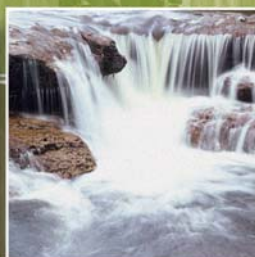


# State of the Environment Queensland 2011



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## Foreword

The State of the Environment Queensland 2011 report presents a comprehensive picture of Queensland's environmental assets are faring, the pressures on them and the actions taken to protect, maintain and restore them.

This report is produced every four years to assess the key factors affecting Queensland's air, land, water and heritage and the progress towards achieving ecologically sustainable development.

Queensland's environment is essential for maintaining the high quality of life we have become accustomed to, as well as providing a base for Queensland's agricultural and tourism sectors. Our environment provides many essential ecosystem services that we take for granted on a daily basis, such as clean air and water.

Since the 2007 report, Queensland's environment has faced a number of key challenges including the accelerated use of Queensland's natural resources, a significant oil spill in 2009 and eight long years of drought, followed by extensive flooding across the state.

The 2011 report highlights that the environmental recovery from the summer 2010–11 statewide flooding is ongoing.

Over the past 18 months, the report has been prepared in collaboration with individuals and organisations from both the private and public sectors. Without the concerted effort and commitment of everyone involved, it would not have been possible to produce such a comprehensive report. I would like to personally thank the many contributors for their assistance over this period.

The information in this report will further our collective understanding of the status of Queensland's environment and inform environmental policy settings and programs.

In closing, I would like to look to the future and note the creation of the Department of Environment and Heritage Protection (EHP). The new agency will have a strong focus on the health of the environment in Queensland, including protection of its flora and fauna, landscapes, pristine waterways and biodiversity. The creation of EHP is recognition of the new government's commitment to the environment as a stand alone priority.

Andrew Chesterman  
Director-General  
Department of Environment and Heritage Protection



## Executive summary

The wellbeing of all Queenslanders is intimately linked to and dependent upon the environment. It provides essential ecosystem services, including clean air and water. Queensland supports a population of more than four and half million people, with much of this population living in urban regions close to the coast. Queensland's agriculture, forestry, fisheries, mining, manufacturing, construction and tourism industries rely heavily on the environment for their resources and output. There is increasing focus on sustainability issues within these sectors and a number of industry initiatives are being undertaken to address potential environmental impacts associated with their activities.

Queensland's landscape is vast, covering an estimated area of 172.8 million hectares (ha). It is also very diverse—encompassing many relatively pristine areas such as national parks, to highly modified areas such as cities, mines and agricultural lands. The terrestrial (land-based) environment is complemented by an extensive marine environment. The mainland coastline of Queensland is approximately 6900 kilometres (km) in length and features 1165 offshore islands and cays.

Queensland has the greatest levels of biodiversity in Australia and is characterised by 85 per cent of the nation's native mammals, 72 per cent of its native birds, more than half of the nation's native reptile and frog species and close to 13 000 native plant species. Queensland also hosts five of Australia's 18 World Heritage areas, provides critical habitat for shorebirds as recognised through international agreements, and includes more than 6.8 million ha of natural or near natural wetlands.

State of the environment reporting is the internationally and nationally accepted method for assessing environmental performance. The State of the Environment Queensland 2011 report is Queensland's fifth state of the environment report. This report is a whole-of-Queensland Government initiative and is prepared to meet the legislative requirements under both the *Environmental Protection Act 1994* and the *Coastal Protection and Management Act 1995*.

The State of the Environment Queensland 2011 report highlights the many environmental challenges facing Queensland since the release of the State of the Environment Queensland 2007. Some challenges have arisen due to a chain of extreme weather events and associated natural disasters. Others have been caused by ongoing pressures on the environment that may have either increased, as in the case of activities associated with mining and energy extraction, or decreased, as in the case of vegetation clearing.

This report summarises the progress on actions developed in response to issues identified in previous reports, as well as the introduction of new initiatives to improve natural resource planning and management. This report enables the government, industry and community to consider the state of Queensland's environment and evaluate the effectiveness of the actions taken to protect it. The report will inform evidence-based decision making and adaptive management of Queensland's natural environment.

## Key findings

### Drivers of change

There are a range of social, economic, cultural and political factors that guide human behaviours, which can lead to changes in the state of the environment. These include demographics, economic activity, cultural values, human development, governance and science and technology. The consequences of behaviours stemming from these drivers has led to significant global environmental pressures, including habitat loss, the spread of invasive species, the unsustainable use of natural resources, the generation of pollutants resulting in the contamination of air, water and land resources, as well as a changing climate.

The size, growth rate, distribution and migration patterns of Queensland's population are all important factors that influence land and water use, and the provision of socio-economic services that support high or improved living standards. Queensland contains an ageing, highly urbanised population, with approximately 88 per cent of the population living within 50 km of the coast. In this reporting cycle, population growth in the regional centres has shown increases. At 30 June 2011, the estimated resident population of regional Queensland (Queensland, excluding the Brisbane Statistical Division) was 2 506 060 people, making up 54.7 per cent of the state's



population. The population growth rate for these regions between 30 June 2006 and 30 June 2011 was 2.33 per cent—slightly above the Queensland average of 2.29 per cent.

Queensland has a relatively strong economy with activity dampened over the past three years due to the impacts of the global financial crisis, widespread flooding in late 2010 and early 2011, and damage from Tropical Cyclone Yasi in early 2011. While economic growth provides a range of benefits to society, it can also lead to pressures on the environment.

Differences or changes in culture can also drive actions that can impact upon the environment. Consumption can result in environmental pressures. Ecological footprints provide a measure of human demand on the earth's ecosystems. In 2009, the ecological footprint for a person living in Queensland was 7.8 global hectares (gha) and for a Brisbane resident was 8.0 gha. This value is similar to the average Australian's ecological footprint of 8.1 gha but is approximately three times the world average of 2.7 gha.

Human development is about enabling people to lead long, healthy, educated and fulfilling lives. Sustainable human development is about ensuring that future generations are not disadvantaged. In 2010, Australia was ranked second highest in the world (out of 169 nations) for its Human Development Index (HDI), a composite measure of life-expectancy, access to knowledge and standard of living at a national level. There are some sectors of Australia's community that remain disadvantaged, as shown by the 7.9 per cent drop in HDI when it is adjusted for inequity. Much of this inequity lies within Aboriginal and Torres Strait Islander communities, where life expectancy, education outcomes and incomes are lower than for non-Indigenous populations.

Science and technological innovation continues to alter the structure of production, the nature of work and the use of leisure time. Fast changing technology can lead to a more rapid turnover in consumer and capital goods, creating waste as older stock is replaced. However, new technology often means the new goods are more energy efficient. Advances in science and technology have significantly improved our ability to monitor and understand the environment.

## Air quality and climate

Air pollutants and emissions can damage human and ecosystem health, deplete stratospheric ozone (O<sub>3</sub>) concentrations that protect us from damaging ultraviolet radiation from the sun, and alter the climate system.

Air quality in Queensland is generally good, with very few exceedences of national standards or guidelines for the air pollutants, air toxics and particles monitored by the Queensland Government. The potential for air pollution remains high in South East Queensland due to its increasing population, the dependence on motor vehicles and industrial activity.

The National Environment Protection (Ambient Air Quality) Measure (Air NEPM) provides a framework for monitoring, assessing and reporting on ambient levels of the six 'criteria pollutants'—carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), O<sub>3</sub> and particles (PM<sub>10</sub> and PM<sub>2.5</sub>). These pollutants are emitted from a wide range of sources, including domestic, commercial, industrial, transport, agricultural and natural sources, and high concentrations can affect health and the environment. There were no exceedences of the Air NEPM standards for NO<sub>2</sub> and carbon dioxide (CO<sub>2</sub>) in the past decade anywhere that monitoring was carried out in the state. Sulfur dioxide concentrations in Mount Isa, where a major emitter of this pollutant is located, exceeded Air NEPM 1-hour and 24-hour standards on occasions. However, the SO<sub>2</sub> levels measured in Mount Isa do not constitute a breach of the *Mount Isa Mines Limited Agreement Act 1985* air quality limits.

Periods of elevated particle levels have occurred in all areas of Queensland where monitoring takes place, largely as a result of events such as dust storms and bush fires. Breaches of the Air NEPM PM<sub>10</sub> goal (<5 days per year when PM<sub>10</sub> levels were above the Air NEPM standard of 50 micrometres per cubic metre (µm/m<sup>3</sup>)) were caused by major dust storms and/or bushfires during 2002, 2003, 2005 and 2009. South East Queensland and Gladstone PM<sub>2.5</sub> levels occasionally exceed the Air NEPM advisory standards (<5 days per year), primarily as a result of smoke from vegetation burning.

Lead is monitored in Mount Isa and Townsville, the areas where there are industrial sources of lead emissions. There have been no exceedences of the Air NEPM air quality standard for lead in Townsville. Additionally, there have been no exceedences of the air quality limit for lead set in the *Mount Isa Mines Limited Agreement Act 1985* for Mount Isa since 2003.

The National Environment Protection (Air Toxics) Measure (Air Toxics NEPM) provides a framework for monitoring, assessing and reporting on ambient levels of five air toxics—benzene, formaldehyde, toluene, xylene and polycyclic aromatic hydrocarbons (PAHs).

Measurements of concentrations of air toxics in South East Queensland and Gladstone indicate that levels are well below the Air Toxics NEPM investigation threshold levels for the protection of human health.

Ozone levels in South East Queensland, Gladstone and Townsville have not exceeded air quality standards in the past five years. Prior exceedences were very low (<5 days per year). Additionally, there has been an overall downward trend in the number of days with reduced visibility throughout Queensland, with very few days recording poor visibility.

While Queensland's total greenhouse gas emissions in the global context are relatively small, the state is a high per capita emitter. Queensland's greenhouse gas emissions, excluding emissions associated with changes in land use and vegetation were 134.3 Mega tonnes of carbon dioxide equivalent (Mt CO<sub>2</sub>-e) in 2009–10 (a 69.2 per cent increase on 1989–1990). When emissions and removals associated with changes in land use and vegetation such as the end of broadscale tree clearing is included, the total becomes 157.3 Mt CO<sub>2</sub>-e (a 4.7 per cent decrease on 1989–1990). Emissions from the transport and energy sector continue to grow. Overall electricity generation in Queensland increased by five per cent between 2004–05 and 2008–09, from 51 635 gigawatt hours (GWh) to 54 222 GWh, of which the amount generated from gas increased from 2035 GWh to 5404 GWh. Queensland's carbon emissions are influenced by a range of factors, such as the key drivers of the economy, the significant decentralisation in the state and the large distances travelled, as well as the current pattern of industrial activity.

Queensland's climate and weather is highly variable. From 2001, drought conditions persisted over much of the state, followed by record flooding at the end of the decade. Queensland's rainfall is influenced by seasonal variations (such as the summer monsoon), year-to-year fluctuations in the climate system (such as the El Niño Southern Oscillation), and multi-year cycles (such as the Interdecadal Pacific Oscillation). These features of Queensland's climate provide much of the variability observed in Queensland rainfall.

The wettest year on record for Queensland was 2010, with a total rainfall of 1110 millimetres (mm) averaged over the state. At the start of 2010, El Niño conditions prevailed in the Pacific Ocean; however towards the end of 2010 there was a shift to a strong La Niña that resulted in higher than average rainfall across the state, with South East Queensland and inland areas experiencing severe flooding. Indicators of La Niña conditions showed that this La Niña event was the strongest at least since the mid-1970s and one of the four strongest in the last century. Previous strong La Niña events, such as those in 1973–74 and 1955, were also associated with severe flooding in Queensland.

In December 2010, the Southern Oscillation Index (SOI) was +27.1, the highest December value on record and the highest monthly value since 1973. The SOI is a key indicator of the development and intensity of El Niño or La Niña events in the Pacific Ocean. The SOI is usually persistently positive during La Niña events while with El Niño episodes the SOI becomes persistently negative, for example during the drought years of 2002–2008.

North Queensland experienced its largest and most intense cyclone since 1918. Category five Tropical Cyclone Yasi was 500 km wide with an eye of 30 km in diameter and crossed the coast near Mission Beach at approximately 00:30 AEST on 3 February 2011. Estimated wind gusts were up to 285 km per hour, with maximum recorded winds up to 185 km per hour.

The 10 years from 2002 to 2011 were Australia's equal-warmest 10-year period on record. The average surface temperature in Queensland has risen by almost 0.9 °C since early last century. In the last two decades up until 2011, Queensland experienced three years with an annual mean temperature below the 1961–1990 average.

Key initiatives relating to air quality implemented since the last reporting period include the Environmental Protection (Air) Policy 2008 and the State Planning Policy 5/10 Air, Noise and Hazardous Materials.

### Aquatic ecosystems and the coast

For most of the first decade of the 21st century, drought dominated Queensland's weather and two-thirds of Queensland experienced eight years of exceptional drought. Widespread flooding towards the end of the decade broke the drought but brought new challenges. In January 2009, the Gulf of Carpentaria experienced extreme flooding and long periods (>10 days) of inundation. The catastrophic impacts of both the flooding events of 2010–

11 and the destruction caused by Tropical Cyclone Yasi saw more than 99 per cent of Queensland declared as disaster affected.

Major flooding from December 2010 to January 2011 affected the southern area of the Great Barrier Reef, while Tropical Cyclone Yasi (category five) in early February 2011 caused damage across 89 090 square kilometres (km<sup>2</sup>) of the Great Barrier Reef Marine Park. The effect of the cyclone on coral reefs was found to be highly variable, ranging from minor damage to 90 per cent of the same reef area. In the Great Barrier Reef Marine Park, 15 per cent of the total area incurred some coral damage, while six per cent was severely damaged.

The 2010–11 floods caused significant damage to waterways and adjacent floodplains in South East Queensland. It has been estimated that in 10 days during the floods the amount of sediment leaving non-urban areas in South East Queensland was just over three times the average annual sediment load.

On 11 March 2009, the Pacific Adventurer cargo ship was caught in Tropical Cyclone Hamish off the coast of Moreton Island. The vessel suffered two hull punctures from falling shipping containers. As a result, an estimated 270 tonnes of heavy fuel oil leaked into the ocean off the northern coast of Moreton Island in South East Queensland. The resultant oil slick affected beaches, rocky reefs, two coastal wetlands on the island, and beaches and mangrove wetlands between Bribie Island and Coolumb Beach. The enormous clean up operation took over two months, involved 2500 people and resulted in the removal of 3000 tonnes of polluted sand.

Findings from the Ecosystem Health Monitoring Program, managed through Healthy Waterways Pty Ltd, indicates freshwater rivers and creeks in South East Queensland vary in condition, from good in systems such as the Noosa, Stanley and Nerang, to very poor in the Oxley, lower Brisbane and Redlands systems. Only the Bremer River appears to have shown an improvement in health over time. The Noosa River may be in decline; however this may be a reflection of previous drought conditions. In South East Queensland, there has been a general reduction in total phosphorus loads discharged from wastewater treatment plants over the last four years. While total nitrogen loads have remained steady in the four year reporting period, with a significant reduction in nitrogen loads discharged since 2002.

The Surface Water Ambient Network ambient water quality monitoring from across nine biological provinces in Queensland shows that of the sites where information was available, most sites passed guidelines for turbidity and electrical conductivity (a measure for salinity) (more than 90 per cent of the 192 sites sampled). For total phosphorus, 76 of the 118 sites sampled (or more than 64 per cent) met guideline values. For total nitrogen, 125 of the 154 sites sampled (or more than 81 per cent) met guideline values.

The Ecosystem Health Monitoring Program found estuaries in South East Queensland exhibited a wide range of conditions, from very good in the Noosa estuary to very poor in the Bremer, Oxley and Albert estuaries, all of which are subject to point discharges and considerable urban run-off. In the Fitzroy to Tin Can Bay region, monitoring showed that the condition of estuaries varied from near pristine to moderately impacted. Impacts on water quality were caused by both point source discharges and by inflows of catchment pollutant loads (i.e. nutrients and sediments). In many estuaries, greater impacts were probably associated with other factors, for example the restriction of freshwater inflows due to the construction of large and small impoundments and the associated impacts on fish passage between estuary and freshwater reaches.

In Gladstone Harbour, concerns about the impact of industry on ecosystems have also been highlighted by a number of abnormal occurrences associated with fish and other marine animal health. A major investigation program has been in place since September 2011 and includes fish health, water quality and human health aspects. At this stage, fish health is stabilising with slight improvement, water quality and sediment quality reports do not show a cause for the fish health issues. The human health cases described did not form a single outbreak of one disease and there was no indication of an outbreak of disease in fishers that could be linked with disease in fish. Of all the possible explanations, the data indicates the flood event at the beginning of 2011 as the most likely cause.

The Great Barrier Reef First Report Card established a baseline for key indicators in 2009. The results demonstrate that the overall condition of the Great Barrier Reef is moderate, with regional variability evident as summarised below:

- Seagrass: Inshore seagrasses are in moderate condition. Seagrass abundance is moderate and has declined over the past five to 10 years, associated with excess nutrients. The reproductive capacity of seagrass is poor or very poor in four of the six regions, indicating limited resilience to disturbance.

- Water Quality: Inshore water quality is moderate overall. Concentrations of total suspended solids range from poor (Burdekin and Mackay–Whitsunday regions) to very good (Burnett–Mary region).
- Coral: Most inshore reefs are in moderate condition, based on coral cover, macroalgal abundance, settlement of larval corals and numbers of juvenile corals; however corals in the Burdekin region are mostly in poor condition.

The catchment load estimates from the 2009 Reef report card for nutrients (total nitrogen, dissolved nitrogen, total phosphorus and dissolved phosphorus), sediments (total suspended solids) and pesticides are summarised below:

- Annual total suspended solid loads (sediment) were 17 million tonnes, of which 14 million tonnes was from human activity.
- The largest contribution of total suspended sediment load was from the Burdekin and Fitzroy regions (4.7 and 4.1 million tonnes respectively), mainly derived from grazing lands.
- Agricultural fertiliser use is a key source of dissolved nitrogen and phosphorus run-off, annual loads of dissolved nitrogen are 31 000 tonnes, of which 17 500 tonnes were from human activity.
- The highest total load of dissolved nitrogen was from the Wet Tropics region with 11 000 tonnes per year, of which 6300 tonnes were from human activity.
- The total annual pesticide loads were approximately 28 000 kilograms (kg), with the highest loads from the Mackay–Whitsunday and Wet Tropics regions (approximately 10 000 kg each per year).

Pollutants discharged from major wastewater treatment plants in the Great Barrier Reef catchments have been monitored over the last four years. Upgrades in treatment facilities have resulted in a significant reduction in loads of both total nitrogen and total phosphorus over this time.

The Sustainable Rivers Audit provides a long-term assessment of the condition and health of the 23 river valleys in the Murray–Darling Basin. The ecosystem health of catchments in Queensland was generally better than southern catchments due to cumulative pressures along the river system. The Paroo Valley was rated in good health, while the Border Rivers and Condamine valleys were rated in moderate health. However, the Warrego Valley was in poor health.

The reporting period 2005–09, represents the final years of a prolonged drought. Groundwater levels (quantity) fell in the long-term over most areas. The exceptions were aquifers along the coast around Bundaberg and north of Mackay where water tables tended to be stable or rising. The Great Artesian Basin water levels remained relatively stable, except around some intake areas. Most aquifers contained moderate to poor water quality.

Wetlands are widespread throughout Queensland and support the most diverse freshwater fish fauna of any Australian state, as well as 210 species of waterbirds both resident and migratory, and more than 3000 species of plants. In 2009, Queensland supported around 6.8 million ha of natural or near natural wetlands, which covered around 3.9 per cent of the state. Loss of wetlands over the 2001–05 period was 6790 ha, which reduced to a loss of 1890 ha over the 2005–09 period. These net figures included gains in the extent of lacustrine wetlands of 120 ha and 90 ha for each period due to modifications associated with levee construction. The highest losses were in the palustrine (includes vegetated non-estuarine wetlands, such as swamps and marshes) (2370 and 800 ha) and riverine (4290 and 1100 ha) systems.

Riparian areas occur along watercourses, such as freshwater creeks, rivers and lakes. In 2009, 66.12 per cent (approximately 13.6 million ha) of riparian areas were forested and those areas with less than 15 per cent foliage projective cover had a mean ground cover of 57.59 per cent.

The introduction of the *Vegetation Management Act 1999* in 2000 and the *Vegetation Management and Other Legislation Amendment Act 2004* prohibiting broadscale clearing have seen a significant decrease in the rate of riparian vegetation clearing.

With regards to freshwater fish stocks, the number and conservation status of native fish species across Queensland are unchanged from the previous reporting period. However, when compared with 2007, the number of exotic species incursions has increased by one with the reporting of tilapia for the first time in the Burnett River catchment. Most Queensland fish stocks are either sustainably fished or their exploitation status is ‘uncertain’ or ‘undefined’ due to information deficiencies. Concerns remain for the status of snapper stocks in the Rocky Reef Fin Fish Fishery off southern Queensland.



In 2011, the reduction in seagrass meadows along the Queensland urban coast in response to flooding and cyclone damage took its toll. More than 1500 turtle strandings were reported in 2011, in comparison to an average of 900 strandings in previous years.

Queensland is largely free of marine pests. Twenty-six species are listed as actual or potential threats to Australia's marine resources on the National Introduced Marine Pest Information System. Asian green mussel and Asian bag mussel were detected in Queensland in 2007–08 and 2009. Queensland has experienced outbreaks of cyanobacteria (Lyngbya) and the crown-of-thorns starfish in the reporting period. Both of these species are native to Queensland. Freshwater pests are distributed predominantly along the coast and in South East Queensland. Species outbreaks in this reporting period included tilapia (five outbreaks), climbing perch and the red-eared slider turtle. The 2010 and 2011 flood events may result in further outbreaks.

Queensland has three state marine parks including the Great Barrier Reef Coast Marine Park, Great Sandy Marine Park and Moreton Bay Marine Park. The extent of Queensland's coastal waters marine park system in 2010 was 7 206 000 ha. In 2008, the area of green zones in Moreton Bay Marine Park increased from 0.5 per cent to 16 per cent of the total area of the marine park. In comparison with approximately 33 per cent and four per cent for the Great Barrier Reef Coast and Great Sandy marine parks respectively.

The *Water Act 2000* establishes a statutory planning framework for the sustainable allocation and management of Queensland's water resources. Water Resource Plans, under the Act, have been completed for 92 per cent of the state's key catchments.

Since the last reporting period, key initiatives relating to aquatic ecosystems and the coast implemented include the:

- *Great Barrier Reef Protection Amendment Act 2009* and the Reef Water Quality Protection Plan 2009 (Reef Plan)
- amendments to the *Water Act 2000* in 2010 to introduce a framework for managing the impacts of underground water extraction as part of the petroleum and gas industries
- Environment Protection (Water) Policy 2009
- State Planning Policy 3/11 Coastal Protection
- State Planning Policy 4/10 Healthy Waters
- State Planning Policy 4/11 Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments.

## Land and terrestrial ecosystems

Intensification of land use and long-term changes in climate remain the most significant factors causing land degradation in Queensland. Both can lead to a range of impacts. Land-use change for food production, particularly irrigated agriculture and certain cropping activities may cause decline in soil quality, including nutrient imbalances, salinisation, soil erosion and loss and weed invasion.

Climate and weather variability adds to the severity of land-use impacts. The severe drought between 2001 and 2006, coupled with the retention of livestock numbers and elevated grazing pressures, caused impacts on landscape health. Since 2006, Queensland's rangeland areas have had higher rainfall resulting in an improved carrying capacity, with a partial recovery in landscape function across many areas. However, recovery remains slow in very low condition areas and regions that suffered recent extended flood inundation, such as the Northern Gulf.

The proportion of the total area of land used for agriculture in Queensland has declined by eight per cent from 2007 to 2010 to 129.7 million ha.

Estimated modelled average pasture utilisation for Queensland in 2010–11 suggests there was a significantly lower level of pasture utilisation by animals (stock) compared to the historical record. Studies show soil fertility is declining in most of the grain cropping lands in Queensland. During 2007–09, wind erosion was more active than the long-term average (1960–2009) in seven of the 13 natural resource management regions in Queensland.

More than half of Queensland—or 96.66 million ha—is under some form of granted exploration or production tenure for coal, mineral, petroleum, coal seam gas or geothermal energy. The actual current mining footprint (excluding coal seam gas) is 160 000 ha or 0.09 per cent of the state. The area affected by mining over the last 150

years is 170 000 ha or 0.1 per cent of the state. In 2011, there were 55 coal mines, 36 significant mines for metallic and industrial minerals and numerous smaller gold, industrial mineral, opal and gemstone mines.

Vegetation loss, primarily as a result of clearing, remains one of the major causes of landscape change and biodiversity loss. Queensland has approximately 140 million ha of remnant vegetation (81 per cent of the total area), of which some 70 million ha is woody remnant vegetation protected from broadscale clearing by vegetation management legislation. The loss of woody vegetation was reported at 482 000 ha per year for 2003–04, while for the most recent reporting period (2008–09) clearing totalled 99 940 ha per year. The 2008–09 results represent the lowest rate of woody vegetation clearing since the introduction of the *Vegetation Management Act 1999*.

The majority of remnant vegetation cleared in the period between 2006 and 2009 occurred in the Mulga Lands bioregion (45.3 per cent of clearing in Queensland). This was followed by the Brigalow Belt bioregion at 31.5 per cent. Most of the woody vegetation clearing was for conversion to pasture for grazing purposes (more than 90 per cent).

The northern and western bioregions of Queensland have the highest percentage of remnant regional ecosystems remaining, with percentages well above 90 per cent. Clearing has been more widespread across the east and south of the state with the Brigalow Belt, Southeast Queensland and New England Tableland bioregions retaining less than 45 per cent remnant regional ecosystem cover.

The widespread high rainfall during the 2010–11 summer resulted in a very high level of pasture biomass across much of Queensland, increasing bushfire potential. Long-term remote sensing of 'fire scars' indicates that areas with the highest fire incidence are in the Cape York Peninsula and the western region of the Gulf of Carpentaria. The risk of damaging bushfire is increased in areas where gamba grass has become established, including across an estimated 60 000 ha of North Queensland.

