Tweed Vegetation Management Strategy

AUGUST 2004

Tweed Shire Council's floral emblem the Coolamon

Photos: John Turnbull

Volume 2 of 3 Technical Report

TWEED VEGETATION MANAGEMENT STRATEGY 2004

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for

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THE TWEED COUNCIL

Table of Contents

List of Tables

List of Maps and Figures

List of Appendices (see Volume 3)

Acronyms

ABS	Australian Bureau of Statistics
AKF	Australian Koala Foundation
AMG	Australian Map Grid
CAMBA	China Australia Migratory Bird Agreement
CAR	Comprehensive, Adequate and Representative reserve system
CBD	Central Business District
CD	Compact Disc
CMA	Catchment Management Authority
CRA	Comprehensive Regional Assessment
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCDB	Digital Cadastral Data Base
DCP	Development Control Plan
DEC	Department of Environment and Conservation
DIPNR	Department of Infrastructure, Planning and Natural Resources
DLWC	Department of Land and Water Conservation (now DIPNR)
EPA Act	Environmental Planning and Assessment Act 1979
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ESD	Ecologically Sustainable Development
FM Act	Fisheries Management Act 1994
GIS	Geographic Information System
GPS	Global Positioning System
GRP	Gross Regional Product
HCV	High Conservation Value
ISG	Integrated survey Grid
JAMBA	Japan Australia Migratory Bird Agreement
KHC	Key Habitats and Corridors project (Scotts *et al.* 2000)
KPOM	Koala Plan of Management
LEP	Local Environmental Plan
LG Act	Local Government Act 1993
LGA	Local Government Area
NPWS	National Parks and Wildlife Service (now DEC)
NRAC	Natural Resources Audit Council
NRCMB	Northern Rivers Catchment Management Board
NV Act	Native Vegetation Act 2003
NVC Act	Native Vegetation Conservation Act 1997
PVP	Property Vegetation Plan
R&E	Rare and Endangered
REP	Regional Environmental Plans
ROTAP	Rare or Threatened Australian Plants; Briggs & Leigh (1995)
RVC	Regional Vegetation Committee
RVMP	Regional Vegetation management Plan
SEPP	State Environmental Planning Policies
SIS	Species Impact Statement
SOE	State Of Environment
TAFE	Technical And Further Education
TBCCC	Tweed Brunswick Care Coordinating Committee
TBLALC	Tweed Byron Local Aboriginal Land Council
TPO	Tree Preservation Order
TRC	Tweed River Committee
TSC Act	Threatened species Conservation Act 1995
TVMP99	Tweed Vegetation Management Plan 1999; Kingston *et al*. (1999)
UNE	Upper North East NSW biogeographic region
VAT	Value Attribute Table
VCA	Voluntary Conservation Agreement

1.0 Remnant Vegetation

1.1 What is Remnant Vegetation

As the name suggests, *remnant vegetation* is defined as the small 'remaining' areas of naturally occurring vegetation and their natural systems left over from major changes in the environment. These remnants were once part of a continuously vegetated landscape, but since European settlement, native vegetation has been, and continues to be, cleared and modified to make way for grazing and agricultural land, forestry, mining and the development of towns and cities (ANCA 1994; Giblin 1990).

Today, these remnants occur in the form of small fragments and corridors (ecological linkages) embedded in a human-dominated matrix. In many cases these areas represent the only examples of floral and faunal communities similar to those pre-dating European settlement. Remnant vegetation maintains many of the biological processes necessary to support a diverse range of native flora and fauna (Breckwoldt 1986; Forman & Gordon 1986). **It is important to recognise that remnant vegetation is not confined to pristine areas only.**

From this functional point of view, the mere presence of non-native species should not necessarily be used to exclude areas from categories of remnant vegetation. Rather, such exclusion from mapping should be based on notions of ecological function. Appropriate tests of this might include questions such as:

Does the area support a diverse range of native flora and fauna?

Could effective rehabilitation occur without complete habitat reconstruction?

Positive answers to these questions would suggest that the affected areas should be considered as *remnant vegetation*. Although this means that most stages of regrowth are included as *remnant vegetation*, such areas can be categorised to represent any perceived or measured differences in ecological function. For example, an area of forest regrowth with a substantial Camphor Laurel component in the canopy may be recognised as remnant vegetation but may be distinguished from less disturbed areas using an appropriate sub-category (eg. Camphor dominated bushland).

The mapping of *remnant vegetation* is perhaps the most efficient way of sampling natural communities and assessing the human impacts upon them. It should also be noted that the number of categories and the resolution of any mapping is dependent on the source data (usually aerial photos or satellite imagery), and the extent of any field survey work. Limitations in this regard are noted in Section 2.2.

For the purposes of this strategy the term *bushland* includes mapped areas of *remnant vegetation* but may also include Camphor Laurel dominated areas even where they fail the tests above, and native forest plantations (see Appendix 7; field = CONTVEG). Both of these latter types of vegetation are included on a precautionary basis. Camphor laurel dominated forests are very common in the Tweed and almost invariably support numerous native species at least in the understorey. Native plantations often provide habitat for native flora and fauna and these values are likely to increase with the age of the plantation. In addition, not all native plantations are managed exclusively for silvicultural values.

The term *native vegetation* is also commonly equated to *remnant vegetation* or *bushland*. For the purposes of this Strategy, *native vegetation* is specifically defined within the NV Act and includes any indigenous vegetation (mapped or not) but excludes mangroves and associated estuarine vegetation. Thus with the exception of any mapped estuarine vegetation, *bushland* can be viewed as a component (albeit an important one) of *native vegetation.* The non-*bushland* component of *native vegetation* includes indigenous vegetation that has not been mapped (eg. individual plants, or areas of *remnant vegetation* too small to map).

1.2 Why Manage It

Australia's remnant bushland was often viewed by European colonialists as harsh, unattractive and unproductive. Vast areas were cleared for rural, industrial and residential purposes. Many natural areas continue to exist only because of rugged topography, low soil fertility, land tenure or historical development patterns (Beale & Fray 1990; Catterall & Kingston 1993; Catterall *et al.* 1996; Department of Planning 1991; Ledger 1990). Although in the past the value of remnant vegetation has been underestimated (Castles 1992, Kirkpatrick 1994), today its values are being increasingly recognised. These values are not simply ecological; there are important economic, social, educational and scientific reasons why natural areas should be preserved. This chapter provides some general background on the role and values of

remnant vegetation. The first section outlines the ecological value (Section 1.3) and ecological issues relating to remnant vegetation; the second (Section 1.4) covers economic, social and other values of remnant vegetation.

1.3 Ecological Values of Remnant Vegetation

Remnant vegetation plays a major role in maintaining biological diversity, in the function of ecological processes, and life support systems and services. In fact, humans would not exist today without it. These services are currently provided for free and their loss is rarely accounted for in the overall development of our environment (Hobbs 1991; Kirkpatrick 1994). A recent appraisal of the ecological role of native vegetation in NSW is contained within Smith *et al.* (2000). Some major ecological functions that remnant vegetation provide include:

1.3.1 Maintaining and Increasing Biological Diversity.

Remnant vegetation is critical in stabilising and increasing genetic, species, and ecosystem diversity as it provides the essential habitat for most native flora and fauna, especially rare and threatened species (BIDAC 1992; Biodiversity Unit 1993; Glanznig 1995; Halliday 1990). Remnant patches and corridors also maintain biological diversity by allowing individuals to move from one area to another.

In global terms, Australia has an appalling record of species which are endangered, threatened or already extinct (SOE 1996). Since European settlement, the number of species presumed to be extinct includes:

- 19 mammals;
- 76 flowering plants;
- 20 birds (only one from the mainland) and;
- 3 amphibians.

In addition to this, over 300 species of native flora are endangered and over 700 are vulnerable, while 80 vertebrate species are considered endangered and 110 vulnerable (SOE 1996).

Clearing of natural vegetation – particularly for agriculture and urban development (including the depletion of coastal habitats) - is recognised as the most significant cause of loss of biological diversity (Glanznig 1995; SOE 1996).

1.3.2 Protecting and Maintaining Ecological Processes

This function supports biodiversity and helps prevent and stabilise land degradation. Some ecological processes supported by remnant vegetation include:

- soil formation and maintenance of soil nutrients, protection from erosion and nutrient leaching;
- facilitation of the storage and cycling of nutrients;
- energy flows and feedbacks; and
- protection and maintenance of water resources including: reducing the rate of pollution escape in stormwater runoff, improving water quality, protecting against siltation, preventing water tables from rising and subsequent salinity effects, and reducing flood and drought extremes.

(Biodiversity Unit 1993; Breckwoldt & Buchanan 1990; Carne 1994).

1.3.3 Maintaining Life Support Systems

Remnant vegetation also:

- helps absorb greenhouse gases and other pollutants such as carbon monoxide, nitrogen oxides, sulphur dioxide, ammonia and more;
- provides the basis of all food chains, through plants' ability to convert solar into chemical energy;
- contributes to the maintenance of regional rainfall patterns and temperatures; and
- produces oxygen.

(Breckwoldt 1986; Carne 1994; Dendy 1987; Glanznig 1995; McDonald 1991; National Trust 1987).

1.4 Economic, Social and Other Values of Remnant Vegetation

A summary of the direct economic benefits of protecting and managing remnant vegetation are provided below. A more detailed review of the social and economic values of native vegetation in NSW is contained within Lambert & Elix (2000) and Gillespie (2000) respectively.

1.4.1 Industrial / Genetic

The biodiversity represented in native remnant vegetation (and attendant wildlife, microorganisms etc) contains a vast reserve of genetic material, which has been developed into applications for agriculture, food, medicine, pharmaceutical products and gene technology, energy and building materials. Species-rich habitats such as rainforests and the ocean tend to be particularly abundant in genetic resources but useful genes can be found in any type of environment. High levels of investment by pharmaceutical companies researching potential applications indicates the importance of the genes found in natural areas for useful human products. Loss of remnant vegetation means a loss of biodiversity, and with it, a loss of potential income for all these applications.

1.4.2 Agricultural

The importance of the retention of native vegetation, and strategic revegetation plans, is becoming increasingly recognised by Australia's farming community. Production losses through land degradation, the result of removal of native vegetation, are some $800 million per annum, with CSIRO (1990) estimating the full annual cost of land degradation in Australia to be over $1 billion (Greening Australia 1995).

The Commonwealth State of the Environment report (SOE 1996) illustrates the importance of remnant vegetation in the landscape with the following example:

> *The maintenance of soil fertility and structure depends largely on the activity of groups of poorly understood organisms that constitute soil biodiversity. Loss of these organisms through disturbance to native vegetation results in the disruption of processes essential to agriculture, such as water intake, nitrogen fixation and other types of nutrient cycling. By failing to take appropriate action to conserve biodiversity, particularly through conservation of remnant vegetation, Australia could be losing species vital to the sustainability of its rural industries.*
>
> (SOE 1996).

In general, remnant vegetation maintains, and may increase, crop and stock productivity by:

- providing shelter and shade for stock;
- providing windbreaks for crops;
- contributing toward crop pest control, by providing a habitat for native predators;
- protecting and stabilising land degradation problems.

(Breckwoldt & Buchanan 1990; Breckwoldt 1990; Cameron & Elix 1991; McDonald 1991).

A minimum cover of native vegetation increases the resilience of land and farm resources during drought. It buffers soil moisture levels against lack of rainfall, binds and stabilises the soil, and provides shade, shelter and emergency fodder for stressed stock (Greening Australia 1995). In high rainfall areas or during flood, it provides protection for the soil from erosive forces of water and enables penetration of water deep into the soil thereby reducing runoff.

Remnant vegetation provides opportunities for renewable, sustainable production of honey, flowers, timber, oils and seed collection. The bush tucker market relies on the discovery and development of native species, which can only be found in their native habitat. In a climate of declining productivity and returns for traditional agricultural products, bush tucker offers an important economic opportunity.

Notwithstanding the advantages, maintaining remnant vegetation can also provide a host for pests, present a threat from bushfire, compete for moisture and nutrients, and shade out agriculturally productive pastures. Where agricultural production is a major focus effective management needs to balance these advantages and drawbacks.

1.4.3 Recreation and Tourism

The multi-million dollar Australian tourism industry is dependent on the survival of Australia's biota (Breckwoldt 1986; Dendy 1987; Kirkpatrick 1994). A major attraction for tourists is the availability of nature–based activities such as: mountain bike riding, fishing, swimming, rock climbing, abseiling, orienteering, camping, picnicking, bushwalking, bird watching, scenic views and spiritual values.

1.4.4 Social, Educational and Scientific Value

Remnant vegetation is of great social, educational and scientific value. Within the built environment especially, the value of natural areas cannot be underestimated. These values include the following:

- amenity for residents, workers and visitors;
- character or identity of an area or region;
- relief from the built environment;
- areas for passive and active recreation and appreciation of natural areas;
- history of our natural heritage which should be responsibly passed on to future generations;
- buffers between incompatible land uses, against noise and visual pollution;
- conserving areas of genetic resources for appropriate medical and scientific discovery;
- conserving the chemicals found in plants for medicine and pharmacology;
- contains evidence of Aboriginal and European settlement and impacts of human development on ecosystems;
- providing areas for educational and scientific research for schools, universities, and TAFEs; and
- information on the geology and archaeology of areas.

(Breckwoldt 1986; Dendy 1987; Ledger 1990; Kirkpatrick 1994; National Trust 1987).

2.0 Vegetation Communities

2.1 Biogeographical Context

A biogeographic region is an area defined by the similarity in biophysical characters such as geomorphology, landform, lithology, climate and characteristic flora and fauna (Thackway & Cresswell 1995). Tweed LGA lies within a zone of overlap between two major biogeographical regions, the Toressian Region of tropical northern and north eastern Australia, and the Bassian Region of temperate, south east Australia. This zone encompasses an area of land from Lamington National Park in south east Queensland to Barrington Tops in NSW and has been defined by Burbidge (1960) as the *Macleay-McPherson Overlap*. Biogeographic regions and subregions have a distinct biota; thus in overlap zones a diverse mix of flora and fauna species and communities occur, with many at the southern or northern limits of their range and endemic species not found in other regions.

Within NSW, smaller biogeographic regions have also been defined. Tweed falls within the northern zone of the NSW North Coast Biogeographic Region (Thackway & Cresswell 1995). The Region has a rich assemblage of plant species forming complex mosaics of vegetation communities that includes the greatest diversity of rainforest types in NSW, some areas of which have been World Heritage listed. Over ninety species of *Eucalyptus* occur in the bioregion making it one of the richest areas on the continent for this genus (NSW NPWS 1995).

Over the whole North Coast Biogeographic Region, large changes to the landscape have occurred due to European activities. In the past 150 years, over 44 % of the original vegetation cover has been cleared or heavily disturbed (NSW NPWS 1995). Clearing on the coastal lowlands has been particularly extensive leaving only fragmented remnants on the steeper slopes. Most clearing has concentrated on the areas of low to moderate slope, fertile soil, higher rainfall and higher temperature (NSW NPWS 1995). Other major disturbances include logging, grazing, drainage works, and the use of fire. The ecological consequences of such extensive habitat fragmentation and disturbance have resulted in major floristic and structural changes to the vegetation (and faunal) communities of the Region. Ecological issues relating to fragmentation and disturbance are an important part of managing native vegetation, and are discussed in detail in Section 3.1.

The following sections of this chapter describe the methods used to map vegetation and provide summary data on the areal extent and current distribution of the mapped vegetation communities. Appendix 1 provides a descriptive overview of the major natural habitats on the Tweed. Appendix 6 provides detailed descriptions of each mapped vegetation type.

2.2 Vegetation Mapping

The vegetation mapping used for this strategy is based on an updated version of that derived for the TVMP99 (Kingston *et al.* 1999). This mapping involved the use of multi-attribute codes to record the following aspects of each mapped area:

- Vegetation Type (floristic composition)
- Structural Formation
- Camphor Laurel (*Cinnamomum camphora*) Abundance
- Reliability
- Data Source

The attribute mapping (described above) was based on a combination of the following:

- Incorporation of Existing Mapping;
- API (Aerial Photograph Interpretation); and
- Field Survey.

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Details of the methodology used to derive the maps used in the TVMP99 are reproduced as Appendix 2.

The mapping for the TVMP99 was carried out at a nominal scale of 1:25000 for most of Shire and was based on 1996 aerial photos. Areas along the coast were based on more detailed mapping carried out by the Caldera Environment Centre (1:8000) between 1991 and 1998.

2.2.1 Recent Updates

In the period since the TVMP99 maps were prepared, there has been changes in vegetation cover, and mapping of previously untyped areas in the National Park estate have been made available by DEC. In addition, more recent and more detailed aerial photography has become available to Council. This enabled the TVMP99 maps to be updated resulting in significant improvements in coverage and the level of detail.

Recent updates to the vegetation mapping are outlined in the subsections below.

2.2.1.1 Shire-wide Revision of Bushland Boundaries

The boundaries between bushland and the non-bushland matrix (pasture, cropping, roads, open water, urban areas etc) were revised on the basis of two overlapping sets of orthorectified aerial photography.

Areas east of ISG 346000E (see map series) were assessed using colour orthophotos dated 26/7/2001 supplied by Tweed Shire. This imagery was based on 1:16000 aerial photography sampled at a resolution of 0.5m. The interpretation of bushland boundaries for this section was carried out by manually editing the TVMP99 boundaries. In this section bushland was mapped down to about 0.15ha and widths of 10m.

Areas west of ISG 346000E were revised on the basis of colour orthophotos dated 10/9/2000 supplied by Tweed Shire. This imagery was based on 1:50000 aerial photography sampled at a resolution of 1m. In this case the interpretation of bushland boundaries was carried out by digital image analysis techniques followed by manual editing. This approach resulted in a more detailed interpretation; bushland was mapped down to about 0.05ha and widths of 10m.

It should be noted that in many cases there are discrepancies between this mapping and the Digital Cadastral Data Base (DCDB; ie property boundaries) used by the Council. Because of the controlled way in which the orthophotos were generated we are of the opinion that most of these "errors" are due to the DCDB, which is known to be of variable precision.

2.2.1.2 Site Condition

Where possible an attribute (CONDCODE) has been added to each polygon to indicate the condition of the vegetation. This information is of particular use when determining Ecological Status (see Section 3.0) at the regional scale. This attribute can be used to ensure that highly disturbed or areas in very good condition are appropriately recognised. At present the attribute consists of a number of nominal categories (Table 2.1). Generalised details of the criteria used to define each of the codes are presented in Appendix 3. Because of the inherent complexity involved in defining vegetation condition, especially with respect to normal successional processes, the criteria used are at present confined to major indicators of structural disturbance such as thinning of the upper strata in an effort to separate highly impacted and/or areas in the early stages of regeneration from other relatively natural areas. The *Excellent* category provides recognition for areas that are good examples of their type with negligible structural or other disturbance.

In general the criteria used allow codes to be allocated on the basis of the normal survey effort necessary to prepare regional scale mapping of the type used for this Strategy. Although more precise assessment of disturbance is desirable this is not feasible without extensive fieldwork. The need for a more detailed assessment of condition is however necessary for development control purposes. This issue is addressed in more detail in subsequent sections of this Strategy.

Table 2.1 Condition Codes

Code	Description
Ex	Excellent
RN	Relatively Natural
HD	Highly Disturbed/ Early Regeneration
ND	Not Determined
NA	Not Applicable (non-bushland)

2.2.1.3 Incorporation of DEC Mapping

Vegetation typing information was incorporated for the following areas based on mapping supplied by DEC: Numinbah Nature Reserve, Limpinwood Nature Reserve, Border Ranges National Park, Couchy Creek Nature Reserve, Nightcap National Park. These data were supplied in March 2000 but were based on work carried out for a National Resources Audit Council project in 1995.

The mapping was based on NSW State Forests–Forest Types (RN17; Forestry Commission of NSW 1989). Codes were allocated to each polygon on the basis of RN17 equivalents as noted in Appendix 4. Bushland in the areas noted above were subsequently coded to reflect the source of this mapping (DATACODE= "NPWS00").

The incorporation of this mapping necessitated the creation of three new vegetation types:

- 107 - Cool Temperate Rainforest;
- 213 - New England Blackbutt Open Forest; and
- 503 – Montane Heathland.

Data from this source was not checked in the field or otherwise verified. Nonetheless the following comments are made with respect to the following RN17 State Forest Types:

- *234 – Rock Faces* – Casual examination of aerial photography suggests that these areas are overrepresented, particularly on the northern slopes of Mt.Warning National Park;

- *23 - Myrtle* – All areas so coded have been allocated to *105 – Myrtaceous Riparian Low Closed Forest to Woodland* however many, but not all, of these areas do not appear to be riparian in nature, and may well have greater affinity with our *Dry Rainforest* or *Montane Heathland* (codes 103 and 503 respectively).

2.2.1.4 Clarification and Review of Vegetation Typing in Selected Areas

Due to the broad scope of some of the Caldera Environment Centre descriptions for their mapping of the coastal lowlands (Murray & James 1998) the initial allocations to TVMP99 codes were reviewed in conjunction with digital orthophotos (May 2001). Several hundred changes relating to structural, floristic and camphor code allocations were made (see Appendix 4, pp. 18-63). Due to additional site data/mapping and digital orthophotos further revisions were also carried in the following areas: Tanglewood, Cobaki, west Kingscliff, Black Rocks, Kings Forest, Mt. Burrell, Fernvale, and Tweed coast Littoral Rainforests.

2.2.1.5 Rationalisation of Coding

Due to the complexity of the remnant mapping and problems associated with maintaining all original linework it was decided to confine the data following core attribute codes: VEGCODE, STRUCCODE, CONDCODE, CAMPHCODE, RELCODE, DATACODE. This meant that original Caldera Environment Centre descriptions were no longer retained, however this information can easily be accessed by consulting their original data layer (CALDERAVEG). Details related to any of these codes are now accessed though a relational join to look-up tables. Appendix 5 contains the current look-up tables for each of these core vegetation attributes.

2.3 Bushland Cover

Table 2.2 summarises the overall extent of bushland within the Shire. Important statistics from the table include:

- About half of the Shire is covered by bushland (68570 ha or 52.1%).

- Most bushland occurs outside of National Parks (48584 ha or 70.9% of all bushland). National parks account for 16.1 % of the Shire.

Other points to be noted include the following:

- Appendix 7 lists individual vegetation types that are included as bushland (see field = CONTVEG).

- Non-bushland areas also exist in National Parks. These areas incorporate works depots, roads, public recreation facilities, open water and other cleared areas.

- Areas of open water account for 2467 ha (1.9% of Shire; see Table 2.4).

- Most differences between the estimate of total bushland cover reported in the TVMP99 (47.9%) and that reported in Table 2.2 (52.1%) are likely to be due to revision of the mapping at a finer scale rather than changes due to clearing or regrowth. Broad trends in bushland change are identified in Section 2.7.

Table 2.2 Bushland Cover in Tweed Shire

Category	Bushland Area (ha)	Non- Bushland Area (ha)	Total Area (ha)	% Bushland	% Total Bushland in Shire	% of Shire
National Parks	19986	1235	21221	94.2	29.1	16.1
Balance of Shire	48583	61889	110472	44.0	70.9	83.9
Total	**68571**	**63121**	**131692**	**52.1**	**100.0**	**100.0**

2.4 Broad Vegetation Communities

The distribution of *Broad Vegetation Communities* recognised within the Shire are displayed on Map 1. The area and proportion of the Shire occupied by these broad categories are shown in Table 2.3. Appendix 1, which is taken from TVMP99 provides a descriptive overview of the major natural habitats on the Tweed.

Table 2.3 Areas of Broad Vegetation Communities in Tweed Shire

Broad Vegetation Community	Area (ha)	% of mapped bushland	% of Shire
Rainforest and Riparian Communities	10568	15.4	8.0
Sclerophyll Open Forests on Bedrock Substrates	40005	58.3	30.4
Sclerophyll Forests / Woodlands on Sand Substrates and Alluvium	834	1.2	0.6
Melaleuca and Swamp She-oak Forests	1975	2.9	1.5
Heathlands	477	0.7	0.4
Estuarine Complexes	523	0.8	0.4
Sedgelands and Related Communities	333	0.5	0.3
Foredune Complex	2.1	0.003	0.002
Miscellaneous Map Units[#]	4025	5.9	3.1
Highly Modified / Disturbed*[#]	9829	14.3	7.5
Total	68571	100.0	52.1

*Includes vegetation types that are indicative of disturbance. Does not include all areas coded as *Highly disturbed/ Early Regeneration* on the basis of the vegetation condition attribute (see Section 2.2.1; Appendix 3). Condition attributes are not confined to any particular vegetation types and may apply to any mapped bushland area.
[#] Figures confined to bushland vegetation types within these groups (see Appendix 7; Field = CONTVEG).

The *Sclerophyll Open Forest on Bedrock Substrates* occupies by far the greatest area of all the Broad Vegetation Communities, comprising over 40000 ha and covering about 30% of the Shire. This broad community occurs predominantly on metasediments associated with slopes, gullies and ridges throughout the Shire. These areas include both wet and dry sclerophyll forest types.

Another Broad Vegetation Community occupying a substantial area is the *Rainforest and Riparian Communities*, which accounts for about 10500 ha or 8.0% of the Shire. The vegetation types making up this broad community are confined mainly to sheltered, south-facing slopes and gullies, on better volcanic soils, and on dry scree slopes and stony ridges usually forming a habitat complex with sclerophyll communities. They are also found at higher altitudes along the Caldera rim and within the National Parks of the Shire. Additionally these communities occur in lowland riparian areas (e.g. Stotts Island Nature Reserve) and to a limited extent behind the foredunes in coastal areas. The recent inclusion of

mapping from DEC accounts for the apparently significant increase in the area and proportion of is broad community type. It should also be noted that some areas of National Park are still not typed. In particular a relatively large area (app 1100 ha; see Map2) of the Border Ranges National Park west of Tyalgum remains untyped but is likely to contain a large proportion of rainforest vegetation

With the exception of *Miscellaneous* and the *Highly Modified/Disturbed* categories (the components of which are not necessarily phylogenetically related), most other major community categories occur as very small proportions of the total Shire area. Many of these communities are associated with coastal and/or fertile alluvial areas, and have suffered disproportionally from past clearing activities.

Within the *Miscellaneous Map Units* category are areas classified as *Not Assessed* (Vegetation Code - 998; see Table 2.4). As noted previously, these include some remaining areas of National Park but also include many small areas of bushland picked up in the more detailed revisions based on the recent orthoimages (see above).

2.5 Vegetation Types

The Vegetation Types that make up the Broad Vegetation Communities, are shown on Map 2.

The mapped area, proportion of total bushland and proportion of the Shire for each individual *Vegetation Type* unit is presented in Table 2.4 below. The relationship of these vegetation types to other relevant mapping is provided in Appendix 4. Descriptions of these vegetation types, their occurrence and growth form are detailed in Appendix 6.

Table 2.4 Areas and Proportions of Mapped Vegetation Types in Tweed Shire

Code	Vegetation Type	Area (ha)	% of Mapped Bushland	% of Shire
Rainforest and Riparian Communities				
101	Littoral Rainforest	102	0.15	0.08
102	Sub-tropical / Warm Temperate Rainforest on Bedrock Substrates	8919	12.99	6.77
103	Dry Rainforest	157	0.23	0.12
104	Lowland Rainforest on Floodplain	283	0.41	0.21
105	Myrtaceous Riparian Low Closed Forest to Woodland	472	0.69	0.36
106	River Sheoak Open Forest	635	0.92	0.48
107	Cool Temperate Rainforest	1	0.002	0.001
Sclerophyll Open Forests on Bedrock Substrates				
201	Blackbutt Open Forest Complex	6875	10.02	5.22
202	Grey Ironbark / White Mahogany / Grey Gum Open Forest Complex	12820	18.68	9.73
203	Broad-leaved Apple Open Forest	15	0.02	0.01
204	Scribbly Gum / Pink Bloodwood Open Forest	189	0.28	0.14
205	Sydney Blue Gum Open Forest	653	0.95	0.50
206	Flooded Gum Open Forest	4047	5.90	3.07
207	Brush Box Open Forest	10211	14.88	7.75
208	Tallowwood Open Forest	4068	5.93	3.09
211	Turpentine +/- Pink Bloodwood Open Forest	1051	1.53	0.80
213	New England Blackbutt Open Forest	76	0.11	0.06
Sclerophyll Forests / Woodlands on Sand Substrates and Alluvium				
301	Coastal Pink Bloodwood Open Forest to Woodland	54	0.08	0.04
302	Coastal Pink Bloodwood / Brush Box Open Forest to Woodland	6	0.01	0.00
303	Coastal Brush Box Open Forest to Woodland	57	0.08	0.04
304	Coastal Forest Red Gum Open Forest to Woodland	52	0.08	0.04
305	Coastal Swamp Mahogany Open Forest to Woodland	170	0.25	0.13
306	Coastal Scribbly Gum Open Forest to Woodland	125	0.18	0.09
307	Coastal Blackbutt Open Forest to Woodland	14	0.02	0.01
308	Coastal Tallowwood Open Forest to Woodland	5	0.01	0.004
309	Coastal Swamp Box Open Forest to Woodland	197	0.29	0.15
310	Banksia Dry Sclerophyll Open Forest to Shrubland	89	0.13	0.07
311	Coastal Acacia Communities	20	0.03	0.02
312	Black Sheoak Low Open Forest to Woodland	15	0.02	0.01
313	Cypress Pine Open Forest to Woodland	29	0.04	0.02
Melaleuca and Swamp She-oak Forests				
401	Broad-leaved Paperbark Closed Forest to Woodland	1131	1.65	0.86
402	Broad-leaved Paperbark / Swamp Sheoak Closed Forest to Woodland	180	0.26	0.14

Code	Vegetation Type	Area (ha)	% of Mapped Bushland	% of Shire
403	Broad-leaved Paperbark + Eucalyptus spp.+/- Swamp Box Closed Forest to Woodland	145	0.21	0.11
601	Swamp She-oak Closed Forest to Woodland	519	0.76	0.39
Heathlands				
501	Dry Heathland to Shrubland	72	0.11	0.05
502	Wet Heathland to Shrubland	108	0.17	0.08
503	Montane Heathland	306	0.45	0.23
Estuarine Complexes				
602	Mangrove Low Closed Forest to Woodland	474	0.69	0.36
603	Saltmarsh Communities	49	0.07	0.04
Sedgelands and Related Communities				
701	Sedgeland / Rushland (Murray & James 1998 Study Area only)	262	0.38	0.20
702	Fernland / Forbland (Murray & James 1998 Study Area only)	58	0.09	0.04
703	Freshwater Wetlands	13	0.02	0.01
Foredune Complex				
801	Foredune Complex	2	0.003	0.002
Miscellaneous Map Units				
901	Rock Faces	744	NA	0.57
903	Open Water	2467	NA	1.87
998	Not Assessed	4025	5.86	3.06
Highly Modified / Disturbed				
902	Native Grasslands (Murray & James 1998 Study Area only)	29	NA	0.02
1001	Mowed Heathland (Murray & James 1998 Study Area only)	0.3	NA	0.0002
1002	Early Regrowth Rainforest	2985	4.35	2.27
1003	Acacia / Other Sclerophyll Regrowth Open Forest to Woodland	1382	2.01	1.05
1004	Camphor Laurel Dominant Closed to Open Forest	3645	5.31	2.77
1005	Native Plantation	1307	1.90	0.99
1006	Exotic Plantation	306	NA	0.23
1007	Urban Bushland	17	0.02	0.01
1008	Post-mining Regeneration	503	0.73	0.38
1099	Substantially Cleared of Native Vegetation	59563	NA	45.18
	Total Mapped Area	**131678**	**100**	**100**

2.6 Camphor Laurel

The extent and distribution of Camphor Laurel (*Cinnamomon camphora*) throughout the Shire is shown on Map 3. Areas and proportions are presented in Table 2.5. A number of important points can be made from consideration of Map 3 and Table 2.5:

- Major concentrations of Camphor Laurel occur in two broad regions of the Shire. In these areas Camphor is either a *Dominant* or *Co-dominant* component of the bushland landscape. In the north of the Shire, areas around Terranora, Duroby, Bilambil, Carool, across to Cobaki and Pigabeen are heavily affected. Many of these areas are associated with soils of Tertiary volcanic origin. The other major concentration occurs as a broad band extending from Byangum, Uki, Smiths Ck., and Stokers Siding to Burringbar, and through to Byron Shire.

- Minor concentrations of Camphor were noted in the following regions: Chillingham, Tyalgum, Nobbys Ck, Eviron, and Duranbah.

- Although there are known Camphor Laurel infestations around Clothiers Ck., Palmvale, Cudgera Ck., Sleepy Hollow, Mooball, Wardrop Valley and Fernvale, the extent of infestation in these areas is underestimated. This is due primarily to the fact that the vegetation typing in these areas was based substantially on work carried out for the Tweed Coast Koala Habitat Atlas (Phillips and Callaghan 1996) which focussed on eucalypt communities and did not attempt to estimate the degree of camphor infestation. Except for a few areas where camphor was considered to be *Dominant* most bushland in these areas are currently coded as *Not Determined.*

- There are many small but significant areas of Camphor Laurel associated with the riparian zones of almost all sub-catchments and very small bushland areas (< 0.5ha) within the Shire. At present many of these areas remain untyped and are coded as *Not Determined* for Camphor Laurel.

- Of a total of approximately 41000 hectares of bushland surveyed (codes D, C, S, N; Table 2.5) over one third (15238 ha) showed some evidence of infestation by Camphor Laurel (i.e. codes D, C, S; Table 2.5). It should be noted however that areas coded as "S" may be quite large in relation to the actual area affected by camphor, particularly in areas where camphor occurred along the edges but not in the interior of large areas of bushland. Thus, Camphor Laurel was considered either *Dominant* or *Co-dominant* in over 13 % of all bushland surveyed for its presence.

Table 2.5 Areas and Proportions of Mapped Camphor Laurel in Tweed Shire

Code	Description	Area (ha)	% of mapped bushland	% of Shire
D	Dominant*	3553	5.18	2.70
C	Co-dominant*	1956	2.85	1.49
S	Occasional / Patchy or Edges* Only	9729	14.17	7.39
N	Not Detected from API*	26138	38.08	19.85
ND	Not Determined*	27264	39.72	20.70
NA	Not Applicable (non-bushland)	63052	NA	47.88
	Total	**131692**	**100.00**	**100.00**

* Figures confined to bushland vegetation types within these groups (see Appendix 7; Field = CONTVEG).

2.7 Trends in Bushland Change

Estimates of the rates, location and direction of change in bushland cover provide useful information on the need for enhanced protection. Such estimates can be obtained by comparing remotely sensed data (e.g. aerial photography) at different points in time. Although a comprehensive assessment of the rates of bushland change has not been carried out over the entire Shire, a portion in the Tweed Heads-Bilambil Heights area was assessed for the TVMP99. This analysis compared aerial photos between 1962 and 1996 and suggested the following patterns:

- Overall bushland gains were much greater losses – gains and partial gains accounted for 12.4% and 5.4% respectively while losses and partial losses accounted for 6.7% and 1.4% respectively.

- Losses in bushland occurred due to urban expansion in coastal lowland areas such as Cobaki, South and West Tweed Heads. Another major loss occurred at Upper Duroby for pastoral uses. Partial losses of bushland were scattered across the study area, though major areas which were present within Tweed Heads and South Tweed Heads.

- Gains of bushland appeared to be mainly associated to regrowth upon the ridges and steeper slopes that have probably become uneconomical to retain for pastoral or agricultural uses. They have regrown accompanied by woody weeds, particularly Camphor Laurel.

- A relatively small proportion of the Study Area (12.3%) appeared to remain unaffected by some form of bushland change. This highlighted the scarcity of mature or older growth forests were rare in the study area.

Although it is difficult to generalise across the Shire, these patterns are likely to be indicative of some more general trends in vegetation change:

1. Losses are most likely to be associated with urbanisation along the coast.

2. Gains are common on steep land, much of which is no longer economically viable for farming.

3. Gains in bushland are commonly associated with the proliferation of woody weeds such as Camphor Laurel.

4. Very few areas remain in pristine condition.

With respect to the last point it should be noted that this does not necessarily imply a lack of ecological value (see Section 3.0 for further details).

3.0 Ecological Assessment

The vegetation of the region was outlined in the previous chapter. The purpose of this section is to synthesise and interpret this and other information as a basis for decision making. There are at least three major ecological themes that are relevant to the management of remnant vegetation:

1. Ecological Status
2. Ecological Sensitivity
3. Threatened Species Requirements

Ecological Status deals with attributes that contribute to the continued ecological functioning of a region, and in addition quantifies the regional status of ecosystems, communities and species. Areas of high Ecological Status might include areas where endangered communities or species are present, areas of critical habitat or high biodiversity, such as riparian areas or heathlands, significant corridors or simply large areas of forest.

Ecological Sensitivity measures those components that are sensitive to ecological degradation. Examples of highly sensitive areas might include; dunal vegetation, narrow corridors, small isolated bushland remnants, or areas adjacent to forest edges.

It is important to recognise the distinction between these two themes. Areas of high Ecological Status are not necessarily the most Sensitive. The reverse may also be the case. For example, a small isolated bushland remnant may be regarded as having a relatively low Ecological Status but at the same time may be considered to be highly sensitive to degrading processes. On the other hand, a large and remote area of forest containing a small area of a rare vegetation community may be considered to have high Status but low Sensitivity. It is equally possible to have areas that exhibit both high Status and Sensitivity (eg. a small patch of lowland rainforest).

Threatened Species Requirements identify specific habitat requirements of threatened species known or likely to occur in the region. This information can be used to predict the likelihood of occurrence of particular species and thus target surveys to species most likely to occur at a particular location.

In order to understand the basis of the ecological assessment it is necessary to examine some major issues relating to the ecology of remnant vegetation. The first section of this chapter provides some relevant background information related to remnant vegetation ecology, conservation and management in Australia.

The second and third sections of this chapter detail the methodology and results of *Ecological Status* and *Sensitivity* assessments. In the threatened species section we review the status and some of the major habitat requirements of threatened or otherwise significant species that have been recorded (or might be expected to be found) in the Shire.

Key considerations for implementation arising from these assessments are presented in the final section.

3.1 Major Ecological Issues Relating To Remnant Vegetation

There are a wide range of biological and physio-chemical changes that result from the loss, fragmentation and disturbance of native bushland cover. Some of this background information is provided below, much of which is drawn from Catterall & Kingston (1993). A wider perspective can be obtained by consulting Soule (1986), Adams & Dove (1989), Saunders *et al.* (1987), Bennett (1990), Saunders & Hobbs (1991), Hobbs *et al.* (1993), Hobbs & Saunders (1993), Hobbs *et al.* (1993), Saunders *et al.* (1993a, b) Bunn *et al.* (1993) and Catterall (1993). The ecological role of native vegetation within NSW has also recently been reviewed by Smith *et al.* (2000).

Biological consequences involve changes to the distribution, abundance and/or genetic characteristics of living organisms, while physical and chemical changes involve the alteration of material fluxes across the landscape. Catterall & Kingston (1993) have itemised a number of commonly observed changes:

- Loss of species as a consequence of reduced habitat area and isolation
- Loss of genetic diversity resulting from population fragmentation
- Loss of wildlife species due to disruption of habitat complexes
- Loss of wildlife due to the selective removal of critical refuge habitat
- Loss of migratory species due to removal of part of the species' range

- Alterations to ecosystem function resulting from edge effects in small remnants
- Loss of certain vegetation types and species due to selective targeting of parts of the landscape for clearance (particularly level fertile moist areas)
- Changes to water table levels, which may bring salt to the surface
- Changes to hydrological cycles within catchments, including increased drought flood extremes
- Increased salinity and turbidity in waterways due to runoff
- Increased soil erosion and runoff
- Increased siltation of waterways
- Loss of soil nutrients due to altered runoff/erosion patterns
- Nutrient pollution of waterways due to altered runoff/erosion patterns and land uses.
- Feedback cycles of ecological degradation particularly on edges and within small remnants.

In order to properly manage remnant vegetation it is important that the factors underlying these consequences are well understood. These factors are related to the way remnant landscapes are created, and for any particular species usually involve a combination of reductions in remnant size and connectivity, and changes to their shape. Changes directly affecting habitat quality may also be important, as habitat fragmentation is usually associated with major changes in land management practices. Some of the ecological processes associated with these factors are outlined briefly below.

3.1.1 Fragmentation and Loss of Remnant Vegetation

3.1.1.1 Remnant Size

Empirical observations and intense ecological research over the past 30 years show that the number of species a region can hold is related to its area and its isolation (see for example MacArthur & Wilson 1967; Diamond 1975). In other words, the extinction rate increases with decreasing remnant area and increasing isolation. In general, for species confined to a small forest remnant this means that the probability of extinction is higher than for the same species living within a larger but otherwise similar forest remnant. Local extinctions are more likely within small remnants, simply because these areas do not provide sufficient resources to meet long term needs of many species. In practice, if species are not extirpated at the time of land clearance, many will subsequently do so in response to changed environmental conditions (see factors below) or an unfavourable natural event such as a storm, fire, or flood. This loss of species may then initiate a progressive cycle of further ecological degradation. It is also possible that a persistent small population may suffer genetically (through inbreeding depression; see Frankle & Soule 1981) if the number of breeding individuals is small and the possibility of immigrating individuals is remote.

Mammals and birds with large home ranges, territorial habits, or other specific requirements often disappear first. Koalas, for example, are highly susceptible to reductions in habitat area because they are highly social, preferring to live in colonies, and are often forced to move on the ground across totally unsuitable habitat (busy highways and vast areas of suburban development) after depleting an area of suitable food or other habitat resources. Powerful Owls, which prey mainly on large arboreal marsupials, may require up to 800 hectares of continuous bushland to forage effectively each night over an extended period of time (see Brouwer & Garnett 1990). Kangaroos and wallabies have similar problems with small remnants.

Similar problems are faced by plants. Many plant species have localised distributions, and although they may appear to be adequately conserved within existing remnants, their long term survival may be jeopardised by the absence of an adequate means of dispersal. The dependence of some species of plants on pollination or seed dispersal by animals makes such species vulnerable to the same ecological processes experienced by animals. Many rainforest species fall into this category. There is even concern that native insect pollinators may be displaced within small isolated remnants. Furthermore, it is possible that rare and endangered flora may be over-represented within small remnants simply because habitat clearance has been focussed on fertile lowland vegetation communities (Catterall & Kingston 1993; Catterall *et al.* 1996)

Although the literature suggests that it may take thousands of square kilometres to accommodate all species that may naturally exist within an area (see for example Taylor 1987), limited research (Catterall & Kingston 1994) suggests that most species of birds and arboreal mammals manage to persist even within relatively small forest remnants (tens of hectares). For remnants less than ten hectares, however, there are often noticeable species absences or lower than expected population abundances. One reason for this is what is termed *edge effects*.

3.1.1.2 Remnant Shape and Edge Effects

The microenvironment within the centre of a remnant will, in most cases, differ from its edge. The edges of remnants are subject to the effects of increased penetration by the sun, rain, wind, aggressively competitive native species, feral animals, exotic plants, litter and other inappropriate human activities. The degree of edge effect differs between the types of remnant vegetation, its location, and surrounding land uses (Bennett 1990; Forman & Godron 1986; Kirkpatrick 1994; Soule 1991), but as a general rule the edge of a remnant can be considered to have ecological properties common both to the interior of the remnant and that of the surrounding matrix. In this sense the edge acts as a buffer around a core remnant area. Generally, the larger the reserve, the less the disturbance by edge effect.

It is important to note that one of the factors contributing to edge effects arises from a distinctive suite of native species that find conditions within suburban or cleared rural areas favourable. Many of these species are opportunistic, having expanded their ranges to take advantage of changes in the landscape. Unfortunately, many are also partially dependent on bushland for purposes such as nesting or cover, and will aggressively exclude shyer forest dwelling species from the remnant's edge. A good example in north eastern NSW is the Noisy Miner which often form large aggressively defended colonies on the edge of forest remnants, while also exploiting resources from suburban gardens and other highly modified areas.

For species unable, or unwilling, to tolerate conditions toward the remnant edge the remnant's effective size (or core area) may be considerably less than its actual area. There are large numbers of species affected by this process including most small insectivorous birds (see Catterall *et al.* 1991). For most forest dwelling bird species, edge effects are likely to penetrate up to 100 metres into a forest remnant. Since edge effects make a major contribution to the problems faced by small isolated remnants, there are good reasons for favouring the more vulnerable forest interior species in the management context.

The condition and ecological characteristics of an area of remnant vegetation is also related to its shape (Forman & Gordon 1986; Russell 1987; Saunders *et al.*1991). Many argue that circular remnants are subject to less disturbance and penetration especially if one boundary is natural; for example a river, ocean or cliff (Kirkpatrick 1994). This is because a circular shape minimises the perimeter exposed to the environmental conditions that prevail outside the forest. On the other hand, linear or interdigitated remnants maximise the amount of exposed edge.

3.1.1.3 Connectivity and Corridors

Another inherent feature of the remnant landscape is that of isolation. As natural habitats are cleared, remnant areas become progressively more isolated from each other. For many species this results in a major inability to disperse in order to locate new food resources, territories etc. and successfully reproduce. In general, the more isolated the remnant, and the more hostile the intervening habitat (usually urban or pastoral), the less likely it is that plants and animals can survive there in the longer term. In most cases the effects of isolation aggravate the problems associated with small remnants.

One of the most effective ways of reducing the adverse consequences of remnant size and isolation is to retain or rehabilitate connections (corridors) among remnant areas. A network of connected habitats facilitates the movement of biota between patches. For fauna, at least, such movement may be either short term, for example to avoid unfavourable environmental conditions (fire, food shortage etc), or long term. Long term dispersal may include movements undertaken for the purpose of finding a mate or establishing a new territory. For plants too, corridors can be important. There are limited numbers of plants that have seed dispersal mechanisms (eg. wind) adequate to cross vast areas of unsuitable habitat. Many slower growing, longer-lived species rely on water or fauna to disperse their seeds. Some research (Catterall & Kingston 1994) suggests that even migratory birds may be reluctant to visit small remnants, or those isolated within a sea of hostile habitat.

The optimal width and arrangement of corridor systems is a difficult issue. For some species corridor widths of less than 10 metres may be adequate, while for others, particularly large mammals and shy birds that avoid the forest edge, several hundred metres may be necessary. This is mainly because corridors are essentially linear remnants and as such may be acutely affected by edge conditions. To be useful to the widest range of species, connecting areas should contain a substantial core habitat area. Corridor widths should also be proportional to the size of the areas being connected and the distances between them; large remnants (1000s of ha) may require connections hundreds of metres to kilometres wide, while tens of metres may be sufficient for connecting small remnants. In addition to these factors, the type of habitat within the corridor should also be suitable. A rainforest regeneration project linking dry sclerophyll habitats, for example, may not always provide for optimal dispersal for all species.

Perhaps the best strategy to facilitate corridor function is to encourage multiple linkages to form habitat networks consisting of large core areas, habitat nodes (smaller remnants), and connecting corridors. In this way the adverse

effects of remnant size, isolation and unsuitable habitat are further reduced, while providing alternative routes for dispersing biota.

3.1.1.4 Effects of Selective Clearing and Disturbance on Remnant Diversity and Habitat Quality

When native vegetation is cleared it is usually driven by economic imperatives which take little or no account of the ecological consequences. The pattern of clearance within north east NSW is clear evidence of this. The flattest, most accessible and productive areas are selectively targeted while the steeper rugged and inaccessible areas are spared (Catterall & Kingston 1993; Catterall *et al*. 1996). Often the areas cleared are also biologically rich; species confined to or dependent upon these areas for at least part of their needs will suffer population declines. Examples include a significant proportion of the bird fauna that overwinter in the lowlands and spend the summer months either at higher altitudes or latitudes. This selective clearing pattern has had particularly significant effects on community types such as wetland, estuarine, riparian and lowland rainforest areas.

At a finer scale, vegetation types are often selectively removed disrupting *habitat complexes*. Habitat complexes occur when different habitats close to one another are ecologically inter-related. Areas in which several different types of natural habitat occur in close proximity are often especially rich in wildlife, since they contain species typical of both habitat types. Furthermore, they may support an additional set of species that require both habitats for all their needs. Species that rely on such combinations are particularly vulnerable to local extinction as a result of selective clearing.

Within north east NSW dry eucalypt associations frequently form complexes with the more diverse riparian (streamside) vegetation consisting of mixed eucalypt and paperbark species. There is substantial evidence indicating that riparian areas are important to many species normally found in adjacent habitats (see for example Bunn *et al*. 1993). Knopf *et al*. (1988) characterises the riparian zone as the *aorta of an ecosystem*; similarly Hunt (1985) claims that these areas are among the most productive and valuable ecosystems on earth. Many species are dependent on riparian areas for all or part of their life cycles. Dependencies may involve nest sites, cover, roosting, migratory stopovers, foraging opportunities, water resources etc., and may occur diurnally, seasonally or for some species as critical refuge habitat during adversity such as drought or fire. Riparian zones are also thought to facilitate migration and dispersal routes for wildlife (see Catterall 1993). The selective clearing of riparian areas can therefore greatly reduce the overall habitat quality at the local and ultimately regional level.

Disturbance

Besides the effects of selective clearing, disturbance from a multiplicity of activities within forested areas also degrades the quality of remnant vegetation. Disturbance may occur directly from activities such as logging, grazing, recreation, fire management, pilfering and the dumping of rubbish, or indirectly: through the introduction of exotic weeds and pests; the inadvertent encouragement of inappropriate native species; or from problems related to siltation, erosion, or the diversion of runoff. Biological and physical changes resulting from these activities commonly include:

Removal or modification of shrub and understorey layers. Often carried out to support grazing, fire management, or for aesthetic reasons. Reduces habitat diversity particularly for forest interior species, and small mammals and birds requiring low cover. Maybe created by manual removal or by frequent burning

Removal of fallen logs, rocks or leaf litter. Often carried out to support grazing, fire management, or for aesthetic reasons. Reduces habitat opportunities for a wide range of ground dwelling fauna including native rodents, marsupials, reptiles, frogs, and invertebrates.

