.4	Risk of loss (%) without offset	10%	Risk of loss (%) with offset	0%	
								Future area without offset (adjusted hectares)	329.8	Future area with offset (adjusted hectares)	366.4	
					Time until ecological benefit	0	Start quality (scale of 0-10)	6	Future quality without offset (scale of 0-10)	5	Future quality with offset (scale of 0-10)	7

Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?
36.64	95%	34.81	27.42	81.85	181.89%	Yes
2.00	95%	1.90	1.90			



**Table A4: Regent Honeyeater**

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset	
					Time over which loss is averted (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset	
Area of habitat	Yes	28.00	Adjusted hectares	237.7	20	237.7	Start area (hectares)	237.7	Risk of loss (%) without offset	10%	Risk of loss (%) with offset	0%
									Future area without offset (adjusted hectares)	213.9	Future area with offset (adjusted hectares)	237.7
					Time until ecological benefit	0	Start quality (scale of 0-10)	5	Future quality without offset (scale of 0-10)	4	Future quality with offset (scale of 0-10)	6

Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?
23.77	95%	22.58	17.79	51.32	183.29%	Yes
2.00	95%	1.90	1.90			

# Memorandum

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**To:** Rowena Mitchell  
**From:** David Rohweder  
**Re:** Devils Pulpit Pacific Highway Upgrade – offsets calculator assessment

**CC:**  
**Date:** 2 August 2013

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## Background

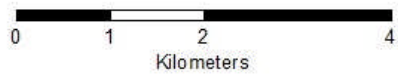
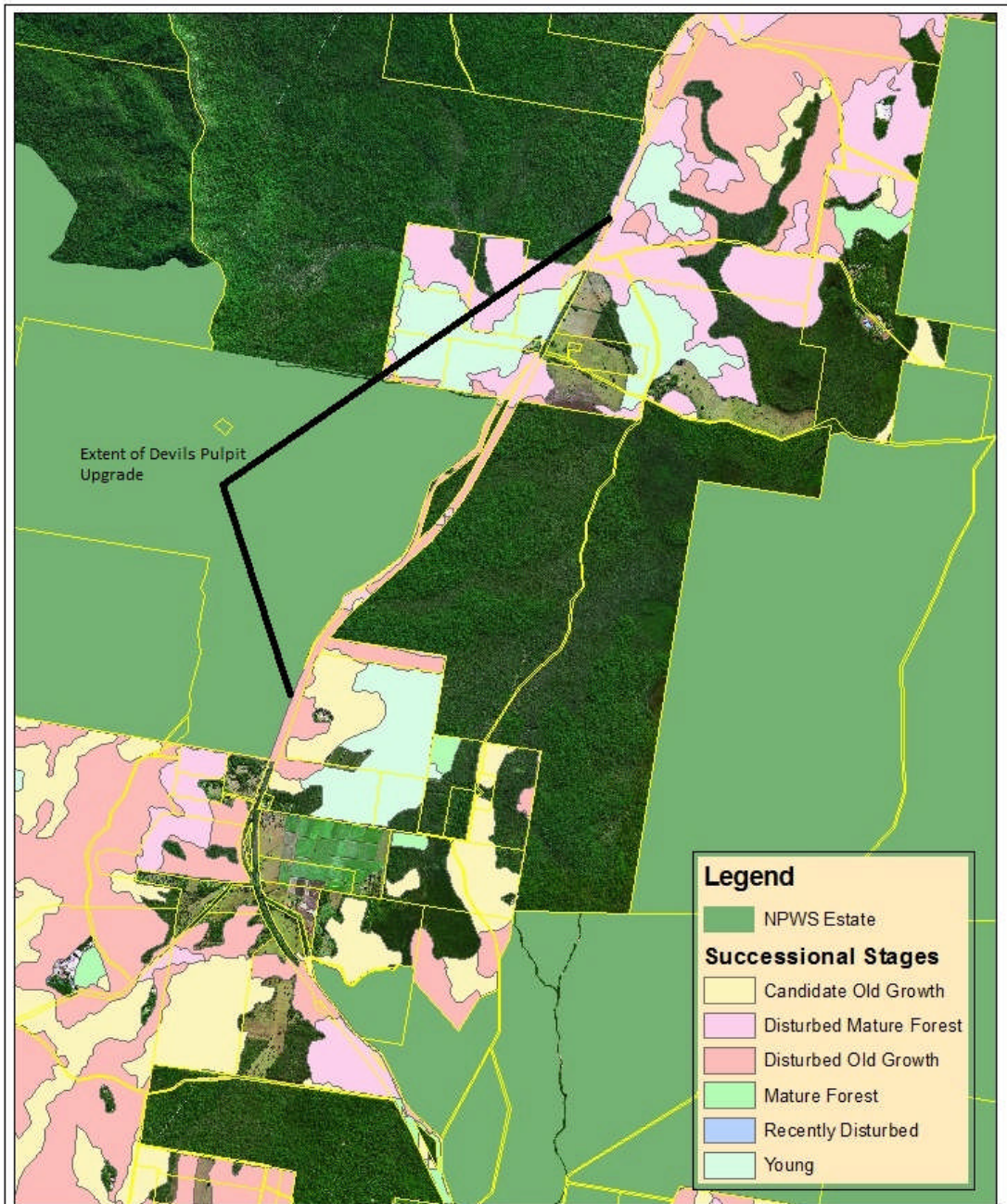
Sandpiper Ecological Surveys (2013) applied SEWPaCs Offsets Assessment Calculator to the proposed Bungawalbin offsets site. Following review of the assessment SEWPaC requested further information on some aspects of the assessment and revision of others. These issues are addressed below. The area of clearing (at Devils Pulpit) used in the initial assessment (see BEM 2012) was 75ha, however, according to Hyder (2012) the M-class motorway proposal would remove 55.5ha of forest, including a 12.5m disturbance buffer around the proposed alignment. The figure of 55ha has been used for this assessment.