Invasive species can pose a significant threat to Queensland's environment. Queensland has 19 mammal, 13 bird, three reptile and one amphibian species that are naturalised. These are exotic species that have developed self-sustaining wild populations. The Indian house crow, yellow crazy ants and Asian honey bee have been introduced since the last state of the environment report. The distribution of cane toads continues to spread south and west across Queensland and has reached Windorah at the head of Coopers Creek.

The Queensland Herbarium has recorded 1260 naturalised plant species in Queensland. Of these, 23 are terrestrial 'weeds of national significance' with some representation in Queensland, 10 of which were added to the list in April 2012.

Myrtle rust is a serious fungal disease that was detected in Queensland in December 2010. It affects plants of the Myrtaceae family, the second largest plant family in Australia and also dominant in many of Australia's forests and woodlands. Hendra virus is another disease that has been of focus in this reporting cycle. Hendra virus is a zoonotic disease, which means it can transfer from animals to humans.

As of August 2011, 1372 species were listed as 'near threatened', 'vulnerable', 'endangered' or 'extinct in the wild' in Queensland under the Nature Conservation (Wildlife) Regulation 2006 (i.e. threatened species). In 2007, 1449 species were listed as 'rare', 'vulnerable', 'endangered' and 'extinct in the wild'. The discontinuation of the 'rare' category since the 2007 reporting period and the introduction of the 'near threatened' category make comparison between the reporting periods challenging.

In 2008, surveys of the Koala Coast in South East Queensland found the koala population had declined by 50 per cent since the 2005–06 surveys (from an estimated 4600 animals to an estimated 2300 animals). In 2010, population estimates indicated a decline of 13 per cent since the 2008 surveys (to an estimated 2000 koalas). The decline between these two years was not statistically significant, however it should be noted that the long-term downward trend since the 1996–1999 survey is still statistically significant, demonstrating a 68 per cent decline between 1996–1999 and the latest (2010) survey. Further surveys will be required to determine whether the overall trend continues downward or whether there is a levelling off in the decline.

For mammals, the greatest percentage of threatened species occurs in the Cape York Peninsula, while for frogs it occurs in the Wet Tropics and Southeast Queensland bioregions. Percentages of reptile species threatened are mostly highest in the more easterly bioregions of the state, while for birds it is greatest in Southeast Queensland and the Brigalow Belt.

There are 90 regional ecosystems classed as ‘endangered’, 532 identified as ‘of concern’ and 764 listed as ‘least concern’ under the *Vegetation Management Act 1999*.

As at December 2011, over 8 662 744 ha—or approximately 5.01 per cent of Queensland—were included in protected areas including national parks, conservation parks or resource reserves.

Of the 1386 regional ecosystems recognised in Queensland, 80 per cent are represented in the protected area estate to some extent. This is an increase from 72 per cent in 1997 and 75 per cent in 2003. As at December 2011, Southeast Queensland, Central Queensland Coast and the Wet Tropics are the bioregions with greater than 90 per cent regional ecosystem representation in protected areas. The Gulf Plains, Mitchell Grass Downs and the Einasleigh Uplands bioregions have the lowest representation with 48 per cent, 53 per cent and 63 per cent respectively. Eighty six per cent of threatened animals and at least 71 per cent of threatened plants are represented in protected areas.

Nature refuges are a voluntary agreement between a landholder and the Queensland Government and reflect the landholder's commitment to conservation, while allowing compatible and sustainable land uses. Since 2007, 194 nature refuges covering 2 336 298 ha have been established. This brings the total for the state to 398 nature refuges covering 2 799 393 ha. Nature refuges protect conservation values in all bioregions. Over 65 per cent of nature refuges contain ‘endangered’ or ‘of concern’ regional ecosystems. More than 20 per cent of nature refuges contain threatened ecological communities and more than 400 threatened species are known to be protected on nature refuges.

Land use conflicts increased over the reporting period, particularly in relation to the growing coal seam gas mining industry. The Coal Seam Gas and Liquefied Natural Gas Annual Compliance Plan 2011 establishes a strong monitoring program to ensure effective management and response to reports or complaints concerning the impacts of the industry.

Regulation including the *Nature Conservation Act 1992* and the *Vegetation Management Act 1999* play an important role in the protection of terrestrial ecosystems.

Key initiatives relating to land and terrestrial ecosystems implemented since the last reporting period include the:

- Queensland Biosecurity Strategy 2009–14 and ongoing work by Biosecurity Queensland
- Delbessie Agreement (Statewide Rural Leasehold Land Strategy) was introduced in 2008 as a framework of legislation, policies and guidelines to support the environmentally sustainable, productive use of rural leasehold land for grazing and agriculture. The Delbessie Agreement clarifies the duty of care obligations of all holders of rural leasehold land; however its primary focus is on the sustainable management of rural leases with terms of 20 years or more and covering an area of 100 ha or more
- *Strategic Cropping Land Act 2011* is designed to strike a balance between the agriculture, mining and urban development sectors to help maintain the long-term viability of our food and fibre industries, and support economic growth for regional communities.

## Human settlements

Human settlements in Queensland are diverse, ranging from rural towns and communities to major cities. Human settlements have impacts on the environment through land use conversion, the development of physical and social infrastructure, the consumption of water and energy, and the generation of wastes.

The availability of fresh water is greatly influenced by climate and weather variability and demand. The millennium drought reduced the amount of water available for use in Queensland and major urban centres in South East Queensland were subject to unprecedented level 5 water restrictions.

In Queensland, a total of 3351 gigalitres (GL) of water was consumed in 2008–09. This was a 23 per cent decrease on the total amount consumed in 2004–05 (4361 GL). It is likely that the reduction is related to the widespread drought conditions and associated water restrictions in the intervening years.

In 2008–09, agriculture accounted for 64 per cent of Queensland's water consumption (2 144 201 megalitres (ML)), while households consumed 9.1 per cent (308 037 ML).

The main mode of transport remains the private motor vehicle, with increases in the average distance people travel to and from work in the Gold Coast and Sunshine Coast. However, public transport use has, overall, increased

significantly in South East Queensland since 2002–03, peaking at 64.5 public transport trips per capita per annum in 2008–09.

Energy consumption in Queensland has increased since 2005, and most fuel was sourced from non-renewable sources. However, the use of black coal as an energy source has declined over the last four years due to uptake of gas as an electricity generation fuel as a result of the Queensland Gas Scheme.

Household waste in Queensland is mostly handled by local governments. They have recorded a steady increase in the amount of household waste generated with an increase of 59 per cent over a six-year period (2004–05 to 2008–09), in comparison to a 13 per cent growth in population for the same time period.

In 2008–09, Queensland households generated approximately 2.25 million tonnes of domestic waste, or about 438 kg of waste per capita, excluding segregated green waste dropped off at local government landfills and transfer stations. Local governments diverted 2.3 million tonnes of the 4.9 million tonnes of the wastes they received from landfill in 2008–09, recycling some of this material themselves and forwarding the remainder to composters and other recyclers in Queensland, other states or overseas. Queensland power stations generated 5.84 million tonnes of fly ash and Queensland alumina refineries generated 4.49 million tonnes of red mud. Other waste streams generated in 2008–09 included 2.35 million tonnes of construction and demolition waste, 1.4 million tonnes of clean fill, 830 000 tonnes of segregated green waste, 713 000 tonnes of contaminated and acid sulfate soils, 568 000 tonnes of biosolids and 2.65 million tonnes of other commercial and industrial wastes.

The growth in the number of households is occurring at a faster rate than population growth. New residential development across the state continues to be predominantly low density and mainly in the form of larger detached houses. Queensland has an increasing proportion of small households with one or two occupants.

Brisbane continues to be rated as a highly liveable city; however its ranking has dropped in comparison to other cities around Australia and the world. South East Queensland residents generally enjoy living in the region and believe they have a high quality of life.

The *Water Act 2000* continues to establish a statutory planning framework for the sustainable allocation and management of the state's water resources. A key initiative relating to the management of impacts from human settlements on the environment introduced in this reporting period, has been the introduction of the *Sustainable Planning Act 2009*, guiding ecologically sustainable development in the state.

## Cultural heritage

Queensland's rich and diverse cultural heritage continues to be under significant pressure from a range of factors, including unauthorised collection, wear and tear from public access, poor maintenance, development and land clearing. In addition, climate and weather variability, storms and cyclones, and fire can all result in negative impacts on cultural heritage. A major factor limiting protection has been an imbalance in the identification and recognition of existing cultural heritage places.

South East Queensland has by far the largest amount of development activity in the state impacting on places entered in the Queensland Heritage Register. This is followed at some distance by North Queensland. While this generally reflects the level of development activity, it also has close parallels with the number and distribution of places entered in the Queensland Heritage Register.

A Statewide Heritage Survey was conducted between 2005 and 2010 and resulted in the Queensland Heritage Register being more representative of the range of Queensland's heritage places. As of December 2010, there were 1647 places entered into the Queensland Heritage Register, an increase of 170 places since 30 June 2006.

Condition audits found that more than seven per cent of heritage registered places were in need of significant repair and maintenance, or were completely destroyed.

Local governments play a key role in the conservation of cultural heritage. South East Queensland and Far North Queensland local governments lead the state in the identification of heritage precincts within their planning schemes.

The Queensland Heritage Strategy: a 10-year plan provides the policy framework for the pursuit of a range of innovative projects, such as planning, investment, partnerships and capacity building that will conserve Queensland's heritage.



The *Aboriginal Cultural Heritage Act 2003* and the *Torres Strait Islander Cultural Heritage Act 2003* continue to protect Aboriginal and Torres Strait Islander cultural heritage via a range of instruments.

A Cultural Heritage Register was established under these Acts. Between the end of June 2006 and June 2010, there was a 17 per cent increase in the number of sites in the register (from 23 613 sites in 2006 to 27 698 in 2010). The number of search requests made for information in the database has increased from 5770 in 2006–07 to 9898 in 2009–10.

Cultural Heritage Management Plans are a major element of the *Aboriginal Cultural Heritage Act 2003* and *Torres Strait Islander Cultural Heritage Act 2003*. The plans outline how land-use activities can be managed to avoid or minimise harm to Aboriginal or Torres Strait Islander cultural heritage. Cultural Heritage Management Plans are required for certain high-level impact activities—for example, where an environmental impact statement (EIS) is required under legislation—or where excavation or relocation of cultural heritage is proposed. In 2009–10 there were 29 registered Cultural Heritage Management Plans in Queensland.

Native title describes the rights and interests of Aboriginal people and Torres Strait Islander people under their traditional laws and customs. The *Native Title (Queensland) Act 1993* recognises and protects native title. It is administered by the state government, who also has a primary responsibility for implementing the Commonwealth *Native Title Act 1993* in Queensland. As at 31 December 2011, there were 101 active native title claimant applications. In 2011, 10 native title claims were resolved through consent determination, which brings the total number of claims resolved in Queensland to 63.

Museums are an avenue through which Queenslanders can connect with their cultural heritage. Museums play a key role in preserving our history, covering a diverse range of topics. They also provide access to research and heritage objects.

The Queensland Museum is a statutory authority of Arts Queensland, governed by a Board of Trustees under the provisions of the *Queensland Museum Act 1970*. For more than 148 years, the Queensland Museum has been documenting, preserving and sharing Queensland's natural and cultural heritage. More than one million items and specimens make up the state collection that tells the changing story of Queensland.

Throughout Queensland, 294 institutions self identify as museums out of 352 listed museums, galleries, historical societies, and other cultural heritage sites. The remainder of collections are kept within historical societies, cultural centres, galleries and historic houses.

The *Queensland Heritage Act 1992*, the *Aboriginal Cultural Heritage Act 2003* and *Torres Strait Islander Cultural Heritage Act 2003*, the *Aboriginal Land and Torres Strait Islander Land and Other Legislation Amendment Act 2010* and the *Commonwealth Historic Shipwrecks Act 1976* are the major instruments outlining how heritage is to be managed and protected. The Queensland Heritage Council continues to work to identify and protect places that have special cultural value to the community and future generations.

## Outlook

The commitment to ecologically sustainable development, as set out in the *Environmental Protection Act 1994* and the *Coastal Protection and Management Act 1995*, continues to be a focus for the state. In this reporting cycle, many complex and inter-related environmental issues have come to the fore that have challenged existing approaches to environmental planning and management. This has led to the development and introduction of new and exciting approaches.

Adaptive management will be of ongoing relevance in addressing complex, inter-disciplinary environmental issues that often involve multiple stakeholders across a range of scales, such as from paddock to reef. Adaptive management is a cyclic process that depends on the regular review of performance indicators and objectives, backed by effective research, monitoring, evaluation and reporting. It can inform regular adjustment of planning and management to deal with changing circumstances and high levels of uncertainty.

Science is critical to adaptive management. It plays a key role in the development of environmental policy, setting of standards, monitoring of implementation of policy programs to assess whether desired objectives have been achieved, the evaluation of policy or management interventions to review appropriateness, effectiveness and efficiency, and in the redesign of initiatives to enhance outcomes.

It is anticipated that many of the key challenges discussed in this report will again be of focus in the next reporting cycle due to their complex, ongoing and inter-related nature. Arresting the decline in biodiversity, enhancing

sustainable practices that help with the achievement of the principles of ecological sustainable development, mitigating and adapting to a changing climate, implementing planning and regulatory frameworks that assist with managing the many different uses for our natural assets, and protecting, maintaining and restoring our significant natural and cultural heritage all fall into this category.

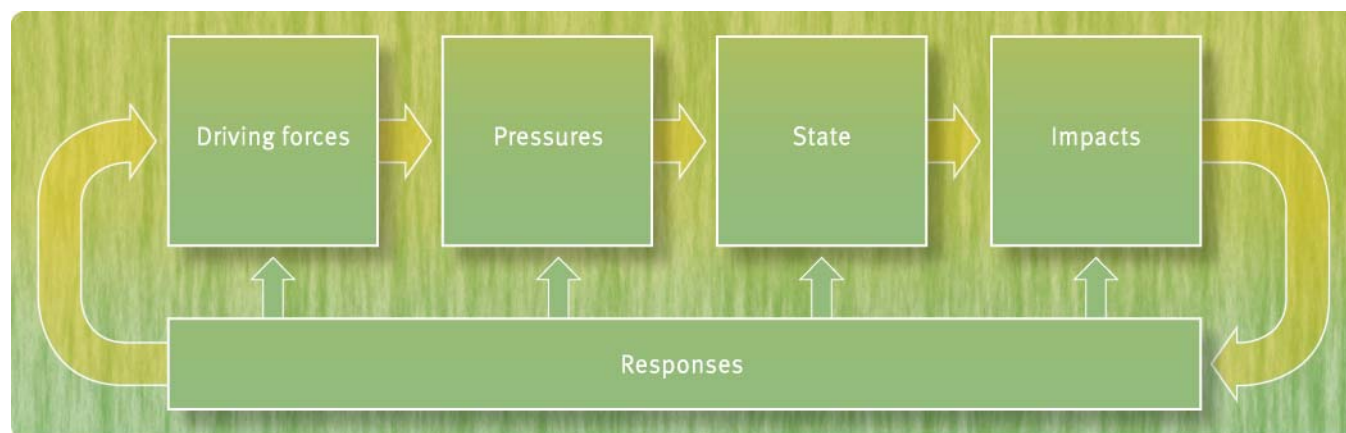
## For the reader

State of the Environment Queensland 2011 is the fifth state of the environment report to be produced by the Queensland Government. State of the Environment reports are produced to ensure that decisions made in the pursuit of economic growth and higher living standards are well informed and do not result in unintended consequences arising from the degradation of the environment and the natural assets on which all life depend. Like its predecessors, this report explores the impact of human endeavour on the environment and society's capacity to respond and manage these impacts. This analysis has been achieved by applying the Driving forces–Pressures–State–Impacts–Responses (DPSIR) framework (see Diagram 1). The DPSIR framework is an internationally accepted approach to assessing environmental performance and the condition and trend of natural capital (Kristensen, 2004).

The approach generally taken in the 1999, 2003 and 2007 state of the environment reports revolved around key assets (atmosphere, land, water and cultural heritage) and examined these primarily in terms of their pressures, state and responses (EPA, 1999, 2003). Driving forces and impacts were incorporated into aspects of the sustainability and human settlements chapters.

In contrast to the three previous reports, the approach taken in this reporting cycle differs slightly through a more rigorous application of the DPSIR framework. The report begins with a general introduction to state of the environment reporting (Chapter 1) and then moves on to investigate the main driving forces that affect Queensland (Chapter 2). The subsequent chapters include Pressures (Chapter 3), State (Chapter 4), Impacts (Chapter 5) and Responses (Chapter 6). The report concludes with a summary of future challenges (Chapter 7).

In this report, the key natural and cultural assets—atmosphere, water, land and cultural heritage—are still central to the discussion. However, they are considered as topics under each of the DPSIR headings. The purpose of adopting this approach was to move away from a purely asset-based approach to reporting and towards a more integrated and synthesised analysis and presentation of issues. Data and information have been provided by a range of scientific researchers, policy makers, planners and other specialists.



Source: Adapted from UNEP, 2012.

**Diagram 1. DPSIR framework.**

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# 1 Introduction





The wellbeing of all Queenslanders, both now and into the future, is intimately linked to and dependent upon the natural environment. Queensland's landscape is vast, covering an area of around 172.8 million ha. It is also very diverse, encompassing relatively pristine areas such as national parks, to highly modified areas such as cities, mines and agricultural lands. The terrestrial (land-based) environment is complemented by a large marine environment. The mainland coastline is approximately 6900 km in length, and features 1165 offshore islands and cays.

Historically, the environment has been regarded as a resource, providing us with minerals, food and fibre, building materials and fuel. More recently, there has been greater acknowledgement of the many other services provided by the environment that are necessary for our long-term survival. These services are known as ecosystem services (see text box below).

Sustaining healthy, functioning ecosystems to deliver the range of ecosystem services currently available to us will ensure that the state's environment, society and the economy all work together and remain in good condition. Achieving the right balance between maintaining enough natural capital to deliver nature's free ecosystem services, while supporting the demands of a growing population, is a major challenge for all Queenslanders.

Ecosystems have been naturally adapting to changing conditions and natural disasters over many millennia. This capacity to absorb change without altering the state is known as 'resilience'. Resilience can be defined as:

‘the capacity of a system to absorb disturbance and re-organise while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks’ (Walker et al., 2004).

There is a threshold point beyond which the state of the system is altered, sometimes irreversibly. In natural systems, this usually results in a shift from a higher functioning state to a lower one. This change in state leads to a loss of ecosystem function and subsequently, a loss or reduction in ecosystem services.

Human activities often exacerbate and can even drive this shift in state. While it may be possible to rehabilitate and regenerate affected ecosystems to facilitate recovery back to the higher functioning state, this is a costly exercise that may not always succeed. This suggests that, wherever possible, it is far better to prevent these shifts occurring in the first place (TEEB, 2010).

### Ecosystem services

All humans depend on nature for their existence and wellbeing—from their basic physical needs such as food, fresh water, fibre or fuel, to requirements such as storm protection and air regulation, or to satisfy more intrinsic needs such as recreation and spiritual fulfilment. The earth's many and diverse ecosystems provide these benefits upon which humans depend. Collectively, ecosystems form the earth's green infrastructure or natural capital and the benefits derived from them are known as ecosystem services.

Ecosystems services are classified as:

- supporting (e.g. soil formation and nutrient cycling)
- provisioning (e.g. food, fibre and water)
- regulating (e.g. regulating climate, flood and disease)
- cultural (e.g. aesthetic, spiritual and educational).

The ecosystem services approach recognises that in order to maintain healthy ecosystem functions (i.e. the processes that generate ecosystem services), resources should not be used at a rate faster than they can be replenished and/or recycled; or the environment's capacity to absorb and neutralise waste. Additionally, the ecosystem services concept recognises that the environment provides more than just its productive or extractive value to humans, it provides for spiritual needs and has its own intrinsic value separate to the services it provides. Ecosystem services are an important approach for directly relating human health and wellbeing to environmental health and wellbeing.

Sources: Costanza, et al., 1987; Colby, 1991; Costanza and Daly, 1992; de Groot, et al. 2002; Millennium Ecosystem Assessment, 2003; Norgaard, 2010

State of the environment reporting is the internationally accepted method for assessing environmental performance. In Queensland, state of the environment reporting includes an assessment of the state of major environmental and

cultural assets and the identification of significant trends. Reporting also includes a review of the significant programs, activities and achievements of public authorities in the protection, maintenance, restoration and enhancement of the state's environment.

The State of the Environment Queensland 2011 report represents a collaborative effort between experts from government, the research sector, industry, non-government organisations and the community. This is the fifth report produced for Queensland.

## 1.1 Statutory requirements

State of the environment reporting in Queensland is a statutory requirement under both the *Environmental Protection Act 1994* (EP Act) and the *Coastal Protection and Management Act 1995* (Coastal Act). The EP Act requirement applies to Queensland's environment generally, while the Coastal Act requirement relates specifically to the coastal zone.

The EP and Coastal Acts require the preparation of an assessment of the state of the environment and the coastal zone at least every four years. This report is designed to meet the requirements of both Acts. Section 547 of the EP Act and section 166 of the Coastal Act specify that the report must:

- include an assessment of the condition of Queensland's major environmental and coastal resources
- identify significant trends in environmental and coastal values
- review significant programs, activities and achievements of persons and public authorities relating to the protection, restoration or enhancement of Queensland's environment and coastal zone
- evaluate the efficiency and effectiveness of environmental and coastal management strategies implemented to achieve the objects of the Acts.

## 1.2 Scope

The scope of this report is broad, examining a range of physical and cultural topics. The physical aspects revolve around the state's major natural assets of atmosphere, water and land. The cultural aspects relate to Queensland's heritage given that the state's history and traditions greatly influence the present, including how the environment is perceived, used and managed.

The topics considered in this report are consistent with the definition of the environment provided in section 8 of the EP Act:

- a. ecosystems and their constituent parts, including people and communities
- b. all natural and physical resources
- c. the qualities and characteristics of locations, places and areas, however large or small, that contribute to their biological diversity and integrity, intrinsic or attributed scientific value or interest, amenity, harmony and sense of community
- d. the social, economic, aesthetic and cultural conditions that affect, or are affected by, the things mentioned in paragraphs (a) to (c).

## 1.3 The importance of reporting

The EP Act outlines that the protection of Queensland's environment is to be achieved by an integrated management program that is consistent with ecologically sustainable development (ESD). Ecologically sustainable development is defined in the EP Act as:

‘...protecting the environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.’

Under the EP Act, state of the environment reporting is an important part of an integrated management framework (Figure 1). State of the environment reports provide an assessment of Queensland's natural and cultural assets at least every four years. The reports outline if the state of natural and cultural assets has remained the same,

improved or deteriorated. The findings reflect how well Queensland is responding to environmental challenges, both in reducing or eliminating pressures and the underlying driving forces that cause these pressures. Actions to achieve this include protecting the environment and preventing or limiting damaging activities, restoring and rehabilitating degraded natural assets, and changing behaviour and practices to reduce the demand or pressures placed on environmental resources. Usually, a combination of these actions is required to produce the desired outcome of a win-win solution for the economy, society and the environment.

Reporting on the state of the environment is important to ensure accountability of environmental strategies and policies. It also provides objective measures of environmental performance to inform evidence-based decision making and progress towards sustainability. Additionally, state of the environment reporting plays a role in assisting strategic planning by identifying new and emerging issues that require intervention.

The successful performance of the initiatives instigated by public authorities is often not immediate due to long environmental time lags. Thus, the importance of a continuous reporting system such as state of the environment reporting that assesses progress over time becomes apparent.



**Figure 1. Protecting Queensland's environment through an integrated management framework.**

## 1.4 Queensland's natural and cultural assets

Queensland's natural and cultural assets include the atmosphere, water, land and cultural heritage. These assets are the cornerstone for our existence and support the high quality of life enjoyed by Queenslanders.

### 1.4.1 Atmosphere

The atmosphere is essential for life and links all the principal components of the earth's systems including water, land and the organisms living within them. It provides us with clean air, the stratosphere protects us from damaging ultraviolet radiation from the sun, and it plays a major role in regulating climate. Good air quality is critical to the health and wellbeing of all living things that use the atmosphere as the basis of their metabolic processes that sustain life.

Air pollution can result in impacts to human health, ecosystem processes and climate change.

Queensland's climate is naturally highly variable. The major climate features affecting the amount and pattern of rainfall across Queensland are the El Niño Southern Oscillation (ENSO), the Inter-decadal Pacific Oscillation (IPO), the Madden-Julian Oscillation (MJO) and the Sub-Tropical Ridge (STR). The impacts of climate change on these major climate features (and the associated climate variability) are difficult to assess.

### 1.4.2 Aquatic ecosystems and the coast

Queensland's aquatic ecosystems are diverse and encompass rivers (riverine), lakes (lacustrine) and swamps (palustrine), underground water bodies (subterranean), coastal creeks and rivers (estuarine) and coastal waters, such as bays and inshore areas (marine). Mainland Queensland is divided into 120 catchments that are grouped into four drainage divisions, two of these divisions are internally draining and one division occurs entirely within Queensland.

Queensland's wetlands support much of the state's native biodiversity, including migratory birds, frogs, dugongs, dolphins, turtles and commercially important fish species. Additionally, many unique species occur in these important systems, such as the red-finned blue eye fish found in the groundwater-fed mound springs of the inland arid and semi-arid zones.

Queensland also contains a large section of the Lake Eyre Basin, along with South Australia, New South Wales and the Northern Territory. The Lake Eyre Basin is one of the largest internally draining systems in the world, covering approximately 1.2 million km<sup>2</sup>, and is the world's fifth largest terminal lake.

Many of Queensland's wetlands are recognised at a national and international level for their role in supporting migratory bird populations and other values, as is the case with the five Ramsar wetlands including Moreton Bay in South East Queensland and Bowling Green Bay in North Queensland.

