

3.6 Flora

The Brunswick Valley and, in particular, the lower Brunswick Valley where the project is located, is an area of national significance for the conservation of Threatened rainforest plants. The mitigation of impacts on threatened flora was identified as being of prime concern in planning studies for the Brunswick Heads to Yelgun upgrade of the Pacific Highway including the Environmental Impact Statement (SKM 1998a), Species Impact Statement (SKM 1998b) and Modifications to the Approved Design (CW 2002).

3.6.1 Pre-Construction Translocation

The threatened species survey conducted by Connell Wagner 2002 extended approximately 100 metres on both sides of the existing Pacific Highway, except in constrained sections such as Brunswick Heads Nature Reserve where the survey extended 20 metres from the existing highway. The results from that survey, and the numbers in the (smaller) road footprint, which required relocating, are summarised in Table 3.1.

As a proactive measure, and more than a year before construction commenced, the RTA, in consultation with the project ecologist, undertook the translocation of all identified threatened plants within the proposed road footprint. Two compensatory habitat sites were established for the translocated threatened species for the project. The specific details of the translocation programme are detailed in Section 2.6. A small number of additional plants were translocated as they were discovered for the construction phase.

Table 3.1: Species and number of impacted individuals that required transplanting from the Brunswick Heads to Yelgun Highway Upgrade.

Species	No. of impacted individuals to be transplanted	Size of population within highway corridor (CW 2002)
Threatened Species		
Davidson's Plum (<i>Davidsonia jerseyana</i>) *	10	104
Rusty Green-leaved Rose Walnut (<i>Endiandra muelleri</i> subsp. <i>bracteata</i>) *	8	63
Crystal Creek Walnut (<i>Endiandra floydii</i>) *	3	13
Spiny Gardenia (<i>Randia moorei</i>) *	8	17
Xylosma (<i>Xylosma terrae-reginae</i>)	1	2
White Yiel Yiel (<i>Grevillea hilliana</i>)	4	15
Marblewood (<i>Acacia bakeri</i>)	33	85
Red Lilly Pilly (<i>Syzygium hodgkinsoniae</i>)	1	1
Stinking Cryptocarya (<i>Cryptocarya foetida</i>)	3	12
Coolamon Tree (<i>Syzygium moorei</i>)	1	2
Bush Nut (<i>Macadamia tetraphylla</i>)	2	6
ROTAP Species		
Black Walnut (<i>Endiandra globosa</i>)	12	84
Veiny Laceflower (<i>Archidendron muellerianum</i>)	2	2
Regionally Significant		
Medicosma (<i>Medicosma cunninghamii</i>)	3	3
Thin-leaved Cooodoo (<i>Planchonella chartacea</i>)	2	2

* Subject to DEC Recovery Plan



Photograph 3.18 Translocation area with translocated species marked with red tape for ongoing monitoring. The area has been fenced to prevent grazing by wallabies and to demarcate the translocation management area.



Photograph 3.19: Population enhancement Introductions at Site 1. Clockwise from top left:
Acacia bakeri cutting,
Acacia bakeri seedling,
Grevillea hilliana seedling,
Randia moorei cutting and *Davidsonia jerseyana* seedling.

The pink tags record the provenance number or parent tree from which the enhancements were propagated.

3.6.2 Construction

Control Measures

Statutory requirements for the protection of *in situ*, roadside specimens of Threatened and rare plants stemming from the project EIS, SIS and the DECC (NPWS) Consent Conditions and Byron Shire Council were provided in Abigroup's Construction Environmental Management Plan (CEMP) for the Brunswick Heads to Yelgun Highway Upgrade project.

The CEMP included a range of environmental control measures designed specifically to protect roadside specimens of Threatened and Rare plants, and to avoid potential damage and disturbance during highway construction, as outlined above. Many of these plants were found within rainforest prior to vegetation clearing and highway construction and are now subject to varying degrees of increased exposure and habitat modification.

To minimise the impact associated with the Upgrade, safeguards were developed and incorporated into the Flora and Fauna Management Plan in accordance with MCoA No 35, including:

- Compensatory habitat
- Locating and mapping threatened flora species to sub-metre accuracy
- Protection of threatened flora species including median "glider trees" and coastal SEPP 14 wetland areas prior to clearing. (This physical protection included highly visible plastic "Paraweb" fencing around designated areas on site, and marking of individual plants with high visibility flagging tape.)
- Maintaining a 'construction buffer zone'
- Installation of "Protected Vegetation" signage
- Collecting native seed prior to and during clearing
- Translocating threatened flora and flora species in consultation with DECC (NPWS)
- Translocating seagrass in consultation with DPI (Fisheries)
- Induction of all site personnel in awareness of sensitive vegetation
- Special 'toolbox' training with clearing contractors prior to the commencement of clearing
- Erecting three-metre high barrier fencing with shade-cloth cover in areas adjacent to the Brunswick Heads Nature Reserve
- Controlling weeds during and after the clearing operation
- Stockpiling topsoil and mulch for reuse from areas other than the worst weed infested areas
- Progressive revegetation of disturbed areas
- A monitoring programme was developed for all of the individual plants within ten metres of the construction footprint, where potential physical damage and adverse effects on habitat quality are most likely to occur due to edge effects.