## Assessment of Outstanding Issues

### 1. Reference to Old Growth Forest in Environmental Assessment

The Devils Pulpit Environmental Assessment (Hyder 2010) contains the following with respect to Old Growth Forest (page 62) “The Comprehensive Regional Assessment (CRA) old growth forests project mapped a substantial proportion of the study area as disturbed mature forest and disturbed old growth forest with small areas of candidate old growth forest.” Importantly, Hyder (2010) refer to the study area which includes the subject site and adjoining habitat. Sandpiper (2013) acknowledged the presence of Old Growth Forest in the Devils Pulpit study area but emphasized that the highest quality habitat adjoined the subject site and was not affected by the upgrade. A review of mapping undertaken as part of the Comprehensive Regional Assessment Old Growth Forests (OGF) Project confirms that the subject site was mapped as containing Disturbed Old Growth and Disturbed Mature Forest (Figure 1). That project also mapped large areas of Candidate Old Growth and Disturbed Old Growth in private land adjoining the subject site. The OGF project did not cover public land and no mapping is available for Devils Pulpit State Forest. Although observation during the survey indicated that equivalent aged and better quality forest occurred in that area. This is supported by the hollow tree transect data.

Some important issues to consider when interpreting OGF mapping include: the mapping was not ground-truthed, the mapping shows the existing highway as containing Disturbed Old Growth Forest, when it clearly does not and the results are not supported by field data (i.e. hollow tree transects and habitat plot data – refer to Appendix 1). Ignoring field data in preference for un-verified mapping, with notable errors, does not represent a balanced approach to the offset assessment.



GDA94 MGA Zone 56

**Figure 1:** Devils Pulpit Pacific Highway Upgrade Successional Stages map.

**Disclaimer:**  
 This map is not guaranteed to be free of errors or omissions and was prepared by Wildsearch Environmental Services & Sandpiper Ecological Surveys using information and field survey data taken at or under the conditions specified. Successional Stages and NPWS Estate data provided by NSW OEH.

## 2. Further discussion on the type/quality of habitat at Devils Pulpit

Sandpiper (2013) stated that the assessment of habitat value at Devils Pulpit (i.e. Hyder 2010) was influenced by the presence of adjoining Old Growth Forest in Devils Pulpit State Forest. And pointed out that three of the six habitat assessment plots were outside the alignment. In response, SEWPaC requested to view the field data sheets, which are included in Appendix 1. The datasheets indicate that only one of the three plots within the impact site contained mature-age vegetation, the remainder contained uneven-aged forest. The data sheets also enable us to further compare hollow log density. The average density of hollow logs in the six plots sampled at Devils Pulpit was 13.3/ha (n=6, range 0-45/ha), whilst the average at Bungawalbin was 10/ha (n=8, range 0-48/ha). Average hollow log density in the three transects within the upgrade corridor was 18.3/ha (n=3, range 0-5/ha). Sandpiper (2013) already established that the Bungawalbin site has a higher density of Hollow-bearing Trees and hollows per hectare than the Devils Pulpit site. Two of the (three) habitat plots within the Devils Pulpit site scored a moderate ranking for logging and fire.

The raw data substantiate the conclusion of Sandpiper (2013) that the value of habitat within the Devils Pulpit site was bolstered by the presence of high quality adjoining habitat and the EA considered habitat values both within and adjoining the subject site to identify conservation values. Such an approach is consistent with standard impact assessment processes where developments have off-site impacts such barrier and edge effects.