The Great Barrier Reef, stretching more than 2000 km along the Queensland coastline and covering 35 million ha, is the world's largest coral reef. More than 1500 species of fish, 4000 species of molluscs, 400 species of sponge and 300 species of hard corals live here. Extensive seagrass beds provide a home for the threatened dugong. Green and loggerhead turtles nest on islands in the reef and humpback whales migrate there to give birth. Birdlife is also abundant and hundreds of species nest in the reef islands. The reef is very important to Aboriginal and Torres Strait Islander people, and there are significant cultural sites on many of its islands.

The Great Barrier Reef is not discussed in depth in this report because its status is assessed under the *Great Barrier Reef Marine Park Act 1975* by the Great Barrier Reef Marine Park Authority, with findings released via outlook reports every five years. The first Great Barrier Reef Outlook Report was released in 2009 (GBRMPA, 2009). However, in this report the Great Barrier Reef is considered within the context of the work being carried out under the Reef Water Quality Protection Plan 2009 (DPC, 2009a). This work has been incorporated into this report because it involves the effects of activities in the adjacent catchments on the water quality of the Great Barrier Reef lagoon.

### 1.4.3 Land and terrestrial ecosystems

Queensland's land area is approximately 172.8 million ha of which 74 per cent (129.7 million ha) is used for agriculture and 2.2 million ha of this area—or 1.3 per cent—is used for cropping. Overlaying these land uses, more than half of Queensland—or 96.66 million ha—is under some form of granted exploration or production tenure for coal, mineral, petroleum, coal seam gas or geothermal energy (DEEDI, 2011a).

The state supports a wide range of ecosystems that are grouped into 13 bioregions. One thousand, three hundred and eighty-six regional ecosystems have been mapped across most bioregions for 85 per cent of Queensland. As at December 2011, more than 8 662 744 ha—or approximately 5.01 per cent of Queensland—was contained in national parks, conservation parks or resource reserves. Since 2007, 194 nature refuges covering 2 336 298 ha have been established. This brings the total for the state to 398 nature refuges covering 2 799 393 ha.

Queensland's terrestrial (land-based) ecosystems are biologically diverse, containing 85 per cent of Australia's native mammals (239 species), over 70 per cent of its native birds (562 species) and just over half of the nation's reptiles (473 species) and native frogs (127 species). Many of these species are endemic to Queensland, meaning they do not occur anywhere else (DERM, 2011a).

Queensland also supports an abundance of invertebrates and microorganisms that are a vital component of the state's biodiversity. These organisms play a crucial role in food webs, as pollinators, and in recycling, mulching and composting of organic matter.

More than 8400 species of native flowering plants, gymnosperms (e.g. cone producing, non-flowering plants such as bunya pines), ferns and fern allies are known to occur in Queensland, representing approximately 45 per cent of the known Australian species. More than 30 per cent of these are endemic to Queensland (DERM, 2011a).

There are more than 900 species of mosses, liverworts and hornworts in Queensland and more than 1500 species of algae. Lichens account for more than 1900 known species, while macrofungi number over 1100 species. There are many species yet to be discovered—especially of algae, fungi and lichens—and their importance in ecosystem health and function is still poorly understood (DERM, 2011a).

All landscapes change continually over time from natural processes. However, our use of the land can alter the condition of natural resources and affect many of the processes within ecosystems. The cumulative impacts of agriculture, grazing, mining, urbanisation and transport, if not managed well, can degrade the quality of land and water resources and adversely affect agricultural production and other uses we make of our land (EPA, 1999, 2003, 2008).

#### 1.4.4 Cultural heritage

Cultural heritage is the invaluable physical, spiritual and intellectual evidence of who and what has been here before us. Aboriginal and Torres Strait Islander people were the first human colonisers of Queensland. Traditionally, they lived as part of the land and their lifestyle was nomadic.

Today, Aboriginal and Torres Strait Islander cultural heritage remains highly diverse and covers both the tangible and intangible. The tangible cultural heritage includes places and items, such as shell middens, rock art and hunting implements (Horton et. al, 1994a, b), while the intangible cultural heritage includes language, spiritual beliefs and stories.

The traditional knowledge within the cultural heritage of Queensland's Aboriginal and Torres Strait Islander people is an exceptionally important resource. For at least 60 000 years, the Aboriginal and Torres Strait Islander people of Australia actively managed their natural environment. The integration of traditional and modern principles into environmental and natural resource management is a key step towards achieving future sustainable outcomes, and encourages the re-establishment of connections between humans and their landscape.

Historic cultural heritage encompasses the important places, artefacts and stories associated with the people of Queensland since European settlement, including shipwrecks, the built environment and the development of landscapes that are now considered quintessentially Queensland. It is heavily influenced by colonial European and subsequent migrant settlement.

Museums are an avenue through which Queenslanders can connect with their cultural heritage. Museums play a key role in preserving our history, covering a diverse range of topics. They also provide access to research and heritage objects, which can give context for how we live today and assist Queenslanders to understand the different cultures within their state.

### 1.5 DPSIR framework

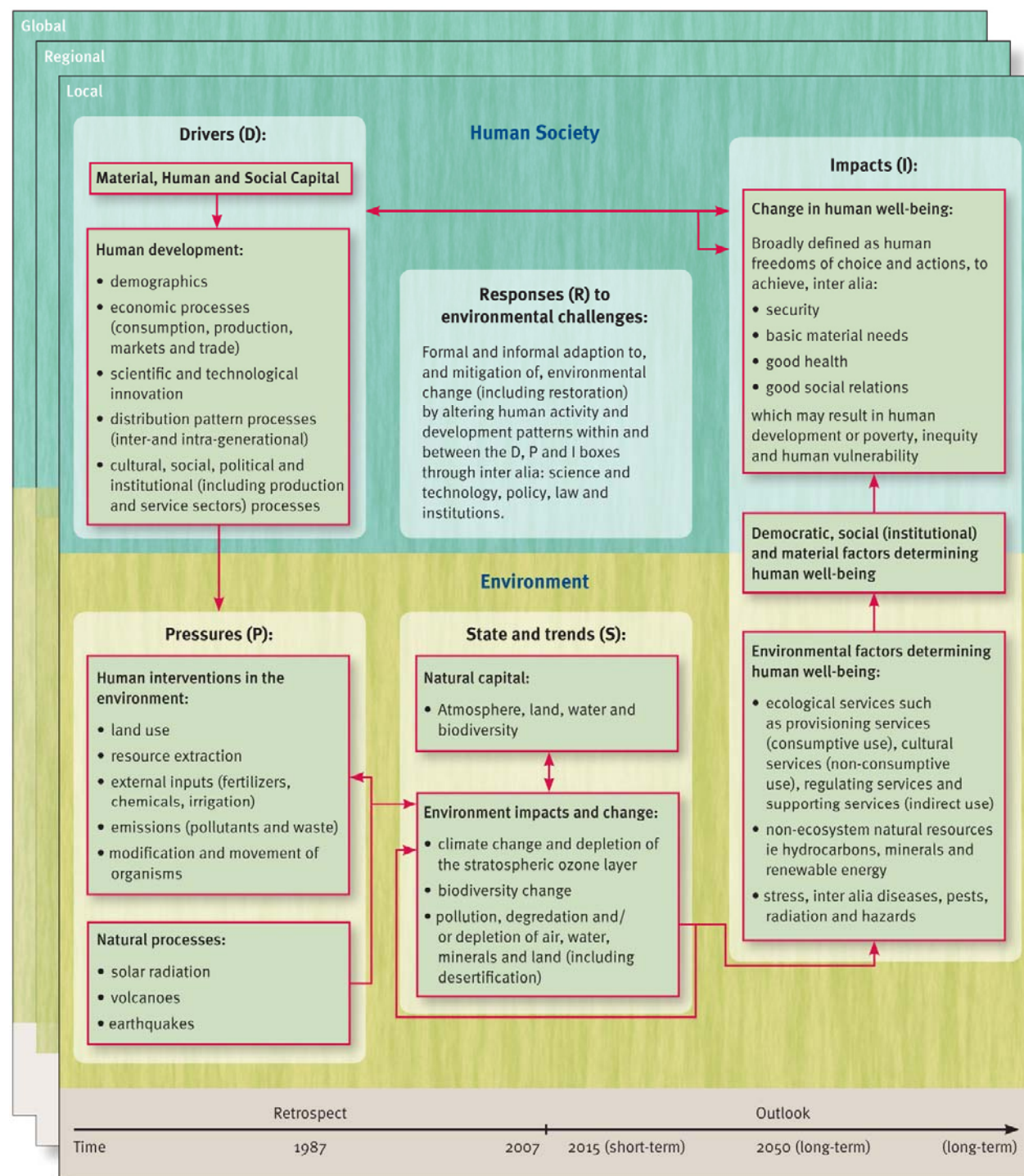
The state of the environment report uses the Driving forces–Pressures–State–Impacts–Responses (DPSIR) framework to explore key contemporary environmental issues for Queensland. The DPSIR framework was developed by the European Environmental Agency to improve the socio-economic and socio-cultural aspects of environmental reporting.

This framework recognises the role of humans in environmental degradation and the capacity for society to manage these impacts (Figure 2). Driving forces are the socio-economic, cultural and political forces that guide human activities and that increase or mitigate pressures on the environment. Pressures are the stresses that human activities place on the environment. State encompasses quantity, quality, extent and/or condition of the environment, while impacts are the consequences of environmental degradation and/or interventions. The responses refer to the actions undertaken by society to improve, manage, mitigate and adapt to environmental changes.

It is widely recognised that the costs of prevention of environmental damage are lower than the costs of rehabilitation or repair of degraded areas and the costs associated with threat of extinction, habitat loss, loss of ecosystem functionality, or impaired human health. Indeed, some environmental damage is irreversible in that no amount of action can remedy the impact. Thus, understanding driving forces and the pressures they exert is critical to the development and implementation of initiatives (legislation, policies, strategies, plans, partnerships and projects) that change human behaviour to facilitate sustainable practices and inhibit harmful ones.



The DPSIR framework is not a simple linear cause-and-effect framework. As explained in the Global Environment Outlook 4 report (UNEP, 2007), the conceptual framework reflects the key components of a complex chain of spatial and temporal cause-and-effects and the many feedback loops that characterise the interactions between society and the environment. Environmental changes are induced by drivers and caused by pressures, but they do also affect each other. These changes interact with demographic, social, material and other factors in determining human wellbeing. These processes take place at all spatial scales, from global to local (UNEP, 2007). A key purpose of the framework is to assist with informing an effective transition towards sustainable development.

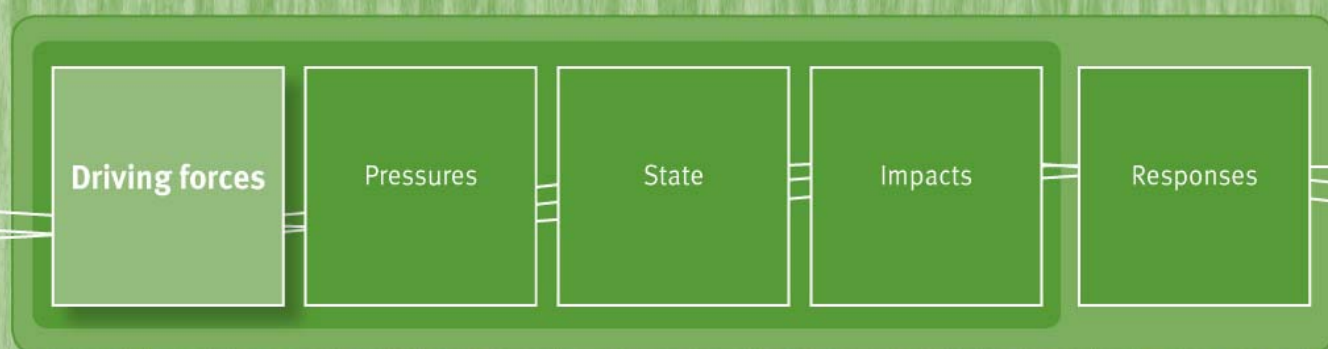


Source: Adapted from UNEP, 2007 (GEO 4, page 31). \*Combining the Driving forces–Pressures–State–Impacts–Responses (DPSIR) framework with the concepts of human wellbeing and ecosystem services.

**Figure 2. The Global Environment Outlook 4 conceptual framework\*.**



## 2 Driving forces



Driving forces are the socio-economic, socio-cultural and socio-political forces that guide human activities and which increase or mitigate pressures on the environment. The level of pressure exerted on the environment that is induced by driving forces can range from low to high. The amount of damage incurred at any given time depends on the combination of socio-economic, socio-cultural and socio-political forces applied and the current status of the environment, amongst other factors. Driving forces include demography, economic activity, culture, human development, governance and science and technology.

The consequences of these driving forces have led to significant pressures on the environment. These pressures have significant potential to incur, or have resulted in, substantial costs to Queensland's wellbeing and prosperity.

## 2.1 An interconnected world

The world in which we live is a complex place consisting of interrelated social, economic and environmental systems. This interconnectivity has meant that changing one element within a system may cause unexpected and sometimes harmful effects to another element, either within the same system or between systems.

In the past, damage to these systems was largely confined to specific regions and countries and managed that way. However, through globalisation, the different parts of the world have become much more connected than ever before. As a consequence, the influences of human activities, both positive and negative, are now impacting at a much larger scale. To achieve sustainable practices, it has become increasingly important to understand the mechanics of the world's complex and interrelated social, economic and environmental systems at multiple scales of operation.

Queensland's prosperity depends on global interests. International, regional (Asia-Pacific) and national development have a significant bearing on what happens in Queensland. Such development can influence patterns of behaviour and the use of natural resources, and can result in both positive and negative outcomes for the environment. International tourism, for example, can boost the protection of iconic species, ecosystems and Aboriginal and Torres Strait Islander cultural heritage, while international demands for resources may deplete and degrade natural resources even though they may boost our economy and lifestyle. The impact of climate change, driven by global trends, will also influence the wellbeing of Queenslanders.

Decision-makers in Queensland contend with state matters within this highly complex, global web. Their objective to seek sustainable, long-term outcomes for society, the economy and the environment is a challenging one, given that many issues shaping Queensland's future are often outside the realm of the state's direct influence.

This section of the report explores the key driving forces influencing the state's environmental systems. It concludes with a brief examination of the environmental consequences, leading on to topics that will be discussed in more detail in the following sections of the report.

## 2.2 Key drivers for Queensland

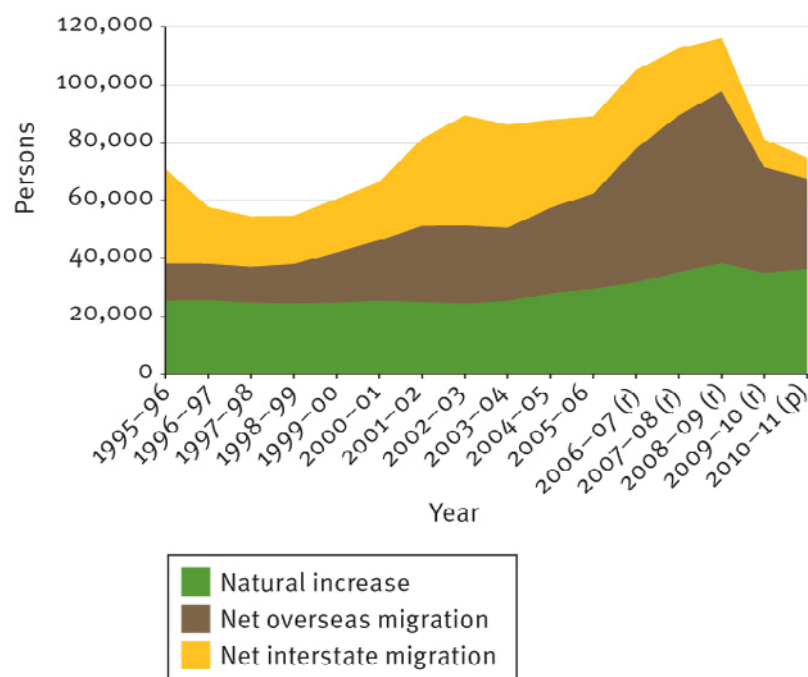
### 2.2.1 Demography

The size, growth rate, distribution and migration patterns of Queensland's population are all important demographic factors that drive land use, natural resource demand and challenge the provision of socio-economic services that support high or improved living standards. The estimated resident population for Queensland at 30 June 2011 was 4 580 282 (ABS, 2011a). Queensland contains a highly urbanised population, with approximately 88 per cent of the population living within 50 km of the coast (OESR, 2011a). Growth in this population is sustained by both migration and natural increase (births minus deaths) (Figure 3), with the population experiencing unprecedented ageing (Figure 4).

In this reporting cycle, population growth in the regional centres has shown increases. At 30 June 2011, the estimated resident population of regional Queensland (Queensland, excluding the Brisbane Statistical Division) was 2 506 060 people, making up 54.7 per cent of the state's population. The population growth rate of these regions between 30 June 2006 and 2011 was 2.33 per cent—slightly above the Queensland average of 2.29 per cent. It is projected that this trend will continue in the larger regional cities of Cairns, Townsville and Toowoomba, as well as regional centres such as Rockhampton, Hervey Bay, Mackay and Gladstone, as a result of the lifestyle

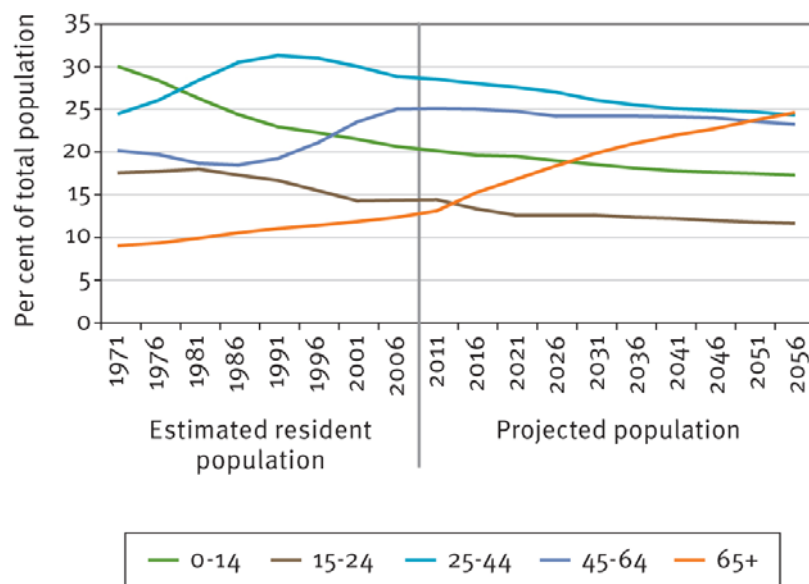


and employment opportunities they offer (OESR, 2011b). Further growth is also projected within the Darling Downs, North West and South West statistical divisions due to the continuing resource boom (OESR, 2011b).



Source: ABS, 2011a various issues (3101.0); r = revised statistics; p = preliminary statistics.

**Figure 3. Population growth patterns for Queensland.**



Source: ABS, 2011a (3101.0); OESR, Queensland Government Population Projections 2011 edition.

**Figure 4. Age structure for Queensland's population.**

## 2.2.2 Economic activity

Queensland historically had a strong economy (Figure 5), with activity dampened over the past three years by the impacts of the global financial crisis, widespread flooding and Tropical Cyclone Yasi in early 2011. The

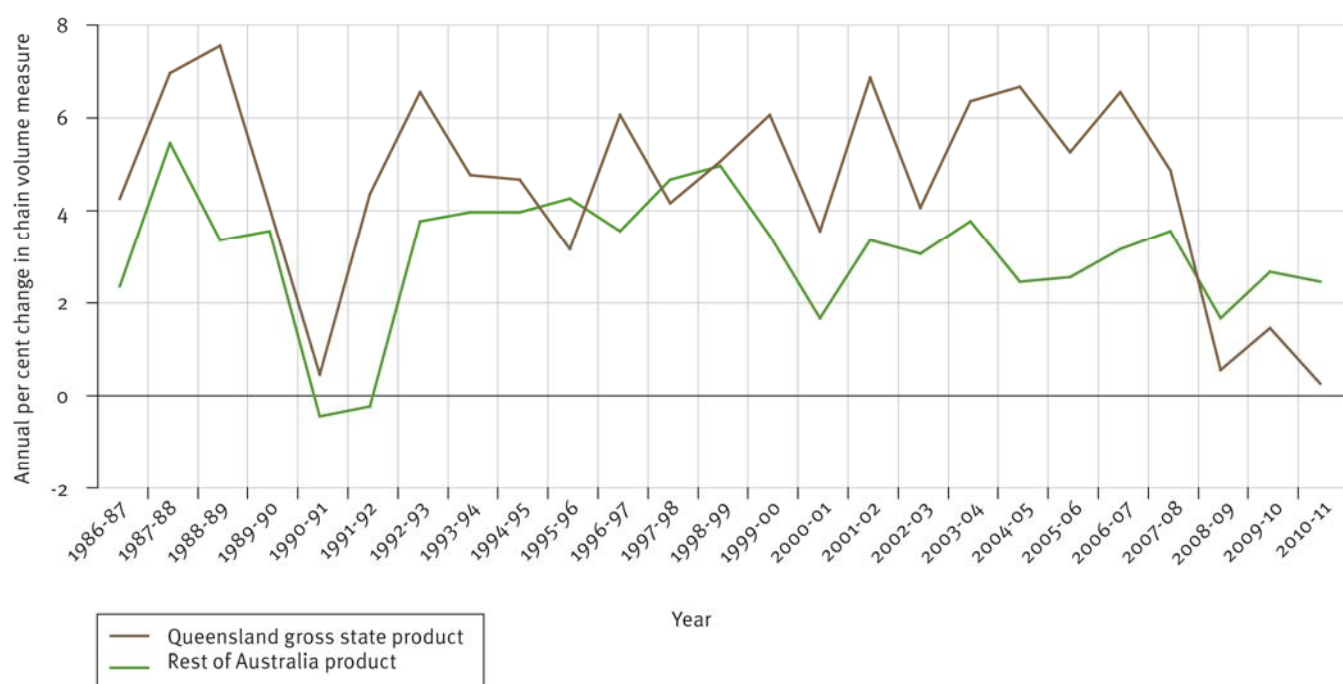
Queensland agriculture, forestry, fisheries, mining, manufacturing, construction and tourism industries rely heavily upon the environment for their output.

Increasing global demand for Queensland's natural resources and the corresponding growth of Queensland's agricultural and mining activities can put pressure on the environment. The extraction of resources, cropping and grazing practices, along with associated infrastructure requirements (e.g. ports, roads, processing plants and storage facilities), directly and indirectly affect ecosystems by modifying land- and seascapes and generating pollution. In contrast, other industries such as tourism rely heavily on the maintenance of Queensland's environmental assets for their viability.

The generation of waste is often a consequence of economic growth. Waste includes surplus, leftover or unwanted materials from domestic, commercial, industrial and other activities. Waste may contain contaminants, which could pose a hazard to human and ecosystem health and the sustainability of agricultural production systems. Ecosystem processes may be able to break down some of the waste produced by humans; however this capacity is finite and intrinsic waste detoxification capabilities could be lost with environmental degradation or overwhelmed with large quantities of waste production (MA, 2005).

Many of the state's major industries are also key emitters of greenhouse gases—through electricity generation, land clearing and land-use change, agricultural production and transport.

The conundrum faced by Queensland in maintaining prosperity is balancing the needs of today, while ensuring that the needs of future generations are not compromised. Current economic measures such as the Gross Domestic Product or State Gross Product do not incorporate environmental transactions. A System of Environment-Economic Accounting (SEEA) has been developed to provide a more comprehensive overview of the economy, incorporating an improved account of collective social, environmental and economic outcomes (UNSD, 2012; SEEA, 2003).



Source: OESR, 2011c (Queensland State Accounts, September Quarter 2011).

**Figure 5. Economic growth for Queensland and the rest of Australia, from 1986–1987 to 2010–2011.**

### 2.2.3 Culture

Human actions are driven in part by culture and attitudes, amongst other factors such as socio-economic influences (Assadourian, 2010). The main driver of urbanisation is economic growth (MA, 2005). While economic growth provides a range of benefits to society, it can also lead to pressures on the environment (Browne and McPhail, 2011). Many Australians have a high standard of living supported by economic growth, which drives a culture of

consumerism. Globally consumption has grown significantly over the past five decades, with consumption expenditures per person almost tripling (Assadourian, 2010).

The ecological footprint is a measure of the biologically productive area (land and water) that people use for provision of renewable resources, occupy with infrastructure, or required for the absorption of wastes (Wackernagel and Rees, 1996). Essentially, it measures what resources nature can provide or generate to support human activities.

The earth's biocapacity is 11.9 billion gha or 1.8 gha per person. In 2007, the world's average ecological footprint was 2.7 gha per person, representing an ecological overshoot of 50 per cent (WWF, 2010). Using more resources than can be regenerated is only possible until the resources become depleted.

In 2009, the ecological footprint for a person living in Queensland in 2008–09 was 7.8 gha and that for a Brisbane resident was 8.0 gha. This value is similar to the average Australian's ecological footprint of 8.1 gha in 2008–09. Queensland's ecological footprint and biocapacity is approximately four times the world average and five times higher than the average available biocapacity (Dey, 2011). It is important to note that a substantial amount of the ecological footprint for Queensland is located in other parts of the world, providing the wide range of goods and services consumed by Queensland residents.

Queensland's consumption activities that contribute most significantly to its ecological footprint include electricity consumption (1.07 gha/capita), house construction (0.56 gha/capita), retail trade (0.51 gha/capita), hospitality (0.44 gha/capita), air travel (0.35 gha/capita); and petrol consumption (0.32 gha/capita).

## 2.2.4 Human development

Human development is about enabling people to lead long, healthy, educated and fulfilling lives. Sustainable human development is about making sure that future generations can do the same (intergenerational equity). These two concepts are not mutually exclusive and cannot be separated (UNDP, 2010). Poorer rural households in developing countries face disproportionate losses from the depletion of natural assets due to their relatively high dependence on certain ecosystem services for income and insurance against hard times (TEEB, 2010). Queensland is not immune to this trend.

The Human Development Index (HDI), developed by the United Nations Development Program, is a composite measure of three basic dimensions of human development—a long and healthy life, access to knowledge and a decent standard of living. In 2010, Australia was ranked second in the world (out of 169 nations), with a HDI of 0.937. However, when this index was adjusted for inequity across Australia's population (inequity-adjusted HDI), it dropped by 7.9 per cent to 0.864, whereas under perfect equality the HDI and IHDI would be equal (UNDP, 2010).

