

4.0 Overview of the Broadsound Basin.

4.1 Climate

The Broadsound Basin is centred about 250 km north of the Tropic of Capricorn. It is subject to a seasonally dry tropical climate. Most rain falls between October and April. Driest month is generally September. Annual mean rainfall ranges from about 800mm in the south to about 1,100mm in the north. The Herbert Creek and Styx River catchments tend to be relatively dry while the Clairview Creek catchment and northern part of the St Lawrence Creek catchment are relatively wet. Mean monthly maximum temperatures are highest in January / February (about 32°C) and lowest in June/ July (about 24°C). Mean minimum temperatures drop to 11°C in July. There is a strong seasonal component to the regional weather. Historically, a major climatic driver has been intense cyclonic low pressure influences and associated rain depressions.

A broader regional profile of the Broadsound climate is available through the National Agricultural Monitoring System (NAMS) at <http://www.nams.gov.au/> . This site is a decision making tool for evaluating the impact of climate on primary production. It is aimed at dryland and broadacre primary industries.

Detailed weather data can be obtained from the Bureau of Meteorology at <http://www.bom.gov.au/> .

More recently there have been unprecedented drought impacts and changing climate patterns with less frequent cyclonic influences. These have been linked to global climate change.

4.1.1 Temperature

Since the 1950's Australia's temperature has risen on average 0.9°C. In the Broadsound region the records show a general warming with the rate varying somewhat among seasons.

Maximum temperature

Annual maximum temperatures have increased at a rate of about 0.1°C per decade. The changes are not so evident in spring and summer, with increases of 0.05 to 0.15°C per decade. Winter increases ranged from between 0.1 to 0.15°C per decade. Autumn temperatures, however, have risen at a rate of 0.2 to 0.3 °C per decade since 1950.

Minimum temperature

Annual minimum temperature has risen from 0.15 to 0.2 °C per decade. The rate of increase was steepest in winter with minimum temperatures rising 0.3 to 0.4 °C per decade. Autumn rates were from 0.2 to 0.3°C per decade. Summer rates were from 0.15 to 0.2 °C. The spring rate was slightly lower at 0.1 to 0.15°C per decade.

4.1.2 Rainfall

The rainfall record shows a general declining trend of greater than 50mm per decade since 1950 across most of east coast Queensland. In the Broadsound region this trend is evident in the summer rainfall record and a slightly slower decline in autumn (- 20 to 30 mm per decade). Winter rainfall has declined very slightly (up to -5 .0 mm per decade). Contrary to these declining trends, spring rains have increased at a rate of up to 10mm per decade.

In the light of these observed changes the use of long-term average data is probably of limited utility in understanding the contemporary climate of the Broadsound basin.

(See Chapter 8 S1 for a broader discussion of climate change in this region).

Table 4.1 Summary weather data for the Broadsound Basin.

| Weather Station Location | Mean maximum temperature (°C) | Highest monthly temperature (°C - month) | Mean minimum temperature (°C) | Lowest mean monthly temperature (°C - month) | Mean annual rainfall (mm) |
|--------------------------|-------------------------------|--|-------------------------------|--|---------------------------|
| St Lawrence | 28.4 | 31.8 - January | 28.4 | 10.9 - July | 1011.5 |
| Pine Inlet | 26.5 | 30.4 - December | 26.5 | 17.3 - July | 873.5 |
| Rockhampton | 28.3 | 32.1 - December | 28.3 | 9.5 - July | 792.8 |

(Commonwealth of Australia 2007, Bureau of Meteorology)

4.2 Regional ecosystems and wetlands

The Broadsound Basin lies within two bioregions. The majority is included in the Southern Brigalow Belt bioregion. Parts of the western portions of the St Lawrence Creek catchment and north and western portions of Clairview Creek Catchment fall within the Central Queensland Coast bioregion (EPA 2007).

Based on the DCDB, the Broadsound Basin land tenures cover some 508,445 ha. About 41 % is cleared or significantly altered. About 46 % supports remnant native vegetation that is classified as *not of concern*. Almost 13 % supports native plant communities that are considered *endangered* or *of concern*. There are differences among catchments.

4.2.1 Clairview Creek Catchment

Regional ecosystems

The Clairview Creek catchment covers some 27,292 ha. Just over 29 % is cleared or significantly altered. About 71 % supports remnant native vegetation. Nearly 12 % is considered to be *of concern*. Just over 2 % is *endangered* or contains elements of endangered ecosystems. The endangered ecosystem elements are largely confined to the riparian systems and provide the major biodiversity corridors across the cleared lowlands (figures 4.1 & 4.2).

The Clairview catchment includes about 3,827 ha of intertidal and freshwater wetlands – about 14 % of the catchment area (figure 4.3).

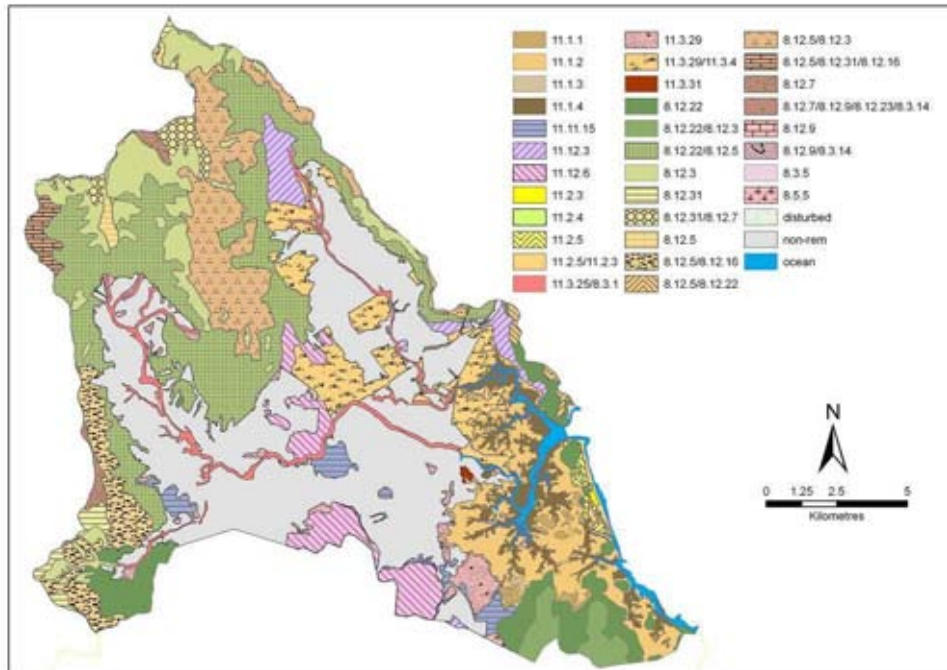


Figure 4.1 Regional ecosystems across the Clairview Creek catchment. See chapter 8 S6 for a short description of the regional ecosystem codes. Codes beginning in 11 refer to the Brigalow Belt bioregion. Codes beginning in 8 refer to the Central Queensland Coast bioregion. The term *non-rem* refers to lands modified to the extent those lands no longer reflect remnant native ecosystems.

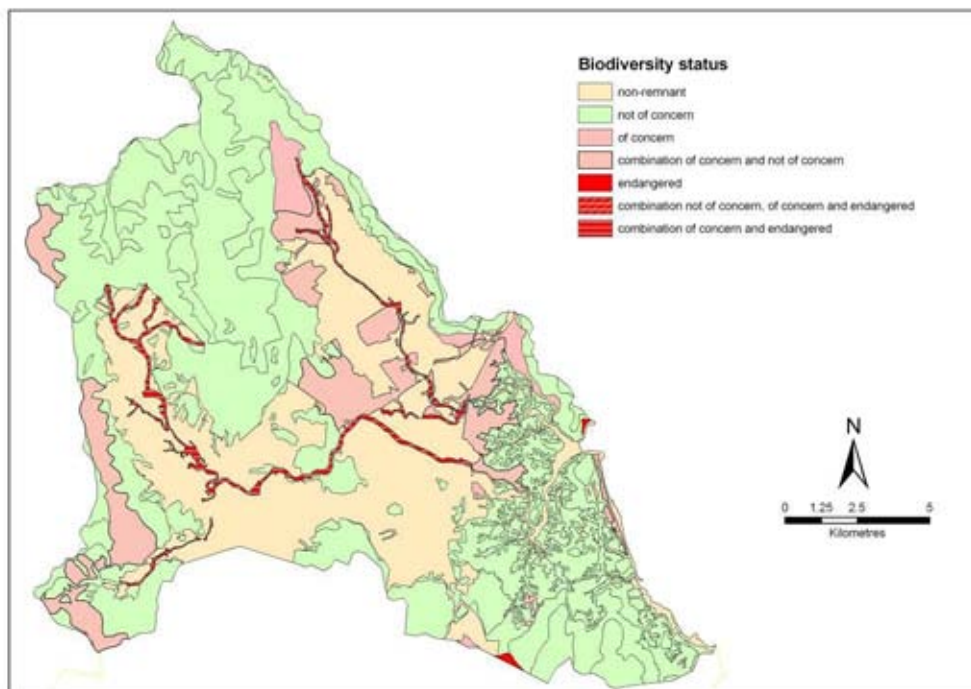


Figure 4.2 Conservation status of regional ecosystems of the Clairview Creek catchment. *Not of Concern* indicates that greater than 30% of the pre European extent of this ecosystem remains in Queensland. *Of Concern* indicates that 10 -30% of the pre European extent of this ecosystem remains in Queensland. *Endangered* indicates that < 10% of the pre European extent of this ecosystem remains in Queensland. The term *Non-remnant* refers to lands modified to the extent those lands no longer reflect remnant native ecosystems.

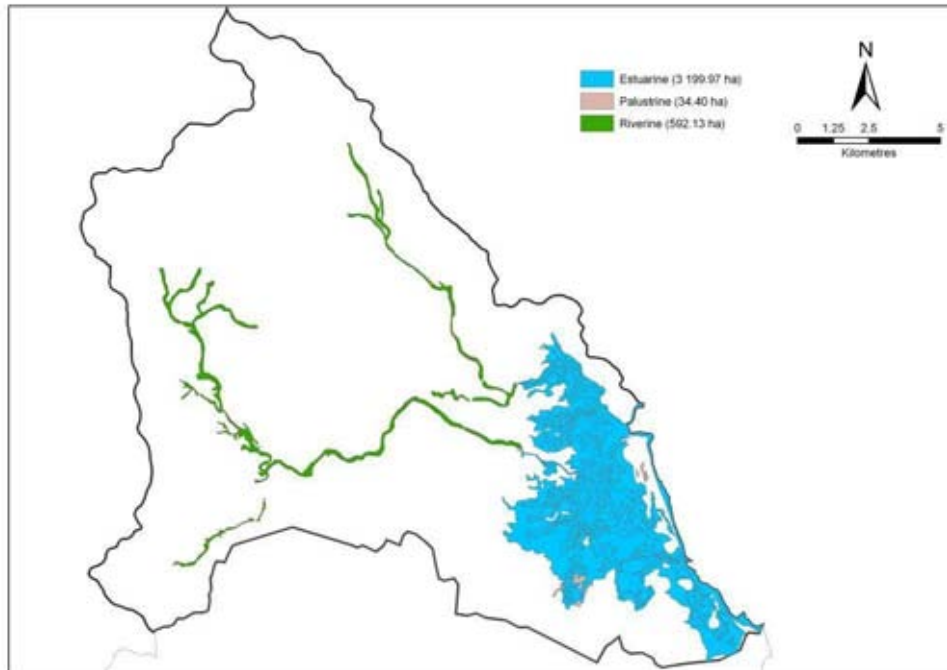


Figure 4.3 Wetland ecosystems in the Clairview Creek catchment.
See chapter 8 S4 for definitions of wetland types.

4.2.2 St Lawrence Creek Catchment

Regional ecosystems

The St Lawrence Creek catchment covers slightly less than 41,441 ha. Just less than 27 % is cleared or significantly altered. So 73 % supports remnant native vegetation. Nearly 8 % of the remnant native vegetation consists of plant communities that are *endangered* or contain elements of endangered ecosystems. Just over 7 % of the remnant native vegetation is considered to have an *of concern* conservation status. The riparian communities fringing the major streams contain elements of endangered ecosystems and, as in the Clairview catchment, form biodiversity corridors across the cleared lowlands. In the St Lawrence catchment, however, there are extensive areas of remnant vegetation (*not of concern*) associated with this riparian matrix. Together these elements form a more extensive and complex biodiversity corridor between the western escarpment and the eastern coast line (figures 4.4 & 4.5).

The St Lawrence Creek catchment includes about 7,041 ha of freshwater and intertidal wetlands (17.4 % of the catchment) (figure 4.6).

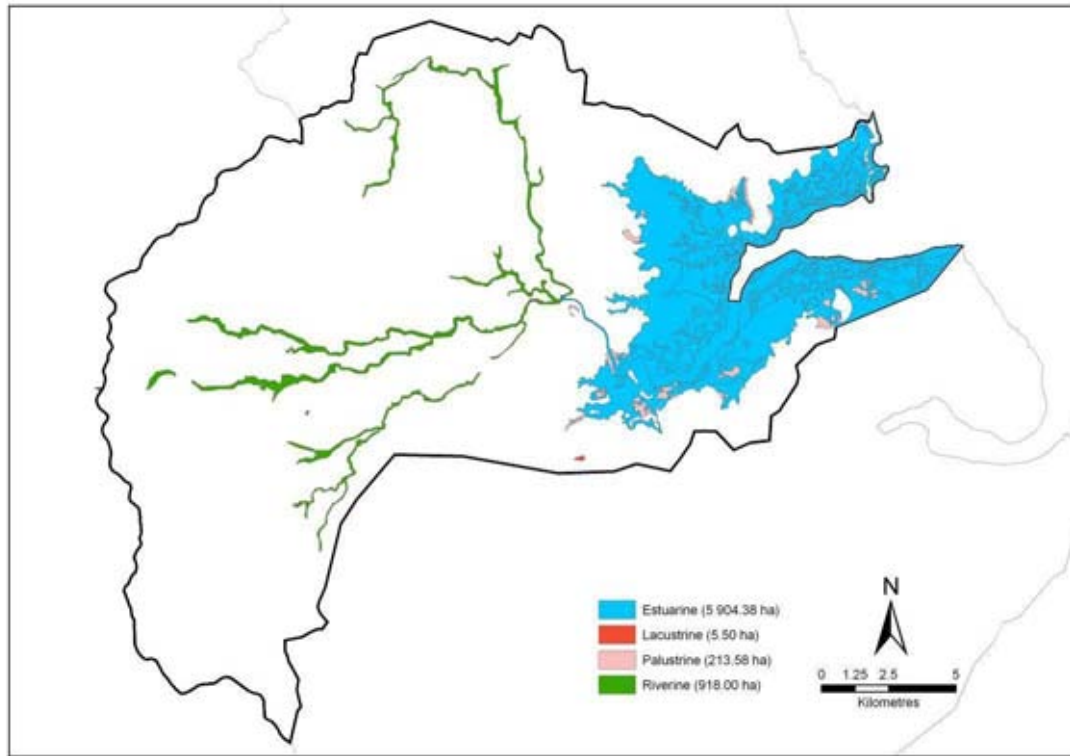


Figure 4.6 Wetland ecosystems in the St Lawrence Creek catchment.

The map depicts the pre-development situation whereas large areas of wetland on marine plains in the Broadsound basin have been modified by sea-walls and banks. These tide-excluding structures have changed wetland to the landward side such that many such wetlands of estuarine origin now exhibit typical features of palustrine or lacustrine freshwater wetlands. See chapter 8 S4 for definitions of wetland types.