## 3. Revise the weighting given to habitat quality components for spotted-tailed quoll and grey-headed flying-fox

Sandpiper (2013) assessed quality of habitat against 9 attributes divided into three components, Site Condition, Site Context and Species Stocking Rate as per Section C of SEWPaC (undated). SEWPaC (undated) state "The quality score for *area of habitat* ..... is a measure of how well a particular site supports a particular threatened species or ecological community and contributes to its ongoing viability". With respect to weighting SEWPaC state "...the weighting given to each component is dependent on the ecological requirements of the impacted species or ecological community." Sandpiper (2013) applied a standardized weighting to each component to reduce the opportunity for calculations to be affected by subjective assessment. The weighting applied to the three components was Condition – 4 pts, Context – 4 pts and Stocking Rate – 3 points.

*Spotted-tailed Quoll* - The primary value of the impact site is its connection between coastal forests in Bundjalung National Park and lowland eucalypt forests on the Bungawalbin floodplain. These forests are in turn linked with escarpment forests along the Richmond Range. There is no evidence that quolls reside within the impact site, which reduces the importance of stocking rate and, to some extent, habitat condition if use is limited to occasional movement. A stronger emphasis on connectivity also reduces the importance of habitat condition as quolls are known to move through fragmented landscapes of varying age to access preferred habitat and therefore the presence of hollows is less important. The revised weighting is: condition – 3 pts; connectivity – 6 pts and stocking 1 pt. A nominal value has been retained for stocking rate as the presence of resident individuals is a standard component in assessing habitat value. The moderate weighting given to condition reflects the general importance of key habitat attributes such as arboreal hollows and large hollow logs.

*Grey-headed Flying-fox* – The original weighting used for grey-headed flying-fox was the same as spotted-tailed quoll. Habitat condition (seasonal abundance of blossom, presence of roosting habitat etc) and stocking rate (area of foraging habitat) are of greater importance than connectivity as flying-foxes will readily traverse areas of unsuitable habitat. The revised weighting for flying-foxes has therefore been biased towards habitat condition and stocking rate. The revised weighting is: condition – 5 pts; connectivity – 1 pt and stocking rate – 4 pts. Connectivity has been given a

nominal weighting to reflect the value of maintaining connectivity in the landscape that enable flying-foxes to forage progressively rather than needing to cross large gaps of unsuitable habitat when moving between foraging sites.

#### **4. Substantiate the *Quality of Habitat* score assigned to the Devils Pulpit site for spotted-tailed quoll**

Although SEWPaC requested that further evidence be provided to substantiate the Quality of Habitat score at the Bungawalbin (compensatory) site a full revision of that score is warranted in view of the changed weighting discussed above. This section evaluates the Quality of Habitat at both impact and compensatory sites using the modified weighting for key habitat components. The revised weighting means it is necessary to review all attributes considered in the previous assessment.

**4.1 Condition** - A large area of contiguous forest, abundant arboreal and ground mammals, abundant large logs (including hollow logs), abundant arboreal hollows, rock outcrops, drainage lines and mature or old growth forest have repeatedly been identified as key habitat features for spotted-tailed quoll (Glen & Dickman 2006a & b; Glen & Dickman 2011; Belcher & Darrant 2006). Glen and Dickman (2011) also emphasise the importance of large contiguous areas of habitat to support viable populations. The impact site contained abundant large logs (including hollow logs), abundant large hollow-bearing trees, mature forest and abundant arboreal mammals (Hyder 2010; Geolink 2012). These attributes were primarily concentrated in the section adjoining Devils Pulpit State Forest, with lower quality habitat occurring between the state forest and Tabbimoble overflows. Based on the attributes present and the documented importance of these attributes a condition score of 3/3 is assigned to the Devils Pulpit site.

The Bungawalbin site contains approximately 20ha of mature forest along Bungawalbin and Physics Creeks, a moderate density of ground and arboreal mammals, abundant arboreal hollows in the riparian forest and moderate density of logs. Furthermore, it is situated in a large area of contiguous forest including a substantial area of habitat protected in conservation reserve or by covenants. Apart from the riparian forest, most HbT in the dominant vegetation community (Red Gum/Swamp Box Woodland) are stags and logs that are in the advanced stages of decay, which means they may not persist in the long-term. A natural progression of hollow development in live trees and stags to logs is expected, which would provide habitat into the future. The site does presently contain key habitat attributes known to be important for quolls. The lower abundance of arboreal and ground hollows in the central part of the site is countered by high abundance in riparian habitat and Bungawalbin Nature Reserve. In view of these factors a condition score of 2/3 was assigned to the Bungawalbin site.

**4.2 Connectivity** - A high connectivity weighting warrants greater scrutiny of threatening processes that compromise connectivity. The Pacific Highway is a source of mortality to quolls and compromises the connectivity value of the Devils Pulpit site. Nonetheless, all east-west corridors in the locality experience a similar threat.