Much of this inequity in Australia, including in Queensland, lies within Aboriginal and Torres Strait Islander communities. When the HDI is calculated for Aboriginal and non-Aboriginal people in Australia, Canada, New Zealand and the United States, there is a consistent gap of 6–18 per cent (UNDP, 2010). In Queensland and nationally, Aboriginal and Torres Strait Islander people have a lower life expectancy, poorer education outcomes and lower incomes (DFHCSIA, 2008).

The challenge of achieving sustainability has yet to be obtained by any nation, as measured by plotting the Human Development Index against the ecological footprint (Ewing et al., 2010). Australia may rank highly for the Human Development Index but its ecological footprint exceeds the earth's limits (as discussed previously). The Genuine Progress Indicator (a comprehensive approach to measuring wellbeing) suggests that Queensland could do better in terms of its social and environmental outcomes (Lawn, 2008).

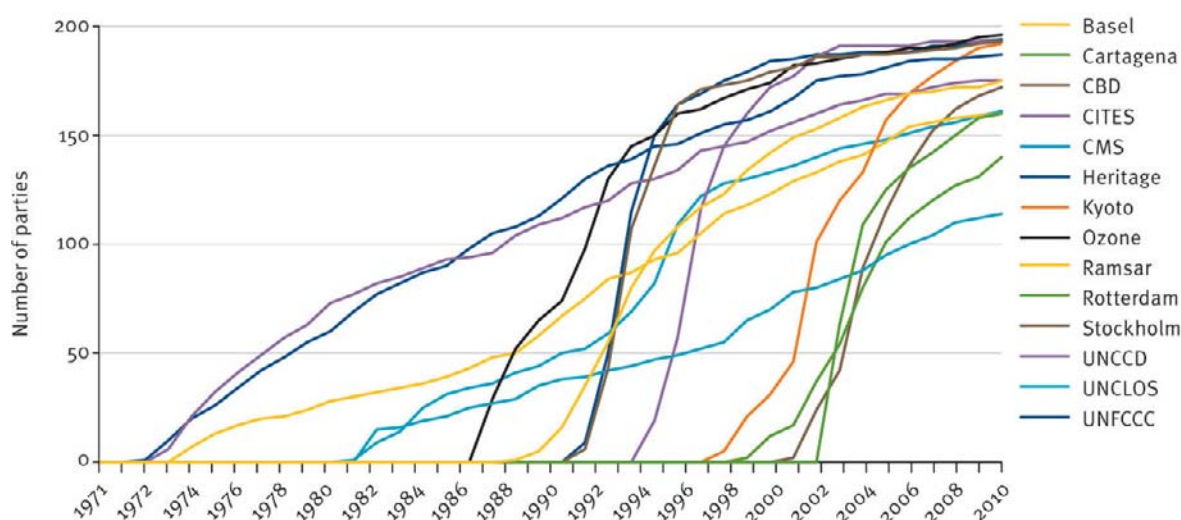
The HDI has been linked to 'resilience' with respect to human and environmental capacity to respond to natural disasters. The importance of enhancing the resilience of Queensland's communities, economy and environment has been brought to the fore during this reporting cycle after a spate of natural disasters hit the state. Building resilience is also central to meeting the challenges of a changing climate.

## 2.2.5 Governance

Governance refers to how authority is exercised via actions, processes, traditions and institutions in private and public institutions (UNEP, 2002; McGrath, 2011). Governance can drive changes in human behaviour, which

ultimately determines how the natural environment is treated, from the extraction of resources to environmental protection.

Sound governance at all levels is needed to ensure that environmental considerations receive the weight they deserve in the balance of economic, social and cultural rights. Globally, there has been a rise in the development of environmental agreements over the past few decades to counteract several concurrent environmental crises including a changing climate, biodiversity loss, pollution, and fuel, food and water security (Figure 6; UNEP, 2011a). This trend highlights growing recognition of the importance of governance in bringing about positive environmental outcomes.



Source: UNEP, 2011b (page 70; Data sources: GEO Data Portal, compiled from various MEA secretariats).

CBD – Convention Biological Diversity

CITES – Convention on International Trade in Endangered Species

CMS – Convention on the Conservation of Migratory Species

UNCCD – United Nations Convention to Combat Desertification

UNCLOS – United Nations Convention on the Law of the Sea

UNFCCC – United Nations Framework Convention on Climate Change

Parties – refers to the number of signatories to environmental conventions.

**Figure 6. Ratification of major multilateral environmental agreements from 1971–2010.**

## 2.2.6 Science and technology

In today's world, humans are living in a continuously accelerating knowledge revolution. Science and technological innovation continues to alter the structure of production, the nature of work and the use of leisure time (UNEP, 2002). It is the driver behind how the needs and desires of society are met and, thus, a fundamental determinant of humanity's impact on the environment.

It is unknown whether the aggregate effects of science and technology are positive or negative. For instance, science and technology can reduce environmental pressure through greater efficiency, allowing for reductions in the use of resources and the production of wastes to meet the same level of demand. At the same time, these decreases in pressure per unit of demand can lead to increases in overall environmental pressures if they result in increased demand. The speed of technological change can result in redundancy or replacement of technology and lead to increased waste, such as with computers and televisions.

Science and technological advances have, however, significantly improved our ability to monitor and understand the environment, helping to promote better environmental outcomes. Taxonomy, mapping, ecological studies, monitoring programs and modelling can all add to our understanding of how natural systems work and lead to more informed management decisions.

### Using telemetry to conserve water and time and reduce greenhouse gas emissions

To address concerns about his greenhouse gas emissions, a Mitchell local in South West Queensland, Kent Morris, worked with the Queensland Murray–Darling Committee to implement an observant telemetry system on his property. This system enabled him to monitor his watering points remotely, cutting down on the need for site visits. The system communicated rainfall, water pump flow rates and water storage levels from bore and three watering points to his base station in Mitchell; and used automatic pumps that kicked in when triggered by low water levels and stopped when triggered by high water storage levels. The Morris family also replaced their earth tank storage system with two 22 000 litre (L) tanks, reducing evaporative and seepage water losses.

Collectively, the installation of the observant telemetry system and the new water storage tanks enabled the Morris family business to:

- reduce travel by more than 15 000 km per year, thus reducing vehicle fuel use by 2000 L per year, leading to a lowering of emissions of 5.4t CO<sub>2</sub> equivalent per year
- reduce unnecessary fuel consumption for pumping wasted water of 200 L per year or more, or an additional saving on emissions of 0.5t CO<sub>2</sub> equivalent per year
- provide overall water efficiency gains of 50 per cent of annually pumped water.



Photograph, © Queensland Murray Darling Commission.

Photo 1. Demonstrating the observant telemetry system.

## 2.3 Implications for the environment

It is of little doubt that humans are having a massive effect on the natural world (CEC, 2010; EEA, 2010; UNEP, 2011b). The rate and extent of environmental change as a consequence of human activity is now considered by many as unsustainable and a potential threat to the health and wellbeing of future generations.

The most notable global environmental pressures that have been internationally recognised and are being addressed on a large scale include biodiversity loss, modifications to terrestrial and aquatic ecosystems, the spread of invasive species and climate change. The depletion of the stratospheric ozone layer and the generation of pollution through emissions and waste also fit within these notable pressures (UNEP, 2011b). The following section will explore the pressures on the state's environment, stemming from human and natural causes and/or a combination of both.

## A changing climate

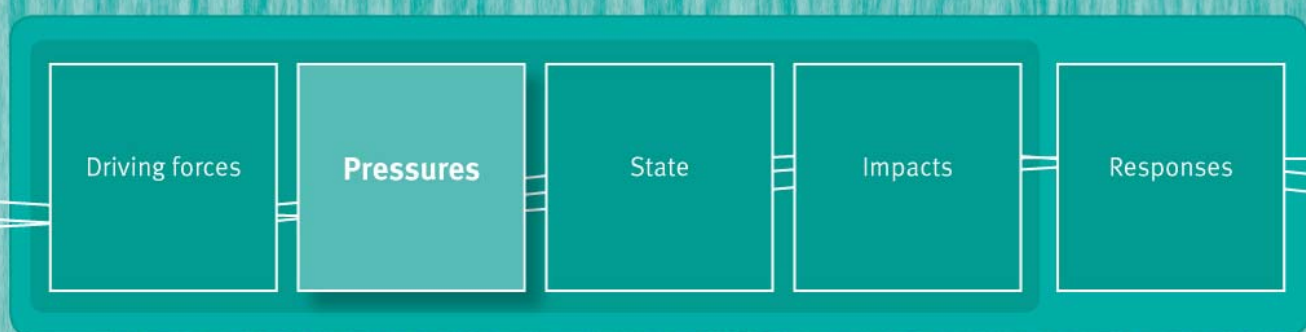
Future impacts of climate change on Australia are likely to include:

- projected increases in average surface temperature of 0.6–1.5 °C by 2030 and 2.2–5.0 °C by 2070
- decreased average annual rainfall over much of Australia
- more intense rainfall on days with heavy rainfall over many areas
- an increase in the proportion of severe tropical cyclones, with a possible decrease in the total number of cyclones
- more frequent heatwaves
- more frequent droughts
- ocean acidification
- sea level rise.

These findings (Australian Academy of Science, 2010) indicate stronger than expected and sooner than expected climate changes. The potentially profound consequences of a changing climate have meant that it has become a key driver in its own right in terms of the Queensland state of the environment (DERM, 2010a).



### 3 Pressures



Pressures are the stresses that human activities place on the environment. They can range in intensity depending on a number of factors, such as spatial and temporal scale, toxicity, sensitivity of the receiving environment, past exposure and frequency.

The spatial scale of the effect can range from very small (local) to large (global). In some instances the effect may be cumulative, such as the concentration of chemicals in food webs. Some pressures are highly toxic in nature, while others can cause sub-lethal chronic effects. Pressures may originate from a point source, such as a sewage plant discharge, or from multiple diffuse sources, such as agricultural or urban run-off. The effects of the pressure may occur on-site or off-site.

The capacity of an ecosystem, community or species to deal with a given pressure and/or set of pressures depends on their natural susceptibility to the pressure, as well as recent or historical events that may have made them more vulnerable to harm. Pressures may be exacerbated by natural events, such as floods, droughts, cyclones and dust storms. These events can reduce the resilience of ecosystems, communities and species, impairing their capacity for recovery.

All systems have some capacity to absorb change. However, there may be tipping points beyond which the state of the system becomes radically altered, sometimes irreversibly. Monitoring programs that track changes in the environment are crucial to successfully identifying and addressing pressures. There is a wide range of monitoring programs in place to assess air and water quality, track coastal physical processes, and follow the health of ecosystems, communities and species.

Building Nature's Resilience – A Biodiversity Strategy for Queensland (DERM, 2011b) identifies the following as key threats to Queensland's native biodiversity:

- habitat loss, degradation and fragmentation
- invasive species
- unsustainable use of resources
- changes to aquatic environments, water flows, freshwater systems and wetlands
- altered fire regimes
- climate change.

Other major threats to the environment include air, water and land pollution. For example, sediment, nutrient and pesticide run-off into Moreton Bay and the Great Barrier Reef lagoon feature in this reporting cycle. Natural disasters have also impacted upon the state of the environment. While these occurrences may be an intrinsic part of the natural environment with many positive outcomes, they can also cause detrimental impacts when considered in the context of the multitude of other pressures caused by human activity.

Human activities resulting in the above pressures can include:

- urban, infrastructure and industry development
- agriculture
- pastoralism
- mining
- forestry.

Some of the major types of pressures relevant to Queensland are explained in detail below. These pressures are not listed in any priority order; however the section begins with climate change because of its potentially pervasive influence on ecosystems and society.

The pressures are presented separately, yet many overlap or reinforce one another. For example, vegetation loss is a key driver of many ecosystem changes and is often influenced by the growing demand for food and fibre production, which itself has impacts. The nature of these pressures have not changed significantly since the advent of state of the environment reporting in Queensland, although the severity of each may have changed markedly. For example, the balance between vegetation clearing and energy resource extraction as key pressures has reversed in just a few years. Also, recognition of the importance of some pressures may have changed due to improved scientific information or community awareness.



It is not possible in a few pages to describe all pressures applying to Queensland's environment. This report concentrates on a few high profile issues, while recognising that there are many other pressures on Queensland's environment.

## Wetlands

Queensland's wetlands are under pressure. Some pressures result in wetland loss, a key wetland indicator, while others impact the condition of the wetland ecosystems and the services they provide. Pressures include those in the surrounding catchment area, as well as those directly affecting the wetland itself.

Indirect pressures include catchment disturbance, impacts on the fringing zone of the wetland, hydrological disturbances and the loss of connectivity of the wetland to the overall landscape. Catchment disturbance includes land use changes, wetland draining or filling, vegetation clearing, the introduction of sediments and pollutants to the wetland and an increase in weed and pest animal species. Hydrological disturbances, generally associated with catchment disturbance, include the diversion of water from wetlands, increased flows of water to wetlands through altered stormwater flows, changes to the hydrological water regime of the wetland through water extraction (both surface and groundwater) and impoundments. Modification of the fringing zone can affect the area required to support key wetland process and services.

Direct pressures on wetlands include those associated with impacts on wetland soils and water quality, wetland biota and the physical form of the wetland. Grazing can result in the disturbance of the soil, leading to increased sediment suspension, nutrient input from faeces and disturbance to wetland plants. Direct input of contaminants (nutrients, sediments, metals, pesticides and herbicides, pathogens, litter, excess heat) to wetlands can occur through stormwater, groundwater contamination (e.g. septic systems), sewage outfalls, agricultural run-off and seepage from landfills. Mechanical disturbance of acid sulphate soils can lead to a low pH and metal mobilisation. Feral pigs, cane toads, carp, tilapia and other pest species can have a significant effect on wetland condition by disturbing soils, contaminating water, out-competing and feeding on wetland biota. Likewise aquatic and terrestrial weeds such as water hyacinth, hymenacne, chinese apple and others impact wetlands condition. Unsustainable harvesting or removal of wetland plants and animals is a pressure on wetlands as are inappropriate fire regimes, which can damage sensitive wetland soil and plants.

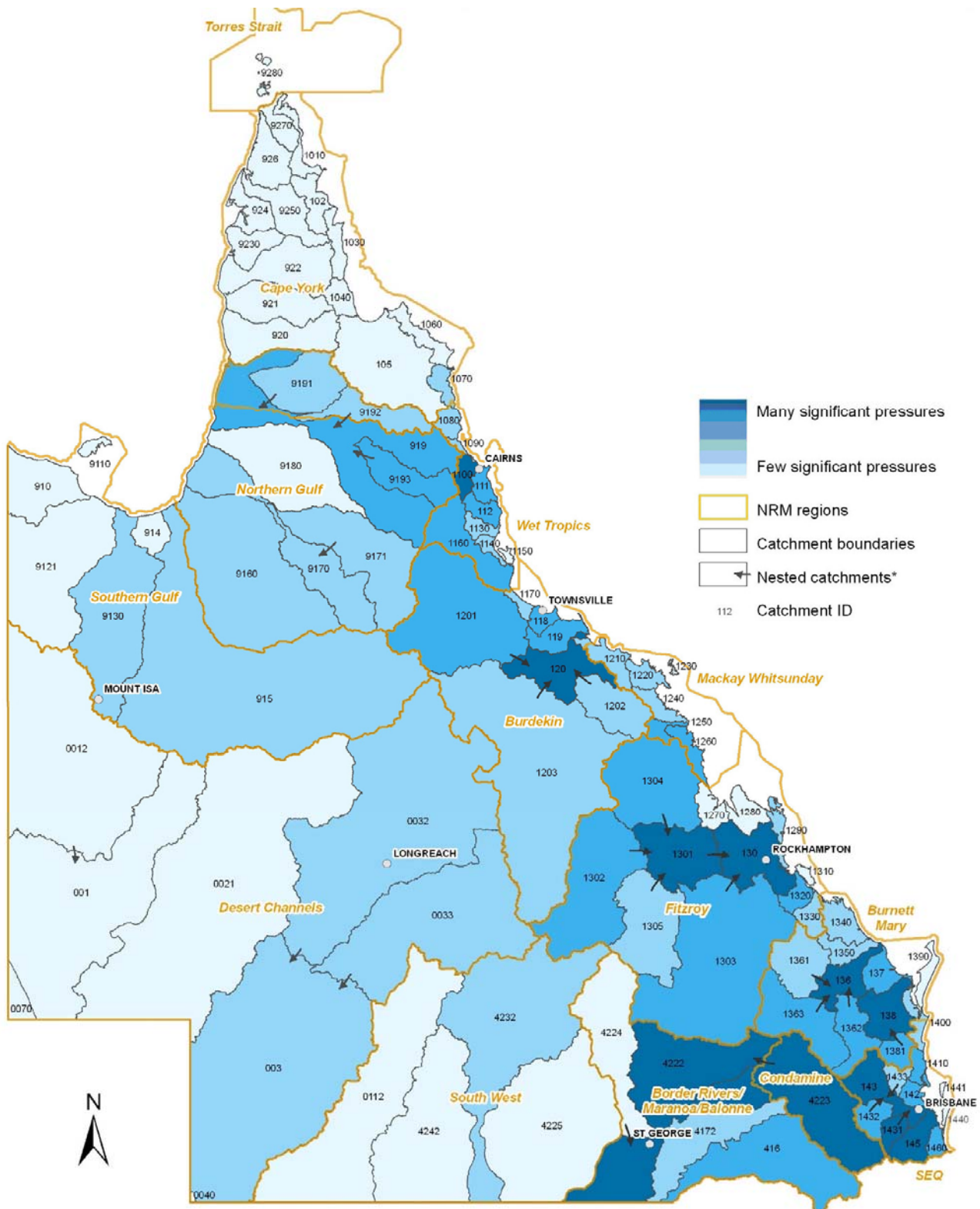
Climate change will compound the pressures above. Rising sea levels will effect the landward movement of estuarine wetlands, thus putting pressure on existing freshwater wetlands which have little opportunity to migrate landward. Extreme weather events associated with climate change, including higher temperatures, more intense rainfall and droughts will result in increased pressure on wetland ecosystems.

## Risks used to inform waterway monitoring priorities

The *Assessment for prioritising integrated waterway monitoring in Queensland* report produced by the Queensland Government identifies areas of the state faced with the greatest pressures from human activities (DERM, 2011c). The report provides the most comprehensive overview of pressures in Queensland that is currently available and could be applied to most terrestrial and aquatic ecosystems.

For each ecosystem type, two assessments were carried out, separating the ongoing risks and one-off incident-based risks. Ongoing risks are those that occur continuously or regularly (such a loss of riparian vegetation from residential development; run-off from grazing areas). One-off incident-based risks occur through accidents (such as a failure of a water treatment plant, overflow from containment structures at a mine site), or unanticipated climatic events. Areas of the state where aquatic ecosystems are under greatest ongoing pressure from human activities are the Barron River catchment, Burdekin River catchment, Mackenzie and Fitzroy River catchments, Burnett and Mary River catchment, Balonne and Condamine River catchments and the Lockyer, Logan, Albert and Brisbane River catchments (Figure 7a). Areas of the state where aquatic ecosystems may be at most risk from incident-based point source pressures are the Barron River catchment, Fitzroy River catchment, Burnett and Mary River catchment, Balonne and Condamine River catchments and the Lockyer, Logan, Albert and Brisbane River catchments (Figure 7b).

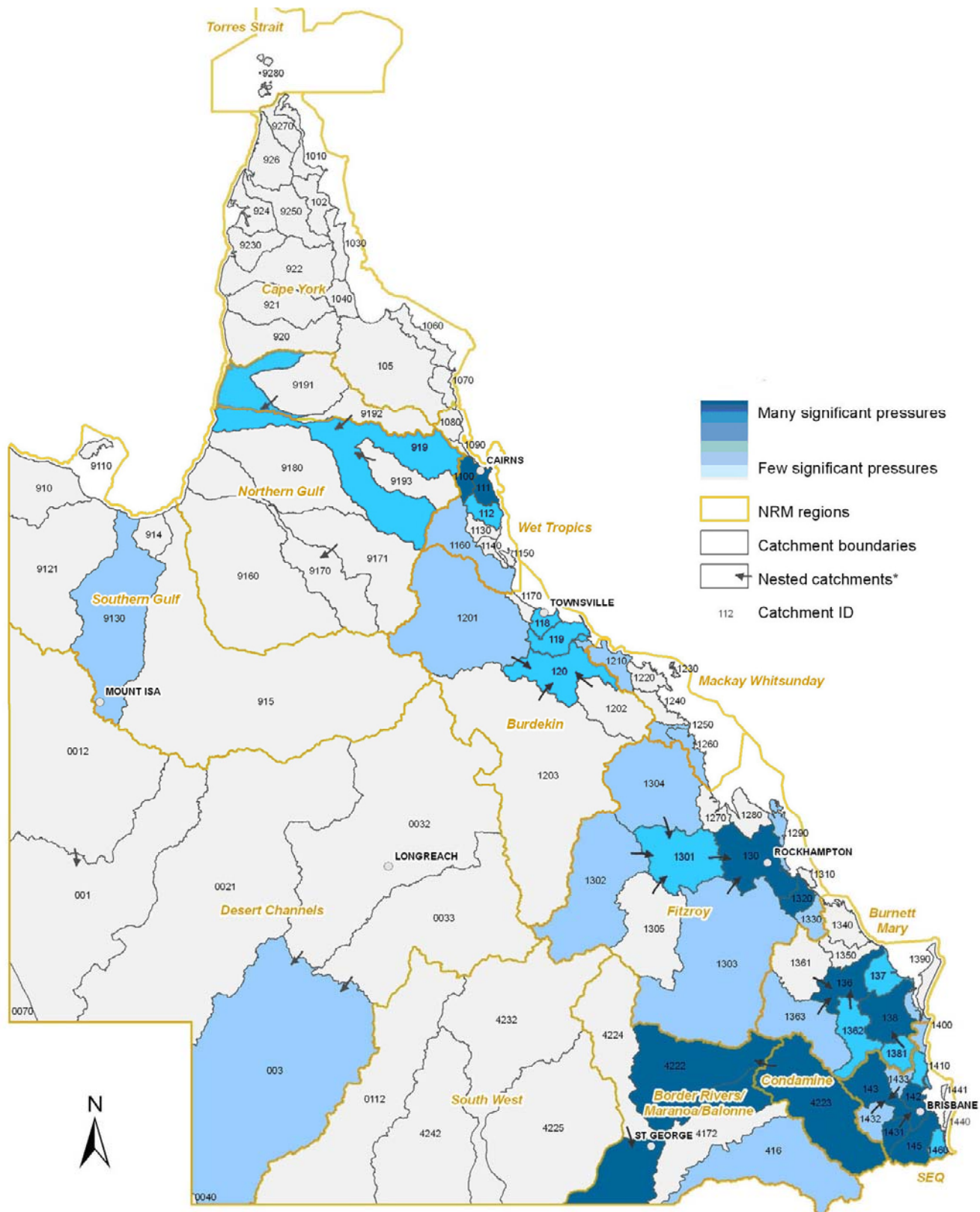
a



Source: DERM, 2011c (Assessment of prioritising integrated waterway monitoring in Queensland). Note: Catchment ID key is provided below Figure b.

**Figure 7. (a) Areas of the state where aquatic ecosystems are under greatest ongoing pressure from human activities and (b) areas of the state where aquatic ecosystems are may be most susceptible from incident-based point source pressures.**

b



Source: DERM, 2011c (Assessment of prioritising integrated waterway monitoring in Queensland). Note: Catchment ID key is provided below Figure b.

**Figure 7. (a) Areas of the state where aquatic ecosystems are under greatest ongoing pressure from human activities and (b) areas of the state where aquatic ecosystems are may be most susceptible from incident-based point source pressures.**



Catchment ID					
001	Eyre Creek	1160	Herbert River	1340	Baffle Creek
0012	Georgina River	1170	Black River	1350	Kolan River
0021	Diamantina River	118	Ross River	136	Burnett River
003	Cooper Creek	119	Haughton River	1361	Upper Burnett River
0032	Thomson River	120	Burdekin River	1362	Barker & Barambah Creeks
0033	Barcoo River	1201	Upper Burdekin River	1363	Boyne & Auburn Rivers
0040	Lake Frome	1202	Bowen River	137	Burrum River
0070	Hay River	1203	Suttor River	138	Mary River
0112	Bulloo River	1210	Don River	1381	Upper Mary River
1010	Jacky Jacky Creek	1220	Proserpine River	1390	Fraser Island
102	Olive & Pascoe Rivers	1230	Whitsunday Island	1400	Noosa River
1030	Lockhart River	1240	O'Connell River	1410	Maroochy River
1040	Stewart River	1250	Pioneer River	142	Pine River
105	Normanby River	1260	Plane Creek	143	Brisbane River
1060	Jeannie River	1270	Styx River	1431	Bremer River
1070	Endeavour River	1280	Shoalwater	1432	Lockyer Creek
1080	Daintree River	1290	Waterpark Creek	1433	Stanley River
1090	Mossman River	130	Fitzroy River	1440	Stradbroke Islands
1100	Barron River	1301	Mackenzie River	1441	Moreton Island
111	Mulgrave River	1302	Nogoa River	145	Logan & Albert Rivers
112	Johnstone River	1303	Dawson River	1460	Coomera & Nerang Rivers
1130	Tully River	1304	Isaac River	416	Border River
1140	Murray River	1305	Comet River	4172	Moonie River
1150	Hinchinbrook Island	1310	Curtis Island	4222	Balonne & Condamine Rivers
		1320	Calliope River	4223	Condamine River
		1330	Boyne River	4224	Maranoa River
				4225	Wallam Creeks
				4232	Warrego River
				4242	Paroo River
				910	Cliffdale Creek
				9110	Mornington Island
				9121	Nicholson River
				9130	Leichhardt River
				914	Morning Inlet
				915	Flinders River
				9160	Norman River
				9170	Gilbert River
				9171	Einiasleigh River
				9180	Staaten River
				919	Mitchell River
				9191	Alice River
				9192	Palmer River
				9193	Walsh River
				920	Coleman River
				921	Holroyd River
				922	Archer River
				9230	Watson River
				924	Embley River
				9250	Wenlock River
				926	Ducie River
				9270	Jardine River
				9280	Torres Strait Islands

### 3.1 Climate change

Changes to our climate have a direct effect not only on the environment but also on social and economic aspects of life. Global increases in temperature, ocean heat content and rising sea levels all indicate the world is warming.