4.2.3 Waverley Creek Catchment

Regional ecosystems

The Waverley Creek Catchment is 60,056 ha in area. Almost 22,383 ha (38.2%) is cleared or significantly altered. About 6 % of the remnant native vegetation is classified as *endangered* (936 ha) or *of concern* (2,653 ha) (figures 4.7 & 4.8).

The Waverley Creek catchment includes 17,624 ha of freshwater and intertidal wetlands-over 29.7 % of the catchment (figure 4.9).

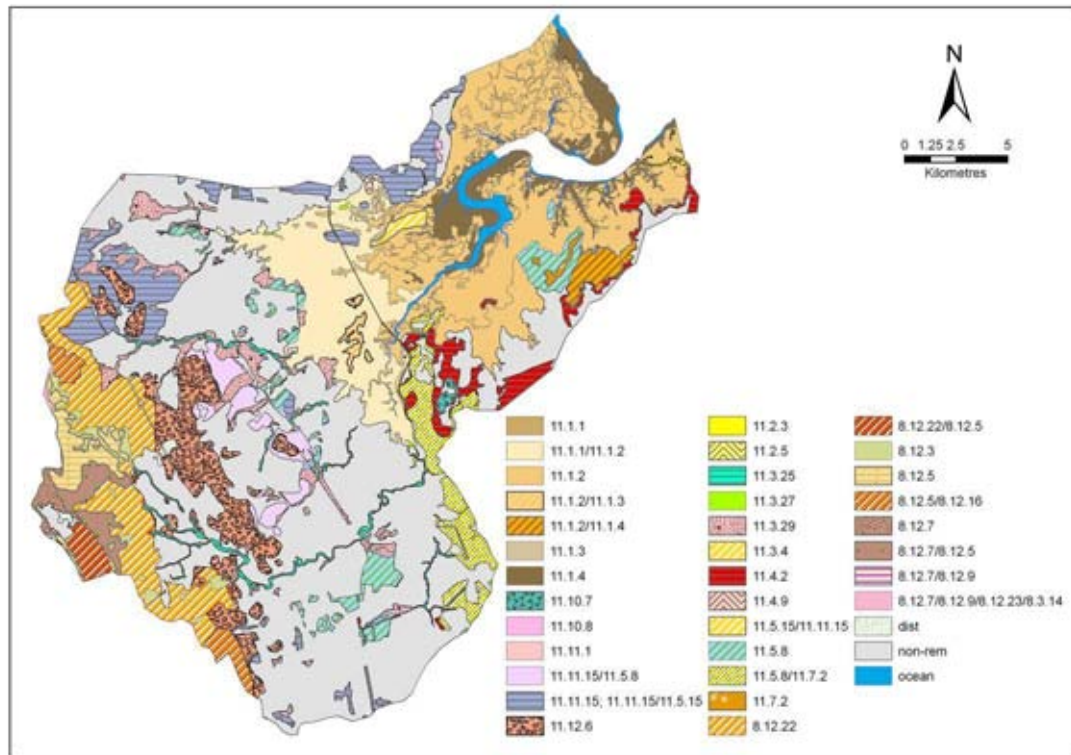


Figure 4.7 Regional ecosystems across the Waverley Creek catchment. See chapter 8 S6 for a short description of the regional ecosystem codes. Codes beginning in 11 refer to the Brigalow Belt bioregion. Codes beginning in 8 refer to the Central Queensland Coast bioregion. The term *non-rem* refers to lands modified to the extent those lands no longer reflect remnant native ecosystems.

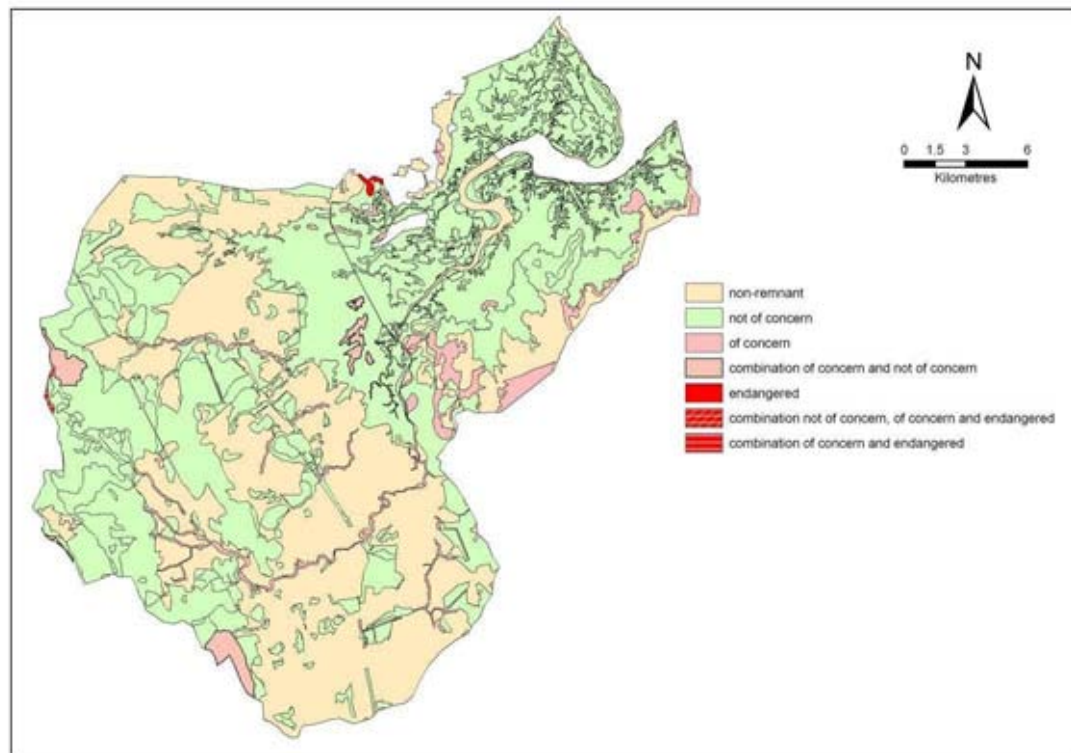


Figure 4.8 Conservation status of regional ecosystems of the Waverley Creek catchment. *Not of Concern* indicates that greater than 30% of the pre European extent of this ecosystem remains in Queensland. *Of concern* indicates that 10 -30% of the pre European extent of this ecosystem remains in Queensland. *Endangered* indicates that < 10% of the pre European extent of this ecosystem remains in Queensland. The term *Non-remnant* refers to lands modified to the extent those lands no longer reflect remnant native ecosystems.

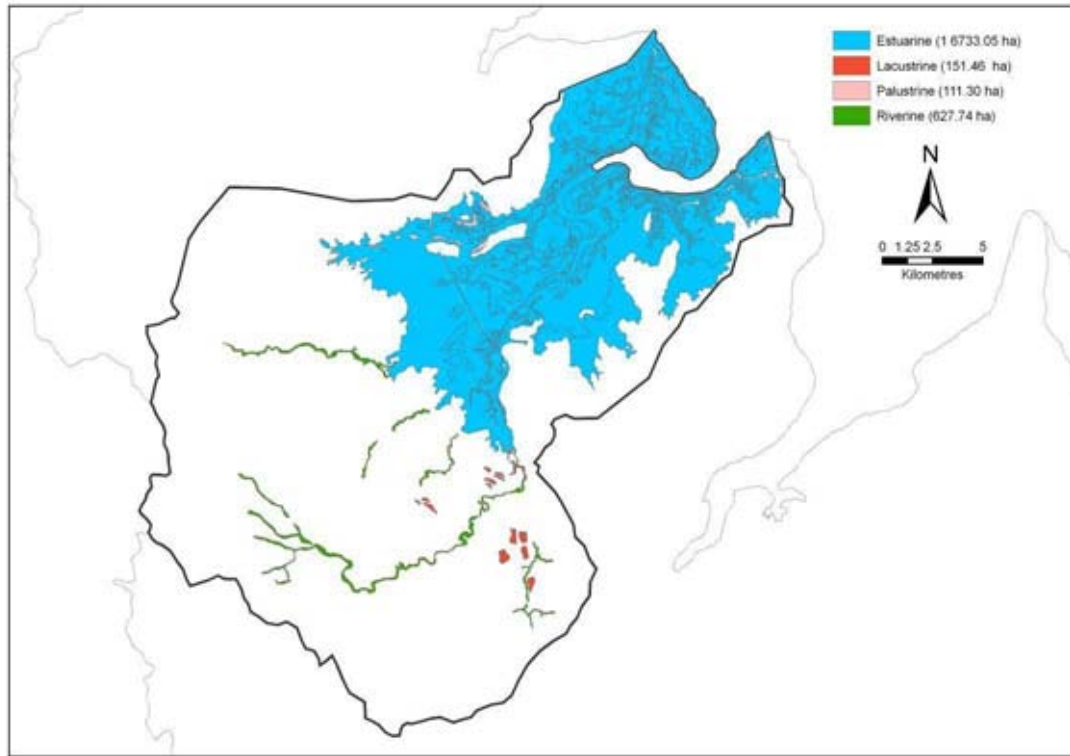


Figure 4.9 Wetland ecosystems in the Waverley Creek catchment.

The map depicts the pre-development situation whereas large areas of wetland on marine plains in the Broadsound basin have been modified by sea-walls and banks. These tide-excluding structures have changed wetland to the landward side such that many such wetlands of estuarine origin now exhibit typical features of palustrine or lacustrine freshwater wetlands. See chapter 8 S4 for definitions of wetland types.

4.2.4 Styx River Catchment

Regional ecosystems

The Styx River catchment covers 177,624 ha. Of this 52 % is cleared or significantly altered. The remnant native vegetation includes 21,974 ha (12.5% of catchment) of native vegetation classified as *of concern* or *endangered* (figures 4.10 & 4.11).

The contribution of wetlands to the Styx River catchment is relatively small with about 8.3% of the catchment comprised of freshwater or intertidal wetlands (14,780 ha) (figure 4.12).

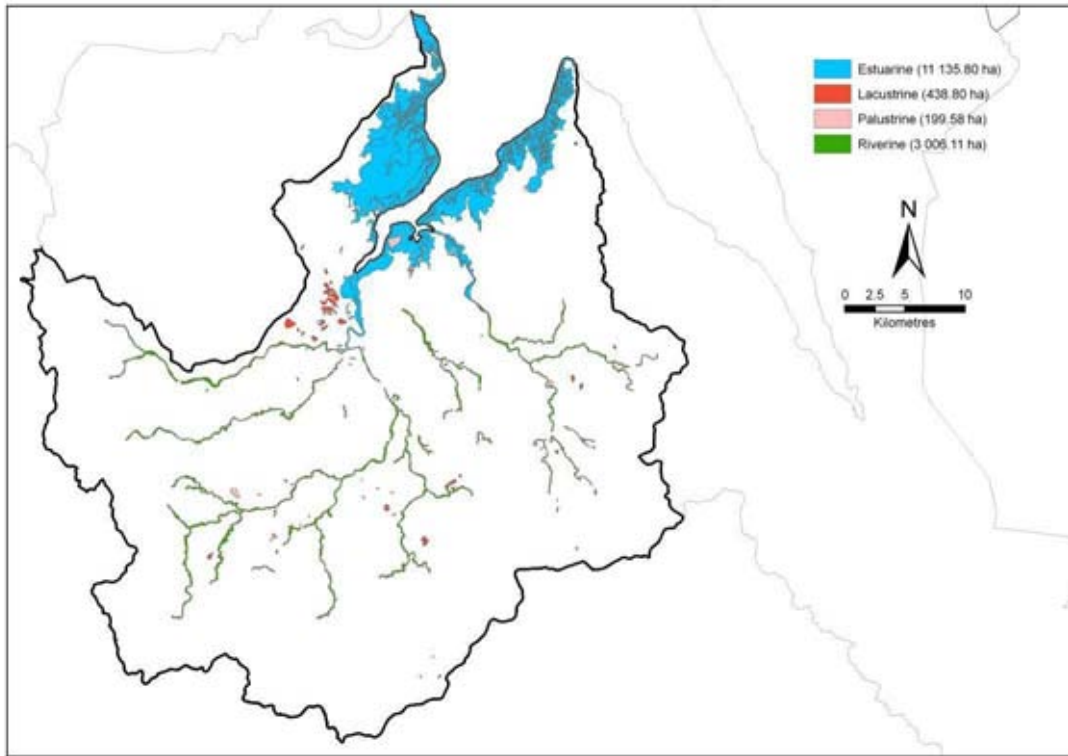


Figure 4.12 Wetland ecosystems in the Styx River catchment.

The map depicts the pre-development situation whereas large areas of wetland on marine plains in the Broadsound basin have been modified by sea-walls and banks. These tide-excluding structures have changed wetland to the landward side such that many such wetlands of estuarine origin now exhibit typical features of palustrine or lacustrine freshwater wetlands. See chapter 8 S4 for definitions of wetland types.

4.2.5 Herbert Creek Catchment

Regional ecosystems

The Herbert Creek catchment covers 189,293 ha. Some 38 % is cleared or significantly altered. Just less than 62 % is remnant native vegetation. About 12 % of the catchment area supports native vegetation classified as *of concern* or *endangered* (figures 4.13 & 4.14).

Nearly 25 % of the Herbert Creek catchment (about 46,719 ha) is classed as intertidal or freshwater wetland (figure 4.15).

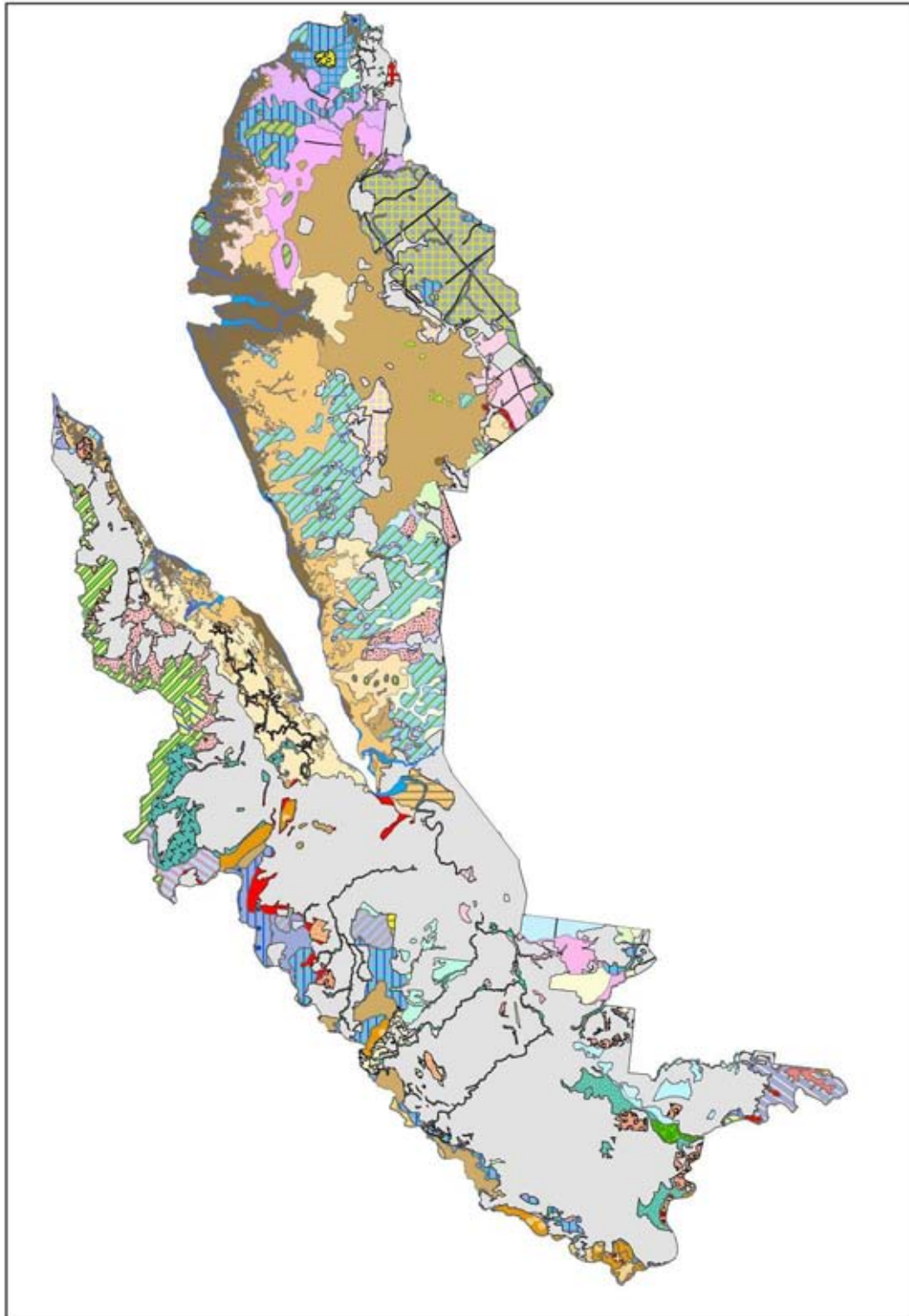




Figure 4.13 Regional ecosystems across the Herbert Creek catchment.