The value of connectivity can be determined by considering the type of habitats that are connected. For example, a connection between two known quoll populations is of high value. In contrast, a connection between areas where quolls have been recorded but do not support resident populations, or support very small populations are of less importance. In the latter case a connection is still important as it may ensure the viability of small populations. Based on Atlas of NSW Wildlife records it is reasonable to assume that habitat to the east and west of Devils Pulpit supports a small number of quolls. To determine the connectivity value of Devils Pulpit it is necessary to compare connectivity options along the Bundjalung/Bungawalbin interface.

The vegetated interface between the Bungawalbin and Bundjalung areas is ~27.67km and the impact site constitutes ~22% of this. Scotts (2003) modeled four regional corridors in the area at Mororo, Devils Pulpit, Tabbimoble State Forest and Tabbimoble Swamp Nature Reserve (Figure 2). All corridors are affected by the Pacific Highway. The Devils Pulpit section represents the major public land connection as all of the remaining corridors contain areas of private land, albeit forested, and public land. The Atlas of NSW Wildlife contains records of quolls near the Mororo and Tabbimoble Swamp Nature Reserve corridors and there is a recent record of a road-killed quoll at Devils Pulpit.

The Devils Pulpit site is not the only potential crossing point for quolls in the locality, which reduces the overall significance of the site. The presence of a highway further reduces significance. Given the number of potential crossing points along the Bundjalung/Bungawalbin interface, the presence of a known source of mortality and distribution of quoll records it is concluded that the Devils Pulpit site, whilst important, is not critical to the movement of quolls between Bungawalbin and Bundjalung and a connectivity score of 4/6 has been assigned.

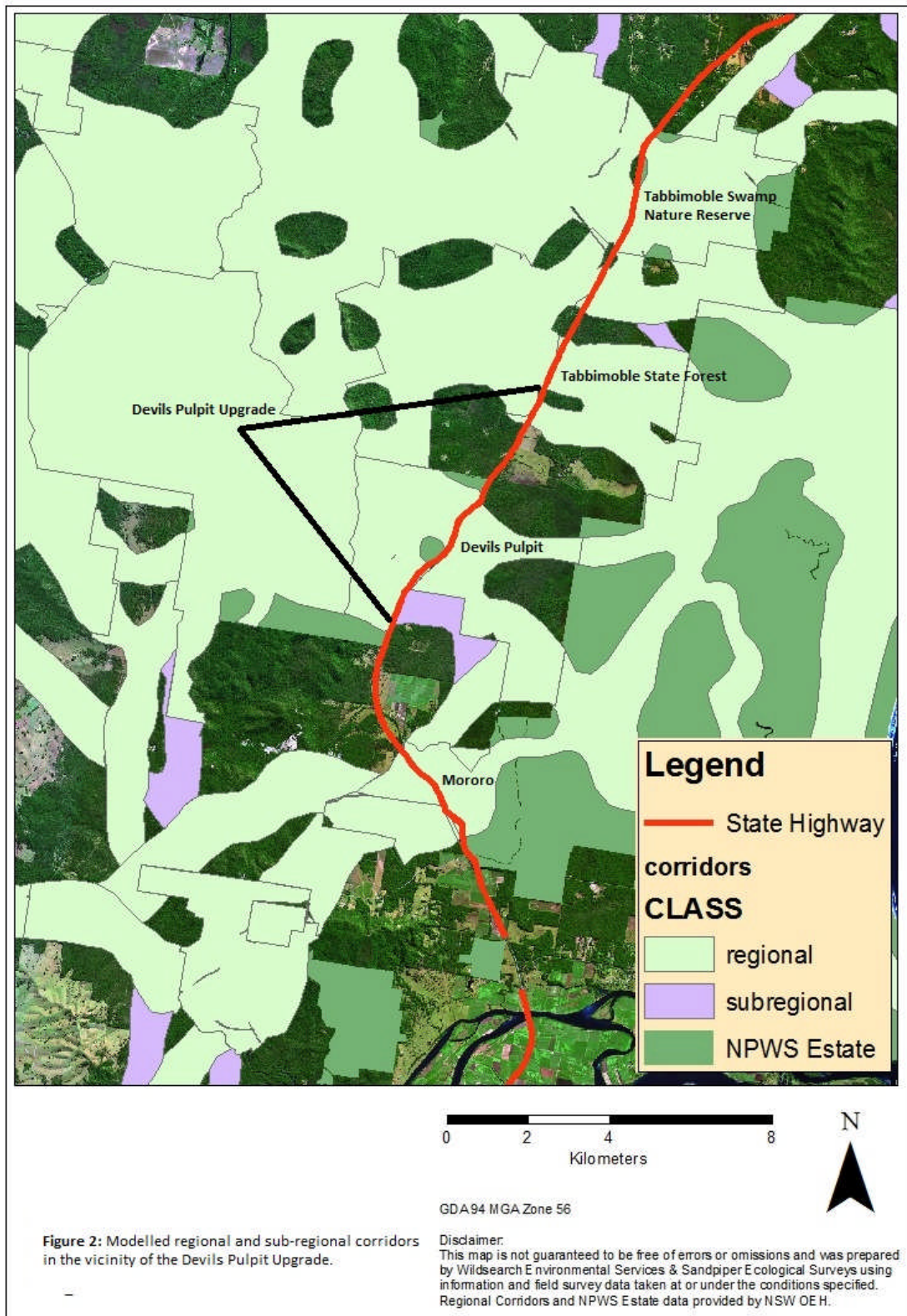
The Bungawalbin site is situated in a large area of contiguous habitat which could be used by quolls dispersing or roaming more broadly during the breeding season. Importantly, Glen and Dickman (2011) emphasise the value of large areas of forest in supporting viable quoll populations. The site does not directly link two areas of otherwise isolated habitat, as is often the case with corridors (see Bennett 1999), but it does provide a linkage between Bungawalbin Creek and Bungawalbin Nature Reserve. Riparian zones are recognized worldwide as providing important corridor function (see Bennett 1999). The riparian zone of Bungawalbin Creek is an important corridor as it provides a connection between large areas of forest and the subject site plays a role in protecting that corridor. The mature age of riparian vegetation coupled with the presence of large areas of dry eucalypt forest with abundant arboreal and ground mammals means the riparian corridor may play a vital role in recovery of quolls in the locality.