It is now considered very likely that human activity has played a role in contributing to changes to the global climate by altering the composition of the atmosphere, in particular, through the rise in concentrations of greenhouse gases (CSIRO, 2011).

The 2002–2011 10-year period (matched by the period 2001–2010) was the warmest decade on record, with global temperatures 0.46°C above the 1961–1990 mean (WMO, 2012). Global sea levels are rising at around 3 mm a year (Church and White, 2011).

Temperatures in Queensland over the decade 2001–2010 averaged 0.52°C above the 1961–1990 mean (BoM, 2011a). Averaged across storm tide monitoring sites situated along the Queensland coast there is a trend in sea-level rise of approximately 1.8 mm per year over the period 1975–2010. While cooler than 2010, sea surface temperatures in the Australian region in 2011 were 0.39 °C above the 1961 to 1990 average (BoM, 2012). The past 10 years (2002–2011) has seen the warmest 10-year averaged sea surface temperatures in the Australian region since 1910 (BoM, 2012).

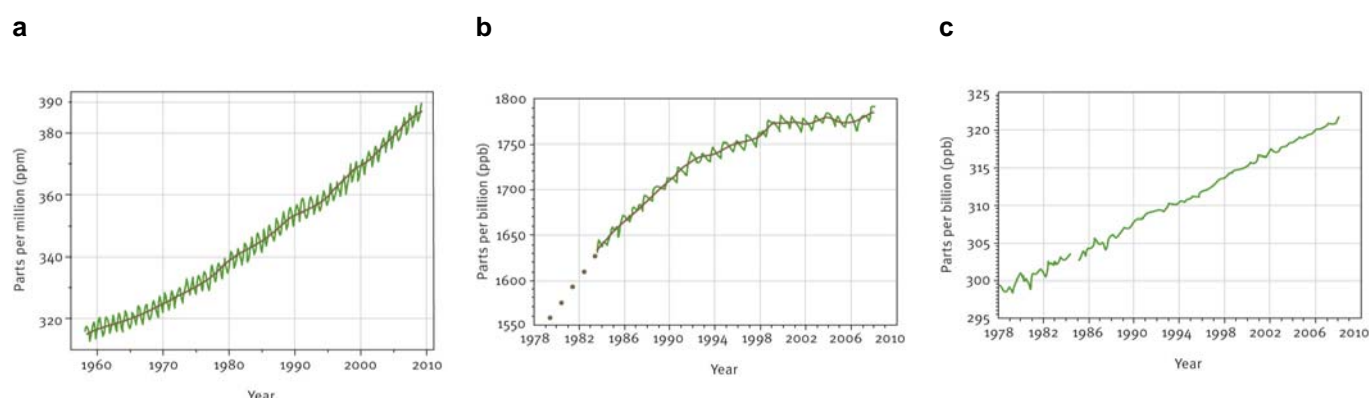
The impact of human activities on the climate is an area of ongoing research.

#### 3.1.1 Changes in atmospheric composition

Changes to atmospheric composition from human activities, such as from the combustion of fuel and the clearing of land, as well as from some natural events (e.g. carbon from fires) can change the earth's radiative (energy) balance. Radiative forcing from CO<sub>2</sub> is the largest single contributor to human-induced climate change (CSIRO, 2011).

Global CO<sub>2</sub> concentrations are calculated from a network of global observation sites coordinated by the World Meteorological Organization (WMO). These observations indicate that in 2010, the concentration of CO<sub>2</sub> in the atmosphere had increased to around 390 parts per million (ppm), from about 280 ppm in 1750 at the start of the industrial revolution (WMO, 2011). Le Quéré et al. (2009) found that CO<sub>2</sub> emissions grew 3.4 per cent per year between 2000 and 2008, more than triple the growth experienced during the 1990s.

Figure 8 shows the concentration of CO<sub>2</sub> and nitrous oxide (N<sub>2</sub>O) have increased significantly over recent decades. Methane (CH<sub>4</sub>) concentrations plateaued to near zero growth from 1999 to 2006; however since 2007 atmospheric CH<sub>4</sub> has been increasing again. The reasons for the renewed growth are not fully understood (WMO, 2011).



Source: Richardson et al., 2009; Tans, 2011; Hoffman, 2009; Dlugokencky et al., 2005.

**Figure 8. Concentration of three greenhouse gases, (a) carbon dioxide, (b) methane and (c) nitrous oxide in the atmosphere.**

### 3.1.2 Changes in sea levels

Sea-level rise and an increase in the frequency and intensity of tropical storms, coupled with storm surges that inundate property, have been predicted as a consequence of climate change (BoM, 2011b).

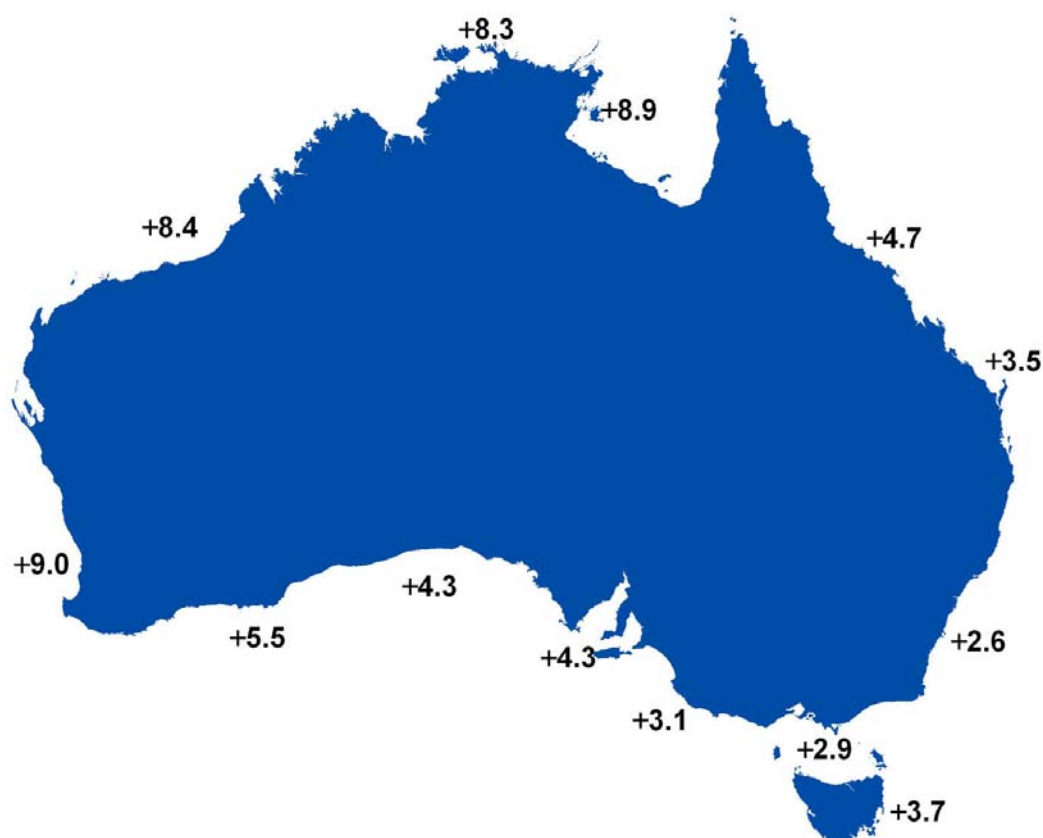
Wave and storm-tide monitoring programs administered by the Queensland Government's Coastal Impacts Unit have been recording high sea-level events and wave heights in the state for around 40 years. The data from the storm-tide network appears to support the findings of almost all other researchers around the world—that sea levels are indeed rising.

The Australian Baseline Sea Level Monitoring Project is run by the Bureau of Meteorology's National Tidal Centre. This project maintains an array of monitoring stations around the Australian Coast, which measure sea level accurately and have been operating since the early 1990s. Figure 9 shows the trend in sea-level rise for the Australian Baseline Sea Level Monitoring Project stations—the variation in the rates of change in sea level is considerable.

Figure 10 shows the results of the average monthly mean sea levels recorded at Queensland storm-tide gauges from the 1960s to the present, superimposed on global mean sea-level reconstructions and global sea-level projections.

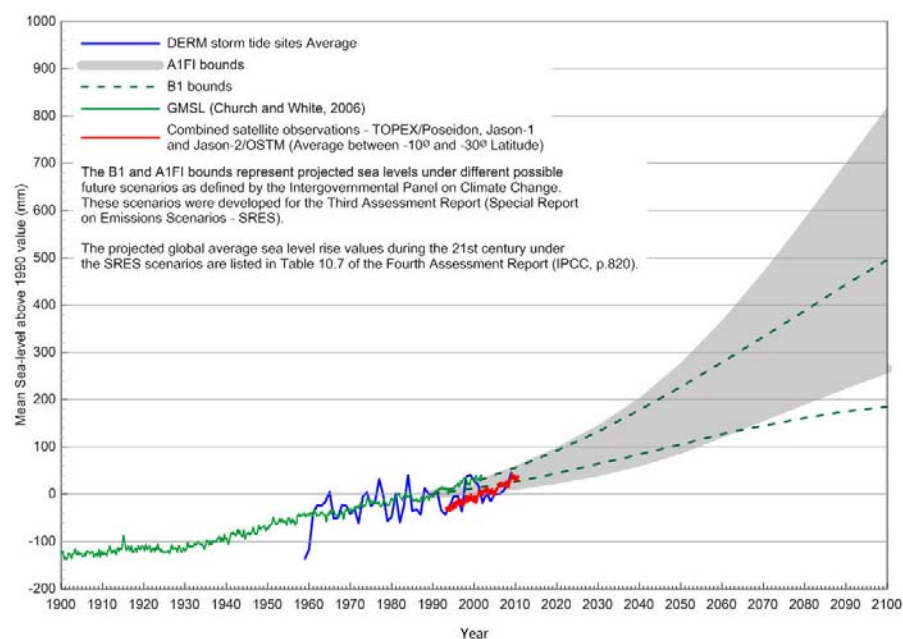
Averaged across all Queensland sites there was a trend in sea-level rise of approximately 1.8 mm per year over the period 1975–2010, with northern Queensland and the Gulf of Carpentaria experiencing the highest rates of annual rise. However, Figure 9 shows that there was also significant annual variation for the Queensland coastline.

Projections indicate that global sea levels could be as much as 0.15 metres (m) above 1990 levels in 20 years, and 0.2 m above 1990 levels in 30 years—both relatively short time periods (Hunter, 2010).



Source: BoM, 2011b.

**Figure 9. Local sea-level rise (mm/year) around Australia from the early 1990s to June 2011.**



Source: Church and White 2006; Hunter 2010.

**Figure 10. Average sea-level trends in Queensland.**

### 3.1.3 Productive lands and climate change

The continuing change in the state of the global climate patterns—for example, from the increasing levels of greenhouse gases and their projected regional impacts—present new major drivers of change in the management and use of Queensland's productive lands.

‘Production from primary industries is projected to decline by 2030 over much of eastern Australia due to increased drought, reduced water resources and higher temperatures.’  
(DERM, 2010a)

The vulnerability to climate change of the productive lands of 13 regions of Queensland has been identified (DERM, 2010a).

The effects of declining rainfall and run-off into streams are already being felt by primary producers and the effects of temperature changes are likely to be felt within the next decade. Key impacts on the primary industries sector are likely to include:

- warmer and drier weather in future decades over much of Queensland
- more frequent droughts
- increased frequency of severe weather events, including flooding that could also reduce primary and agricultural production through reduction in crop yields and through stock losses
- changes in average rainfall and temperatures, in seasonal distribution of rainfall and in rainfall variability, which directly affect crop production (DERM, 2010a).

## 3.2 Vegetation management

In Queensland, there has been a marked reduction in clearing. Two significant mapping programs within the Queensland Government track changes in vegetation cover across Queensland.

The Statewide Landcover and Trees Study (SLATS) gathers accurate woody vegetation cover and woody land cover change information for vegetation management, planning and compliance, and for Queensland Government greenhouse gas inventory purposes.

Complementing the SLATS program, the Queensland Herbarium has completed regional ecosystem surveying and mapping for more than 85 per cent of the state's vegetation at a scale of 1:100 000. This mapping includes both remnant and non-remnant vegetation for both woody and non-woody regional ecosystems. The surveying and mapping of vegetation communities and regional ecosystems in Queensland provides information for regional natural resource management groups, non-government organisations, local, state and federal governments and private industry for planning and management purposes.

Queensland has approximately 140 million ha of remnant vegetation (81 per cent of the total area), of which some 70 million ha is woody remnant vegetation protected from broadscale clearing by vegetation management legislation. Woody vegetation is mapped as remnant where the dominant canopy has greater than 70 per cent of the height and greater than 50 per cent of the cover relative to the undisturbed height and cover of that stratum and is dominated by species characteristic of the vegetation type if it was undisturbed.

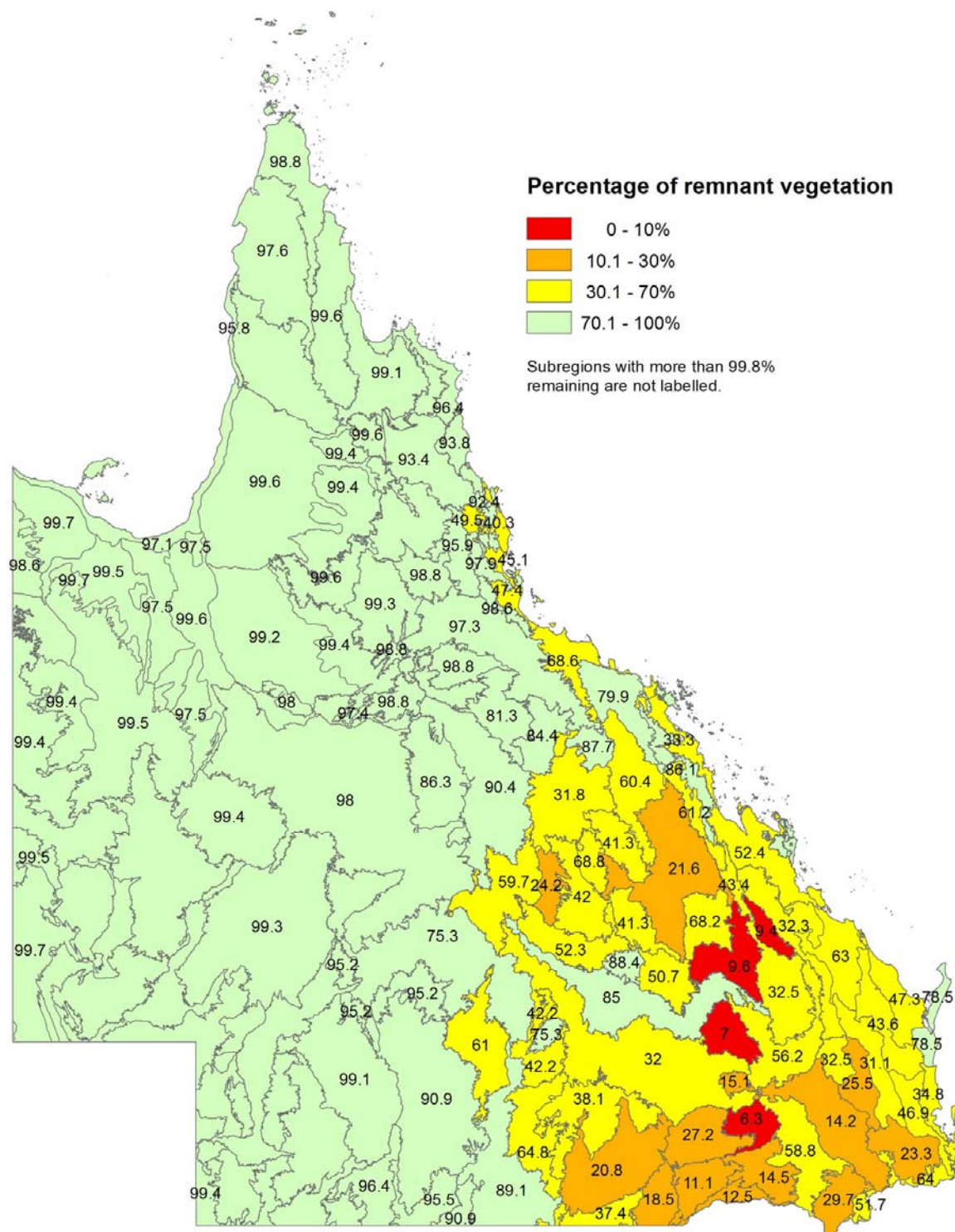
An undisturbed stratum (or layer) is defined as one that shows no evidence of extensive mechanical or chemical disturbance (logging, clearing, poisoning, etc) evident in field inspections or on the available historical aerial photographic record.

Non-woody vegetation is vegetation in which the ecologically dominant stratum is composed of grasses and/or other non-woody vegetation.

Regional ecosystems are vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil (Sattler and Williams, 1999).



Bioregion and subregional analysis of remnant vegetation in 2011 by the Queensland Herbarium showed that the New England Tableland bioregion had the lowest remaining vegetation by bioregion (33.8 per cent). The Brigalow Belt bioregion had the second lowest (41.7 per cent), with the Tara Downs and Taroom subregions having the lowest remaining subregional vegetation, at 6.3 per cent and 7.0 per cent respectively (Figure 11).



Source: Queensland Herbarium, 2012, in press.

**Figure 11. Remnant vegetation in Queensland in 2011 by subregions.**



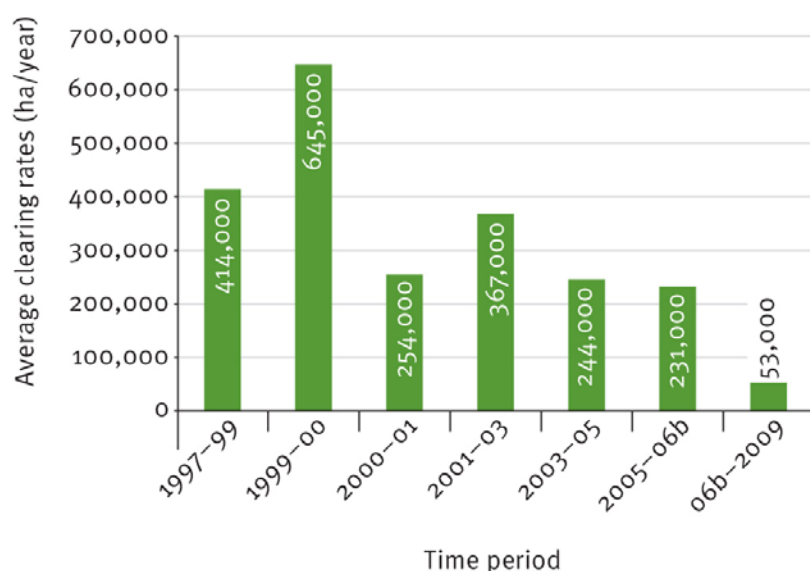
### 3.2.1 Clearing rates

The clearing rate of remnant vegetation and regional ecosystems in the 2006–2009 period was 53 000 ha per year (Figure 12). This compares with 645 000 ha in 1999–2000 before the introduction of the *Vegetation Management Act 1999*. Most remnant regional ecosystem clearing (47.8 per cent) occurred on leasehold tenure for legal purposes under the *Vegetation Management Act 1999* (VMA), with 46 per cent on freehold tenures, and 6.2 per cent on other tenures.

The majority of remnant vegetation cleared during the years 2006 to 2009 was legal fodder harvesting under a permit of *Acacia aneura* (mulga), and/or *Eucalyptus populnea* (poplar box) and/or *E. melanophloia* (silver-leafed ironbark) and/or *Corymbia clarksoniana* (Clarkson's bloodwood) on Cainozoic sand plains/remnant surfaces.

The clearing during 2006–2009 mainly occurred in the following broad vegetation groups:

- *Acacia aneura* dominated open-forests, woodlands and shrublands
- Eucalypt dry woodlands on inland depositional plains
- eastern eucalypt woodlands to open-forests
- other *Acacia* spp. dominated open-forests, woodlands and shrublands.



Source: Queensland Herbarium, 2012, in press. Note: time intervals portrayed in the graph relate to mapping updates under the *Vegetation Management Act 1999*.

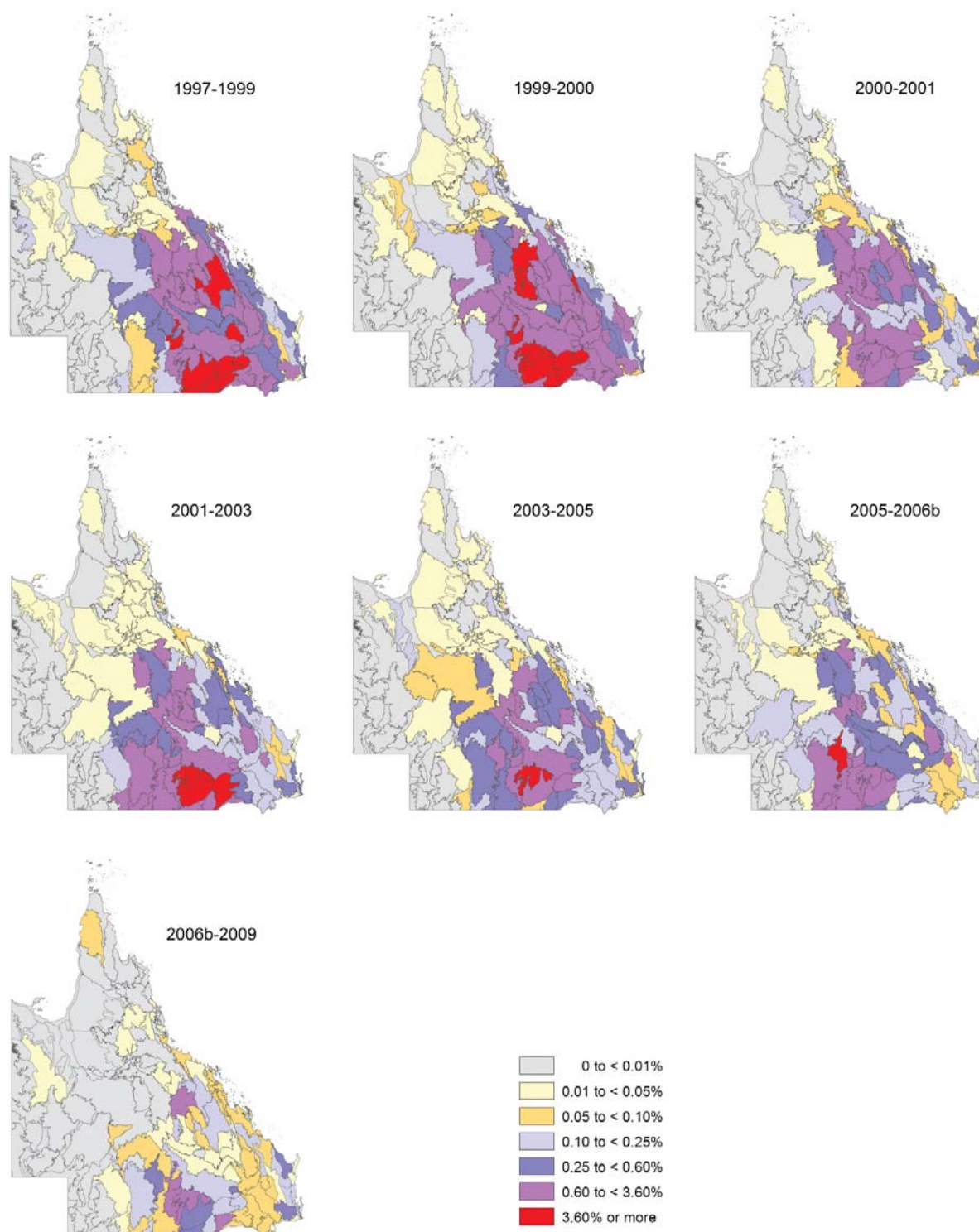
**Figure 12. Average annual clearing rates for remnant vegetation from 1997 to 2009.**

The clearing rate by subregion over time is shown in Figure 13 (Queensland Herbarium, 2012, in press).

The majority of the remnant vegetation clearing in the recent period between 2006 and 2009 occurred in the Mulga Lands bioregion (45.3 per cent of clearing in Queensland) and largely within the Eastern Mulga Plains, Nebine Plains, Langlo Plains, West Warrego, North Eastern Plains, Warrego Plains and West Balonne Plains subregions. Clearing for other bioregions and subregions was as follows:

- Brigalow Belt bioregion—31.5 per cent and largely within the Belyando Downs, Southern Downs and Northern Bowen Basin subregions
- Southeast Queensland bioregion—6.6 per cent and largely within Burnett–Curtis Coastal Lowlands and Moreton Basin subregions
- Mitchell Grass Downs bioregion—5.0 per cent and largely within the Southern Wooded Downs subregion
- Cape York bioregion—4.1 per cent and largely within Weipa Plateau subregion
- Einasleigh Uplands bioregion—2.4 per cent and largely within Kidston subregion
- Northwest Highlands bioregion—1.5 per cent and largely within the Mount Isa Inlier subregion

- Desert Uplands bioregion—1.2 per cent and largely within the Jericho subregion
- Central Queensland Coast bioregion—1.0 per cent and largely within the Clarke–Connors Ranges and Proserpine–Sarina Lowlands subregions
- Gulf Plains, Wet Tropics, New England Tableland and Channel Country bioregions each contributed less than 1.0 per cent.



Source: Queensland Herbarium, 2012, in press.