See chapter 8 S6 for a short description of the regional ecosystem codes. Codes beginning in 11 refer to the Brigalow Belt bioregion. Codes beginning in 8 refer to the Central Queensland Coast bioregion. The term *non-rem* refers to lands modified to the extent those lands no longer reflect remnant native ecosystems.

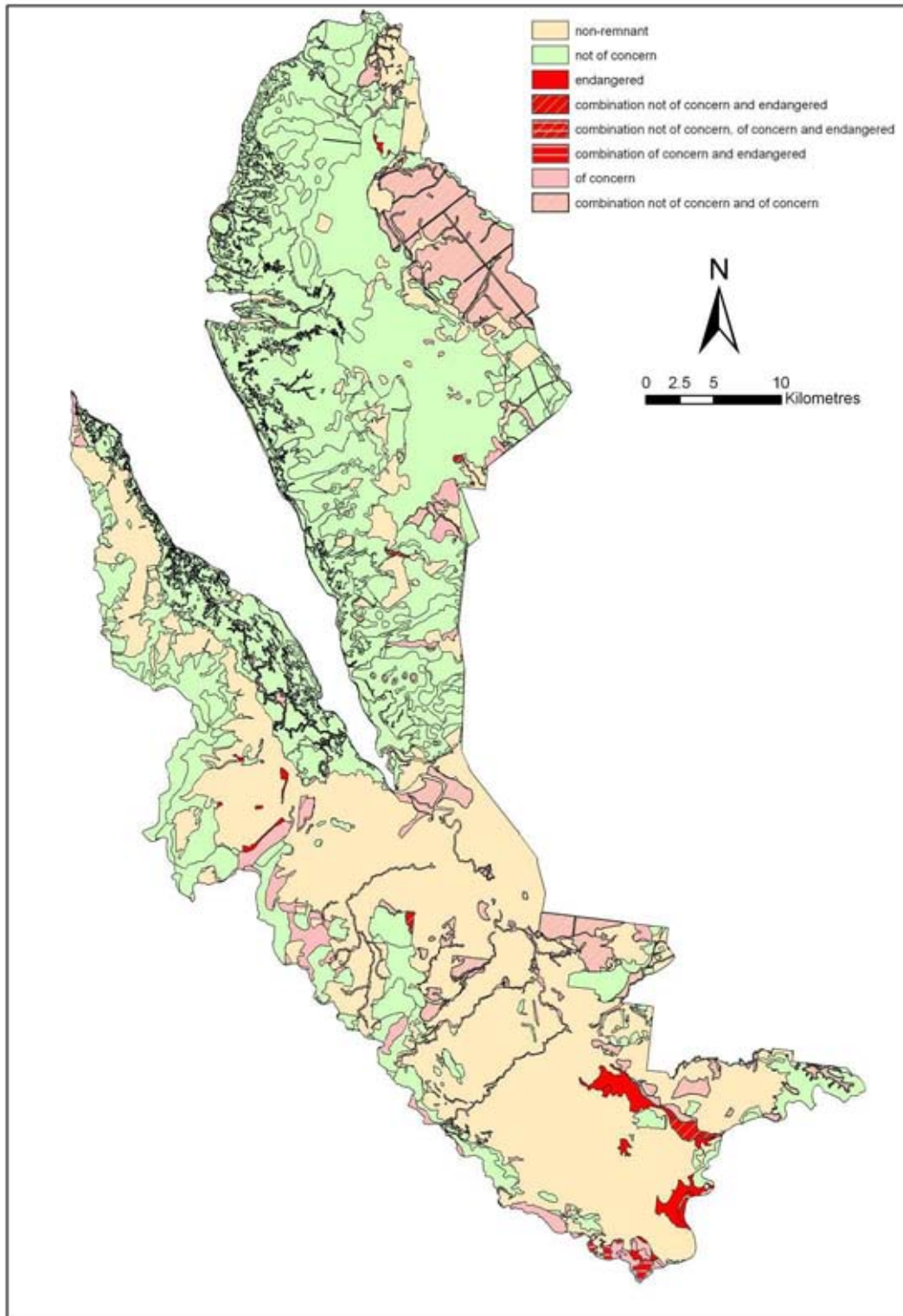


Figure 4.14 Conservation status of regional ecosystems of the Herbert Creek catchment.

Not of Concern indicates that greater than 30% of the pre European extent of this ecosystem remains in Queensland. *Of concern* indicates that 10 -30% of the pre European extent of this ecosystem remains in Queensland. *Endangered* indicates that < 10% of the pre European extent of this ecosystem remains in Queensland. The term *non-remnant* refers to lands modified to the extent those lands no longer reflect remnant native ecosystems.

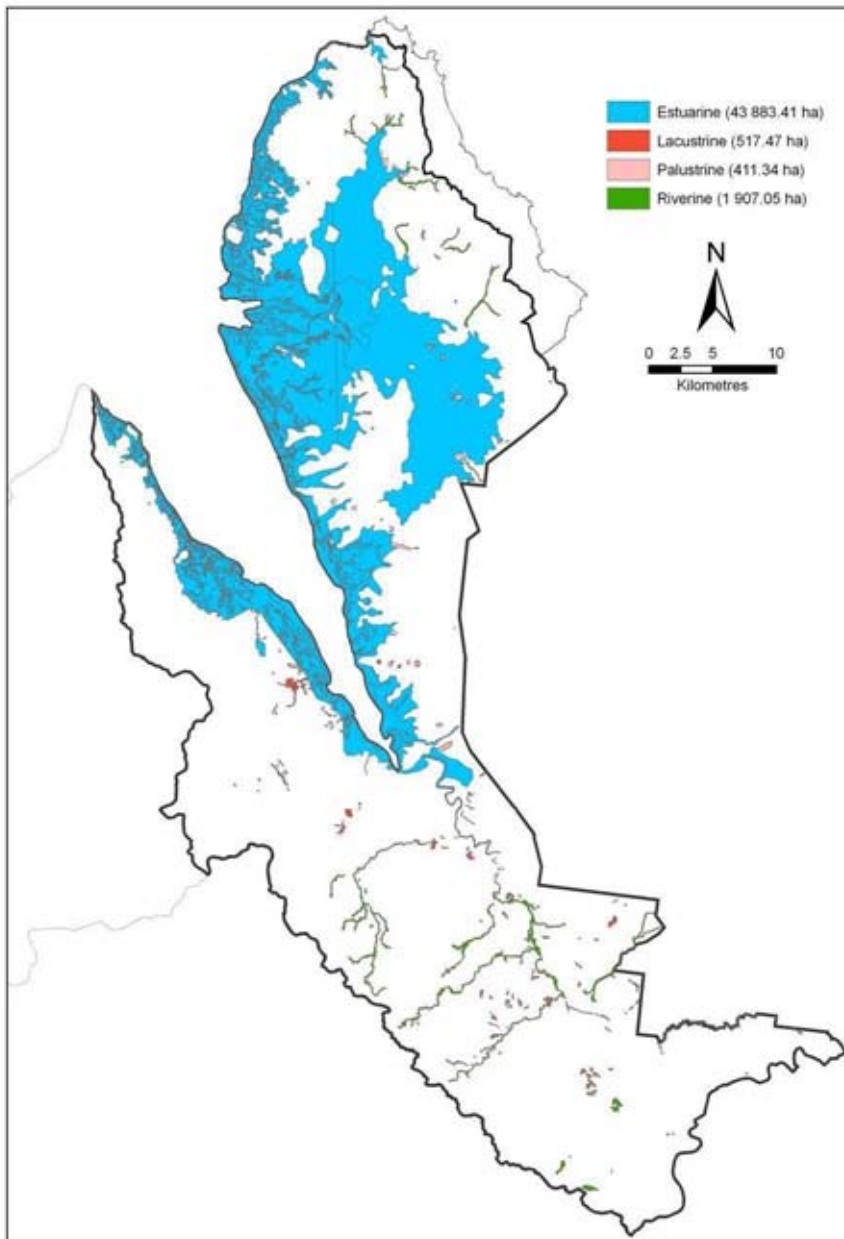


Figure 4.15 Wetland ecosystems in the Herbert Creek catchment.

The map depicts the pre-development situation whereas large areas of wetland on marine plains in the Broadsound basin have been modified by sea-walls and banks. These tide-excluding structures have changed wetland to the landward side such that many such wetlands of estuarine origin now exhibit typical features of palustrine or lacustrine freshwater wetlands. See chapter 8 S4 for definitions of wetland types.

4.2.6 Stanage Coast Catchment

Regional ecosystems

The Stanage Coast catchment covers 7678 ha. Just under 67% (5,042 ha) supports remnant native vegetation that is classified as *of concern* or *endangered*. Nearly 16 % is cleared or significantly altered (figures 4.16 & 4.17).

Only about 6% (453 ha) of the Stanage coast is classified as wetland (figure 4.18).

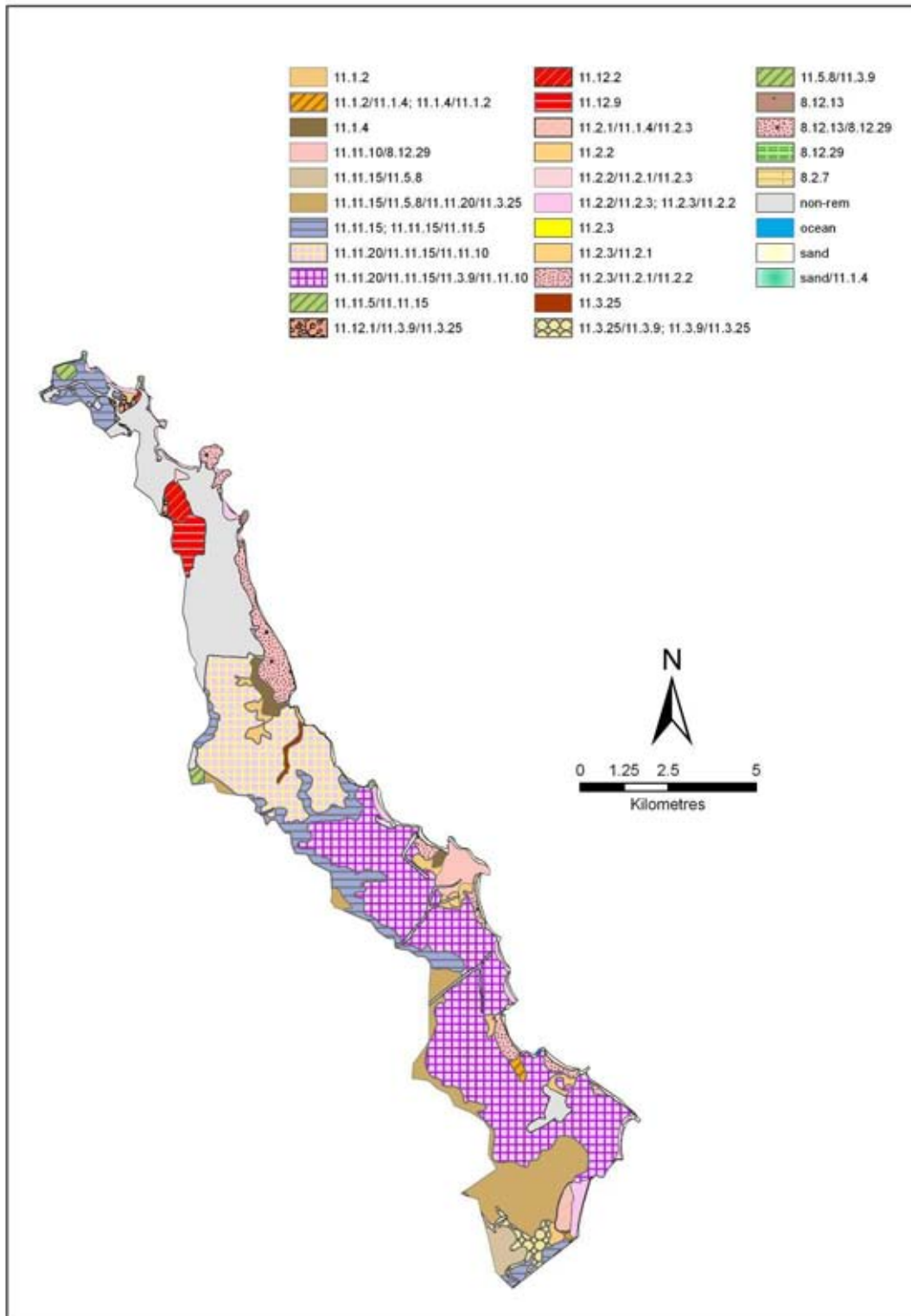


Figure 4.16 Regional ecosystems across the Stanage Coast catchment.

See chapter 8 SX for a short description of the regional ecosystem codes. Codes beginning in 11 refer to the Brigalow Belt bioregion. Codes beginning in 8 refer to the Central Queensland Coast bioregion. The term *non-rem* refers to lands modified to the extent those lands no longer reflect remnant native ecosystems.