As is the case with Devils Pulpit the connectivity value of the subject site is not unique in the locality, although the site does protect part of a significant riparian corridor. Threats that compromise connectivity (i.e. fragmentation, fire, logging) would be low if the site becomes a conservation reserve as proposed. Key connectivity values are riparian corridor and linkage between riparian corridor and conservation reserve and protected private land. The site has been assigned a connectivity score of 3/6 in recognition of the Bungawalbin and Physics Creek corridors and adjacent conservation reserves.

*4.3 Stocking rate-* There is no evidence that quolls reside permanently at either site, however, permanent habitation of the Bungawalbin site is more likely given its location within a large area of contiguous habitat and linkage with the riparian corridor of Bungawalbin and Physics Creeks. The presence of a large area of contiguous habitat was noted by Glen and Dickman (2011) as an important feature of quoll habitat on the eastern fall of the Great Dividing Range in NSW. The Devils Pulpit site adjoins the Pacific Highway a noted source of mortality, noise and light. The likelihood of quolls residing at Devils Pulpit is lower than Bungawalbin and the respective stocking rate scores are:

- Devils pulpit 0/1; and
- Bungawalbin 1/1.

The score reflects the stocking rate compared to each other and in the context of the locality. Neither site would gain a score of 1/1 when compared to known quoll habitats on the eastern fall of the Great Dividing Range.



**5. Revise the time until ecological benefit score for spotted-tailed quoll and grey-headed flying-fox**

The *Time Until Ecological Benefit* score for spotted-tailed quoll has been increased from five to 20 years to reflect the time required for arboreal and ground hollows to develop, and the score for grey-headed flying-fox has been increased from 0 to 10 years. A 10 year timeframe is deemed appropriate as blossom abundance will increase incrementally as trees age. A 5 year time frame would be appropriate, however, after 10 years measurable benefits should be evident.

**6. Substantiate the *Future Quality With Offset* score for spotted-tailed quoll at Bungawalbin**

Sandpiper (2013) assigned a *Future Quality With Offset* score of 6 to the Bungawalbin site. This represented a 1 point increase on the start quality score of 5. The increase was due to improved habitat condition associated with: ongoing arboreal hollow formation as trees mature; increased ground hollow abundance due to decay of stags, improved fire management and gradual loss of stags; increased arboreal mammal density as forest matures and develops a more stable structure; and moderate ground prey density as midstorey vegetation develops.

In its present state the Bungawalbin site received a (revised) condition score of 2/3 (see Pt 4 above). However, the site is at the lower end of the 2 score level. Whilst improvements in habitat quality will occur over 20 years habitat condition would not warrant a score of 3/3 as it will not contain the key elements of high quality quoll habitat (refer Glen & Dickman 2006; Belcher & Darrant 2006). A condition score of 3 may be achieved over the extended timeframe i.e 20-50 years. Connectivity and stocking rate would not change over the 20 year period.

Application of the revised condition weighting means that the Bungawalbin site would have a *Future Quality With Offset* score of 6. Although this score would increase after 20 years.

**7. Reduce *Risk of Loss Without Offset* score for spotted-tailed quoll and grey-headed flying-fox**

The *Risk of Loss (%) Without Offset* score has been reduced from 5% to 2% in recognition that the compensatory site would be included in the conservation reserve network and be managed by the National Parks and Wildlife Service. In effect this score could be reduced to 1% but has been set at 2% as agreed.