**Figure 13. Average annual clearing rate of remnant vegetation as a percentage of the starting year by subregion.**

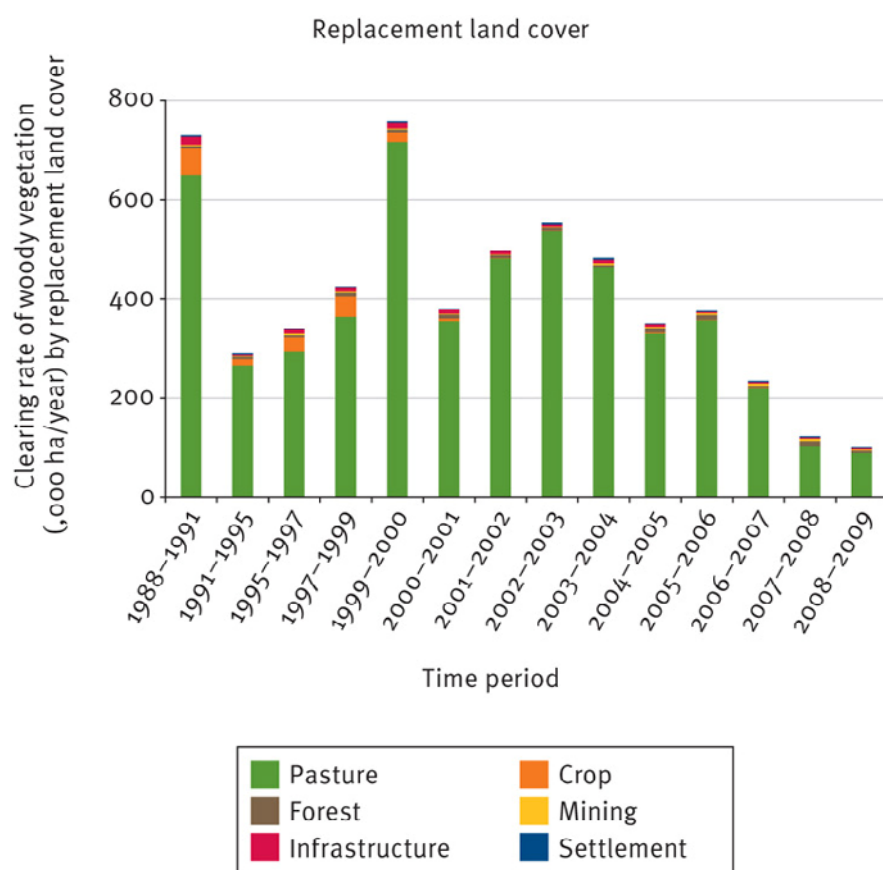
### 3.2.2 Woody vegetation clearing

The vegetation management framework, including the *Vegetation Management Act 1999* and *Sustainable Planning Act 2009*, regulates clearing of native woody vegetation in Queensland. The 2008–09 SLATS report outlines the recent clearing of woody vegetation in Queensland. Woody vegetation includes remnant and non-remnant (regrowth) woody vegetation.

Clearing of all woody vegetation has been assessed through SLATS annually since 1999 and on a two to four yearly basis for 1988 to 1998. All woody vegetation clearing in the latest SLATS report for the 2008–09 period totalled 99 940 ha per year. In comparison, clearing of all woody vegetation totalled 757 790 ha per year in 1999–2000 and 479 350 ha per year in the 2003–04 reporting period. The 2008–09 rate represents an 87 per cent decrease from the 1999–2000 rate and a 79 per cent decrease from the 2003–04 rate. The 2008–09 rate is the lowest annual clearing rate since the *Vegetation Management Act 1999* was introduced. This is also the lowest recorded rate of woody vegetation clearing since the period 1988–1991 when SLATS figures were first recorded.

### 3.2.3 Replacement land cover

The majority of woody vegetation clearing was for conversion to pasture for grazing purposes (more than 90 per cent). Woody vegetation includes remnant and non-remnant (regrowth) woody vegetation. Since 2004, forestry was the second largest replacement land cover by area and this trend continued during 2008–09 (Figure 14).



Source: DERM, 2011d, Land cover change in Queensland 2008–2009, Table 7, page 32.

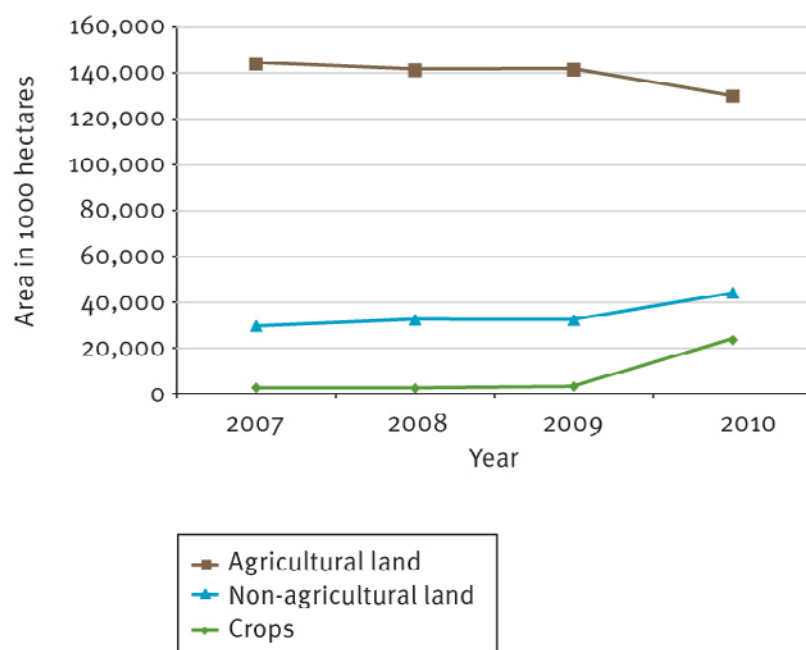
**Figure 14. Woody vegetation clearing by replacement land cover from 1988–2009.**

### 3.3 Food and fibre production

The production of food and fibre is an important contributor to the Queensland economy. However, it is associated with significant landscape change that can exert both direct and indirect environmental pressures. These include:

- the modification of the environment from clearing of native vegetation resulting in a change in species composition and reconfiguration of land form
- the use of resources, such as soil and water, beyond their rate of formation or recharge
- fire regimes unsuited for the land type
- stocking rates too high for the prevailing conditions
- management techniques that degrade soil structure, composition and fertility
- the misuse of external inputs, such as chemicals and nutrients
- the introduction and spread of invasive species.

According to the bi-annual Australian Bureau of Statistics Agricultural Survey (ABS, 2008; ABS, 2011b), the proportion of the total area of land used for agriculture in Queensland has declined by eight per cent from 2007 to 2010 to 129.7 million ha (Figure 15). This decline in agricultural use for food and fibre production from 82 per cent to 74 per cent is mirrored by an eight per cent increase in non-agricultural land use during the same period from 17 per cent to 25 per cent. These changes represent a 10 per cent decline in the area used for agriculture between 2007 and 2010 and a 49 per cent increase in the land area used for non-agricultural uses.



Source: ABS, 2008 and ABS, 2011b.

**Figure 15. Broad change in land use in Queensland from 2007–2010.**

#### 3.3.1 Grazing pressure

Queensland's rangelands are utilised differently by three broad groups of grazing animals that collectively place a 'total grazing pressure' on the primary productive capacity of the land. These groups include introduced domestic-managed grazing animals or 'livestock' (mainly cattle and sheep), native species (macropods—kangaroos, wallaroos and wallabies), and pest species of wild or feral populations of introduced animals (e.g. rabbits, goats, camels, pigs and deer). Populations of these animals can increase when food supply (grasses, forbs, herbs and shrubs, etc) is abundant from high growth seasons. These elevated populations can place increased pressure on the

land, particularly as pastures decline during drier periods. An excess of total grazing pressure over available resources can result in a decline in land condition, such as a reduction in desirable pasture species, an increase in undesirable pasture species and other impacts, including increased bare ground and elevated soil erosion risk. The grazing pressure from these groups of animals is not uniform across the groups or landscape due to a combination of factors, such as the sequence of climatic events, as well as distribution of both watering points and preferred pasture species.

It follows that total grazing pressure is strongly influenced by the location of waterpoints in the landscape and how stock densities are managed near waterpoints. Increased grazing near waterpoints can increase soil erosion and alter the structure and composition of the pasture, often replacing palatable perennial grasses and shrubs with short-lived annuals, weeds and less palatable and/or less productive species, for example Indian couch (*Bothriochloa pertusa*) or native perennial tussock wire grass (*Aristida* spp).

### 3.3.1.1 Livestock

A large proportion of Queensland is used for grazing by domestic livestock. The extensively grazed regions of Queensland include the rangelands, occupying approximately four-fifths of the state (Figure 16). Here the rainfall is too low or unreliable and the soils too poor to support regular cropping, yet some level of grazing can be sustained. The remaining eastern parts of Queensland where rainfall is higher and soils are generally more fertile have higher levels of production from grazing.

Pasture utilisation is a measure of the ratio between pasture consumption and pasture growth and is used to assess grazing pressure on the pasture resource. High levels of pasture utilisation results in the rapid decline of the proportion of soil covered by pasture species (McKeon et al., 2004). This is especially important under poor growing conditions. High levels of pasture utilisation also results in the loss or weakening of the valuable grass tussock bases and root zone from which the plant recovers during favourable conditions. A decline in the grass tussock base can result in the increased growth of unpalatable species in the form of perennials, weeds or forbs.

Estimates of animal grazing pressure suggest that during the 2001–06 drought, cattle numbers on pasture were maintained across the state at 10.4 to 11 million head. Sheep numbers declined from 8.7 million in 2000–01 to a low of 4.4 million head in 2002–03, but then rose to 4.9 million head in 2005–06 (ABS Various Issues, 2012). Regular reporting confirmed that across regions livestock were removed to some extent in response to regional rainfall deficit and lack of pasture growth (DEEDI, 2005–2011).

Although good seasons are welcomed by land managers as opportunities to rebuild herds on abundant pastures, pasture species need to replenish root stores and seed reserves. It should also be recognised that damage to the pasture base can occur unnoticed during high-growth periods if excessive grazing pressure is maintained, resulting in reduced carrying capacity during future drier periods (McKeon et al., 2004).

Estimated modelled average pasture utilisation for Queensland for 2010–11 suggests there was a significantly lower level of pasture utilisation compared to the historical estimated record, whereas the last four-year period (2007–2011) showed a progressively declining trend in pressure on the landscape (QCCCE, 2012. pers. comm.). This pattern indicates that the substantial increase in pasture growth since 2007–08 due to the easing of drought conditions has likely led to the current reduced level of grazing pressure on the pasture base. Assessment of grazing pressure from livestock, macropods and feral animals supports this finding.





Source: Bastin, G and the ACRIS Management Committee, 2008.

**Figure 16. Extent of Australian rangelands.**

### 3.3.1.2 Native species

As overgrazing can be particularly acute in areas of low or unpredictable rainfall, such as in Australia's rangelands, understanding the level of pressure exerted by different groups, including native animals is essential. These native animals can include macropods and the more extreme population fluctuations of locusts (spur-throated, Australian plague and migratory).

Comparative measurements of the food and water requirements of Australia's largest marsupial, the red kangaroo, with that of domestic sheep challenges long held assumptions that macropods compete strongly with domestic stock for resources (Munn et al., 2008). Munn et al. (2008) tested the assumption that the grazing pressure of a red kangaroo is equivalent to 0.7 sheep and showed this to be a potential two-fold overestimation of their contribution to total grazing pressure. Further research in this area will help clarify and confirm how much lower the grazing pressure and water needs of macropods are in comparison to livestock.

In favourable years the spur-throated locust, Australian plague locust and migratory locust form dense swarms that feed on crops, pastures and trees. High density swarms can cause severe damage to vegetation and are also a general nuisance to human habitation and activity. Locusts affected the central west, south central and south west Queensland regions in 2010 due to favourable conditions for breeding, hatching and survival resulting from the 2009–10 wet season (APLC, 2012).

### 3.3.1.3 Introduced pest species

Among the many introduced and now feral pest species in Queensland, goats and rabbits are of particular concern. In 2010, the feral goat population Queensland's semi-arid rangelands was estimated at 491 000 (Pople and Froese, 2012). Most feral goats in Queensland occur in the Mulga Lands bioregion, where numbers have increased almost five-fold over the past 20 years (Pople and Froese, 2012). In New South Wales, feral goat numbers in the rangelands have been increasing at five to 10 per cent per year since the early 1990s and were estimated at approximately three million in 2011 (Ballard et al., 2011; Pople and Froese, 2012). Both feral and farmed goats compete with domestic and native grazing animals and contribute to environmental damage. However, goats and camels are used on some grazing properties to manage undesirable shrub and weed species, such as prickly acacia (*Acacia nilotica*) (NRME, 2004). Over the past 20 years, 0.6–1 million goats have been harvested each year to be exported as meat and hides. Across Australia's rangelands, this has represented 20–50 per cent of the estimated population size. With no apparent breeding season for goats in arid areas and with favourable conditions, breeding can occur twice in one year for females older than six months and above 15 kg in weight (DEEDI, 2010a). Goats are thus capable of almost doubling in population size in a year. In addition, wetter conditions and floods have generally restricted opportunities to carry out control measures, such as trapping and mustering (Swadling pers. comm.).

Rabbits are reported in many Queensland regions and numbers have been reduced over the past 15 years by the combined effect of rabbit haemorrhagic disease virus (RHDV, also known as rabbit calicivirus) and drought. The RHDV has had a varying impact on populations, but diminished effectiveness of the virus could result in numbers building up to pre-RHDV numbers (Berman et al., 2011). Densities may not be kept relatively low unless physical intervention, such as ripping warrens, has taken place (Berman et al., 2011). Destruction of warrens with heavy machinery with ripping tines, or sometimes explosives, can remove essential breeding areas. In arid areas, this can be an efficient and long-term control strategy if rabbit numbers have already been reduced by drought and concentrated into refuge areas near permanent water.

## 3.4 Soil loss and degradation

Soils are a vital part of the natural environment. They are complex and many different types occur in Queensland. The different properties of soils influence the types of flora and fauna that exist on them and the ways in which we may use them. Our soils are directly linked to the health of our land and water ecosystems and, after the oceans, our soils are the largest store of carbon.

Loss of ground cover in pastoral, mining and cropping areas may make the land resource more susceptible to wind and water erosion. Soil erosion by wind and water can be a natural process that results in the movement or loss of topsoil, organic matter and nutrients through a catchment. However, it can also be associated with a decline in soil health when combined with the impacts of human activities and with severe climatic and weather events. Covering of soils in urban and industrial settings, for example for development purposes, results in a permanent loss of the function of soil in that landscape.

Destruction and contamination of soils can also result in the permanent loss of soil ecosystem function. Soil acidification from excessive use of nitrogenous fertilisers and build up of organic matter can affect overall soil fertility, toxicity and biodiversity and result in leakage of nutrients to aquifers and waterways. Increasing sodicity (the proportion of sodium in the soil) from irrigating or fertilising with high sodium content leads to a decline in soil structure, hard-setting of soils and increased risk of erosion.

Soil structure is the arrangement of the solid and porous parts of a soil that allow oxygen and moisture movement and access to nutrients and, depending upon how the soil was formed, it maximises soil biodiversity and productivity. While some soils are more resilient to disturbance, others are very vulnerable. Soil structure will decline under most forms of cultivation. Compaction of soil from tractor tyres in cropping areas or trampling from hooved animals (domestic or feral) can cause further physical damage to soils, changing its structure and reducing its productivity.

Increasing secondary soil salinity (the concentration of salt in the soil profile or at the surface) progressively limits which organisms can thrive within soils and alters the physical and chemical properties of the soil. Salts may also flow onto neighbouring properties and waterways.

### 3.4.1 Soil fertility decline

The decline in soil fertility in cropping areas increases costs and reduces land productivity. Soil fertility is assessed by examining the nutrient budgets of a farming system, which is the nutrient input in fertiliser less the nutrients removed in the crop. Soil fertility decline occurs when nutrient removal from an agricultural system exceeds nutrient inputs and, eventually, results in crop yield decline and soil biota loss.

From soil sampling of cropped and uncropped paired sites across the major grain growing areas of Queensland during 2008, soil fertility (in terms of carbon, nitrogen, phosphorus and potassium) was shown to decline at all the sites studied (Bell et al., 2010). On average, cropped soils across all regions contained 60 per cent less organic carbon, 48 per cent less total organic nitrogen, 36 per cent less particulate organic nitrogen, 68 per cent less inorganic phosphorus and 55 per cent less exchangeable potassium reserves than the uncropped reference sites. This confirms earlier studies that soil fertility is declining in most of the grain cropping lands in Queensland (Dalal and Chan, 2001).

### 3.4.2 Effects of wind erosion on soils

Wind erosion is a common cause of land degradation in the arid and semi-arid grazing lands of inland Queensland. It reduces soil fertility and soil water storage capacity, particularly in our driest regions where soil fertility is generally very low. This reduces the ability of these soils to sustain biodiversity and to support pastoralism and agriculture (McTainsh and O’Loingsigh, 2011).

Significant wind erosion occurs when strong winds blow over light-textured soils that have been cleared of vegetation, heavily grazed or cultivated during periods of drought. The timing, intensity and spatial distribution of wind erosion events are influenced by a range of environmental factors. The strongest driver is climate through its effect on vegetation cover that is, in turn, associated with agricultural management practices.

Some examples of the negative effects on the environment as a result of wind erosion are:

- soil fertility can be reduced as a consequence of the loss of nutrients that are concentrated on fine soil particles and in organic matter in the topsoil. This reduces the soils capacity to support productive pastures and sustain biodiversity
- ground cover can be lowered because of erosion at the base of bushes and plants that can result in the plant being isolated and ground cover being thinned out. Additionally, sand grains transported by strong winds can damage vegetation in their path by sandblasting, or covering vegetation, again resulting in thinning
- infrastructure function impairment can occur when the build up of soil particles against obstacles may bury fences and roads
- ecosystem health can be affected by the suspension of fine particles in the air and the deposition on vegetation, which can also cause respiratory health issues in vulnerable people.

## 3.5 Fire

Fire is a key factor shaping many Queensland ecosystems. Driven by climatic conditions and other natural processes, fire has also been an important hunting tool used by Aboriginal people. Changes to fire regimes (that is, season, frequency, intensity and extent), or exclusion of fire in an area, have the potential to impact upon life, assets and the state of the environment in a positive or negative manner. While there is potential for bushfires to occur, there is also opportunity for land managers to use a combination of burning and reduced grazing pressure to prevent woody weed encroachment and undesirable grass species.

Bushfire potential is driven, in part, by the fuel load of an area, including pasture biomass in Queensland’s extensive grazing lands. The Australian Grassland and Rangeland Assessment by Spatial Simulation (AussieGRASS) project at the Queensland Climate Change Centre of Excellence produces monthly fire maps to determine fire risk (Carter et al., 2000).

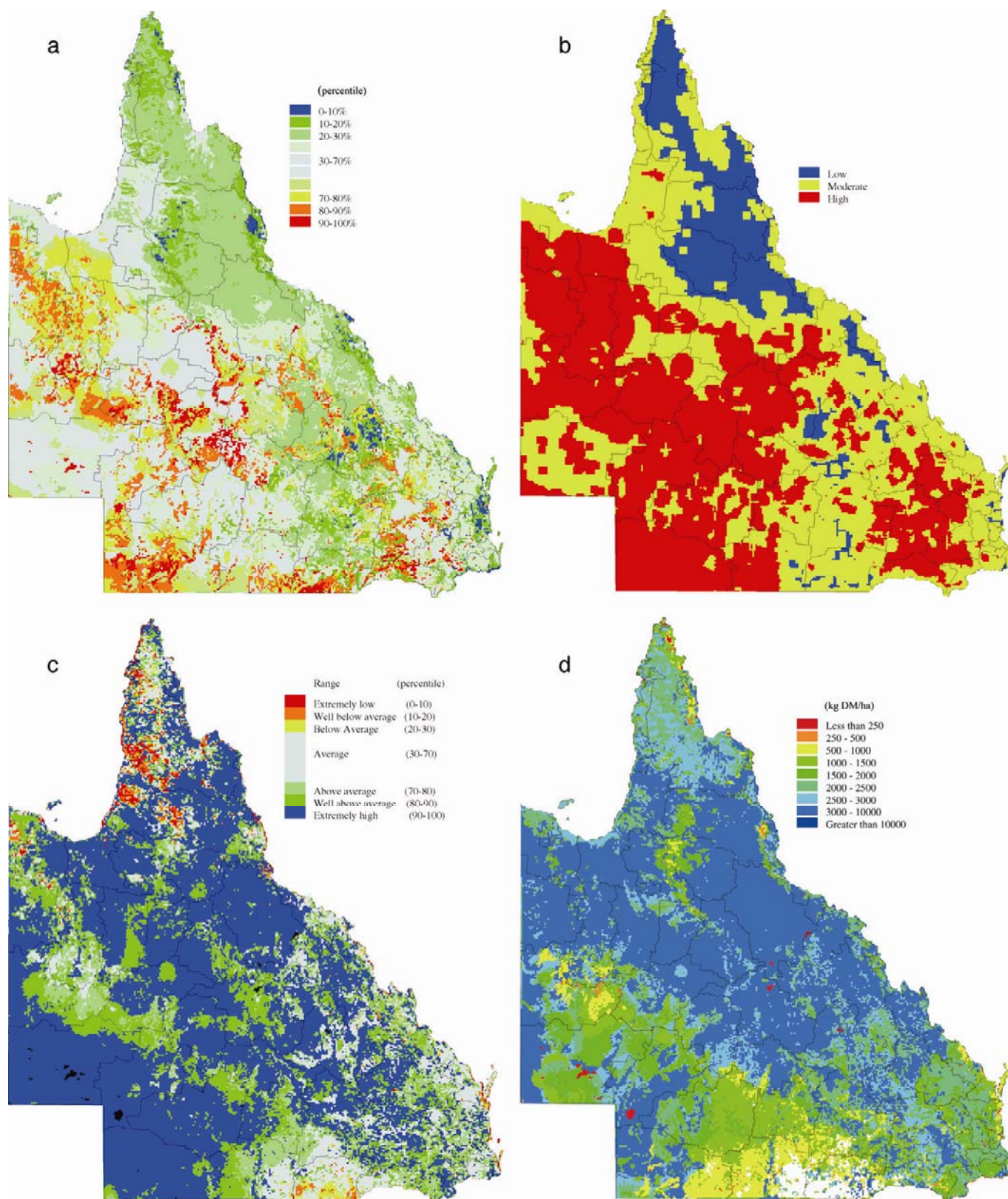
For example, in April 2011, the simulated potential grassfire risk was high in many areas of Queensland (Figure 17). The widespread high rainfall during the 2010–11 summer resulted in very high level of pasture biomass across much of Queensland (Figure 17c, d). The fuel loads from pasture biomass is an estimate of the Total Standing Dry Matter (kg DM/ha) which is calculated in the model by simulating the processes of plant growth, senescence,



detachment, animal consumption and decay. These maps include a curing index (Figure 17a) based on simulated percentage of actively growing pasture (0 per cent cured) to dead pasture (100 per cent cured). The curing index (Figure 17a) is combined with information on fuel biomass (Figure 17d) to create a Potential Grassfire Risk (Figure 17b).

In Figure 17c, areas on the eastern side of Cape York Peninsula have very low simulated pasture biomass (shaded red) relative to the historical record, in contrast with adjacent areas showing reasonable total pasture biomass. The areas of low simulated pasture biomass are due to the effects of fire in the previous recent months and will recede as pasture growth occurs, as shown in Figure 17d.

The risk of damaging bushfire is increased in areas where gamba grass has become established in Queensland. Gamba grass, a declared Class 2 pest plant that competes strongly with native pasture, occurs in scattered populations across North Queensland, with most sites on Cape York Peninsula (estimated total of 60 000 ha). Landscapes infested with gamba grass carry up to eight times higher fuel loads than native forest and pastures. This high biomass fuels intense and extensive bushfires that reach into the tree canopy, progressively transforming woodlands to grasslands. The severity of gamba grass fires also presents a serious threat to people and property (DEEDI, 2011b).



Source: QCCCE, 2011. Output generated on 11 April, 2011. Note: Some pasture communities in south-west Queensland have been shaded white (i.e. St George region), indicating that simulated pasture growth was regarded as uncertain, as it is very strongly affected by representation of nitrogen availability.