Thinning of canopy trees. Often carried out to support grazing or for aesthetic reasons. Reduces the structural integrity of the forest, making it less suitable for forest interior species, and more suitable for species which often dominate cleared areas and forest edges. Often creates an artificial woodland which is maintained by frequent fires.

Removal of hollow-bearing trees. Hollows are important for nesting or roosting birds, arboreal mammals and bats. Frequent burning of areas may cause these trees to weaken and fall, while thinning or too frequent timber harvesting will prevent sufficient trees from reaching this old growth stage.

Soil degradation and erosion. Increased water volumes from stormwater, urban, or agricultural runoff may cause erosion and soil loss within remnant bushland.

Algal blooms and weed infestations within waterways. Increased nutrient levels from stormwater, urban, or agricultural runoff may stimulate weed and algal growth and eventually clog waterways.

Tree death due to drainage impedance or diversion. Drainage works near remnant vegetation, particularly swamp habitats, may result in extensive habitat destruction.

Invasion of exotic or inappropriate plants. Plants often escape from domestic or agricultural situations, or are dumped in bushland, and may become a serious threat to the integrity of natural areas. It should be noted however that some exotic weeds may provide habitat value, particularly in already degraded or regenerating areas.

Problems with feral pests, uncontrolled pets, stock or opportunistic native fauna. Cats, foxes and dogs are carnivorous and can be a major threat to native fauna. Other species such as rabbits and domestic stock may compete for resources such as food or water. In addition, some like the cane toad are poisonous when eaten. Native animals can also act as ecological pests within fragmented landscapes.

3.1.2 Threats and Management Issues

3.1.2.1 Flora

Leigh and Briggs (1995; cited in SOE 1996) report on the pressures and major causes of extinction for Australian flora. Their findings are reproduced in Table 3.1. Agricultural and grazing land uses are the major causes for the past extinction of Australian plants. These land uses continue to threaten 105 species with extinction. Other major threats to endangered plants include low numbers, weed competition, roadworks and industrial/urban development.

Table 3.1 Pressures and Major Causes for Extinction for Australian Flora Species (Reproduced from SOE 1996)

Threat/Cause	Number of species presumed extinct	Past Threat	Present and future threat
Agriculture	44	112	50
Grazing	34	51	55
Low numbers	-	10	85
Weed competition	4	12	57
Roadworks	1	8	57
Industrial and urban development	3	20	21
Fire frequency	-	10	17
Forestry	-	10	10
Collecting	-	6	17
Mining	1	3	11

Within NSW the Threatened Species Conservation Act 1995 (TSC Act) schedules a number of *Key Threatening Processes* likely to directly adversely affect significant and other flora. Since many *Key Threatening Processes* affect both flora and fauna these are listed separately in Section 3.1.2.3 below. Leigh, Bowden and Briggs (1984) note that extensive clearing and burning of rainforests in the early stages of European settlement is likely to have been the initial cause of rarity and eventual endangerment or extinction of several rainforest species in the region. More recently, the rapid expansion of the coastal urban populations has placed additional pressure on species of coastal habitats.

3.1.2.2 Fauna

SOE (1996) compiled a list of current threats to Australian birds, marsupials, rodents, reptiles and freshwater fish. In general the greatest threats to these fauna are habitat clearance and/or fragmentation, altered fire regimes, grazing and/or trampling and direct exploitation. Table 3.2 reproduced from SOE (1996) details other confirmed and speculated threats to these faunal species.

Table 3.2 Sources of Current Threats to Australian Birds, Marsupials, Rodents, Reptiles and Freshwater Fish (Reproduced from SOE 1996)

Threatening process	Birds		Marsupials		Rodents		Reptiles	Freshwater fish	
	C	S	C	S	C	S	S	C	S
Habitat clearance and/or fragmentation	32	4	13	3	3	4	35		
Altered fire regimes	16	35	1	16		2	10		
Grazing and/or trampling	10	35	5		1	6	21		
Fishing		3							
Disease		3		1					
Pollution		7					7		
Erosion	1	1							
Environmental weeds	2	9					5		
Forestry operations	3	14	2	1		1	6		
Changed hydrological regimes	1	3					5	5	4
Climatic variations	2	7							
Shortage of nest hollows	3	20	1						
Predation	8	29	9	13	1	4	14		
Competition	3	20	1	11		1			
Direct exploitation	10	33	2					3	1
Cropping							21		
Urban development	4	3					14		
Pasture improvement							12		
Soil degradation							9		
Visitor disturbance							8		
Mining	2	4					6		
Rabbit grazing				11	1	2	6		
Habitat drainage							4		
Rock removal							4		
Geomorphic alteration								12	6
Water quality								4	1
Introduced exotic species			9		1	10		5	10
Introduced native species				14					3
Loss of genetic diversity			1	1					2
Road kills			1						
Unknown			4			3			

NOTES: **C** - confirmed **S** - speculative
The figures in each column are the number of species affected by each process. However, a species may be affected by more than one process.

3.1.2.3 Key Threatening Processes

Within NSW, the Threatened Species Conservation Act 1995 (TSC Act) schedules a number of *Key Threatening Processes* likely to adversely affect two or more threatened species, populations or communities, or alternatively cause other species, populations or communities to become so. Those that relate to the management of terrestrial vegetation and habitat within the Tweed region include the following:

Clearing of native vegetation
Predation by the European Red Fox, Vulpes vulpes
Predation by feral cats
Predation by the plague minnow (or mosquito fish, Gambusia holbrooki)
Bushfires that are too frequent
Invasion of plant communities by Chrysanthemoides monilifera (Bitou Bush)
Bushrock Removal
Destruction or degradation of sites used for "hill-topping" by butterflies
Climate change brought about by human activities
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis
Infection of native plants by Phytophora cinimomi
Introduction of the large earth bumblebee, Bombus terrestrius

Alteration of natural flow regimes of rivers and streams and their floodplains and wetlands
Competition from feral honeybees, Apis mellifera
Removal of dead wood and trees
Invasion of native plant communities by exotic perennial grasses
Psittacine Circovira (beak and feather) Disease affecting Endangered psittacine species
Importation of red imported fire ants, Solenopsis invicta

In relation to each of these declarations, the DEC is obliged to prepare a *Threat Abatement Plan*, which must be taken into account by the consent authority in the planning process. See www.DEC.nsw.gov.au for current details.

The Fisheries Management Act 1994 contains similar to provisions contained in the TSC Act. Of particular importance to the management of terrestrial vegetation are:

The removal of large woody debris from watercourses
The degradation of native riparian vegetation along New South Wales watercourses.

See the NSW Fisheries web site (www.fisheries.nsw.gov.au)for full details of scheduled Threatened Species, Populations or Ecological Communities and Key Threatening Processes.

In addition the Federal Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) contains similar provisions. EPBC Act scheduled processes that relate to the management of terrestrial vegetation in the region include the following:

Competition and land degradation by feral goats
Competition and land degradation by feral rabbits
Dieback caused by root-rot fungus (Phytophora cinnamomi)
Infection of amphibians with chytrid fungus resulting in chytridiomycosis
Land clearance
Loss of climatic habitat caused by anthopogenic emissions of greenhouse gases
Predation by feral cats
Predation by the European Red Fox (Vulpes vulpes)
Predation, habitat degradation, competition and disease transmission by feral pigs
Psittacine circoviral (beak and feather) disease affecting endangered psittacine species
The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, Solenopsis invicta .

See the Environment Australia web site (www.ea.gov.au) for current details.

Details of individual significant species of both flora and fauna found or likely to be found on the Tweed are presented in Section 3.3 below. Priorities for species recovery and threat abatement are addressed in Chapter 8.0.

3.2 Ecological Status and Sensitivity Assessment

This section describes the methods and datasets used to classify mapped bushland in terms of Ecological Status and Sensitivity.

3.2.1 Background

The analysis draws heavily on data generated for the recent Comprehensive Regional Assessment (CRA). The CRAs were designed to implement the National Forest Policy Statement (NFPS; Commonwealth of Australia 1992) as a basis for the negotiation of Regional Forest Agreements (RFAs). The development of conservation targets was guided by a nationally agreed set of criteria for the development of a Comprehensive, Adequate and Representative (CAR) reserve system known as the JANIS criteria (JANIS 1997). These criteria focus on three major components: Biodiversity, Old Growth, and Wilderness. Conservation targets were set for each of these components (and sub-components). For the biodiversity component the JANIS criteria anticipate conservation targets in relation to: specific vegetation communities (eg. reservation, depletion of forest ecosystems or their vulnerability to threatening processes); high quality habitats (eg. areas supporting high species diversity, significant species, natural refugia, unique combinations of species etc); and factors affecting habitat integrity and viability (eg. size and spatial configuration).

In NSW, the National Parks and Wildlife Service (now DEC) carried out the biological diversity component. The CRA process on the NSW north coast identified and documented a wide range of forest values, and provides a sound basis for conservation and management on both public and private land tenures.

3.2.2 Methodology

A number of objective attributes (derived from the CRA and other sources) were assigned to each polygon within the remnant vegetation GIS layer. These attributes were associated either with categories of remnant bushland or major vegetation types. Using a GIS model consisting of a set of rigorously defined criteria, these polygons were then classified into categories of Ecological Status or Sensitivity (see Sections 3.2.2.2 and 3.2.2.3).

This approach builds on those developed by Ecograph (eg. Kingston *et al.* 1996 - Logan Shire; Storey & Kingston. 1997 - Ipswich Shire; Kingston *et al.* 1998 - Gold Coast Shire; Kingston *et al.* 1999 – Tweed Shire) and similar assessments carried out by DLWC (now DIPNR) and NPWS (now DEC) on the north coast. The specific criteria used to derive Ecological Status of mapped areas within the Study Area have been developed in consultation with representatives of both agencies.

It is important to note that the derived categories are based solely on ecological data and do not account for potential threats arising from human activity at the local level, or suggest management goals. An evaluation of the legislative protection afforded to vegetation within the Study Area is provided in the following chapters. The ecological classification provides a consistently interpreted regional perspective that is intended to be used as a strategic tool against which conservation priorities can be evaluated.

A number of important limitations and precautions that may influence the interpretation of the ecological assessment are provided in Section 3.2.2.4.

Specific combinations of the following major attributes were used to estimate Ecological Status and/or Sensitivity of the Shire's bushland:

- Regional Vegetation Type Status
- Reservation Status
- Depletion Status
- Rare & Endangered Status
- DEC priorities for private lands
- Local Endemism
- Growth Stage
- Significant Ecosystems
- Key Fauna Habitats

- Corridors and Connectivity
- Remnant Size
- Remnant Diversity
- Significant Species*
- Vegetation Condition*
- TSC Act Threatened Communities and Critical Habitat
- Edge Distance

* denotes supplementary attributes (i.e. not determined for all areas; see below)

While this is not a complete list of all attributes that may be involved in determining the ecological status of mapped areas, it does represent the attributes for which useful data is currently available. Ideally comprehensive information should be available for all areas however this is not always possible. For example, the presence of a Threatened (or otherwise significant) species within a bushland remnant would imply a high ecological status, however the location of Threatened species will always be incomplete and those records that do exist are often imprecisely located within current databases. As a consequence this attribute is considered as supplementary. For this Strategy, *Vegetation Condition* was also considered supplementary since information on the condition of bushland was not available for all areas. Unless extremely detailed mapping is available, important micro-habitat (site) attributes such as tree hollows, caves, and understorey condition should also be considered as supplementary attributes.

Thus, the assessment of ecological values in this Strategy is based substantially on **landscape-scale** attributes rather than **site-scale** attributes. Providing these landscape attributes are comprehensive, robust and reflect important ecological processes this approach is adequate for strategic and regional planning purposes. However, it must be recognised that for the purposes of site-based assessment (e.g. Development Applications, clearing controls, Threatened species assessments, rehabilitation planning etc) **both landscape and site attributes need to be taken into account**. Planning approaches to address this issue are contained in Volume 1.

Each of the major ecological attributes noted above are discussed in some detail below. Specifically, information is provided on the importance of the attribute, its context within regional conservation planning frameworks such as the JANIS criteria, and details on the data sources, category levels and relevant GIS data fields. Table 3.3 provides a summary of these attributes and their definitions.

Details of the way in which the attributes were combined to yield mapped categories of Ecological Status and/or Sensitivity are provided in Sections 3.2.2.2 and 3.2.2.3 respectively. The GIS analyses were performed using ARC/INFO GRID. The results of these analyses are stored in grids called ECOLSTAT and ECOLSENS respectively. These output grids also store the results of individual queries used to derive each category (see Sections 3.2.2.2 and 3.2.2.3). Table 3.3 documents the source of the data for each of the individual input attributes. In the case of the grid ALLVEGG referred to in Table 3.3 two look-up tables (VEGSTAT and ECOLATT) which are stored with the grid are used to access specific variables. Both of these tables can be related (or joined) to the default VAT table using the common variable VEGCODE. The data contained in these look-up tables is reproduced in Appendix 7.

Table 3.3 Summary of Ecological Attributes

Ecological Attribute	GIS Field name (Grid.Table.Field)	GIS Field Value	GIS Field Description	Data Source and other notes
Reservation Status (%target Met)	ALLVEGG.VEGSTAT. Z_TARGET_M	<continuous percentages>	The extent to which CRA reservation targets were met after creation of new reserves. Categories used: 0-33%, 33-67%, 67-100%, >100%.	CRA data as at Jan 2000 - based on reservation targets derived over Upper North East NSW. Applied to Tweed mapping by use of equivalent codes (see Appendix 7).
Depletion Status (% Remaining)	ALLVEGG.VEGSTAT. Z_REMAIN	<continuous percentages>	The estimated proportion remaining since 1750 of specific vegetation communities. Categories used: 0-30%, 30-50%, 50-70%, 70-100%	CRA data as at Jan 2000 - based on modelled pre-1750 extents of specific vegetation types over Upper North East NSW. Applied to Tweed mapping by use of equivalent codes (see Appendix 7).
R&E Status	ALLVEGG.VEGSTAT. RE_STATUS	R	Rare	CRA data as at Jan 2000 - based CRA assessment of vulnerability of threatening processes to specific vegetation communities over Upper North East NSW. Applied to Tweed mapping by use of equivalent codes (see Appendix 7).
		V	Vulnerable	
DEC priorities for private lands	ALLVEGG.VEGSTAT. NPWSPRIV	Y	Considered by DEC to be a priority community for conservation on private land	CRA data as at Jan 2000 - Applied to Tweed mapping by use of equivalent codes (see Appendix 7).

Ecological Attribute	GIS Field name (Grid.Table.Field)	GIS Field Value	GIS Field Description	Data Source and other notes
Local Endemism	ALLVEGG.VEGSTAT. Z_ENDEM	<continuous percentages>	Estimated % of community on Tweed with respect to Upper North East NSW. Categories used: 0-50%, 50--75%, >75%.	CRA data as at Jan 2000 - Applied to Tweed mapping by use of equivalent codes (see Appendix 7) after calculation of %. I.e % based on CRA mapping.
Growth Stage (Old Growth etc)	CRACOMBO.VAT. OGSS1	1	Candidate Old Growth	CRA data as at Jan 2000 – based on Growth Stage mapping of Eucalypt communities over Upper North East NSW (nominal 1:100000 scale). Used only where coincident with Tweed bushland
		2,3	Disturbed Old Forest; Mature Forest	
		4	Disturbed Mature Forest	
Significant Ecosystems	ALLVEGG.ECOLATT. BIODIVERSE	Y	High Biodiversity System	Derived from specific Tweed vegetation codes (see Appendix 7)
	ALLVEGG.ECOLATT. DUNAL	Y	Dunal System	
	ALLVEGG.ECOLATT. RIPARIAN *Or* RIPARIAN.VAT.VALUE	Y 1	Riparian Community Riparian Zone	Riparian zone layer defined as near-level terrain associated with major named watercourses (as supplied by DLWC – Grafton) upstream of the 10m contour or 50m on each side of the bank below the 10m contour.
	ALLVEGG.ECOLATT. ESTUARINE	Y	Estuarine Community	
	ALLVEGG.ECOLATT. WETLAND	Y	Wetland Community	
Key Fauna Habitats	CRACOMBO.VAT. CRAKEYHAB	1	Includes all identified core habitats, fauna hotspots and centres of endemism.	Key Habitats and Corridors Project (DEC; Scotts *et al.* (2000) – based on known and predicted high quality faunal habitat over Upper North East NSW (nominal 1:100000 scale). Used only where coincident with Tweed mapping
Corridors	CORR_CLASS.VAT. VALUE	1	Regional Habitat Corridor by Scotts *et al.* (2000). Defines "least cost" habitat corridors wide enough to have their own ecological integrity.	Key Habitats and Corridors Project (DEC; Scotts *et al.* (2000) – based on "least cost pathway analysis" over entire North Coast Bioregion (nominal 1:100000 scale). Used only where coincident with Tweed mapping
		2	Sub-regional Habitat Corridor by Scotts *et al.* (2000). Defines "least cost" habitat corridors wide enough to support resident populations of priority species, or provide substantial links between key habitats.	
Connectivity	CONNECTS.VAT. CONNECTAREA	<continuous>	Indicates connectivity by the area of a 50m buffer surrounding a contiguous area of bushland. Effectively identifies small isolated remnants. Categories used: Isolated - <50 ha; Partially Connected - 50 – 600 ha; well Connected - > 600 ha.	Derived from Remnant Bushland layer as described below. For further details see text.
Remnant Size	REMNANTS.VAT. REMNANTAREA	<continuous>	Area in hectares of remnant as defined (see text). Categories used: Extensive - >500ha; Large - 25 - 500 ha; Moderate - 5 - 25 ha; Small - < 5 ha	Remnant Bushland layer - derived for this project from a combined layer including vegetation mapping within the Shire and broad-scale bushland mapping for a minimum of 10km around the Shire. Rules for defining remnants described in text.
Remnant Diversity	REMDIV.VAT.VALUE	<continuous>	Number of unique vegetation types within a remnant (as noted above) :High - > 4; Moderate – 2 – 3; Low – 1 - 2	Derived from Remnant Bushland layer as described above.
Significant Species	< Not precisely defined>	E	Endangered Species under TSC Act	Supplementary attribute only - Locations dependent on site survey Some indicative locations available on DEC Wildlife Atlas Potentially includes both flora and fauna Determination of area affected will depend on both site and species in question
		V,R	Vulnerable species under TSC Act or DEC "Rare" species	
		Oth	Other significant species – ROTAP CRA regionally significant etc	
Vegetation Condition	ALLVEGG.VAT. CONDCODE	Ex	Excellent	As coded for Tweed Vegetation mapping

Ecological Attribute	GIS Field name (Grid.Table.Field)	GIS Field Value	GIS Field Description	Data Source and other notes
		RN	Relatively Natural	See Appendix 3 for classification criteria
		HD	Highly Disturbed/ Early Regeneration	Supplementary attribute only- Not all areas assessed.
		ND, NA	Not Determined Not Applicable (non-bushland)	
TSC Act Threatened Communities and Critical Habitat	CRIT_HAB.VAT.VALUE	1	Identifies land designated as Critical Habitat under the TSC Act	At present Stotts Is. Nature Reserve is the only declaration of Critical Habitat in the NSW
	ALLVEGG.VAT.VEGCODE	104	104-Lowland Rainforest on Floodplain 101 – Littoral Rainforest 603 – Saltmarsh Communities	Scheduled as an Endangered community under the TSC Act.
Edge Distance	INTERIOR.VAT.VALUE	1	Identifies bushland areas within 50 m of the bushland/cleared land interface	Derived from Remnant Bushland layer as described above. Used in conjunction with other attributes to define ecologically sensitive areas. Not used to determine Ecological Status

3.2.2.1 Description of Attributes

Regional Vegetation Type Status

As noted, an important biodiversity component of the JANIS criteria involves the conservation of specific vegetation communities (or forest ecosystems). JANIS biodiversity criteria relating to forest ecosystems were based on the premise that … *the priority for reservation of* [the biological diversity of] *a forest ecosystem is related to how much remains relative to its initial distribution and its vulnerability to threatening processes* (JANIS 1997).

On the NSW North Coast forest ecosystems were defined (using floristic and biophysical attributes) and mapped at the regional scale (1:100000). For private lands this mapping was largely predictive. The distribution of every forest ecosystem before 1750 was also mapped, using a combination of modelling (based on environmental correlations) and historical records (see NSW NPWS 1999c). Additionally, three categories were defined to describe the vulnerability of forest ecosystems to threatening processes: Vulnerable, Rare and Endangered.

A forest ecosystem was considered Vulnerable if:

- it is approaching a reduction in areal extent of 70% within a bioregional context and which remains subject to threatening processes; or
- is not depleted, but is subject to continuing and significant threatening processes which may reduce its extent.

A forest ecosystem is considered Rare if:

- its geographic distribution involves a total range of generally less than 10000 ha, a total area of generally less than 1000ha, or patch sizes of generally less than 100 ha, where such patches do not aggregate to significant areas.

A forest ecosystem is considered Endangered if:

- its distribution has contracted to less than 10% of its former range or the total area has contracted to less than 10% of its former area, or where 90% of its area is in small patches which are subject to threatening processes.

Relevant JANIS criteria include:

> (1) As a general criterion, 15% of the pre-1750 distribution of each forest ecosystem should be protected in the CAR reserve system with flexibility allowed according to regional circumstances, and recognising that as far as possible, the proportion of Dedicated Reserves should be maximised.

(2) Where forest ecosystems are recognised as vulnerable, then at least 60% of their remaining extent should be reserved.

(3) All remaining occurrences of rare and endangered ecosystems should be reserved or protected by other means as far as is practicable.

(4) Reserved areas should be replicated across the geographic range of the forest ecosystem to decrease the likelihood that chance events such as wildfire or disease will cause the forest ecosystem to decline.

(7) To ensure representativeness, the reserve system should, as far as possible, sample the full range of biological variation within each forest ecosystem, by sampling the range of environmental variation typical of its geographic range and sampling its range of successional stages.

(Source: JANIS 1997)

Details regarding the way in which these criteria were applied for the CRA on the NSW north coast are presented in NSW NPWS (1999a, 1999b).

As a result of this, and associated analyses, a substantial body of statistical information relating to the specific forest ecosystems and their status on the NSW North Coast was derived. Some important indicators of the regional status of individual forest ecosystems include:

- Percent remaining since 1750 (Depletion Status)
- Percent target met (Reservation Status)
- Vulnerability to threatening processes (Rare & Endangered Status)
- DEC priorities for private lands
- Local Endemism

In order to make best use of this information individual vegetation codes defined for this Strategy were assigned to equivalent (or near equivalent) forest ecosystems using a combination of the predictive forest ecosystem mapping and accompanying floristic descriptions (NSW NPWS 1999c; see Appendix 7). This allowed the indicators noted above (and others) to be directly related to the more detailed mapping compiled for this Strategy. Since the Shire lies within the Upper North East (UNE) Bioregion as defined by the CRA (NSW NPWS 1999c) statistical data relating to this area were used. Data derived from the CRA was based on calculations as at January 2000 (current to August 2004).

The criteria defined in Table 3.4 were used to derive a single indicator from the five attributes noted above, of the regional status of each mapped vegetation type. Due to the fact that Depletion Status, Reservation Status and Local Endemism are expressed as numerical percentages it was necessary to categorise these on the basis of cut-offs reflecting their ranked status. Although these cut-offs are essentially arbitrary, they were set at specified levels (see Table 3.4) in order to get a reasonable spread of vegetation types across status categories, and illustrate any broad trends regarding the overall conservation status of vegetation types in the Study Area. The results of applying these criteria are presented in Appendix 7 and can be accessed in the Geographical Information System (GIS) by relating the INFO table VEGSTAT (see Appendix 7) to the Value Attribute Table (VAT) of the grid ALLVEGG on the common field of VEGCODE.

Table 3.4 Criteria Used to Determine Regional Vegetation Type Status

Regional Veg. Type Status Class	CRA Reserve Status (%target Met)	Depletion Status (Est. pre-1750 % Remaining)	R&E Status (Endang, Vulner. etc.)	DEC Private Land Priority	Local Endemism (% of Forest Ecosyst. in Tweed)	Exclusions	Comments
1	0-35% OR	0-30% OR	Rare OR (Vulnerable AND %target Met =< 100%) OR	Private Land Priority OR	>= 75 % in Tweed	NOT 1002 Early Regrowth Rainforest 1003 Acacia / Other Sclerophyll Regrowth Open Forest to Woodland 1004 Camphor Laurel Dominant Closed to Open	Includes highly depleted and poorly reserved vegetation communities. Excludes vegetation communities defined by their high levels of

Regional Veg. Type Status Class	CRA Reserve Status (%target Met)	Depletion Status (Est. pre-1750 % Remaining)	R&E Status (Endang, Vulner. etc.)	DEC Private Land Priority	Local Endemism (% of Forest Ecosyst. in Tweed)	Exclusions	Comments
						Forest 1008 Post-mining Regeneration	disturbance
2	35-65% OR	30-50% OR	Vulnerable AND %Target Met > 100%	_	50 - 75 % in Tweed	NOT 1003 Acacia / Other Sclerophyll Regrowth Open Forest to Woodland 1004 Camphor Laurel Dominant Closed to Open Forest 1008 Post-mining Regeneration NOT in Category 1	Includes inadequately conserved and/or depleted vegetation communities. Excludes vegetation communities defined by their high levels of disturbance except 1002 Early Regrowth Rainforest which is a regenerating Endangered community
3	65-100% OR	50-70% OR	_	_	_	NOT 1004 Camphor Laurel Dominant Closed to Open Forest 1008 Post-mining Regeneration 1003 Acacia / Other Sclerophyll Regrowth Open Forest to Woodland NOT in Category 1 or 2	Includes vegetation communities marginally below target and those enduring moderate levels of depletion.
4	>100% OR	70-100% OR	_	_	_	NOT 1004 Camphor Laurel Dominant Closed to Open Forest 1008 Post-mining Regeneration NOT in Category 1, 2,3	Includes vegetation communities where CRA targets were met and/or communities subject to minimal clearing. Includes 1003 Acacia / Other Sclerophyll Regrowth Open Forest to Woodland in this Category
5	-	-	_	_	_	NOT in Category 1, 2, 3, 4	Includes 1004 Camphor Laurel Dominant Closed to Open Forest and 1008 Post-mining Regeneration in this Category
6 (Not Determined)	-	-	_	_	_	NOT 903 Open Water 1099 Substantially Cleared of Native Vegetation NOT in Category 1, 2, 3, 4, 5	Not Determined Includes untyped areas, native grasslands, native and exotic plantations and urban bushland
7 (Not Applicable)	-	-	_	_	_	NOT in Category 1, 2, 3, 4, 5, 6	Not Applicable Includes open water and cleared areas.
Note: Vegetation Communities allocated to Regional Vegetation Type Status Codes hierarchically starting with row 1							

Growth Stage

Old-growth forests have biological, aesthetic and cultural values not present or as prevalent in forests of lesser age. In terms of biodiversity, these values are related in particular to the provision of certain habitats essential for some species - for example tree hollows, which can be a limiting factor in the abundance of some fauna (JANIS 1997). Old-growth is defined by JANIS (1997) as follows: *Old-growth forest is ecologically mature forest where the effects of disturbances are now negligible.*

The conservation target criteria developed by JANIS (1997) for old-growth forests (as defined above) are (in summary):

> 1. Where old-growth forest is rare or depleted (generally less than 10% of the extant distribution) within a forest ecosystem, all viable examples should be protected.
>
> 2. For other forest ecosystems, 60% of the old-growth forest should be protected, which could be increased where necessary to protect old-growth values (such as geographic representation across the ecosystem's range, and protection of high quality habitat for particular species).

The following set of growth stage categories was derived for the CRA process to describe the structural maturity of forest and was originally mapped at 1:100000 scale (NSW NPWS 2000):

- Candidate Old Growth Forest
- Disturbed Old Growth Forest
- Mature Forest
- Disturbed Mature Forest
- Young Forest
- Recently Disturbed Forest
- Rainforest

For the purposes of this study, the first four of the mapped classes were used, and only where our finer scale bushland mapping overlapped with CRA data. See Table 3.3 for the relevant fields in the GIS databases.

Significant Ecosystems

In comparison to other natural systems, some areas have additional ecological roles within the landscape. Because of their particular values, vegetation types known to be associated to the following systems - high biodiversity, dunal, riparian, estuarine, and wetlands - are recognised within the ecological assessment.

Estuarine and wetland systems are important for their roles in both terrestrial, aquatic and marine ecosystems. These areas perform a number of important ecosystem functions including regulation and recharge of groundwater, protection of shorelines, flood mitigation, and sediment, nutrient and water quality control. Many species of fish and other biota are entirely dependent on these ecosystems for their survival and reproduction. In Tweed Shire, the terrestrial components of these systems (the aquatic and marine components have not been mapped) comprise mangrove and saltmarsh complexes (estuarine) and swamp sclerophyll communities (wetlands). The important ecological roles of wetland and estuarine ecosystems are recognised within Council's Local Environmental Plan, by State legislation through the implementation of State Environmental Planning Policy 14 – Coastal Wetlands (SEPP 14), and also at a national level through treaty arrangements such as the Japan Australia Migratory Bird Agreement (JAMBA) and China Australia Migratory Bird Agreement (CAMBA).

Riparian vegetation performs similar filtering and buffering roles to wetland areas, but in addition also provide essential linkages facilitating the movement of flora and fauna between larger areas of habitat. As noted in Appendix 1 these areas can be highly species diverse and commonly contain significant and depleted taxa. Riparian areas generally support a higher diversity and density of flora and fauna because they are more fertile and better watered than the surrounding landscape. They are also necessary for the long-term survival of aquatic ecosystems, providing shade, shelter, food and habitat diversity, and stream bank protection (Catterall 1993). The importance of riparian areas are recognised in State legislation such as the Soil Conservation Act 1938 and the Native Vegetation Act 2003.

High biodiversity systems within Tweed Shire apply to rainforests and heathland communities. The important roles of these communities are discussed in Appendix 1 and some of these systems are recognised within State Government legislation (eg. SEPP 26 and the Soil Conservation Act 1938).

Dunal systems within Tweed Shire include the Foredune Complex, Coastal heathland/Shrubland, and Littoral Rainforest communities. These dunal systems have important roles in dunal stabilisation and erosion control. They are often very sensitive to disturbance.

See Table 3.3 for the relevant fields in the GIS databases.

Key Fauna Habitats

Most of the ecological attributes outlined in this section are essentially properties of mapped vegetation (i.e vegetation types or bushland). If the objective is to preserve the full range of biodiversity including fauna we need to be confident that; either these vegetation-based attributes are good predictors of high quality faunal habitats or, seek additional information. While it is clear that some of the vegetation-based attributes, such as remnant size, connectivity and significant ecosystems are useful in this regard they do not on their own identify known or predicted areas of high quality fauna habitat.

To address this issue (and related JANIS criteria noted below) the NPWS (now DEC) have recently initiated the Key Habitats and Corridors Project (KHC; Scotts *et al.* 2000). The project mapped a number of types of key habitat to reflect the recommendations and directions found within the contemporary landscape ecology literature:

> **Fauna assemblage core habitats**; areas where the highest proportion of species comprising each priority fauna assemblage are predicted to occur (an index of priority species diversity).
>
> **Fauna assemblage hot spots**; areas where the highest quality habitats for at least one third of species comprising each priority fauna assemblage are predicted to occur (an index of priority species relative abundance).
>
> **Centres of endemism for vertebrates and invertebrates**; areas where the highest proportion of endemic vertebrates and invertebrates are predicted to occur.

The way in which these layers were derived involved the modelling of species-environment relationships for selected priority species, which were then mapped in accordance with the key habitat types noted above. See Scotts *et al.* (2000) for details.

As noted, an important biodiversity component of the JANIS criteria involves the conservation of high quality habitats. Relevant JANIS criteria include:

> (5) The reserve system should seek to maximise the area of high quality habitat for all known elements of biodiversity wherever practicable, but with particular reference to:
>
> - the special needs of rare, vulnerable or endangered species;
> - special groups of organisms, for example species with complex habitat requirements, or migratory or mobile species;
> - areas of high species diversity, natural refugia for flora and fauna, and centres of endemism; and
> - those species whose distributions and habitat requirements are not well correlated with any particular forest ecosystem.
>
> (Source: JANIS 1997)

The mapping carried out for the Key Habitats and Corridors Project was provided at a nominal scale of 1:100000 (100 m grid cell). For the purposes of this study, all three types of key habitat were combined (GIS field; FAU_KEYHAB), and recognised only where coincident with the more detailed bushland mapping prepared for this Strategy.

See Table 3.3 for the relevant fields in the GIS databases.

Corridors and Connectivity

An inherent feature of disturbed landscapes is the fragmentation of vegetated areas. As natural habitats are fragmented by clearing, remnant patches become progressively more isolated from each other. As noted previously (Section 3.1), for many species this results in a major inability to disperse and successfully reproduce. In general, the more isolated the remnant, and the more hostile the intervening habitat (usually urban or pastoral), the less likely it is that plants and animals can survive there in the longer term. In most cases the effects of isolation aggravate the problems associated with small remnants. Conversely, small remnants close to each other will have a greater connectivity, and therefore greater ecological integrity, than remnants more isolated from the remnant system.

Connectivity can be estimated by considering the proximity of patches of bushland to each other. For the purposes of this study connectivity was modelled by externally buffering each remnant to a distance of 50 metres. Areas of high connectivity are thus defined by the creation of a buffer much larger than the remnant itself while isolated remnants are characterised by a buffer that is marginally larger in area than the remnant. Associating the value of this buffered area (CONNECTAREA) with any coincident remnant (as defined previously) thus provides a relative estimate of connectivity. The results of this process mean that small and isolated remnants can be distinguished objectively from those that are close to large areas of bush or clusters of small remnants. Furthermore, the process also accounts for existing corridor connections and "stepping stone" configurations. For the purposes of determining Connectivity each remnant was classified within one of the following categories: Isolated <50 ha; Partially Connected - 50 – 600 ha; and Well Connected - > 600 ha.

While the approach to measuring connectivity described above is particularly useful in discriminating levels of connectivity among small remnants, it does not identify those areas within larger remnants that make the most significant contribution to overall connectivity. This task is most usefully approached by the consideration of habitat corridors. The KHC Project (Scotts *et al.* 2000), uses GIS techniques (least-cost pathways analyses and subsequent refinement) to generate an "optimal" set of regional and sub-regional habitat corridors over the North Coast Bioregion. It should be noted that in many cases the least-cost pathway traversed cleared land and as a consequence the mapped corridors are not confined to bushland areas. Scotts *et al.* (2000) provide the following descriptions of regional and sub-regional corridors, but also anticipate the finer scale development local corridors and the identification of "stepping stone" patches:

> **Regional Habitat Corridors** – corridors wide enough (or planned to be wide enough) to have their own ecological integrity, including sufficient habitat for resident populations of focal species and interior habitat for species detrimentally impacted by edge effects. While local conditions may limit the final width of regional corridors they should be planned to be of the order of kilometres wide. A minimum of 500 metres would be acceptable in certain instances but typically 1000 metres width is envisaged. Planned regional corridor widths should reflect known demographics of focal species selected to represent the species assemblages. Regional corridors will often link formal reserves to other public lands, key habitats or to other corridors. Regional corridors will often run along major gradients such as altitudinal and latitudinal gradients. Regional corridors linking the escarpment to the coast, as well as a near-continuous north-south regional coastal corridor will be emphasised in the KHC Project. Where ever possible, regional corridors should occupy all available landforms (ridge, mid-slope, flat, gully) to ensure representation of habitat variation and resources.
>
> **Sub-regional Corridors** – corridors wide enough to support resident populations of at least a subset of priority species or wide enough to provide a substantial link between key habitats and other key habitats, reserves, public lands or other corridors. A benchmark minimum of 300 metres is envisaged but, where possible, they should be wider (eg. 400-1000 metres). Sub-regional corridors should be positioned to maximise the protection and linkage of available landforms (ridge, mid-slope, flat, gully).
>
> (Source: Scotts *et al.* 2000)

The mapping carried out for the KHC Project was provided at a nominal scale of 1:100000. For the purposes of this study, only regional and subregional corridors were used and recognised only where coincident with the more detailed bushland mapping prepared for this Strategy. This of course means that areas of mapped corridor over cleared land are not recognised for the purpose of the ecological status or sensitivity assessments, however they may be recognised for the purposes of strategic rehabilitation (see Chapter 8.0).

See Table 3.3 for the relevant fields in the GIS databases.

Remnant Size

Remnant size is a major indicator of ecological status. For reasons discussed previously, larger remnants are less susceptible to ecologically degrading processes, and as a consequence are more likely to be able to sustain viable populations of native flora and fauna. Even if such remnants have suffered high levels of internal disturbance in the past, there exists the potential for self-regeneration within relatively short time periods.

Smaller and more isolated remnants often suffer significantly from edge effects and neighbouring human activities, and as a consequence are likely to require active intervention to enhance ecological qualities. These smaller sized remnants are likely to experience progressively greater cycles of degradation due to the combined effects of isolation, edge effects, and other factors influencing habitat quality. Section 3.1 contains additional research information relating to the ecological effects of remnant size.

As noted, an important biodiversity component of the JANIS criteria involves the factors affecting habitat integrity and viability such as remnant size. Relevant JANIS criteria include:

> (6) Reserves should be large enough to sustain the viability, quality and integrity of populations.
>
> (8) In fragmented landscapes, remnants that contribute to sampling the full range of biodiversity are vital parts of a forest reserve system. The areas should be identified and protected as part of the development of integrated regional conservation strategies.
>
> (Source: JANIS 1997)

Before the size of the remnant can be utilised for analysis, the concept of the remnant itself must be defined. If remnants were defined as "a continuously connected area of bushland" then some small areas of bushland with tenuous connections to large tracts of bushland would be considered part of that large tract, thus over-estimating their effective size. To overcome this problem, GIS techniques were employed to split attenuated remnants. Remnant polygons were split if their connection was less than 100 meters wide. Similarly, small "peninsulas" were separated from the larger core areas, and are thus also considered as separate entities.

In order to address issues of remnant size and connectivity with areas adjacent to the Study Area, calculations for each attribute were made by taking into account all bushland within ten kilometres of the Shire boundary. This was achieved using broad vegetation systems mapping (Roberts 1992; 1:100000 scale) for areas outside of the Shire in NSW and bushland mapping of Catterall & Kingston (1993; 1:100000 scale) for adjacent areas within Queensland.

Having defined "remnant areas" (noted in the GIS database as REMNANTAREA) using the approach described above, these areas were categorised into one of four size classes: 0-5 ha, 5-25 ha, 25-500 ha., and >500ha. Whilst the classes are determined arbitrarily, close examination of small areas will frequently suggest the impacts of degrading processes.

See Table 3.3 for the relevant fields in the GIS databases.

Remnant Diversity

This refers to the number of mapped vegetation community types present within a single remnant (as defined above). It is another reasonably tractable indicator of ecological status. In most instances large remnants will contain a greater diversity of vegetation types than small remnants; however, the importance of small but diverse remnants can be highlighted using this measure. As noted in Section 3.1.1 such remnants are more likely to be used by a wider range of fauna.

See Table 3.3 for the relevant fields in the GIS databases.

Significant Species

Since viable populations of threatened and other significant species (flora and fauna) cannot exist in the absence of suitable habitat the known presence of such species has an important bearing on the ecological status of any particular patch of bushland. As mentioned previously such information is rarely comprehensive and the extent to which individual species depend on specific areas or components of the habitat vary widely and are very difficult to predict with certainty. Even for species with well-known habitat requirements it is rare that these habitat indicators are mapped in sufficient detail to predict their location in the landscape.

As a consequence the presence of threatened or otherwise significant species needs to be addressed as a supplementary attribute on a site-by-site basis rather than at the landscape scale. This means that the contribution of this attribute is not reflected in the current mapping of Ecological Status (Map 4). It should be noted however that the occurrence or likely occurrence of significant species at an individual site in most cases only elevate rather than erode, the status indicated on Map 4.

An important issue arising from the presence of significant species is the areal extent of their influence on Ecological Status. For plants a common approach has been to circumscribe a fixed distance around the individual specimens. This approach is entirely arbitrary and does not necessarily recognise the essential requirements to maintain (or facilitate) viable populations. The situation is even more complex for fauna, which may utilise different types of habitat for different purposes. Furthermore, aberrant observations are common and in this case the mere presence of a significant species may not warrant higher Ecological Status.

Guidance on the known habitat requirements for most of the significant fauna found on the Tweed is presented in Section 3.3.4 and Appendix 10.

Vegetation Condition

As noted previously (Section 3.1), there are many sources of disturbance that can adversely affect the ecological values of particular areas. For the purpose of quantifying these values it is important to take condition into account. Areas in poor condition may indicate lower ecological status, however areas in exceptionally good condition may indicate high ecological status even for vegetation communities that are not considered to be regionally threatened. On the other hand, areas in poor condition highlight the potential for rehabilitation.

Details of the vegetation condition attribute and codes have been previously outlined in Section 2.2.1.2. Generalised details of the criteria used to define each of the condition codes are presented in Appendix 3. See Table 3.3 for the relevant fields in the GIS databases.

It should be noted that because not all areas have been assessed for condition this attribute should be considered as supplementary.

TSC Act Threatened Communities and Critical Habitat

In addition to individual species, the Threatened Species Conservation Act 1995 makes provision for the scheduling of Threatened Populations and Communities, and the declaration of Critical Habitat. At present on the Tweed there are three vegetation communities recognised under this Act as Endangered; Lowland Rainforest on Floodplain (Vegetation Type 104), Littoral Rainforest and Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions (Vegetation Types 101 and 603 respectively). The only declaration of Critical Habitat in NSW is Stotts Is. Nature Reserve in the Tweed River.

The inclusion of these criteria ensures that the areas affected are explicitly recognised in the calculation of Ecological Status (see Table 3.5).

See Table 3.3 for the relevant fields in the GIS databases.

Edge Distance

As noted in Section 3.1.1.2 ecological interactions associated with the bushland/clearance interface have important implications for management. In general, the edges of forest remnants are considered more susceptible to the effects of increased penetration by sun, wind, rain, weeds, feral animals, and human activities than areas within the interior of the remnant. This attribute is used in the Ecological Sensitivity assessment only.

Using GIS techniques it is possible to identify areas close to the remnant edge. For the purposes of this study a uniform distance of 50 m was used to define these areas.

See Table 3.3 for the relevant fields in the GIS databases.

3.2.2.2 Criteria Used to Estimate Ecological Status

Most of the ecological attributes described in the previous section were used to classify remnant areas into categories of Ecological Status using the model summarised in Table 3.5 (see below). The modelling was achieved using ARC/INFO GRID. The results of the analyses are stored in a grid called ECOLSTAT through which the values of all contributing ecological queries (see Table 3.3) can be accessed. As noted previously, the criteria presented in Table 3.5 were derived in consultation with representatives of both DLWC (now DIPNR) and NPWS (now DEC), and are similar to other assessments carried out elsewhere on the NSW North Coast.

The model delineates four major categories of Ecological Status. The major difference between categories is one of degree. In general the first category (Very High) identifies areas with special ecological values. This includes areas which are either very poorly conserved or highly depleted as well as old growth forest, or significant ecosystems such as riparian areas and wetlands above certain area thresholds. The second category (High) also picks up areas with special ecological values (albeit at lower levels than Very High; eg poorly conserved vegetation communities) but also captures a number of attributes primarily related to ecological function and viability. This latter group includes large tracts of forest, regionally significant corridors, and numerous types of key fauna habitat. It should be noted that even in the Moderate category it is possible to pick up under-conserved vegetation communities, however it is not expected that these areas will be as functionally significant as those in High. The moderate category also contains areas coded as Highly Disturbed/Early Regeneration from the following vegetation Communities: 1002 – Early Regrowth Rainforest, 1003 – Acacia/other Sclerophyll Regrowth Open Forest to Woodland, 1008 Post Mining Regeneration, and riparian occurrences of 1004-Camphor Laurel Dominant Closed to Open Forest. The Low category picks up other areas of mapped bushland that have been typed and may also include the remaining disturbed areas or native plantation. Areas of bushland that have not been typed were allocated to category 5 – Not Determined even if they have values for other attributes (e.g Key Habitats, Remnant Size etc.). Areas identified as non-bushland such as cleared areas, open water and exotic plantations were not classified (see column "CONTVEG" in Appendix 7).

It is important to note that not all attributes are weighted evenly, and that the criteria are arranged hierarchically so that highest category is determined first, and so on to the lowest. This ensures that the most important attributes prevail. Exceptions to this occur with the exclusions that prevent the inclusion of areas on the basis of specific attributes. For example, the vegetation community 1004-Camphor Laurel Dominant Closed to Open Forest was prevented from being included within the first two categories irrespective of any other attributes (unless threatened species were present).

It should also be recognised that in some cases the allocation of attribute levels (or ranges) to specific Ecological Status categories is based not only on their perceived ecological importance, but also on the source and spatial reliability of the datasets. For example, the Key Fauna Habitat layer was prevented from occurring in the highest category. This was because, despite its ecological importance, the layer was largely modelled and mapped at a relatively coarse resolution (e.g. 1:100000), and could not be easily transferred to the finer local scale (< 1:15000). Similarly, any areas identified as both Candidate Old Growth (from the Growth Stage layer; 1:100000 scale) AND coded as Highly Disturbed/Early Regeneration (from the mapping prepared for this project) were also prevented from occurring in the Very High category. In these sorts of cases it was assumed that the more detailed mapping was more likely to be accurate.

The criteria presented in Table 3.5 were only applied to areas of mapped bushland and areas identified as non-bushland were not considered even if coincident with other independently derived layers (eg. Growth Stage, Corridors, Key Fauna Habitats).

Table 3.5 Criteria for Mapped Categories of Ecological Status

Note: Mapped areas allocated to Ecological Status Codes heirarchically starting with row 1

Ecological Status Category	Regional Vegetation Type Status (see separate criteria table)	Significant Ecosystems (Riparian/Floodplain, Wetlands, Estuarine, Dunal, Biodiverse)	Growth Stage (Regional Old Growth etc)	Regional Key Habitats% (Core, Hot spots, COE etc)	Corridors (derived by NPWS)	Remnant Size	Remnant Diversity (No of Vegetation Communities in Remnant)	Connectivity/ Isolation	Significant Species#*	Threatened Communities and Critical Habitat (TSC Act 1995)	Vegetation Condition# (see separate criteria table)	Exclusions
CODE	VEG@	ECO	OG	KEY	COR	SIZ	DIV	ISO	SPP	TSC	CON	
1 - Very High	**1.1@~** (Class 1 AND Area > 2ha) OR **1.2~** (Class 1 AND Remnant Size > 5 ha) OR **1.3~** (Class 2 AND Area > 10ha) OR	**1.1~** (Riparian/Floodplain Communities AND Area >2 ha) OR (**1.2~** Dunal/ **1.3~** High Biodiversity (Heathlands)/**1.4~** Wetland Communities AND Remnant Size > 50 ha) OR **1.5~** Estuarine Communities OR **1.6**~ High Biodiversity (Rainforest) OR	**1.1~** Candidate Old Growth OR	N/A	N/A	N/A	N/A	N/A	**1.1~** (Endangered Species present* and Exclusions not applicable) OR	**1.1~** (TSC Endangered - Vegetation Type 104, 101, 603 AND Exclusions not applicable) OR **1.2** ~ (TSC Critical Habitat - Stotts Is NR AND Exclusions not applicable) OR	**1.1~** Excellent Condition OR	NOT Site Condition = Highly Disturbed (except 104, 101, 603, TSC Act Critical Habitat) NOT 1002 Early Regrowth Rainforest 1003 Acacia / Other Sclerophyll Regrowth Open Forest to Woodland 1004 Camphor Laurel Dominant Closed to Open Forest 1008 Post-mining Regeneration NOT Regional Vegetation Type Status = Class 6 OR 7
2 - High	**2.1~** (Class 1 AND Area <= 2ha) OR **2.2~** (Class 1 AND Remnant Size <= 5 ha) OR **2.3~** (Class 2 remaining) OR **2.4~** (Class 3 AND Area > 10ha) OR	**2.1~** (Riparian Communities AND Area <= 2 ha) OR (**2.2~** Dunal /**2.3~** High Biodiversity /**2.4~** Wetland Communities AND Remnant Size 5 - 50 ha) OR	**2.1~** Disturbed Old Forest OR **2.2~** Mature Forest OR	**2.1~** Any AND Remnant Size > 10ha OR	**2.1~** "REGIONAL" OR	**2.1~** > 500ha OR	**2.1~** (>= 4 AND Remnant Size < 10ha) OR	**2.1~** (Well Connected AND Remnant Size > 10ha) OR	**2.1~** (Vulnerable / Rare Species present* AND Exclusions not applicable) OR	N/A	**2.1~ (**Highly Disturbed AND Vegetation Type 101 - Littoral Rainforest AND Exclusions not applicable)	NOT Site Condition = Highly Disturbed (except 1002 Early Regrowth Rainforest, 101 Littoral Rainforest) NOT 1003 Acacia / Other Sclerophyll Regrowth Open Forest to Woodland 1004 Camphor Laurel Dominant Closed to Open Forest 1008 Post-mining Regeneration NOT Regional Vegetation Type Status = Class 6 OR 7 NOT in Category 1
3 - Moderate	**3.1~** (Class 3 remaining) OR **3.2~** Class 4 OR	(**3.1~** Dunal /**3.2~** High Biodiversity /**3.3~** Wetland/Riparian Communities remaining) OR	**3.1~** Disturbed Mature Forest OR **3.2~** Disturbed Old Forest remaining OR **3.3~** Mature Forest remaining OR	**3.1~** Any Remaining OR	**3.1~** "SUBREGIONAL" OR **3.2~** "REGIONAL" remaining OR	**3.1~** > 5 ha remaining OR	N/A	**3.1~** Well Connected remainiing OR **3.2~** Partially Connected OR	**3.1~** (Other ROTAP/CRA regionally Significant Spp AND Exclusions not applicable) OR	N/A	**3.1~** Highly Disturbed AND Regional Vegetation Type Status 1 OR 2	NOT Vegetation Community = 1004 Camphor Laurel Dominant Closed to Open Forest (except in riparian areas) NOT Regional Vegetation Type Status = Class 6 OR 7 NOT in Category 1, 2
4 - Low	**4.1~** Class 5 OR	N/A	N/A	N/A	N/A	**4.1~** <= 5ha OR **4.2~** > 5 ha remaining OR	N/A	**4.1~** Isolated OR **4.2~** Partially Connected remaining OR	N/A	N/A	**4.1~** Highly Disturbed AND Regional Vegetation Type Status 3 OR 4	NOT Regional Vegetation Type Status = Class 6 OR 7 NOT in Category 1, 2, 3
5 - Not Determined	**5.1~** Class 6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NOT Regional Vegetation Type Status = Class 7 NOT in Category 1, 2, 3, 4

^Analysis applies to all bushland vegetation types (see field = CONTVEG in Appendix 7).