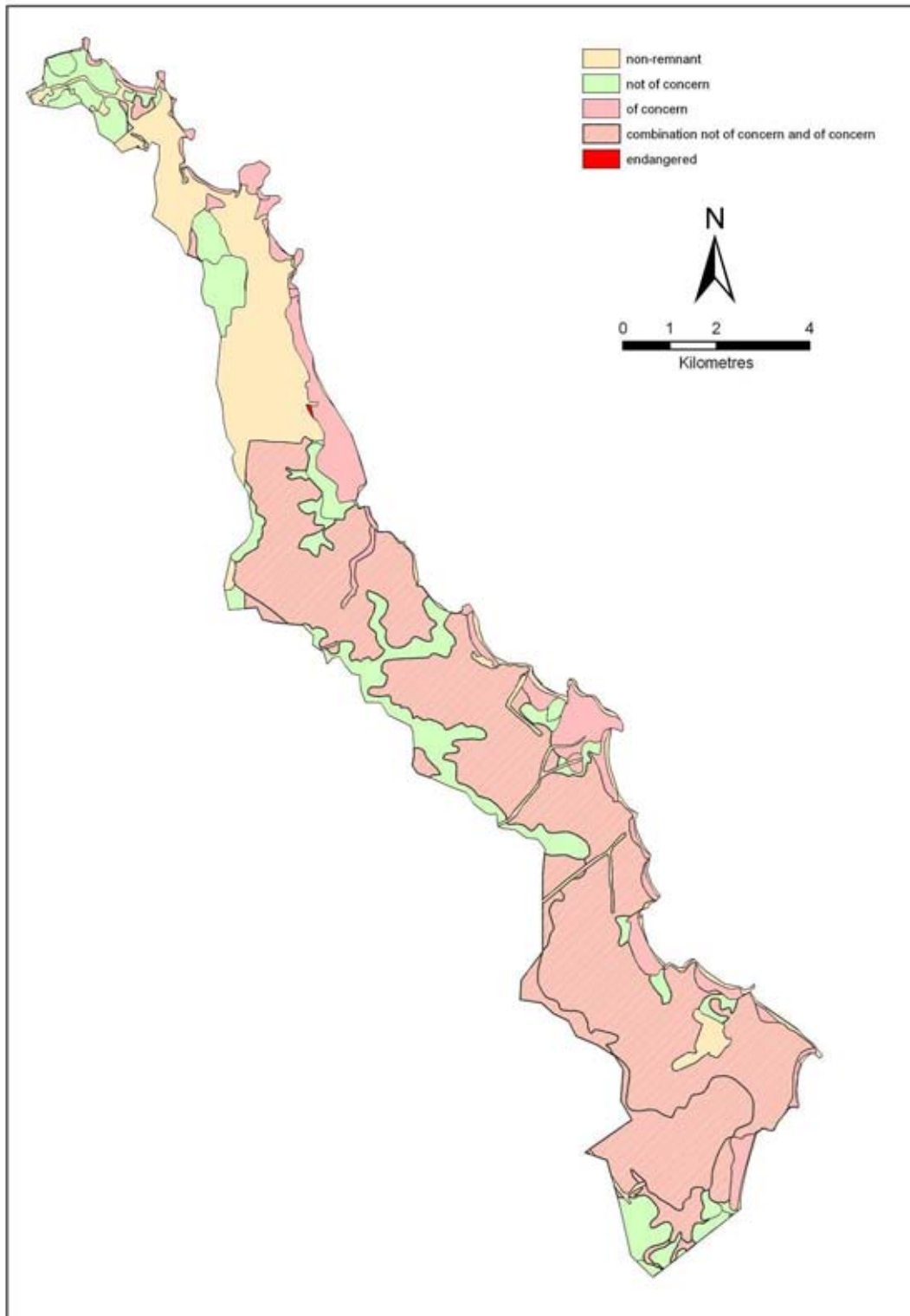


Figure 4.17 Conservation status of regional ecosystems of the Stange Coast catchment.

Not of Concern indicates that greater than 30% of the pre European extent of this ecosystem remains in Queensland. *Of concern* indicates that 10 -30% of the pre European extent of this ecosystem remains in Queensland. *Endangered* indicates that < 10% of the pre European extent of this ecosystem remains in Queensland. The term *Non-remnant* refers to lands modified to the extent those lands no longer reflect remnant native ecosystems.

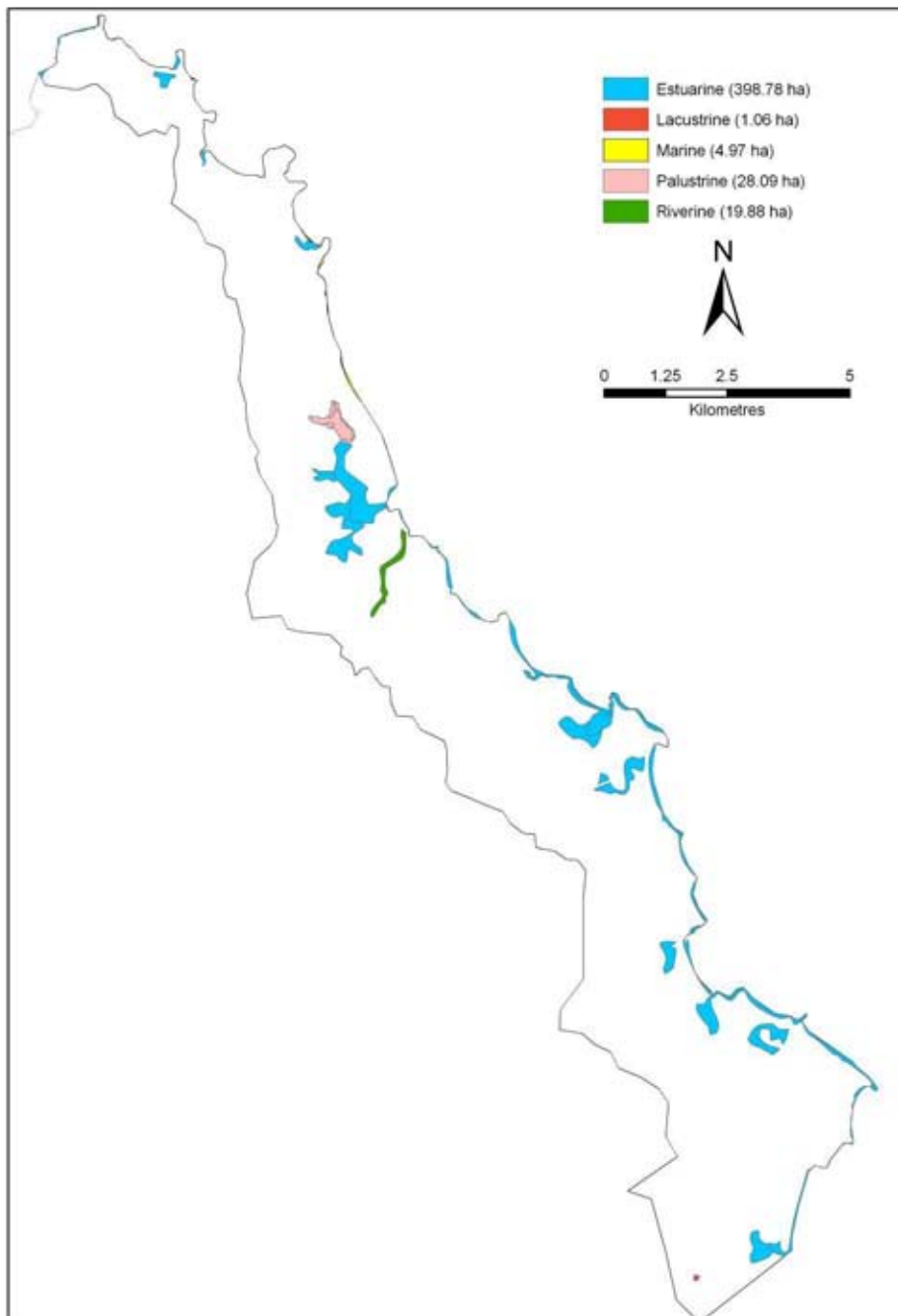


Figure 4.18 Wetland ecosystems in the Stanage Coast catchment.
See chapter 8 S4 for definitions of wetland types.

4.3 Significant biota

4.3.1 Plants

The Queensland Herbarium has records of 783 species within the Broadsound Basin. Of this assemblage 10 specimens were collected by Joseph Banks and D. Solander from Quail Island in May 1770. Four species are listed as endangered, five as vulnerable and six as rare. Ninety three species (12 %) are exotic species. Two endangered species, five vulnerable species and two rare species occur from one ecosystem on the south-western rim of the basin - the Marlborough Hills serpentine landscape. See chapter 8 S7 for a list of significant and exotic species from the Broadsound region.

The Marlborough Hills serpentine landscapes are of extremely high biodiversity value supporting a large number of endemic plant species.

4.3.2 Animals

The Queensland Environmental Protection Agency Wildnet records 393 species within the basin and adjacent waters. This includes two butterflies, seven freshwater fish, 255 species of birds, 19 species of insectivorous bat, two fruit bat species, 30 terrestrial and arboreal mammals, two marine mammals, 23 amphibians, four turtle species, 14 snakes and 34 lizard species. Of these eight are naturalised exotic species and 25 are classified as endangered, vulnerable or rare. The significant and exotic species are listed in chapter 8 S8.

4.4 Terrestrial environmental bench mark sites

4.4.1 Regional ecosystem condition benchmark sites

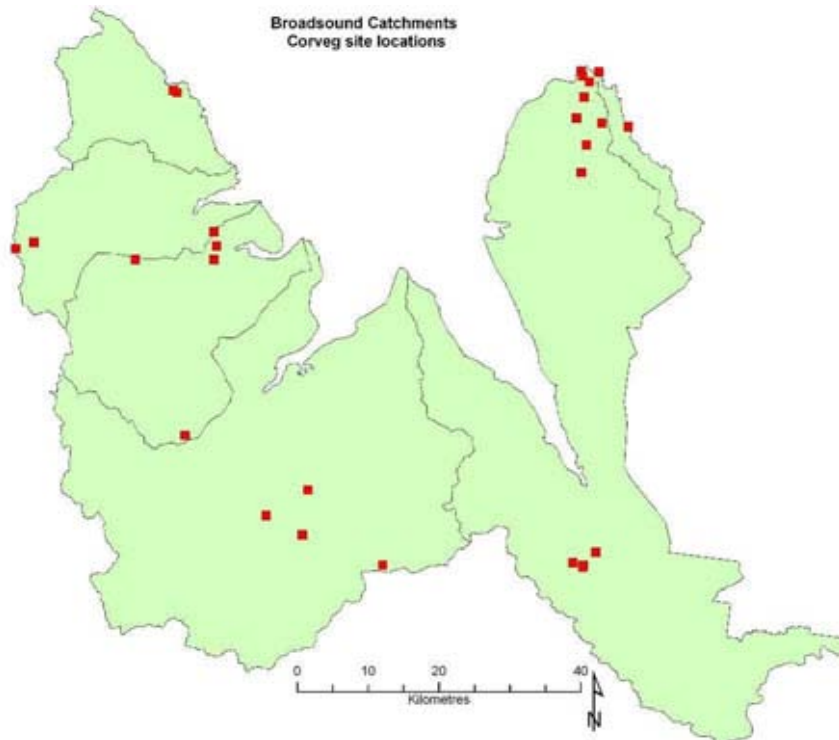


Figure 4.19 Distribution of regional ecosystem bench mark sites across the Broadsound basin. See chapter 8 S3 Queensland Herbarium Ecosystem Condition Benchmark Sites for more detail.

Twenty eight bench mark sites have been established by the Queensland Herbarium as part of state wide assessment of regional ecosystem mapping and condition assessment. They are located in a range of environments from coastal beach scrubs, wetlands, eucalypt woodlands and mountainous rainforests (see table S3.1). These sites provide a valuable environmental condition baseline. This baseline is complemented by the regional photo points below.

4.4.2 Regional photo point sites

Fifty one regional photo points have been established across five of the six catchments within the Broadsound Basin (figure 4.19, table 4.2). Sites are associated with four major land use classes (table 4.3) that also included timber plantation and conservation tenures subject to grazing. The site array was influenced by property access permission achieved within the project timeframe. Sites were established after good regional rains and overall land cover was good in the post wet season environment. To be an effective assessment tool the photo point array should be revisited in poor conditions and the array should be expanded to give a more even spread of assessment over the catchments and over lands under a full range of

management regimes. See chapter 8 S2 for a full description of the methodology and the site data summaries.

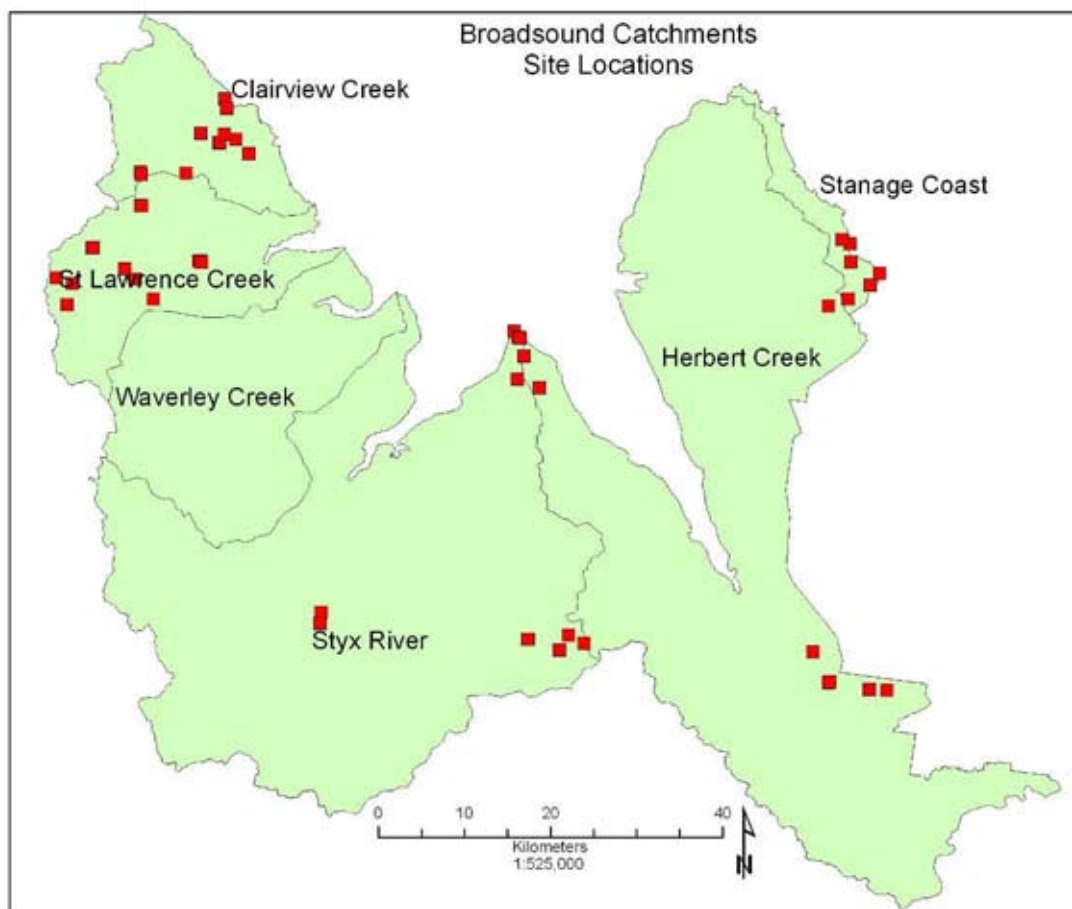


Figure 4.20 Location of regional photo point sites across the Broadsound basin. see chapter 8 S2 *Field assessment and photo points* for site data and methodology.