Compensatory habitat, including seagrass and mangroves, is addressed in section 3.8.

Construction methods mostly proved to be effective at minimising the project footprint, and preventing encroachment outside the project boundary. There were a couple of minor exceptions including damage to a protected Davidsons Plum, and encroachment into the Brunswick Heads Nature Reserve. These were addressed through increasing awareness through toolbox training, and site-specific briefings. The Davidsons Plum has since recovered, and the disturbance to the reserve was rehabilitated.

Some additional individual were detected during vegetation clearing and these were moved to the translocation areas.

The three-metre high barrier fencing with shade-cloth along the edge of the Brunswick Heads Nature Reserve proved affective at preventing encroachment by humans and construction materials, an also at minimising edge effects from light during this period.



Photograph 3.20 'Paraweb' fencing delineating clearing zone.

Prior to the opening of the road, trimming of branches overhanging from the Brunswick Head Nature Reserve into the road reserve was required. An Environmental Assessment was undertaken and provided to DECC (NPWS), for approval prior to undertaking this work. DECC consequently supervised, and were satisfied with the work.

The intrusion of sediments into adjacent habitats has resulted in the establishment of invasive exotic grasses (e.g. south African pigeon grass and giant paspalum) at numerous locations, most notably along the edge of the Billinudgel Nature Reserve. These grasses aggressively occupy sites and prevent normal successional processes. These grasses are still evident along the road and will remain in place until a hot fire or active management eliminates them. Whilst these grasses were widespread and common in non-forested areas, more targeted and careful use of topsoil seedbanks could have decreased infestations of these species.

During an environmental assessment for the concrete batch plant, Hairy-joint Grass was discovered in a portion of the Jagwen property adjacent to the Upgrade and an area proposed for the disposal of unsuitable soil. The EPBC Act lists this species as Vulnerable, and to avoid impacting this threatened species, the batch plant was relocated to the site of the Yelgun Rest Area and Truck Stop.

The Jagwen property is currently owned by the RTA and a population management plan for *Arthraxon hispidus* was approved by DECC on 28 September 2007 and implementation of the plan is underway with the first monitoring report having been submitted to DECC on 6 June 2008 - plants have responded to the planned actions, and no adverse impacts are noted to date.



Photograph 3.21 Progressive revegetation was undertaken throughout the construction phase. This assisted with both erosion control and dust management.

Weeding and mulching was also undertaken by the RTA in some areas outside of the highway road reserve to minimise the source of weed seeds and consequent edge effects associated with these plants. Special efforts were made not to spread a new invasive vine for NSW along the road corridor – Twin Leaf Vine *Pithecoctenium cynanchioides*. At the infestation adjacent to Rajah Rd on the road footprint, all topsoil and vine material was collected and trucked to a quarry off Coolamon Scenic Drive where it was disposed of and sprayed. The RTA has also been undertaking a program of removal of the vine from the road reserve next to Wetland B (next to Brunswick Heads Nature Reserve).



Photograph 3.22 The area between the back of Wetland B and the Upgrade was the subject of a significant weed removal programme to reduce edge effects upon nearby significant habitats.

In accordance with the Translocation Plan developed in consultation with DECC (NPWS), monitoring of the threatened species translocation site / and associated actions continues to be undertaken for the RTA. Under the five year approval there are still a couple of years of maintenance / monitoring actions remaining.

Saltmarsh rehabilitation

There was a MCoA for a Saltmarsh Rehabilitation Plan to be prepared for the SEPP14 wetland immediately south-west of the Brunswick River Bridge. This plan has now been approved following consultation with the relevant agencies, and works are underway. To date, this has included supplementary planting and fencing of the area. Further planting is proposed.

3.6.3 Operation Phase

Over one hundred individual threatened and rare species remained *in situ* after vegetation clearing, in close proximity to the new upgrade alignment (i.e. 0 -10m from the construction footprint/edge of clearing). These will be monitored and maintained by the project ecologist for a period of three years after commissioning. He has reported that widespread new shoot growth indicated that the great majority of species could adjust to the more exposed growing conditions on the road edge after clearing. The vigour of some trees may even have been improved by the removal of competing trees. Several new seedlings of Davidson's Plum were recorded indicating that disturbed conditions on the roadside are conducive to recruitment in

this species. Mulch was spread to improve the condition of a small number of individuals showing crown decline. Of the 130 roadside individuals monitored, one had died, and six had declined in condition. These recovered following implementation of the remedial measures that Abigroup subsequently carried out in April 2007. The remaining 95% of individuals were in good condition.

The project ecologist noted that some increase in weed levels is inevitable at the edge of forest clearing and should not be a problem unless the weed growth becomes so dense that it inhibits growth of native rainforest or adjacent rainforest tubestock plantings designed to grow over the exposed edges of the original forest. Control measures appear to be generally effective, though additional measures will be required for some plants at various times.