Supplementary Attribute - Not determined for all mapped areas

* Threatened species are not included formally within this model but their presence would classify remnants within the Ecological Status category indicated within this table.

@ Indicates codes used to identify the specific criteria used to allocate mapped areas to individual Ecological Status categories.

% Includes the following layers modelled for CRA:

a) Fauna Key Habitats, Core Areas, Hot spots

b) Centres of Endemism (vertebrates and invertebrates)

3.2.2.3 Criteria Used to Estimate Ecological Sensitivity

As noted previously, Ecological Sensitivity measures those components of the ecological system that are sensitive to degradation. Using a process similar to that described for Ecological Status, ecologically sensitive areas can be identified and located by defining particular combinations of ecological attributes associated with mapped bushland areas. The results of the analyses are stored in a grid called ECOLSENS through which the values of all contributing sub-code attributes can be accessed. The ability to identify and locate areas of differing Sensitivity is an important and necessary component of a strategic rehabilitation strategy.

It should be noted that such degradation may take many forms, but inevitably results in a decline in the quality of an area of vegetation. Degradation is often measured by one or more of the following conditions:

- Increases in the populations of exotic species;
- Death of individual plants resulting in population declines;
- Changes in species composition or age structure;
- Inhibition of normal successional processes;
- Inability to successfully reproduce.

For the purposes of this assessment, Sensitivity can be considered as a broad measure of the extent of degradation likely without deliberate human disturbance. On the highest end of the spectrum are areas where degradation is likely under prevailing environmental conditions - in other words, without active human disturbance. Within the fragmented landscape, forest edges are often susceptible to weed invasion and other biological changes without any active intervention. Some notable local examples in this category include almost all dunal vegetation, riparian zones, rainforest edges, and small urban remnants. Regrowth communities may also be subject to degradation through inhibition of normal successional processes. On the north coast the effects of aggressive exotic weeds often seriously affect rainforest regrowth. At the lower end of the Sensitivity spectrum are areas that are more resilient to all forms of disturbance and would require considerable human input to cause degradation. For example, wetlands are susceptible to changes in the water table caused by drainage works. Drainage works require a level of intervention above prevailing environmental conditions. Clearing is a further example of high level intervention.

Three broad categories of Sensitivity are defined: High, Moderate, and Low. Areas classified as the most sensitive (High) are considered to be subject to degradation without human disturbance. Areas classified as Moderate would, in general, to require some active disturbance, while areas ranked Low are thought to require active human disturbance to cause degradation.

The criteria used to define categories of Ecological Sensitivity are presented in Table 3.6.

Table 3.6 Criteria for Mapped Categories of Ecological Sensitivity*

Code (GIS Field –SENS_CODE)	Category (GIS Field – ECOL_SENS)	Sub Code	Criteria
1	High	S1.1	Dunal Communities (except 1008 – Post Mining Regeneration); or
		S1.2	Riparian Communities; or
		S1.3	Wetland edges; or
		S1.4	Littoral Rainforest Communities; or
		S1.5	Other Rainforest edges; or
		S1.6	Other Rainforest regrowth; or
		S1.7	Small Remnants (< 5 ha)
		S1.8	*Endangered* or *Vulnerable* species present[#]
			NOT 1004-Camphor Dominated (except in riparian areas) or 1005 -Native Plantation or 998 – Not Assessed
2	Moderate	S2.1	Estuarine Communities; or
		S2.2	Other Wetland Communities; or
		S2.3	Remnant Size Moderate (5 – 25 ha); or
		S2.4	Non-Rainforest regrowth

Code (GIS Field –SENS_CODE)	Category (GIS Field – ECOL_SENS)	Sub Code	Criteria
		S2.5	Other edges
		S2.6	Camphor Co-dominant or Edges Only/Patchy
		S2.7	Post Mining Regeneration; or
			NOT 1004-Camphor Dominated or 1005 -Native Plantation or 998 – Not Assessed
			NOT in High category above
3	**Low**	**S3.1**	All remaining bushland
			NOT 998 – Not Assessed
			NOT in categories above
4	**Not Determined**	**S4.1**	998 – Not Assessed

*Allocation to categories hierarchical: High determined first, Moderate determined second etc.
Mapped areas must meet at least one of the criteria listed for the relevant category. The results the analyses are stored in a grid called ECOLSENS through which the values of all contributing sub-code attributes can be accessed.
Supplementary attribute - not included formally within the associated mapping but presence would classify remnants within the category indicated within this table.

3.2.2.4 Limitations and Precautions

Like any form of modelling there are limitations to the data and its interpretation that need to be understood. Some of the limitations and precautions associated with this ecological assessment are outlined below:

Preference has been given to attributes for which information is available for every polygon in the remnant vegetation database. There are many other attributes for which it would be desirable to have comprehensive data. This of course includes the precise locations of all significant species. Other parameters may include: species richness; detailed disturbance and regeneration history; structural attributes; systematically collected and precisely located faunal data; detailed habitat indicators; data on corridor utilisation etc. As noted previously the inclusion of both such site- and landscape-scale attributes is applicable for site assessment purposes (e.g. Development Applications, clearing controls, Threatened species assessments, rehabilitation planning etc). Planning approaches to address this issue are contained in Volume One.

As noted previously, it should also be recognised that in some cases the allocation of attribute levels (or ranges) to specific Ecological Status categories is based not only on their perceived ecological importance, but also on the source and spatial reliability of the datasets. For example, despite its ecological importance, the Key Fauna Habitat layer which was largely modelled and mapped at a relatively coarse resolution (e.g. 1:100000), could not easily be transferred to the finer local scale (1:25000). As a consequence, it was only used where coincident with the more detailed mapping prepared for this project, and was also prevented from occurring in the highest status category.

Faunal data are particularly difficult to incorporate into an area-based ecological assessment. This is because fauna may be highly mobile, and species-specific habitat requirements are rarely known in sufficient detail to accurately map their distribution. Even where species distributions can be accurately predicted on the basis of known requirements, it is important to consider any other needs, and also more generally, the needs of species for which data is not available. Koalas, for example may need to move from one food source to the next, and it is obviously desirable for this to occur within bushland, or at least through bushland corridors. Therefore, to adequately protect the widest range of species, factors that have been shown to be reliable indicators of long-term maintenance of species diversity (such as remnant size) should be used in preference to information sets on specific species requirements.

Since later inclusion of any additional parameters will not replace the attributes already considered, but rather complement them, the present rankings should generally be regarded as a minimum level of ecological significance. With the exception of additional information on disturbance, it is most unlikely that the inclusion of extra parameters will highlight the need to downgrade the significance of an area. For example a remnant (or part of a remnant) classified into the lowest level of ecological significance would be regarded as *Very High* if it was later found to contain an endangered floral specimen.

Perhaps the most important precaution of all relates to the interpretation of the categories of Ecological Status. **The hierarchy of the ecological categories should not be used to devalue the importance of any particular bushland remnant(s)**. All remnant bushland is important and even small losses will affect the long term viability of the entire remnant system. Small and isolated remnants may have enhanced values at the local level. Apart from providing habitat refuges for native plants and animals these areas often have important landscape, catchment management, social,

educational, and recreational values. For example, smaller remnants may provide vital stepping stones between larger and more ecologically intact remnants. The loss of these stepping-stones may prevent dispersal and movement of species from one area to another. The consequences of this type of disturbance were described previously in Section 3.1.

3.2.3 Results and Discussion

3.2.3.1 Ecological Status

Map 4 shows the distribution of the remnant vegetation classified by Ecological Status (see also ARC/INFO GRID called ECOLSTAT). Areas classified as Very High account for one third of all mapped bushland within the Shire (22683 ha; see Table 3.7). This bushland is distributed throughout the Shire, most notably along the coast and associated with the National Park estate around the caldera rim and Mt.Warning. In fact the vast majority of bushland along the coastal strip falls within this category. This is essentially because coastal vegetation communities have been disproportionally removed and/or are poorly reserved. It is also noted from Map 4 that many riparian areas throughout the Shire are also included in the Very High category. Although, broadly distributed across the Shire, these areas are often only present as small linear remnants, and many areas remain untyped. As a consequence these and other similar areas have been allocated to the Not Determined category (7.8% of all mapped bushland; see Table 3.7)

Table 3.7 Bushland Areas within each Category of Ecological Status

Ecological Status Category	Bushland Area (ha)	% of all mapped Bushland in the Study Area	% of Shire
1 - Very High	22683	33.1	17.2
2 - High	31074	45.3	23.6
3 - Moderate	6235	9.1	4.7
4 - Low	3236	4.7	2.5
5 – Not Determined	5342	7.8	4.1
Total	68571	100.0	52.1

Bushland classified as High (31074 ha; Table 3.7) accounts for over 45% of all bushland mapped within the Shire. Again this category is broadly distributed throughout the Shire but is most commonly associated with ranges away from the coast. Vegetation in these areas consists mostly of moist and dry sclerophyll communities.

Areas classified as Moderate Ecological Status account for a relatively small but significant percentage of mapped bushland within the Study Area (9.1%; 8811 ha; Table 3.7). These areas are distributed patchily across the Shire and most notably capture much of the post-mining regeneration along the coast and many areas of early regrowth forest throughout the rest of the Shire. Areas classified as Low Ecological Status account for about 5% of mapped bushland within the Study Area. The vast majority of these areas were allocated to this category on the basis of the dominance of Camphor Laurel. Notwithstanding their allocation to the Moderate and Low status categories it should be remembered that the additional presence of significant species would, in most cases, effectively elevate the mapped status of these areas. This is particularly likely in some of the camphor-dominated areas.

3.2.3.2 Ecological Sensitivity

Map 4 also shows the distribution of the remnant vegetation classified by Ecological Sensitivity. The areal extent of each category is shown in Table 3.8. A number of points can be made from Map 4 and Table 3.8:

- Areas of either High or Moderate sensitivity account for over half (54.8 %) of all mapped bushland
- Almost all coastal areas are ranked as either High or Moderate sensitivity
- Areas ranked as High from non-coastal areas are comprised mostly of rainforest regrowth and/or riparian areas
- Areas ranked as Moderate from non-coastal areas comprise mostly of sclerophyll regrowth and forest edges.

Table 3.8 Bushland Areas within each Category of Ecological Sensitivity

Ecological Sensitivity Category	Bushland Area (ha)	% of all mapped Bushland in the Study Area	% of Study Area
1 - High	21499	31.4	16.3
2 - Moderate	15902	23.2	12.1
3 - Low	27152	39.6	20.6
4 – Not Determined	4018	5.9	3.1
Total	**68571**	**100**	**52.1**

3.3 Threatened and Significant Species Assessment

As a result of the major changes to the vegetated landscape caused by human activities over the past 150 years, many species have suffered dramatic declines in population size and contraction in range. Managing these significant species is an important component of overall remnant vegetation management in Tweed Shire. This section gives an overview of the threatened and otherwise significant flora and fauna of the region and canvasses some of the issues associated with their protection and management.

3.3.1 Methodology

In order to properly examine the relationship between significant species and vegetation management it is necessary, at a minimum, to examine the following issues:

- Known or predicted occurrence within the region;
- Habitat requirements of individual species and;
- Known threats and management issues.

Lists of species known or likely to occur in the region have been compiled on the basis of locational records contained in the NSW DEC Wildlife Atlas and relevant literature. Detailed information on known habitat requirements of listed fauna have been collated from the natural history literature and provided in tabular form primarily as an aid to determining the likely occurrence of species on the basis of selected indicators (see Section 3.3.4; Appendix 10). Since the actual site occurrence of significant flora is simply a matter of survey no attempt has been made to determine the habitat requirements of significant flora, although notes are provided in Appendix 8 that indicate general details of their known occurrence and habitat affiliations. Generalised information on threats to species have been addressed in Section 3.1.2 above and further detail relating to recovery and threat abatement priorities are suggested in Section 8.3.

Within NSW, *Threatened* species are identified and listed under the Threatened Species Conservation Act 1995 (TSC Act). The Act uses the categories of *Presumed Extinct, Endangered* and *Vulnerable* to describe conservation status. These terms have the following meanings:

- *Presumed Extinct* – Species that have not been located in nature during the preceding 50 years despite searching of known and likely habitats during that period.
- *Endangered* – species that are likely to become extinct in nature in NSW unless the circumstances and factors threatening its survival or evolutionary development cease to operate, or its numbers have been reduced to a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
- *Vulnerable* – species that are likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

Source: Threatened Species Conservation Act 1995

Further to species scheduled under the TSC Act are species considered *significant* on the basis of other characteristics or categorisations. For example with respect to flora, ROTAP listings (Briggs & Leigh 1995), which are a nationally recognised classification system for plants, use a similar classification schema to the TSC Act, but also include plant species classified as Rare or Poorly Known, which currently do not have any identifiable threat. Additionally, recent biological inventories (eg. NSW NPWS 1995; see below) recognise the significance of species that are at the edge of their distribution, locally endemic, disjunct or uncommon throughout their distribution, or occur in atypical habitat.

3.3.1.1 Locational Records

Except for the analysis of koala sitings (see Section 5.3.3) the collation of locational records for significant flora and fauna were confined to data sourced from the NSW DEC Atlas (current to July 2004). Maps were produced from these data, and show the distribution of significant species within the Tweed (see Map 4). It should be noted that the data shown on Map 4 are presented as received. No attempt has been made to validate or remove questionable observations or locations.

Because information contained within the DEC Flora and Fauna Atlas is gathered opportunistically rather than systematically, using a range of techniques and carried out by observers of variable ability, it is important to recognise that such data have number of inherent limitations.

1. Locational accuracy

Recordings of the locations of observations are commonly imprecisely (and incorrectly) georeferenced and written information regarding the exact location(s) of a significant species observation is often vague. Difficulties in recording the precise location of an individual or population can be due to the species being in remote and/or inaccessible places, and/or inadequate tools or techniques for accurate geographic positioning (eg. sufficiently small scale maps, GPS). Errors made during note taking in the field (recording sheets) and during transfer of records into a database also can reduce locational accuracy of data. These problems tend to be worse with older records, especially with place name changes or references to features that no longer exist. In general, data presented on Map 4 are only accurate to within 500m of the mapped location.

2. Comprehensiveness

Due to the opportunistic way data has been collected the distribution of records within the landscape is a reflection of survey effort rather than species abundance. Records tend to be concentrated in areas that are accessible, and within a relatively short distance from roads, tracks etc. The absence of records from a particular area does not imply the absence of the species.

3. Reliability of Species Records

Care should also be exercised with respect to the correct identification of species recorded within the Atlas database. Due to differences in observers, species groups and the type of observation, species are often misidentified. This is particularly so for cryptic or morphologically variable species. For example bats, reptiles, and amphibians are particularly prone to misidentification, and positive identification frequently requires specialist examination. Even species that are normally conspicuous (eg. most birds) can be easily misidentified when the observer only catches a glimpse. While it is not possible to confidently validate all identifications, without discarding a large number of records, caution should be exercised particularly for records of species not otherwise known from the region.

3.3.2 Significant Flora

3.3.2.1 Introduction

The biogeographic region that includes Tweed Shire is regarded nationally and internationally as a significant centre of biodiversity. Schenk (1990) demonstrated that Tweed Shire has the highest plant diversity within a 2000 km section of the Australian east coast. The Macleay-McPherson overlap described by Burbidge (1960) identifies a region including Tweed Shire as the transition between the two phytogeographic zones. The region supports both tropical and temperate species, many of which at the limits of their range (McDonald & Elsol 1984). Species at the edge of their range may contain genetic characteristics and adaptive potential for extension into new habitats (Pressey & Griffith 1992), an important feature for species to successfully overcome environmental change (e.g. climate change).

The result of clearing for agricultural, commercial and residential land uses is an extensive list of rare, vulnerable, endangered or otherwise significant species (Appendix 8).

Schenk & Wallace (1996) surveyed 179 sites within bushland remnants for a section of Tweed Shire (see Map 1, TVMP99). Approximately two-thirds of the bushland remnants visited contained significant species. Six remnants (4% of sites) contained Endangered species, 27 remnants (15% of sites) contained Vulnerable species and 82 remnants (46% of sites) contained Rare species.

3.3.2.2 Data Sources and Status Categories

In order to compile a list of significant species found on the Tweed a limited number of data sources were consulted. Significant plant species within New South Wales are defined by a number of different authors or agencies. The following is a brief list of sources, which were used to determine the conservation status of the flora, and habitat communities within Tweed Shire:

- **ROTAP** (Rare or Threatened Australian Plants; Briggs & Leigh 1995) A definitive source for the status of rare or threatened plants in Australia. The conservation status categories were created to emulate those of the International Union for the Conservation of Nature Red Book categories (see Appendix 9).

- **Threatened Species Conservation Act (TSC Act)** NSW state government legislation, which uses categories of *Extinct, Endangered and Vulnerable* conservation status. These are similar to the codes used for the Commonwealth Endangered Species Act 1992.

- **National Parks and Wildlife Service of NSW** NSW Wildlife Atlas Database: Flora. *Threatened Species of the Upper North Coast of New South Wales: Flora*. (NPWS 2002a)

- **Natural Resources Audit Council (NRAC)** NRAC (Sheringham & Westaway 1995) used criteria such as *Nationally Rare* or *Threatened*; *Uncommon Throughout their Distribution*; *Rare in NSW* and *Regionally Uncommon Species* as shown in Appendix 8. Also incorporated in their publication are records from other Herbaria including: State Forest Research Herbarium, Coffs Harbour; Queensland Herbarium: NSW Herbarium and New England Herbarium, Armidale. Also cited are records from the North East Forest Biodiversity Study (NSW NPWS 1994); ROTAP (Briggs & Leigh 1995) and rainforest lists of Floyd (1990).

- **NSW Herbarium** *The Flora of NSW*. Vols. 1-4 (Harden 1991-2002).

- **Other Publications** A number of other publications also contain useful information regarding the status and distribution of particular species:

  Rainforest Trees of Mainland South-eastern Australia (Floyd 1989).
  Trees and Shrubs in Rainforests of NSW and Southern Queensland (Williams *et al.* 1984).
  Students Flora of N-E NSW. (Beadle 1971-1987).
  Flora of South-East Queensland. Vols. 1-3. (Stanley & Ross 1983-1989).
  Vegetation of the Coastal Lowlands of Tweed Shire, Northern NSW: Plant Communities, Species and Conservation (Pressey & Griffith 1992).
  NSW Rainforests - The Nominations for the World Heritage List (Adam 1987).
  Rainforests of NSW. Vols. 1 & 2. (Floyd 1990).

3.3.2.3 Significant Species

Tweed Shire has at least 207 significant plant species recognised by one (or many) of the above-mentioned sources. Of these, some 96 are ROTAP scheduled, of which one is considered under the TSC Act to be *Extinct*, 25 *Endangered*, and 29 *Vulnerable*. A complete listing of these species and their status is contained within Appendix 8. Table 3.9 is an abbreviation of this list that contains only those species that are ROTAP (Briggs & Leigh 1995) listed. It is estimated that the Tweed / Gold Coast region supports Australia's highest concentration of threatened plants (see SOE 1996). Although significant, some of the species listed below are cultivated by the nursery trade and common in cultural plantings.

Table 3.9 ROTAP Listed Flora of Tweed Shire

Scientific Name	Common Name	TSC Act 1995	ROTAP - Briggs & Leigh 1995 [1]
Rapanea sp.1 (Richmond River)	Lismore Muttonwood	Presumed Extinct	2X
Diploglottis campbellii	Small-leaved Tamarind	Endangered	2E
Isoglossa eranthemoides		Endangered	2E
Tylophora woollsii		Endangered	2E
Davidsonia jerseyana	Davidson's Plum	Endangered	2ECi
Davidsonia johnsonii	Smooth Davidson's Plum	Endangered	2ECi
Diospyros mabacea	Red-fruited Ebony	Endangered	2ECi
Elaeocarpus williamsianus	Hairy Quandong	Endangered	2ECi
Ochrosia moorei	Southern Ochrosia	Endangered	2ECi
Uromyrtus australis	Peach Myrtle	Endangered	2ECi
Austromyrtus fragrantissima	Sweet Myrtle	Endangered	3EC-
Acronychia littoralis	Scented Acronychia	Endangered	3ECi
Cynanchum elegans		Endangered	3ECi
Randia moorei	Spiny Gardenia	Endangered	3ECi
Desmodium acanthocladum	Spiny Trefoil; Thorny Pea	Vulnerable	2VC-
Endiandra floydii	Crystal Creek Walnut	Endangered	2VC-
Macadamia tetraphylla	Rough-shelled Bush Nut	Vulnerable	2VC-
Symplocos baeuerlenii	Small-leaved Hazelwood	Vulnerable	2VC-
Corokia whiteana	Corokia	Vulnerable	2VCi
Owenia cepiodora	Onion Cedar	Vulnerable	2VCi
Syzygium moorei	Durobby, Coolamon	Vulnerable	2VCi
Euphrasia bella	Pretty or Mt. Merino Eyebright	Vulnerable	2VCit
Gaultheria viridicarpa subsp. merinoensis		Vulnerable	2VCit
Pterostylis nigricans	Dark Greenhood	Vulnerable	3V
Bulbophyllum globuliforme	Hoop Pine Orchid	Vulnerable	3VC-
Clematis fawcettii	Lobed-leaf or Northern Clematis	Vulnerable	3VC-
Endiandra hayesii	Rusty Rose Walnut	Vulnerable	3VC-
Floydia praealta	Ball Nut	Vulnerable	3VC-
Sarcochilus fitzgeraldii	Ravine Orchid	Vulnerable	3VC-
Sarcochilus hartmannii		Vulnerable	3VC-
Sarcochilus weinthalii	Blotched Sarcochilus	Vulnerable	3VC-
Sophora fraseri	Scrub Sophora	Vulnerable	3VC-
Syzygium hodgkinsoniae	Red Lilly Pilly	Vulnerable	3VC-
Arthraxon hispidus		Vulnerable	3VC-+
Phaius tankervilliae	Swamp Orchid	Endangered	3VC-+
Phaius australis	Swamp Orchid	Endangered	3VCa
Cryptocarya foetida	Stinking Cryptocarya	Vulnerable	3VCi
Fontainea australis	Southern Fontainea	Vulnerable	3VCi
Haloragis exalata subsp. velutina		Vulnerable	3VCi
Thesium australe	Austral Toadflax	Vulnerable	3VCi+
Acacia orites	Nightcap Wattle		2RC-
Ardisia bakeri	Ardisia		2RC-
Brachyscome ascendens	Border Ranges Daisy	Endangered	2RC-
Cordyline congesta	Narrow Palm Lilly		2RC-
Cupaniopsis newmani	Long-leaved Tuckeroo		2RC-
Cyperus rupicola		Vulnerable	2RC-
Endiandra globosa	Black Walnut		2RC-

Helichrysum sp.1 (Mt. Merino)			2RC-
Lepiderema pulchella	Fine-leaved Tuckeroo	Vulnerable	2RC-
Leucopogon sp.5 (Echo Point)			2RC-
Pimelea umbratica			2RC-
Rhodamnia maideniana	Smooth Scrub Turpentine		2RC-
Rulingia salviifolia			2RC-
Uromyrtus lamingtonensis			2RC-
Wahlenbergia scopulicola	Rock-face Bluebell	Endangered	2RC-
Pararistolochia deltantha var. laheyana			2RC-+
Helmholtzia glaberrima	Stream Lilly		2RCa
Lastreopsis silvestris	Mountain Shield Fern		2RCa
Olearia heterocarpa	Nightcap Daisy Bush		2RCa
Ozothamnus vagans			2RCa
Podolepis monticola			2RCa
Westringia blakeana			2RCa
Pittosporum oreillyanum	Thorny Pittosporum		2RCat
Cassia brewsteri var. marksiana	Brush Cassia	Endangered	2RCi
Parsonsia tenuis	Slender Silkpod		2RC-t
Pomaderris notata		Vulnerable	2RC-t
Zieria adenodonta	Wollumbin Zieria	Endangered	2RC-t
Acianthus amplexicaulis	Lobed Gnat Orchid		3RC-
Acomis acoma			3RC-
Acronychia baeuerlenii	Byron Bay Acronychia		3RC-
Corynocarpus rupestris ssp. arborescens	Glenugie Karaka		3RC-
Dendrobium schneiderae			3RC-
Hibbertia hexandra		Endangered	3RC-
Hicksbeachia pinnatifolia	Red Bopple Nut	Vulnerable	3RC-
Kunzea bracteolata			3RC-
Marsdenia longiloba	Slender Marsdenia	Endangered	3RC-
Muellerina myrtifolia	Myrtle-leaf Mistletoe	Endangered	3RC-
Ozothamnus whitei			3RC-
Podolobium aestivum			3RC-
Prasophyllum exilis			3RC-
Quassia sp.2 (Mt. Nardi)	Southern Quassia		3RC-
Sarcochilus dilatatus			3RC-
Senna acclinis		Endangered	3RC-
Tinospora tinosporoides	Arrow-head vine	Vulnerable	3RC-
Trichosanthes subvelutina	Velvet-leaved Cucumber		3RC-
Millettia australis	Blunt-leaved Native Wistaria		3RC-+
Alloxylon pinnatum	Dorrigo Waratah		3RCa
Amorphospermum whitei	Rusty Plum	Vulnerable	3RCa
Archidendron muellerianum	Veiny Lace Flower		3RCa
Argophyllum nullumense	Silver Leaf		3RCa
Austrobuxus swainii	Pink Cherry		3RCa
Gahnia insignis			3RCa
Bulbophyllum weinthalii			3RCi
Ricinocarpos speciosus			3RCi
Schistotylus purpuratus			3RCi
Plectranthus nitidus	Nightcap Plectranthus	Endangered	2KCi

1. ROTAP codes are described within Appendix 9

Table 3.10 is also derived from Appendix 8 and lists 55 significant species endemic to Tweed Shire and immediate surrounds.

Table 3.10 Significant Flora Confined to Tweed Shire and Immediate Surrounds

Scientific Name	Common Name	STATUS		Notes
		TSC Act 1995 #	ROTAP - Briggs & Leigh 1995 *	
Acacia baueri ssp. baueri				Dwarf to small shrub from coastal, damp to dry heath (Kingscliff -P & G 1992; Beadle 1982); In danger of extinction in extreme SE Qld. (Stanley & Ross 1983); also from adjacent tablelands, N from Robertson to Qld. (Harden 1991). Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Acacia orites	Nightcap Wattle		2RC-	Medium to tall tree in WTRf on acidic volcanic soils from Rosebank to Springbrook; restricted to the Mt. Warning and Focal Peak shield volcanoes (Floyd 1989). Nightcap, Mt. Warning and Border Ra. NP. (Sheringham & Westaway 1995). Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Acronychia baeuerlenii	Byron Bay Acronychia		3RC-	Small tree in STRf & WTRf, Lismore-Byron Bay to McPherson Range (Williams et al. 1984); also recorded from Iluka to Qld. (Harden 1991); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Archidendron muellerianum	Veiny Lace Flower		3RCa	Medium tree in STRf, LRf, DRf and Riverine Rf from Richmond, Brunswick and Tweed rivers NSW to Upper Tallebudgera (Floyd 1989). Border Ra. & Mt. Warning NP (Sheringham & Westaway 1995); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Ardisia bakeri	Ardisia		2RC-	Tall shrub to small tree in WTRf and STRf in the Tweed valley and McPherson Range (Williams *et al.* 1984; Harden 1990); rare on north coast, extends to Qld. (Harden 1990); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Asplenium harmanii				Epiphytic fern on rocks in Rf. in higher parts of Border Ranges and into Qld. (Harden 1990); from The Pinnacle (QldHerbrec); Couchy Ck. Numinbah NR (NRAC) in Sheringham & Westaway 1995; Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Austromyrtus fragrantissima	Sweet Myrtle	E	3EC-	Shrub or small tree in dry STRf and riverine Rf of coastal districts and DRf, N from Lismore to Tallebudgera Valley (Williams *et al.* 1984; NSW NPWS 2002); rare, (Harden 1991); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Brachyscome ascendens	Border Ranges Daisy	E	2RC-	Perennial herb to 30cm of montane shrubland of clifftops in Border Ranges/Lamington NP area (Stanley & Ross 1986; ROTAP 1995); not in Flora of NSW. Known from only 1 location in NSW on Tweed Escarpment in Border Ranges NP (NSW NPWS 2002); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Bulbophyllum globuliforme	Hoop Pine Orchid	V	3VC-	Epiphytic orchid forming spreading patches of pseudobulbs on Rf trees, particularly Hoop pine in Rf. of McPherson range from 300 -600m. (Beadle 1987; Harden 1993)
Cassia brewsteri var. marksiana	Brush Cassia	E	2RCi	Tree in LRf and riverine Rf, and in regrowth in farmland and along roadsides, N from the Brunswick Heads, around Murwillumbah and N to SE Qld around Beenleigh, rare (Harden 1991; NSW NPWS 2002); Inadequately reserved,

Scientific Name	Common Name	STATUS		Notes
		TSC Act 1995 #	ROTAP - Briggs & Leigh 1995 *	
				Crabbes Ck. to Currumbin (Pressey & Griffith 1992; Floyd 1989); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Citrus australasica	Finger Lime			Shrub in Riverine, DRf and STRf N from Woodburn to Qld., can be common in regrowth (Harden 1991). Cudgen, Border Ra., Nullum & Mebbin SF, Mt. Warning NP and Limpinwood NR; Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Clematis fawcettii	Lobed-leaf or Northern Clematis	V	3VC-	Small to medium climber of upper drier rainforest canopy usually near streams, rare in mountainous areas in NE NSW north of Lismore and SE Qld. (Beadle 1982; NSW NPWS 2002). Rf N of Richmond River (Harden 1990). Limpinwood NR and Border Ranges NP (Sheringham & Westaway 1995); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Corokia whiteana	Corokia	V	2VCi	Shrub or small tree to 4m in three distinct populations, Nightcap Range, Tweed Valley and near Brunswick Heads. Inland populations in boundaries between WSf and WTRf on poorer soils at altitudes up to 800m; on coast found in Brush Box (*Lophostemon confertus*) forest associated with LRf species, rare (Harden 1992; NSW NPWS 2002). Recorded from Hogans Scrub (Floyd), Tumbulgum (ROTAP), Nullum SF and Uki (SF Herbrec) in Sheringham & Westaway 1995, prev. known only from the Nightcap Range (Williams *et al.* 1984; Harden 1992); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Cupaniopsis newmanii	Long-leaved Tuckeroo		2RC-	Shrub to small tree in and on the margin of WTRf (STRf Floyd) from Mullumbimby to Mt. Tamborine (Williams *et al.* 1984; Harden 1991); Border Ra. & Mt. Warning NP., Limpinwood, Inner Pocket & Numinbah NR. (Sheringham & Westaway 1995); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Cyperus rupicola		V	2RC-	Tussock forming perennial amongst rocks or on exposed cliff faces near forest (Harden 1993). Rocky sites on Mt. Warning and Nightcap Range (Beadle 1987)
Davidsonia jerseyana	Davidson's Plum	E	2ECi	Slender tree confined to STRf and WSf at low altitudes (below 300m) in coastal areas, rare (Harden 1990; NSW NPWS 2002); Basaltic soils and Riverine Rf. From Brunswick and Tweed rivers (Floyd 1989); considered of State significance (J. Hunter pers. comm.) Metamorphic-derived soils, not on basalt (B. Stewart pers. comm. July 2004); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Davidsonia johnsonii	Smooth Davidson's Plum	E	2ECi	Bushy tree in disturbed STRf, LSTRf or on margin with WSf at low altitude (below 300m) from Tintenbar-Broken Head district to Currumbin Valley, rare (Harden 1990; NSW NPWS 2002); Margin of lowland STRf and Wet sclerophyll forest from Richmond R. to Currumbin Ck. (Floyd 1989); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)

Scientific Name	Common Name	STATUS		Notes
		TSC Act 1995 #	ROTAP - Briggs & Leigh 1995 *	
Diospyros ellipticifolia var. ebenus	Shiny-leaved Ebony	E		Tall shrub to small tree in riverine or lowland STRf from lower Tweed R. to Gympie, considered as rare (Williams *et al.* 1984); very rare, confined to Tweed area? Qld. (Harden 1990); Found only in Hogan's Scrub at North Tumbulgum and on Mt Cougal in Tweed, also in SE Qld. (NSW NPWS 2002). Also Brunswick R (B. Stewart pers. comm. July 2004); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Diospyros mabacea	Red-fruited Ebony	E	2ECi	Small tree in LSTRf & riverine Rf often close to rivers, on basalt derived or alluvial soils, found in a few stands on the Tweed and Oxley Rivers, upstream from Murwillumbah, on Stotts Island, west of Mullumbimby on the Brunswick River, largest population in Limpinwood NR; rare (Williams *et al.* 1984; Floyd 1989; Harden 1990; NSW NPWS 2002); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Diploglottis campbellii	Small-leaved Tamarind	E	2E	Large tree in riverine Rf, STRf and Brush Box forest from Tintenbar on the Richmond River and Tweed River to Upper Tallebudgera Valley SE Qld., found at only a small number of locations (Floyd 1989; Harden 1991; NSW NPWS 2002). Also from Mudgeeraba, SE Qld (B. Stewart pers. comm. July 2004); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Doryanthes palmeri	Spear Lilly	V		Tall perennial herb forming on exposed rock outcrops in WSf of Mt. Warning Caldera and into Qld (Harden 1993); Mt. Warning NP (NSWHerbrec in Sheringham & Westaway 1995); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Elaeocarpus williamsianus	Hairy Quandong	E	2ECi	Small to medium tree in STRf, WTRf or disturbed Rf of Upper Burringbar Creek, Very rare (Williams *et al.* 1984; Harden 1990); Limited specimens recorded from Burringbar in Tweed (Floyd 1989); Known from very few sites between Goonengerry and Burringbar in NE NSW (NSW NPWS 2002). Recorded from Broken Head (B. Stewart pers. comm. July 2004); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Endiandra floydii	Crystal Creek Walnut	E	2VC-	A medium to small tree in WTRf & STRf with Brush Box overstorey, and in regrowth Rf and Camphor Laurel forest on moderately steep slopes below 430m. From Couchy, Crystal and Nobby's Cks., Urliup and Tomewin on S side of McPherson Range (Harden 1993; NSW NPWS 2002); Also Brunswick Heads (pers. comm. M. Healey 1997); Confined to Tweed and Brunswick Valleys and Byron Bay area and one or two locations in SE Qld. (NSW NPWS 2002); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Endiandra globosa	Black Walnut		2RC-	Medium to large tree restricted to riverine Rf. on rich alluvial soils and on moist slopes in STRf (Harden 1990); In Tweed & Brunswick Valleys to Tallebudgera Qld.; reservation adequacy unknown; (Floyd 1989). Often in Brush Box and WSf on metasediments (B. Stewart pers. comm. July 2004); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)

Scientific Name	Common Name	STATUS		Notes
		TSC Act 1995 #	ROTAP - Briggs & Leigh 1995 *	
Euphrasia bella	Pretty or Mt. Merino Eyebright	V	2VCit	Dwarf perennial herb restricted to exposed sites in CTRf (Harden 1992). Recorded only from Mc Pherson Range on NSW-Qld. Border along cliff edges in Antarctic Beech forest (Beadle 1984). Mt. Merino in Limpinwood NR, wet but well drained. Closely related species on 'The Pinnacle' Tweed Range (NSW NPWS 2002)
Fontainea australis	Southern Fontainea	V	3VCi	Shrub or small tree in LSTRf, usually on basaltic alluvial flats and also in cooler STRf in the Nightcap Range, restricted to the Tweed Valley and a few locations in the upper reaches of the Richmond Valley recorded from Oxley R. in Tweed Shire (Harden 1990; NSW NPWS 2002); Northern distributional limit in lowland STRf of the Tweed (Floyd 1989); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Gaultheria viridicarpa subsp. merinoensis		V	2VCit	Erect or creeping shrub from Limpinwood NR and Lamington NP only (ROTAP 1995); Population recorded from Mt. Merino on NSW/Qld has smaller, broader leaves that *G.* species A and has been treated as a different taxon. Border and into Qld, rare (Harden 1992).
Gynura drymophila var. drymophila				Herb in Sf. usually on skeletal, volcanic soils, apparently rare, N from Ballina (Harden 1992); on rocky escarpments of SEQld & NE NSW (Jones & Elliott 1990); Mt. Nullum 1896 (NSWHerbrec) in Sheringham & Westaway 1995; Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Helichrysum sp.1			2RC-	Perrenial herb to c. 40cm., from cliff edges near Antarctic Beech forests in McPherson Range (Stanley & Ross 1986); not in Flora of NSW
Hibbertia hexandra		E	3RC-	Tall shrub or small tree chiefly in heath, open or xeromorphic forests or rainforest of Mt. Warning NP, Nightcap NP and the McPherson Range and separate occurrence in Wauchope-Kendall area (Beadle 1982; Harden 1990; NSW NPWS 2002); Nightcap Range (Sheringham & Westaway 1995); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Isoglossa eranthemoides		E	2E	Herb to 50cm from herbaceous, stony ground stratum of STRf, rare (Harden 1992); Only recorded from Tweed R. (Beadle 1984); Booyong (near Lismore) and Inner Pocket NR, Burringbar (Sheringham & Westaway 1995). Restricted distrbution from Tweed to Lismore in moist situations in lowland STRf (NSW NPWS 2002). Mt Warning, Cedar Creek, Amaroo FR, Oxley R (B. Stewart pers. comm. July 2004); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Lastreopsis silvestris	Mountain Shield Fern		2RCa	Fern in Rf at high altitudes of Border Ranges, rare in NSW (Harden 1990); McPherson Range at higher altitude in Rf. (Beadle 1982); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Lastreopsis smithiana	Smooth Shield Fern			Fern along creek banks in Rf in Border Ranges, not common in NSW (Harden 1990); McPherson Range in very wet places in Rf. (Beadle 1982); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)

Scientific Name	Common Name	STATUS		Notes
		TSC Act 1995 #	ROTAP - Briggs & Leigh 1995 *	
Lepiderema pulchella	Fine-leaved Tuckeroo	V	2RC-	Small tree from riverine, LSTRf and LRf from Brunswick River to Tallebudgera Ck., Qld., in NSW largely confined to infertile metasediments in the Tweed Valley, the majority occur on private property (Floyd 1989; Harden 1991; NSW NPWS 2002); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Lindsaea fraseri		E		Terrestrial fern with creeping underground root, locally common in one area on Tweed coast in swamp forest-dry sclerophyll forest ecotone, Bogangar (Griffith 1986); rare in NSW (Harden 1990); Four records for NSW all in this locality (Nat. Herb. NSW 1986 pers. comm.); also S Qld. (P & G 1992); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Macadamia tetraphylla	Rough-shelled Bush Nut	V	2VC-	Medium-sized tree in STRf, usually near the coast N of Clarence R., confined chiefly to the Tweed and Richmond Rivers (Floyd 1989; Harden 1991); extends into S Qld.; Mt. Warning NP, Numinbah and Inner Pocket NR (Sheringham & Westaway 1995); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Mitrasacme pygmaea		E		Annual herb, erect to 20 cm high, found in Qld & NSW. The species reaches its southern limit in NSW, and is known from only one location within Mount Warning NP, a population of about 20 plants was recorded in 1995, but the species has not been found there since (A Benwell, 2003 pers. com.); NPWS web site (12 Aug 2004).
Olearia heterocarpa	Nightcap Daisy Bush		2RCa	Shrub from WSF and woodland, OF, fringing mallee scrub on obsidian and WTRf margins from Nightcap Range to Springbrook (Williams *et al.* 1984); Nullum SF (Sheringham & Westaway 1995); Gibbergunyah Range in Whian Whian area and Qld. also (Harden 1992); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Owenia cepiodora	Onion Cedar	V	2VCi	Tree in STRf and DRf on or near soils derived from basalt from Bangalow (Richmond River) to the McPherson Range in Qld., very rare (Harden 1991; NSW NPWS 2002); Confined to dry Hoop pine forests of N NSW and Qld Border regions (Floyd 1989); Mebbin SF, Mt. Warning and Border Ra. NP (Sheringham & Westaway 1995); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Ozothamnus vagans			2RCa	Straggling, spindly shrub in and around Rf. from Qld., McPherson Range and on Mt. Warning; rare (Stanley & Ross 1986; Harden 1992); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Ozothamnus whitei			3RC-	Straggly shrub in forest on rocky hillsides in the McPherson, Gibraltar, Tweed and Nightcap Ranges and Qld.; rare (Harden 1992); From McPherson Range border region (Stanley & Ross 1986); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Pararistolochia deltantha var. laheyana			2RC-+	Vine in high altitude Rf. of McPherson Range (Stanley & Ross 1983). CTRf N from Nightcap Ra. (Harden 1990). Border Ra. NP (Sheringham & Westaway 1995); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)

Scientific Name	Common Name	STATUS		Notes
		TSC Act 1995 #	ROTAP - Briggs & Leigh 1995 *	
Parsonsia tenuis	Slender Silkpod		2RC-t	Slender-stemmed twiner growing in Antarctic Beech Rf. and in CSTRf to 1250m.only recorded from McPherson Range in both NSW and Qld. (Harden 1992; Williams & Harden 1980; Beadle 1984)
Phyllanthus microcladus	Brush Sauropus	E		Rare small shrub in disturbed STRf recorded only from Tweed Valley and Range (Williams *et al.* 1984); Upper Main Arm, Mullumbimby Ck.-Southern limit (NSWHerbrec. in Sheringham & Westaway 1995); extends into Qld (Harden 1990). Found on banks of creeks and rivers, in streamside rainforest at localities in Tweed, Brunswick, Richmond and Wilson River Valleys and near Grafton (NSW NPWS 2002).
Pimelea umbratica			2RC-	Much branched shrub to 1m. in shrubland on stony soil, above Rf., not common, confined to Tweed Valley and McPherson Range (Harden 1993); Border Ranges area (ROTAP 1995); Mebbin Rock (Hanging Rock) Tweed Range (Sheringham & Westaway 1995)
Pittosporum oreillyanum	Thorny Pittosporum		2RCat	Spinescent shrub in Antarctic Beech Rf. and CTRf, on higher slopes and peaks of McPherson and Tweed Ranges, including Limpinwood NR and Qld.; rare (Harden 1992; Williams *et al.* 1984); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Podolepis monticola			2RCa	Prostrate perennial herb restricted to rock ledges and crevices at high altitude, adjacent to Antarctic Beech Rf. from McPherson Range; rare (Harden 1992; Stanley & Ross 1986); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Pomaderris notata		V	2RC-t	Shrub to 2m confined to rocky basalt ranges of McPherson Range, sometimes locally dominant (Harden 1990); Recorded from Mt. Warning NP >1000 specimens reserved and Qld. (Briggs & Leigh 1995); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Rulingia salviifolia			2RC-	Shrub, mainly in *Eucalyptus* forests N from Mt. Warning and the McPherson Range and adjacent areas (Beadle 1982; Harden 1990); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Strangea linearis				Shrub confined to coastal sandmasses of far North Coast and SE Qld as scattered specimens N from Byron Bay area, rare (Harden 1991); former R or T status (Leigh *et al.* 1981), only reserved at Tyagarah NR; recorded from near Cudgen Lake (Murray 1989); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Symplocos baeuerlenii	Small-leaved Hazelwood	V	2VC-	Shrub or small tree in STRf & WTRf N from Nightcap and Mt Jerusalem NPs, in Tweed and Brunswick valleys and limited occurrence in SE Qld to Springbrook; Uncommon (Williams *et al.* 1984; Harden 1992; NSW NPWS 2002); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)

Scientific Name	Common Name	STATUS		Notes
		TSC Act 1995 #	ROTAP - Briggs & Leigh 1995 *	
Uromyrtus australis	Peach Myrtle	E	2ECi	Shrub or small tree in WTRf. on less fertile and shallow yellow earths with high rainfall, often associated with Coachwood (*Ceratopetalum apetalum*), found only in Nightcap and Mt. Jerusalem NPs and Whian Whian SF (Floyd 1989; NSW NPWS 2002); known only from McPherson Range (Harden 1991); Nullum SF (Sheringham & Westaway 1995); Nightcap NP (Adam 1987); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Uromyrtus lamingtonensis			2RC-	Much-branched small tree to shrub on very steep ridges in DRf and shrubland of Mt. Wagawn, Mt. Durigan and spurs of eastern McPherson Range and Limpinwood NR and Qld; possess smaller leaves and more oil dots than *U. australis* (Floyd 1989; Sheringham & Westaway 1995; Harden 2002); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Wahlenbergia scopulicola	Rock-face Bluebell	E	2RC-	Perennial, tufted, hirsute herb in damp crevices of rhyolite outcrops in McPherson Range to Qld. (Stanley & Ross 1986; Beadle 1984; Harden 1992); Border Ranges NP (Qld Herbrec from Sheringham & Westaway 1995); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)
Zieria adenodonta	Wollumbin Zieria	E	2RC-t	Dense, bushy shrub to 3m confined to exposed, steep, rocky mountain slopes of McPherson Range and Mt. Warning (Stanley & Ross 1983; Harden 1991); Summit of Mt. Warning (New England Herbarium record in Sheringham & Westaway 1995); Only near top of Mt. Warning in dense shrubby vegetation with tea-tree, bottlebrushes and grass-trees (NSW NPWS 2002); Recorded in Tweed (L. FitzGerald pers. comm. Aug 2004)

Codes: E = Endangered; V = Vulnerable; X = presumed Extinct
* ROTAP Codes are described within Appendix 9

Tweed Shire Significant Tree Register

In recognition of the rich flora of the Tweed, Council has initiated a Significant Tree Register to catalogue and manage rare, threatened or otherwise significant trees occurring within Shire road reserves. As an educational initiative many of the specimens have been signposted.

This database has been reconstructed and Council's Recreation Services Department is currently revising the records.

Some Noteworthy Species

In order to illustrate the significance of some of the species identified, brief profiles of a few are discussed below:

Austromyrtus fragrantissima - Sweet Myrtle

This rare shrub occurs in riverine rainforest from Woodburn in northern NSW to the Tallebudgera Valley in south-east Queensland. Due to extensive clearing of its habitat for agricultural purposes it now only occurs as isolated specimens in remnant vegetation from Limpinwood, Terranora, Tomewin and Bilambil in Tweed Shire. Specimens are recorded on the Tweed Significant Tree Register. This species should be considered for planned recovery and preservation of its habitat due to its rarity and slow germination characteristics.

Endiandra floydii - Crystal Creek Walnut

This medium to small tree is largely confined to the Tweed Valley where it occurs in warm temperate or sub-tropical rainforest with Brush Box (*Lophostemon confertus*) in the overstorey. It inhabits moderately steep slopes on Palaeozoic metamorphics with overlying basalt nearby at altitudes below 430 m. The only known records are from Couchy Ck, Crystal Ck, Nobbys Ck, Urliup Road and Tomewin on the southern side of the McPherson Range within the Tweed Shire, and at Brunswick Heads. In recent times several specimens at Tomewin have been killed by bushfire and herbicide drift from roadside spraying programs. This mismanagement has added to the rarity of this species. Specimens are recorded on the Council's Significant Tree Register.

Diploglottis campbellii - Small-leaved Tamarind

A large tree of the coastal lowlands, occurring from the Nerang River of south-east Queensland to the Richmond River of north-east N.S.W. The NSW DEC through the Endangered Species Program are making considerable progress with restoration of habitat within NSW.

Known specimens within Tweed Shire occur at Cedar Creek, Mt. Warning Rd., Eungella Dip (10 mature specimens), Oxley River, Farrant's Hill, Terranora Country Club and the Tweed River. The present rarity of this species is almost certainly due to the destruction of its habitat. It will require positive management to remove threats, such as weed competition, to enhance remaining habitat.

With the exception of the Cedar Creek population, all of the remaining individuals occur on private property or road reserves. Most property owners are aware of their presence and are generally sympathetic to conservation aims, but limited actions have been taken to remove threats to these specimens. Those individuals surviving in small rainforest remnants or regrowth are threatened by the gradual decline in their number, and potentially by future clearing of habitat by unsympathetic landowners.

Tweed Shire Council has taken positive action to protect this species by identifying them in their Significant Tree Register.

As a result of the limited field checking of areas previously mapped by the Australian Koala Foundation (Phillips & Callaghan 1996) a further 12 individuals of this species were identified at Farrants Hill. These trees are also located on private property and funding is being sought for their conservation and enhancement (M. Healey pers. comm. 1999).

Ediothea hardeniana – Nightcap Oak

Nightcap Oak is a recently discovered species of Proteaceae, the same family as Macadamia and Banksia. The largest recorded specimen is a tree of 40m although most are smaller. They produce creamy flowers in compact heads and a globular dull golden fruit that are superficially similar to the Macadamia.