Table 4.2 Photo point sites within Broadsound Basin catchments

| Catchment | Catchment Area (ha) | Sites/catchment |
|-------------------|---------------------|-----------------|
| Clairview Creek | 27222.73 | 12 |
| St Lawrence Creek | 40534.73 | 13 |
| Waverley Creek | 59172.15 | none |
| Styx River | 174568.61 | 12 |
| Herbert Creek | 188021.30 | 8 |
| Stanage Coast | 7590.11 | 6 |

Table 4.3 Land use classes associated with photo point sites

| Land use | Site numbers |
|-------------------|--------------|
| Grassland grazing | 7 |
| Woodland grazing | 21 |
| Reserve | 4 |
| Conservation | 15 |

4.5 Land tenure and land use

4.5.1 Clairview Creek Catchment

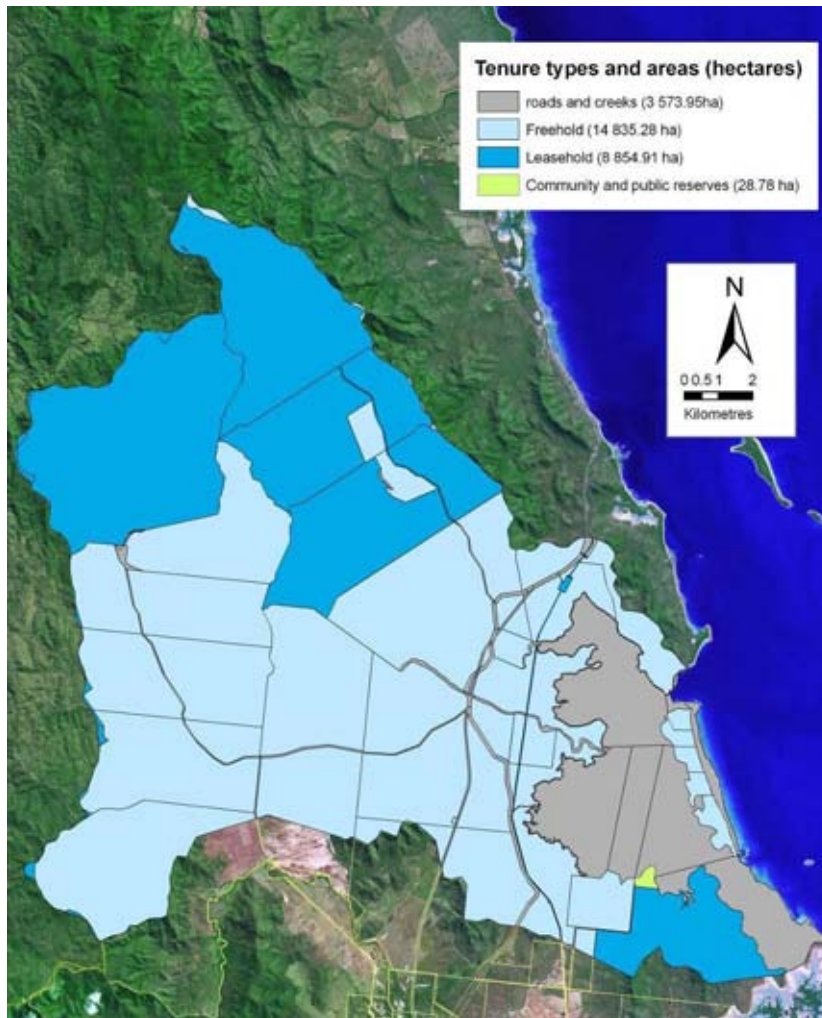


Figure 4.21 Land tenure types within the Clairview Creek catchment. Data derived from the DNR&W DCDB.

Table 4.4 Land tenure within the Clairview Creek catchment

| Tenure | Area (ha) | % |
|-------------------------------|-----------------|-------|
| community and public reserves | 28.78 | 0.11 |
| roads, creeks, mangroves | 3573.95 | 13.09 |
| Leasehold | 8854.91 | 32.44 |
| Free hold | 14835.28 | 54.36 |
| Total | 27292.92 | |
| Covenant | 4514.57 | 16.54 |

Clairview Creek catchment is predominantly under freehold tenure although with a significant leasehold component (figure 4.20, table 4.4). There is little public land. There is about 4,500 ha (16.5%) under an environmental covenant.

4.5.2 St Lawrence Creek catchment

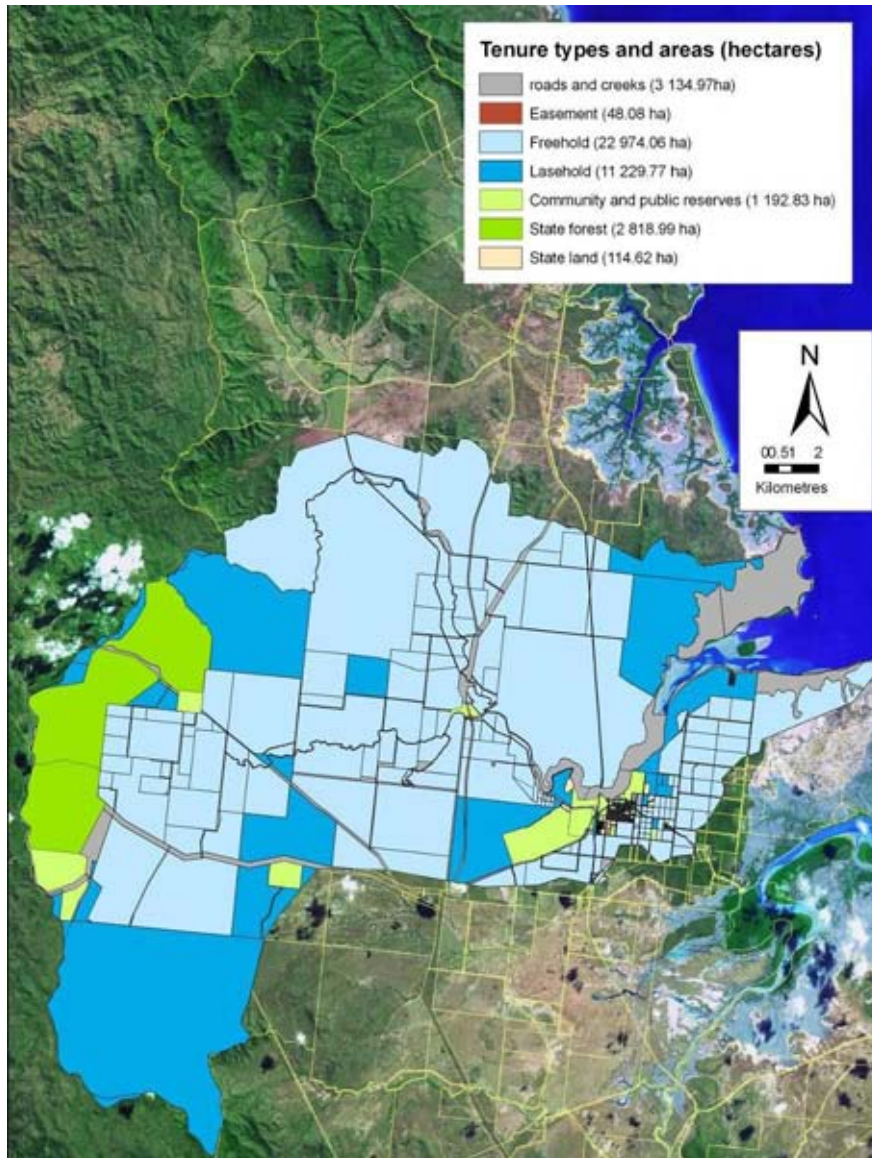


Figure 4.22. Land tenures within the St Lawrence Creek catchment. Data derived from the DNR&W DCDB.

Table 4.5 Land tenure within the St Lawrence Creek catchment

| Tenure | Area (ha) | % |
|-------------------------------|-----------|-------|
| Easements | 48.08 | 0.10 |
| State land | 114.62 | 0.25 |
| community and public reserves | 1192.83 | 2.57 |
| State forest | 2818.99 | 6.08 |
| roads, creeks, mangroves | 7983.3 | 17.22 |
| Leasehold | 11229.77 | 24.22 |
| Free hold | 22974.06 | 49.55 |
| Total | 46361.65 | |
| Covenant | 1805.85 | 3.90 |

St Lawrence Creek catchment is predominantly covered by freehold tenure with a substantial area of leasehold land. Conservation tenure (state forests) covers about 6% of the catchment. Another 4% of the catchment is under environmental covenant.

4.5.3 Waverley Creek catchment

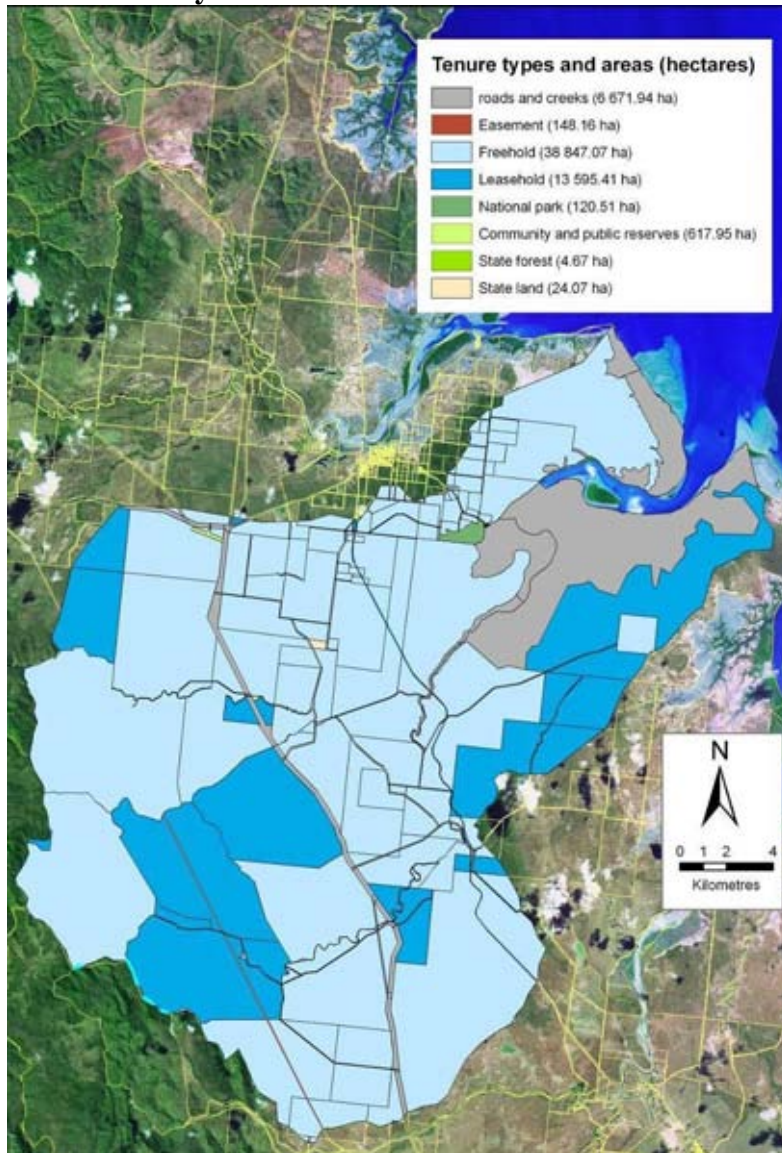


Figure 4.23. Land tenures within the Waverley Creek catchment. Data derived from the DNR&W DCDB.

Table 4.6 Land tenure within the Waverley Creek catchment

| Tenure | Area (ha) | % |
|-------------------------------|-----------------|-------|
| State land | 24.07 | 0.04 |
| National park | 120.51 | 0.20 |
| Easements | 148.16 | 0.25 |
| community and public reserves | 617.95 | 1.03 |
| State forest | 4.67 | 0.01 |
| roads, creeks, mangroves | 6671.94 | 11.11 |
| Leasehold | 13595.41 | 22.65 |
| Free hold | 38847.07 | 64.71 |
| Total | 60029.79 | |
| Covenant | 2812.48 | 4.69 |

Waverley Creek catchment is predominantly covered by freehold tenure with a substantial area of leasehold land. There is little land under conservation tenure in the catchment. However, just less than 5% of the catchment is under environmental covenant.

4.5.4 Styx River catchment

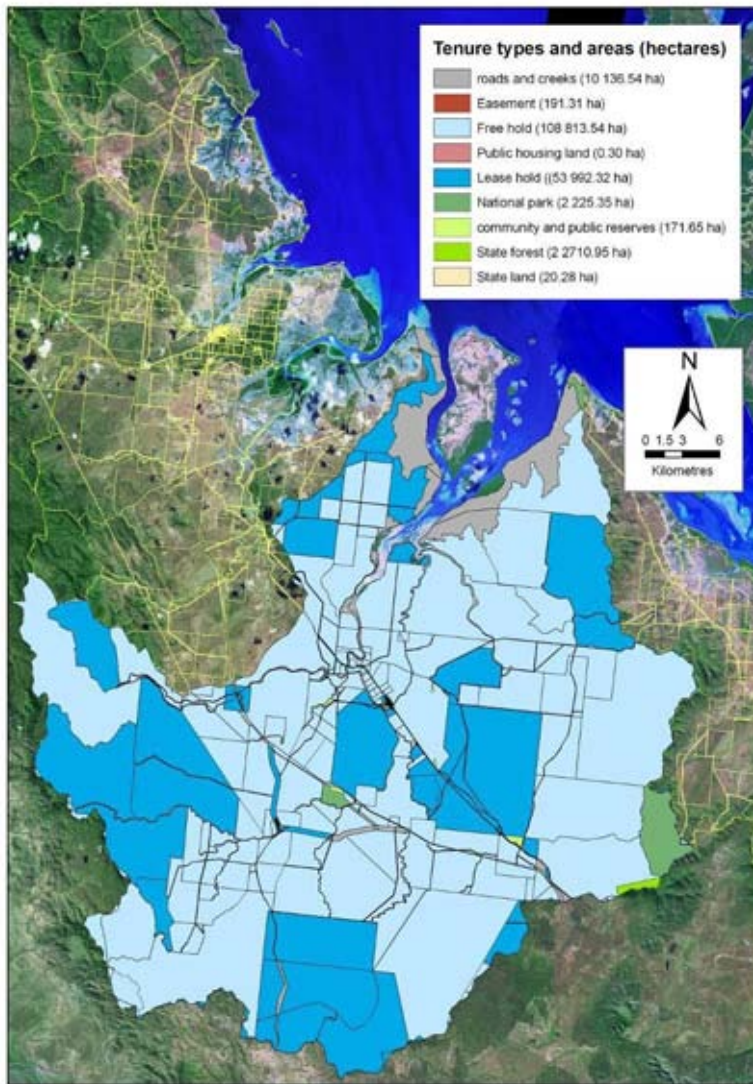


Figure 4.24 Land tenures within the Styx River catchment. Data derived from the DNR&W DCDB.

Table 4.7 Land tenure within the Styx River catchment

| Tenure | Area (ha) | % |
|-------------------------------|-----------------|--------|
| Public housing land | 0.31 | 0.0002 |
| State land | 20.28 | 0.01 |
| community and public reserves | 171.65 | 0.10 |
| Easements | 191.31 | 0.11 |
| National park | 2225.35 | 1.25 |
| State forest | 2270.95 | 1.28 |
| roads, creeks, mangroves | 10136.54 | 5.70 |
| Leasehold | 53992.32 | 30.36 |
| Free hold | 108813.5 | 61.19 |
| Total | 177822.2 | |
| Covenant | 13957.19 | 7.85 |

The Styx River catchment is predominantly covered by freehold tenure with a substantial area of leasehold land. Only 2.5% of the catchment is under conservation tenure. However, just less than 8% of the catchment is under environmental covenant.