A number of trees in close proximity to the construction footprint have subsequently died, some more than 18 months following the completion of earthworks. These are found in both cut and fill areas and along the entire alignment. Both eucalypts and pine trees have been affected. This impact is common where soil disturbance occurs close to a tree, and is often associated with secondary infection following damage to the roots.

DECC (NPWS) is now responsible for landscape maintenance in the Brunswick Heads Nature Reserve. However trimming of overhanging branches from the Brunswick Head Nature Reserve and into the road reserve will, if required again in the future, be undertaken in accordance with the Work Method Statement prepared for this task. This requires the supervision of an officer from DECC (NPWS)

Slashing, mowing and weed control is not undertaken in environmentally sensitive areas such as SEPP14 Wetlands.

Mangrove regrowth at the south and north abutments of the old bridge and the southern abutment of the new bridge appears to be highly successful.

General plant growth is addressed in Section 3.12 (Visual and Landscape Assessment)

3.6.4 Learnings

3.6.4.1 Topsoil Seedbank

Whilst significant efforts were made on this project to separate and store topsoil, there were many constraints and conflicts, which, with greater recognition in the planning phase, may have resulted in better outcomes.

Where any good quality native vegetation, which is relatively free of weeds, is to be cleared, the topsoil should be salvaged, and then appropriately stored to maintain the viability of the native plant soil. Whilst this is generally an integral part of the overall landscaping and revegetation of major earthworks projects, this issue is raised as the industry value placed upon topsoil as a resource is still low – stripping is poorly performed (*c.f.* mining and pipeline industries where removal in two passes is normal); appropriate testing is a rarity; separation according to weeds or quality is hardly ever performed; storage methods are poor (stockpiles are usually too big, too

steep, compacted, and/or not rotated); and insufficient concern is associated with it being eroded from batters and deposited into local watercourses.

Environmental managers, planners, and engineers should view topsoil with a largely native seedbank as a highly valuable natural resource (biologically and economically). It can be utilised to reinstate vegetation compatible with local ecological communities with a much better outcome than introducing seed (particularly in terms of genetics) while at the same time significantly reducing landscaping and revegetation. It should be noted that some native seed costs \$2,500/kg, so the seedbank in topsoil can be extremely valuable.

There are a number of issues / guidelines that need to be established regarding the effective use of topsoil and native seedbank, including the best way to store it. There is the related problem of how to use woodchip mulch from vegetation clearing. Soil conservations like to spread mulch over the surface to mitigate erosion. However, this may be disastrous for the native flora as it can inhibit soil seedbank germination and if soft, can tie-up soil nitrogen, which may result in domination by weeds. Mixing mulch with the topsoil also ties up nitrogen, and can inhibit seed germination. These impacts can be minimised by properly composting mulch can be achieved through a controlled process, or ameliorated through nitrogen supplementation and leaving the material in low bunds where it can function like a sediment fence.

Any landscape plan where there is a perceived conflict between soil conservation, soil science, and revegetation needs to be properly assessed and a compromise established between these conflicts. Optimising the outcome will usually require a higher standard of planning and execution than currently occurs.

3.6.4.2 Edge Effects

Widespread new shoot growth indicated that the great majority of species could adjust to the more exposed growing conditions on the road edge after clearing. The vigour of some trees may even have been improved by the removal of competing trees. In the case of one tree growing in the gully at the Holmes property, a thick layer of clearing mulch spread on the steep slope above it, (to minimise erosion and sediment run-off) may have been the stimulus for prolific flowering observed during monitoring. Several new seedlings of Davidson's Plum were recorded indicating that disturbed conditions on the roadside are conducive to recruitment in this species.

The small number of individuals that declined in condition were subject to increased exposure and/or reduction of root system area caused by earthworks. Recovery of these individuals to good condition can be promoted by application of the simple remediation measures (chiefly additional feeding to improve vigour).

Where trees are in close proximity to earthworks, consideration must be given to possible root damage due to soil disturbance, or through grade changes which may disturb the delicate relationship between roots and the surrounding soil. Consequences include root mortality, decline in vigor, and frequently, death of the tree. An arborist should be consulted early in the design and / or construction process with regard to treatment of the tree, changes to design which may limit such disturbance, or removal of the tree due to a low likelihood of survival.

These issues are discussed in detail by Smiley E.T (1999) *Preventing Damage to Trees from Grade Changes*. Bartlett Tree Research Laboratories, Charlotte, North Carolina. The document also provides excellent examples of how to manage this issue.



Photograph 3.23 Bunya Pines near the STP access Road. These, and a small number of other trees along the alignment died several years following the completion of earthworks, most likely due to soil disturbance in, or over, the root zone. These impacts are difficult to predict and the preferred approach is to leave the trees in place whenever possible, with the understanding that some will die, and have to be removed later.

3.6.4.3 Weed control

Many weed infestations begin as one or a few plants, which could have been easily removed. Too often weeds are allowed to develop into large infestations that are very expensive, or practically impossible, to remove. Early intervention is a much more efficient and cost-effective means of weed control and would result in much better quality habitat for rare and threatened plants over the long-term.