This species has been found in only a single catchment in the Nightcap Range north of Lismore and south of the Tweed Shire border and there is a possibility that other isolated populations of this species exist in the Tweed. It occurs in upland warm temperate rainforest, usually near creeks.

Only one other species of Ediothea has been recorded in Australia, *Ediothea zoexylocarpa* from Mt. Bartle Frere in NE Queensland.

Elaeocarpus williamsianus - Hairy Quandong

A small tree up to 15m tall and confined to immature sub-tropical / warm-temperate rainforest. Specimens are only known from five localities, two of which are near Burringbar within Tweed Shire. It occurs on steep and actively eroding slopes at these two sites. Accompanying them at these sites are a number of other rare and threatened species, including Red Lilly Pilly (*Syzygium hodgkinsoniae*), Durroby (*Syzygium moorei*), Black Walnut (*Endiandra globosa*), Smooth Davidsons Plum (*Davidsonia johnsonii*), Spiny Gardenia (*Randia moorei*), Smooth Scrub Turpentine (*Rhodamnia maideniana*) and Veiny Lace Flower (*Archidendron muellerianum*). The greatest threat to both known populations is invasion and smothering by exotic species, particularly Lantana (*L. camara*). Fire is also a potential threat and erosion is a problem at one location. One population is possibly reserved within or adjacent to the Inner Pocket Nature Reserve. The second population occurs on private property. The long term survival of this species is dependent on a maintenance program that includes weeding and tree planting to restore habitat. Propagation of this species is slow and difficult.

Diospyros mabacea - Red-fruited Ebony

A small to medium tree growing to 25m in height which is confined to riparian and sub-tropical rainforest (Floyd 1990). It occurs at low altitudes on the fertile soils of the inner erosion caldera of Tweed Shire adjacent to the Oxley and Tweed Rivers and possibly Snows Gully near Mullumbimby. It is conserved in Limpinwood and Stotts Island Nature Reserves, but its representation in these reserves is considered inadequate for conservation (Briggs & Leigh 1995). It also occurs at Limpinwood and Eungella and behind Tyalgum on the edge of Limpinwood Nature Reserve on private property. Due to the very restricted distribution of the species, all habitats where this species occurs should be considered as significant. The NSW NPWS (1997) state that:

> *Inadequate knowledge of factors affecting regeneration success and of the genetic viability amongst remnant populations means that the species is at serious risk of genetic depletion if unreserved populations are not subject to recovery planning. Research and appropriate management actions are essential to successful recovery.*

3.3.3 Significant Fauna

3.3.3.1 Terrestrial Vertebrates

The NSW DEC maintains a database of flora and fauna observations (Wildlife Atlas). This database contains details such as the common and scientific names, the legal status, the observer, and georeferencing information. Other sources of significant species records within the Shire include Tanton (1996), NSW NPWS (2002b) and CSIRO (1996). Table 3.11 lists all significant species (Threatened Species Conservation Act 1995) recorded within Tweed Shire from these sources. Of the 105 significant species recorded in Table 3.11, 17 are *Endangered* and 88 *Vulnerable* (TSC Act 1995). These figures indicate that on an Australia-wide basis the region contains a very high concentration of threatened vertebrates (see SOE 1996).

The rich structural and floristic diversity of the vegetation and wide range of geological, topographic and climatic influences in the Region have resulted in a complex mosaic of habitat types. The faunal diversity of the Region is equalled only by the wet tropics of northern Australia (NSW NPWS 1995). Over 630 vertebrate species are known from the Region, many of which are endemic. Avifaunal diversity is second only to the wet tropics and the region has the highest diversity of marsupials, frogs, snakes and non-*Ctenotus* skinks in Australia (NSW NPWS 1995).

Table 3.11 Significant Vertebrates and Invertebrates Recorded in Tweed Shire

(Compiled from CSIRO 1996, Tanton 1996, NSW NPWS 2002b, NPWS Fauna Atlas 2001)

TSC Act Status	Scientific name	Common Name
	Mammals	
Vulnerable	*Aepyprymnus rufescens*	Rufous Bettong
Vulnerable	*Chalinolobus dwyeri*	Large-eared Pied Bat
Vulnerable	*Chalinolobus nigrogriseus*	Hoary Wattled Bat
Vulnerable	*Dasyurus maculatus*	Spotted-tailed Quoll
Vulnerable	*Miniopterus schreibersii*	Common Bent-wing Bat
Vulnerable	*Miniopterus australis*	Little Bent-wing Bat
Vulnerable	*Mormopterus beccarii*	Beccari's Mastiff-bat
Vulnerable	*Mormopterus norfolkensis*	Eastern Freetail Bat
Vulnerable	*Myotis adversus*	Large-footed Myotis
Vulnerable	*Scoteanax rueppellii*	Great Broad-nosed Bat
Vulnerable	*Nyctimene robinsonii*	Eastern Tube-nosed Bat
Vulnerable	*Nyctophilus bifax*	Eastern Long-eared Bat
Vulnerable	*Petaurus australis*	Yellow-bellied Glider
Vulnerable	*Petaurus norfolcensis*	Squirrel Glider
Vulnerable	*Phascolarctus cinereus*	Koala
Vulnerable	*Kerivoula papuensis*	Golden-tipped Bat
Vulnerable	*Phascogale tapoatafa*	Brush-tailed Phascogale
Vulnerable	*Planigale maculata*	Common Planigale
Vulnerable	*Potorous tridactylus*	Long-nosed Potoroo
Vulnerable	*Pteropus alecto*	Black Flying-fox
Vulnerable	*Saccolaimus flaurventris*	Yellow-bellied Sheathtail-bat
Vulnerable	*Sousa chinensis*	Indo-Pacific Humpbacked

TSC Act Status	Scientific name	Common Name
		Dolphin
Vulnerable	*Syconycteris australis*	Common Blossom Bat
Vulnerable	*Thylogale stigmatica*	Red-legged Pademelon
	Birds	
Endangered	*Burhinus grallarius*	Bush Stone-curlew
Endangered	*Cyclopsitta diophthalma*	Coxen's Fig Parrot
Endangered	*Dasyornis brachypterus*	Eastern Bristlebird
Endangered	*Ephippiorhynchus asiaticus*	Black-necked Stork
Endangered	*Erythrotriorchis radiatus*	Red Goshawk
Endangered	*Esacus neglectus*	Beach Stone-curlew
Endangered	*Nettapus coromandelianus*	Cotton Pygmy-goose
Endangered	*Pterodrona leucoptera*	Gould's Petrel
Endangered	*Sterna albifrons*	Little Tern
Endangered	*Turnix melanogaster*	Black-breasted Button-quail
Endangered	*Xanthomyza phrygia*	Regent Honeyeater
Vulnerable	*Amaurornis olivaceus*	Bush-hen
Vulnerable	*Anseranas semipalmata*	Magpie Goose
Vulnerable	*Atrichornis rufescens*	Rufous Scrub-bird
Vulnerable	*Botaurus poiciloptilus*	Australasian Bittern
Vulnerable	*Calidris alba*	Sanderling
Vulnerable	*Calidris tenuirostris*	Great Knot
Vulnerable	*Calyptorhynchus banksii*	Red-Tailed Black-Cockatoo
Vulnerable	*Calyptorhynchus lathami*	Glossy Black Cockatoo
Vulnerable	*Charadrius leschenaultii*	Greater Sand Plover
Vulnerable	*Charadrius mongolus*	Lesser Sand Plover
Vulnerable	*Coracina lineata*	Barred Cuckoo-shrike
Vulnerable	*Dasyornis brachypterus*	Eastern Bristlebird
Vulnerable	*Diomedea exulans*	Wandering Albatross
Vulnerable	*Ephippiorhynchus asiaticus*	Black-necked Stork
Vulnerable	*Falco hypoleucos*	Grey Falcon
Vulnerable	*Grantiella picta*	Painted Honeyeater
Vulnerable	*Grus rubicunda*	Brolga
Vulnerable	*Gygis alba*	White Tern
Vulnerable	*Haematopus fuliginosus*	Sooty Oystercatcher
Vulnerable	*Haematopus longirostris*	Pied Oystercatcher
Vulnerable	*Irediparra gallinacea*	Comb-crested Jacana
Vulnerable	*Ixobrychus flavicollis*	Black Bittern
Vulnerable	*Lathamus discolour*	Swift Parrot
Vulnerable	*Lichenostomus fasciogularis*	Mangrove Honeyeater
Vulnerable	*Limicola falcinellus*	Broad-billed Sandpiper
Vulnerable	*Limosa limosa*	Black-tailed Godwit
Vulnerable	*Lophoictinia isura*	Square-tailed Kite
Vulnerable	*Menura alberti*	Alberts Lyrebird
Vulnerable	*Monarcha leucotis*	White-eared Monarch
Vulnerable	*Ninox conivens*	Barking Owl
Vulnerable	*Ninox strenua*	Powerful Owl
Vulnerable	*Oxyura australis*	Blue-billed Duck
Vulnerable	*Pachycephala olivacea*	Olive Whistler
Vulnerable	*Pandion haliaetus*	Osprey
Vulnerable	*Phaethon rubricauda*	Red-tailed Tropicbird
Vulnerable	*Podargus ocellatus*	Marbeled Frogmouth
Vulnerable	*Procelsterna cerulea*	Grey Ternlet
Vulnerable	*Pterodroma leucoptera*	Gould's Petrel
Vulnerable	*Pterodroma nigripennis*	Black-winged Petrel
Vulnerable	*Pterodroma solandri*	Providence Petrel
Vulnerable	*Ptilinopus magnificus*	Wompoo Fruit-Dove
Vulnerable	*Ptilinopus regina*	Rose-crowned Fruit-Dove
Vulnerable	*Ptilinopus superbus*	Superb Fruit-Dove
Vulnerable	*Puffinus assimilus*	Little Shearwater
Vulnerable	*Puffinus carneipes*	Flesh-footed Shearwater
Vulnerable	*Rostratula benghalensis*	Painted Snipe
Vulnerable	*Sterna fuscata*	Sooty Tern
Vulnerable	*Stictonetta naevosa*	Freckled Duck
Vulnerable	*Sula dactylatra*	Masked Booby

TSC Act Status	Scientific name	Common Name
Vulnerable	*Todiramphus chloris*	Collared Kingfisher
Vulnerable	*Tyto capensis*	Grass Owl
Vulnerable	*Tyto novaehollandiae*	Masked Owl
Vulnerable	*Tyto tenebricosa*	Sooty Owl
Vulnerable	*Xenus cinereus*	Terek Sandpiper
	Frogs	
Endangered	*Litoria aurea*	Green and Golden Bell Frog
Endangered	*Mixophyes fleayi*	Fleay's Barred Frog
Endangered	*Mixophyes iteratus*	Giant Barred Frog
Vulnerable	*Assa darlingtoni*	Pouched Frog
Vulnerable	*Crinia tinnula*	Wallum Froglet
Vulnerable	*Litoria brevipalmata*	Green Thighed Frog
Vulnerable	*Litoria olongburensis*	Wallum Tree Frog
Vulnerable	*Philoria loveridgei*	Loveridge's Frog
	Reptiles	
Endangered	*Caretta caretta*	Loggerhead Turtle
Vulnerable	*Cacophis harriettae*	White-crowned Snake
Vulnerable	*Chelonia mydas*	Green Turtle
Vulnerable	*Coeranoscincus reticulatus*	Three-toed Snake-tooth Skink
Vulnerable	*Dermochelys coriacea*	Leathery Turtle
Vulnerable	*Hoplocephalus stephensii*	Stephen's Banded Snake
	Invertebrates	
Endangered	*Petaleura gigantea*	Giant Dragonfly
Endangered	*Thersites mitchellae*	Mitchell's Rainforest Snail

Brief profiles (adapted from Kingston *et al*. 1998) of some significant terrestrial vertebrate fauna are provided below. A few notable invertebrates are also discussed. More extensive management based profiles of most of these species can be found in Tanton (1996), CSIRO (1996), Smith (1996) and NSW NPWS (2002b).

FROGS

Giant Barred River Frog, *Mixophyes iteratus*, is very restricted in distribution, occurring only in southern Queensland and northern New South Wales in rainforest and wet sclerophyll forest near streams.

Wallum Tree Frog, *Litoria olongburensis,* occurs in reed beds within Wallum heath. It is one of the "acid" frogs that can only breed in slightly acidic coastal waters.

Wallum Froglet, *Crinia tinnula*, is restricted to coastal northern sites of NSW, but was probably more widespread in the past, before coastal heaths were cleared for housing. It needs slightly acidic water in which to breed, in swamps, ponds and soaks surrounded by paperbark forest or heathland (including Wallum).

Loveridge's Frog, *Philoria loveridgei*, is known only from the McPherson and Gibralter Ranges. This species inhabits Antarctic Beech cool temperate rainforest and other rainforest, and wet sclerophyll forest above 750m. It burrows in loose, moist soil or moss, or sits in mossy cavities beside streams.

MAMMALS

Spotted-tailed Quoll, *Dasyurus maculatus*, appears to be declining within this region, and has disappeared from the D'Aigular Range and Brisbane regions. It now appears to be restricted to relatively remote, mountainous intact *Eucalyptus* open forest or rainforest. It occurs within closed and open forest (preferably moist) of high soil fertility. They require minimal disturbance, the absence of Red Foxes and tree hollows for nesting and sleeping.

Yellow Bellied Glider, *Petaurus australis*, lives in a range of moist and dry *Eucalyptus* open forests and occasionally woodlands. It requires large tree hollows for resting and nesting, and tree species that shed bark allowing them to feed on sap.

Koala, *Phascolarctos cinereus*, is a culturally significant species with restricted habitat and dietary requirements. It prefers foliage from a limited selection of tree species (e.g. - Forest Red Gum (*E. tereticornis*), Grey Gum (*E. propinqua*) and Swamp Mahogany (*E. robusta*)), and is commonly associated with high nutrient soils (Hume 1990). Populations require a large amount of suitable *Eucalyptus* open forest (containing significant numbers of their food trees) to remain viable. Populations that are artificially split by human activities (e.g. freeways) may slowly decline, leading to local extinction. Details of current planning provisions for koalas are addressed in Section 5.3.3.

REPTILES

Stephen's Banded Snake, *Hoplocephalus stephensii*, is widespread in the region, occurring wherever rainforest is present. Although listed as a rare species, it is not rare within this specialised habitat.

Three-toed Snake-tooth Skink, *Coeranoscincus reticulatus*, is restricted to high altitude rainforest and adjacent wet sclerophyll forest. Fallen logs and thick mulch are used for burrowing. It lives under rotting logs and feeds on worms and grubs.

BIRDS

Red Goshawk, *Erythrotriorchis radiatus*, is one of the most significant species in the region, inhabiting open forest or rainforest, usually near watercourses. It needs large vegetation remnants, preferably in hilly country, and is difficult to locate and easily misidentified. Loss of riparian vegetation is thought to be a major threatening process.

Coxen's Fig-Parrot, *Cyclopsitta diophthalma*, was once relatively common and widespread in rainforests of southern Queensland and northern NSW but is now endangered. The fig seeds of rainforest fig trees are their staple food. Clearing of rainforest, especially Sub-tropical lowland rainforest has broken the seasonal supply of figs needed to maintain this bird.

Rufous Scrub-bird, *Atrichornis rufescens*, has a very patchy distribution within rainforest, occurring only at certain sites with thick undergrowth confined to small areas of upland rainforest, Antarctic Beech cool temperate rainforest, and wet sclerophyll forest with a thick understorey. This species is declining in abundance. They have exacting habitat requirements: a cool and moist microclimate, very dense uninterrupted groundcover (to 1m high) for nesting and dispersal, and deep leaf litter for foraging.

Glossy Black-Cockatoo, *Calyptorhynchus lathami,* is restricted to open forests, woodlands, heath and coastal forests with seeding She-oak species (*Casuarina* spp. and *Allocasuarina* spp.). This species is threatened by vegetation clearing, which leads to loss of hollows for nesting, and loss of She-oak species, the seeds of which are its only food.

Marbled Frogmouth, *Podargus ocellatus*, depends for survival on large upland rainforest remnants, to which it is confined. It is usually found near water and often near palm trees.

Powerful Owl, *Ninox strenua*, appears to be restricted to relatively large remnants of lowland forest. Some evidence suggests it may be increasing in numbers, probably after an earlier decline. They live and hunt in wet and dry sclerophyll habitats containing sufficient arboreal mammal prey. They need live *Eucalypts* containing deep hollows 9-37m above the ground (trees over 150 years old) for nesting.

Black-breasted Button-quail, *Turnix melanogaster*, is a secretive bird that may be resident or a visitor to the region, inhabiting patches of dry rainforest and areas with thick groundcover (e.g. lantana patches) above leaf litter.

Black-necked Stork, *Xenorhynchus asiaticus*, is mobile and highly visible, and the relatively large number of sightings probably applies to a small number of birds. It occurs in swampy grasslands, paddocks and mudflats.

Sooty Oystercatcher, *Haematopus fuliginosus*, is confined to rocky headlands by the sea. It is easily disturbed by anglers and holidaymakers scrambling over rocky headlands.

Albert's Lyrebird, *Menura alberti*, is confined to large remnants of upland rainforest entirely within the McPherson and nearby Ranges. Threatened in the past by rainforest clearing, it prefers rainforest and dense wet sclerophyll forest above 300m. For nesting it needs a very dense understorey sheltered by a large feature (boulder or tree) and the male displays in areas with a floor of interwoven vines.

Sooty Owl, *Tyto tenebricosa*, restricted to rainforest and adjoining wet sclerophyll forest, is probably found in all rainforest national parks but is threatened by the clearing of rainforest on private land. It is very shy and difficult to detect except during the breeding season when it calls loudly.

JAMBA and CAMBA species

Birds of cultural significance to the Shire are those listed under the Japanese Australian Migratory Bird Agreement (JAMBA) or the Chinese Australian Migratory Bird Agreement (CAMBA) for the conservation of migratory birds and their habitats.

An incomplete list of those observed or expected on the Tweed Coast is presented below.

White-bellied Sea-Eagle, *Haliaeetus leucogaster*
Osprey, *Pandion haliaetus*
Fork-tailed Swift, *Apus pacificus*
White-throated Needletail, *Hirundapus caudacutus*
Cattle Egret, *Ardeola ibis*
Great Egret, *Egretta alba*
Eastern Reef Egret, *Egretta sacra*
Large Sand Plover, *Charadrius leschenaultii*
Mongolian Plover, *Charadrius mongolus,*
Lesser Golden Plover, *Pluvialis dominica*
Grey Plover, *Pluvialis squatarola*
Oriental Cuckoo, *Cuculus saturatus*
Wandering Albatross, *Diomedea exulans*
Least Frigatebird, *Fregata ariel*
Great Frigatebird, *Fregata minor*
Barn Swallow, *Hirundo rustica*
Common Noddy, *Anous stolidus*
White-winged Tern, *Chlidonias leucoptera*
Caspian Tern, *Hydroprogne caspia*
Arctic Jaeger, *Stercorarius parasiticus*
Pomarine Jaeger, *Stercorarius pomarinus*
Bridled Tern, *Sterna anaethetus*
Lesser Crested Tern, *Sterna bengalensis*
Common Tern, *Sterna hirundo*
Rainbow Bee-eater, *Merops ornatus*
Brown Booby, *Sula leucogaster*
Glossy Ibis, *Plegadis falcinellus*
Streaked Shearwater, *Calonectris leucomelas*
Flesh-footed Shearwater, *Puffinus carneipes*
Sooty Shearwater, *Puffinus griseus*
Short-tailed Shearwater, *Puffinus tenuirostris*
Ruddy Turnstone, *Arenaria interpres*
Sharp-tailed Sandpiper, *Calidris acuminata*
Sanderling, *Calidris alba*
Red Knot, *Calidris canutus*
Curlew Sandpiper, *Calidris ferruginea*
Pectoral Sandpiper, *Calidris melanotos*
Red-necked Stint, *Calidris ruficollis*
Great Knot, *Calidris tenuirostris*
Latham's Snipe, *Gallinago hardwickii*
Broad-billed Sandpiper, *Limicola falcinellus*
Bar-tailed Godwit, *Limosa lapponica*
Black-tailed Godwit, *Limosa limosa*
Little Curlew, *Numenius minutus*
Whimbrel, *Numenius phaeopus*
Grey-tailed Tattler, *Tringa brevipes*
Wood Sandpiper, *Tringa glareola*
Common Sandpiper, *Tringa hypoleucos*
Wandering Tattler, *Tringa incana*
Greenshank, *Tringa nebularia*
Marsh Sandpiper, *Tringa stagnatilis*
Terek Sandpiper, *Tringa terek*
Masked Booby, *Sula dactylatra*

3.3.3.2 Invertebrates

Due to a general lack of knowledge, information on the conservation status of invertebrate populations is scarce. Consequently, invertebrate species are often overlooked from a conservation viewpoint. Nevertheless, a few of the more conspicuous taxa have been classified as significant. Of the noteworthy species listed below the Giant Dragonfly and Mitchell's Rainforest Snail are listed as Endangered under the TSC Act:

Giant Dragonfly, *Petaleura gigantea*, found in scattered locations in coastal and upland areas from Moss Vale in the NSW southern highlands to North Stradbroke Island in south-east Queensland. Coastal populations have recently been described as a separate species called *Petaleura litorea*. They inhabit permanent wetlands, swamps and bogs with some free water and open vegetation, especially large, relatively deep wetlands with high water quality. Adults fly over these areas on sunny days hunting for other flying insects, while the juveniles live in burrows under the wetland.

Mitchell's Rainforest Snail, *Thersites mitchellae*, found only on the coastal plain between Ballina and Tweed Heads. Extensive clearing for agriculture and urban development has confined these snails to remnant areas of lowland subtropical rainforest and swamp forest on alluvial soils. Typically found amongst leaf-litter on the forest floor they are active at night, feeding on leaf-litter, fungi and lichen.

Richmond Birdwing, *Ornithoptera richmondia*. A *Vulnerable* butterfly of wet lowland and upland rainforests. The region is a stronghold for this species, supporting some of the largest populations. Populations are known from Border Ranges National Park, Mount Warning National Park and Limpinwood Nature Reserve as well as Nerang, Tamborine Mountain, Burleigh Heads, Tallebudgera Valley and Natural Arch on the Gold Coast. Birdwings confuse the escaped garden plant, Dutchman's Pipe (*Aristolochia littoralis*) which is toxic to them, with its food plants, *Pararistolochia praevenosa* and *P. laheyana*.

Lamington Spiny Crayfish, *Euastacus sulcatus*. A spectacularly blue coloured crayfish that inhabits mountain streams in the rainforests of the McPherson Range. Although this species is locally common it has a very restricted distribution.

3.3.4 Significant Fauna Habitat Database

As noted the presence of significant species has an important bearing on the ecological status of any particular patch of bushland. At the landscape scale we rarely have sufficient information on the likely occurrence of threatened species, and it is for this reason that their presence is treated as a supplementary attribute in the assessment of ecological status. However when it comes to a site assessment (e.g. for a Development Application) it is necessary to make sure that the presence of significant species is addressed. For almost all plants this is usually a matter of a single thorough site survey but in the case of fauna their presence or utilisation of a site cannot be so easily established. Fauna often utilise different types of habitat for different purposes and at different times, and simple one-off snapshots, no matter how thorough are almost always insufficient. What is needed is a method to predict their likely presence or site utilisation based on specific and easily measured habitat features.

This need is not merely academic; there are significant issues for Council in respect of the requirements of the Threatened Species Conservation Act 1995. This is particularly so on the north coast which has perhaps the highest concentration of threatened species, both flora and fauna, in Australia (see SOE 1996). Threatened species surveys required for development applications are commonly approached in a cursory and dismissive manner, and Council officers often do not have the tools at their disposal to make informed decisions about whether or not threatened species are likely to be affected by a particular proposal.

The Significant Fauna Habitat Database (Appendix 10) for Tweed has been adapted from a more comprehensive database developed by *Ecograph*. It provides guidance on target species and habitat requirements. In particular the database can be used to determine:

1. Target species for consideration; and

2. Site specific habitat conditions necessary to support target species.

This information could be provided to proponents to assist in the completion of the "Eight part test" initially required under the Threatened Species Conservation Act 1995. It is suggested that the proponent be encouraged to assess the site in relation to known habitat requirements supplied for each species.

This would give both the proponent and Council a relatively clear indication of whether or not threatened species are likely affected by the proposal. Proponents would have a limited subset of species to consider, and secondly would not have to expend resources researching their habitat requirements. Thus major focus could be directed toward establishing whether or not habitat requirements are met on site. On the other hand Council officers would have some objective criteria against which proposals could be assessed.

There are a number of issues that should be recognised in utilising information from the database.

1. Many fauna species, particularly Threatened Species, are poorly studied, and there is a paucity of information regarding their ecology and critical habitat requirements. Caution must therefore be used before dismissing an area as unlikely to contain a species – even degraded areas have habitat values and may be part of important movement corridors. The database should therefore not be considered as a static tool and will require periodic review in the light of new and more detailed knowledge.
2. Fauna move constantly, and the lack of a species' presence at a site that appears to have ideal habitat for this species should not be used as an excuse to downgrade its importance. Areas of habitat are often used seasonally, or as part of a species' range. Repeated sampling over several months, even years, may be required to establish the presence of a species at a site. In a partial attempt to address these issues, the database contains details on the likely affiliation with specific habitat indicators (essential, preferred etc) and for what purpose (foraging, breeding, shelter etc).
3. Notwithstanding the presence of suitable habitat, for some species it is highly unlikely that their presence will be confirmed even after multiple surveys. This applies to some extremely rare or locally extinct species (especially those with limited capabilities of dispersal), vagrant and nomadic species, and species that are possible but have not been observed in the region. In these cases it may not be feasible to actively sample for such species in the course of the Development Assessment processes. Such species have been tagged in the database as *Low Survey Priority* in pragmatic recognition of this issue.

Details of the codes used in the database are also provided in Appendix 10.

3.4 Key Considerations

Based on the ecological values described in this chapter a number of recommendations can be made to assist the planning process. At this point, however such recommendations are limited to broad issues that arise directly from the analyses presented in this chapter.

Strategic planning priorities for **protection** of remnant vegetation should be based on the Ecological Status categories but take into account other environmental considerations, and the land use planning framework.

Planning provisions and priorities for **management and rehabilitation** of existing remnant vegetation should be based on both the Ecological Status and Sensitivity categories but take into account other environmental considerations, and the land use planning framework.

Additional work also needs to be carried out to determine a **protocol for site assessment**. Such a process should review the presence of **landscape attributes**, which have currently been used to determine Ecological Status but should also include guidance on important **site attributes** such as habitat indicators for significant fauna (e.g. utilising the Significant Fauna Habitat Database presented in Appendix 10) and surveys for significant flora. The guidelines could be included in a Development Control Plan and be used to determine impacts on ecological values from specific development (or clearing) proposals, and would also provide a consistent standard for both proponents and Council.

4.0 Soil and Water Considerations

In addition to ecological values there are also a number of other important considerations related to the management of remnant vegetation. Implications related to the management of soil, water and geological resources have long been recognised by land management authorities such as the Department of Land and Water Conservation (DLWC; now DIPNR).

This chapter provides an overview of the major issues affecting soil and water resources in Tweed Shire (matters relating to archaeological and anthropological issues are essentially cultural and are not dealt with here). Information was collated from existing sources in order to determine what the major characteristics and issues for soil and water resources were, and how native vegetation management may influence the quality of these resources.

While the potential impact of vegetation management on areas of geological heritage are likely to be minor, we also itemise areas listed on the NSW Register of Geological Heritage.

4.1 Geology and Landforms

4.1.1 Geological History

Tweed Shire is located within the remnant caldera of the Mount Warning shield volcano. The caldera consists of three distinct geomorphological features; the central elevated massif (Mt. Warning), the erosion caldera and the dissected outer rim. The Mount Warning caldera is one of the major examples of this landform in the world. It is notable for its size, for the presence of a prominent central mountain mass and because the Tweed River has eroded the caldera floor down to basement rock (Stevens 1977). Graham (2001) provides a highly accessible account of the geological history of the region and much of the following discussion is from this source.

The landscape where the caldera now stands started to form approximately 360 million years ago. It was then below sea level on the continental shelf off the coast of Pangaea. Inland of the coastline at that time a barren volcanic mountain range underwent relatively rapid weathering and erosion due to the moist climate. The sediments produced by this process were washed into the ocean, onto the continental shelf and into a deep offshore trench. Here they accumulated and through compression over millions of years, produced sedimentary rocks. As the continental plate drifted northwards the oceanic plate subducted beneath it and forced the sedimentary layers upward. Numerous folds and faults occurred due to the extreme pressure. These rock layers became known as the Beenleigh Block and the rock series as the Neranleigh-Fernvale Beds, which emerged as dry land approximately 245 million years ago.

Twenty million years later the Chillingham Volcanic seam opened between the Beenleigh Block and the Clarence–Moreton Basin to the west, and produced flows of rhyolite and layers of tuff, agglomerates and breccia. These layers were themselves later largely covered in sediments known as the Woogaroo Sub-group and the Bundamba Group. Later still the Walloon Coal Measures were laid down over the Clarence-Moreton Basin to the west. Then followed roughly 120 million years of relative inactivity.

The continent continued drifting north until approximately 25 million years before present it drifted over a hot spot in the earth's surface. This hot spot represented a large volume of molten magma of largely basaltic origin, which forced its way up through lines of weakness in the earth's crust, creating fissures and flows of lava onto the surface and into the drainage lines and valleys of the landscape. These fissures would have developed into cones as the volume of magma increased. The main flow would most probably have been the Mount Warning central mass but a number of other satellite flows would have occurred from other vents and fissures in the region. These flows covered the majority of earlier volcanic and sedimentary deposits stretching from Tamborine in the north to Coraki in the south and Kyogle in the west and out to sea. Solomon (1964) extrapolated that these flows formed a low dome or shield volcano approximately 2000 metres high over several million years.

At this time it is thought that the newly formed mountain would have attracted plentiful coastal rainfall particularly on the eastern slopes. The lava flows would have begun weathering as a result and a drainage system of radial stream patterns would have formed around the central cone. This process continued over time leading to the slow deepening and broadening of the original streams. Stepped valley sides, escarpments and steep cliffs formed where more resistant rock formations were encountered. Broadening continued as softer materials eroded around the resistant flows and old

vents, which are now visible as rock outcrops or "doughboys" and rocky coastal headlands. Waterfalls developed at the heads of gullies on particularly resistant flows and these too eroded gradually upstream forming steep sided gorges.

Stevens (1977) states that the Tweed River eroded in a north-east direction possibly due to structural trends in the Palaeozoic (Neranleigh-Fernvale) rocks. He further asserts that it is not possible to determine if the river breached the crater and increased its catchment. However strong evidence points to the tributaries eroding back by "parallel scarp retreat" or the progressive backward movement of a slope with very little gradient change. The headwaters of the river eroded westward forming the amphitheatre-like structure of the northern and north-western erosion caldera with its irregular escarpment the result of wider stream spacing and hard rhyolite overflows that protect these basaltic promontories. In the western area of the caldera, erosion through parallel scarp retreat has been aided by the soft nature of the sandstones and shale that occur there. This escarpment has receded in a uniform manner as closely spaced parallel streams drain it (Stevens 1977). Much of the eastern rim has completely eroded. Sediments carried downstream have deposited as alluvium on the increasingly broad floodplain adjacent to the Tweed River system.

Of course this erosion still continues today and has been accelerated by the clearing of vegetation for agriculture and timber particularly on the lower slopes and floodplains of the region.

4.1.2 Major Landforms

Morand (1996) describes eight physiographic regions within the Tweed (Figure 4-1).

Tweed-Byron Coast - a complex narrow strip of coastal plain composed of deltaic interbarrier river sediments and Pleistocene inner barrier sands and peats. Holocene outer barrier sands fringe the coast. Major soil types include deep Siliceous and Calcareous Sands on beaches and Podzols, Humus Podzols, Acid Peats and Humic Gley soils within Pleistocene and Holocene dune systems. Estuarine areas contain Solonchaks, Humic Gleys and estuarine muds.

Border-Nightcap Range - The high hills and mountains of this landform occur on the western areas of the shire. Most of this region comprises the planeze topography of the Tweed Shield Volcano. Steep forested hills and mountains, often cliff-lined, are typical. A prominent scarp encircling the eastern edge is an outstanding feature of this physiographic region. Major soil types include Krasnozems, Chocolate Soils, Lithosols (on scarps), Prairie Soils and Chernozems.

Mount Warning Massif - occurs on the Mount Warning Central Complex (gabbro, basalt, trachyte, syenite) and consists of Mount Warning and it's associated ring dyke system. The massif is the prominent feature of the Tweed Valley and is distinguished by the heavily forested, steep and rugged topography of the Mount Warning National Park, with Mount Warning rising to a unique, isolated pinnacle. At 1156 m this is the highest point on the mapped area.

Burringbar Hills - are steep rolling hills formed predominantly on the metamorphics of the Neranleigh- Fernvale Group. This is an extensive region that occupies much of the eastern half of the mapped area and includes the narrow alluvial plains of the streams draining these hills. The steep, rolling hills formed on the Chillingham Volcanics occur as a narrow north-south spine bisecting the Tweed Valley, marking the western limit of the Burringbar Hills. Also included within this physiographic region is the granitic Mount Nullum. Major soil types include Red and Yellow Earths, Red and Yellow Podzolic: Soils and Grey Earths/Lithosols on the metamorphics; Structured Yellow Earths, Brown Alluvial Clays and Alluvial Soils on the alluvial plains; Red Earths, Red Podzolic Soils and some Brown Earths on the Chillingham Volcanics, and Red and Yellow Podzolic Soils on granite**.**

Tweed Volcano Caldera - an area of mixed geology forming a subdued landscape of low rolling hills within the eroded caldera of the Tweed Volcano. These hills occur on the exposed sediments of the Clarence-Moreton Basin which includes the Walloon Coal Measures and the Bundamba Group Formation. The narrow alluvial plains of the Tweed, Oxley and Rous Rivers also occur. Major soil types include Grey-brown Podzolic Soils, Yellow Podzolic Soils, Dark Podzolic Soils, Red Podzolic Soils, Red and Yellow Earths, Gleyed Podzolic Soils and some Krasnozems on the Walloon Coal Measures and Bundamba Group. Brown and Black Alluvial Clays and clayey Alluvial Soils occur in the alluvial plains**.**

Tweed Estuary - the lower section of the Tweed catchment consisting of the plain formed by in-filling of this ancient estuary and from more recent alluvial/ estuarine processes. Major soil types include Brown Alluvial Clays on levees and Humic Gleys and Peats elsewhere. Potential acid sulfate soil materials are very common.

Mackellar Hills - steep, elevated areas consisting mostly of the Lismore Basalts, which occur on the south-west of the Shire. Slopes are steep and mass movement is common. Benching is typical and steeper slopes are often fluted. Kangaroo Creek Sandstone has been exposed in places. Major soil types include Chocolate Soils and Prairie Soils on

slopes and Black Earths and Brown Clays on footslopes and lower slopes. Yellow Podzolic Soils occur on Kangaroo Creek Sandstone.

Terranora Hills - low hills on the metamorphics of the Neranleigh-Fernvale Group which are often capped by Lamington Basalt remnants. This region occurs as a north easterly extension of the Burringbar Hills and includes the Cudgen Plateau. It is characterised by long north easterly trending ridges interspersed by narrow alluvial plains. Major soil types include Yellow Earths, Red and Yellow Podzolic Soils and Grey Earths/ Lithosols on the metamorphics with Chocolate Soils, Krasnozems and Brown Earths on the basalts. Brown Alluvial Clays occur on the alluvial plains.

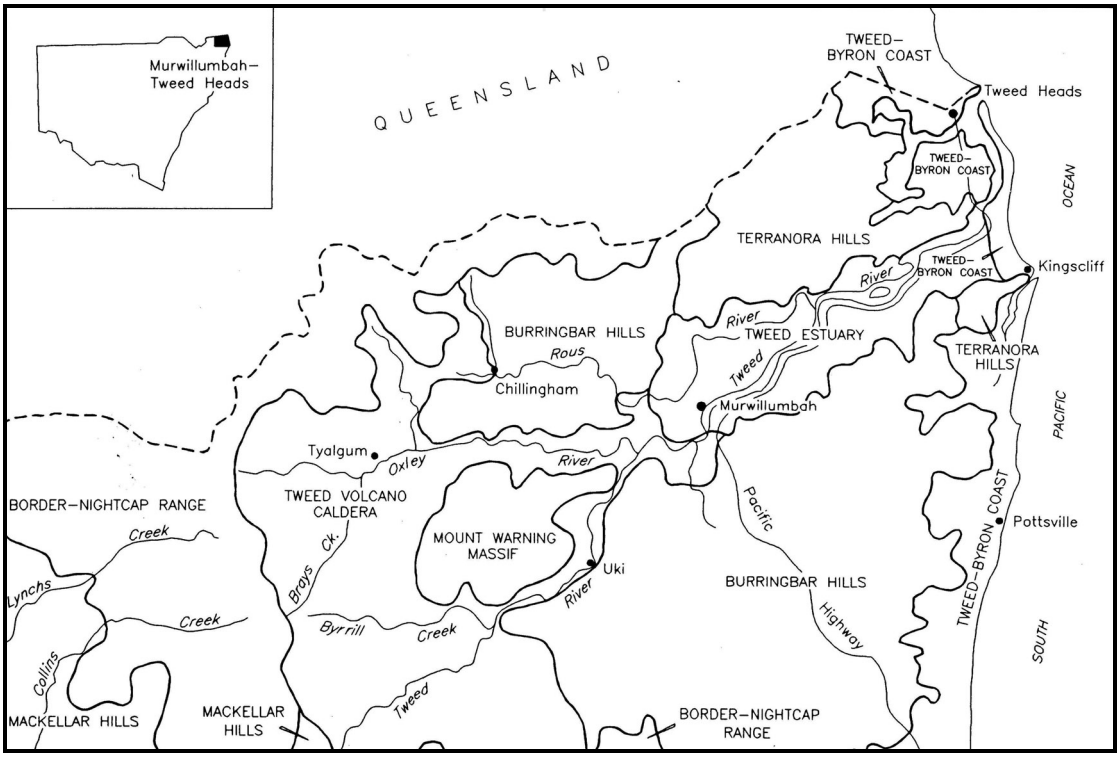

Figure 4-1 Physiographic Regions of the Tweed

4.1.3 Soil Landscapes

Soil landscapes are areas of land that "have recognisable and specifiable topographies and soils, that are capable of presentation on maps, and can be described by concise statements" (Northcote 1978). Morand (1996) notes that the soil landscape concept permits the integration of both soil and landform constraints into a single mapping unit. Since such units describe areas subject to similar geomorphological processes they provide a useful basis for the consideration of issues related to land degradation.

The spatial location of each soil landscape unit defined by Morand (1996) is presented on Map 5. Brief descriptions of each of these groupings (taken from Morand 1996) and a list of the soil landscapes that make up each group is presented below.

Residual Soil Landscapes

Residual landscapes are dominated by sites where deep soils have formed from in-situ weathering of parent materials (this has presumably taken place over long periods where the rate of soil formation has been greater than rate of erosion). Residual landscapes typically have level to undulating elevated topography. Landform elements include some summit surfaces, plateaux, terrace plains, peneplains and old ground surfaces. Stream channels are usually poorly defined. This group consists of a single soil landscape unit; Cudgen (cu).

Colluvial Soil Landscapes

Colluvial landscapes are affected by mass movement. Soil parent material mostly consists of colluvial mass movement debris including scree and talus along with other landslide, mudflow and creep deposits. Colluvial landscapes usually include alcoves, cliffs, cliff-footslopes, scarps, landslides, talus, some moderately inclined to precipitous hillslopes and areas of commonplace evidence of mass movement. This group consists of the following soil landscape units; Carool (ca), Georgica (ge), Korrumbyn (ko), Mount Warning (mw), Nullum (nu) and Pinnacle (pi).

Erosional Soil Landscapes

Erosional landscapes have been primarily sculpted by erosive action of running water. Streams are well defined and competent to transport their sediment load. Soil depth is usually shallow (with occasional deep patches) and mode of origin is variable and complex. Soils may be either absent, derived from water washed parent materials or derived from in situ weathered bedrock. Erosional soil landscapes usually include tors, benches, and areas of rock outcrop. Evidence of mass movement is rare. This group consists of the following soil landscape units; Billinudgel (bi), Burringbar (bu), Byrrill (by), Frogs Hollow (fh), Green Pigeon (gp), Kunghur (ku), Limpinwood (li), Mount Terragon (mt) and wollumbin (wl). The Mebbin (me) unit is considered as an Erosional/Colluvial landscape.

Transferral Soil Landscapes

Transferral landscapes are deep deposits of mostly eroded parent materials washed from areas directly upslope. Stream channels are often discontinuous and slopes are generally concave. Transferral landscapes include footslopes, valley flats, fans, bajadas and piedmonts. This group consists of a single soil landscape unit; Ophir Glen (og).

Alluvial Soil Landscapes

Alluvial landscapes are formed by deposition along rivers and streams. Soil parent material is alluvium. Alluvial soil landscapes include floodplains and alluvial deposits. Typical landform elements include those found on meander plains; including bars, backplains, scrolls, scroll plains, flood-outs, ox-bows, levees, terraces, prior and current stream channels. This group consists of the following soil landscape units: Brays Creek (bc), Crabbes Creek (cr), Cudgera (cd), Oxley (ox) and Rous (ru).

Estuarine Soil Landscapes

Estuarine landscapes occur where rivers and streams enter large bodies of water such as the sea or inland lakes. Channel flow is dissipated and is also modified by wave and/ or tidal action. Soil materials may be influenced by saline conditions. Estuarine soil landscapes include estuaries, deltas, tidal creeks and tidal flats. This group consists of the following soil landscape units: Cobaki (cb) and Ukerabagh (uk). Tweed (tw) is considered an Estuarine/Alluvial landscape.

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Beach Soil Landscapes

Beach landscapes have ground surfaces and soil parent materials which have been deposited by wave action. Beach landscapes typically occur near sandy coastlines and lake edges. Typical landform elements include beaches, berms, beach ridges, and some plains. Due to map scale limitations, associated foredunes and windblown soils are included. This group consists of a single soil landscape unit; Angels Beach (ab) which includes the barrier beaches and associated foredunes fringing the Tweed-Byron coast.

Aeolian Soil Landscapes

Aeolian landscapes have accumulated by deposition of sand-sized particles by wind action. Aeolian landscapes include dunefields, dunes, blowouts, sand sheets and lunettes. This group consists of the following soil landscape units: Bogangar (bo), Kingscliff (ki) and Wooyung (wy). Pottsville (po) is considered an Aeolian/Swamp landscape.

Swamp Soil Landscapes

Swamp landscapes are dominated by ground surfaces and soils which are at least seasonally wet. Soil parent material includes large amounts of accumulated decayed organic matter. Water tables are frequently close to the surface. Landform elements may include swamps and some relic ox-bows, abandoned channels, lagoons and swales. Pottsville (po) is considered an Aeolian/Swamp landscape.

Disturbed Soil Landscapes

Disturbed soil landscapes are dominated by ground surfaces arising from human activity. Soil parent materials have been moved, accumulated, removed or replaced (with soil or other items). Landform elements include fill-tops, embankments, cut faces, cut-over surfaces, dams, mounds and pits. Denoted as Disturbed Terrain (xx).

Associated Landscapes

Associated landscapes occupy relatively small areas of land in the Shire and are represented more fully outside of the Shire. This group consists of the following soil landscape units: Bald Mountain (bm), Calico (cl), East Ballina (eb), Mackellar (ma), Minyon (mi), Mount Burrell (mb) and Terania (te).

4.2 Land Degradation Hazards

Characteristics of both soils and landforms contribute to land degradation hazards. Within the Tweed region some of the more prevalent factors affecting the potential for land degradation with implications for vegetation management are described briefly below. Most of the following descriptions are taken or adapted from information contained in Morand (1996). Table 4.1 (also adapted from Morand 1996) indicates the relative incidence of these limitations within each soil landscape shown on Map 5.

Soil Erodibility

Soil erodibility is the susceptibility of a soil to erosion. It is based solely on soil properties. Landscape properties such as slope gradient, slope length, landform element, and rainfall characteristics are not included in the assessment.

Disturbance should be minimised on erodible soils, and disturbed areas protected by vegetation cover as soon as possible. Although many areas of erodible soil soils have been cleared the retention of native vegetation will in general reduce the risk of erosion in these areas.

Steep Slopes

A number of landscape hazards increase with slope. Soil erosion is more severe, and various forms of mass movement are more likely with increasing slope. To address this issue areas generally in excess of 18 degrees have been mapped by the Department of Land and Water Conservation (DLWC; now DIPNR) and certain provisions (under the Native Vegetation Act 2003) apply to the clearing of vegetation cover on these areas. Further details of these provisions are provided in Chapter 5.0. Map 5 indicates the location of these areas.

Streambank Stability

Due to high and often intensive rainfall in the catchment and the fact that many floodplain areas have been cleared completely, leaving the stream and riverbanks exposed the protection of these areas has become a priority land degradation issue over much of the Shire. To address this issue in the estuarine areas, the Tweed River Committee has recently completed the Tweed River Estuary Bank Management Plan (Patterson Briton 1998) and has commenced its implementation.

The protection of lands within, or within 20m of a *prescribed* stream is also mandated under the Native Vegetation Act 2003. In these areas consent must be sought to clear native vegetation and exotic trees. In the Tweed Shire some *prescribed* streams are mapped and others are listed by name (see DIPNR for details). In the past, this approach has resulted in considerable confusion since their designation is not always consistent with fluvial processes, stream size or morphology, and for those that are listed it is not clear how far upstream such provisions should apply. To address this issue it is suggested that DIPNR review their designation of *prescribed* streams such that all are explicitly and consistently defined, preferably by reference to scheduled maps.

Further details of these provisions are provided in Chapter 5.0. Map 5 shows the drainage network for drainage lines of 2nd order and above (*sensu* Strahler 1964; i.e. two 1st order channels meet to form 2nd order, two 2nd order meet to form 3rd order and so on) as derived from 1:25000 scale topographic map series. It should be noted that the drainage lines shown of Map 5 do not conform to the *prescribed* streams definitions (i.e. maps and lists) currently used by DIPNR.

Mass Movement

Mass movement is a general term for a number of forms of slope failure. It includes rock falls, earth slumps, slips and flows on steep, and often wet, slopes. It may lead to severe damage to buildings and infrastructure and presents a considerable constraint to agricultural production.

As a consequence of the large number of *Erosional* and *Colluvial* landscapes, mass movement is prevalent and conspicuous in the Tweed. Specific mapping of areas subject to mass movement hazards have not been accurately mapped although most are known to be associated with steep lands (see Map 5).

The maintenance of vegetation cover especially deep-rooted trees is important in areas susceptible to mass movement.

Acid-Sulphate Soils

Acid sulphate soils are clays, muds and sometimes sands associated with pyrite-rich marine sediments. They may also occur in association with some sulphidic ore bodies and sulphur-rich deposits (e.g. some coals). These soils become extremely acid following exposure or drainage as sulfur compounds are oxidised and converted to sulphuric acid. Apart from corrosive effects on infrastructure, the acidification of estuarine waters commonly results in spectacular mortality of estuarine fauna.

In the Tweed, many of the coastal landscapes (*Estuarine, Alluvial, Aeolian*) are acutely affected by acid-sulphate potential. The sugar industry in particular has been very active in acid-sulphate research and most landholders are aware of the issues and are active participants in measures for management and rehabilitation through the implementation of State Government approved Best Practice Guidelines. Tweed Local Environmental Plan (LEP) also makes special provision for works in other areas affected by acid sulphate soils.

Although vegetation removal is not likely to cause the oxidisation of acid sulphate soils subsequent activities such as foundations and drainage works may. At present trails are underway to examine the utility of some species of native vegetation to assist in the rehabilitation of areas affected by acid sulphate soils.

Coastal Erosion

Along the coast, both wind and wave action can be responsible for significant and rapid change in the coastal landforms. In geomorphological terms the coastline is dynamic advancing and retreating with prevailing conditions. Sand mining and urban development since the 1950s have been responsible for the removal of native vegetation and the reshaping of the natural dune systems for much of the Tweed coast. The persistent human desire to be as close as possible to the sea has meant that the protection of these areas has become paramount.

The maintenance of appropriate vegetated buffer zones is generally considered to be the most appropriate long-term solution to minimising coastal erosion. Accordingly, the Tweed LEP attempts to enforce strict setbacks and allowable land uses in these areas.

Table 4.1 Soil Landscapes and Land Degradation Potential

● - General/widespread occurrence
■ - Localised occurrence

Soil Landscape	Area (Ha)	Soil Erodibility	Steep Slopes	Streambank Stability	Mass Movement	Acid Sulphate Soils	Coastal Erosion	Suggestions for sustainable land use
Cudgen (cu)	733	●		■	■			This land is best retained as agricultural land due to the favourable characteristics and versatile nature of Krasnozems. Where residential development exists appropriate waste disposal systems should be used (I.e., not septic). Use of aggressive tillage practices should be avoided due to associated decline in soil structure.
Carool (ca)	4353	■	●	■	●			High erosion hazard. Maintain vegetative cover and avoid disturbance of slip-prone areas and mass movement debris. Hazard reduction burning (or any clearing) should not be undertaken in late spring-summer when extremely erosive storms occur. Appropriate effluent disposal systems (generally avoid septic systems) should be established, particularly within urban areas.