4.5.5 Herbert Creek catchment

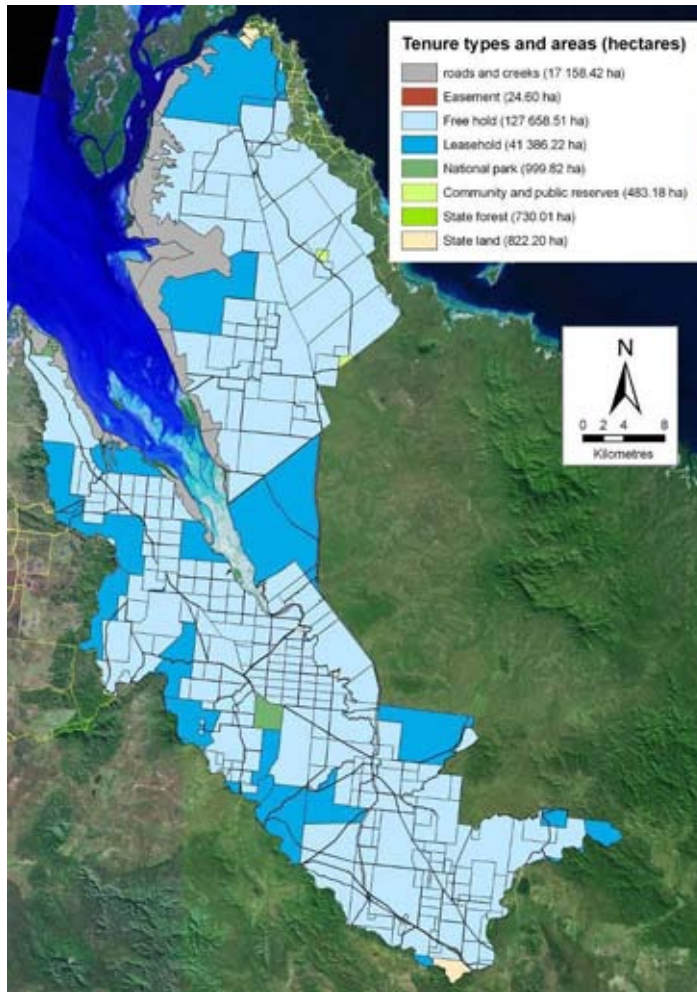


Figure 4.25 Land tenures within the Herbert Creek catchment. Data derived from the DNR&W DCDB.

Table 4.8 Land tenure within the Herbert Creek catchment

| Tenure | Area (ha) | % |
|-------------------------------|---------------|-------|
| easements | 24.60 | 0.01 |
| community and public reserves | 483.18 | 0.26 |
| State forest | 730.01 | 0.39 |
| State land | 822.20 | 0.43 |
| National park | 999.82 | 0.53 |
| roads, creeks, mangroves | 17158.42 | 9.07 |
| Leasehold | 41386.22 | 21.87 |
| Free hold | 127658.5 | 67.45 |
| Total | 189263 | |

The Herbert Creek catchment is predominantly covered by freehold tenure with a substantial area of leasehold land. Less than 1% of the catchment is under conservation tenure and there are no land covenants in this catchment.

4.5.6 Stanage Coast catchment

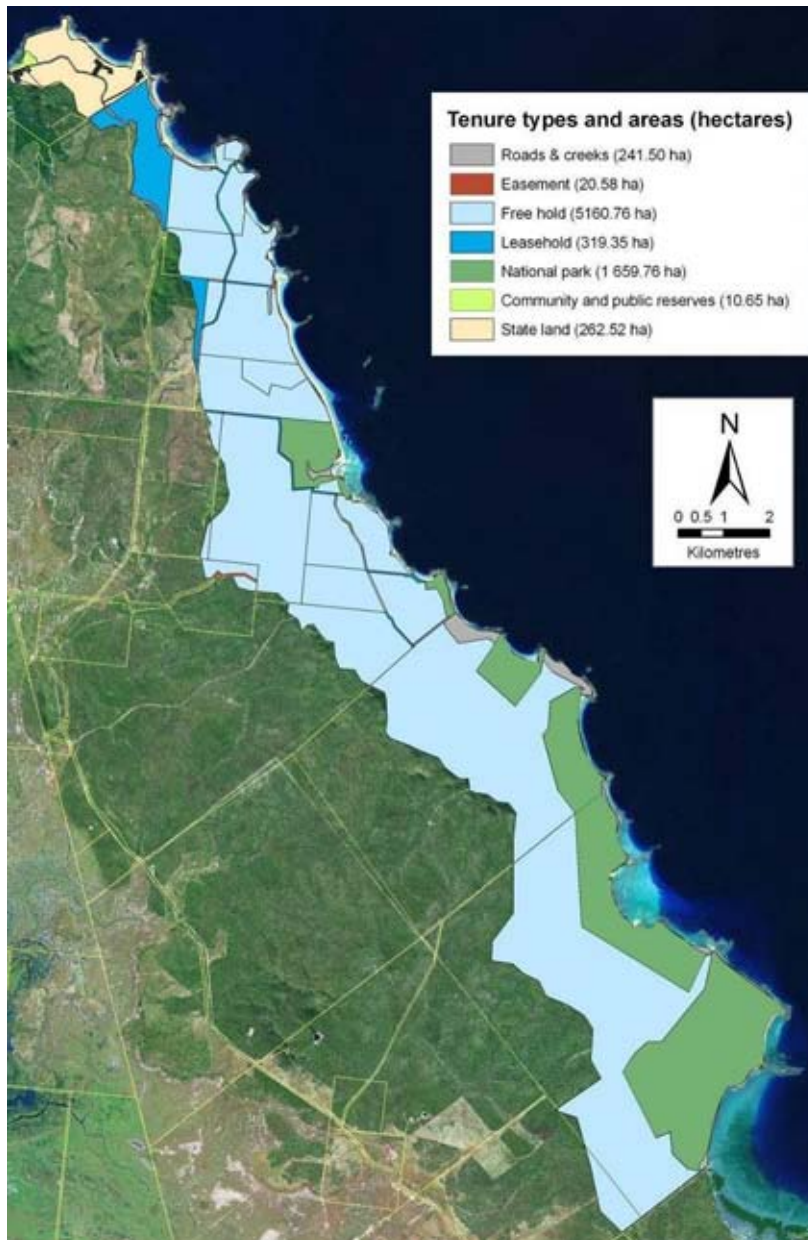


Figure 4.26 Land tenures within the Stanage Coast. Data derived from the DNR&W DCDB.

Table 4.9 Land tenure within the Stanage Coast catchment

| Tenure | Area (ha) | % |
|-------------------------------|----------------|-------|
| community and public reserves | 10.65 | 0.14 |
| Easements | 20.58 | 0.27 |
| roads, creeks, mangroves | 241.50 | 3.15 |
| State land | 262.52 | 3.42 |
| National park | 1659.76 | 21.63 |
| Leasehold | 319.35 | 4.16 |
| Free hold | 5160.76 | 67.24 |
| Total | 7675.13 | |

The Stanage Coast catchment is the smallest catchment in the Broadsound Basin. It is predominantly covered by freehold tenure. In contrast to the other catchments the Stanage Coast includes a high proportion of national park (22%). There is no land under covenant in this catchment.

4.6 Towns

St Lawrence

St Lawrence is a well managed town with interesting historical and natural values. The well restored and unrestored historical buildings and European cultural relics seem to be an underutilized asset (figure 4.27). The surrounding terrestrial plant communities (figure 4.28) are of high biodiversity and conservation value. The relatively easy access to saline and freshwater wetlands around the town provides excellent opportunities for bird watching and water based recreation and fishing (figure 4.29).



Figure 4.27. Historical relics at St Lawrence.



Figure 4.28. Complex dry rainforests of conservation and scientific importance surround St Lawrence.



Figure 4.29. Aquatic and wading birds using lagoons at St Lawrence as a dry season refuge.

Ogmore

Ogmore is a well managed town with interesting historical values. The unrestored historical buildings and European cultural relics (figure 4.30) seem to be an underutilized asset. There is a local oral history of World War II events that require confirmation and associated sites that are poorly known.



Figure 4.30 Cultural relics at Ogmore

Stanage Bay

The Stanage Coast and the settlement at Stanage Bay contain high aesthetic, recreation, tourism and natural values. The coastline is dramatic and accessible (figure 4.31). There are opportunities for nature based recreation and tourism developments exploiting the appeal of the remote rocky coast and access to the coastal waters and reef. The extensive national park and the complex of offshore islands guarantee the maintenance of many natural values. Long term investment opportunities are high.



Figure 4.31 Stanage Coast south from Alligator Point.

4.7 Mining and petroleum prospects

There are extensive minerals and petroleum interests in the Broadsound Basin. If fully developed they have the potential to alter the socio-economic profile of the region and have major consequences for the environmental and aesthetic values of the coastline in particular. The interests are summarized in tables 4.10 and 4.11. Interests associated with coal, oil shale and magnesite are the most extensive and have the highest potential to influence the region. Metaliferous mines are small and almost all abandoned. They have some potential to influence the region if poorly managed and downstream contamination occurs. These sites have not been visited as part of this study. The importance of the interests within each of the basin's catchments is summarized in the following maps and tables.

Table 4.10 Mines in the Broadsound Basin

| Mine Name | Locality | Status | Size of mine | Commodity | Yield |
|-------------------------------|--|---|--------------|-----------|---|
| UNNAMED 984454 | 1km south of Stanage Point, Shoalwater Bay. | Mineral occurrence | Very small | Copper | Very Small <500 Tonnes Copper |
| PRINCHESTER ASBESTOS | North of Princhester in headwaters of Paddock Camp Creek. | Abandoned mine | Very small | Asbestos | Very Small <100 Tonnes Asbestos |
| AMITY CREEK | East of the Broadsound Ranges. | Abandoned prospect | Very small | Gold | Very Small <0.5 Tonnes Gold |
| IRON KNOB | Stanage Point, Shoalwater Bay. Herbert creek north of | Abandoned mine | Very small | Copper | Very small <500 tonnes Copper |
| BOUNDARY FLAT LAGOONS | Marlborough, 175km nw of Gladstone. | mineral occurrence (active prospect) | Medium | Oil shale | Medium 10 000 000 - 1 billion barrels oil shale |
| KUNWARARA | 60 km north-west of Rockhampton. | Operating mine (active prospect) Abandoned mine | Large | Magnesite | Large >10 000 000 tonnes magnesite |
| NOB CREEK | 10km nne of Marlborough. | (abandoned prospect) Mineral occurrence | Very small | Copper | Very small <500 tonnes copper |
| PRICE MOUNTAIN | East of Thirsty Sound on Stanage Peninsula. | (abandoned prospect) Mineral occurrence | Very small | Zinc | Very small <200 tonnes zinc |
| STANNAGE BAY COPPER | 5km ws of Stanage Bay. On high ridge north of Mt Magog. | Abandoned mine | Very small | Copper | Very small <500 tonnes copper |
| M J JOHNS COPPER LODGE | West of Clairview Homestead on upper Calabash Creek, near Fort Arthur. | Mineral occurrence (abandoned prospect) | Very small | Copper | Very small <500 tonnes copper |
| SULPHIDE GULLY | 12km north of St Lawrence. | Abandoned mine (abandoned prospect) | Very small | Gold | Very small <0.5 tonnes gold |
| SALT HILL | 11km north of Marlborough. | Abandoned mine (abandoned prospect) | Very small | Gold | Very small <0.5 tonnes gold |
| SHIRLROY | 11km north of Marlborough. | Mineral occurrence (abandoned prospect) | Very small | Gold | Very small <0.5 tonnes gold |
| WELLINGTON CREEK | 11km nw of Marlborough. | Mineral occurrence (abandoned prospect) | Very small | Gold | Very small <0.5 tonnes gold |
| MARLBOROUGH MAGNETITE | 12km north of Marlborough. | Mineral occurrence (abandoned prospect) | Very small | Iron | Very small <5 000 tonnes iron |
| LANGDALE HILL | Road to Langdale Hill Telstra stn | Mineral occurrence (abandoned prospect) | Very small | Gold | Very small <0.5 tonnes gold |
| WITHNALLS FOLLY | Ssw of Anglewood 20 km north east of Marlborough, | Mineral occurrence | Very small | Gold | Very small <0.5 tonnes gold |
| HERBERT CREEK MAGNESITE | 175km nw of Gladstone. 25 km ne of Marlborough, | mineral occurrence (active prospect) | Large | Magnesite | Large >10 000 000 tonnes magnesite |
| BLOCK CREEK | 160km nw of Gladstone. | mineral occurrence (active prospect) | Medium | Oil shale | Medium 10 000 000 - 1 billion barrels oil shale |

Table 4.11 Minerals permits and leases in the Broadsound Basin

| Tenure type | Tenure number | Status | Date granted | Date expires | Principle holder | Name of lease | Area (ha) |
|---|---------------|-------------|--------------|--------------|-------------------------------------|-----------------|-----------|
| Exploration permit for coal | | | | | | | |
| | 1029 | Granted | 20-Apr-2006 | 19-Apr-2011 | Waratah Coal Pty Ltd | | 55746.89 |
| Exploration permit for minerals | | | | | | | |
| | 16551 | Application | | | Drummond West Pty Ltd | | 3040.86 |
| | 16553 | Application | | | Bandanna Oil Shale Pty Ltd | | 20947.77 |
| | 16422 | Application | | | Accord Mining Pty Ltd | | 1445.81 |
| | 15305 | Application | | | Eastern Mining Corporation Pty Ltd | | 4762.33 |
| | 14500 | Granted | 18-May-2007 | 17-May-2011 | Australia Oriental Minerals NL | | 21614.43 |
| | 15845 | Granted | 20-Dec-2006 | 19-Dec-2011 | Wonjin Pty Ltd | | 30979.45 |
| | 10006 | Granted | 29-Mar-1994 | 28-Mar-2010 | Smarttrans Holdings Ltd | | 174.77 |
| | 16427 | Granted | 24-Oct-2007 | 23-Oct-2012 | Accord Mining Pty Ltd | | 13444.28 |
| | 3469 | Granted | 05-May-1983 | 04-May-2009 | Queensland Energy Resources Ltd | | 13235.88 |
| | 15092 | Granted | 29-Nov-2005 | 28-Nov-2010 | King eagle Resources Pty Ltd | | 5516.28 |
| Exploration permit for petroleum | | | | | | | |
| | 759 | Granted | 19-Oct-2000 | 31-Oct-2008 | Ome Resources Australia Pty Ltd | | 797.82 |
| | 700 | Granted | 24-Mar-2003 | 31-Mar-2019 | Arrow Energy NL | | 106563.30 |
| | 758 | Granted | 19-Oct-2004 | 31-Oct-2008 | Ome Resources Australia Pty Ltd | | 434.33 |
| | 716 | Granted | 14-Oct-2003 | 31-Oct-2007 | Arrow Energy NL | | 123460.25 |
| Mining lease | | | | | | | |
| | 5868 | Granted | 15-Mar-1990 | 31-Mar-2011 | Qmch Pty Ltd | Kunwarara ko510 | 540.98 |
| | 80067 | Granted | 29-Jun-2000 | 30-Jun-2012 | Qmch Pty Ltd | Kg3 | 201.24 |
| | 5870 | Granted | 15-Mar-1990 | 31-Mar-2011 | Qmch Pty Ltd | Kunwarara ko540 | 391.83 |
| | 5869 | Granted | 15-Mar-1990 | 31-Mar-2011 | Qmch Pty Ltd | Kunwarara ko520 | 4.10 |
| | 80125 | Granted | 06-Apr-2006 | 30-Apr-2027 | Qmch Pty Ltd | Oldman south | 131.62 |
| Mineral development lease | | | | | | | |
| | 194 | Granted | 21-Jun-1996 | 30-Jun-2011 | Wonjin World Wide Pty Limited | | 900.01 |
| | 344 | Granted | 17-Sep-2003 | 30-Sep-2008 | Qmch Pty Ltd | Kunwarara | 6575.61 |
| | 196 | Granted | 11-Sep-1996 | 30-Sep-2011 | Queensland Energy Resources Limited | | 4896.56 |
| | 197 | Granted | 08-Oct-1996 | 31-Oct-2011 | Queensland Energy Resources Limited | | 3592.94 |