**Figure 17. Maps created from the AussieGRASS model for assessing fire risk for April 2011: (a) Pasture curing index (from 0 % actively growing pasture to 100 % fully dried/cured), (b) Potential grassfire risk (low–high—combining degree of curing and level of biomass), (c) total standing dry matter (percentiles) relative to historic record and (d) total standing dry matter biomass (kg dry matter/ha).**

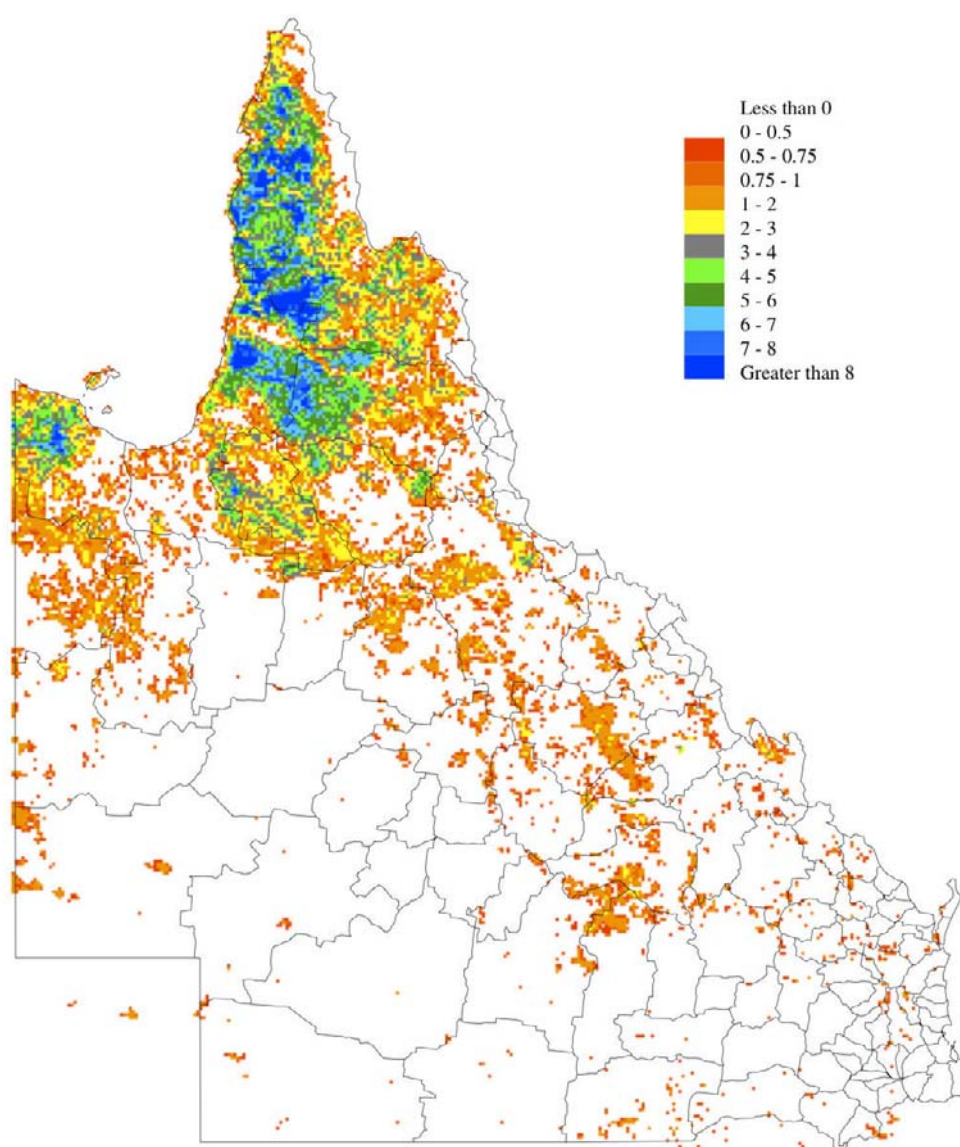
### 3.5.1 Fire occurrence

When it is appropriately applied, fire is a valuable land management tool. Fire can be used to:

- manage ecosystems to maintain biodiversity values
- manage grazing lands
- reduce the risk to public safety, private property and infrastructure.

The Queensland Fire and Rescue Service promotes hazard reduction activities that reduce fuel loads and lessen the threat to communities during bushfire incidents.

Along with the detailed records of fire management activities undertaken by a number of agencies, remote sensing is used to provide a long-term record of the incidence of fires. Fires in Queensland have been remote-sensed as ‘fire scars’ since 1994 (Craig et al., 2002). A composite fire frequency map described as ‘Incidence of fire occurrence’ from January 1994 to May 2011 is presented in Figure 18. The map suggests that areas with the highest fire incidence occur in Cape York Peninsula and the western region of the Gulf of Carpentaria.



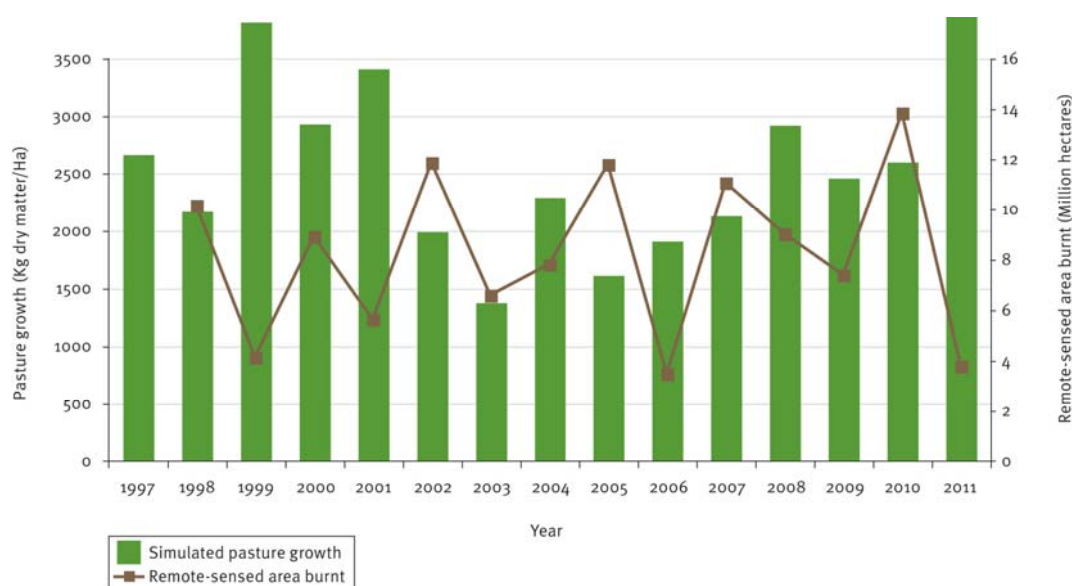
Source: Craig et. al., 2002. Note: Fire scars are not detected if they are: less than 1 km x 1 km, ‘cool fires’ under trees that don’t affect tree leaves; and where cloud is obscuring the vegetation. Additionally, ‘false’ fire scars are also possible where land becomes dark due to cloud shadows or flooding. Additional note: a 19-month data gap exists (1995 (Aug) – 1997 (Mar)).

**Figure 18. Incidence of fire occurrence in Queensland for the period 1994 (Jan) to 2011 (May).**



The remote-sensed area of Queensland burnt from year to year and the corresponding simulated pasture growth is presented in (Figure 19), showing alternating peaks and troughs. Generally, years with the high area of burning (e.g. 2009–2010) coincide with consecutive moderate-to-high fuel availability from pasture growth. Years with lower burnt areas detected (e.g. 2005–2006) could be due to lower levels of available fuel (e.g. 2010–2011).

There are a number of important additional factors that influence the variation in the incidence of fire across the state. These include natural factors such as climatic phases (i.e. El Niño or La Niña), which influence seasonal grass growth, the rate of curing and the number of lightning strikes on high risk pastures (high fuel load of well cured pasture biomass). Variation in management practices must also be considered. In northern areas, such as Cape York and the Gulf region, fire is more frequently used for improving the productivity of the pasture by removing rank growth of low nutritive value, undesirable pasture species and weeds, and to assist in stock mustering. In southern and western areas graziers will exclude or use fire much more selectively to help maintain pastures across El Niño or La Niña events.



Source: QCCCE, 2011. Pers. Comm. Note: Annual period: 1 April to 31 March.

**Figure 19. Annual remote-sensed area of Queensland burnt for the period 1998–2011.**

### 3.6 Urban development

Growing human settlements have impacts on the environment through land use conversion, the development of physical and social infrastructure, the consumption of water and energy and the generation of waste.

Well planned and densely populated urban development is considered to have less impact on the environment than suburban sprawl (UNEP, 2002; MA, 2005). Well planned urban development can concentrate any impacts into a smaller area, reduce the need for land conversion, provide opportunities for energy saving and make recycling more cost effective (MA, 2005). While state and local governments have been adopting planning policies that encourage greater urban consolidation, urban sprawl coupled with the concentration of business in the city centre of Brisbane and other major regional centres can create pressures (both directly and indirectly) on the environment. Indicators demonstrating some of these trends include:

- continued dominance of large detached houses as residential dwellings, with these often built on land outside of existing urban areas
- continued reliance on private motor vehicles and an increase in the distance people travel from home to work
- an increase in the total amount of energy consumed and a large increase in domestic waste production
- a reduction in the liveability in Brisbane in comparison to other cities around Australia and the world; however quality of life remains high.

### 3.7 Invasive species

Invasive species can pose a significant threat to the Queensland environment. Additionally, numerous invasive species have been associated with major economic and social impacts to humans. Globalisation has resulted in increasing levels of trade, transport, travel and tourism, such that the potential to spread non-native species from one country to another has greatly increased (CBD, 2009). Once an exotic species has been transported to Queensland, it has the potential to become an invasive species. An invasive species is one that has spread and multiplied to a point where it has an impact on ecosystems, agriculture, industry, human health, recreation or scenic amenity. Native species can also become potentially invasive when transported outside their area of natural occurrence.

There are a range of mechanisms for the introduction and/or spread of invasive species, these include:

- released or escaped into the wild from the pet, aquarium or nursery trade
- hitchhiking on products, equipment and vehicles
- introductions for agriculture or forestry
- historical releases for biological control
- transportation via shipping
- introduced via travel for tourism purposes (CBD, 2009).

The prevalence and impacts of invasive species can be perpetuated by other pressures such as a changing climate; habitat, loss, fragmentation and degradation; pollution; and other forms of human disturbance (CBD, 2009). In turn, invasive species can exacerbate other pressures, for example weed growth increasing the incidence of fires and pest animal species spreading disease (Attiwill and Wilson, 2006).

An overview of the status of invasive species in Queensland is summarised in Table 1 below.

**Table 1. Summary of status for marine, freshwater and terrestrial invasive species.**

Category	Indicator	Status of indicator
<b>Marine</b>	Established species	Queensland is currently largely free of marine pests. Twenty-six species are listed as actual or potential threats to Australia's marine resources on the National Introduced Marine Pest Information System.
	Introduced species	Asian green mussel and Asian bag mussel were detected in Queensland in 2007–08 and 2009.
	Species outbreaks	Queensland has experienced outbreaks of the cyanobacteria, <i>Lyngbya</i> and the crown-of-thorns starfish. Both these species are native to Queensland.
	Current and potential extent, density and distribution	Incursions of Asian green and Asian bag mussels have been localised to ports, such as Cairns and Brisbane. These mussels could potentially spread throughout most Queensland ports and estuaries. Caribbean tubeworm is established in Trinity Inlet, Cairns but it is not considered a risk to native species.
<b>Freshwater</b>	Established species	<b>Examples of established pest plants:</b> alligator weed, Senegal tea, <i>Hygrophila</i> , <i>Limncharis</i> , pond apple, cabomba, water hyacinth, <i>Hymenachne</i> , water lettuce and <i>Salvinia</i> . <b>Examples of established pest animals:</b> exotic fish (European carp, goldfish; guppies, gambusia and tilapia) red-eared slider turtle and the cane toad. The red-eared slider turtle has been identified as one of the top 100 of the 'World's Worst' invaders by the World Conservation Union and is a declared pest in Queensland.
	Introduced species	Pearl cichlid – 2009 Kidneyleaf mudplantain – 2007
	Species outbreaks	Recent species outbreaks: <ul style="list-style-type: none"> <li>• tilapia (five outbreaks)</li> <li>• climbing perch</li> <li>• red-eared slider turtle.</li> </ul> The 2010 and 2011 flood events may result in further outbreaks.



Category	Indicator	Status of indicator
	Current and potential extent, density and distribution	Freshwater pests are distributed predominantly along the coast and in South East Queensland. There is potential for the number of pest species to increase and for aquatic pest plants to spread west. The distribution of cane toads continues to spread south and west across Queensland to Windorah at the head of Coopers Creek. The potential distribution of cane toads is expected to spread to South Australia.
<b>Terrestrial pest animals</b>	Established species	Queensland has 19 mammal, 13 bird, three reptile and one amphibian species that are naturalised. Naturalised species are exotic species that have developed self-sustaining wild populations. Many naturalised species are pests.
	Introduced species	Queensland has experienced the following recent species introductions: <ul style="list-style-type: none"> <li>• Indian house crow – 2010</li> <li>• yellow crazy ants – 2008</li> <li>• Asian honey bee – 2007.</li> </ul> Sporadic single incursions attributed to illegally held exotic animals (e.g. ferrets, boa constrictors, green iguanas, American corn snake and Burmese pythons) have also occurred.
	Species outbreaks	Queensland has experienced the following recent outbreaks of established pest species: <ul style="list-style-type: none"> <li>• Mice plague – 2008 and 2011</li> <li>• Locust plague – 2010–11</li> <li>• Feral pig and wild dog – 2010–11</li> <li>• Deer – pre 2005</li> </ul>
	Current and potential extent, density and distribution	Terrestrial pest animals are widespread across Queensland. Exotic birds and invertebrate species are currently patchily distributed but have the potential to expand across the state. Exotic pest birds are currently distributed predominantly along the Queensland coast.
<b>Terrestrial pest plants</b>	Established species	The Queensland Herbarium has recorded 1260 naturalised species in Queensland. Of these, 23 are terrestrial Weeds of National Significance including: athel pine; bitou bush; blackberry; bridal creeper, Chilean needle grass, lantana, mesquite, <i>Mimosa pigra</i> , parkinsonia, parthenium, prickly acacia, rubber vine, willows, African boxthorn, Asparagus weeds, bellyache bush, brooms, cat's claw creeper, fireweed, gamba grass, madeira vine, opuntoid cacti and silverleaf nightshade.
	Introduced species	Queensland has experienced the following recent pest plant species introductions: <ul style="list-style-type: none"> <li>• Mexican feather grass – 2008</li> <li>• Candy-leaf – 2009</li> </ul> The Queensland Herbarium recorded the detection of 66 new plant species in Queensland in this reporting cycle.
	Current and potential extent, density and distribution	Terrestrial pest plants are widespread across Queensland. The number of species increases from west to east, and there is significant potential for the number of weed species present in Far North Queensland to increase.

## 3.8 Disease

Diseases can lead to significant social, ecological or economic harm. Some of the diseases that have received focus in this reporting cycle are outlined below.

Hendra virus causes a potentially fatal disease known to occur in bats, horses, dogs and humans. The virus is carried and transferred by flying foxes to horses, although the mode of transmission is currently not fully understood. Hendra virus can be transferred from horses to humans where there has been contact before or after infection and/or death of the horse. The disease was discovered in 1994 and, although the rate of transmission has remained low, it has been fatal on some occasions in both horses and humans.

Myrtle rust is a serious fungal disease that was detected in Queensland in December 2010. It affects plants of the Myrtaceae family, the second largest plant family in Australia and dominant in many of Australia's forests and woodlands. The rust can cause deformed leaves, heavy defoliation of branches, dieback, stunted growth and even death.

Turtle fibropapilloma disease, which causes tumours to grow on and inside turtles, has been previously considered a significant threat to marine turtles. However, long-term mark-recapture studies are showing good recovery of turtles following infection. Spirorchid blood flukes infection has been identified as the most significant disease causing deaths of green turtles in Moreton Bay.

Chytridiomycosis, an amphibian disease, continues to pose a significant risk to Queensland's frog populations (e.g. tinker and day-frogs).

## 3.9 Identifying key pressures at a species level

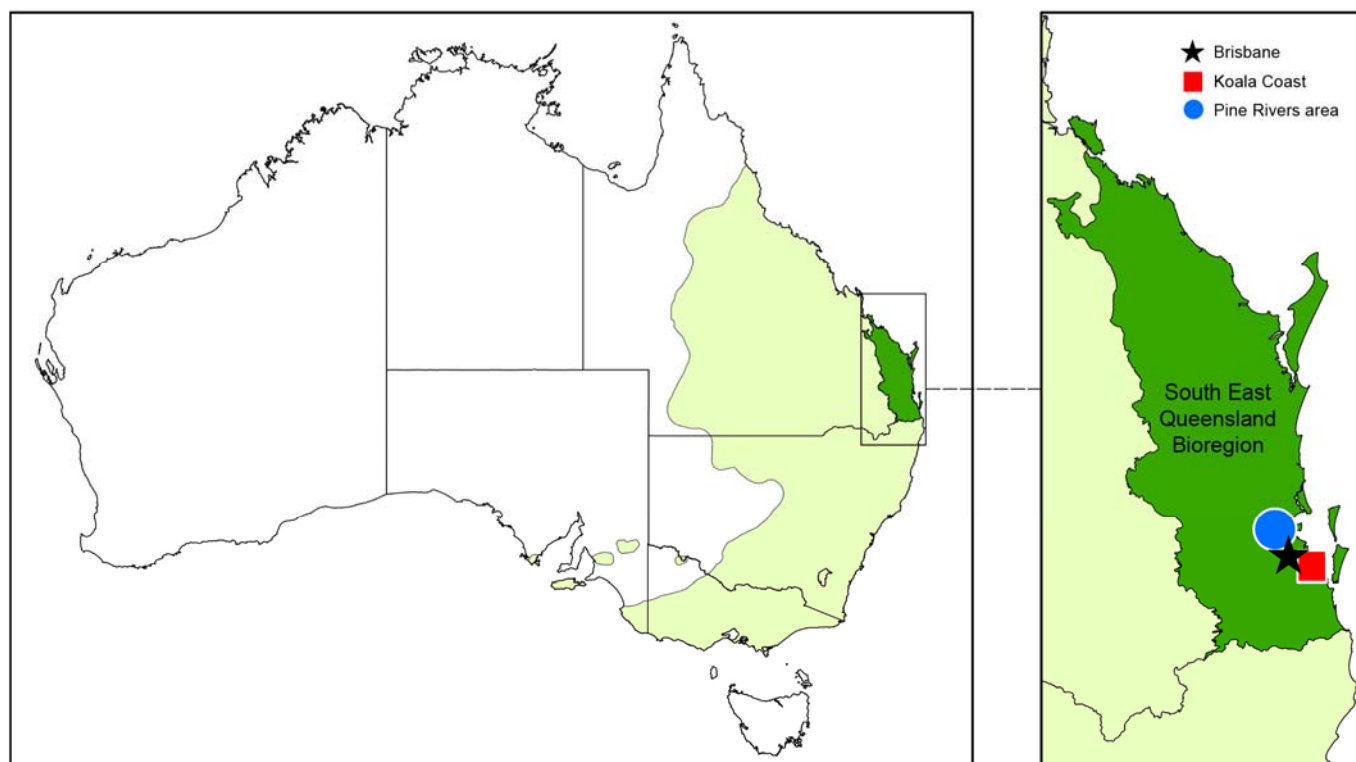
### 3.9.1 Major pressures affecting priority species

Queensland's native plants and animals are an important part of our state's natural environment. Yet some species have declined in number and are even threatened with extinction by a range of pressures. The Back on Track Species Prioritisation Framework (Back on Track) (DERM, 2009a) has been developed to assist with directing management and recovery actions for priority species.

Through the Back on Track framework, 87 pressures have been highlighted as major threats contributing to the decline of priority species in Queensland. The major pressures that affect the greatest number of species are 'inappropriate fire regimes' (148 species) and 'clearing of vegetation' (101 species). There are four other major pressures that affect between 50 and 100 species each. These are 'inappropriate grazing regimes' (91), 'weeds' (75), 'urban development' (58) and 'feral pigs' (53).

### 3.9.2 Koala populations in Queensland

The koala *Phascolarctos cinereus* occupies a scattered area throughout Queensland (Figure 20). They are known to occur in the moist forests of coastal regions, the sub-humid woodlands in Southern and Central Queensland and have been found along water courses that are lined with eucalypts in the semi arid areas in the west. Koalas have also been found in low density in semi-arid areas away from creek lines and a small number of island populations have been documented as well. Queensland harbours a significant percentage of the national koala population and South East Queensland contains the greatest density of koalas recorded in Queensland. A significant downward trend in koala numbers in Queensland translates to a national decline of some importance (Beeton, 2010).



Note: Distribution based on Martin, 1995.

**Figure 20. Distribution of koalas in Australia (main box) and location of the Koala Coast study area (inset).**

The Koala Coast, located 20 km to the south east of Brisbane, has been regarded nationally as a very significant koala population due to its size and genetic diversity. Koalas in the Pine Rivers area have also been identified as significant due to the size and relative good health of its population. Survey data from the Koala Coast over the past 15 years and data from the Pine Rivers area suggest a marked decline in the overall koala population in South East Queensland. Due to widespread development in the area, koalas are suffering from a number of anthropogenic related impacts. Habitat loss and fragmentation, together with disease, are the greatest threats to the koala in South East Queensland.

Disease exacerbated by environmental stress may be triggered by habitat loss, changes in habitat due to developmental reconfiguration, disruption to koala population dynamics, available nutrition, or extreme weather events including those generated by climate change. Currently, *Chlamydia* is the main disease type known to affect koala populations in South East Queensland. *Chlamydia* largely affects the koala's reproductive potential, which influences population dynamics and can impact population decline and recovery.

Vehicles and dogs have also been identified as significant threats to koalas in South East Queensland. Dogs are primarily a threat in urban or rural residential environments, or where there is developmental disturbance influencing koala movement. Vehicle strikes take a heavy toll on koalas particularly in developing areas where habitat has been disturbed and traffic flow increases. Despite a growing awareness of these issues, koala mortality continues.

Myrtle rust is an emerging threat to koalas on the east coast of Australia. It has the potential to affect koala populations through its damaging affects on eucalypt and other species essential to the koala. It is currently spreading in Queensland and will infect koala bushland, as well as plantations used to produce fodder for captive and rehabilitating koalas.

Any one of these issues alone may not have resulted in such a negative effect on the koala populations of South East Queensland. However, the implication of multiple threatening processes is that koalas in South East Queensland are under significant threat. The application of science in this context is important to be able to monitor and understand the koala's environmental context; to be able to identify, prioritise and apply the best management solutions and so head towards better conservation outcomes.

### 3.9.3 Kroombit tinkerfrog (*Taudactylus pleione*)

The genus *Taudactylus* is unique to Queensland and contains six species of tinker and day-frogs. From the late 1970s to early 1990s, the members of the genus *Taudactylus* suffered catastrophic declines—three species are now thought to be extinct, one is critically endangered, while another appears to have weathered the storm. The cause of these declines and disappearances is almost certainly due to the amphibian chytrid fungus, a deadly pathogen thought to have been accidentally introduced to Australia. This fungus has also decimated frog populations in many areas internationally. The observed pattern of decline of the Kroombit tinkerfrog is consistent with chytridiomycosis.

Other major threats to the species include fire and introduced plants and animals (e.g. feral pigs). Significant damage to habitat has followed bushfires, including an increase in the weed lantana *Lantana camara*. Lantana has the potential to increase fire intensity, stall rainforest regeneration through competition and alter the invertebrate community (tinkerfrog food). On the plateau, cattle and horses heavily impact streams, particularly during dry times. Feral pigs have only become established in the eastern part of Kroombit Tops, where the Kroombit tinkerfrog occurs, within the last 10 years. Initially signs of feral pigs were recorded in rainforest patches below the escarpment, but over several years their impact steadily increased and spread across all of the eastern part of Kroombit Tops. The most obvious impact of feral pigs at Kroombit is the damage they make through feeding and wallowing within the seepages and drainage lines suspected to be critical breeding habitat for Kroombit tinkerfrog.

## 3.10 Pollution

Pollution enters our natural environment through a number of different ways, such as via emissions, run-off, precipitation and discharge. The key pressures arising from pollution are discussed below.

### 3.10.1 Air pollution

The major pressures on the atmosphere and many aspects of the environment are emissions, including greenhouse gases, arising from human activities. The key sources of human caused greenhouse gas emissions include electricity generation, land clearing, agriculture and transport. The emission of greenhouse gases beyond natural limits is the main driver behind climate change and places significant pressure across all areas of the environment and ecosystems.

Other pressures include emissions of oxides of nitrogen (NO<sub>x</sub>), CO, SO<sub>2</sub>, volatile organic compounds (VOCs) and particles.

These emissions can impact on the health of people, plants and animals, cause acidification of land and water, and diminish amenity (e.g. via reduced visibility and the deposition of dust and soot).

The release of O<sub>3</sub>-depleting substances with long lifespans in the past has reduced the stratospheric ozone layer, resulting in increased exposure to ultra-violet radiation.

Queenslanders are largely car dependent, with car ownership increasing in most of the state and road congestion increasing in inner city areas and along major arterial highways to urban areas. The number of vehicle kilometres travelled (VKT) has risen faster than population growth. Additionally, road transport accounts for a large percentage of freight movement. These effects were reported in the Air Emissions Inventory for South East Queensland (EPA and BCC, 2004). They showed that in this region, motor vehicles and other modes of transport contributed:

- 72 per cent of total regional emissions of NO<sub>x</sub>
- 71 per cent of CO
- 24 per cent of SO<sub>2</sub>
- 23 per cent of VOCs
- 13 per cent of particles.

Industrial facilities emit a wide range of air pollutants (NO<sub>x</sub>, CO, SO<sub>2</sub>, VOCs, metals and particles).

Vegetation, through its natural metabolic processes, contributes to VOC emission, emitting over 60 per cent of the VOCs in South East Queensland. Additionally, burning of vegetation, whether during agricultural burning, hazard reduction burning or bushfires, releases large amounts of particles, NO<sub>x</sub> and VOCs into the atmosphere.

The rise of levels of greenhouse gases in the atmosphere is the main driver of human-induced climate change. In particular, the concentration of CO<sub>2</sub> has been increasing rapidly, rising to 390 ppm in 2010, which is well above the concentration at the start of the industrial revolution, estimated at about 280 ppm in 1750. While Queensland's total greenhouse gas emissions in the global context are relatively small, the state is a high per capita emitter. In 2009, Queensland's per capita emissions were 35.2 tonnes of CO<sub>2</sub>-e per person. This is down (by 38 per cent) from 56.6 tonnes CO<sub>2</sub>-e per person in 1990 (DCCEE, 2011).

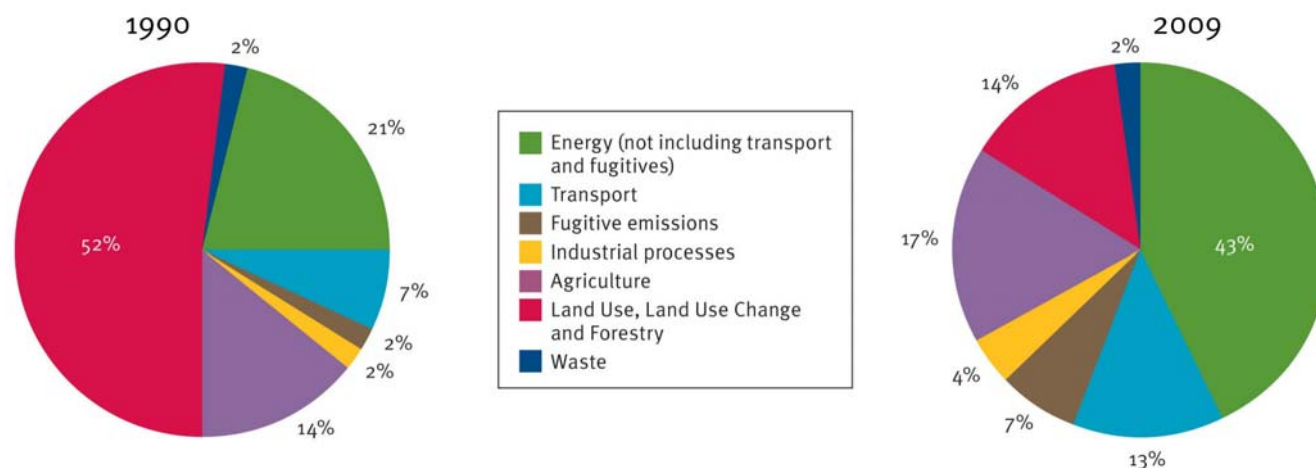
Despite substantial progress in reducing emissions from land clearing since 1990, compared with other states, emissions from land clearing remains a key contributor to Queensland's high emissions (DERM, 2011d).