● - General/widespread occurrence
■ - Localised occurrence

Soil Landscape	Area (Ha)	Soil Erodibility	Steep Slopes	Streambank Stability	Mass Movement	Acid Sulphate Soils	Coastal Erosion	Suggestions for sustainable land use
Georgica (ge)	560	■	●	■	●			Hazard reduction burning on steep slopes is contributing to severe sheet erosion. This activity (or any clearing) is best undertaken outside late spring and early summer when extremely erosive storms occur. Careful planning is necessary to ensure dams are not constructed within mass movement debris or potential source areas. Seepage may trigger failure.
Korrumbyn (ko)	2261		●		●			Retain native vegetation. Steep slopes, rock outcrop, mass movement and shallow soils severely limit any other land use options.
Mount Warning (mw)	2371		●		●			Retain native vegetation. Steep slopes, rock outcrop, mass movement and shallow soils severely limit any other land use options.
Nullum (nu)	1924	●	●					Retain native vegetation. Steep slopes, rock outcrop, mass movement and shallow soils severely limit any other land use options. Erosion hazard is very high to extreme on cleared areas. Disturbance of footslope areas should be avoided. See Lyons (1993) for guidance on the sustainable management of banana plantations.
Pinnacle (pi)	3390		●		●			Maintain natural condition. Precipitous rock outcrop precludes any other land use option.
Billinudgel (bi)	12854	●	■	●	■			See Lyons (1993) for guidance on the sustainable management of banana plantations. Erosion hazard is high when cleared, and clearing should be avoided on steeper slopes - generally best left as grazing country.
Burringbar (bu)	29996	●	●	●	●			See Lyons (1993) for guidance on the sustainable management of banana plantations. Erosion hazard is high when cleared. Generally should not be cleared due to steep slopes and high erosion hazard, particularly during summer months. Major road cuttings should be adequately designed and maintained as numerous batter failures have occurred.
Byrrill (by)	7158	■	■	●	●			Best left uncleared or as grazing country due to steep slopes with high erosion hard and relatively infertile soils. Hazard reduction burning (or any clearing) should not be undertaken in late spring-summer when extremely erosive storms occur.
Frogs Hollow (fh)	5532	●	●	●	●			Retain native vegetation - very steep slopes with localised rock outcrop, mass movement hazard and shallow soils severely limit any other land use options. Erosion hazard is very high to extreme on cleared areas. See Lyons (1993) for guidance on the sustainable management of banana plantations.
Green Pigeon (gp)	300	●	●		●			Retain vegetation - steep slopes, rock outcrop, mass movement and shallow soils severely limit any other land use options.
Kunghur (ku)	9065	●	●	●	●			Maintain as grazing country or under forest. Hazard reduction burning (or any clearing) should not be undertaken in late spring - summer when extremely erosive storms occur. Roadside batters and drainage is commonly inadequate.
Limpinwood (li)	3392	■	●	●	●			Maintain as bushland or light grazing country. If hazard reduction burning (or any clearing) is necessary, it should not be undertaken during late spring-summer when extremely erosive storms occur. Careful planning is necessary to ensure dams are not constructed within mass movement debris or within potential source areas - seepage may trigger failure.
Mount Terragon (mt)	1018	●	●		●			Maintain as bushland or light grazing country. If hazard reduction burning (or any clearing) is necessary, it should not be undertaken during late spring-summer when extremely erosive storms occur. See Lyons (1993) for guidance on the sustainable management of banana plantations.
Pumpenbil (pu)	2579	■	■	●	●			Preferably maintain as grazing country. If cultivated, minimum tillage and incorporation of organic matter are recommended in order to reduce soil structure decline.
Wollumbin (wl)	3655	■	●	■				Generally best left undisturbed and vegetated. Erosion hazard is high and hazard reduction burning (or any clearing) should not be undertaken in late spring-summer when extremely erosive storms occur. See Lyons (1993) for guidance on the sustainable management of banana plantations.
Mebbin (me)	4405	■	●		●			Generally best left undisturbed - steep slopes, rock outcrop and mass movement hazard severely restrict any other land use options.
Ophir Glen (og)	1227	■		●				Maintain as light grazing country. Any gullies should be closed to stock and revegetated.
Brays Creek (bc)	1063	●		●				Grazing should be restricted to within at least 10 m of stream banks, and revegetation of banks with native riparian species is recommended.
Crabbes Creek (cr)	1331	●		●				Grazing should be restricted to within at least 10 m of stream banks, and revegetation of banks with native riparian species is recommended.
Cudgera (cd)	1141	■		●				Grazing should be restricted to within at least 10 m of stream banks, and revegetation of banks with native riparian species is recommended. Minimum tillage and incorporation of organic matter is recommended in order to reduce soil structure decline within cultivated land.
Nobbys Creek (no)	887	●		●				Grazing should be restricted to within at least 10 m of stream banks, and revegetation of banks with native riparian species is recommended.
Oxley (ox)	1581	●		●				Grazing should be restricted to within at least 10 m of stream banks, and revegetation of banks with native riparian species is recommended.
Rous (ru)	557	●		●				Grazing should be restricted to within at least 10 m of stream banks, and revegetation of banks with native riparian species is recommended.

● - General/widespread occurrence
■ - Localised occurrence

Soil Landscape	Area (Ha)	Soil Erodibility	Steep Slopes	Streambank Stability	Mass Movement	Acid Sulphate Soils	Coastal Erosion	Suggestions for sustainable land use
Cobaki (cb)	3860	■		■		■		Maintain undisturbed areas. Within residential areas appropriate effluent disposal systems (avoid septic systems) should be established. Minimal tillage and incorporation of organic matter is recommended in order to reduce soil structure decline. Appropriate guidelines should be followed to manage actual and potential acid sulphate soils.
Ukerabagh (uk)	337	●				●		Avoid disturbance. Appropriate guidelines should be followed to manage actual and potential acid sulphate soils.
Tweed (tw)	9007	●		●		■		Minimal tillage and incorporation of organic matter is recommended in order to reduce soil structure decline. Appropriate guidelines should be followed to manage actual and potential acid sulphate soils.
Angels Beach (ab)	248	●	■				●	Maintain and encourage native vegetation on dunes - extreme wind erosion hazard exists when dunes are cleared. Wave erosion of beaches and foredunes is generally unavoidable during severe storms and cyclones and is part of the natural processes of coastal erosion and shaping. However, coastal sediment (sand) movement can be interrupted by unwise siting of breakwaters and other barriers.
Bogangar (bo)	887	●					●	Extreme wind erosion hazard exists - maintain vegetation. This landscape should be left as a buffer between coastal erosion processes and the hinterland. Appropriate waste disposal systems (I.e., not septic) should be utilised in urban areas.
Kingscliff (ki)	3003	●				■		Extreme wind erosion hazard exists - maintain vegetation. Appropriate waste disposal systems (I.e., not septic) should be utilised in urban areas.
Wooyung (wy)	218	●	■					Maintain and encourage vegetation on dunes. Extreme wind erosion hazard exists when dunes are cleared.
Pottsville (po)	1006	●						Maintain vegetation and avoid disturbance.
Bald Mountain (bm)	287	●	●					Retain vegetation - steep slopes, rock outcrop, mass movement hazard and shallow soils severely limit any other land use options apart from light grazing on less steep areas.
Disturbed Terrain (xx)	1119							

4.3 River Stress and Water Quality

Good quality water is fundamental to aquatic ecosystems and the health of human populations. Rivers and estuaries provide the food and the habitat for many plants and animals whose continued health is directly dependent on water quality (Sinden & Wansborough 1996).

In 1997 the New South Wales State Government began its water reform process. A key factor was the assessment of the current level of hydrologic and environmental "stress" in each subcatchment. Most of the following sub-sections are adapted from the results of the Stressed Rivers Assessment Report for the Tweed Catchment (DLWC 1999a) and the Northern Rivers Water Quality Assessment (Sinden & Wansborough 1996).

As noted previously, terrestrial vegetation along watercourses (e.g. riparian areas) helps trap sediments, assists in streambank stabilisation and provides shelter, nutrients and habitat for aquatic organisms. The maintenance and rehabilitation of vegetation in these areas can have a major positive influence on the health of aquatic ecosystems and water quality in general.

4.3.1.1 Methods

The stressed rivers assessment was undertaken in four steps:

1. Selection of subcatchment and mapping boundaries;
2. Estimation of the proportion of daily flow extracted within subcatchments;
3. Compilation of evidence of environmental stress;
4. Overall stress classification.

In general, the boundaries of subcatchments were defined on a hydrological basis. When defining the boundaries, consideration was also given to geology, terrain, social groupings of the area (eg. government or water user group boundaries, more subcatchments in intensive landuse areas), stream gauging and major water quality sampling points.

The hydrologic stress of a subcatchment was calculated as the estimated proportion of daily flow that has been made available for extraction under existing licences. This required estimation of streamflow and water use.

To enable a 'relative comparison' between subcatchments it was important to have environmental indicator measures available across the Region. For the North Coast Region these were:

- riparian vegetation extent;
- bank condition;
- terrestrial vegetation cover;
- the presence of structures;
- water quality data; and
- the extent of acid sulfate soils and their risk to aquatic systems (tidal zone areas only).

For estuaries, indicators were also selected according to whether they were permanently open, intermittently closed or coastal lakes. Water quality scores were not available for some subcatchments. In these cases, values were set to the average for the catchment concerned.

The hydrologic and the environmental stress ranking were combined using the stress classification matrix (see Table 4.2) to create a final category of stress for a subcatchment.

Table 4.2 Matrix of Stress Classifications and Management Categories (DLWC 1999a)

	Low **ENVIRONMENTAL STRESS**	**Medium** **ENVIRONMENTAL STRESS**	**High** **ENVIRONMENTAL STRESS**
High PROPORTION OF WATER EXTRACTED	CATEGORY U1 Despite high levels of water extraction the river seems reasonably healthy. However, more detailed evaluation should be undertaken to confirm. It is also likely that conflict between users may be occurring during critical periods.	CATEGORY S3 Water extraction is likely to be contributing to environmental stress.	CATEGORY S1 Water extraction is likely to be contributing to environmental stress.
Medium PROPORTION OF WATER EXTRACTED	CATEGORY U2 There is no indication of a problem and, therefore, such rivers would be a low priority for management action.	CATEGORY S4 Water extraction may be contributing to environmental stress	CATEGORY S2 Water extraction may be contributing to environmental stress.
Low PROPORTION OF WATER EXTRACTED	CATEGORY U4 There is no indication of a problem and, therefore, such rivers would be a low priority for management action.	CATEGORY U3 Environmental stress is likely to be due to factors other than water extraction and, as stress is not high, these rivers would be a low priority for management action	CATEGORY S5 While environmental stress is likely to be due to factors other than water extraction, the high level of environmental stress means it is important to ensure extraction is not exacerbating the problem.

Notes:
1. Dark shading indicates categories with high combined stress rating
2. Lighter shading indicates categories with medium combined stress rating
3. Absence of shading indicates categories with low combined stress rating

4.3.1.2 Results

The results of the Stressed Rivers Assessment process for Tweed are reproduced in Table 4.3. Subcatchment boundaries are presented on Map 5.

Table 4.3 Summary Table of Stress Classifications for Tweed Subcatchments (DLWC 1999a)

Subcatchment	Present Management Classification	Hydro. Stress	Enviro. Stress	Identified Conservation Value	
				DEC	Fisheries
Cobaki Creek	S1	High	High	Yes	Yes
Sheens Creek	S1	High	High	No	Yes
Duroby Creek	S1	High #	High	No	Yes
Cobaki Broadwater	S2	Medium	High	Yes	Yes
Terranora Broadwater	S2	Medium	High	Yes	Yes
Doon Doon Creek	S2	Medium	High	Yes	No
Mid Tweed River	S3	High	Medium	Yes	Yes
Piggabeen Creek	S3	High	Medium	Yes	Yes
Pumpenbil Creek	S3	High	Medium	No	No
Upper Tweed River	S3	High	Medium	No	No
Bilambil Creek	S3	High	Medium	No	Yes
Clothiers Creek	S5	Low	High	Yes	Yes
Cudgen Lake	S5	Low	High	Yes	Yes
Cudgera Creek	S5	Low	High	No	Yes
Mid Rous River	S5	Low	High	No	Yes
Mooball Creek	S5	Low	High	Yes	Yes
Tweed Estuary	S5	Low	High	Yes	Yes
Nobbys Creek	S5	Low	High	No	No
Brays Creek	U1	High	Low	Yes	No
Upper Oxley River	U1	High	Low	Yes	No
Crystal Creek	U2	Medium	Low	Yes	No
Rolands Creek	U2	Medium	Low	Yes	Yes
Christies Creek	U3	Low	Medium	No	Yes
Dungay Creek	U3	Low	Medium	No	Yes
Lower Oxley River	U3	Low	Medium	Yes	Yes
Byrill Creek	U4	Low	Low	Yes	No
Smiths Creek	U4	Low	Low	No	Yes
Upper Rous River	U4	Low	Low	Yes	No
Dunbible Creek	Unresolved	Unresolved	High	No	Yes
Hopping Dicks Creek	Unresolved	Unresolved	Medium	Yes	No
Lower Burringbar Creek	Unresolved	Unresolved	High	No	Yes
Upper Burringbar Creek	Unresolved	Unresolved	Medium	No	Yes

# Denotes use of 94/95 data, rather than 93/94 data used in other subcatchments.

The stressed rivers assessment sub-catchment Report Cards (in DLWC 1999a) indicated that water quality was a primary stress factor for the sub-catchments of Cobaki Broadwater, Cobaki Creek, Crystal Creek, Doon Doon Creek, Dungay Creek, Hopping Dicks Creek, Lower Oxley River, Mid Rous River, Pumpenbil Creek, Rolands Creek, Terranora Broadwater, Tweed Estuary, Upper Oxley River and Upper Tweed River.

In addition, Sinden & Wansborough (1996) determined that: *water quality in the Tweed River Catchment was generally good, with 58% of sample site ranks being Good or Fair. However some distinct regional differences were observed in the catchment*.

These differences included the fact that in the freshwater section of the catchment, 65% of the sites were ranked *Good* or *Fair*, with the main reason for failure being low values of dissolved oxygen. While 80% of all estuarine sites were

ranked *Poor* or *Very Poor* with the predominant reason for failure being excess suspended solids concentrations. Better water quality results were recorded near the mouth of the river, a result likely to be related to the effects of tidal flushing.

Sinden and Wansborough (1996) also assessed potable water, with 95% of freshwater sites receiving a *Very Poor* ranking due to excess levels of both faecal coliforms and total coliforms. In addition the overall water quality for primary recreational contact was poor, while that for secondary recreational contact was significantly better, with all sites receiving a *Good* rank.

Other results included the ranking of 75% of sites as *Good* for agricultural irrigation purposes; 80% of sites as *Good* for agricultural livestock use and 40% of estuarine sites as either *Good* or *Fair* for edible seafood production, however the remaining 60% fell into the *Poor* or *Very Poor* ranks.

4.4 Areas of Geological Heritage

The Tweed Shield Volcano is listed in The Geological Heritage of New South Wales (Site No. 39; Percival 1985)

4.5 Vegetation Management Implications

As a result of the preceding information a number of vegetation management considerations are relevant to the management soil and water resources:

- Protection and management of vegetation on steep land is important in terms of erosion control, slope stability, minimising sedimentation and water quality impacts in the headwaters and further downstream.
- In addition to habitat and corridor functions Riparian vegetation enhancement and management is important for stream health (bank stability, runoff filtration, instream water quality)
- The coastal dunes are a fragile zone because disturbance of the vegetation exposes erodible soils to erosive wind and rain.
- The high potential for soil erosion in the Shire due to climatic, topographic and soil factors.
- The presence of acid sulfate soils.

4.6 Key Considerations

Based on the issues described in this chapter a number of recommendations can be made to assist the planning process. At this point, however such recommendations are limited to broad issues that arise directly from the analyses presented in this chapter.

1. Native vegetation on steep lands (ie. all land generally in excess of 18^{o}; Map 5), along drainage lines (e.g. see Map 5), in wetlands and Coastal dune systems be given the highest level of protection and priority for rehabilitation.

2. That DIPNR review their designation of *prescribed* streams such that all are explicitly and consistently defined, preferably by reference to scheduled maps.

3. Vegetation management activities whether or not requiring consent, should be carried out in accordance with guidelines (Best Management Practices etc) that include sound soil erosion and water management practices.

4. Council should continue to maintain an active interest in the management and rehabilitation of areas affected by acid sulphate soils.

5.0 Planning Assessment

There is a wide range of land use planning tools available to government, which provide opportunities for vegetation management. These include the local government legislative and non-legislative tools, and regional, national and international strategies and obligations. The manner in which this framework currently operates is an important factor in determining the direction and extent of any new initiatives for vegetation management.

This chapter provides:

1. A review of the current planning framework relating to the vegetation protection and management in the region and;

2. An assessment of the level of protection afforded to mapped bushland under the current planning framework.

5.1 Existing and Regional Framework for Vegetation Management

5.1.1 Statutory Framework

The most relevant State statutes affecting local and regional vegetation conservation and management are in the Local Government Act 1993 (LG Act), the Environmental Planning and Assessment Act 1979 (EPA Act), the Threatened Species Conservation Act 1995 (TSC Act) and the products of recent State resource management reforms including the Native Vegetation Act 2003 (NV Act) which will replace the Native Vegetation Conservation Act 1997 (NVC Act) The implications for vegetation management of these and a number of other Acts are summarised below.

5.1.1.1 Environmental Planning and Assessment Act 1979

The Environmental Planning and Assessment Act 1979 (EPA act) is one of the more prominent pieces of State legislation which provides Local Government with landuse planning and development assessment powers and specific provisions that enable Councils to collect contributions (land, money or works) from land development for public facilities and services.

Under the NSW planning system there are basically two tiers of planning control:

1. **Forward Planning Controls**. The EPA Act enables local and State Government to prepare landuse planning intruments whereby allocation of landuse is based on a balance between environmental, social and economic factors and current community and Government attitudes on these issues. Examples include State Environmental Planning Policies (SEPPs), Regional Environmental Plans (REPs), Local Environmental Plans (LEPs), Development Control Plans (DCPs) and Section 94 Developer Contribution Plans.

2. **Development assessment and control**. The basic philosophy contained in the provisions of the EPA Act is that no decision is made without first having considered the potential environmental, social and economic implications of a development proposal.

Forward Planning Control

State Environmental Planning Policies (SEPPs)

These policies are prepared by the State Government (DIPNR) for matters considered to be of State significance. SEPPs affecting the North Coast, with implications for vegetation management are:

> ***SEPP 14 – Coastal Wetlands.*** This SEPP identifies, by maps, vegetation considered to be State significant coastal wetlands. The policy requires consent and the concurrence of Planning NSW for clearing, draining, filling of, or constructing a levee within, the identified wetlands.

SEPP 26 – Littoral Rainforests. This SEPP identifies, by maps, areas of State significant littoral rainforests, and requires consent and the concurrence of DIPNR for clearing or partial clearing or landform alteration or landuse within the mapped areas. A 100m buffer around the mapped areas also applies.

SEPP 44 – Koala Habitat Protection. This SEPP sets up two key processes for the protection of koala habitat. The first is a requirement to consider the impact on potential koala habitat when assessing development applications, with the possible outcome a requirement to prepare a koala plan of management for the site. The second is the preparation of a Shire-wide Koala Plan of Management, which provides policy input into the Shire-wide Local Environmental Plan. At present comprehensive Koala Plan of Management has not been prepared for Tweed Shire although a significant amount of preliminary work has been carried out (e.g. Community surveys of koala occurrence; Tweed Coast Koala Habitat Atlas, Philips & Callaghan 1996). Further details on Koala Management are presented in Section 5.3.3.

SEPP 71 – Coastal Protection. This SEPP is an interim measure to control and coordinate development along the NSW coastline subject to the preparation by DIPNR of Regional Strategies and a Comprehensive Coastal Assessment. The policy aims:

- further the implementation of the NSW Coastal Policy 1997: A Sustainable Future for the New South Wales Coast;
- manage the coastal zone in accordance with ecologically sustainable development principles;
- ensure that coastal cities, towns, centres, villages, hamlets, and their communities thrive by protecting the natural and cultural attributes that attract people to the coast to live, work, and recreate;
- protect and manage the coast in a coordinated manner so the community and future generations can enjoy its natural, scenic and cultural beauty;
- ensure that existing public access to the coastal foreshore is retained — and new opportunities for public access are provided — in accordance with the natural and cultural attributes of the area
- ensure that development is appropriate for the coastal environment.

The policy applies to the *coastal zone*, which is defined by maps held by DIPNR, but in general includes the land area contained within a one kilometre buffer to the coast and associated estuaries. In these areas DIPNR becomes the consent authority for certain types of development (*State significant development*) and categories of land (*sensitive coastal locations*).

The types of development include mining, extractive industry, industry, landfill, recreational establishments, marinas, tourist facilities (except bed and breakfast establishments and farm stays), structures greater than 13 metres in height above the natural ground level, and some types of land subdivision. At present *sensitive coastal locations* includes land within 100 m of coastal features such as the mean high water mark of the sea, a bay or an estuary, a coastal lake, and land to which SEPP 14 applies.

Regional Environmental Plans (REPs)

These plans are (usually) prepared by the regional office of DIPNR in relation to matters of significance for the environmental planning of the region.

The North Coast REP sets up two main processes. The first provides guidelines for Council in preparing Local Environmental Plans (LEPs). A number of clauses in the North Coast REP relate to vegetation management:

Clause 14 requires draft LEPs to zone wetlands, fishery habitats and associated buffers as environmental protection zones.

Clause 29 requires draft LEPs to retain existing environmental protection zones, include significant areas of natural vegetation and wildlife habitat and corridors in environmental protection zones and requires consent for clearing within these zones. The clause also has a definition of clearing of natural vegetation.

Clause 32A requires draft LEPs to include provisions to give effect to the NSW Coastal Policy 1997.

The REP also has implications for the development control process (see below). Clauses with implications for vegetation management are:

Clause 15 requires Council to consider the impact of development on water quality and quantity flows into wetlands or fishery habitats, any loss of habitat, and the need to conserve native vegetation around wetlands.

Clause 29A requires Council to consider whether clearing in environmental protection zones will significantly disturb wildlife habitat, or adversely affect the scenery.

Clause 32B requires Council to consider the NSW Coastal Policy 1977, Coastline Management Manual and the North Coast: Design Guidelines.

Local Environmental Plans (LEPs)

The EPA Act gives local Councils the opportunity to prepare draft Local Environmental Plans which reflect both local landuse and planning issues and State Government landuse planning objectives. Local plans can be initiated by a local Council, such as Shirewide plans, or can be initiated by landowners or developers seeking 'spot' rezoning to increase development potential of specific sites.

Local plans define landuse zones (maps) and permissible landuse activities within these zones. Local plans can also contain guidelines (numerical or performance based) to assist in development proposal preparation and assessment.

The landuse zones of particular relevance to vegetation management are the 'Environmental Protection Zones'. Landuse activities within these zones are generally more restricted than other landuse zones to ensure protection of identified natural assets (e.g. wildlife habitat) or to avoid environmental hazards (e.g. coastal erosion).

There are no compensation requirements provided by State legislation for restrictive zones unless the land is to be acquired and used by a State government for a public purpose.

Background studies often precede local plan preparation (e.g. environmental studies) and all draft plans involve a process of public consultation. Local plans generally require regular review (every 5-10 years) to ensure they do not become outdated. They are not intended to be static documents.

Tweed Shire Council currently has one local environmental plan (LEP), the Tweed LEP 2000 (Shirewide Plan). This may be reviewed by Council in conjunction with a new strategic plan for the Shire (Tweed Futures).

In addition to the restriction of land uses in specific zones (e.g. Environmental Protection zones) the most significant provisions for vegetation management from the current LEP are:

Clause 5 requires that the principles of Ecologically Sustainable Development (ESD) underpin all development. ESD includes: (1) the Precautionary principle, (2) Inter-generational equity; (3) Conservation of biological diversity and ecological integrity; and (4) Improved valuation, pricing and incentive mechanisms.

Clauses 25-28 requires consent to clear vegetation (irrespective of land use) in Environmental Protection Zones.

Clause 29 requires consideration of impacts of development adjacent to National Parks and Nature Reserves.

Clause 31 requires consideration of impacts of development adjoining waterways.

Clause 35 requires consent to disturb mapped acid sulphate soils except where associated with a production entitlement with the NSW Sugar Milling Co-operative and the works are carried out in accordance with State Government approved guidelines.

Clause 44 requires consideration of impacts of development on likely or known archaeological sites.

Clause 54 makes provision for Council to make Tree Preservation Orders (TPOs). At present a TPO 1990 applies to mapped areas (limited to a few non-rural zones) and prevents *the ringbarking, topping, lopping, removing, poisoning, injuring or wilful destruction of trees of thirty centimetres (30cm) or more girth (circumference) measured at forty-five centimetres (45cm) above ground, three meters (3m) or more in height*…..without consent. Certain exceptions apply with respect to the maintenance of infrastructure, public reserves, agricultural tree crops and plantations, within 8m of building foundations, and for Camphor Laurel and Privet species.

Table 5.1 indicates the current area occupied by various landuse zones under Tweed local plans and mapped State policies.

Draft local plans and Council's development assessments must be consistent with State Government planning policies and guidelines. State Environmental Planning Policies (SEPPs) and Regional Environmental Plans (REPs) are prepared where the State Minister is concerned with matters of State and regional significance. Draft Local Plans prepared by local Councils are reviewed by the State Government before approval.

Table 5.1 Area of Landuse Zones from Tweed LEP 2000 and Other Instruments

Zone	Area (ha)	Percentage Of Shire
Tweed LEP 2000		
1(a) Rural	69635	52.9
1(b) Agricultural Protection	13234	10.0
1(f) Forestry	2136	1.6
7(a) Wetland	1982	1.5
7(d) Scenic/Escarpment	5782	4.4
7(l) Habitat	5531	4.2
7(f) Coastal Lands	256	0.2
8(a) National Parks	19036	14.5
Other Zones (Urban, open space, unzoned land)	14100	10.7
TOTAL	**131692**	**100**
SEPP 14 (State Wetland)	1735	1.4
SEPP 26 (State Littoral Rainforest)	251	0.2
Tree Preservation Order 1990	4586	3.5

Development Control Plans (DCPs)

Development Control Plans (DCPs) are created by Council under the provisions of the Environmental Planning and Assessment Act. Development Control Plans deal in more detail with selected parts of an area covered by a Local Environmental Plan (LEP). They can be used as guidelines or as requirements for development proposals. Unlike LEPs, DCPs are not legally binding unless they area specifically tied to a clause in an LEP as is the case with DCP's for exempt and complying development (DCP 40).

Examples of DCPs, which have implications for vegetation management in Tweed, are DCP 17 - Cobaki Lakes and DCP 21 - Searanch. These cover new urban release areas (2,500-14,000 people) on the NSW/Queensland border and near Pottsville Village respectively. The DCPs provides guidelines for the developer and Council on various issues including wildlife corridor management and vegetation management (e.g. Heathland and Scribbly Gum, Koala Habitat etc).

Section 94 Developer Contribution Plans

The EPA Act contains special provisions, which enable local Councils to impose conditions on developers as part of their development to dedicate land or make monetary contributions to Council for providing or increasing "public amenities" and "public services". Alternatively, the developer can, with the agreement of Council, provide a 'material and public benefit'. Public amenities and public services can include land acquisition and embellishment for public open space. Tweed Shire Council, for example, has a contribution plan for 'street trees'. Lismore Council currently has a contribution plan for embellishing public reserves with koala food trees. Councils are required to prepare contribution plans that illustrate how the contribution levy was derived and the 'nexus' between the proposed development(s) and the need for increased public amenities and services. Council cannot levy existing development costs associated with the facility or service. The latter is a major budgetary issue, which Councils need to confront when considering increasing facilities such as public open space. Other revenue sources, such as rates, must be used for this purpose. The issue of ongoing maintenance costs of public services and facilities is also an issue that Councils need to address. Tweed Council currently does not include maintenance costs when calculating developer contributions.

Development Control

The basic philosophy contained in the EPA Act is that no decision is made without first having considered the potential environmental implications of that decision (does not apply to Federal matters e.g. Federal Airports). There are basically two mechanisms in which environmental impacts are assessed:

1. ***Development Control*** - (Part 4 of the EPA Act). This procedure is the process by which Council will make specific development decisions by assessing a proposal (Development Application) against the provisions or directions contained within a Local Environmental Plan e.g., Tweed Local Environmental Plan 2000, State Environmental Planning Policies such as No 14 (Wetlands) etc., Regional Environmental Plans eg. North Coast REP 1988, Development Control Plans (e.g. DCP 21 Searanch) and assessment criteria contained in the Environmental Planning and Assessment Act (e.g. Threatened species and ecological communities; Development Application required). Since the 1997 amendments to the EPA Act, the process of classifying 'development' has become more complex. In broad terms the Act establishes a threefold classification for development:
    - development that does not need development consent (including exempt and complying development)
    - development that needs consent
    - development that is prohibited

2. ***Duty of Public Authorities*** - (Part 5 of the EPA Act). Some forms of development do not require approval under the development control mechanism, and are thus not subject to directions or controls by environmental plans such as the Tweed Local Environmental Plan 2000. These developments are called activities. In these cases Council has a duty to consider the environmental implications of granting approval for the "activity" (e.g. road works within a road reserve). The exception is a category of development introduced in 1997 called 'exempt development'. This is development considered to have minimal environmental impact. Part 5 of the EPA Act was designed to catch those undertakings which fell through the net of Part 4 that have potential to have a significant environmental impact. In Tweed Shire these developments are listed in DCP 40.

It should be noted that in some rare cases a development proposal could fall partly within the development control process, and partly within the duty of public authorities. The two procedures, however, can never apply simultaneously to the same part of a development proposal.

In some situations no approval is required under either Part 4 or 5 of the Act (i.e., projects on private land that do not require any approval or licensing etc. by a Government authority). Some agricultural activities fall into this category, including clearing of vegetation in general rural zones that are currently exempt from the Native Vegetation Conservation Act 1997.

Designated Development is a special category of development that requires preparation and exhibition of an Environmental Impact Statement and concurrence of the DIPNR. Third party appeal is possible when the designated development is determined under Part 4 of the EPA Act.

Where a development is proposed on land that is not zoned to allow that proposal, an additional process (spot rezoning) must be completed before a development proposal can be considered by a local Council. The site must be rezoned in accordance with State and regional guidelines.

Councils are the responsible authority in preparing draft 'spot' rezonings and their public exhibition; however, the final responsibility for making the Plan rests with the State Government Planning Minister.

In considering the question of significant impact of a proposal under Part 4 or 5 of the EPA Act, Council's and proponents are required to consider the impact on Threatened Species, Ecological Communities and Populations and Critical Habitat under the Threatened Species Act 1995 (see below).

5.1.1.2 Threatened Species Conservation Act 1995

The Threatened Species Conservation Act 1995 (TSC Act) was introduced in late 1995 to promote the protection and recovery of threatened native fauna and flora species, populations, ecological communities and their habitats. Threatened species and populations etc. are listed within a schedule. This Act has amended various provisions in the EPA Act regarding the preparation of Local Environmental Plans and assessment of development proposals by Local Government. It has had major implications for Councils in administration and resources.

The main issue that must be initially addressed by proponents and consent authorities is whether a Species Impact Statement (SIS) is required to be lodged with a development proposal. This also includes any works undertaken by Council (e.g. roadworks). An *eight part test* is required to be undertaken to determine if an SIS is required. This poses a significant issue with Council regarding methodologies used and assessment skills in identifying potential threats to threatened species by a proposed development, and whether or not the development will have a 'significant' effect on threatened species, populations etc.

Given that such species are almost always difficult to find (particularly fauna) there is an urgent need to develop check lists of preferred habitat indicators so that species likely to exist at a particular location (even if they are not present at the time of field survey) can be identified. Conversely, and perhaps more importantly, species that are not likely could be rapidly eliminated. At present, threatened species surveys required for development applications are often approached in a cursory and dismissive manner, and Council officers do not have the tools at their disposal to make informed decisions about whether or not threatened species are likely to be affected by a particular proposal. The Significant Fauna Habitat Database (see Appendix 10 and Section 3.3.4) is designed to provide guidance for Council and proponents in this area. The DEC have a dual role to play with Local Government in administering the TSC Act. Where a SIS is required, Council must first have the concurrence of the DEC before approving a development proposal.

Within Tweed Shire there are a significant number of species scheduled under the Act that are likely or known to occur in the Study Area (see Section 3.3). At present Stotts Is Nature Reserve is the only area declared as *Critical Habitat* in NSW. Several *Endangered Ecological Communities* and *Key Threatening Processes* have been identified that relate to the region (see Sections and 3.2.2.1 and 3.1.2.3). In relation to each these declarations, the DEC is obliged to prepare a *Recovery Plan*, or in the case of a *Key Threatening Process* a *Threat Abatement Plan*, which must be taken into account by the consent authority in the planning process.

5.1.1.3 The Native Vegetation Conservation Act 1997

The Native Vegetation Conservation Act 1997 (NVC Act), which came into force in January 1998, aims to:

a) Provide for the conservation and management of native vegetation on a regional basis.
b) Encourage and promote native vegetation management in the social, economic and environmental interests of the State.
c) Protect native vegetation of high conservation value.
d) Improve the condition of existing native vegetation.
e) Encourage the revegetation of land, and the rehabilitation of land, with appropriate native vegetation.
f) Prevent the inappropriate clearing of native vegetation.
g) *Promote the significance of native vegetation.*

Due to recent State Government reforms (see Section 5.1.1.4) of natural resource management, the NVC Act is set to be replaced by the Native Vegetation Act 2003 (NV Act). However, the NVC Act will remain in force until the NV Act regulations are finalised in late 2004.

Features of the NVC Act that remain relevant are outlined below.

Exclusions

Land excluded from the operation of the NVC Act includes:

- land zoned residential, village, township, industrial and business under an environmental planning instrument such as a LEP;
- land to which SEPP 14 - Coastal Wetlands applies;
- land to which SEPP 26 - Littoral Rainforest applies;
- state forest, national forest, flora reserve or timber reserve under the Forestry Act;
- land dedicated or reserved under the National Parks and Wildlife Act, and land acquired for that purpose;
- land subject to a conservation agreement or an interim protection order under the National Parks and Wildlife Act;
- land subject to a conservation instrument under the Heritage Act;
- land that is Critical Habitat (TSC Act);

- local government areas listed on Schedule 1 (partial exclusion) and Schedule 2 (total exclusion) of the NVC Act.

Certain activities involving clearing are also excluded from the operation of the Act if authorised under any of the following:

- the Rural Fires Act;
- the State Emergency and Rescue Management Act
- the Noxious Weeds Act;
- the Threatened Species Conservation Act;
- the Environmental Planning and Assessment Act;
- the Fisheries Management Act;
- the National Parks and Wildlife Act;
- the Mining Act;
- the Petroleum (Onshore) Act;
- the Timber Plantations (Harvest Guarantee) Act;
- the Roads Act;
- the Rivers and Foreshores Improvement Act;
- the Water Act.

Protected Lands

State Protected Land is land previously defined as "protected land" under the Soil Conservation Act 1938. There are three categories:

Category A - land generally in excess of 18 degrees slope and identified on a map;
Category B - land within, or within 20 metres of, the bed or bank of a prescribed stream;
Category C - land that is defined as "environmentally sensitive".

The definition of "vegetation" on protected land extends to include any tree (regardless of whether it is dead or alive, standing or fallen, or whether it is indigenous or not). However, "vegetation" does not include non-indigenous ground cover.

In the Tweed, DIPNR hold maps that define Category A and C land, however the Category C designations are not considered reliable (B. Hungerford, pers com.). Category B land is mapped for the Tweed catchment area but is only listed for the coastal catchments.

Regional Protected Land is defined only in conjunction with a RVMP but is otherwise similar to State Protected Land.

Development Consent

The NVC Act identifies the Minister as the consent authority for the clearing of native vegetation or clearing in State Protected and Regional Protected Land. The provision for development consent follows the procedures of Part 4 of the EPA Act.

A person may undertake clearing in accordance with a Regional Vegetation Management Plan (RVMP; not relevant in Tweed Shire), an exemption (see below), or a Development Consent granted by the Minister for Land and Water Conservation. It is intended that the assessment and consent system applicable under the NVC Act be consistent with that proposed in the Integrated Development Assessment system currently being developed. Consent issued by the Minister for clearing under the provisions of the Act can override the provisions of an environmental planning instrument, including any prohibitions.

Exemptions

The Act does not apply to various categories of clearing (exemptions). At present, and in the absence of a RVMP, applicable exemptions have been carried over as transitional provisions from repealed SEPP 46 – Protection and Management of Native Vegetation. Different exemptions apply to State Protected Land and non-protected Land. The full wording of these exemptions can be found in Fact Sheet No.5 available at DIPNR offices.

On **non-protected land**, there is no need for Development Consent to be obtained if clearing of native vegetation complies with any of the following exemptions**:**

- minimal clearing (up to 2 hectares per annum);
- minimal tree cutting (up to 7 trees per hectare per year for on farm purposes);
- lopping for stock fodder;
- lopping for mistletoe control;
- minimal clearing for rural structures;
- burning: clearing by use of fire in accordance with a bushfire management plan under the Rural Fires Act;
- minimal clearing for public utilities and emergency work;
- clearing of planted native vegetation for certain purposes;
- certain clearing for private native forestry;
- removal of regrowth less than 10 years of age;
- clearing authorised under the Noxious Weeds Act;
- minimal clearing for vermin control.

On **Category A protected land** there is no need to obtain Development Consent if clearing of vegetation complies with any of the following exemptions:

- minimal tree destruction (seven trees per hectare per year);
- minimal clearing (up to 2 hectares if <25% total area of State Protected Land);
- normal harvest or pruning associated with orchard or banana plantation;
- certain survey activities;
- certain clearing for powerline maintenance.

On **Category B protected land** there is no need to obtain Development Consent if clearing of vegetation complies with the following exemptions:

- certain survey activities;
- certain clearing for powerline maintenance.

Compliance

Appropriate measures are in place to ensure compliance with the requirements of the Act. These can include stop work notices, remedial notices and penalties. Appeals to the Land and Environment Court can be made regarding development consent, stop work orders and remedial notices.

5.1.1.4 Recent Reforms in Natural Resource Management

In December 2003, the NSW State Government introduced significant natural resource management reforms in response to the Wentworth Report (Wentworth Group, 2003) and the subsequent work by the Native Vegetation Reform Implementation Group (Sinclair Report; NVRIG, 2003). This resulted in the creation of three related Acts; the Native Vegetation Act 2003 (NV Act), the Catchment Management Authorities Act 2003, and the Resources Commission Act 2003. This legislation aims to provide for improved management of natural resources and to establish a Statewide legislative framework for targets and standards that can be adapted at a regional scale.

The NV Act will replace the NVC Act once the regulations (guidelines that set out how the Act will actually work) are finalised.

Apart from a streamlining of administrative processes relating to vegetation management in NSW, the major difference (from the NVC Act) in clearing controls for landholders in the Tweed will be the removal of the minimal clearing (up to 2 ha per annum) and minimal tree cutting (up to 7 trees per hectare per year for on farm purposes) exemptions.

Some important features of these reforms are outlined below.

Native Vegetation Act 2003

The objects of this Act are:

a) *to provide for, encourage and promote the management of native vegetation on a regional basis in the social, economic and environmental interests of the State, and*

b) *to prevent broadscale clearing unless it improves or maintains environmental outcomes, and*

c) *to protect native vegetation of high conservation value having regard to its contribution to such matters as water quality, biodiversity, or the prevention of salinity or land degradation, and*

d) *to improve the condition of existing native vegetation, particularly where it has high conservation value, and*

e) *to encourage the revegetation of land, and the rehabilitation of land, with appropriate native vegetation,*

in accordance with the principles of ecologically sustainable development.

To achieve these aims, the Act sets up a framework which includes the following features.

Definitions

Native vegetation

Any vegetation species that existed in NSW before European settlement including trees, saplings, shrubs, scrub, understorey, ground cover or plants in a wetland. Mangroves, seagrasses or other marine vegetation are not covered by the NV Act.

Regrowth

All native vegetation that has grown since 1 January1990 is regrowth. This date may be varied in a Property Vegetation Plan (PVP) where exceptional circumstances, related to existing rotational farming, can be demonstrated. Regrowth does not include native vegetation that has regrown:

- after unlawful clearing of remnant vegetation, or
- after the clearing of remnant vegetation as a result of bushfires, floods, drought or other natural events.

Protected regrowth

Protected regrowth is any native vegetation that:

- is identified as protected regrowth in a PVP, environmental planning instrument (eg. a Council LEP), certain natural resource management plans or an interim protection order under the NV Act; or
- has been grown or preserved using public funding granted for biodiversity conservation purposes.

Remnant vegetation

Remnant vegetation is native vegetation that is not regrowth or protected regrowth.

Clearing

Clearing is defined as cutting down, felling, thinning, logging, removing, killing, destroying, poisoning, ringbarking, uprooting or burning native vegetation.

Broad-scale clearing

Broad-scale clearing is any clearing of remnant native vegetation or protected regrowth.

Routine agricultural management activities

Routine agricultural management activities are farming activities that do not require approval for the associated clearing. Subject to the finalisation of the regulations (expected in late 2004) these include:

(a) the construction, operation and maintenance of rural infrastructure including dams, permanent fences, buildings, windmills, bores, stockyards, and farm roads, but not including rural infrastructure in areas zoned as rural-residential under environmental planning instruments or on small holdings (as defined in the regulations),

(b) the removal of noxious weeds under the Noxious Weeds Act 1993,

(c) the control of noxious animals under the Rural Lands Protection Act 1998,

(d) the collection of firewood (except for commercial purposes),

(e) the harvesting or other clearing of native vegetation planted for commercial purposes,

(f) the lopping of native vegetation for stock fodder,

(g) traditional Aboriginal cultural activities (except commercial activities),

(h) the maintenance of public utilities (such as those associated with the transmission of electricity, the supply of water, the supply of gas and electronic communication),

(i) any activity reasonably considered necessary to remove or reduce an imminent risk of serious personal injury or damage to property.

Improve or maintain environmental outcomes

Improve or maintain environmental outcomes means the gains for biodiversity, water quality and the prevention of land degradation and salinity are equal to or greater than any losses resulting from the clearing. For example, in some cases clearing of native vegetation may improve the condition of the vegetation. In other cases clearing may have negative impacts on streams or the soil. In cases where environmental outcomes cannot improve or maintain on their own, the negative impacts may be able to be offset by positive management actions. For example, clearing of isolated paddock trees may in some circumstances be offset by not clearing certain regrowth or destocking areas of remnant native vegetation.

Landholder

A landholder is a person who owns land, is in occupation or possession of land or has management or control of land.

Excluded Land and Activities

Land excluded from the operation of the NV Act includes:

- land zoned residential (but not rural-residential), village, township, industrial and business under an environmental planning instrument such as a LEP;
- land to which SEPP 14 - Coastal Wetlands applies;
- land to which SEPP 26 - Littoral Rainforest applies;
- land designated as Core Koala Habitat under SEPP 44 – Koala Habitat Protection;
- state forest, national forest, flora reserve or timber reserve under the Forestry Act;
- land dedicated or reserved under the National Parks and Wildlife Act, and land acquired for that purpose;
- land subject to a conservation agreement or an interim protection order under the National Parks and Wildlife Act;
- land subject to a conservation instrument under the Heritage Act;
- land that is Critical Habitat (TSC Act or Fisheries Management Act);

Certain activities involving clearing are also excluded from the operation of the Act if authorised under any of the following:

- the Rural Fires Act;
- the State Emergency and Rescue Management Act
- the Noxious Weeds Act;

- the Threatened Species Conservation Act;
- the Environmental Planning and Assessment Act;
- the Fisheries Management Act;
- the National Parks and Wildlife Act;
- the Mining Act;
- the Petroleum (Onshore) Act;
- the Plantations and Reafforestation Act;
- the Roads Act;
- the Rivers and Foreshores Improvement Act;
- the Water Act.

Clearing Consent and Regulations

Permitted Clearing and Activities

The following activities and types of clearing do not require consent:

- Non-protected regrowth
- Native groundcover in accordance with the regulations
- Routine agricultural management activities in accordance with the regulations
- Existing farming activities not affecting remnant native vegetation
- Legislative exclusions (see above).

Clearing Requiring Approval

Other types of clearing require consent in the form of:

(a) a development consent granted in accordance with this Act, or
(b) a Property Vegetation Plan (PVP).

Regulations

Regulations that provide the detail and support for the Act are currently being developed. Input from the general public and major stakeholder groups is being sought for the development of these regulations.

Significant issues that will be addressed by the regulations are:

- matters that must be considered for clearing approval
- how the requirement in the Act for all broadscale clearing to "improve or maintain environmental outcomes" is to be assessed
- the form and content of Property Vegetation Plans
- definitions and other aspects of routine agricultural management activities
- details of the public register of clearing applications and approvals.

State Protected Land

Despite the repeal of the NVC Act provisions applying to State Protected Land will continue to apply. In the longer term a SEPP under the EPA Act will be developed to address issues related to steep and sensitive parts of the landscape.

Property Vegetation Plans (PVPs)

A Property Vegetation Plan is a legal agreement that will clarify what can be done with native vegetation on a property and give certainty that this agreement will continue for the period of the plan. Regulations for preparing a PVP are

currently being jointly developed by DIPNR and the DEC. It is expected that this framework will be available late 2004 as part of the commencement of the *Native Vegetation Act 2003.*

A PVP will be submitted by the landholder to the Catchment Management Authority (CMA) for authorisation and is expected to take one of three forms:

- Continuing use PVP to enable the landholder to manage native vegetation in accordance with their existing landuse
- Incentive PVP to seek access to incentives
- Development PVP for landholders to seek approval for landuse.

Although the plan is voluntary, a PVP will be:

- required when applying for natural resource incentive funding
- an alternative to a development application to clear any remnant native vegetation or protected regrowth that is not exempt under the Native Vegetation Act 2003
- required when seeking to secure offsets associated with clearing proposals.

Once a PVP is assessed and approved by the CMA, it will be a legal agreement under the Act for an agreed period, however clearing provisions in a PVP will be limited to15 years.

Catchment Management Authorities

Catchment Management Authorities are established under the Catchment Management Authorities Act 2003. The CMAs will engage regional communities in the key natural resource management issues facing their catchments. Specific functions will include:

- preparing catchment action plans and associated investment strategies, in consultation with local government and the catchment's communities;
- ensuring these catchment action plans integrate and build on the current catchment blueprints and regional vegetation management plans;
- recommending and managing incentive programs to implement catchment action plans and maximise environmental outcomes;
- providing landholders, including indigenous landholders, with access to data needed to prepare Property Vegetation Plans (PVPs) and implement catchment action plans;
- allocating funds to support development of PVPs and for PVP-based incentive programs;
- certifying or facilitating certification of PVPs;
- monitoring performance against catchment action plans and certified PVPs;
- providing education and training on natural resource management, especially vegetation management;
- developing transparent procedures for the CMA to consider and resolve local disputes related to implementing the catchment action plans; and
- any other responsibilities delegated by the Minister.

Following a review and streamlining of existing regulatory processes, the powers to assess clearing applications and make consent decisions for on-farm activities, will be devolved to CMAs in 2005.

Tweed Shire will be included in the Northern Rivers CMA which includes the coastal catchments (east of the Great Dividing Range) from the Hastings to the Tweed.

The CMA will take over most of the functions formerly carried out by the Northern Rivers Catchment Management Board and as noted above will integrate and build on the provisions of the Northern Rivers Catchment Blueprint (NRCMB 2002). A summary of the blueprint, which is currently used to provide strategic direction for action and investment in the region, is presented in appendix 18.

Natural Resources Commission and Natural Resources Advisory Council

The Natural Resource Commission (NRC), will be an independent body which will make recommendations to NSW Government. The NRC will be a formally constituted statutory authority under the Resources Commission Act 2003. The NRC will report to the NSW Premier and have a day-to-day relationship with the Minister for the DIPNR. The main function of the NRC will be to establish statewide standards and targets for a range of natural resource management issues: including water quality, salinity, soil and biodiversity. The NRC will also recommend approval of the catchment action plans developed by Catchment Management Authorities (CMAs). In addition to these roles the NRC may conduct inquiries and significant natural resource assessments, and provide advice on specific issues as directed by the NSW Government. The NRC will have the capacity to engage Government agencies and consultants to provide assistance as well as seek advice from the advisory committees which it may appoint and other bodies and stakeholders.

The Natural Resources Advisory Council (NRAC) will comprise key stakeholders currently involved in natural resource management. It will be a powerful single source of stakeholder advice to NSW Government and will be led by Chairperson appointed by the Minister. The NRAC membership is currently being finalised. The NRAC will provide up to date information, advice and feedback from stakeholder groups to the NSW Government on the range of issues affecting natural resource management.

The specific functions of NRAC will be to:

- provide a high level forum for stakeholders to advise the NSW Premier and the Minister; and
- at the Minister's request, broker agreements between the representative stakeholder groups on contentious natural resource management issues.

5.1.1.5 Local Government Act 1993

State of the Environment Report

The Local Government Act 1993 (LG Act) outlines the administrative powers and responsibilities of Local Government in NSW. This recently gazetted Act requires Councils to annually prepare a 'State of the Environment' report (SOE). The requirement for Local Government to prepare SOE reports was introduced to provide an effective means of educating the community about their local environment, how it is affected by human activities, and the actions being undertaken by Government, industry and the community aimed at restoring the environment.

All local Council State of Environment Reports in NSW are required to include material on ten central themes:

1. *Areas of environmental sensitivity;*
2. *Important wildlife and habitat corridor;*
3. *Unique landscape and vegetation;*
4. *Development proposals likely to affect community land or environmentally sensitive land;*
5. *Polluted areas;*
6. *Any storage and disposal sites of toxic and hazardous chemicals;*
7. *Waste management policies;*
8. *Threatened species and recovery plans;*
9. *Any environmental restoration projects;*
10. *Vegetation cover and any related instruments or policies, including any instruments relating to tree preservation.*

The SOE report is simply a means of monitoring the local environment and the effectiveness of Government and community actions in protecting and enhancing environmental attributes.