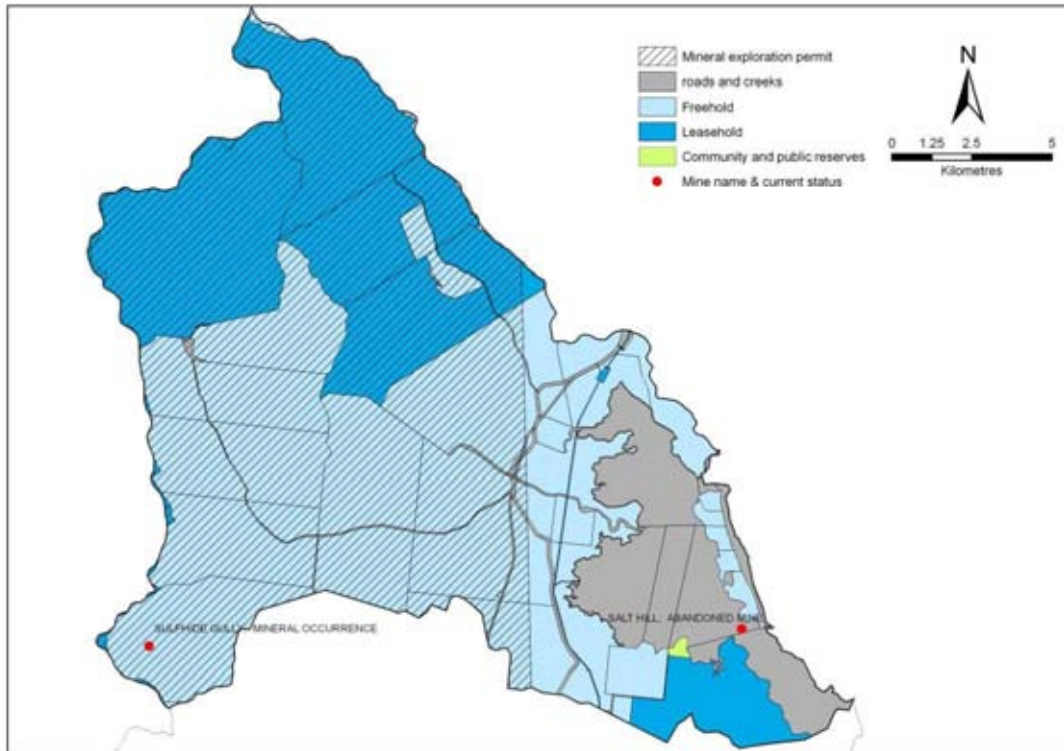


Figure 4.32 Minerals interests within the Clairview Creek Catchment.

Table 4.12 Extent of minerals permits and leases in the Clairview Creek Catchment

| Exploration permit for minerals | |
|--|------------------|
| Tenure affected | Area (ha) |
| roads | 208.89 |
| covenant | 4097.28 |
| freehold | 11223.26 |
| leasehold | 7809.69 |

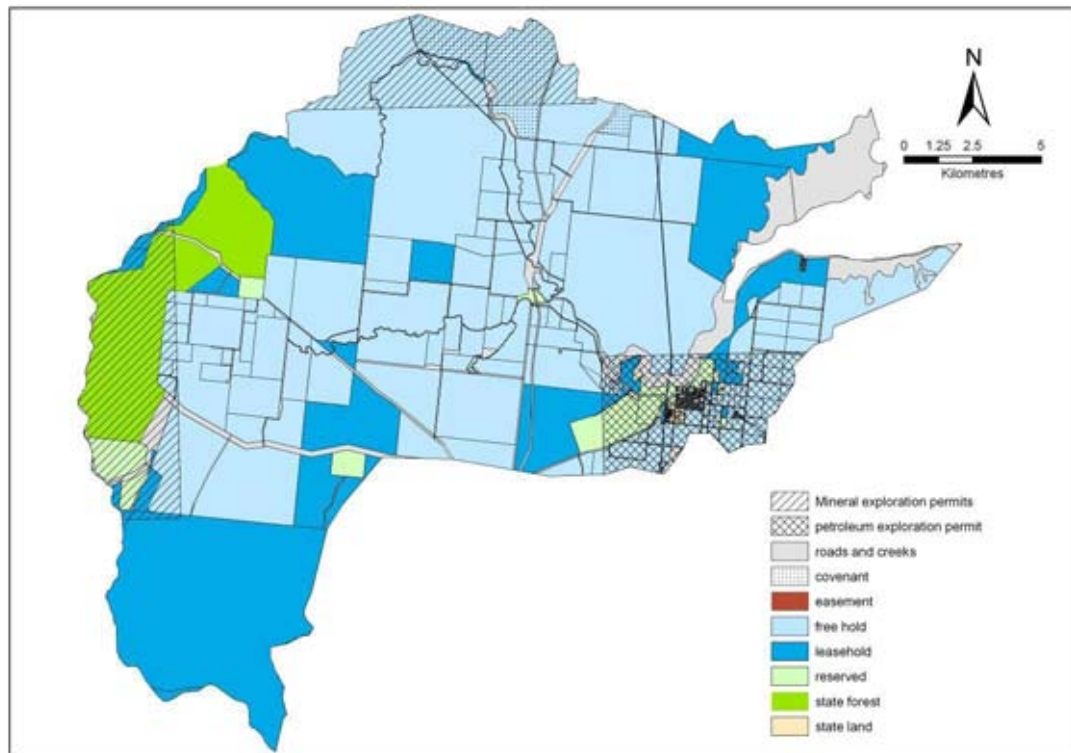


Figure 4.33 Minerals interests within the St Lawrence Creek Catchment.

Table 4.13 Extent of minerals permits and leases in the St Lawrence Creek Catchment

| Exploration permit for minerals | |
|--|------------------|
| Tenure affected | Area (ha) |
| roads | 296.95 |
| covenant | 1217.65 |
| easement | 2.11 |
| freehold | 2845.72 |
| leasehold | 389.97 |
| reserve | 446.08 |
| state forest | 1741.17 |

| Exploration permit petroleum | |
|-------------------------------------|------------------|
| Tenure affected | Area (ha) |
| roads | 387.65 |
| freehold | 1303.39 |
| leasehold | 466.31 |
| reserved | 411.42 |
| state land | 107.60 |

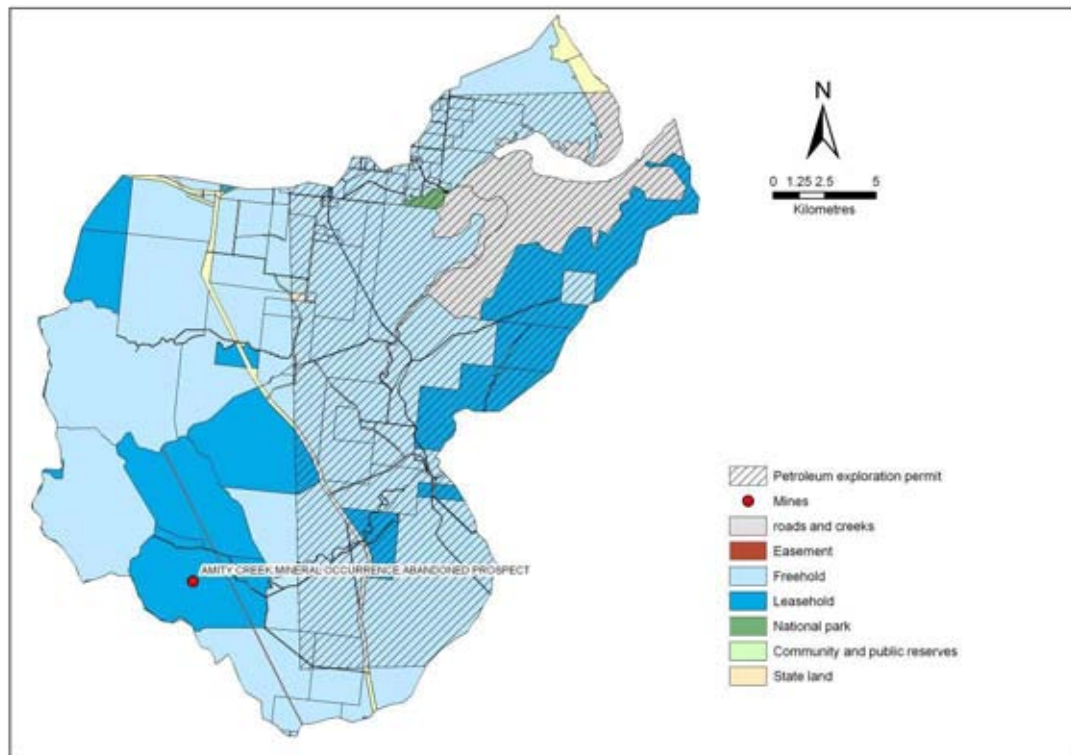


Figure 4.34 Minerals interests within the Waverly Creek Catchment.

Table 4.14 Extent of minerals permits and leases in the Waverly Creek Catchment

| Exploration permit petroleum | |
|------------------------------|-----------|
| Tenure affected | Area (ha) |
| roads | 5996.27 |
| easement | 13.79 |
| freehold | 26152.26 |
| leasehold | 5656.37 |
| reserve | 0.02 |
| state land | 24.07 |

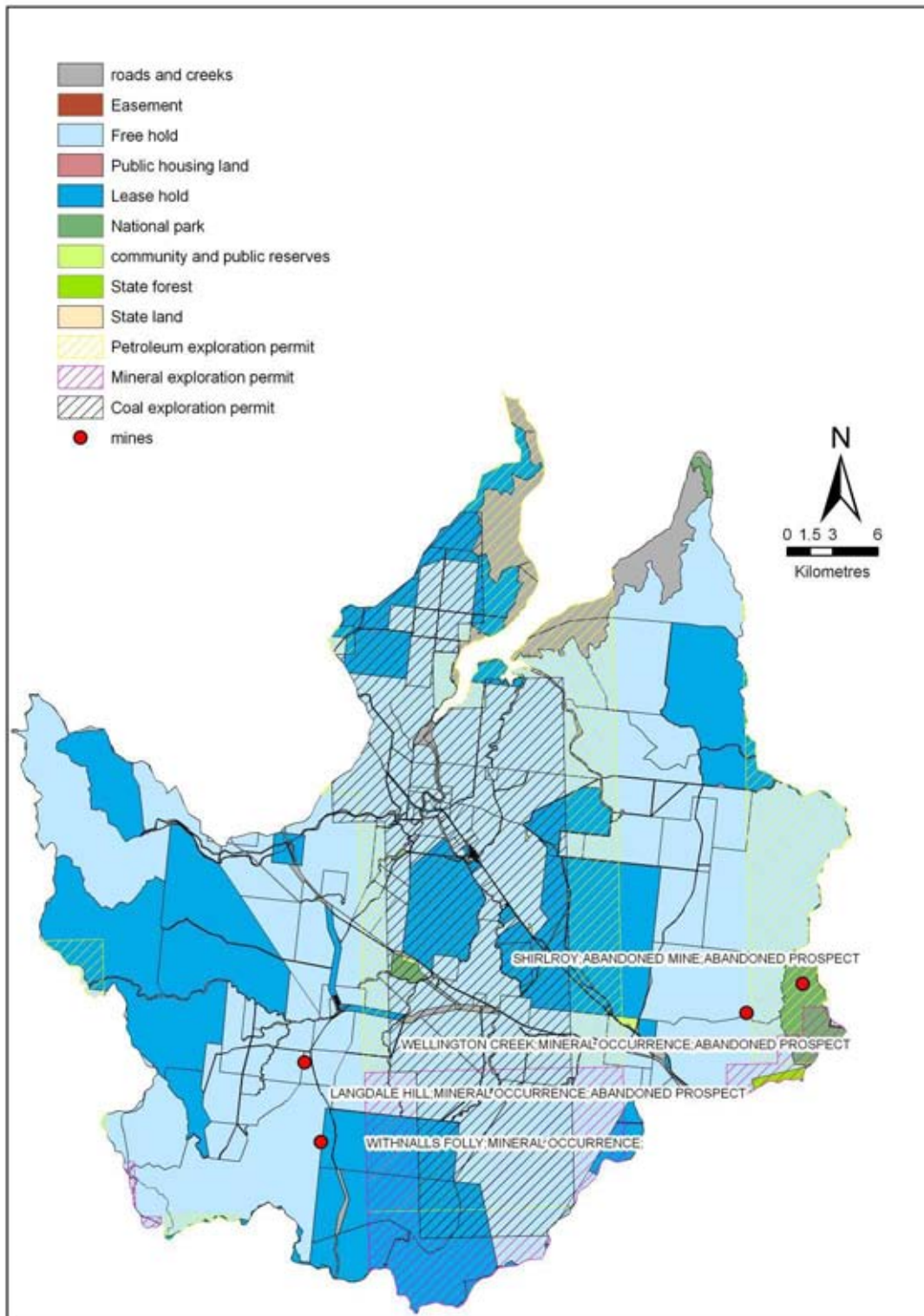


Figure 4.35 Minerals interests within the Styx River Catchment.

Table 4.15 Extent of minerals permits and leases in the Styx River Catchment

| Exploration permit coal | |
|--------------------------------|------------------|
| Tenure affected | Area (ha) |
| road | 1894.30 |
| easements | 82.88 |
| free hold | 34662.43 |
| housing land | 0.30 |
| leasehold | 12697.17 |
| national park | 261.29 |
| reserved | 85.43 |
| state land | 12.80 |

| Exploration permit for minerals | |
|--|----------|
| roads | 259.23 |
| easements | 104.18 |
| freehold | 30314.61 |
| leasehold | 11288.46 |
| national park | 1804.59 |
| reserved | 0.43 |
| state forest | 199.01 |

| Exploration permit petroleum | |
|-------------------------------------|----------|
| road | 6377.0 |
| easements | 142.22 |
| free hold | 84501.17 |
| housing land | 0.30 |
| leasehold | 41255.70 |
| national park | 2065.88 |
| reserved | 156.53 |
| state land | 12.80 |

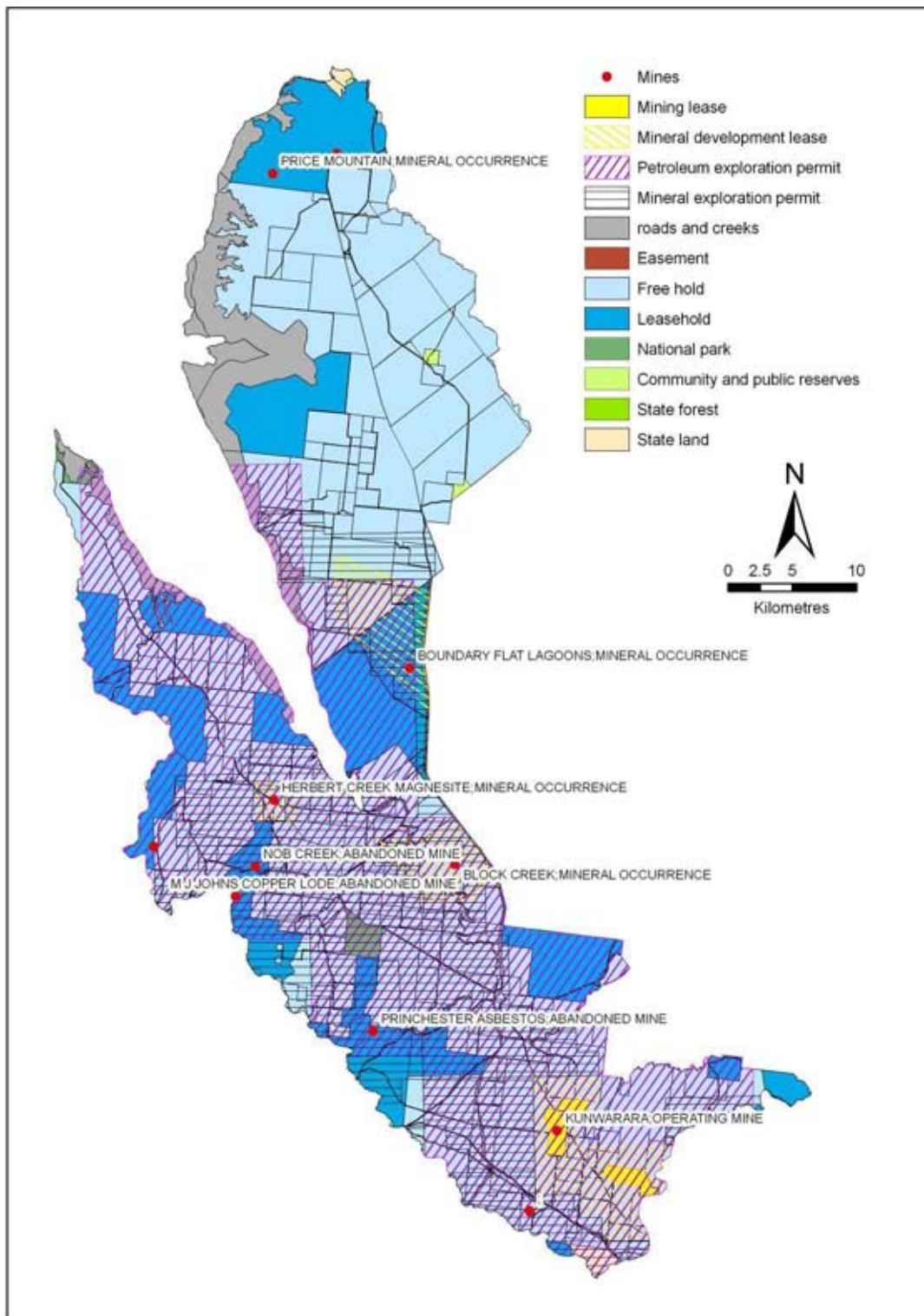


Figure 4.36 Minerals interests within the Herbert Creek Catchment.