**8. Revise *Quality of Habitat Score* for grey-headed flying-fox**

In view of the amended weighting (refer pt 4 above) it is necessary to review the Start Quality score for grey-headed flying-fox. DECWWR (2009) describe critical habitat components for grey-headed flying fox and the following assessment is based largely on those requirements. Critical foraging habitat includes: productive during winter and spring; known to support > 30,000 individuals; productive during breeding season (Sept-May); productive during final stages of fruit development and ripening of commercial crops; supports a continuously occupied camp. Neither site contains a known camp and critical features of camps have not been considered further. Both sites are situated within 50km of a known roost (Iluka).

*9.1 Condition* – Devils Pulpit is dominated by *Eucalyptus pilularis*, *E. tereticornis*, *Corymbia maculata* and *Melaleuca quinquenervia* which potentially provide a year round blossom resource. Devils Pulpit does not contain a high variety of food plants or a fruit resource. In ideal conditions the site would provide year round blossom resource. However, in years of variable blossom, as often occurs in eucalypts, food may be scarce. Such conditions occurred during the field survey of the Devils Pulpit site in December 2009 when no blossom was present. Devils Pulpit has a condition score of 4/5.



Bungawalbin has a wide variety of blossom species, a source of fruit and potential camp habitat on Bungawalbin Creek. Blossom species present include: *Melaleuca quinquenervia*, *E. tereticornis*, *E. seeana*, *E. propinqua*, *E. siderophloia*, *E. grandis*, *E. robusta* and *Corymbia maculata*. Blossom would be available throughout the year, with a peak from April to December. In addition the figs and lily pillies in riparian habitat provide a source of fruit and that habitat could also be used as a roost by small numbers of individuals in the non-breeding season. Based on the variety of blossom and fruit present and occurrence of potential roost habitat the Bungawalbin site has received a condition score of 4/5.

The condition score at Bungawalbin is influenced by a larger variety of food and year round food (blossom and fruit) but negatively influenced by forest age. In contrast, the condition score at Devils is positively influenced by forest age but negatively influenced by the lower diversity of food trees, absence of fruiting trees and roost habitat.

**9.2 Connectivity** – Connectivity is not a major issue for flying-foxes, which can readily cover tree-less gaps. Nonetheless, contiguous habitat between camps and key foraging areas is important as it provides a stepping stone of feeding areas that may be used during dispersal or when returning to camps. Both sites provide good connectivity in this regard and have been assigned a score of 1/1.

**9.3 Stocking rate** – Proximity to a camp, abundance of blossom and area of foraging habitat influence stocking rate. Both sites fall within the 50km radius of a known camp and are therefore within the nightly foraging range. The Bungawalbin site is dominated by immature vegetation, which is thought to provide an inferior blossom resource. In a study of myrtaceous species on the north coast of NSW Law *et al.* (2000) found no evidence that the proportion of foliage in flower was greater in large than medium sized trees for the 20 species studied. However, they found that large trees flowered more consistently than small trees. In the present case that may mean that blossom is more variable at Bungawalbin, however, this variability would be offset by a greater variety of blossom species, the presence of mature *E. grandis*, *C. intermedia* and *E. tereticornis* and fruit. The Bungawalbin site also contains a higher density of blossom producing trees and variable blossom production may be offset by a greater number of blossom trees/ha.

Stocking rate at Devils Pulpit is classified as 3/4 based on presence of mature trees and proximity to a known camp. Bungawalbin has been assigned a score of 2/4 based on variety of food resource, density of trees and location in an extensive area of forest.

## **9. Justify the increase in habitat value for grey-headed flying-fox at Bungawalbin following offset**

As vegetation at Bungawalbin matures the effect of tree age on blossom frequency will decrease. Incremental benefits will occur each year but measurable effects should be evident after 10 years. As vegetation in the subject site matures so too will adjoining forest in Bungawalbin Nature Reserve and protected private land to the south thereby adding to the overall value of the subject site for grey-headed flying-fox. The condition of habitat score at Bungawalbin 10 years after purchase is 8.

## **Conclusion**

According to the Offsets Calculator the Bungawalbin site satisfies the *Minimum (90%) Direct Offset Requirement* for spotted-tailed quoll and grey-headed flying-fox. With respect to spotted-tailed quoll our understanding is that SEWPaC believe the Devils Pulpit site should have a Condition score of 8-9. The assessment has considered published definitions of high quality quoll habitat, the presence of several similar corridors in the locality and the effect of highway traffic on movement and residency in assigning a Condition score of 7. Nonetheless, we acknowledge that the Devils Pulpit site is in the 7-8 range. The assessment of impacts, should the Bungawalbin site not be protected, is also conservative. The Risk of Loss (%) Without Offset has been set at 10%. In reality clearing, fires, grazing, logging and fire-wood collection could affect a greater proportion of the site

and a value of 25% is not unreasonable. Furthermore, the Risk of Loss (%) with offset of 2% could be reduced to 1% given that the site would be included in the conservation reserve network and managed by the NPWS.