Rates and Levies

Financial assistance for vegetation conservation could be made available to landowners through local government under the LG Act. An increase in property based rates is the most obvious and direct way of increasing the resources of local government but this requires approval from the State government.

Rate rebates provide landholders with either a discount or exemption from rates on land that is managed for conservation. Tweed Shire Council currently applies a differential rating system between farmland and non-farmland. At present agricultural land is eligible for a 'Farm Land' rate, which is 40% lower than the general rate. It is possible that this scheme could be extended to provide a conservation incentive. Rate rebates are generally tied to conservation agreements. Landowners are exempt from rates if the land is the subject of a Voluntary Conservation Agreement under the Threatened Species Conservation Act 1995. Rate rebates provide landholders with financial recognition of the public benefit they are

providing through the conservation of vegetation on their land. Rate rebates, however, will have varying financial significance:

- in many rural areas a rebate on rates is likely to only provide a very small incentive as land values and rating percentages are relatively low; and
- in other areas, particularly near major urban centres where land values are high because of development pressure, a rebate on rates will provide a significant financial incentive (Cripps et al. 1999).

A number of councils throughout Australia, including Tweed Shire Council, have moved to introduce special environmental levies to fund environmental management projects. The rationale for using environmental levies is that they have the advantage of raising funds for a particular purpose, which can then be used to market to the community the need for increased revenue. In the case of Tweed Shire Council the environmental levy (Section 495 of the LGA) has been introduced to fund Agenda 21 projects. A special levy is also imposed on residents of Koala Beach Estate to fund management of koala habitat within the residential release area.

Management Plan

During each year, a council must prepare a draft management plan under the LG Act with respect to:

- the council's activities for at least the next 3 years, and
- the council's revenue policy for the next year.

The statement of principal activities must include activities to properly manage, develop, protect, restore, enhance and conserve the environment in a manner that is consistent with and promotes the principles of ecologically sustainable development. Council can only adopt the management plan after exhibiting the plan and taking into account public submissions. The environmental priorities of the 2003/2005 Management Plan requires the completion of this Strategy and to embody its results into the Tweed Local Environment Plan.

Public Land

Section 25 of the LG Act states that all public land must be classified as either 'operational' or 'community'. Community land may then be categorised as natural area, sports ground or for general community use. If it is classified as a natural area, it must be then further categorised into one or more of the following: bushland, wetland, escarpment, watercourse or foreshore, or into a category prescribed by regulation. Once classified, the council must prepare a management plan, which includes the objectives for the area, and the means by which these objectives will be reached. Section 629 states that it is an offence to unnecessarily or unlawfully remove or disturb a plant from a public place (public reserve, road, Crown reserve) and land vested in the council as public land.

5.1.1.6 Plantations and Reafforestation Act 1999

The Plantations and Reafforestation Act 1999 repeals the Timber Plantations (Harvest Guarantee) Act 1995. The objects of Plantations and Reafforestation Act are:

(a) to facilitate the reafforestation of land, and

(b) to promote and facilitate development for timber plantations on essentially cleared land, and

(c) to codify environmental standards, and provide a streamlined and integrated scheme, for the establishment, management and harvesting of timber and other forest plantations, and

(d) *to make provision relating to regional transport infrastructure expenditure in connection with timber plantations, consistently with the principles of ecologically sustainable development.*

In the Act, plantation means an area of land on which the predominant number of trees or shrubs forming, or expected to form, the canopy are trees or shrubs that have been planted (whether by sowing seed or otherwise):

(a) for the purpose of timber production, or

(b) for the protection of the environment (including for the purpose of reducing the salinity of the land or otherwise repairing or improving the land, for the purpose of biodiversity conservation or for the purpose of acquiring or trading in carbon sequestration rights), or

(c) *for any other purpose, but not principally for the purpose of the production of food or any other farm produce other than timber.*

This Act enables the Minister to authorise plantations on land not excluded or exempt from the operation of the Act. The former includes local government areas listed in either schedule 1 or 2 of the Act. The latter includes 'exempt farm forestry' which is the carrying out of plantation operations that do not exceed 30 hectares on a farm and does not involve clearing of native vegetation or State Protected Land that is not exempt under the Native Vegetation Conservation Act. Plantations authorised by the Minister are automatically exempt from any controls exerted by any other State Acts including the Environmental Planning and Assessment Act 1979. In determining an application to authorise a plantation the Minister must have regard to impact on Threatened Species, Populations, Ecological Communities and Critical Habitat under the Threatened Species Conservation Act 1995 and Fisheries Management Act 1994. The Act also makes provision for monetary compensation to the owner or manager of an authorised plantation in order to protect unique or special wildlife values.

The Act makes provision for the levying of contributions to upgrade roads and bridges or the maintenance of roads and bridges that are required as a result of increased traffic generated by plantation establishment and operations.

5.1.1.7 Coastal Protection Act 1979

The Coastal Protection Act 1979 applies to the coastal zone of NSW, as defined under the maps referred to in schedule 1. The Act establishes a coastal council of NSW, which give advice and information on the protection, maintenance and enhancement of the coastal zone. The Act also addresses development within the coastal zone. Development is defined to include the clearing or propagation of vegetation. A local government is prohibited from granting development consent within the coastal zone without the concurrence of the Minister. There are currently no areas in Tweed Shire affected by the provisions of this Act

5.1.1.8 National Parks and Wildlife Act 1974

The National Parks and Wildlife Act 1974 allows for the creation of numerous types of reserves including national parks, nature reserves, wilderness areas, wildlife districts and wildlife refuges. The Act applies to Crown Land or land acquired or dedicated by the Crown and to private land. Once an area is declared a reserve under the Act it essentially excludes the land from any controls by local government. Substantial areas have recently been added to the reserve system as part of the Upper North Coast Regional Forest Agreement. Interim protection orders can be made by the Minister on private land to protect conservation or heritage values on the site. The Act also provides for voluntary conservation agreements between the Minister for the Environment and the landholder. Such an agreement can be for the purpose of the preservation of flora and can impose positive management arrangements on the landowner and can be registered to make it legally binding on successive landholders. Some financial incentives can be provided by the Minister. Where a voluntary conservation agreement exists, councils must take it into account when assessing development applications under the EPA Act. Tweed Shire currently does not have any voluntary conservation agreements however a number of land owners have registered their properties as a Wildlife Refuge with the Service eg. Wollumbin Wildlife Refuge (Portions 67 and 3 Wollumbin), Hoskin Wildlife Refuge (Part Portion 160 Mooball) and Bag End Wildlife Refuge (Portion 74 Goonimbar).

5.1.1.9 Forestry Act 1916

The Forestry Act 1916 primarily applies to Crown land in NSW and allows the Minister to declare areas to be State Forests, timer reserves or flora reserves. Once an area is declared a State Forest it essentially excludes the land from any controls by local government. As a result of the recent Upper NSW Forest Agreement there is only one substantial state forest in Tweed Shire, Wollumbin State Forest that adjoins Mount Warning National Park. The Act establishes State Forests of NSW, which is the government body that has powers of control and management over timber on Crown Lands. These powers extend to the taking of timber, even from within a flora reserve, and the entering into agreements concerning the taking of timber, including privately owned timber. Licences can be issued for several purposes with people who actually carry out the work. Clearing permits cannot be issued for flora reserves.

5.1.1.10 Wilderness Act 1987

This Act aims to provide for the permanent protection and proper management of wilderness areas. A wilderness area is an area, which is in a state that has not been substantially modified by humans and their works or is capable of being restored to such a state and is of sufficient size to make its maintenance in such a state feasible. A landholder must consent to an area of land being subject to a wilderness protection agreement. The provisions of this Act bind local governments, not only by what activities they can approve in wilderness areas, but also in relation to developments they may wish to carry out in a wilderness area. The Minister's concurrence is required for any development approval within a wilderness area. The Act also provides for conservation agreements as provided under the National Parks and Wildlife Act 1974.

5.1.1.11 Roads Act 1993

The Roads Act 1993 provides that the interests of safety will override any other issue. Section 88 allows for the removal or lopping of any tree or other vegetation that is overhanging a public road and/or causing a traffic hazard. It would therefore appear that local governments are free to manage roadsides in accordance with any policies they may have on vegetation conservation. Tweed Shire Council currently maintains a register of significant roadside trees many of which are signposted to try and ensure that they are not damaged or removed during road maintenance works. Schenk and Wallace (1996) however found in a survey of roadside vegetation in Tweed that damage had been occurring to vegetation remnants and rare trees by Council and contract roadside units. Council's Recreational Services Unit have since implemented a monitoring regime using a GIS database to identify problems with significant roadside vegetation and any actions that have been undertaken or are required to address the problems.

5.1.1.12 Rural Fires Act 1997

The Rural Fires Act replaces the Bushfires Act 1949 and is primarily concerned with bushfire fighting and prevention. It also addresses the issue of bush fire risk management. The Act imposes a public duty on public authorities and councils to take steps to prevent the occurrence of bush fires on or originating from any land vested in or under its control or management. The provisions of the Rural Fires Act override many other provisions including the Environmental Planning and Assessment Act and Local Environmental Plans. NSW Rural Fire Service adopted a Bush Fire Risk Management Plan for Tweed Shire (TSBFMC 2001) in February 2002 in accordance with the requirements of the Act. The Management Plan takes into account bushfire hazard and the risk to natural and man-made assets.

Further discussion on the implications of bush fire management is presented in Sections 8.3.4.2 and 5.3.2.

5.1.1.13 Rivers and Foreshores Improvement Act 1948

The Rivers and Foreshores Improvement Act 1948 imposes additional requirements on local government with respect to development on the riverbanks and foreshore areas. The Act could potentially be used to control the vegetation clearance along rivers and foreshores by imposing conditions on a permit to minimise the disturbance and loss of the vegetation.

5.1.1.14 Fisheries Management Act 1994

The aims of this Act are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. In particular, the objects of this Act include:

(a) to conserve fish stocks and key fish habitats, and

(b) to conserve threatened species, populations and ecological communities of fish and marine vegetation, and

(c) to promote ecologically sustainable development, including the conservation of biological diversity, and, consistently with those objects;

(d) to promote viable commercial fishing and aquaculture industries, and

(e) to promote quality recreational fishing opportunities, and

(f) to appropriately share fisheries resources between the users of those resources.

Under the provisions of this Act councils are required to consider the impact of proposed development on threatened species, populations or ecological communities or their habitats listed in a schedule in the Act similar to provisions contained in the Threatened Species Conservation Act 1995. Of particular importance to the management of terrestrial vegetation are a number of *Key Threatening Processes*:

- *The removal of large woody debris;*
- *The degradation of native riparian vegetation along New South Wales watercourses.*

See the NSW Fisheries web site (www.fisheries.nsw.gov.au) for full details of scheduled Threatened Species, Populations or Ecological Communities and Key Threatening Processes.

5.1.1.15 Noxious Weeds Act 1993

The objects of the Noxious Weeds Act 1993 are as follows:

(a) to identify noxious weeds in respect of which particular control measures need to be taken;

(b) to specify those control measures;

(c) to specify the duties of public and private landholders as to the control of those noxious weeds;

(d) to provide a framework for the State-wide control of those noxious weeds by the Minister and local control authorities.

This Act applies to a plant declared, by order of the Minister published in the Gazette, to be a noxious weed. The order may declare a plant to be a noxious weed in respect of the whole of the State or a part of the State. The action required to be taken under this Act to control a noxious weed is the action set out below:

W1 noxious weed, the presence of the weed on land (or on/in water) must be reported to the local control authority and the weed must be fully and continuously suppressed and destroyed;

W2 noxious weed, the weed must be fully and continuously suppressed and destroyed;

W3 noxious weed, the weed must be prevented from spreading and its numbers and distribution reduced;

W4 noxious weed, the action specified in the declaration must be taken in respect of the weed. The action specified in relation to a W4 weed may be more or less stringent, and more specific, than the action required to be taken under the other control categories.

The occupiers of land (this includes owners of land) have responsibility for controlling noxious weeds on the land they occupy. This obligation applies to both private and public occupiers of land, including local control authorities, and can be enforced by the issue of weed control notices by the Minister and local control authorities.

Details of noxious weeds and environmental weeds in the Tweed are addressed in Section 8.3.4.1.

5.1.2 Non-Statutory National and Regional Framework

Government agencies, including local Councils, often develop strategies, policies and guidelines that provide direction on landuse planning and management that are relevant to vegetation management and biodiversity.

5.1.2.1 National Strategy for the Conservation of Australia's Biological Diversity

The National Strategy was developed by the Commonwealth Government in response to the Inter-Governmental Agreement on the Environment. The strategy aims to bridge the gap between current activities and the effective identification, conservation and management of Australia's biological diversity. This is particularly relevant to Tweed

Shire, which has a rich and diverse natural environment. Under this National Strategy, Local Governments are encouraged to cooperate with each other to develop regional biological diversity management plans, with assistance from the State Government.

5.1.2.2 NSW Biodiversity Strategy

The goal of the Strategy, introduced in 1999, is to *protect native biological diversity of NSW and maintain ecological processes and systems.* Implementation of the strategy focuses on the achievement of a core set of priority actions by 2001. The priority actions are primarily targeted at addressing the major threats to biodiversity and maximising conservation benefits. They are also intended to meet NSW commitments under the National Strategy for the Conservation of Australia's Biological Diversity. The objectives and priority actions within the strategy acknowledge that Local Government can play an important role in attaining the strategies goal through Local Environmental Plans and development control processes, management plans and local policies, State of the Environment reporting and by educating and involving local communities.

5.1.2.3 National Local Government Biodiversity Strategy

The strategy, endorsed by the National General Assembly of Local Government, recognises that:

- conservation and sustainable use of our natural resources will only be achieved through local area planning and management, along with community education and participation;
- there is a willingness of Local Government across Australia to play a lead role in dealing with our most pressing and complex conservation issue, the loss of biodiversity;
- a clear and cooperative partnership arrangement is required between the three tiers of government.

The strategy addresses five key issues and identifies relevant actions for each of the key issues. The actions require varying degrees of support from all tiers of government. The five issues are:

1. ***Awareness, training and eduction*** (aim to support local programs).
2. ***Local Government Resourcing***. This was considered a major issue for Local Government. The Strategy acknowledges that Council's have limited taxing power and require additional financial and human resources from central government. Local Government faces falling revenue and growing responsibilities in many areas.
3. ***Legislative Framework***. Council's are able to use local laws, planning schemes and policies to promote and encourage the conservation of biodiversity.
4. ***Regional Partnership and Planning***. In any given region there is a wide range of groups with an interest in biodiversity conservation such as catchment groups, landcare groups, state and federal government agencies and other councils.
5. ***Information and Monitoring***. Present knowledge on biodiversity is poor due to a lack of baseline studies, poor linkages between various databases and unwillingness to share data. GIS databases can be used to link critical information rapidly through council and the community. Monitoring and evaluation of management actions are critical to the success of the management cycle. Indicators are needed to measure biodiversity and need to be simple, measurable, accessible, relevant and timely (SMART). Reporting should draw on State of the Environment Reporting to monitor and disperse information on biodiversity.

5.1.2.4 North Coast Urban Planning Strategy into the 21st Century

Prepared by the State Department of Planning in 1995 to guide urban growth into areas on the NSW North Coast that are environmentally capable of sustaining further human population and associated impacts. In order to address planning issues facing the North Coast area, the strategy recommended 36 Strategic Actions for implementation by State and/or Local Government within 5 years. Strategy Action No 28 is particularly relevant to vegetation management.

5.1.2.5 Strategy Action 28

The DIPNR, in conjunction with the DEC, State Forests of NSW and local Councils, should identify regionally important natural areas and links between them, with a view to identifying a regional greenbelt network. Options for the holistic management of the greenbelt areas should be prepared, canvassing:

- significant wildlife corridors;
- endangered species and their habitats;
- regionally significant plant communities and species;
- wetlands and rainforests and their buffers;
- the need to support biodiversity on the North Coast;
- links with the 'regional open space' network being identified by Queensland's Southern Regional Organisation of Councils;
- scenic values;
- the need for green buffers between expanding urban areas;
- recreational opportunities.

Responsible Agencies include DIPNR, DEC, State Forests of NSW and local government.

5.1.2.6 Northern Rivers Catchment Blueprint

The Northern Rivers Catchment Blueprint (NRCMB 2002) was prepared by the Northern Rivers Catchment Management Board (NRCMB) to provide strategic direction for action and investment by all stakeholders in the catchment's (Tweed, Brunswick and Richmond rivers) natural resources. The Blueprint makes use of targets that are intended to result in measurable change in the short to medium term, and also identifies who will be responsible for implementation.

As a consequence of the recent natural resource management reforms (see Section 5.1.1.4) the Blueprint will be integrated into functions of the Northern Rivers Catchment Management Authority. The Blueprint identifies five areas of concern each with a *Catchment Target* and several related *Management Targets* (see Appendix 18).

5.1.3 Local Non-Statutory Framework

5.1.3.1 Tweed Shire Strategic Plan 2000+

Prepared by Tweed Shire Council to review both landuse planning and corporate planning for the Shire beyond the year 2000. The Strategy translates community values into declared policies and actions, which provide a sound basis for planning and decision-making. The Council's strategic plan is currently being reviewed (Tweed Futures).

A number of policies and actions are relevant to vegetation management. These include policies and actions on:

- identifying and promoting opportunities for plantation forestry;
- encouraging and providing incentives for revegetation and environmental rehabilitation;
- preparation of a Shirewide Koala Management Plan;
- reviewing Council's local landuse plans to protect significant areas of natural vegetation;
- monitoring the effectiveness of the Strategic Plan via 'State of the Environment' reporting;
- employing an Environmental Officer to assist in implementing the actions and recommendations of the Vegetation Management Plan.

5.1.3.2 Local Council Policies

Council has policy-making powers under the Local Government Act 1993, which can be relevant to vegetation management. Councils are not legally bound by these policies but they are usually given consideration in decision making. An example of a current Council policy relevant to vegetation management is an administrative policy on the procedures that Council and developers should follow when dealing with rezoning submissions within environmental protection zones under Council's Local Environmental Plan.

5.1.4 Other Council Activities

Local Councils undertake a variety of other activities, which play a role in local vegetation management. They are often governed by budgetary constraints and the level of staff initiative.

5.1.4.1 Vegetation Management Plan Steering Committee

Since 1996 a steering committee has been active to progress the development of a Vegetation Management Plan. An outline of the way in which the project and the committee has evolved was presented in Volume 1

The present make-up of the Steering Committee is generally in accordance with the NVC Act and consists of voting representatives from; Local Government, Rural Industries, Conservation Interests, Northern Rivers Catchment Management Board, Landcare/Bushcare interests, Local Government, Ecological Society of Australia, Richmond Regional Vegetation Committee, DIPNR and DEC. NSW Agriculture advised that they do not have resources to participate on the Committee. No nominations from the Aboriginal community were received however an open invitation has been extended to encourage their participation and other consultation has been carried out. The Committee also includes three non-voting members; Manager Strategic Town Planning (chair), Council project coordinator, and Council's consultant (Ecograph).

In its current form the Vegetation Management Plan Steering Committee is overseeing the development and implementation of this Strategy.

An abridged list of activities as at (August 2004) including community consultation undertaken by or on behalf of the Committee is presented below.

TVMP99 Consultation

- Project coordinator liaison with government and non-government agencies, Council staff and elected members (1996-1999).
- Greening Australia Consultation with Dunecare groups and Tweed Catchment Management Committee (1996).
- Mary Maher and Ass. Workshops with Steering Committee (March 1997) and Rural Industry Groups (April 1997).
- Tweed shire 2000+ Strategic Plan public consultation.
- Steering Committee workshop (December 1998) on Vegetation Management Options.
- Public Exhibition of Discussion Paper arising from above workshop.
- Review of Draft TVMP99 by CSIRO (Dr Richard Hobbs; October 1999).
- Public exhibition of TVMP99 (December 1999).
- Caldera Environment Centre public meeting and presentation of TVMP99 (December 1999).

Post-TVMP99 Consultation

- In-person consultation with members of the Aboriginal community (Traditional owners and TBLALC).
- Consultation with PlanningNSW (now DIPNR) regarding Council resolution to prepare a draft LEP and requirements for an Environmental Study.
- Formal consultations with State Agencies and other organisations commenced October 2001 (sec. 62 and 34A of EPA Act) for preparation of draft LEP and environmental study (this Strategy). Organisations consulted include: State Forest NSW, NSW Coastal Council, NSW Fisheries, DLWC (now DIPNR), NSW Agriculture, NPWS (now DEC), Richmond Regional Vegetation Committee, Clarence Regional Vegetation committee, NOROC Forestry Taskforce, Byron Shire Council, Gold Coast City Council, Lismore City Council, Kyogle Shire Council, Beaudesert Shire Council, Northern Rivers Catchment Management Board, Native Vegetation Advisory Committee, Planted Forests Division (NSW Forests), Tweed Byron Local Aboriginal Land Council (TBLAC).
- State Agency workshop (October 2001) on Steering Committee's adopted framework for vegetation management.
- Extensive consultation with Steering Committee and State agencies regarding State natural resource management reforms (e.g. NV Act, CMAs etc).

5.1.4.2 Estuarine Management Plans

Through the State Government's Estuary Management Program, Local Governments have an opportunity to obtain technical and financial assistance for the purpose of preparing and implementing estuary management plans, undertaking works to rehabilitate the estuarine environment and improving the recreational amenity of estuarine foreshores.

Tweed Shire Council has taken this opportunity to form two committees under this program;

- Tweed River Committee (TRC);
- Tweed Coast Estuaries Committee. This committee has been integrated with the Coastal Committee.

The TRMPAC has produced and implemented management plans for various sections of the Tweed River Estuary. Two examples of completed management plans for the Tweed River are:

- Terranora Broadwater Management Plan;
- Upper Tweed Estuary Management Plan;
- Cobaki Broadwater Management Plan.

The Tweed Estuaries Management Committee has prepared an Estuaries Management Plan for the Cudgen, Cudgera and Mooball Creeks, which was adopted by Council in August 1997.

These plans have a direct influence on vegetation management through formulation of a management framework and expenditure on works. Examples of a planned vegetation enhancement project include the proposed vegetative riparian corridor between Tumbulgum and Chinderah Bay.

Seagrass enhancement works are also planned as part of these individual management plans.

The TRC is a significant initiative by both Tweed Shire Council and the State Government whereby funding for planning and works are provided by royalties from river dredging.

5.1.4.3 Dune Care

At present, Dune Care groups are based at Fingal Head, Kingscliff North, Kingscliff High School, South Cabarita, Hastings Point and Pottsville.

Groups commenced in the mid 1980's at Kingscliff and Fingal Head. The main charter of these groups was to remove Bitou Bush and to revegetate the dunal systems. The dune care groups have taken on many other tasks in conjunction

with Council, such as construction of fencing, board and chain walks, viewing platforms and a nursery at Fingal to supply the groups within the Shire.

Council has, with the assistance of the Dune Care Groups, put together the Tweed Dune Care Advisory Committee and has recently developed a Strategy to remove Bitou Bush. It is now working on a universal strategy of maintenance and procedures, which will form the basic operational structure for all groups. Meetings are held on a bi-monthly frequency.

Council's most recent project was the North Hastings Point Dune Reafforestation and Effluent Re-use Project. This project drew much publicity and positive Local Government and community feedback. It also demonstrated the possibilities inherent in the co-operation of Federal, State, Local Governments, community groups and private sponsors.

The groups involved were the Department of Employment Education and Training, NSW Public Works, Tweed Shire Council, North Star Caravan Park, Tweed Training and Enterprise Company Ltd, DIPNR and Tweed Coast Dune Care Groups.

More recently, professional rehabilitation work has been undertaken in areas of high conservation value with funding from the Northern Rivers Catchment Management Board.

5.1.4.4 Reforestation and Rehabilitation Projects

Council, in 1984, purchased 1,000 hectares of land within the Byrrill Creek Catchment for the purpose of constructing a second water supply dam for the Shire. A further 120 hectares was purchased in 1994.

To optimise the community's return on this investment Council, in 1993, resolved to enter into a joint venture arrangement with NSW State Forests to develop a hardwood (eucalypt) plantation until such time as the land is required for dam construction.

As well as providing an investment, this project provides encouragement to other landholders in developing a sustainable plantation forestry industry.

Council's Recreational Services Unit has been involved in a number of bushland rehabilitation projects. Examples include rehabilitation of bushland at Council's Environmental Park, Pottsville, dune rehabilitation projects along the Tweed Coast, littoral rainforest rehabilitation at Hastings Point and Cabarita Beach and Council's Botanical Gardens at Duranbah.

5.1.4.5 Nurseries and Plant Propagation

Many Local Government nurseries propagate and distribute local tree and shrub species for urban plantings and local revegetation projects.

Tweed Shire Council is currently involved in the propagation of a number of native and exotic plants. This program involves several rare, endangered and regionally significant rainforest species, which are grown at Tweed Shire Council's nursery.

5.1.4.6 Public Open Space

Local Councils generally have a role in the care and control of Council owned open space or land parcels where it has trusteeship (some Crown Land). Local public open space has a variety of uses:

- Sport and Recreation;
- Nature Conservation;
- Drainage;
- Buffering against incompatible uses;
- Access;
- Visual Amenity.

Vegetation management for nature conservation is highly variable but there are often opportunities to protect and enhance areas of significant vegetation within local reserves and public lands. Tweed Shire Council, for example, have undertaken or promoted a number of projects over the years, which have benefits for nature conservation. Examples include:

1. Environmental Park, Pottsville. Approximately 20 hectares of bushland and associated community facilities (picnic areas, walking trails);

2. Enhancement plantings of urban and roadside parks with endemic species e.g. Bruce Chick Park, opposite Stotts Island.

Councils also have opportunities to negotiate with developers to secure significant areas of vegetation as public open space as part of development trade-offs. Recent examples in Tweed include dedication of approximately 170 hectares of bushland within the 'Searanch' urban release area north of Pottsville adjoining Council's Environmental Park, and over 100 hectares of wetland west of Pottsville Waters and Black Rocks urban estates.

A management plan has been prepared by the DIPNR in consultation with Tweed Shire for degraded Crown Land along the Tweed coastal foreshore. Most of this area has been stripped of its natural vegetation by past sandmining.

The Department proposes that these Crown foreshore areas be managed by Council. While this proposal has merit, the associated ongoing maintenance costs to Council and the community is a significant issue.

5.1.4.7 Other Council Owned Land

Local Councils utilise land for a variety of other uses apart from open space such as roads, water supply and sewerage treatment plants etc. These areas can often contain significant vegetation or provide opportunities for revegetation in conjunction with their primary operational role. A recent survey of Tweed Shire road reserves (Schenk & Wallace 1996) indicated that a high proportion contain rare and threatened plants. Council works associated with these areas can therefore effect their natural values. It is increasingly common for Councils to introduce an environment policy for Council works, and to provide information about conservation and other significant areas for use by Works staff that does not compromise the site's primary function.

For example, the NSW Roadside Environment Committee, a community and Government organisation with an interest in roadside management, is advocating the management of roads for other community benefits such as nature conservation and amenity.

Tweed Shire Council currently has a policy whereby Council undertakes to suitably identify rare and endangered tree species within Council road reserves to ensure that no undue damage is done to them in the process of normal road activity. Council has initiated this with the creation of a Significant Trees Register, which identifies and tags the location of a number of rare trees within Council road reserves. Unfortunately the roadside vegetation survey found that damage to vegetation remnants and tagged rare trees is currently being caused by Council roadside units and contractors. Schenk & Wallace (1996) identified various problems with accurately identifying and locating rare and threatened trees in the Significant Trees Register database.

This has been addressed, at least in part, by the reconstruction of the database into a more user friendly and rigorous format. Locational data is currently being updated and signs erected to warn of the presence of these trees by Council's Recreation Services Unit.

5.1.4.8 Acquisition of Private Land

Councils may consider securing areas of significant vegetation by acquiring freehold land. Funding options include Council's general fund derived from rates revenue (dependent on Council's budgetary constraints) and developer monetary contributions (Section 94 funding). The latter funding source has some disadvantages because it requires preparation of contribution plans that identify land acquisition well in advance, and identify the nexus between development, the proposed land acquisition and embellishments, Council's funding input and how the levy was determined.

Even allowing for transfer of general-purpose grants, the revenue claim that Councils can place on taxpayers is roughly one-sixth that of the States and Territories, and one-tenth that of the Commonwealth. If Councils are expected to reflect

national or state priorities in their own budgets, it could be argued that it is reasonable for Council to seek incentives (including funding) from other Governments to do so (Greening Australia 1995).

State and Commonwealth Governments provide a source of funding for land acquisition through various funding programs such as Landcare. In many cases, however, funds are only available on a dollar for dollar basis requiring some funding from Council. In addition, this source of funding requires a written application that is often complex. Not all applications are successful, and there is no guarantee of recurrent funding for maintenance work.

5.1.4.9 Education and Awareness

Local councils and other local and regional organisations can contribute much to educate the community about vegetation and biodiversity management. Examples of Council actions to educate landholders include:

- providing free advice to landholders and catchment committees and giving access to Council information on vegetation management topics;
- providing information on 149(S) Certificates on Council policy and statutory provisions relating to fauna and flora issues;
- undertaking demonstration projects, in partnership with other community groups, on land rehabilitation (perhaps in partnership with catchment committees and other community groups);
- sharing information with other Government agencies and community groups on vegetation management issues;
- employing environmental specialists to assist landowners, development proponents and Council staff in resolving nature conservation issues, and providing an educational role; and
- preparing an educational kit for schools and other educational establishments on vegetation and remnant bushland in Tweed Shire.

5.1.5 Funding Opportunities

There are a number of government and non-government funding opportunities available to landholders and local government agencies for the protection, management and rehabilitation of native vegetation, and for the preparation of vegetation management plans. Examples of funding opportunities include:

- Natural Heritage Trust Funding (Commonwealth Government);
- NSW Rivercare (NSW Government);
- Wetland Action (NSW Government);
- NSW Environmental Trusts;
- Heritage Council (NSW);
- Greening Australia;
- Native Vegetation Management Fund, Department of Infrastructure, Planning and Natural Resources;
- Local Government Development Contribution Plans;
- Rate rebates and differential rating;
- Funding available through the Tweed River Management Advisory Committee for riparian projects along the Tweed Estuary and its tributaries.

Funding is usually available subject to application to the relevant funding authority and may require a cash or in-kind contribution from the applicant to fund part of the project.

Tweed Shire Council in recent years has obtained funding for various projects from:

- Greening Australia;
- Environmental Trust of NSW;

- Natural Heritage Trust;
- Heritage Council (NSW);
- NSW Rivercare;
- NSW Government royalties from the Tweed River to fund Tweed River environmental, recreational, educational and planning projects.

5.2 Current Protection Arrangements

In order to set priorities for protection it is necessary to know the current level of protection. Highly significant areas that remain unprotected demand the highest priority. On the other hand ecologically significant areas that are well protected are only likely to require management aimed at the maintenance of ecological values.

A detailed spatial analysis of the security of bushland areas of the Tweed was presented in Chapter 12 of the TVMP99 (reproduced here as Appendix 11). This involved a review of land use planning mechanisms used in the protection and management of natural areas, and a conservation assessment which combined land use planning with ecological considerations. The results of these analyses indicated that at that time:

- Approximately half of all mapped bushland (51%) was at least partially protected.
- Over 9000 ha or 15% of mapped bushland was securely protected and managed. This figure represents nearly eight % of the total shire area.
- Only a relatively small proportion of mapped bushland (1.5%) that had a high level of ecological importance was likely to be threatened by development, given existing planning commitments. Nevertheless, this area involved over 900 hectares of bushland, the most prominent of which were at Kings Forest (south of Kingscliff) and in the Cobaki area. Other ecologically significant areas included parts of Tanglewood, Sea Ranch, Kingscliff and Uki.

In response to these findings a large number of general and specific recommendations were made. In the period since the TVMP99 some of these recommendations were incorporated in the Tweed LEP 2000 although major changes, particularly in respect of the Environmental Zones and issues related to the provisions of the Native Vegetation Conservation Act 1997 were deferred and contingent upon the outcomes of this Strategy. Since the TVMP99 had clearly identified most of the "problem" areas it was not considered necessary to revisit the planning protection analysis for the purpose of this Strategy. Thus, the intent of the outstanding unimplemented TVMP99 recommendations remain although due to the unavoidable changes in the administrative options (Volume 1) there will need to be corresponding changes to the way they are implemented.

Details on the suggested approach to implementation are presented in Volume 1.

5.2.1 LEP Issues

Tweed Local Environment Plan 2000 (Tweed LEP 2000) was gazetted on 7 April 2000 after exhibition of the draft plan in late 1998 and early 1999. This plan represents council's primary land use planning document. The first review of the plan in 1999 concentrated mainly on urban zones, a general updating of existing provisions and restructure of the plan framework in response to legislative reforms by the NSW State Government to introduce planning reforms on exempt and complying development and acid sulphate soils.

The second review of the plan was intended to focus on rural zones, particularly the environment protection zones. This review was reliant on the completion of the Tweed Vegetation Management Strategy (2004). Tweed Vegetation Management Strategy (2004) has now been completed with the assistance of the Vegetation Management Plan Steering Committee.

The rural zones and provisions contained in the current Tweed LEP generally reflect provisions contained in the plan it superseded, Tweed Local Environmental Plan 1987 initiated by council in 1982. Environmental protection zones in the 1987 plan were based on information collected from a number of sources including the then State Division of Fisheries (Wetlands) and the National Parks and Wildlife Service (wetlands and wildlife habitat).

The majority of the rural zones under Tweed LEP 2000, including the environmental protection zones, therefore reflect data, information and map drafting technology that is at least **20 years old.**

The majority of the environmental protection zones under Tweed Local Environment Plan 1987 were based on a combination of identifying prominent scenic areas (visible roads and settlements), known wetlands and wildlife habitat and a concept of a network of wildlife corridors. These corridors, according the Council's 1983 Rural Lands Study, were to enable the "*free movement of the more transitory animals between major habitat areas*". Environment zones under

Tweed LEP 1987 created connections (corridors) on private land between national parks, nature reserves and state forests, particularly in the western section of the Shire. This concept has been carried through to Tweed LEP 2000.

The Tweed Vegetation Management Strategy 2004, using more detailed data and the latest mapping technology, provides the framework for second stage review of Tweed LEP 2000. This Strategy uses detailed information and ecological assessment criteria to develop a more holistic and strategic approach to managing ecological processes within the Tweed landscape. The Strategy also acknowledges the recent NSW State Government natural resource reforms that create a substantial role for the new Northern Rivers CMA and DIPNR in managing native vegetation. The framework of draft Tweed LEP 2000 (Amendment 21) therefore represents a combination of improved data collection and mapping technology, a landscape approach to ecological management and integration of the Tweed LEP 2000 with the NSW State Government natural resource management reforms.

Apart from the need to rationalise the LEP with provisions of the Native Vegetation Act 2003 (a goal of this Strategy; see Volume 1) consideration of the current protection arrangements reveal a number of issues of relevance to the LEP's ability to a regulate clearing. At present clearing controls apply mainly under the Native Vegetation Conservation Act 1997, which is soon to be replaced by the Native Vegetation Act 2003. If the LEP clearing controls are to be consistent with the Native Vegetation Act 2003 major issues for the LEP include:

- The current LEP does not acknowledge the role of other State agencies in managing vegetation, particularly the role of DIPNR and the Northern Rivers CMA under the NV Act.
- LEP clearing controls are essentially limited to Environmental Protection zones and areas covered by the Tree Preservation Order (TPO 1990).
- The 7(l) Environmental Protection (Habitat) zone and 7(d) Environmental Protection (*Scenic Escarpment*) Zone is not clearly associated with areas of high ecological value (*Status* or *Sensitivity*) and high scenic value.
- There remains a small but significant proportion of areas with high ecological status that appear to have little regulatory protection and are currently subject to intense development pressure (mostly along the coast). Efforts should be made to increase Environmental Protection zones especially along the coast where development pressure is high.
- The TPO 1990 does not protect habitat (only large trees) and its application is spatially limited. Notwithstanding it does provide a significant disincentive for pre-emptive clearing where it applies.
- The NV Act should provide significant clearing controls in non- State Protected Land.
- In areas of State Protected Land (e.g. steep land) significant exemptions continue to allow unregulated clearing (e.g. up to 2 ha per year in certain circumstances) even for areas of high ecological value. This anomaly may be rectified by the preparation of a SEPP, however these areas cover a very large proportion of the Shire's bushland.
- The Rural 1(a) zone does not reflect differences in the potential for land degradation across the landscape, particularly on steep land. Consideration should be given to LEP provisions (zones, overlays or written provisions) that more closely reflect the management needs (and clearing issues, see point above) associated with lands vulnerable to degradation. Ideally, such provisions should be consistent with the definitions of State Protected Land category a) - Steep land.
- As a result of the lack of clearing controls, the current LEP does not anticipate the need for clearing exemptions associated with routine land management.
- In cases where clearing consent is required there are no clear guidelines for Council on how to address the site assessment requirements (Tweed LEP 2000, Clause 28(4)) for a development application.

5.3 Other Relevant Issues

5.3.1 Scenic Landscape Values

While this report is primarily concerned with nature conservation values, the identification of scenic and landscape values have important implications for environmental protection. It is noted for example that Clause 29 of the North Coast Regional Environmental Plan (1988; see Section 5.1.1.1) requires scenic values to be assessed in conjunction with those of nature conservation.

Brouwer (1995) prepared a scenic landscape assessment for the Tweed, which includes mapping of defined scenic categories. Her work provided a framework for planning and management of Tweed's scenic landscape values. Overlay of Brouwer's management categories with the bushland mapping was carried out for the TVMP99. This indicated that in addition to ecological values, there are relatively large bushland areas considered to be of high scenic value (see Map 11 of the TVMP99). Recommended strategies to address these scenic values in relation to vegetation management were presented in the TVMP99 (reproduced here as Appendix 12). In summary these included the following:

- Consideration should be given to placing a Tree Preservation Order or an Environmental Protection zone (or similar) over bushland areas within Scenic Management Zone A areas (where not already protected by such measures).

- All land use planning zones within Scenic Management Zones A-D should contain objectives relating to the maintenance or enhancement of scenic quality.

- Development Assessment guidelines based on the Scenic Landscape Evaluation Report need to be prepared to assist in the preparation and assessment of development proposals to ensure the scenic landscape values in these areas are maintained or enhanced.

5.3.2 Bushfire Management

Under Tweed LEP 2000 consent is required for bushfire hazard reduction work in the 6(a) Open Space and 6(b) Recreation zones. Consent is also required in Environmental Protection zones except where considered "Exempt Development" (i.e. consistent with the "Bushfire Hazard Reduction" exemption specified in DCP 40 Exempt and Complying Development). In all other zones including the rural zones such work can only be carried out under a DCP 40 exemption.

In relation to DCP 40, Bushfire Hazard Reduction is defined as *a reduction or modification (by controlled burning, chemical, mechanical or manual means) of material that constitutes a bushfire hazard*. Different requirements apply to areas zoned 7(a) Environmental Protection (Wetlands and Littoral Rainforest) and all other zones. In Zone 7(a) Bushfire hazard reduction must *be authorised under the Rural Fires Act 1997, or the State Emergency and Rescue Management Act 1989, in relation to an emergency within the latter Act.* If not in Zone 7(a) bushfire hazard reduction may also be *carried out as the result of written advice from the council to an owner or occupier of a lawful dwelling house that the vegetation is in a "fuelfree zone" within the meaning of the document "Planning for Bushfire Protection" published by the NSW Rural Fire Services, and the vegetation is likely to present a significant fire hazard.*

For most areas this means that hazard reduction works can be undertaken in accordance with the Tweed Bush Fire Risk Management Plan (TSBFMC 2001). The aim of this plan is to provide for the coordinated prevention and mitigation of bush fires for:

1. The protection of life, property and the environment within the community; and

2. The protection, maintenance and, wherever possible the enhancement of the natural and cultural values of the area through the management of appropriate fire regimes.

While the DCP 40 exemption is sufficient to allow the operation of the Bush Fire Risk Management Plan (TSBFMC 2001) under the Rural Fires Act 1997, Tweed LEP 2000 is silent on the considerations for granting consent where an exemption does not apply. The recent publication - *Planning for Bushfire Protection* prepared for PlanningNSW (now DIPNR) by the NSW Rural Fire Service provides guidance on this issue. It is recommended that an appropriately worded clause be added to the LEP under *Part 7 Hazards and Buffers* to address this issue.

A map of Bush Fire Prone Land, certified by the Rural Fire Service Commissioner, has recently (February 2004) been produced using data collected for this Strategy. Where development is proposed on bush fire prone land, section 79BA of the EPA Act requires the consent authority (council) to consult with the NSW Rural Fire Service Commissioner or be satisfied that the development complies with *Planning for Bushfire Protection* prepared for PlanningNSW (now DIPNR)

by the NSW Rural Fire Service. Bush fire prone land is also required to be identified on section 149 Planning Certificates under the EPA Act.

5.3.3 Koala Habitat Management

Tweed Coast Koala Habitat Atlas

In April 1993 Council resolved to contribute financially to the Australian Koala Foundation (AKF) to assist them in the preparation of a Tweed Coast Koala Atlas (Phillips & Callaghan 1996) for the eastern section of the Shire. The 37608 hectare study area comprises approximately 29 % of Tweed Shire.

The objectives of the AKF study were as follows:

1. to quantify tree preferences and habitat utilisation;
2. to delineate areas of Primary and Secondary Koala Habitat;
3. to examine the relationship of this information in terms of State Environmental Planning Policy No.44 (Koala Habitat);
4. to identify threatening processes; and
5. to recommend measures to provide Koala populations with a measure of long term viability.

The Koala Habitat Atlas (Phillips & Callaghan 1996) describes the following four categories Koala Habitat:

1. **Primary Koala Habitat** (2.5% of study area). Tree species preferentially utilised by koalas in which tree utilisation is independent of tree density. Preferred trees are a dominant or co-dominant component of the overstorey vegetation.

2. **Secondary Koala Habitat** (10.7 % of study area) **(Secondary (A) Habitat).** Tree species preferentially utilised by Koalas, on average, constitute less than 35 % of the overstorey vegetation.

3. **Marginal Koala Habitat** (10.3 % of study area) **(Secondary (B) Habitat).** Tree species preferentially utilised by Koalas are largely absent or otherwise occur at very low densities (<10%).

4. **Habitat Value "Unknown"** (0.7% of study area). Composition of the vegetation remains unknown, but where it is possible for one or more preferentially utilised tree species to occur as a dominant or co-dominant component of the overstorey.

The remainder of the study area has either been cleared of native vegetation (66.3 %) or contains other categories of vegetation not listed above (9.5%).

A detailed summary of the Koala Habitat Atlas including comments on related planning and management issues was contained within Appendix 10 of the TVMP99. In summary, however, Phillips & Callaghan (1996) recommended a variety of measures considered necessary to provide for the long term persistence of koalas in the Tweed Coast Study area, including the following:

- Introducing local and state moratoriums on land use activities that would have adverse impacts on primary and secondary habitat identified in the Atlas.

- Introduction of regulatory land use planning measures to protect potential koala habitat (LEP amendments, Development Control Plans, Tree Preservation Orders, Council policy, modification of Bushfire Management Plans/Strategies, Koala Management Plan -SEPP 44, encourage conservation agreements with NPWS (now DEC), traffic management, dog control).

- Initiate a community-based koala survey.

- Employ an environmental officer to supervise implementation of the recommendations.

- Introduction of co-ordinated feral dog and fox control programs with landholders and NPWS (now DEC).

- In consultation with the AKF develop guidelines and standards for assessing Koala Habitat.
- Promote koala habitat enhancement projects to re-establish viable koala populations.
- Consider protocols developed by the AKF for koala translocation.

In response to this report Council resolved on 2 July 1997 as follows:

1. Place the Tweed Coast Koala Atlas on public exhibition for a period of 28 days and provide a copy of the submissions to the AKF for their information.
2. Seek comments on the final Koala Atlas from relevant government authorities prior to the preparation of a Koala Management Plan.
3. Initiate a community based koala survey with the assistance of the National Parks and Wildlife Service.
4. Adopt as, an interim measure, areas mapped as primary and secondary (class A) Koala Habitat in the Atlas and the following Eucalyptus species as representing potential koala habitat in that area covered by the Tweed Coast Koala Atlas for the purposes of SEPP 44 and the Threatened Species Conservation Act 1995:Tallowwood *Eucalyptus microcorys*, Swamp Mahogany *E. robusta*, Forest Red Gum *E. tereticornis,* Hybrid *E. patentinervis* (*E. tereticornis x E. robusta*), Small fruited Grey Gum *E. propinqua.*
5. Seek assistance from the AKF or other appropriate consultants to help Council develop interim development assessment guidelines and standards to identify and manage core koala habitat.
6. Seek assistance from the National Parks and Wildlife Service and the AKF (or other appropriate consultants) to prepare a draft DCP (Koala Management Plan) for further public exhibition and review of submissions to the Tweed Coast Koala Atlas.

Community Based Koala Survey

In 1998, the Tweed Koala Rescue Unit in conjunction with Tweed Shire Council conducted an opportunistic community-based survey of the Shire's residents in order to solicit information on the koala observations and attitudes to their management. A copy of the survey form, which was included with Council's Tweed Link newsletter, is presented in Appendix 13.

At this stage the results of the survey have not been analysed in detail however the koala sitings reported from this survey and other sources (opportunistic reports from Environmental studies, DEC Wildlife Atlas and records of the Tweed Koala Rescue Unit) have been digitised and are presented in Map 6.

Although further work is needed to draw specific conclusions from the data used to produce Map 6, the map illustrates a number of important points:

- The vast majority of sitings are associated with population centres along the coast. This clearly indicates that suitable koala habitat occurs in close proximity to human populations.
- There are other sitings of koalas throughout the shire however because of the opportunistic way in which the data was collected it is not possible to determine whether or not koala densities are high in sparsely settled regions. At a minimum, however, the observations indicate that suitable (but not necessarily optimal) habitat occurs throughout the Shire.

Future Directions

Although enhanced protection of bushland habitat arising from this Strategy will help protect koala populations, such measures on their own will not adequately ensure the survival of this icon species on the Tweed. This is because their most suitable habitat in the Tweed is already highly fragmented and closely associated with human populations (see Map 6). In addition koalas often utilise isolated and scattered trees, which fall below the tree densities used to define bushland,

and are susceptible to numerous threatening processes (e.g. disease, road mortality, predation by dogs). For example Phillips (2002) stated that to ensure the long-term survival of koala populations on the Tweed Coast an innovative solution is required to reduce the potential for vehicle strike at major koala strike hot spots, such as on Clothiers Creek Road between Tanglewood and Cabarita.

The previously adopted recommendation to prepare a Comprehensive Koala Plan of Management is therefore reiterated in this Strategy. Such a Plan would eliminate the need to carry out individual assessments (under SEPP 44 – Koala Habitat Protection) but more importantly would help address the cumulative impacts that continue to threaten the viability of this species in the Tweed. Similar Plans have been implemented in other north coast jurisdictions with substantial koala populations (e.g. Port Stevens, Coffs Harbour). The Plan will need to integrate in further detail the results of the community-based survey as well as address issues related to koala population dynamics (e.g. recruitment, disease, mortality etc) and the management of threatening processes through land-use planning and other measures.

At present there appears to be sufficient data on the coastal koala populations to enable the preparation of a Comprehensive Koala Plan of Management for these areas, however the status of koala populations across the rest of the Shire is not well known. Philips (2002) suggests that koala densities are typically not as high in the hinterland and there is also little data on the most important habitats in these areas. It is quite likely that some areas away from the coast support suitable habitat that is not currently occupied.

It is therefore recommended that further survey work and analysis is carried out in the non-coastal regions of the Shire to determine the patterns of koala utilisation and the potential relationships between sub-populations. Such work could be carried out as part of Comprehensive Koala Plan of Management for the Shire.

5.4 Key Considerations

Based on the existing planning framework and analyses described in this chapter a number of recommendations can be made to assist the planning process. At this point, however such recommendations are limited to broad issues that arise directly from the analyses presented in this chapter.

1. Vegetation management planning provisions in relation to **protection** of natural areas should recognise both the effectiveness of the existing planning framework and ecological values associated with specific areas. In particular specific measures should be taken in urban areas to address ecologically significant areas with poor planning protection. Changes to the LEP should reflect issues highlighted in the TVMP99.

2. If the LEP clearing controls are to be consistent with the Native Vegetation Act 2003 other major issues for the LEP include:
    - The current LEP does not acknowledge the role of other State agencies in managing vegetation, particularly the role of DIPNR and the Northern Rivers CMA under the NV Act.
    - LEP clearing controls are essentially limited to Environmental Protection zones and areas covered by the Tree Preservation Order (TPO 1990).
    - The 7(l) Environmental Protection (Habitat) zone and 7(d) Environmental Protection (*Scenic Escarpment*) Zone is not clearly associated with areas of high ecological value (*Status* or *Sensitivity*) and high scenic value.
    - There remains a small but significant proportion of areas with high ecological status that appear to have little regulatory protection and are currently subject to intense development pressure (mostly along the coast). Efforts should be made to increase Environmental Protection zones especially along the coast where development pressure is high.
    - The TPO 1990 does not protect habitat (only large trees) and its application is spatially limited. Notwithstanding it does provide a significant disincentive for pre-emptive clearing where it applies.
    - The NV Act should provide significant clearing controls in non- State Protected Land.
    - In areas of State Protected Land (e.g. steep land) significant exemptions continue to allow unregulated clearing (e.g. up to 2 ha per year in certain circumstances) even for areas of high ecological value. This anomaly may be rectified by the preparation of a SEPP, however these areas cover a very large proportion of the Shire's bushland.

- The Rural 1(a) zone does not reflect differences in the potential for land degradation across the landscape, particularly on steep land. Consideration should be given to LEP provisions (zones, overlays or written provisions) that more closely reflect the management needs (and clearing issues, see point above) associated with lands vulnerable to degradation. Ideally, such provisions should be consistent with the definitions of State Protected Land category a) - Steep land.