Table 4.16 Extent of minerals permits and leases in the Herbert Creek Catchment

| Exploration permit for minerals | |
|--|------------------|
| Tenure affected | Area (ha) |
| roads | 3016.70 |
| easements | 13.34 |
| freehold | 52288.50 |
| leasehold | 11017.87 |
| national park | 760.47 |
| state forest | 71.14 |
| state land | 538.86 |

| Exploration permit petroleum | |
|-------------------------------------|----------|
| roads | 6620.41 |
| easements | 15.54 |
| freehold | 80601.43 |
| leasehold | 25224.11 |
| national park | 877.31 |
| state forest | 42.18 |
| state land | 560.69 |

| Mineral development lease | |
|----------------------------------|----------|
| roads | 522.77 |
| easements | 0.43 |
| freehold | 12942.80 |
| leasehold | 2465.52 |
| state land | 27.58 |

| Mining lease | |
|---------------------|---------|
| road | 32.08 |
| easement | 1.33 |
| freehold | 1236.73 |

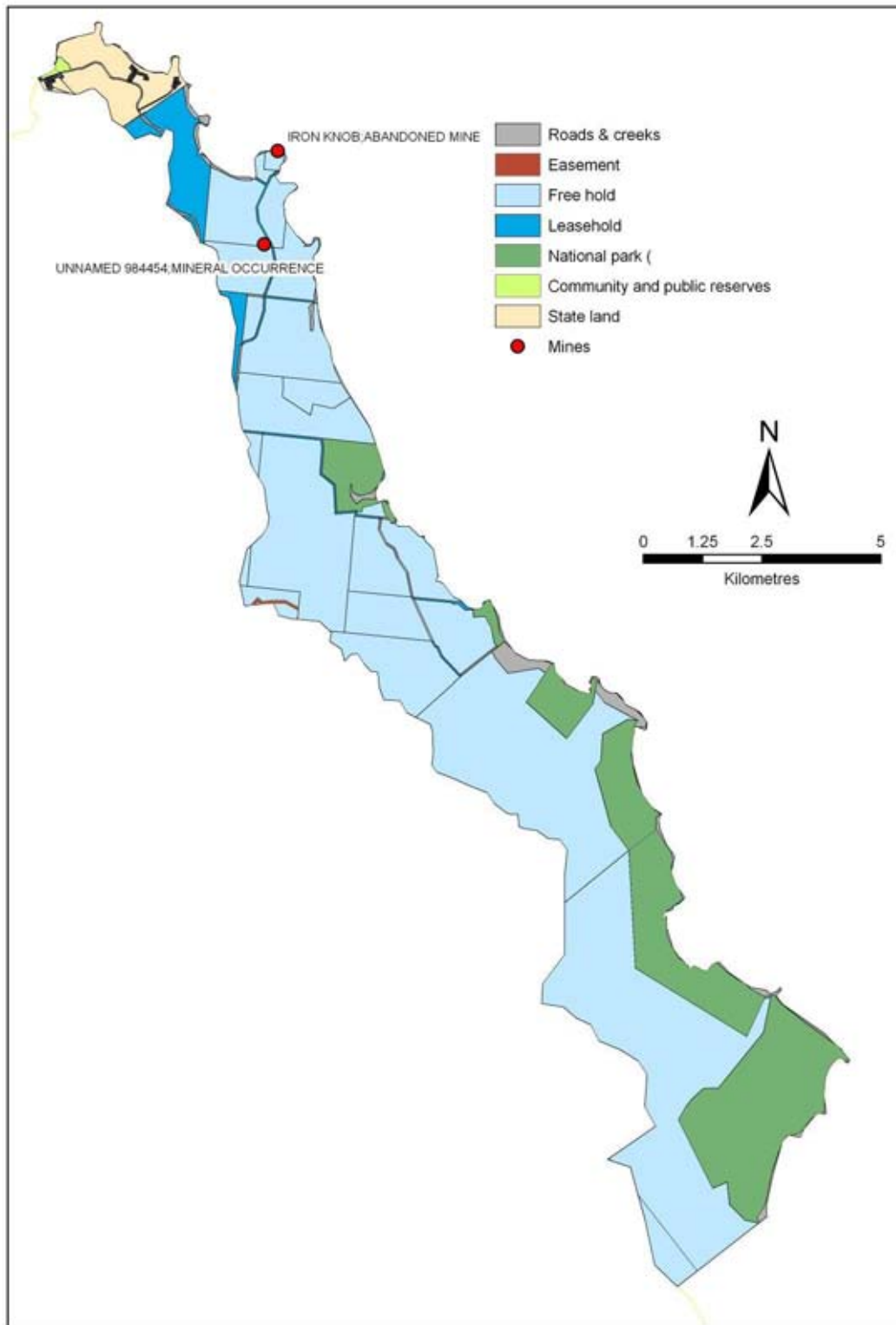


Figure 4.37 Minerals interests within the Stanage Coast Catchment.

There are no mineral prospects or permits issued within the Stanage Coast catchment.

4.8 Intertidal wetlands

Intertidal wetlands comprising intertidal flats, mangrove wetlands and saltmarshes (figure 4.38 a) are well represented in each of the six Broadsound catchments, though only to minor aerial extent on the Stanage Coast. Conversely, beaches (figure 4.38 b) and rocky shores (figure 4.38 c) are prevalent on the Stanage Coast but scarce, often absent, in the other sub-catchments.

Intertidal flats of mud and/or sand may be exposed at low tide in the major estuaries and associated with intervening peninsulas and inner islands of Broad Sound. In the order of 10,000 hectares lie in the inner Herbert Creek estuary, collectively about 5000 hectares are associated with the western estuaries and 2000 hectares with the north-east of the Herbert Creek catchment and adjacent islands. It is assumed that these deposits have increased substantially due to catchment erosion following tree clearing over the past century. High tidal amplitude (around 6-7 metres based on data for Hay Point and local knowledge), twice-daily high tides and deep V-shaped embayments contribute to strong tidal currents and scouring. These factors influence long-term and daily changes in sediments which in turn influence the structure and abundance of invertebrate fauna in this substrate.

Mangrove wetlands in the study area include continuous blocks that are most extensive in the far north-east of the Herbert Creek estuary: over 6000 hectares are attached to the mainland and over 4000 hectares are associated with Long Island. Largest blocks in the western sub-catchments are in the order of 600 hectares. More than 20 islands totally covered by mangrove are spread through Broad Sound, from a few tens to a few hundred hectares in area. Mangrove wetlands are forests and thickets of trees that are tolerant of daily inundation by seawater. These trees have roots that are adapted to substrate that is low in oxygen and high in salt but their survival is influenced by flushing both by sea water and inflowing fresh water. Where extensive salt flats back the mangrove wetlands, the mangrove trees naturally must cope with extreme stress.

Saltmarsh wetlands comprise saline grassland, samphire low shrubland and bare salt flats. Commonly these components occur in complex spatial patterns and lie landward of mangrove wetlands but saltmarsh forms the coastline in a few locations (e.g. part of west side of Herbert estuary). Contiguous blocks of 2000-6000 ha, dominated by bare salt flat, occur on both sides of Broad Sound. Minor tidal creeks provide periodic saline inundation of saltmarshes, though this inundation reaches the landward sides of the largest saltmarshes only with spring tides or storm surges. Human intervention through construction of tide barriers (seawalls, channel block banks) in past decades has altered water flows in many parts of the study area (see Section 5.2 Condition report). Around Broad Sound, there is a marked distinction between saltmarshes that receive significant inflow from freshwater creeks (e.g. central western Torilla Plain) and saltmarshes that receive no significant freshwater inflow other than from direct precipitation. Interplay of local landforms, tidal drainage and freshwater supply determines the persistence of inundation of saltmarsh wetlands and thus the temporal availability of habitat for waterbirds.



(a)



(b)



(c)

Figure 4.38 Intertidal wetlands on the Broad Sound coast include extensive areas of tidal flats and mangroves (a), sandy beaches (b) and more restricted rocky shores (c).
Photo Roger Jaensch.

Waterbird use of intertidal flats and saltmarshes was extensively, though not exhaustively, assessed in this project; results are presented in Chapter 5 section 5.3 and Chapter 8 S5. Migratory shorebirds are the numerically dominant waterbirds feeding and roosting in these habitats. Relatively small numbers of waterbirds inhabit mangrove wetlands but are not readily detectable in this dense habitat; locally, some waterbirds may establish seasonal breeding colonies in mangroves. Other fauna, including benthic invertebrate food resources for shorebirds, were not assessed.

In the Broad Sound Basin, intertidal wetlands support commercial and recreational fisheries and limited tourism. Cattle grazing enterprises value the saline grasslands as seasonal sources of fodder.



(a)



(b)



(c)

Figure 4.39. The Broad Sound intertidal flats are a complex of mud or sand (a) and hypersaline mud plains (commonly at the more landward extent of the intertidal flats), mangrove forests, woodlands and shrublands (b) and saltmarshes as samphire herblands (c) or grasslands. **Photo Roger Jaensch.**

4.9 Non-tidal wetlands

Non-tidal wetlands comprising marine plain wetlands, grass-sedge wetlands, wet meadows, semi-permanent ponds, and wooded swamps are well represented in the Broadsound coastal area, though only to minor aerial extent in the Stanage Coast and Clairview Creek catchments. Torilla Plain, occupying much of the eastern side of the Herbert Creek catchment, is the largest aggregation (over 18,000 ha) of non-tidal wetlands here and is the largest on the Central Queensland coast.

Marine plain wetlands are most extensive on Torilla Plain and (depending on delineation) there are six smaller blocks (ca. 300-4000 ha) on the western side of Broad Sound, some of which are named (Waverley Plain, Bar Plain). They are complexes of relatively small water bodies embedded within coastal plain (Land Zone 1) that is typically tree-less and grass-dominated. Seasonally they support grass-sedge communities but may also have saltmarsh elements such as samphire. Entire marine plains may be briefly inundated from heavy summer rainfall and floods of inflowing freshwater creeks, but, after the wet season, water persists only in ponds and channels with few areas remaining inundated by mid-late dry season. Saline water originally exerted some influence on the seaward sides by penetrating seasonally and/or daily along tidal creeks; since development for cattle grazing, most of this saline influence has been reduced by emplacement of channel block banks (permitting two way flow at high water levels) and elsewhere stopped by seawalls (totally excluding tidal incursion). Consequently, most marine plains and associated saltmarshes landward of these structures provide more persistent (though still temporary), less saline habitat for plants, waterbirds and other fauna than pre-development.

Much of the marine plain and saltmarsh wetland of Torilla Plain, and minor examples in the west, exhibits exceptionally complex, spectacular patterns of channels and ponds which are probably unique in Australia. Presumably these relate to an era when the Plain was sea bed: similar patterns are evident in contemporary intertidal flats in Port Clinton.

Wetlands dominated by sedges (e.g. *Eleocharis*, *Schoenoplectus* and *Cyperus* species) and/or grasses (e.g. *Paspalum*, *Leptochloa* and *Pseudoraphis* species) occupy broad areas (up to 500-1000 ha) on Torilla Plain and (up to 100-300 ha) on marine plain on the western side of Broad Sound. Some basins are effectively small open lakes in the early-mid wet season, before emergent vegetation takes over. Grazing has favoured development of short grass communities that may be referred to as wet meadows; taller sedges may dominate in the wettest sites and in wetter years.

A railway causeway runs north-south through the St Lawrence area (figure 4.41), prolonging inundation of some areas to the west, particularly on Waverley Plain.

Permanent freshwater wetlands are naturally rare on the Broadsound coast. Semi-permanent waterholes associated with creeks are scattered thinly on the landward edges of marine plains. Greater persistence, offering all-seasons refuge for waterbirds, has occurred where channels have been 'ponded' by installation of structures – some quite small – such as road causeways or banks, particularly in the St Lawrence area.



Figure 4.40. *Eleocharis* swamp at Waverly Plains. Photo Roger Jaensch.



Figure 4.41. Railway embankment across wetlands at St Lawrence. Photo Roger Jaensch.

Wooded swamps dominated by *Melaleuca* species, a regional ecosystem that has been destroyed along much of the Queensland coast, persist as about a dozen isolated patches (1-30 ha, one over 100 ha) at the landward edges of marine plains in the St Lawrence and Waverley catchments and fringing Torilla Plain (figure 4.42). Shallow seasonal inundation provides habitat for secretive waterbirds and the trees and dense underlying sedge provide some nesting sites. Waterbird use of non-tidal wetlands of coastal Broadsound was extensively, though not exhaustively, assessed in this project; results are presented in Chapter 5 section 5.3 and Chapter 8 S5. Ducks/geese and herons/ibises are the numerically dominant waterbirds feeding and (to varied extent) breeding in these habitats (figure 4.43); migratory shorebirds and threatened species also occur.



Figure 4.42. *Melaleuca* open woodlands on the landward edge of the marine plain. Some mature trees are persisting but saplings (foreground) are heavily browsed – preventing regeneration. **Photo Roger Jaensch.**

Other fauna, including food resources for waterbirds, was not assessed but some information on dominant plant species was collected for sectors where ground surveys were possible.



Figure 4.43. Magpie Geese in wetlands along the Broad Sound coast. **Photo Roger Jaensch.**

It should be noted that in certain seasons many of the Broadsound wetlands may appear devoid of conspicuous fauna. From May to July, migratory shorebirds are mostly absent (at Asian breeding grounds) from intertidal flats and, in drier years, no waterbirds may be present on the dry non-tidal wetlands – other than the few deeper ponds – from mid winter to the start of summer.

In the Broadsound Basin, non-tidal coastal wetlands principally support cattle grazing enterprises – for which they are highly valued – and some localized, minor tourism (St Lawrence).