In essence the assessment represents a conservative appraisal of habitat condition but this approach has also been adopted in determining risks without protection and the certainty regarding the benefits of purchasing the site.

With respect to grey-headed flying-fox the effect of forest age on blossom frequency has been considered. The Devils Pulpit site has ranked highly based on presence of mature eucalypts and (regrowth) paperbark. However, the condition score at Devils Pulpit has been influenced by the absence of roost habitat and fruit. In contrast, the Bungawalbin site has scored well on the basis of blossom variety, fruit resource and camp habitat but the overall score is affected by forest age. Once again a conservative approach has been adopted to the Risk of Loss without Offset. The Bungawalbin site will definitely improve over time as forest matures and in 20 years the site will exceed Devils Pulpit in habitat condition.

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**Table A1:** Extract from offsets calculator for spotted-tailed Quoll.

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain
					Time over which loss is averted (max. 20 years)	20	Start area (hectares)	386	Risk of loss (%) without offset	10%	Risk of loss (%) with offset	2%	
Area of habitat	Yes	38.50	Adjusted hectares	386	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	386	Risk of loss (%) without offset	10%	Risk of loss (%) with offset	2%	30.88
									Future area without offset (adjusted hectares)	347.4	Future area with offset (adjusted hectares)	378.3	
					Time until ecological benefit	20	Start quality (scale of 0-10)	6	Future quality without offset (scale of 0-10)	5	Future quality with offset (scale of 0-10)	6	1.00

Table A1 cont.

Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?
95%	29.34	23.11	39.86	103.54%	Yes
95%	0.95	0.75			

**Table A2:** Extract from offsets calculator for grey-headed fly-fox.

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain
					Time over which loss is averted (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset		
Area of habitat	Yes	44.00	Adjusted hectares	386	20	Start area (hectares)	386	Risk of loss (%) without offset	10%	Risk of loss (%) with offset	2%	30.88	
					Time until ecological benefit	10	Start quality (scale of 0-10)	7	Future area without offset (adjusted hectares)	347.4	Future area with offset (adjusted hectares)		378.3
								Future quality without offset (scale of 0-10)	5	Future quality with offset (scale of 0-10)	8	3.00	

Table A2 cont.

Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?
95%	29.34	23.11	106.36	241.74%	Yes
95%	2.85	2.53			

Table A3:

HABITAT ASSESSMENT									
Method: At random establish a 25m * 25m quadrat or 100*10m transect and record the following information. Replicate sites should be sampled in each habitat type.									
Survey Name: <i>Devils Puffin (site swamp forest west of dam) Site 3</i> Job No.									
Observer(s): <i>D. Omer</i>					Date: <i>10/12/09</i>				
Location (GPS): Easting - <i>521827</i>			Northing - <i>6762345</i>			Datum - <i>WGS84</i>			
Location Description: <i>Red Gum swamp forest near dam site (site 3)</i> <i>Just outside corridor on west side</i> <i>indicative</i>									
Land Tenure:		freehold	national park	nature reserve	crown reserve	leasehold			
		flora reserve	<u>state forest</u>	road reserve					
Land zoning (if known):					LGA Name:				
Dominant land use:		<u>grazing</u>	cropping	intensive livestock	urban				
		commercial	conservation	<u>timber production</u>	utility corridor				
Physical details: Topographic position <i>flat</i> Slope <i>flat</i> Aspect <i>W/A</i>									
Disturbance History:									
	Severity				Time Since Last Event				
	Nil	Light	Moderate	Severe	Current	<1yr	1-5yrs	5-10yrs	>10yrs
Fire		✓							✓
Logging		✓							✓
Clearing/ fragmentation		✓							✓
Grazing		✓				✓			
Weeds		<del>✓</del>	✓						
Flooding		✓				✓			
Extractive Industry									
VEGETATION STRUCTURE & FLORISTICS									
Stratum	Height (m)	Cover (%)	Dominant Species						
Overstorey	<i>30</i>	<i>35</i>	<i>E. tereticornis / L. suaveolens</i>						
Midstorey	<i>18</i>	<i>25</i>	<i>M. quinquenervia / Angophora sp. (rough bark narrow leaf)</i>						
Understorey	<i>3</i>	<i>10</i>	<i>Close tree / Lophostemon saplings</i>						
Groundcover	<i>0.7</i>	<i>60</i>	<i>Blady Grass / Barlet Grass / Poa sp.</i>						
Age structure:	early regen	advanced regen	<u>uneven age</u>	mature age	old growth				
Soil type & Characteristics:									
DENSITY OF HOLLOWES									
	Large (>15cm)			Medium (5-15cm)			Small (<5cm)		
	B		T	B		T	B		T
Live Trees	.....		.....	.....		.....	.....		.....
Dead Trees	.....		.....	.....		.....	.....		.....
Number of Fallen Logs (>15cm diameter)	<i>8/2000m<sup>2</sup></i>		<i>141 111</i>						
Number of Hollow Fallen Logs (>15cm diameter)	<i>2/2000m<sup>2</sup></i>		<i>11</i>						