- As a result of the lack of clearing controls, the current LEP does not anticipate the need for clearing exemptions associated with routine land management.

- In cases where clearing consent is required there are no clear guidelines for Council on how to address the site assessment requirements (Tweed LEP 2000, Clause 28(4)) for a development application.

3. In cases where clearing consent is required there are no clear guidelines on how to address the site assessment requirements (Tweed LEP 2000, Clause 28(4)). Vegetation management planning provisions in relation to **management and rehabilitation** of natural areas should also recognise that the existing planning framework provides both opportunities and constraints, which should be incorporated into the development of management and rehabilitation priorities.

4. Recommended strategies to address scenic values in relation to vegetation management were presented in Table 15.3 of the TVMP99 (see Appendix 12). In summary these included the following:

    - Consideration should be given to placing a Tree Preservation Order or an Environmental Protection zone (or similar) over bushland areas within Scenic Management Zone A areas (where not already protected by such measures).

    - All land use planning zones within Scenic Management Zones A-D should contain objectives relating to the maintenance or enhancement of scenic quality.

    - Consideration should be given to the preparation of Development Assessment guidelines based on the Scenic Landscape Evaluation Report to assist in the preparation and assessment of development proposals and ensure the scenic landscape values in these areas are maintained or enhanced.

5. The previously adopted recommendation to prepare a Comprehensive Koala Plan of Management (KPOM) is reiterated in this Strategy. The Plan will need to integrate in further detail the results of the community-based survey as well as address issues related to koala population dynamics (e.g. recruitment, disease, mortality, etc.) and the management of threatening processes through land-use planning and other measures. In particular vehicle/koala strike hot spots, such as Clothiers Creek Road, from Tanglewood to the coast require innovative solutions to enable long-term survival of local koala populations (Phillips 2002). Further survey work and analysis (in conjunction with the preparation KPOM or prior to it) is also necessary in the non-coastal regions of the Shire to determine the patterns of koala utilisation and the potential relationships between sub-populations.

6.0 Socio-economic and Cultural Issues

6.1 Introduction

Changes to the planning framework related to vegetation management have the potential to have social and economic implications. The assessment of such impacts are integral to the Environmental Planning and Assessment Act 1979 under which it is expected that any vegetation management provisions will be made. The consideration of socio-economic implications of vegetation management provisions is also required during the preparation of a Regional Vegetation Management Plan under the Native Vegetation Conservation Act 1997.

Importantly, it must be recognised that any impacts need to be measured against the current provisions that regulate (or promote) vegetation management. Of course this cannot be achieved until the exact nature of any proposed changes have been determined. As a preparation for such analysis however it is necessary to:

- Profile the local population and economy;
- Identify trends in the economy that may affect vegetation management;
- Determine current and likely demands on remnant vegetation;
- Outline some of the potential stakeholder impacts.

This chapter is not intended to be a comprehensive socio-economic impact assessment.

6.1.1 Historical Overview

Prior to 1840s when the first Europeans arrived in search of timber, the Tweed region was exclusively inhabited by the Minjungbal peoples of the Bundjalung nation (see Section 7.0 for details on issues of Aboriginal heritage). Timbergetters were followed closely by farmers and as the European population spread throughout the region land was cleared for dairying and cropping. The port of Tumbulgum on the Tweed River served as a centre for the region up until 1902 when the area was gazetted as a Municipality and Murwillumbah became the regional focus for trade and the centre for development. For most of the twentieth century the economy of the region was dominated by primary industry but in the latter decades of the century the shire experienced unprecedented population growth and associated residential development largely focussed on coastal areas.

6.2 Demographics

Demography is the study of populations and how they change. Demographic analysis is useful in identifying population trends for future planning. Important considerations include total population, population change over time, age, income, employment, education and living arrangements. These issues are examined in greater detail below. Employment characteristics are discussed in Section 6.3. Understanding population trends is essential to the analysis of economic development and trends within a region. The size and composition of the resident population establishes basic servicing needs that must be met by both government and the private sector.

6.2.1 Current Population

The total population of the Tweed Shire in 2001 was 74380. Table 6.1 shows the basic composition of the population based on the 2001 Census.

Table 6.1 Population Composition of the Tweed Shire 2001

Category	Males		Females		All Persons	
	No.	%	No.	%	No.	%
Total Persons*	36,196	100	38,184	100	74,380	100
Aged 15 years and over	28783	79.5	31208	81.7	59991	80.7
Aged 65 years and over	7954	22.0	9038	23.7	16992	22.8
Total Indigenous Persons	914	2.5	953	2.5	1867	2.5
Born in Australia	28986	85.0	30362	84.6	59348	84.8
Born overseas	5099	15.0	5537	15.4	10636	15.2
Speaks English only	33461	97.2	35141	97.0	68602	97.1
Speaks other language	964	2.8	1074	3.0	2038	2.9

*Includes Overseas visitors. *Source: ABS 2001 Census data*

Important features from Table 6.1 include:

- Almost one quarter (23 %) of the population were over 65 years of age;
- Indigenous Australians accounted for 2.5% of the total population; and
- A significant majority (85%) of the population is Australian born.

6.2.2 Population Growth

The Tweed Shire is the fastest growing area on the far north coast and one of the fastest in the State. Over the last decade (1991 – 2001; ABS 2001 census) the population of Tweed has increased by 47%. On current trends it is expected that the population will exceed 100000 persons by 2016 (TSC 1999). This represents an increase of 81% from 1991.

Importantly, the vast majority of this growth is expected to occur along the coastal strip (e.g. Cobaki, Bilambil Heights, South Tweed Heads, Kingscliff to Bogangar, and Pottsville).

The main source of this population increase is migration, particularly from southern cities. This migration consists mainly of retirees attracted particularly to coastal areas in search of lifestyle and cost of living benefits. There is also an impact of families with school age children moving to coastal and rural village communities also for lifestyle reasons, and migration out of the region of young people (15-30) in search of education and employment opportunities.

6.2.3 Population Distribution

Due to an historic emphasis on agricultural activity along the river and fertile plains, early patterns of European settlement were strongly influenced by topography, soils and drainage patterns. In particular the use of the river for transport supported the development of service centres such as Murwillumbah and Tweed Heads. Many of the more mountainous areas of the Shire escaped extensive land clearing and continue to support extensive areas of native bushland. Notwithstanding this, many steep lands were cleared for bananas and grazing and extensive timber getting altered the structure of many of the forests.

A decline in the importance of agriculture and a greater recognition of the values of the area in terms of lifestyle coupled with changing demographics has played a major role in determining the settlement pattern in more recent decades. Accordingly, recent development has focussed on coastal areas, with the majority of fast urban development in the Shire over the past decades occurring around Tweed Heads, Kingscliff, Pottsville and Terranora. Figure 6-1shows the proportion of the Shire's population residing in each locality.

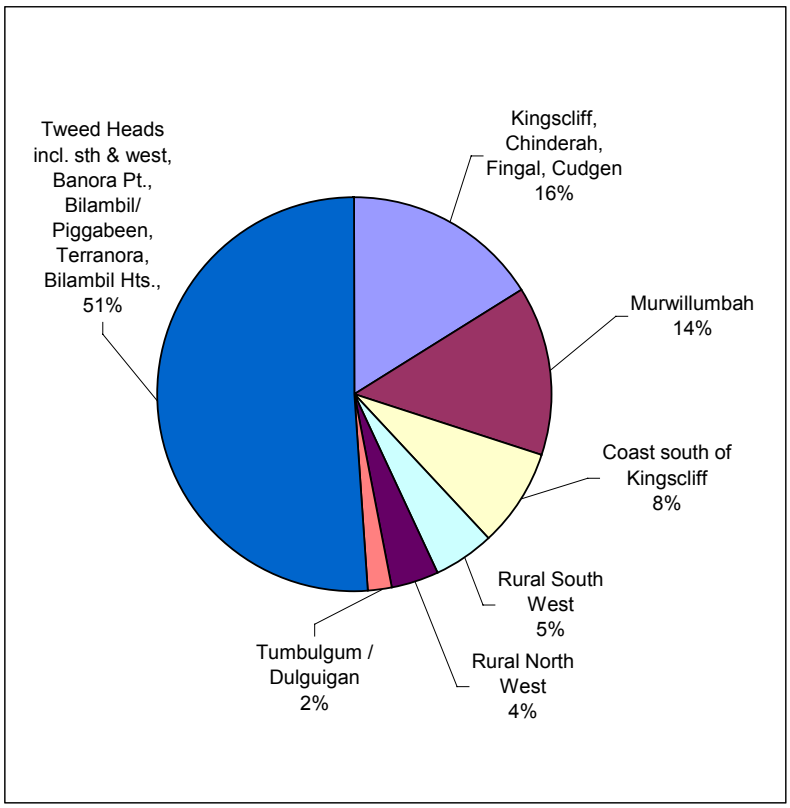

Figure 6-1 Population Distribution in the Tweed Shire (Source: TSC 1999)

As expected the vast majority of the population is concentrated in the urban and coastal localities, with Tweed Heads and surrounds accounting for over half of the Shires total population, Murwillumbah with 14%, and the rural coastal areas with 24% collectively. Further pressure to develop southern coastal areas is expected to follow the recent Pacific Highway upgrade, which bypasses Murwillumbah and the Burringbar Range.

6.2.4 Age, Income, and Housing

A relatively detailed profile of the population of Tweed Shire has recently been compiled by SKM (2001). The following summary of age, income, and housing arrangements is drawn from this source in conjunction with examination of the 2001 Census data (ABS 2001).

Some key features and trends associated with these demographic indicators are listed below:

- A higher than average percentage of peoples over 45 yrs of age with significant aging of the population expected over the next 15 years.
- A higher proportion in low-income brackets and a lower proportion in high-income brackets than NSW as a whole. This result is comparable to the North Coast region as a whole and is not unique to the Shire.
- Tweed Shire is dominated by single / detached dwellings accounting for 71% of the populations' living arrangements. The percentage is higher in the rural areas. The percentage of people living in semi-detached houses, townhouses, flats or units has increased to 21% (1996), up from 15% in 1986.
- The proportion of properties being rented (27.8%) is higher than for the north coast region (26.8%) but lower than that for New South Wales as a whole (28.8%).

6.2.5 Land Use

The Tweed Local Environment Plan 2000 sets out a range of land use zones. Broad land use categories and associated land areas are illustrated in Table 6.2.

Table 6.2 Broad Land Use Zones in Tweed Shire

Broad Category	Hectares	Percentage
Business	181.8	0.1
Industrial	221.5	0.2
Residential	3860.1	3.1
Rural Residential	1544.9	1.2
Rural (general)	69634.5	55.2
Rural (agricultural protection)	13233.7	10.5
Forestry	2136.2	1.7
Environmental Protection	13551.7	10.7
National Park	19036.0	15.1
Open Space	1776.7	1.4
River	5.8	0.0
Roads	5.8	0.0
Special Uses	889.5	0.7
Deferred	7.5	0.0
Total	126085.7	100.0

By far the greatest area is taken up with rural zoned land, with general rural use comprising approximately 55% of total land area in the shire. This land is located mainly in western areas away from the coast. A further 10% is protected agricultural land, which consists of prime agricultural land on the fertile river plains and red kraznozem soils. Approximately 15% of the shire is protected in National Parks and Environmental Protection Areas account for another 10%. These areas are fragmented and are located mainly on the periphery of the shire. Industrial, Business, Residential and Special Uses occupy a relatively small area of land located mostly along the coast, particularly in the north-east of the Shire. Significant commercial areas also occur around Murwillumbah.

6.3 The Economy

6.3.1 Major Economic Sectors and Trends

For the purposes of this Strategy, prevailing economic conditions and projections are presented in terms of two indicators, namely Gross Regional Product (GRP) which is a measure of value adding to the economy, and Employment. Table 6.3 shows projected GRP (in $1996-97) by sector and industry in the Tweed Shire. Table 6.4 shows the distribution of employment (full time equivalents) over the major economic sectors and industries in Tweed Shire. The information in these tables is sourced from ABS Census data compiled by SKM (2001).

Table 6.3 Projected Gross Regional Product for Selected Industries in Tweed Shire

Sector	Industry	Gross Regional Product					
		2001-2		2005-6		2010-11	
		GRP ($x'000)	%	GRP ($x'000)	%	GRP ($x'000)	%
Primary	Agriculture, Forestry and Fishing	47153	4.2	46377	3.5	44960	2.8
	Mining	7636	0.7	10200	0.8	14645	0.9
	Sub Total Primary	**54789**	**4.9**	**56577**	**4.3**	**59605**	**3.7**
Secondary	Manufacturing	77698	6.9	92021	7.0	113204	7.1
	Construction	85978	7.6	101623	7.7	125358	7.9
	Sub Total Secondary	**163676**	**14.5**	**193644**	**14.7**	**238562**	**15.0**
Tertiary	Electricity, Gas and Water Supply	18037	1.6	20105	1.5	23257	1.5
	Trade	179440	15.9	203686	15.5	240135	15.1
	Transport and Storage	76543	6.8	87452	6.7	103392	6.5
	Communication Services	28603	2.5	31583	2.4	35757	2.2
	Finance, Property & Business Services	288134	25.6	344750	26.3	424627	26.7
	Government Administration and Defence	37054	3.3	43078	3.3	52086	3.3
	Community Services	179224	15.9	213976	16.3	266744	16.8
	Recreational, Personal and Other Services	100006	8.9	118438	9.0	146551	9.2
	Sub Total Tertiary	**907041**	**80.6**	**1063068**	**80.9**	**1292549**	**81.3**
	Total	**1125506**	**100**	**1313289**	**100**	**1590716**	**100**

Table 6.4 Employment by Sector and Industry in Tweed Shire

Sector	Industry	1991		1996		2001*		2005-6*		2010-11*	
		No.	%	No.	%	No.	%	No.	%	No.	%
Primary	Agriculture, Forestry and Fishing	1475	8.8	1427	7.1	1381	5.6	1345	4.7	1301	3.8
	Mining	36	0.2	52	0.3	75	0.3	101	0.4	145	0.4
	Sub Total Primary	***1511***	***9***	***1479***	***7.4***	***1456***	***5.9***	***1446***	***5.1***	***1446***	***4.2***
Secondary	Manufacturing	1340	8	1615	8	1946	8	2259	8	2723	8
	Construction	1524	9.1	1882	9.3	2324	9.5	2751	9.7	3398	9.9
	Sub Total Secondary	***2864***	***17.1***	***3497***	***17.3***	***4270***	***17.5***	***5010***	***17.7***	***6121***	***17.9***
Tertiary	Electricity, Gas and Water Supply	135	0.8	117	0.6	101	0.4	136	0.5	158	0.5
	Trade	3697	22	4343	21.5	5102	20.9	5804	20.5	6849	20
	Transport and Storage	718	4.3	848	4.2	1002	4.1	1145	4	1352	3.9
	Communication Services	271	1.6	306	1.5	346	1.4	381	1.3	431	1.3
	Finance, Property &	1604	9.6	2183	10.8	2971	12.2	3535	12.5	4360	12.7

Sector	Industry	1991		1996		2001*		2005-6*		2010-11*	
		No.	%	No.	%	No.	%	No.	%	No.	%
	Business Services										
	Government Administration and Defence	605	3.6	732	3.6	886	3.6	1032	3.6	1249	3.6
	Community Services	2812	16.8	3513	17.4	4389	18	5244	18.5	6541	19.1
	Recreational, Personal and Other Services	2561	15.3	3167	15.7	3916	16	4641	16.4	5739	16.8
	Sub Total Tertiary	***12403***	***74***	***15209***	***75.3***	***18713***	***76.6***	***21918***	***77.3***	***26679***	***77.9***
	Total	**16778**	**100**	**20185**	**100**	**24439**	**100**	**28374**	**100**	**34246**	**100**

* Predicted

From these tables (and other sources), the following points are made:

- The overall economic contribution of the Primary industries to the local economy is relatively minor , with an estimated $54mill (4.9%) of GRP, and 5.9% of employment in 2001-2. This trend is expected to continue. Multiplier effects to other industry sectors are estimated to range between 1.3 and 1.5 for GRP and between 1.1 and 2.1 for employment (CEPM 2001; information supplied by Graham Martin of the Tweed sugar industry suggests that multipliers for the sugar industry may be as high as 5.5 for production and 3.0 for employment). A GRP multiplier effect of 1.5 means that for every $1000 generated $500 are generated in other industry sectors. According to CEPM (2001), sugarcane, and fruit growing are the most significant agricultural activities in terms of output and employment. Sugarcane and fruit (including bananas) each contributed (directly and indirectly via multipliers) approximately $19.4M to GRP in 1996-97. Fruit growing is the larger employer of the two. Contributions from grazing made a much lower overall contribution ($4.5M). Dairy cattle ($5.0M) and vegetables ($6.4M) made similar contributions.

- The Secondary sector contributes an estimated $163M (14.5%) of GRP and 17.5% employment in 2001-2 and is forecasted to remain stable. Manufacturing sector remains static in terms of employment, remaining at 8%. Increases in contribution to GRP are minor. Construction and Building sectors are stronger, but not predicted to increase greatly.

- The Tertiary sector is a major contributor to the Shire in terms of both GRP and Employment, with an estimated $907M (80.6%) of GRP and 76.6% employment in 2001-2. The contribution of the tertiary sector is expected to increase. The Tweed economy is increasingly moving towards a service based economy. Trade and community services are the sectors employing the largest percentage of labour, contributing 21.5% and 17.4% respectively in the 1996 census. Trade is however declining in importance, with the percentage share of employment and GRP both expected to decrease. Further growth sectors include recreation, personal and other services, which accounted for 15.7% in 1996, up from 15.3% in 1991. Tourism, property and business services are also growth industries.

In relation to unemployment, the rate within Tweed Shire fell slightly from 17.8% to 15.6% over the period 1991-1996 (SKM 2001). These rates are high compared to the state average of 8.8 % over the same period (SKM 2001) but are similar to other parts of the north coast.

In summary, economic growth in the Tweed Shire is slow but progressive. The population of the shire is growing rapidly, however high unemployment persists in the region. The Shire is suffering economic restructure similar to trends Australia wide, with the agricultural sector following a long-term pattern of decline, the manufacturing sector remaining stagnant, and the services sector expanding.

6.3.2 Demands on Remnant Vegetation

An important consideration for remnant vegetation protection and management is the demand made by industries on areas of bushland. For many economic activities the protection of bushland is incompatible. The magnitude of this demand reflects prevailing economic trends, land use and other constraints and community aspirations. Table 6.5 summarises major economic trends and the demands that various industries may place on remnant vegetation. Much of the information on economic trends in this table was compiled from SKM (2001). Predictions are based on little or no change in recent trends and planning initiatives.

Table 6.5 Summary of Likely Future Demand for Bushland

Sector / Industry	Role in the Economy	Major Trends	Demands on Remnant Vegetation
Primary (In general)	• **Minor**: Estimated $54M GRP (4.9%), and 5.9% of employment in 2001-2.	• Continued decline both in output and employment share, except in Mining and Extractive Industries which show small increases.	• **Relatively Low** at present although total areas involved may be significant. • Sector sensitive to new technologies and changes in commodity prices. • Most available already cleared.
Sugarcane	• Highly integrated into the local economy. • Highest value individual crop in the shire contributing $19.4Mto GRP in 1996-97, with much larger multiplier effects.	• Industry likely to remain stable at least in the medium term.	• Low – almost all suitable land already under production. • However all remaining floodplain ecosystems are considered to be ecologically important.
Fruit and Vegetables	• Together these industries make the largest contribution to agricultural output and employment.	• Vegetables forecast to remain strong and become more significant in the economy. Local markets are expanding. • Fruit - stable in short term but may decline in medium to long term. Economic constraints and competition from domestic and international markets may reduce viability of some crops.	• Low: Most land is already developed. • Most crops require fertile and arable soils. • Moderate for bananas: sensitive to commodity prices and best suited to steep land. Most suitable land previously cleared but some sensitive areas could come under pressure to clear.
Beef / Dairy	• Moderate and declining.	• Declining due to deregulation of dairy industry and viability and risk in beef cattle market.	• Low to Moderate – Except for very steep slopes, most existing bushland would support grazing (beef) if cleared. • Potentially relatively large areas in this category. • Threats unlikely to be realised until commodity prices improve and stabilise. • Very little direct threat from dairy due to intensive nature and need for flat fertile land (already cleared).
Timber	• Currently of low importance.	• Continue to be of minor significance, with potential to increase especially through plantation establishment.	• Low – clearfelling of native bushland for timber unlikely in foreseeable future. • Low for selective logging but there are issues with ensuring such is ecologically sustainable.
Extractive Industries	• Moderate importance – accounts for about 20% of total primary sector output.	• Expected growth area - In the Tweed closely related to urban growth and construction.	• Relatively Low due to intensive use of land.
Secondary (In general)	• **Low - Moderate**: Estimated $163M(14.5%) of GRP	• Forecasted to remain static.	• **Moderate** (see below).

Sector / Industry	Role in the Economy	Major Trends	Demands on Remnant Vegetation
	and 17.5% employment in 2001-2.		
All Manufacturing	• Moderate	• Stable in short term – decline in medium to long term	• Low - Moderate: Most land already zoned.
Building and Construction	• Moderate	• Stable in short term – may decline in medium to long term once urban expansion areas are filled.	• Moderate - High: mostly in coastal areas associated with urban expansion. Considerable areas not cleared. • Many significant habitats along the coastal strip. • Moderate for rural residential land uses. These uses take up relatively large areas of land and are a common source of impacts that threaten the viability of neighbouring bushland (exotic weeds and animals, rubbish, contaminated run-off etc).
Tertiary (in general)	• **Major**: Estimated $907M (80.6%) of GRP and 76.6% employment in 2001-2.	• Major Growth Area. Tweed is increasingly moving towards a service economy. • Tweed Shire is expected to remain a focus for tourism on the north coast.	• **Low** - most facilities located in already developed CBD areas. • Services themselves provide little threat to bushland but service demand is closely aligned to the construction industry in this region. • **Moderate to High** at construction phase for large tourist developments which present a risk due to their scale and desire to be close to ecologically sensitive areas such as beaches and National Parks.

6.4 Social and Cultural Issues

While ecological and economic imperatives have an obvious influence on the way in which we interact with the landscape, social attitudes and cultural practices are equally important. Indeed, policy that does not adequately reflect social considerations is unlikely to succeed. This section provides a broad overview of social expectations in relation to vegetation management and identifies some common concerns related to vegetation management reform. Lambert & Elix (2000) provide an excellent overview of the social values of native vegetation within NSW.

One of the problems with the analysis of social issues is that different sectors of society have varying social expectations even within local areas such as the Tweed. For example, some rural landholders are strongly influenced by the economic considerations and view native vegetation as little more than an economic resource. Other rural landholders have a very strong stewardship ethic, ecologists and other scientists are concerned with the long term health of ecosystems, while people from urban communities are commonly indifferent to vegetation management issues or express views related to aesthetic and recreational values of native vegetation. Aboriginal perceptions of native vegetation are finely balanced between exploitation and spiritual obligations (see Chapter 7.0).

Social values also change over time. For many decades after European settlement native vegetation was exploited as if limitless, but today there is a much greater appreciation of its value across almost all sectors of society. More generally, local community attitudes change with changing demographics, economic conditions, advances in understanding, and broader-scale expectations (e.g. regional, state, national, or international laws, treaties, agreements etc).

Although there have been no pertinent or extensive surveys of community attitudes to the natural environment on the Tweed, the analysis of demographic and economic trends (see previous sections) clearly imply profound changes in the social fabric over the last few decades. This is seen in:

1. High and continuing population growth evident as urban development concentrated along the coast;
2. A major decline in the economic importance of primary industries with subsequent increase in the service sector; and
3. Other land-use patterns such as the now extensive use of rural allotments for residential rather than commercial (farming) purposes.

One potential area of common ground among stakeholders is (or should be) the idea of sustainability. Ecologically sustainable development (ESD) recognises that development that improves the total quality of life, both now and in the future requires the maintenance of essential ecological processes. The principles of ESD have been endorsed by the Commonwealth, State and Territory Governments and Tweed Shire Council. From a social perspective an important key idea underpinning ESD is the concept of inter-generational equity. This means that our children (and their children) should be able to expect the same opportunities from our natural capital.

While few would disagree with the idea that our use of the environment should be sustainable, the issue is further complicated by the fact that concepts of sustainability vary, and that there are strong economic and other relationships between sectors of society. Irrespective of which stakeholder group one identifies, impacts (and benefits) from one sector inevitably flow on to others. For example, farmers or foresters might benefit directly from exploitation of areas of native vegetation but only because there is an economic demand for the products they produce. Obviously, the cost burdens need to be shared in some way between individual producers and individual consumers or consumers as a whole (taxpayers). It is this cost burden that is critical to the social acceptability or otherwise of vegetation reforms.

Despite recent demographic and economic changes rural landholders control most of the native vegetation in private ownership, and it is this group who are most likely to be affected by changes to the rules governing its management. Recent development of vegetation management plans elsewhere in the north coast region (e.g. Richmond and Clarence Regional Vegetation Management Plans; RVMPs) suggest the some common landholder concerns related to vegetation management reforms may include:

1. High compliance costs;
2. Infringement of property rights by effectively “locking up” areas or inhibiting routine work;
3. Unnecessary “red tape” and interference;
4. Failure to recognise economic imperatives to manage forest resources on a sustainable basis;
5. Regulations driven by a few recalcitrant operators which are applied at a cost to all;
6. Increased regulations act as a perverse incentive to those that have managed their forest resources well, while those that have not may be little affected;
7. Failure to recognise improvements in management techniques and the widespread adoption of stewardship obligations;
8. Too few incentives to offset costs;
9. Map-based controls commonly do not reflect on-ground conditions; and
10. Controls and legislation driven by known problems in other areas.

6.4.1 Stakeholder Impacts

To minimise the social and economic impacts of vegetation management reforms the planning response needs to recognise and anticipate:

- Social and economic trends;
- Sources of conflict and the extent to which planning controls can address these;
- Property rights and cost burdens;
- The extent of the positive and negative impacts;
- The environmental risks associated with inaction or the maintenance of the status quo;
- Legislative requirements;
- Current planning and management framework.

Of course the last of these points is the benchmark against which any impacts on the community need to be assessed. To be comprehensive such an analysis needs to evaluate the entire suite of regulatory controls **and** incentives that arise from the vegetation management plan in relation to the current provisions.

A brief qualitative assessment of some of the potential stakeholder impacts that may arise from the recommended changes to the vegetation management planning provisions in the Shire is outlined in Volume 1 after consideration of various implementation options.

6.5 Key Considerations

1. It is recommended that vegetation management planning provisions recognise the difference between urban (and peri-urban) and rural land uses. Unless the trends in agricultural viability change significantly, clearing provisions in rural areas that are not under development pressure (coastal areas) should be more flexible to enable landowners to carry out routine land management practices.

2. Serious measures (strategic and/or regulatory) should be taken to protect and minimise the loss of natural habitat within areas subject to pressure for urban expansion, particularly along the Tweed coastal area. These measures would also provide greater certainty on the future development potential of land within the Tweed Coastal area, which is and will continue to be under significant development pressure.

3. Given the low income base of the majority of rural landowners and the likely decreases in agricultural viability, all levels of government should canvass positive incentives to assist rural and rural residential landowners to protect and manage remnant vegetation and riparian areas.

4. Further consideration of any socio-economic impacts should be addressed once a *preferred* package of vegetation management provisions has been formulated and presented to the public for comment, including incentives. The nature and scope of any such an assessment should depend on both the extent and nature of public submissions. Any impacts should be measured against the clearing provisions in place at the time of the proposed change.

7.0 Aboriginal Values of Native Vegetation on the Tweed

7.1 Introduction

If we were to reduce the human history of Australia to just one hour we would find that European occupation fits only into less than half a minute. The remaining time belongs to the Aboriginal people who arrived here in canoes from Papua New Guinea and neighbouring islands nearly 60000 years ago.

Aboriginal use of the natural environment was governed by laws that evolved from the bond between the maintenance of natural resources and the physical and spiritual well-being of the people. The aggregation of these laws rendered the Aboriginal worldview, the *Dreaming*. This holistic system of beliefs governed all aspects of life. As a result Aboriginal common law embodied a form of natural resource management that ensured a balanced use of resources. The *Dreaming* is a time when ancestral beings of both human and animal origins travelled the country creating the form of the landscape and its inhabitants and is, for Aboriginal people, when history began (Schnierer *et al.* 2001). The value of native vegetation to Aboriginal people stems from this strong connection with the land and its resources.

Upon contact with European colonists, this relationship was seriously eroded by their forced dispossession from traditional lands and associated environments. Cook's arrival in 1770 is considered by most Aboriginal people to be the first step in the invasion of their country (RACAC 1996). Despite this Aboriginal culture has survived. In addition to its spiritual significance, indigenous Australians value native vegetation as a source of sustenance and medicine. Native vegetation also provides a source of education, recreation and employment. The state of the landscape, its plants and animals was, and still is, linked to the spiritual and physical wellbeing of Aboriginal people. Reconnection with traditional lands and associated resources is an important aspect of today's Aboriginal culture and identity. Aboriginal rights to access traditional lands and utilise natural areas are necessary for maintaining cultural and spiritual knowledge (Schnierer *et al.* 2001).

Aboriginal rights in biodiversity have been voiced at the international level through the United Nations Convention on Biological Diversity signed by over 180 nations including Australia. At the national level, these rights are expressed through the National Strategy for the Conservation of Australia's Biological Diversity, and the *Environmental Protection and Biodiversity Conservation Act 1999* (Schnierer *et al.* 2001). In NSW, the DEC is responsible for the protection of Aboriginal relics and places. Whatever the form of any provisions for vegetation management in the Tweed take, it is important to ensure that Aboriginal interests in vegetation management are adequately addressed.

The purpose of this chapter is to provide a brief overview of the Aboriginal interest in vegetation management on the Tweed, and suggest ways in which these interests can be satisfied.

7.2 Aboriginal Life on the Tweed

To understand Aboriginal connections to vegetation on the Tweed we must first look at the tribes that made the Tweed valley their home and the ways in which their society existed for the majority of human history in Australia. When trying to understand Aboriginal lifestyle before European invasion it is important to remember that the information available to us today is incomplete due to the absence of written history and alleviation of oral tradition. Accordingly, most of the information presented below is derived from written accounts of European or recent origin, and thus may present a distorted perception of Aboriginal life. The following summary of Aboriginal lifestyle on the Tweed is drawn mainly from the following sources: Steele (1984), Nayutah & Finlay (1988), Heron & Reed (1996), RACAC (1996), SKM (1998) and Graham (2001). Some interesting European accounts of Aboriginal life on the Tweed have recently been compiled by Lower Tweed Heads and District Historical Society in their journal - The Log Book (LTHDHS 2002).

Before European invasion, Aborigines dwelling in the area we know now as the Tweed were local groups of the Minjungbal dialect group within the Bundjalung Nation. The Bundjalung homelands extend from the Richmond River to the Logan River in southeast Queensland and westwards as far as Warwick (Steele 1984). There is, however, conflicting evidence about the names and languages of tribes and clans, or sub-groups, in the Tweed valley because of the differing names given to groups in the same area by different European authors. Steele (1984) suggests that the language of the Tweed was Ngandowal rather than Minyungbal (Minjungbal) as this name was equally applicable to other languages of the Bundjalung group.

Academics estimate the length of occupation in the Bundjalung area to be around 6000 years. This is based on the proven age of Sealands Rock Shelter (6 300 BP) and a cave near Kyogle of 6 100 BP. However, Heron and Reed (1996) observe that archaeologists have neglected to appreciate the significance of a 25000 year-old rock shelter known today as the Bushranger's Cave, in the Numinbah Valley.

Aborigines on the Tweed lived in a hunter-gatherer economy based on the natural environment. Tribes or clans were made up of an extended family unit, usually ranging from 20 to 35 individuals in a group. This seemed to be an ideal number to both maintain social solidarity of kinship and provide a capable group of hunters. These family groups combined on occasions for special hunting and gathering purposes and multi-tribal gatherings took place at certain times to share and trade commodities. It is thought that while this society incorporated a degree of nomadism, movement of tribes was generally for social purposes not in order to take up residence in another location. Cooperation and interdependence were essential survival tools within the family group. Many tasks were gender specific with the responsibility of hunting and territory lying with men while women gathered fruit, roots, nuts and small animals.

Early European descriptions of Aborigines in the Tweed area as large, athletic and muscular suggested that the people ate well. Their diet would have been protein rich with shellfish as a significant staple as evidenced from studying middens. Fish, crabs and pippies were popular, supplemented by animals and plants from coastal forests and wetlands. Nayutah & Finlay (1988) and Graham (2001) provide comprehensive lists of food sources and emphasise that this natural supply was used wisely by spreading consumption over a wide range of sources and over different environments at different times of the year. The cultural response to this was an omnivorous, semi-nomadic existence.

Resources were used on a sustainable basis and in ways that recognised the constraints of their physical environment and acknowledged the needs of future generations. For example, Graham (2001) suggests there is evidence that hospital hill at Murwillumbah was not hunted so that it could be a store of food when the land around it was under flood. This type of demand control in a supply driven economy allowed minimal human impact on habitats and other species. Unlike the landscape changes that have occurred since European colonisation (*c.* 200 years BP), there is little evidence of such major impacts on the native habitats of the Tweed over the 6000+ years that Aborigines exercised their stewardship. In fact, early European observers marvelled at the abundance and diversity of the native wildlife.

This lifestyle was maintained until the devastating effect of the European invasion that followed from the appearance of John Oxley in 1823. The infringement of "white man" initiated a process of mass reduction of biodiversity and the decimation of Aboriginal people and culture. Driven by an agricultural and industrial focus, land clearing and the introduction of exotic species, altered or destroyed habitat vital to both native plants and animals and to the Aboriginal people. The refusal of colonists to recognise Aboriginal land rights meant that Aboriginals were forcibly dispossessed of their land and resources, without treaty, thus restricting traditional environmental management practices that had sustained the environment for thousands of years (Schnierer *et al.* 2001). Additionally, the impact of disease and massacres caused the population to crash. According to Graham (2001), out of possibly 1000 Aborigines on the Tweed in the 1840's, there were only 93 left in 1890 while the European population escalated from 0 to 2460. The last "full blood" Aboriginal person (Biddy Richmond from Fingal) on the Tweed died in the 1930s (LTHDHS 2002).

Despite this, the recent population census (ABS 2001) reveals that there are 1867 persons who identify as indigenous on the Tweed. This represents 2.5 % of the human population. Most of the descendants of Tweed Aboriginal inhabitants reside in coastal areas of the Shire such as South Tweed Heads, Fingal and Chinderah. Today most Aboriginal people are aware of their heritage and are concerned with the maintenance of Aboriginal culture and identity. Central to this, is reconnection with traditional lands and involvement in the management of natural resources. Notwithstanding, it is important to recognise that there is a large diversity of opinion within the local Aboriginal community. The Tweed Byron Local Aboriginal Land Council (TBLALC) provides a focus for Aboriginal advocacy but does not claim to represent all Aboriginal interests in the area.

7.3 Aboriginal Values and Vegetation Management

Schnierer *et al.* (2001) provides a concise overview of traditional and contemporary Aboriginal values of native vegetation throughout NSW and much of the following section is drawn from this source, and RACAC (1996).

The identification of indigenous values of native vegetation is problematic when removed from its Aboriginal context. Attempts to describe Aboriginal cultural values through classification ultimately fail to portray the complete Aboriginal reality. A holistic approach can provide a more accurate description but it is often at odds with non-indigenous Australian's perceptions. These difficulties can be attributed to:

> *...the holistic outlook maintained by Aboriginal people where all values are connected and inter-related; The personal nature and complexity of Aboriginal values placed on particular plants and places; A culturally insensitive history of consultation that has occurred with Aboriginal traditional knowledge holders; and a reluctance in the indigenous community about further sharing of knowledge without adequate protection of intellectual property rights.*
>
> (Schnierer *et al.* 2001).

Aboriginal people have been deeply offended by the failure of many non-indigenous Australians to recognise and respect the source of knowledge and to maintain it. This is because recognition and respect underpin Aboriginal knowledge systems. As a result, few are willing to share knowledge about their culture and values. Increasing the involvement of Aboriginal people in biodiversity management may help engender the trust and respect that has been lacking from past relationships between Aboriginal people and non-indigenous people.

The concept of Aboriginal land value is difficult for many non-indigenous people to grasp. To the indigenous Australian, land is the primeval source of life containing within it the spirit of each person. Land creates the unique identity of each individual, shaping itself into a 'place' for each person, his or her 'Country'. 'Country' is the preferred term to illustrate this concept and is used to refer to a place of origin, physically, spiritually and culturally. It encompasses all the places, resources, values, stories and cultural obligations connected to a particular geographical area and includes both land and sea which are viewed as inseparable elements. Aboriginal associations with their country are pivotal to the "Dreaming" and are thus explicitly linked to their history. The "natural" landscape is particularly valued because it provides a link to the traditional landscape (RACAC 1996).

7.3.1 Spiritual Values

Aboriginal spirituality is based on their oneness with the land and everything connected to it. Aboriginal stories provide the origins of natural landscapes including how the stars, the mountains, the waterholes, the minerals and the plants and animals were created. To Aborigines, forest and other native vegetation types are the protectors of sites of significance. Each clan has its own unique places that provide their people with spiritual links necessary to maintain connections with their spiritual ancestors. These sites are sacred and hold deep religious significance (RACAC 1996). In the Tweed area Wollumbin (Mt. Warning) is an example.

The spiritual value and significance placed on native vegetation is well illustrated by the following story related by a Bundjalung woman elder (cited in Schnierer *et al.* 2001 after Becker undated). The tale describes an initiation ceremony performed in the early 1820's on the woman's great grandfather who was the chosen "Mytha" of the tribe.

Bundjalung initiation

A spirit from the time of the Dreaming had chosen a tree for this ceremony. Spears were thrown into its bark until the red sap flowed. The Mytha placed his fingers into the red sticky sap then placed it upon his tongue. Incisions forming a pattern cut into his flesh has this same red sap of the tree rubbed into them, thus anointed he was led away by the men of the tribe to a chosen place in the forest to celebrate with a corroboree of initiation.

'Women are forbidden near this place, it is a sacred place for men. No women ever dared look upon such a place. They have their own ceremony to celebrate the occasion and their own bora ring in which to dance.

'That tree now old and gnarled, having survived the elements and the coming of the white man, stands as sacred to the people of the Bundjalung as Westminster Abbey is to the English, who in 1821 crowned a king of their own; George IV of England.

7.3.2 Bush Foods and Medicinal Values

Existing in a hunter-gatherer based economy, native vegetation provided social, cultural and economic benefits. Bush resources also contain considerable health and nutritional benefits. Aboriginal knowledge about bush foods and medicines is extensive and holds economic value evidenced in the growth of bioproducts industries, including areas such as pharmaceuticals, agribusiness and herbal medicines. This ongoing use of bush medicine in addition to western treatment can be seen in most Aboriginal communities in NSW. These medicines are often supplied to hospital patients, even though in some instances these plants need to be collected from protected areas such as National Parks. In general,

Aboriginal people have not been credited with a fair share of the economic benefits derived from the commercial exploitation of their traditional knowledge (Schnierer *et al.* 2001).

7.3.3 Traditional Uses of Native Vegetation

Native vegetation also holds Aboriginal value in its many traditional uses. Tree fibres provided implements such as spears, shields, boomerangs and coolamons, and raw materials for artwork. Today, similar artefacts are still made from forest products. Lightweight spears and floats for fishing nets are made from the stems of several types of 'kurrajongs' and heavier spears from ironbark. Ironbark, red cedar and 'cherry' also provide wood for boomerangs, woomeras and carvings while shields are made from fig tree wood and stinging tree timber made paddles for boats (Schnierer *et al.* 2001).

In some areas fishing nets are stilled tanned with plant barks like black wattle, ironbark, which produces a strong stiff tan finish, and honeysuckle which, because it makes nets strong and supple with good colour, is said to be the best net tanner. Other plants such as mat rush, flax lily, cane, several types of 'kurrajong' and the inner bark of black wattle can be used in baskets, rope and string making (Schnierer *et al.* 2001).

7.3.4 Education, Employment and Recreational Values

While there are those values that are closely associated with significant sites and traditional uses, there are others related to land, training, employment, teaching and recreation. There is a growing number of Aboriginal communities in NSW seeking greater access to forests and cultural sites in order to pass on traditional knowledge and help maintain their cultural identity (Schnierer *et al.* 2001). On the Tweed the Minjungbul Aboriginal Centre provides a focus for Aboriginal education and cultural awareness.

7.4 Sites of Significance on the Tweed

Because Aboriginal history and knowledge is passed on by way of oral tradition, art, dances and music there are no books that can be bought or loaned from libraries. This means that the only access Aborigines have to their culture and history are the sites which remain in local regions. These sites may also be a part of the *Dreaming* of the local regions and may include events that involve ancestral beings during the time of creation (Heron & Reed 1996).

Remnants and relics of Aboriginal history are spread throughout the Tweed Shire and while these sites are important cultural assets to the Aboriginal people of today, they also hold educational, archaeological and aesthetic value to the wider community. According to a recent survey (TSBFMC 2001), along the costal strip stretching from the south bank of Tweed to the north bank of the Brunswick River there are currently 42 archaeological sites registered with the NSW DEC. Of these 26 are shell middens, 8 are open campsites, 5 are Bora/ceremonial grounds, 2 are burials and 1 is a sacred tree.

A few of the better known sites on the Tweed are listed below (see Steele 1984; Nayutah & Finlay 1988; Heron & Reed 1996):

- **Wollumbin (Mt. Warning)** - Wollumbin is viewed in the Aboriginal perspective of it being the warrior or fighting chief of the mountain. Legends told of the scars on the mountainside being wounds inflicted in battle and the thunder and lightning the result of these battles. It is said that from certain angles the face of the warrior is evident in the mountain outline. This is as close as many Aboriginal people would have gone, as access to the top was restricted to only the fully initiated men. Wollumbin is a very sacred initiation site for men. It is near impossible to find a Bundjalung person who does not consider Mt Warning to be an area of the highest significance. This single mountain helps provide Bundjalung people with a sense of identity and understanding of where they belong in the scheme of life.

- **Red ochre at Cudgen** - Inland from Kingscliff is a ridge of red soil on which the village of Cudgen stands. According to Joshua Bray (c.1900):

  > *...there is a hill at this place where the blacks get the red raddle or pigment to paint themselves with when going fighting or to corroboree.*

The word "Cudgen" means red clay used for body painting.

- **Tweed Heads South Bora Ring -** An important Bora ring has survived just across the Tweed River from Fingal. The site is under the control of the DEC, is open to visitors and is reached by an entrance in Duffy Street. The ring is 22.5 metres in diameter, a pathway extends for a few metres from the western side of the ring and the sandy soil is scattered with seashells. Ceremonies were held there until 1910.

- **Razorback Lookout -** Known to the Aboriginals as Choongurra-ban-narin de-arn, the pelican corroboree ground. According to legend, this hill was the site of a dreamtime corroboree in which all the birds took part. The colours they chose to paint themselves for the corroboree are the colours they have to this day.

- **Cave at Point Danger -** There is a dark cave on the face of Point Danger in Tweed Heads where the sea made a terrific noise in heavy weather. The Aboriginals named the cave Moy-nogumbo, meaning black dog and believed lightning created the cave.

- **King Duranbah's Grave -** Located on a ridge to the west of Limpinwood. The grave has been destroyed by vandals but originally consisted of white chalcedony stones. Semi-precious ornamentation was normal at graves, bora grounds and other sites of sacred importance in the Tweed district. The location of Duranbah's grave is of particular importance because it was on the main route from the Tweed to Beaudesert. It is said that Duranbah, on the occasion of his death from influenza, was returning to Beaudesert after visiting his mother at Fingal.

- **Aboriginal Giantess's Grave -** A stone arrangement existed at Terragon in 1885. Sketches of the arrangement show a ring of twenty or thirty standing stones about five metres in diameter. Within the circle were a number of clear sparkling coloured stones of all shapes and a grey crescent-shaped stone about 280 millimetres long. The site is now lost but was probably on the southern slopes of Mt Terragon. The "Aboriginal giantess's grave" name was derived from a legend told by Wollumbin Johnnie (European nickname for the chief of Murwillumbah clan in the 1870s) about a giantess, 3 metres tall who lived on the Tweed before European settlement. The site however was not a real grave as treasure hunters dug up the site and found no bones. It was Mythical.

7.5 Lost Sites and Restricted Knowledge

In addition to the well-known sites it is likely that there are many other sites that are either known only to a few or have been lost from oral tradition. For religious or cultural reasons and because the significance of important places has not always been respected, there is an understandable reluctance among Aboriginal communities (and individuals) to divulge details of all areas that hold significance. Important sites may also have been "lost" as a consequence of the breakdown of traditional cultural practices. These sorts of sites are nevertheless an important link to indigenous past and must be protected for the benefit of Aboriginal descendants and the wider community.

While it is relatively easy to address known areas it is much more difficult to ensure land uses are compatible with Aboriginal values when these values are not known. A major challenge for land use planning is to find some mechanism to ensure that Aboriginal values are protected even when they are not known in advance.

7.6 Planning and Management Response

A recent publication by the Australian Heritage Commission (AHC 2002) outlines a number of principles that should underlie appropriate planning and management responses that affect Aboriginal values. These principles state that indigenous people:

- *Are the primary source of information on the value of their heritage and how this is best conserved;*
- *Must have an active role in any Indigenous heritage planning process;*
- *Must have input into primary decision-making in relation to Indigenous heritage so they can continue to fulfil their obligations towards this heritage; and*
- *Must control intellectual property and other information relating specifically to their heritage, as this may be an integral aspect of its heritage value.*

In identifying and managing this heritage:

- *Uncertainty about Indigenous heritage values at a place should not be used to justify activities that might damage or desecrate this heritage;*
- *All parties having relevant interests should be consulted on Indigenous heritage matters; and*
- *The process and outcome of Indigenous heritage planning must abide by customary law, relevant Commonwealth and State/Territory laws, relevant International treaties and convents and any other legally binding agreements.*

Consistent with these principles there are a number of ways in which the vegetation management planning process can help safeguard Aboriginal values. It is important to recognise however that scope of such initiatives are confined to vegetation management and landuse issues, and consequently provide only limited opportunity to redress past injustice and present economic disadvantage.

7.6.1 Capacity Building

According to Schnierer *et al.* (2001) one of the major factors inhibiting Aboriginal participation in natural resource management is a lack of experience and understanding of the planning process. Many Aboriginal people feel uncomfortable with the decision making process and as a consequence do not always make their views known. Although the need to involve Aboriginal people in decision making is now widely recognised, resources and cultural priorities also limit their participation. Many Aboriginal communities are struggling to remain economically and culturally viable and demands for their input cannot always be satisfied. This is especially so for bureaucratic activities such as participation on statutory or other committees, where direct benefits to their community are not immediately apparent. Added to the socio-economic disadvantage is widespread and understandable suspicion of government initiatives, and widely divergent opinions within the Aboriginal community itself. This latter point presents considerable difficulty when it comes to seeking adequate representation on a wide range of issues including the management of natural resources. The lack of effective Aboriginal representation on the Vegetation Management Plan Steering committee is symptomatic of these issues. At present the committee maintains an open invitation to the Aboriginal community to participate in its activities.

Given the wide range of Council activities (e.g. community health, land use planning, natural resource management, education, arts and cultural exchange etc.) that require or could benefit from Aboriginal input it is suggested that Council consider employing an Aboriginal Liaison Officer to help coordinate such input. For the vegetation management planning process this would substantially alleviate the problem of individually consulting with numerous Aboriginal interests regarding undocumented places or resources of significance.

A possible, but less attractive alternative is to maintain an open invitation to participate in the activities of the Vegetation Management Plan Steering Committee but also explicitly forward details of development applications to the Tweed Byron Local Aboriginal Land Council (TBLALC) so that they can identify any potential problems. While this approach would partly address the issue of restricted knowledge, it could only be expected to represent the views of that organisation rather than the Aboriginal community as a whole. Such an approach may also place an unwarranted financial burden on TBLALC, which is not a statutory authority.

7.6.2 Development Applications involving Bushland Clearing

Whatever the administrative mechanism, a protocol is needed to ensure any impacts on Aboriginal cultural values are adequately assessed. For development applications involving the clearing of bushland, it is recommended that potential impacts on Aboriginal cultural values be included as a "matter for consideration". Such impacts should extend beyond direct impact on significant sites and relics to include impacts on the contemporary Aboriginal cultural practices. English (2001) lists examples of questions that may need to be asked in relation to the assessment of such impacts:

- *Is development going to affect resources used by the Aboriginal community on adjoining lands (e.g. public lands, Aboriginal owned lands) by causing a decline in environmental health?*

- *Is the development going to affect the community's access to areas used for wild resources use and collection?*

- *Is the development going to affect resources used by the community on other sections of the property being developed?*

- *Is the development going to lead to increased pressure on wild resources (e.g. fish shellfish) due to an increase in the local human population?*
- *Are there any other areas that the community can use/access to obtain wild resources if the development goes ahead?*
- *Is the development going to limit the ability of families to engage in group activities which are currently a major forum for passing on and learning cultural knowledge (e.g. during food collection or visits to a special site/place?*
- *Is the development going to adversely affect the health of members of the Aboriginal community by limiting their use of wild foods and resources?*
- *Is the development going to contribute to a decline in the strength of community esteem and identity by limiting the community's capacity to undertake cultural activities associated with landuse and education?*

7.6.3 Strategic Protection of Known Areas of Significance

At the strategic level efforts should be made to protect important known sites of Aboriginal heritage. These should be identified by schedule in the Local Environmental Plan (LEP) or specifically zoned to control incompatible land use activities. The Aboriginal community should be consulted on the inclusion and extent of individual sites where they are not already protected by a heritage schedule or restrictive landuse zone.