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HABITAT ASSESSMENT									
Method: At random establish a 25m * 25m quadrat or 100*10m transect and record the following information. Replicate sites should be sampled in each habitat type.									
Survey Name: Devils Pulpit (site 4)					Job No.				
Observer(s): D. Owen					Date: 10/12/09				
Location (GPS): Easting - 522850			Northing - 6763395			Datum - WGS84			
Location Description: In road reserve 70m west of main track - inside <del>the</del> corridor 29/1/13. indicative									
Land Tenure:		freehold	national park	nature reserve	crown reserve	leasehold			
		flora reserve	state forest	road reserve					
Land zoning (if known):					LGA Name:				
Dominant land use:		grazing	cropping	intensive livestock	urban				
		commercial	conservation	timber production	utility corridor				
Physical details:		Topographic position ... ..			Slope ... 3° .....		Aspect ... NNW .....		
Disturbance History:									
	Severity				Time Since Last Event				
	Nil	Light	Moderate	Severe	Current	<1yr	1-5yrs	5-10yrs	>10yrs
Fire			✓		✓				
Logging			✓						✓
Clearing/fragmentation	✓								
Grazing	✓								
Weeds	✓								
Flooding	✓								
Extractive Industry									
VEGETATION STRUCTURE & FLORISTICS									
Stratum	Height (m)	Cover (%)	Dominant Species						
Overstorey	30	35	C. maculata / E. pilularis / E. acmenoides						
Midstorey	16	25	Syncarpia / A. tarulosa / Euc. saplings						
Understorey	3	30	Acacia spp. / A. tarulosa						
Groundcover	n/a	n/a	burnt.						
Age structure:	early regen	advanced regen	uneven age	mature age	old growth				
Soil type & Characteristics:									
DENSITY OF HOLLOWES									
	Large (>15cm)			Medium (5-15cm)			Small (<5cm)		
	B		T	B		T	B		T
Live Trees	.....		.....	.....		.....	.....		.....
Dead Trees	.....		.....	.....		.....	.....		.....
Number of Fallen Logs (>15cm diameter)	12/2000m <sup>2</sup>								
Number of Hollow Fallen Logs (>15cm diameter)	9/2000m <sup>2</sup>								

**HABITAT ASSESSMENT**

Method: At random establish a 25m \* 25m quadrat or 100\*10m transect and record the following information. Replicate sites should be sampled in each habitat type.

Survey Name: *Devils Pulpit (Htran 1)* Job No.

Observer(s): *DO.* Date: *9/12/09*

Location (GPS): Easting - *523577* Northing - *6764561* Datum - *WGS84*

Location Description: *Just outside alignment on west side (ca. 7.13) -> indicative*

Land Tenure: freehold national park nature reserve crown reserve leasehold  
flora reserve state forest road reserve

Land zoning (if known): LGA Name:

Dominant land use: grazing cropping intensive livestock urban  
commercial conservation timber production utility corridor

Physical details: Topographic position *mid slope* Slope *5.2°* Aspect *NE*

**Disturbance History:**

	Severity				Time Since Last Event				
	Nil	Light	Moderate	Severe	Current	<1yr	1-5yrs	5-10yrs	>10yrs
Fire			✓		✓				
Logging			✓					✓	
Clearing/ fragmentation		✓							✓
Grazing		✓			✓				
Weeds		✓			✓				
Flooding	✓								n/a
Extractive Industry									

**VEGETATION STRUCTURE & FLORISTICS**

Stratum	Height (m)	Cover (%)	Dominant Species
Overstorey	<i>26</i>	<i>45</i>	<i>E. acuminoides / E. signifera / E. pilularis / E. eugenioides</i>
Midstorey	<i>14</i>	<i>25</i>	<i>A. littoralis / G. suaveolens / juvenile overstorey species</i>
Understorey	<i>3</i>	<i>20</i>	<i>Acacia spp / Euc. saplings / A. littoralis</i>
Groundcover	<i>--</i>	<i>--</i>	<i>n/a - due to fire</i>

Age structure: early regen advanced regen uneven age mature age old growth

Soil type & Characteristics: *clay*

**DENSITY OF HOLLOWES**

	Large (>15cm)		Medium (5-15cm)		Small (<5cm)	
	B	T	B	T	B	T
Live Trees	.....	.....	.....	.....	.....	.....
Dead Trees	.....	.....	.....	.....	.....	.....

Number of Fallen Logs (>15cm diameter) *20 per 2000m<sup>2</sup>* *||||*

Number of Hollow Fallen Logs (>15cm diameter) *0*