7.6.4 Access to Important Resources

Because the definition of clearing includes any harvesting or damage to vegetation it is necessary to provide an exemption to facilitate the clearing by local Aboriginal peoples for the purpose of traditional Aboriginal cultural uses. Of course access to property may need to be negotiated with the landholder. Harvesting as a commercial enterprise however should require consent.

7.7 Key Considerations

1. Council employ an Aboriginal Liaison Officer to help coordinate Aboriginal input into the full range of its activities. (e.g. community health, land use planning, natural resource management, education, arts and cultural exchange etc.). Such an appointment would be responsible for seeking input from all sectors of the Aboriginal community.

2. Vegetation Management Steering Committee (or its successor) should continue to seek participation from the Aboriginal community on matters of vegetation management. Such participation need not involve regular attendance at committee meetings but an open invitation should remain.

3. If recommendation 1 above is not feasible Council should approach the Tweed Byron Local Aboriginal Land Council with a view to establishing a protocol for Aboriginal input into Development Applications involving clearing of bushland.

4. Potential impacts on Aboriginal cultural values should be included as a "matter for consideration" for Development Applications involving the clearing of bushland. Such impacts should extend beyond direct impact on significant sites and relics to include impacts on the contemporary Aboriginal cultural practices.

5. Important known sites of Aboriginal significance should be identified and protected by zoning or schedule in the Local Environmental Plan (LEP). The Aboriginal community should be consulted on the inclusion and extent of individual sites.

6. Vegetation clearing by local Aboriginal peoples for the purpose of traditional Aboriginal cultural uses should be exempt from the need for development consent.

8.0 Management and Rehabilitation Framework

8.1 Introduction

While most of the preceding discussion has been concerned with the **protection** of existing ecological assets, conservation efforts also need to be directed toward **management** and **rehabilitation**. For the purposes of this Strategy management refers to on-ground actions aimed at maintaining existing ecological values while rehabilitation refers to on-ground actions aimed at the recovery or reconstruction of natural habitats.

While the need for protection of ecological assets should remain a high priority, it is not necessary or desirable to limit feasible proposals for management or rehabilitation. Indeed, the conservation status of a number of species and communities identified previously (Chapter 3.0) suggest that many are vulnerable to local, or in some cases, global extinction unless active rehabilitation programs are implemented and successful. Also, within highly fragmented landscapes some areas are unlikely to ever be self-sustaining, and will require constant management. Given current trends in bushland clearing, a general tightening of clearing controls (at all levels of government), and major demographic and economic changes affecting land management practices it is highly likely that issues of rehabilitation and management will come to dominate nature conservation initiatives over the next few decades in the Shire.

It is important therefore that rehabilitation programs strive for consistent goals, and priorities are established to maximise ecological benefits. In general terms, the goal of this framework is to provide a basis for prioritising areas (or sites) to enable the various types of rehabilitation. While this approach is useful in order to prioritise rehabilitation proposals on a site by site basis, it is also important to note that not all situations requiring rehabilitation are necessarily most appropriately handled in this way. In particular the recovery of threatened species is almost always dependent on success at more than one site. In these situations recovery programs need to be **species-based** rather than **site-based**. Similarly, programs designed to alleviate pressure from threatening processes are **process-based**. A comprehensive rehabilitation and management framework needs to provide guidance within all three of these.

Equally important to the ecological priorities is the identification and recognition of **strategic opportunities** for rehabilitation and management. Strategic opportunities include considerations such as sources and requirements for funding, track record and willingness of proponents, the level of protection of the site, the extent of works already carried out or underway etc. These factors have a major influence on the feasibility and probability of successful ecological outcomes. If appropriate funding, other resources, and sites are not available it is very unlikely that ecological priorities will be adequately met.

Thus, the general approach to the rehabilitation and management framework outlined in this Strategy is based on:

1. Maximising ecological benefits across a range of priority areas; and

2. Identifying and exploiting strategic opportunities.

It is important to note that this approach remains independent of any specific funding sources. This is because there are many sources of funding each with different priorities and breadth of focus. Furthermore, changes in priorities and focus are common. A rehabilitation and management framework that is broad-based will maximise accessibility to a wide range of funding opportunities. Naturally and unavoidably however, available funding (and other factors) will determine the rate at which certain works are achieved.

Issues associated with appropriate techniques for rehabilitation are not covered here, but are addressed in detail by other authors (see for example Kooyman 1996; Buchanan 1989; Raine & Gardiner 1995; Cropper 1993; Dorricott & Roberts 1993; DIPNR Vegnote series and draft Best Management Practice Guidelines; DEC Recovery Plans etc.).

Prior to outlining ecological priorities and strategic opportunities for management and rehabilitation, the following sub-sections provide some strategic direction to the implementation of the nominated priorities.

8.2 Guiding Principles

The following principles provide some strategic direction to the implementation of the nominated priorities.

1. **Site selection should maximise ecological benefits to the entire remnant system**. Corridors should be placed to link remnant vegetation, which is of high biodiversity to enable maximum dispersal of species and create larger remnants, which have sustainable populations. Less diverse remnant clumps, scattered trees can be incorporated into the linkage between diverse areas (Greening Australia 1995).

2. **A simple planting and management plan of the revegetation site may need to be considered where rehabilitation is over an extensive area**. This would give some idea of the impact of the proposal to the site and would assist in attracting funding to the proposal. The plan should be simple enough so that it does not discourage the revegetation efforts but be comprehensive enough to enable all groups to introduce ecological principles in the revegetation work and provide a strategic, integrated and planned implementation of the revegetation work. It should consider past vegetation on site, present vegetation on site, changes to landform in the surrounding area since clearing, changes to site (landform and vegetation) as a result of the work i.e. short and long term impacts of the vegetation works on the fauna and flora of the area, soil types and soil nutrients, species being planted, maintenance requirements, planting methodology, fertilisers and chemicals to be used, etc.

3. **Ensure that "rehabilitation" means the restoration of degraded vegetation to as near as is practical the previous naturally occurring native vegetation on that site**. This should include the discouragement of planting or cultivation of exotic species and native plants from outside the region. Elements of species composition should also be considered. However, in rare cases consideration may be toward target species e.g. Koala food trees such as Grey Gum (*E. propinqua*), Forest Red Gum (*E. tereticornis*) etc.; She-oaks (*Allocasuarina* and *Casuarina* spp.) for the recovery of Glossy Black Cockatoo habitat; or a group of species e.g. understorey rainforest plants in wet sclerophyll. The actual dimensions of the corridor particularly the width of the corridor, the plant species within the corridor and the structure i.e. canopy and understorey should be considered in the design (Greening Australia 1995). 'Species distribution planning' for a corridor can be assessed through a study of neighbouring remnant ecology i.e. species composition, structure and life-form groups.

4. **Clear objectives should be established when addressing noxious and environmental weeds**. Appropriate techniques should be employed on a site by site basis for mandatory control of noxious weeds and the voluntary control of other environmental weeds. In particular consideration needs to be directed toward the desired outcomes (e.g. pasture maintenance, bushland rehabilitation etc). Excessive soil disturbance or use of herbicides can lead to land degradation and do not always result in the long-term removal of weeds. See Section 8.3.4.1 for further details.

5. **Recognise that weedy areas have a role as wildlife habitat and land clearing for regeneration work should consider this impact with planting/maintenance techniques developed accordingly.** It should also consider the importance of existing native regeneration species especially in exposed areas during the preparation of the area for planting. Apart from preventing problems for wildlife such as large-scale removal of habitat and exposure to native and feral predators it could also enhance the survival rate of the plantings through less exposure of the area to the elements. This means less water requirements, less regeneration of weeds and possibly less time and funds required. Techniques such as pruning or judicious slashing of small areas which are surrounded by regenerating species or weeds into which groups of native plants are deposited may be more appropriate. This is the "strategic planting window" concept. Existing native species in the area need to be considered in the placement of these "windows" and in the selection of management techniques and species suitable for the site. Other techniques of regeneration should also be investigated such as the successful Bradley method, Wingham Brush Method or methods developed by Kooyman (1996) for rainforest rehabilitation.

6. **Species being planted should be as diverse as is practical and should recognise ecological processes**. Initial plantings are often with a few pioneer or target species but thought is needed in providing follow up plantings of a diverse range across the life form categories, e.g. trees, shrubs, herbs, vines and epiphytes where appropriate. Plantings need to be managed in relation to successional processes. Selection of species for the various locations, community types and for distinct purposes such as wildlife target species is necessary. This also involves identification of fauna and flora, which require urgent attention in addition to the identification of target areas, and species for habitat improvement.

7. **Preserving seed provenance (genetic variability) is important in maintaining ecological integrity at local and regional scales.** Selection of species for rehabilitation should be from seed sources collected in the local area. Preferably, the Shire should be divided into biogeographically distinct areas i.e. planting zones based on vegetation type and soils. Seed should be collected and stored in a 'Native Seed Bank', and grown for the separate areas. For example, there may be four distinct areas of Pink Bloodwood (*Corymbia intermedia*) growing on four different soil types. These should be stored separately and each planted back to the respective areas.

8. **Species selection should also consider the requirements of the fauna of the area** (i.e. the requirements for food, shelter, nesting sites, etc.). This can be achieved by selecting species that supply high quality, high quantity habitat

resources for a wide range of species. The selection of these species is not an easy task and may involve a suitably qualified ecologist (Greening Australia 1995). Ideally, corridor design or site enhancement should also consider:

- a knowledge of the fauna present across the area;
- an estimate of the abundance of the fauna in the area;
- behaviour patterns of the fauna present;
- knowledge of the conservation status of and distribution of the species;
- an understanding of environmental pressure on species such as barriers to animal and plant movement and necessary management required to alleviate these pressures;
- the time required to regenerate habitat components relevant to target species;
- key plant species for fauna habitat. For example, Native Figs (*Ficus* spp.) provide large quantities of fruit, which are consumed by many species of birds, flying foxes and bats. Other important habitat species may include butterfly food plants, protective shrubbery for small birds, artificial tree hollows and water sources and open water systems (Greening Australia 1995).

9. **Fire management practices should consider the ecology of the plant community in addition to the safety of humans and their artefacts.** See Section 8.3.4.2 for further details

10. **Fencing along but not across any vegetation corridor is desirable** (Catterall *et al.* 1993).

11. **Management practices on areas adjacent to a rehabilitation site can have major detrimental impacts, and may need to be addressed as part of the project.** For example roadworks and drainage systems constructed adjacent to remnants should minimise ecological impacts such as soil movement and siltation, nutrient loadings, streamflow and establishment of buffers no less than 100m on either side of riparian remnants. The regular maintenance of drainage lines using herbicides (particularly in wet weather) and mowers should consider riparian values and the operators should be aware of the possible environmental effect.

12. **Bushlands (including wetlands) are often subjected to stock grazing and trampling which results in suppression of vegetation growth**. In rehabilitation areas, the removal of stock, fencing and re-establishment of a forest buffer around the area should be a priority (Catterall *et al*. 1993).

13. **Effective management of target species and threatening processes is likely to involve numerous sites and successful outcomes are often difficult to see.**

14. **Long term security of areas for management and rehabilitation will help minimise wasted efforts.**

15. **Proposals for management and rehabilitation works should make provision for ongoing maintenance in addition to establishment costs.** Ongoing maintenance is often the most significant component of such projects both in terms of costs and ecological outcomes.

8.3 Ecological Priorities

Ecological priorities for rehabilitation and management are conveniently considered in terms of priorities for:

Existing Bushland – which areas or types of bushland are in most need of active management (mostly site-based).

Potential Habitat Areas - which non-bushland areas or types of habitat should be re-instated and where (mostly site-based).

Species-based Recovery – which species (or populations or ecological communities) should be targeted for recovery (species- or taxon-based).

Management of Threatening Processes - which of the numerous threatening processes should be targeted for threat abatement action (process-based).

Education, Planning, Monitoring and Research – programs in these areas indirectly provide a focus for on-ground works and increase strategic opportunities by generating enthusiasm and increased public support and participation.

Each of these areas of interest and suggested priorities are described in further detail in the sub-sections below.

8.3.1 Priorities for Existing Bushland

For mapped bushland it is appropriate to utilise a combination of ecological attributes to determine priority areas:

1. Areas of High Conservation Value (HCV);
2. Ecologically sensitive areas ; and
3. Degraded habitats.

Based on the attributes used for the Ecological Status Assessment (Section 3.1.2), criteria can be developed to define the areas affected by each of these major themes (see Section 3.2.2.2). It should be noted that any particular area may be affected by one or more of these themes. For example, littoral rainforest is considered to have high ecological status but is also sensitive to disturbance. Map 7 shows the results of applying these criteria. A brief explanation of each theme is provided below.

Areas of High Conservation Value (HCV)

HCV areas can be considered as those areas classified as *Very High* for the purposes of the Ecological Status assessment (see Table 3.5 for criteria). These areas consist mainly of vegetation types of high regional status, bushland associated with riparian, estuarine, wetland ecosystems or Critical Habitat.

Areas supporting *threatened* species should also be considered within this category. Because their locations, and habitat requirements, are not adequately known or mapped, the categories shown on Map 7 do not account for the known or likely presence of threatened species.

While many of these areas may not require immediate attention, this category includes the most valuable ecological assets in the Shire, and as such positive efforts should be taken to maintain and improve the values of such areas. These areas must therefore be considered as a high priority for management and recovery actions.

Ecologically Sensitive Areas

As noted in Section 3.1.2, *Ecological Sensitivity* measures those components of the ecological system that are sensitive to degradation. Ecologically sensitive areas can be identified and located by defining particular combinations of ecological attributes associated with mapped remnant areas. Table 3.6 outlines the criteria used to define categories of *Ecological Sensitivity.* Three broad categories are defined: *High, Moderate*, and *Low*. Areas classified as the most sensitive (*High*) are considered to be subject to degradation without additional human disturbance. Areas classified as *Moderate* would, in general, require a lower level of active intervention (management) to prevent ongoing degradation, while areas ranked as *Low* are thought to be more resilient.

Degraded Habitats.

In addition to bushland areas that have high ecological status or are likely to be sensitive to threatening processes, are areas that require recovery actions due to their current level of disturbance. In terms of mapped bushland this group consists of areas coded for Vegetation Condition as *Highly Disturbed/ Early Regeneration* (see Section 2.2.1.2).

It should be noted that these areas are only likely to represent a subset of degraded habitats. This is because the condition coding is not, at this stage, comprehensive.

8.3.2 Priorities for Potential Habitat Areas

For non-bushland areas, it is suggested that habitat rehabilitation actions be directed toward one or more of the following:

1. Habitat specific priorities;
2. Areas subject to land degradation processes;

3. Key landscape linkages;
4. Areas of high scenic quality; and
5. Habitat Fabrication.

Indicative locations for items 2, 3, and 4 are shown on Map 7. Items 1 and 5 cannot be mapped.

Habitat Specific Priorities

It is suggested that priorities for the replacement of specific vegetation communities/habitats in cleared habitats should be based on the criteria used to determine the Regional Vegetetation Type Status (see Table 3.4). On this basis, Table 8.1 lists vegetation communities allocated a Regional Vegetation Type Status of 1 or 2 (see field *RegVegStat* in Appendix 7).

Table 8.1 Priority Vegetation Types for Habitat Rehabilition

Vegcode	Vegetation Type	Priority
101	Littoral Rainforest	1
102	Sub-tropical / Warm Temperate Rainforest on Bedrock Substrates	1
103	Dry Rainforest	1
104	Lowland Rainforest on Floodplain	1
105	Myrtaceous Riparian Low Closed Forest to Woodland	1
106	River She-oak Open Forest	1
107	Cool Temperate Rainforest	1
203	Broad-leaved Apple Open Forest	2
208	Tallowwood Open Forest	2
211	Turpentine +/- Pink Bloodwood Open Forest	2
212	Swamp Box Open Forest	1
301	Coastal Pink Bloodwood Open Forest to Woodland	1
304	Coastal Forest Red Gum Open Forest to Woodland	1
305	Coastal Swamp Mahogany Open Forest to Woodland	1
306	Coastal Scribbly Gum Open Forest to Woodland	1
309	Coastal Swamp Box Open Forest to Woodland	1
310	Banksia Dry Sclerophyll Open Forest to Shrubland	1
311	Coastal Acacia Communities	2
312	Black She-oak Low Open Forest to Woodland	1
313	Cypress Pine Open Forest to Woodland	1
401	Broad-leaved Paperbark Closed Forest to Woodland	1
402	Broad-leaved Paperbark / Swamp She-oak Closed Forest to Woodland	1
403	Broad-leaved Paperbark + Eucalyptus spp.+/- Swamp Box Closed Forest to Woodland	1
501	Dry Heathland to Shrubland	2
502	Wet Heathland to Shrubland	1
503	Montane Heathland/Scrub	1
601	Swamp She-oak Closed Forest to Woodland	1
602	Mangrove Low Closed Forest to Woodland	1
603	Saltmarsh Communities	1
701	Sedgeland / Rushland	1
702	Fernland / Forbland	1
703	Freshwater Wetlands	1
902	Native Grasslands	1

Unfortunately, it is not possible at this stage to precisely define the potential locations of all these habitat types. This is because the pre-European extent of these areas has not been adequately investigated.

Areas Subject to Land Degradation Processes

In addition to encouraging the restoration of habitats that have been particularly heavily affected by human activity in the last 130 years, it is also important to target areas that are commonly subject to land degradation resulting from the removal of native vegetation cover. In this respect there are at least three major areas where restoration is likely to have relatively tangible benefits in the short term:

- Steep lands (e.g. areas generally in excess of 18 degrees from Map 5);
- Riparian zones (e.g. drainage lines from Map 5); and
- Foredunal areas (e.g. soil landscape *ab* from Map 5).

Such areas have traditionally been protected under the Soil Conservation Act 1938 and more recently through provisions of the Native Vegetation Act 2003.

Indicative locations of these areas are shown on Map 7 in relation to mapped bushland.

Key Habitat Linkages

Another priority reason for habitat restoration activities involves the strategic re-establishment of corridor linkages designed to enhance overall ecological values, especially for species unable, or unwilling to cross large areas of cleared habitat. Priority areas for the promotion of such linkages include:

- Restoration of water based and riparian linkages (e.g. drainage lines from Map 5; Map 7)
- Regional Corridors (Scotts *et al.* 2000; Map 7)
- Sub-regional Corridors (Scotts *et al.* 2000; Map 7).

Areas of High Scenic Quality

While this strategy is primarily concerned with nature conservation values, the identification of scenic and landscape values have important implications for environmental protection and rehabilitation. It is noted for example that Clause 29 of the North Coast Regional Environmental Plan (1988; see Section 5.1.1.1) requires scenic values to be assessed in conjunction with those of nature conservation.

A broad-scaled spatial analysis of the scenic values of bushland areas of the Tweed was presented in Chapter 15 of the TVMP99 (reproduced here as Appendix 12). This involved the overlay of bushland areas with Scenic Landscape Management Zones defined by Brouwer (1995).

Map 7 indicates the areas covered by *Scenic Management Zone A*.

Habitat Fabrication

Under a limited number of circumstances, habitat fabrication may be appropriate. This is most likely where habitat reconstruction is not possible, or where uses other than nature conservation are intended. Examples might include:

- Landscaping requirements as a condition of development consent;
- Native plantation forestry;
- Planting of specific trees to attract koalas, birds etc.;
- Creation of habitats which must also meet safety standards eg. low shrubs for visibility along main roads;
- Plantings to stabilise ground or prevent erosion;
- Coastal habitats where full reconstruction of dunal profiles is not feasible.

In these sorts of circumstances it is desirable for habitat fabrication programs to complement the overall Rehabilitation Strategy.

8.3.3 Priorities for Species-based Recovery

As noted above the recovery of threatened species is almost always dependent on success at more than one site, and that recovery programs for threatened species therefore need to be species-based rather than site-based. Setting priorities for such programs is an important component of a comprehensive rehabilitation strategy.

While a relatively large number of significant species have been identified in the region (see Section 3.3), no attempt has been made to prioritise individual species for the preparation and implementation of recovery plans. This task has been,

and continues to be, undertaken by DEC. As a result a number of Recovery Plans have been prepared for Threatened flora and fauna in the region. The status of DEC Recovery Plans are listed on their web site (see www.DEC.nsw.gov.au).

8.3.3.1 Fauna

The Queensland Department of Environment (DEH 1995) suggest some relevant criteria for identifying critical target fauna:

- Species which have a special status because they are threatened, vulnerable or rare;
- Species that require large areas of relatively undisturbed habitat (e.g. Red Goshawk);
- Species which indicate the condition of particular habitats, (e.g. Platypus which requires stable river banks and relatively high water quality);
- Species that are important for maintaining particular vegetation types (e.g. Flying Foxes, Fig Parrots, Fruit Pigeons and the Golden Tipped Bat which disperse seeds and pollen);
- Keystone predator species which indicate the condition and diversity of the natural systems and food webs which support them (e.g. Powerful Owl and Osprey).

The formulation of species recovery plans should address the current threats to the species. The recovery plan ultimately should detail plans for the removal of threats, the restoration of population numbers and potential conflicts with current land uses. Thus, it is suggested that integrated Recovery and Threat Abatement Plans be prepared and implemented under the Threatened Species Conservation Act 1995.

On the basis of the criteria above, the following species (Table 8.2) are suggested as priorities for recovery on the Tweed followed by all remaining significant fauna.

Table 8.2 Fauna Species Suggested for Recovery Plans

Species	Remarks
Calyptorhynchus lathami * Glossy Black Cockatoo	Vulnerable / restricted distribution / restricted habitat requirements / threatened habitat/ recovery program planned for Gold Coast populations.
Litoria freycineti, Litoria olongburensis* Crinia tinnula*, Litoria cooloolensis** Wallum Frogs	Vulnerable or rare / extremely restricted distribution / threatened habitat / occurrences not well documented.
*Phascolarctos cinereus** Koala	Culturally significant / restricted habitat requirements / threatened habitat / highly dependant on large tracts of coastal lowland *Eucalypt* communities.
*Ornithorhynchus anatinus** Platypus	Culturally significant / restricted habitat requirements (indicator of high water and riparian condition) / sensitive to human activities.
Erythrotriorchis radiatus Red Goshawk	Endangered / threatened habitat / requires large home range.
Haematopus fuliginosus Sooty Owl	Rare / restricted habitat requirements / one of the least known bird of prey.
Ninox strenua Powerful Owl	Vulnerable / restricted habitat requirements requires extremely large amount of habitat / threatened habitat.
Ptilinopus magnificus Wompoo Fruit-Dove *Ptilinopus regina* Rose-crowned Fruit-Dove *Ptilinopus superbus* Superb Fruit-Dove	Vulnerable &Rare / restricted habitat requirements / restricted distribution in NSW/ threatened habitat - lowland rainforest.
Ornithoptera richmondia Richmond Birdwing Butterfly	Vulnerable / restricted habitat requirements (i.e. the vines *Aristolochia praevenosa* and *A. Deltantha*) / restricted distribution.
Pseudechis porphyriacus Red Bellied Black Snake	Threatened lowland habitat / decline supposed from introduction of *Bufo marinus* (cane toad).

* Top priority

8.3.3.2 Flora

As noted previously there are a large number of threatened flora for which species recovery is necessary. In addition to simply using conservation status (*Endangered, Vulnerable*, etc.) to guide species recovery initiatives, it is suggested that Council could make most valuable contributions by focusing on species meeting the following criteria:

1. Inhabit lands over which Council has substantial influence and other agencies have minimal control.

2. Inhabit threatened habitat types (see above).

3. Restricted to, or substantially dependent on the Shire to maintain populations. For species spread evenly or whose distributions are concentrated elsewhere, recovery should be initiated co-operatively with agencies or community groups from other areas.

4. Critical for the survival of threatened fauna.

Using this strategy it is suggested integrated Recovery and Threat Abatement Plans be prepared and implemented for the following species immediately, followed by all significant flora and fauna. Such plans should be prepared in accordance with the Threatened Species Conservation Act 1995.

Table 8.3 lists additional species not currently under review by DEC (see www.DEC.nsw.gov.au), which Tweed Shire Council could have a significant role in supporting, encouraging and helping to implement their recovery.

Table 8.3 Flora Species for which Tweed Shire may have Significant Roles within Recovery and Threat Abatement Plans

Botanical Name	Common Name
*Cryptocarya foetida**	Stinking Cryptocarya
Diospyros major var. *ebenus**	Shiny-leaved Ebony
*Macadamia tetraphylla**	Rough-shelled Macadamia
*Syzygium mooreii**	Durroby
Chamaesyce psammogeton	none
Cupaniopsis serrata	Smooth Tuckeroo
Desmodium acanthocladum	Spiny Trefoil
Elyonurus citreus	none
Melicope vitiflora	Coast Euodia
Oberonia titania	none
Ochrosia moorei	Southern Ochrosia
Peristeranthus hillii	none
Pomaderris notata	none
Sarcochilus fitzgeraldii	Ravine Orchid
Sophora fraseri	Scrub Sophora
Syzygium hodgkinsoniae	Smoothbark Rose Apple
Zieria hindii (Z. sp. J)	none

* Top priority

8.3.4 Management of Threatening Processes

As noted in Section 3.1.2.3 both the Threatened Species Conservation Act 1995 (TSC Act) and Fisheries Management Act 1994 (FM Act) and the Federal Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) schedule a number of *Key Threatening Processes* likely to adversely affect threatened species, populations or communities, or alternatively cause other species, populations or communities to become so.

In relation to each of these declarations, the relevant authority (i.e. DEC, NSW Fisheries, Environment Australia) is obliged to prepare a *Threat Abatement Plan*, which would apply at the State or Federal level. At present few have been prepared, and priorities will vary from region to region. In addition some threatening processes may not have been identified at these broader scales but may be problematic in particular areas.

Threatening processes most acutely experienced in the Tweed Shire at present include:

- *Clearing and fragmentation of native vegetation (especially in riparian areas and coastal areas for urban development);*
- *The degradation of native habitats (especially riparian areas) by environmental weeds (e.g. Bitou, exotic vines, camphor laurel, privet etc);*
- *Bushfire management;*
- *Fauna mortality from motorised road traffic;*
- *Predation by cats, dogs and foxes;*
- *Fauna mortality and competition from cane toads;*
- *Management of acid sulphate soils;*
- *Overfishing;*
- *Processes leading to the sedimentation and eutrophication of waterways.*

At the local level the processes listed above are suggested as priorities (no particular order). It should be noted that most of these are consistent or fit within one or more of those scheduled under State or Federal legislation.

There are of course a potentially large number of other processes that threaten natural habitats. Examples include: drainage and other hydrological alterations including water extraction, air and inorganic water pollution, use of recreational vehicles including watercraft, vandalism, rubbish dumping and littering, grazing in natural areas, logging impacts, inappropriate erosion control, additional issues associated with urban development etc. At this point however these are considered to be of minor or localised impact (i.e. of lesser concern than those identified as priorities) or otherwise adequately addressed by existing legislation (see Section 3.1.2.3)

More specific guidance and information relating to environmental weeds and bushfire management issues are presented in the following sub-sections.

8.3.4.1 Environmental Weeds

Everyone has an understanding of what a *weed* is and over time weeds have been assigned numerous definitions often depending on the situation in which they occur. These have been simplified with the most widely accepted definition being *any plant growing where it is not wanted* (Scott 1999). Other names used to describe weed species not native to an area are *exotic*, *alien*, *non-endemic* or *introduced*.

Weeds possess a range of characteristics that enable them to adapt successfully to new environments, such as, high reproductive capacity, tolerance of a wide range of environmental conditions, and rapidity of growth and dispersal. Weeds vigorously exclude native species by deprivation of resources; they prevent or slow natural regeneration, alter soil nutrient levels and may also alter fire regimes. Weeds are commonly a problem within riparian systems where soil moisture, fertility and fluvial disturbance are high and also in fragmented landscapes where the interface between native vegetation and human-dominated landscapes are maximised.

Naturalised species are native or exotic plants that have become established in either disturbed or undisturbed indigenous vegetation and have reproduced for several generations in the wild without direct human intervention (Robin 1991 cited in Groves 1994).

Environmental weed has the connotation that the plant is in some way deleterious to the environment and to human enjoyment of that environment (Groves 1991 cited in Groves 1994) and is the term used here. The effect of environmental weeds can be so serious as to cause rapid major changes to species diversity, abundance or biomass of individual species of other plants or of animals as a consequence of modification of their habitats. However, major changes of this type can occur more slowly and ultimately be as serious in their impacts on the affected ecosystem.

Noxious weeds are declared by the State Government under the Noxious Weed Act 1993 and include those plants considered to pose a serious economic and/or environmental threat.

Examples of serious environmental weeds in Tweed Shire include:

Camphor Laurel (*Cinnamomum camphora*);
Large-leaved Privet (*Ligustrum lucidum*);
Small-leaved Privet (*Ligustrum sinense*);
Groundsel (*Baccharis halimifolia*);
Lantana (*Lantana camara*);
Mist Flower (*Ageratina riparium*);
Crofton Weed (*Ageratina adenophorum*);
Kudzu Vine (*Pueraria lobata*);
Madeira Vine (*Anredera cordifolia*);
Morning Glory (*Ipomoea purpurea*);
Cats Claw Creeper (*Macfadyena unguis-catii*);
Blue Trumpet Vine (*Thunbergia grandiflora*);
Bitou Bush (*Chrysanthemoides monilifera* var. *rotundata*).

In addition a number of native plant species have been identified as potential environmental weeds in the Tweed, including:

Alexander Palm (*Archontophoenix alexandrae*);
Fishbone Fern (*Nephrolepis cordifolia*);
Umbrella Tree (*Schefflera actinophylla*); and
Cadaghi (*Corymbia torelliana*).

Appendix 14 lists:

- all declared and proposed noxious weeds identified in the Noxious Weeds Act 1993 for the North Coast region;
- weed species observed in Tweed Shire that are considered by the authors to have the invasive potential to naturalise and/or become major environmental weeds; and
- other weed species observed in the region that may be difficult to control within their preferred habitat but are generally less invasive than those included above. Many garden escapees are included in this category and their use should be actively discouraged, especially in gardens near natural vegetation.

The list presented in Appendix 14 is by no means exhaustive and numerous other species, including a range of naturalised grasses, could be added. It is presented as a guide to discourage their proliferation and to identify species that must be controlled by law.

The NSW North Coast Weed Advisory Committee's Environmental Weed Taskforce identified 187 weeds as having, or with the potential to have, a significant impact on native vegetation on the NSW North Coast. The Committee is also is in the process of preparing Regional Control Plans for specific weed species. These plans identify an aim and a set of objectives for control of the weed species as well as a summary of the current weed problem, the known extent of infestation and the barriers to be overcome for successful control. In addition an approximate time frame for action to be taken is established and the control authorities that will be involved in any control measures are identified. Some of the species that plans have been prepared for include:

- W1 noxious aquatic weeds - Alligator Weed and Water Lettuce;
- W2 noxious agricultural weeds - Giant Parramatta Grass, Groundsel Bush, Noogoora and Bathurst Burrs;
- W3 noxious weeds – Lantana, Bitou Bush, Crofton Weed and Mistflower;
- W4 noxious weeds – Camphor Laurel and Prickly Pear;
- Proposed W2 noxious weeds Chinese Elm and Broad-leaved Pepper Tree; and
- Proposed W4 noxious weeds – Cadaghi, Large and Small-leaved Privet, Winter Senna and the vines, Madeira Vine, Cat's Claw Creeper, Balloon Vine, Mile-a-Minute and Blue Morning Glory.

Strategies for controlling specific weeds however vary according to the species, the degree of infestation, the locality and prevailing conditions and often include one or more of the following;

- Hand weeding, raking or removal;

- Cut and swab or frilling with herbicide;
- Scrape and paint with herbicide;
- Stem injection with herbicide;
- Crowning;
- Use of fire;
- Controlled grazing;
- Use of machinery;
- Hand or aerial spraying; etc

For specific information regarding appropriate control measures Far North Coast Weeds (www.fncw.nsw.gov.au), DIPNR (www.dipnr.nsw.gov.au) and/or local Landcare groups (www.landcarensw.org) should be consulted.

8.3.4.2 Bush Fire Management

The issue of bush fire management in the Tweed has been exhaustively addressed in the Tweed Bush Fire Risk Management Plan. (TSBFMC 2001). The Plan provides a strategic and integrated approach to managing bush fire risks to both community and ecological assets, and suggests that fire regimes that maintain the current distribution of vegetation types should be encouraged unless there are over-riding threats to human life and property. Much of the remainder of this sub-section has been extracted Tweed Bush Fire Risk Management Plan. (TSBFMC 2001) and provides some guidance on ecologically appropriate fire regimes. The use of fire for hazard reduction or ecological purposes should be consistent with the Risk Management Plan and in consultation with the Rural Fire Service.

Fire is one of the most important disturbances in Australian ecosystems. It has a profound impact on the flora, fauna, and important indirect effects on ecological processes such as succession, nutrient cycling, seedling recruitment, species composition, structure and habitat. The presence of fire in nearly all but the wettest ecosystems over evolutionary time has meant that native plants and animals are well adapted to cope with fire. With the exception of a few vegetation types (such as rainforest) all of Australia's vegetation communities rely to some extent on fire for regeneration (Recher & Christensen 1981). Fire frequency is the most critical aspect of fire regimes for flora and fauna because fires repeatedly interrupt processes such as fruit production and growth that maintain the capacity of the population to persist and regenerate (Keith 1994). Other important ecological variables include fire intensity, season, patch size and interactions with grazing and habitat fragmentation. The observed ecological effects of fire regime has led to a categorisation of some vegetation communities as *fire-sensitive, fire-prone, fire-tolerant,* or *fire-promoting* (Gill 1975).

In recognition of the close relationship between fire and the ecological response of specific vegetation communities, it is appropriate to consider these natural assets in terms of their likely response to bush fire. Unlike community assets, which may be damaged by bush fire, fires in many vegetation communities are considered necessary for their continued existence. Moreover, there is no evidence to suggest that areas of high ecological status (e.g. as determined in Chapter 3.0) or areas protected by environmental planning provisions, are necessarily more sensitive to fire than areas of lower ecological status or not covered by planning instruments. Thus, in the case of vegetation communities, (and their associated fauna) any assessment of the risk from bush fire needs to be considered in terms of the likely ecological response rather than conservation status.

Ecological Response of Vegetation Communities to Bush Fire

A number of broad ecological communities on the Tweed exhibit similar responses to bush fire. These communities and their bush fire response are described briefly below. Map 5 of the Tweed Bush Fire Risk Management Plan (TSBFMC 2001) shows the mapped distribution of these response groups within the Tweed.

1. Rainforests, riparian and related communities – These communities generally do not support bush fires except in extended drought periods. This is due to high fuel moisture levels, limited ground fuel, closed canopies and relatively fire resistant understoreys. Rainforests however are very sensitive to fire and will not tolerate high fire frequencies or intensities. In some riparian communities canopy species may be fire tolerant (e.g. eucalypts) but understorey species are frequently rainforest related and fire sensitive. Fire in riparian areas is generally rare due to the location of this community in the landscape (e.g. valley bottoms). Due to the sensitive nature of the vegetation and the high habitat values (including as a refuge from fire) fires in riparian areas should be avoided.

2. Wet sclerophyll and related forests – These forests may carry high fuel loads (up to 50 t/ha) but will not usually carry low intensity fire because of their moist nature. After extended dry periods however, they can support very high intensity fires. These can kill younger trees and severely damage mature trees. The most diverse species

assemblages for many faunal groups can be found in wet sclerophyll associations with a closed understorey of rainforest species and ferns. The greater faunal diversity can be largely attributed to the structural diversity of the vegetation, including large, hollow-forming old-growth trees, and the nutritional value of the vegetation, as it generally occurs on moister, more fertile soils. The wet sclerophyll associations are particularly important for koalas, which feed on species such as Swamp Mahogany (E. robusta), Forest Red Gum (E. tereticornis), and Tallowwood (E. microcorys), common dominants of these forest types. Fires are less common in moist forests than in dry sclerophyll, and in certain circumstances the absence of fire allows regenerating rainforest species to eventually dominate the sclerophyllous species, particularly the eucalypts. Bradstock *et al.* (1995) suggests that a decline in the values of this vegetation community could be expected if successive fires, of any intensity, occur less than 50 years apart or if there is no fire for more than 200 years.

3. Dry sclerophyll and related forests – Generally have a dry understorey of grasses and shrubs which burn readily under a much broader range of conditions than other forest types. Moderate to high fuel levels (up to 25 t/ha) and relatively open canopies allow sunlight and wind to quickly dry available fuels, giving these forests the potential to support high intensity bush fires. These forests will support low intensity prescribed fire in most years – hazard reduction in these forests can help to protect adjacent areas of wet sclerophyll forest from wildfire. These vegetation communities are usually dominated by fire adapted species which are capable of surviving moderate and high intensity fires. Frequent fire in the form of regular low intensity burns favour a grassy understorey whereas intense fires every 10 - 15 years produce a diverse understorey including shrub species. Complete absence of fire will favour eucalypts at the expense of wattles, banksias and some heath species. Too frequent fires will favour wattles and oaks at the expense of eucalypts. Areas that have not been burnt for extended periods often support rainforest related species in the understorey. Bradstock *et al.* (1995) suggests that a decline in the values of this vegetation community could be expected if more than two successive fires occur at intervals of less than 5 years or if there are no fires for more than 30 years. Declines can also be expected if successive fires occur which totally scorch or consume the tree canopy.

4. Dry coastal heathland and shrubland - Short heath (heath up to 2m) generally contains a relatively high proportion of fire prone species and carries moderate fuel loads (15 t/ha). Fuel loads are typically continuous from ground to canopy. Resulting fires are generally of moderate intensity. Tall heathlands typically carry higher fuel loads (up to 25 t/ha) than short heath and hence fire behaviour is generally of moderate to high intensity. Many species are adapted to fire and rely on it for regeneration. Occasional high intensity fires are required to maintain a high diversity of species. Bradstock *et al.* (1995) suggests that a decline in the values of this vegetation community could be expected if more than two successive fires occur at intervals of less than 8 years, if more than two successive fires occur at intervals of more than 15 years, or if no fire occurs for more than 30 years.

5. Coastal wetland and related communities – typically consisting of *Melaleuca* and *Casuarina* species, often with rainforest species in the understorey or as pockets within. Occurs in areas usually subject to inundation or high water table. Fuel levels are similar to other sclerophyll forests however ground fuels are generally not available due to inundation but can become more available during prolonged dry periods. Bark on *Melaleuca* can burn above water levels and is prone to spotting and can carry fire across wet areas. Under these conditions swamp sclerophyll forest can support higher intensity fire and can lead to peat fires. Forests are very susceptible to fire damage. Whilst *Melaleuca* are able to withstand fires, many of the understorey species are highly sensitive to fire. High fire frequencies (less than 5 years) do not enable shrub species to mature and reproduce.

6. Saline Communities - Mangrove and saltmarsh communities rarely burn due to their location in the landscape and waterlogged conditions. Mangrove communities are generally unable to support fire. These communities are sometimes damaged by fire at their perimeter.

7. Non-Bushland Matrix - With the exception of exotic pine plantations and patches of remnant bushland too small to map, fire behaviour in this response group is dominated by the influence of grass fuels. Fires occur most readily once grass is cured beyond 70%. In heavy grass fuels, fires may be intense but will only persist for a short time, and hence are less hazardous relative to forest and heath fires. Grass/woodland fires are open to the influence of wind and typically have high rates of spread (relative to forest and heath vegetation). Grass fire behaviour is reduced dramatically by limiting the height and continuity of grass fuels – most often achieved by grazing. Exotic pine plantations are spread across the Shire with the most substantial area at Kings Forest south of Kingscliff. Fires in exotic pine plantations burn at high intensity and are likely to result in significant tree death.

Bush Fire and Threatened Species

The majority of Threatened species either occur in rainforest, wet sclerophyll forest or high altitude forest which will not burn under conditions in which fuel management burning is carried out, and are infrequently burnt by high intensity wildfires. The management of fire regimes play a major role in the management of Threatened species.

As more information becomes available through the National Register for the Fire Responses of Plant Species being developed by CSIRO Division of Plant Industries (Gill and Bradstock 1992) and other fire ecology research, specific guidelines for conservation of individual flora species can be developed. Until then, the accumulated knowledge of the life cycles and fire responses of plant species in various vegetation communities has allowed the development of fire frequency thresholds for vegetation communities. By maintaining fire frequency within the thresholds identified for vegetation communities, the likelihood of local extinction of flora species within vegetation communities as a result of fire is generally minimised.

Fire can be a major factor determining fauna distribution by way of its ability to influence the distribution of the flora (vegetation communities) on which fauna depend. Fire management activities can impact on Threatened fauna either directly or indirectly. Direct impacts occur where high intensity wildfires or prescribed fires burn over broad areas in conditions that leave few unburnt areas / patches. Some adverse impacts on fauna of too frequent or infrequent burning include:

- Vegetative habitat structures may be burnt from ground to canopy resulting in high fauna mortality;
- Widespread and near complete removal of food sources for immediate post fire recovery;
- Destruction of ground habitat structures such as fallen logs;
- Falling of large numbers of senescent, hollow bearing habitat trees;
- Improved access for feral predator species, and near complete removal of refuge for species susceptible to predation;
- Burning of habitat types that may not normally be burned by lower intensity fire (eg. vegetation in gullies and on SE aspects).
- Localised extinction of plant species or communities may lead to localised extinction of animal species or communities dependent on those plant species or communities;
- Fire may increase the opportunity for weed invasion leading to further habitat modification or degradation.

The observed and predicted locations of a number of fire sensitive flora and fauna species have been modelled by NPWS (now DEC). The results of these analyses are shown on Map 11 and Appendix 5 of the Tweed Bush Fire Risk Management Plan. (TSBFMC 2001).

Fire as a Management Tool

While fire was used extensively to clear native vegetation in the past, it remains an important and legitimate tool for the management of ecological values, to promote pasture growth, and for the strategic protection of life and property. As noted previously, the use of fire for any purpose should be consistent with the Risk Management Plan and in consultation with the Rural Fire Service. There are a number of different ways in which fire is used to achieve these purposes (Jim O'Brien; pers. com.):

Hazard Reduction Burns – aim to reduce fuel load at the time when a lower intensity and controlled burn has a much reduced impact and is more manageable than a later season fire. Its primary purpose is usually to safeguard infrastructure.

Ecological Burns – aim to promote or maintain ecological values. Burn frequency, intensity and timing are important considerations. It should be noted that in some circumstances intense fire is required to maintain ecological values (e.g. coastal heathlands, hollow development in wet sclerophyll forests etc.), however such events are usually left to occur naturally. In the Tweed ecological burns are rarely carried out but may be warranted where the absence of fire (all types) can be shown to result in changes to forest structure and species composition.

Property Management Burns – where a landholder uses fire as a tool to achieve a desired result e.g. removal of unwanted vegetative material (timber, debris, stubble, trash, dry grass), reduce vermin and insect habitat, destroy (or damage) weeds, initiate eucalypt germination etc.

Backburning – planned use of a controlled fire line to remove fuel ahead of an advancing fire front to enable its containment. Typically this is the province of trained fire fighting personnel.

8.3.5 Priorities for Education, Planning, Monitoring and Research

Providing education, planning, monitoring or research projects are consistent with the other ecological priorities already outlined above, there is no need to further limit priorities in these areas.

8.4 Strategic Opportunities and Priorities

Although it may be desirable to rehabilitate all areas suggested as ecological priorities, it is an unfortunate fact that only certain areas will be available for such work. Priorities therefore need to be filtered on the basis of likely opportunities. Some important strategic opportunities include:

Sources and requirements for funding – Funding for rehabilitation and management actions can come from a wide range of sources (e.g. see section 5.1.5). Most funding programs are limited to areas of specific interest to the funding body and are not necessarily in accordance with actions that are considered as local priorities. While efforts should be encouraged to meet local ecological priorities this should not mean that viable opportunities for lower level priorities should be ignored. On the contrary all available sources of funding support should be exploited, however it needs to be acknowledged that funding availability will inevitably affect the progress and direction of current initiatives.

Commitment and willingness of proponent – No matter what the ecological priorities are, strong commitments of the landholder will be needed to ensure adequate project outcomes.

Track record of proponent – The experienced gained by individual landholders and associated support groups (e.g landcare groups) will have a major influence on the likely success of specific projects. This is especially important for projects with large technical components.

Resources required or available – Apart from funding, projects will have differing demands for resources. In some circumstances landholders may be able to provide support in the form of farm machinery, propagation/nursery facilities etc. that substantially enhance the probability of success.

Level of protection of the site – For successful ecological outcomes there should be an expectation that the sites on which projects are carried out have some long-term protection. Examples of areas with such protection include environmental zones, public lands, areas under voluntary conservation agreements etc. Areas with high potential for incompatible land use (eg residential land, productive farmland) may not always be good long-term propositions especially when properties change hands.

Strategic position – The current progress on meeting the ecological objectives should also have an influence on which proposals are supported. For example in the case of narrowly focused funding there may be a need to re-prioritise the ecological priorities to avoid imbalance in the diversity of supported projects. At present most organised rehabilitation and management projects are coordinated by Tweed Brunswick Care Coordinating Committee (see below for details).

Thus it is expected that priorities for support will not only be dependent on the strength and number of expected ecological benefits but also on the strategic opportunities available.

8.5 Current Landcare Initiatives

At present most of the publicly funded management and rehabilitation activities in the Shire are co-ordinated by Tweed Brunswick Care Coordinating Committee (TBCCC), an organisation supported by Department of Infrastructure, Planning and Natural Resources. TBCCC is an umbrella group for over 40 local Landcare, Dunecare and Rivercare groups operating in the Tweed.

TBCCC is currently in the process of mapping and documenting management and rehabilitation projects being undertaken by individuals and groups. The locations of these projects are indicated on Map 7 and listed in Appendix 15.

8.6 Relationship to Northern Rivers Catchment Management Authority

As it is intended that the new CMA framework (see Section 5.1.1.4) will administer major sources of funding for rehabilitation and management on a regional basis, the operation of the Northern Rivers CMA will have important implications for the implementation of priorities identified in this Strategy.

Although the Northern Rivers CMA priorities for rehabilitation and management have not yet been finalised, it is understood that an initial framework will be established by integrating the catchment and management targets set out in the catchment blueprints produced the now-defunct Catchment Management Boards. In this part of the Northern Rivers CMA, the relevant document is the Northern Rivers Catchment Blueprint (NRCMB 2002), the major features of which are presented in Appendix 18.

Of the five major areas of concern identified in the Blueprint the *biodiversity targets* are the most critical. Within this area of concern all Management targets relate to *High Conservation Value (HCV)* areas as defined through the Stressed Rivers or Vegetation Management Planning process. For the Tweed this essentially equates to those areas of existing bushland identified as areas of *Very High* Ecological Status (see Sections 3.2 and 8.3.1) and represents a very small subset of the Ecological Priorities associated with existing bushland (i.e. ecologically sensitive areas and degraded habitats are not accounted for). In relation to priorities for potential habitat areas (non bushland) the Blueprint does provide scope for the rehabilitation of riparian habitat along "targeted stream sections" which include Upper Tweed River, Mid Tweed River, Upper Oxley River, Byrill Creek and Brays Creek (see Map 5). Again this represents only a small component of the priorities identified for potential habitat areas in this Strategy. That is, other than riparian areas within the selected subcatchments no specific provision is made for the replacement of depleted habitat types, rehabilitation of areas subject to land degradation, rehabilitation of key landscape linkages or areas of high scenic value. Moreover the Blueprint appears to provide little opportunity for taxon-specific recovery or the abatement of specific threatening processes (e.g. environmental weeds, feral animals, diseases etc) other than in relation to HCV areas. It could be argued that this approach is too tightly focussed and does not acknowledge other important factors related to biodiversity management or the need to balance ecological priorities with strategic opportunities.

If the current limited focus on HCV areas prevails under the Northern Rivers CMA, additional support, including an additional administrative structure will be needed to fund other priority areas outlined in this Strategy. Although this imbalance may be able to be addressed by a Council initiated incentive program (e.g. Environmental Levy), it would be more desirable if the major sources of funding available to landholders were administered under a single framework. One possibility might be for a local organisation (e.g. Tweed Shire Council) to broker for the CMA in Tweed Shire. In this way the CMA could set its own regional priorities which would be administered with other (local) sources of funding from single local contact point. Apart from reflecting local priorities such a structure is likely to provide a strong focus for monitoring and evaluation.

8.7 Key Considerations

Naturally, the implementation of the management and rehabilitation framework will be dependent on available costs and resources. Most areas will be private lands and positive incentives will be essential. Some suggested directions for implementation are listed below:

1. The principles and framework for rehabilitation and management outlined in this Strategy be endorsed by Council, DEC and the DIPNR as an appropriate basis for determining, prioritising and evaluating proposals for rehabilitation and management works.

2. Council should provide a package of positive financial (or in kind) incentives for rehabilitation and management works based on ecological priorities and strategic opportunities identified in this chapter. Where possible such incentives should complement existing programs.

3. An appropriate organisational structure will need to be formed to coordinate financial and other assistance for rehabilitation and management projects, preferably in conjunction with the Northern Rivers CMA.

4. Encourage further education, planning, monitoring and research on the ecological values of the region, and the provision of extension services to residents.

5. Investigate the use of Council and State owned land for rehabilitation.

6. In suitable areas encourage the establishment of native plantation forests particularly where designed to yield high value timber products or to sequester carbon from the atmosphere.

7. In conjunction with DIPNR, Northern Rivers CMA and/or DEC consider locally appropriate strategies for the control of major environmental weeds such as Camphor Laurel and Privet, including the establishment of demonstration sites to address technical issues and economic feasibility, and incentives to landholders.

8. To address the issue of species-wide recovery plans it is suggested that DEC continue as the lead agency responsible for their coordination, preparation and implementation in the region.

9. Council initiated vegetation planning and management provisions should promote the abatement of threatening processes at the local level.

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