Figure 21 shows the change in Queensland's emissions profile by sector between 1990 and 2009. It illustrates the changing composition of Queensland's emissions profile, especially the decline in significance of land use, land use change and forestry (LULUCF) and the growth in relative significance of other sectors, especially energy.

Key changes between 1990 and 2009 include:

- the decline in significance of the LULUCF sector from 52 per cent to 14 per cent
- the increase of energy sector emissions from 21 per cent to 43 per cent
- the near doubling of relative emissions from transport (seven per cent to 13 per cent) and industrial processes (two per cent to four per cent)
- the increase in significance of fugitive emissions from two per cent to seven per cent
- the relative stability of emissions from agriculture and waste.

The findings from the National Greenhouse Gas Inventory in 2009 also show that Queensland's total greenhouse gas emissions are decreasing, with a 5.7 per cent decrease between 1990 and 2009, despite carbon pollution continuing to rise on national basis (DCCEE, 2011).



Source: DCCEE, 2011.

**Figure 21. Queensland emissions by sector in 1990 and 2009.**

### 3.10.2 Water pollution

The most significant pressure on inland waters (both surface and groundwater) is that of pollution from agriculture, mining, industry and human settlements. The pressure arises from chemical (such as fertilisers, pesticides, various wastes, sewage and stormwater), physical (such as sediments), and biological (such as vegetation from invasive water weeds and organic debris) pollutants. Artificial changes to natural temperature variations can lead to thermal pollution and may also affect the behaviour of other contaminants.



Pollution can have serious ecosystem impacts and, at the extreme, result in eutrophication (i.e. increases in nutrient concentrations in aquatic ecosystems). This can result in the development of algal blooms leading to a depletion in oxygen levels that can threaten aquatic populations of plants and animals.

An emerging issue in freshwater management is the disposal of large quantities of treated water, a by-product of coal seam gas extraction. The regular introduction of large quantities of water, even if treated, into systems that have evolved within a regime of minimal flows for most of the year has the potential to result in adverse effects.

Pollution entering coastal and marine waters from freshwater streams has had major impacts in some regions. For example, accelerated eutrophication has adverse consequences on marine ecosystems, while rural diffuse pollution, including from far inland, has resulted in the decline of coral biodiversity on the Great Barrier Reef. A reduction in these discharges would improve the reef's resilience to other emerging pressures from ocean warming and acidification due to atmospheric carbon pollution.

Marine litter, sourced from both land and sea-based activities, is of growing concern. The impacts include the dispersion of invasive species, plus the entanglement of marine life and the ingestion of litter by marine organisms.

Wetlands and waterways can become polluted through point source discharges (e.g. sewage outfalls and industrial waste), through run-off after rainfall events, or through leaching to groundwater. Pollutants can also concentrate in these systems in times of drought. Less commonly, waterways can become polluted through incident-based occurrences, such as oil spills and the overtopping of mining dams.

The identification of water pollution pressures from monitoring programs for the Great Barrier Reef Catchment and South East Queensland are presented below. These areas have been recognised as under considerable strain from human activities. Case studies are also presented on two incident-based occurrences—an oil spill in Moreton Bay and the flooding of Ensham mine, which took place during this reporting cycle.

### 3.10.2.1 Catchment run-off that flows into the Great Barrier Reef

The Great Barrier Reef is an iconic World Heritage listed ecosystem with very high ecological and socio-economic values. The catchment area adjacent to the Great Barrier Reef is also of considerable ecological and socio-economic value (e.g. Waterhouse and Brodie, 2011). The health of the Great Barrier Reef is intimately connected to the environmental management of the adjacent catchments, as run-off of pollutants from these areas can negatively impact upon the reef (e.g. Haynes et al., 2007).

A synthesis report compiled by Waterhouse and Brodie (2011) identified priority pollutants in the Great Barrier Reef, as well as key management interventions. The priority pollutants derived from anthropogenic land uses considered most likely to pose a threat to the quality of run-off water entering the Great Barrier Reef are suspended sediment, nutrients (various forms of nitrogen and phosphorus) and photosystem II (PS-II) herbicides (Waterhouse and Brodie, 2011). For a summary of pollutant loads from the Great Barrier Reef catchments, see section 4.2.4.2.

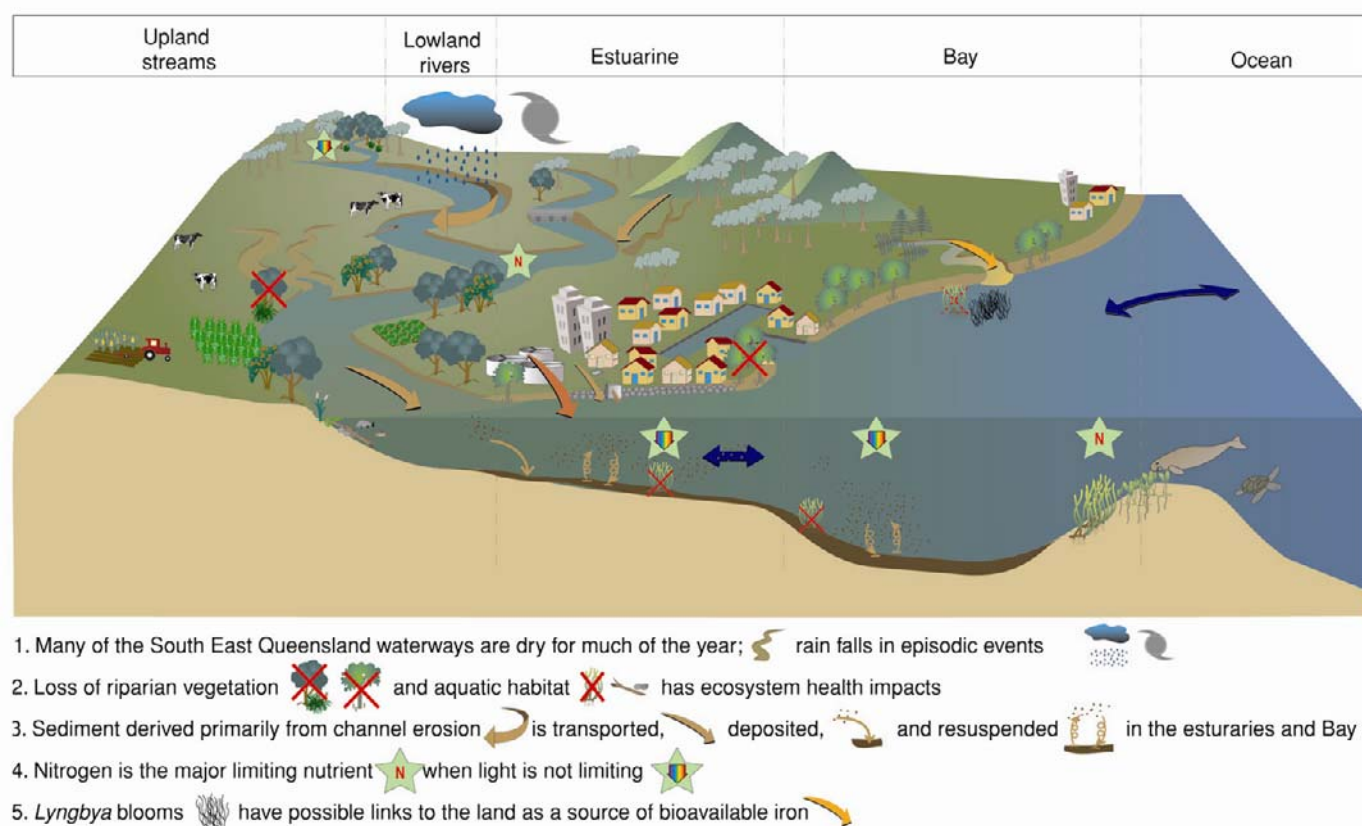
Discharges from wastewater treatment plants in Great Barrier Reef catchments are also a potential source of nutrients. Over the last four years, there has been a significant reduction in these loads as a result of treatment plant upgrades, see section 4.2.4.2.

### 3.10.2.2 South East Queensland waterways

The Ecosystem Health Monitoring Program (EHMP) (visit [www.ehmp.org](http://www.ehmp.org)) has been set up to measure waterway health using a broad range of biological, physical and chemical indicators of ecosystem health. This information assists with informing protection, management and restoration of these waterways. The program focuses on waterways extending from the Queensland–New South Wales border, north to Noosa and west to the Great Dividing Range.

The issues affecting South East Queensland waterways have been identified through consultation with the region's scientific community under the EHMP and are presented below using a conceptual model approach (Figure 22) (Pantus and Dennison, 2005; Healthy Waterways, 2007; and Bunn et al., 2010). The rivers flowing into Moreton Bay are heavily loaded with nutrients and sediments, which have degraded some of the inshore ecosystems of the bay. The majority of nutrient and sediment loads are transported in waterways during high-flow periods (events) rather than during low-flow periods. Hence the monitoring for these contaminants focuses on high-flow events. Rainfall events can cause erosion, destabilising of creek channels and riparian (riverbank) areas. These processes are exacerbated by current practices associated with development for industry, human settlements and agriculture.

The South East Queensland Event Monitoring (SEQEM) program which is part of the EHMP, focuses on non-point source loads of nutrients and sediments entering South East Queensland's waterways under both ambient and event-based situations.



Source: Healthy Waterways, 2012.

**Figure 22. Conceptual model of the current ecosystem health of Moreton Bay and its river estuaries based on community derived environmental values.**

### 3.10.2.3 Oil spills

Marine pollution incidents generally involve petroleum hydrocarbon (PHC) spills and are associated with a range of adverse environmental impacts that vary in severity according to the nature and quantity of the material spilt and the aquatic ecosystems exposed.

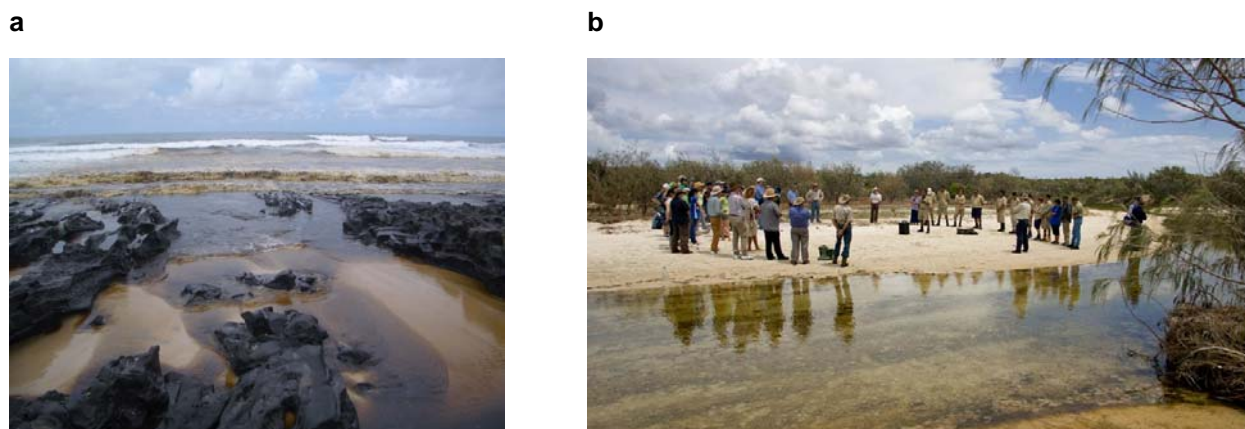
Mishaps associated with the storage of fuel, during refuelling of vessels in harbours and farm machinery in rural areas is a common source of diesel fuel spills onto land and into waterways. Diesel fuel is one of the more toxic PHC mixtures.

The impacts of oil spills on waterways may be the result of the floating slick, the dissolved fraction, or both. The environmental hazards posed by surface slicks include coating of vegetation and sediment surfaces, smothering of organisms, fouling of the plumage of birds, and poisoning of animals that feed on oil-contaminated plants and animals directly contaminated by the slick.

#### Moreton Island oil spill

On 11 March 2009, the Pacific Adventurer cargo ship was caught in Tropical Cyclone Hamish off the coast of Moreton Island. The vessel suffered two hull punctures from falling shipping containers. As a result, an estimated 270 tonnes of heavy fuel oil leaked into the ocean off the northern coast of Moreton Island in South East Queensland. The resultant oil slick affected beaches, rocky reefs, two coastal wetlands on the island, and beaches and mangrove wetlands between Bribie Island and Coolum Beach. Many of the affected areas were located within

the Moreton Bay Marine Park and Moreton Bay Ramsar site. The enormous cleanup operation took over two months, involved 2500 people and resulted in the removal of 3000 tonnes of polluted sand.



Source: SEQ Catchments. Photo: Sean Galvin.

Source: SEQ Catchments. Photo: James McEwan.

**Photo 3. Moreton Island oil spill showing (a) oil washed up around coffee rock and (b) members of the Moreton Bay Oil Spill Environmental Restoration Program.**

#### 3.10.2.4 Discharges from flooded mines

Mines place pressure on aquatic ecosystems when discharges from a mine site (either through pumping or uncontrolled overland flow) carry toxicants, salts and/or altered pH into waterways. The pumping of floodwaters from mine pits can also change the flow regimes of natural systems.

In early 2008, parts of Central Queensland were hit by unprecedented rainfall that caused the Fairbairn Dam to overflow, flooding the township of Emerald. A number of mines in the region were also inundated and the area was declared a disaster zone. It was determined that the longer the water remained in the large mine pits, the more likely contamination was increasing the risks to natural waterways, the aquatic environment and water users in the region. Under emergency provisions of the *Environmental Protection Act 1994*, the Queensland Government allowed the affected mines to discharge flood waters to nearby streams, subject to strict conditions based on the Australian and New Zealand Environment and Conservation Council (ANZECC) Water Quality Guidelines for Fresh and Marine Water Quality (2000).

The Ensham Coal Mine near Emerald, which flooded with an estimated 150 000 ML of water, was authorised to discharge this water to the Nogoa River, which ultimately flows into the Fitzroy. After discharge, the water in the river was monitored to assess any potential impacts. Some exceedances of the water quality guidelines were found. For instance, in August 2008, water quality results for Bedford Weir downstream of Ensham Coal Mine indicated that salinity was increasing, and that domestic water supplies for some townships using this source for their drinking water were being affected.

The water quality in the catchment has since returned to normal, meeting the water quality guidelines. A review of event procedures resulted in new protocols for managing and preventing mine discharge into river systems. These new protocols have guided the management and safe release of contaminated water relating to the 44 of the 57 Queensland coal mines that were affected by the 2010–2011 summer floods (DERM, 2009b).

### 3.10.3 Land pollution

Land pollution generally results from the incorrect disposal of chemicals and wastes the excessive application of fertilisers and pesticides or the disturbance of acid sulfate soils resulting in land degradation.

#### 3.10.3.1 Chemicals

Chemicals are used in every aspect of life, including industrial processes, energy, transport, agriculture, pharmaceuticals, cleaning and refrigeration (UNEP, 2007). There are around 50 000 chemicals available for use in

Australia and, when appropriately managed, these chemicals deliver major benefits to the community. However, the use of some chemicals presents risks for public health, workplace safety, the environment and national security (Productivity Commission, 2008).

### 3.10.3.2 Waste generation and disposal

The disposal of solid wastes generated by households, businesses and public agencies into landfill can be of concern. Potential pressures include reducing scenic amenity and causing long-term pollution of the environment through leaching of toxic substances (e.g. heavy metals and household chemicals).

In 2008–2009, Queensland households generated approximately 2.25 million tonnes of domestic waste, or about 438 kg of waste per capita, excluding segregated green waste dropped off at local government landfills and transfer stations. Queensland power stations generated 5.84 million tonnes of fly ash and Queensland alumina refineries generated 4.49 million tonnes of red mud. Other waste streams generated in 2008–09 included 2.35 million tonnes of construction and demolition waste, 1.4 million tonnes of clean fill, 830 000 tonnes of segregated green waste, 713 000 tonnes of contaminated and acid sulfate soils, 568 000 tonnes of biosolids and 2.65 million tonnes of other commercial and industrial wastes.

In Queensland, household waste is mostly handled by local governments, they have recorded a steady increase in the amount of household waste generated with an increase of 59 per cent over a six-year period (2004–05 to 2008–09), compared with a 13 per cent growth in population for the same time period.

The flooding that occurred in many parts of Queensland in the summer of 2010–11 damaged infrastructure, buildings and personal possessions, causing a peak in the disposal of affected material. The Brisbane City Council estimated that they collected around 291 000 tonnes of material in the Brisbane area alone in the month following the floods.

### 3.10.3.3 Contaminated lands

Brownfields is one product of contaminated land and are abandoned, vacant or underused former industrial areas. These derelict industrial and commercial areas are sought after for urban renewal programs, including residential, commercial and other sensitive land use projects. Redevelopment of brownfields is hampered by environmental problems and lack of adequate information on contamination (UNEP, 2002). The areas most affected in Queensland are the former industrial zones in an eight km radius from the central business districts of Brisbane, Toowoomba, and the coastal cities including Maryborough, Townsville and Cairns.

The disturbance of acid sulfate soils can result in the contamination of land and coastal waters. An estimated 2.3 million ha of potential acid sulfate soils occur along the 6500 km of Queensland coastline and typically where land elevation is less than five m above sea level (Australian Height Datum). These areas are often in high demand for agricultural and urban development. Acid sulfate soils are benign when left undisturbed, but when disturbed and exposed to oxygen they release large quantities of sulfuric acid. They can also release toxic quantities of iron, aluminium and heavy metals. This can have major environmental, health, engineering, and economic effects. For example, acid sulfate soils can affect infrastructure by corroding concrete and steel, in turn accelerating maintenance and replacement. Run-off of acid into aquatic environments can kill marine life and degrade aquatic plant communities.

Some agricultural practices can lead to land degradation or contamination. In particular, the excessive input of external substances, such as fertilisers, can disrupt the natural balance of nutrient cycling and lead to soil acidification. Additionally, the application of pesticides and herbicides can be harmful to the health of many plants, animals and humans. Intensive livestock production (mainly feedlots, piggeries and poultry farms) can also result in contamination when wastes are inappropriately disposed of. This issue may become more problematic as intensive livestock production increases (e.g. use of feedlots has increased by over 1000 feedlots from 30 June 2007 to 2010 (ABS, 2008, 2011c).

## 3.11 Use of natural assets

The manner in which we extract and use our natural resources can result in pressure on natural assets, such as water and soils. Over-harvesting of populations can detrimentally impact on ecosystems, communities and species.



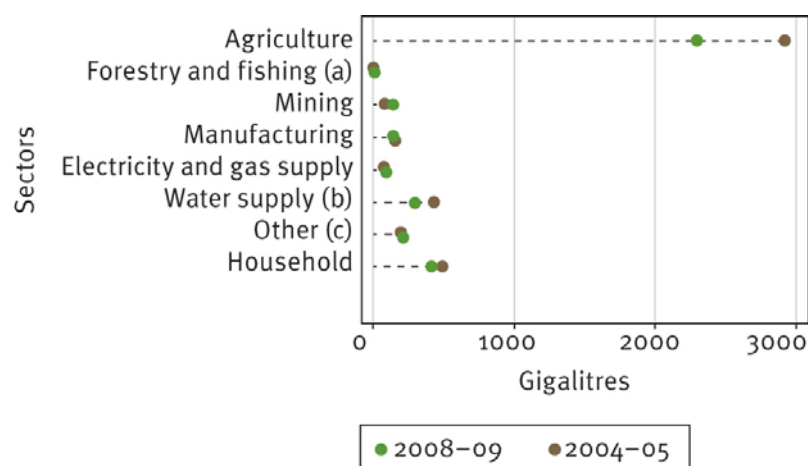
### 3.11.1 Water extraction and consumption

Water is one of the world's most abundant yet most exploited resources. Queensland's freshwater resources consist of both natural wetlands (e.g. upland streams, rivers, lakes and groundwaters) and artificial reservoirs (e.g. dams and tanks).

The supply of water is greatly influenced by climate and weather variability. The millennium drought, which reduced the amount of water available for use (supply), coupled with high levels of population and economic growth that increased demand, saw many parts of Queensland facing substantial water shortages issues (EPA, 2008). As a consequence, when conditions were the most challenging, the major urban centres in South East Queensland were subject to unprecedented Level 5 water restrictions (EPA, 2008).

In Queensland, a total of 3351 GL of water was consumed in 2008–09 (ABS, 2010a). This was a 23 per cent decrease on the total amount consumed in 2004–05 (4361 GL). It is likely that the reduction is related to the widespread drought conditions and associated water restrictions in the intervening years.

The amount of water consumed by sector varies (Figure 23 and Table 2). In 2008–09, agriculture was responsible for 64 per cent of Queensland's water consumption (2 144 201 ML), while households consumed 9.1 per cent (308 037 ML) (ABS, 2010a). The aquaculture sector consumed the lowest amount of water (11 ML), followed by waste collection, treatment and disposal services (219 ML).



(a) Includes Services to agriculture; hunting, trapping and aquaculture

(b) Includes Sewerage and drainage services

(c) Includes Waste Collection, treatment and disposal services

Note: This graph presents an activity view of agriculture rather than an industry view

Source: ABS, 2010a (4610.0 Water Account Australia 2008–09, page19).

**Figure 23. Comparison between 2004–2005 and 2008–2009 water consumption by sector in Queensland.**

**Table 2. Water use by sector in Queensland for the period 2008–2009.**

Sector	Consumption (%)	Consumption (megalitres)
Agriculture, forestry and fishing	65	2 178 829
Household	9.1	308 037
Manufacturing	4.4	147 654
Mining	3.5	117 981
Other Industries	6.5	219 942
Electricity, gas, water and waste	11.3	379 000
<b>Total</b>		<b>3 351 443</b>

Source: ABS, 2010a (4610.0 - Water Account Australia 2008–09).



Water used in agriculture includes water for irrigation of crops and pastures, or for watering livestock. Nationally, water consumption across the agricultural industry was 7359 GL in 2009–10, accounting for 55 per cent of total national water consumption (ABS, 2011c). Queensland's agricultural water demand was up slightly on the national average at 62 per cent, even though this represents a drop of 10 per cent on the 2008–09 agricultural demand. Of the states and territories, Queensland had the second highest water consumption for 2009–10, at 2 037 251 ML, using 27.7 per cent of the total agricultural water for Australia. New South Wales (2 204 243 ML or 30 per cent) and Victoria (1 664 108 or 22.6 per cent) are the other significant users (ABS, 2011d).

The majority of water consumed by the agricultural sector in Queensland in 2009–10 was self-extracted water (915 GL or 47.5 per cent) and distributed water (1002 GL or 52 per cent). Reused water only accounted for a small proportion of water consumption (10 ML or 0.5 per cent).

The majority of water consumption (distributed and self-extracted) by the Queensland agricultural sector in 2009–10 originated from surface water (71.7 per cent). Groundwater made up 27.7 per cent.

In the agricultural sector, irrigation practices account for much of the water consumed. Of the total area of agricultural holdings in Queensland (129 667 586 ha in 2009–10), less than one per cent is irrigated. A total volume of 1 823 879 ML of water was applied to Queensland's 502 600 ha of irrigated land in 2009–10 (an application rate of 3.6 ML/ha) (ABS, 2011d).

For the period 2008–09, most of the irrigation occurred on land used to produce sugar cane (35 per cent), cereals for grain or seed (18.3 per cent) and cotton (13.1 per cent) (see page Table 5.4, ABS, 2011d). The rest of the agricultural activities used only a small amount of their land for irrigation.

The coal seam gas (CSG) industry extracts a large volume of groundwater as a necessary by-product of the gas extraction process. Over the life of the coal seam gas industry in Queensland (around 50 years), it is estimated that the industry will extract around 2500 GL (averaging about 125 GL per year over the initial 14 years) of water from the Great Artesian Basin.

Meckonnen and Hoekstra's work illustrate that statistics may hide the fact that water footprints have a spatial dimension (Meckonnen and Hoekstra, 2011). Australia's average water footprint (i.e. the total amount of freshwater that is used to produce the goods and services consumed by inhabitants per country) is 2315 ML per year per capita, reflecting the country's heavy reliance on primary production activities. The global average water footprint is 1385 ML per year per capita (WFN, 2011). The part of Australia's footprint drawn from outside of the country is 11.8 per cent (Meckonnen and Hoekstra, 2011).

Through the trade of agricultural products, such as cotton, beef, wheat and rice (Meckonnen and Hoekstra, 2011), Australia is one of the world's biggest net exporters of virtual water (around 89 million GL per annum). Global trade in agricultural products provides an efficiency dividend by reducing global water use (Meckonnen and Hoekstra, 2011).

### 3.11.2 Tourism and recreation

While tourism is an important sector for the Queensland economy, it is heavily reliant on the state's natural attractions. As such, the sector is acutely aware of the importance of managing any pressures that tourism related activity places on the natural environment.

The effects of tourism activity on the environment are difficult to differentiate from the effects caused by the general community, as pressures may be related to infrastructure, transport, accommodation and entertainment needs. Further, visitor numbers do not provide a direct causal link or directly quantify the environmental impacts of tourism; however they may provide a relative measure of change that could imply increasing pressures on the surrounding environment.

### 3.11.3 Fishing

Every year in Queensland around one million people fish for employment, recreation or traditional purposes. Sustainable fisheries can support strong commercial and recreational fishing sectors.

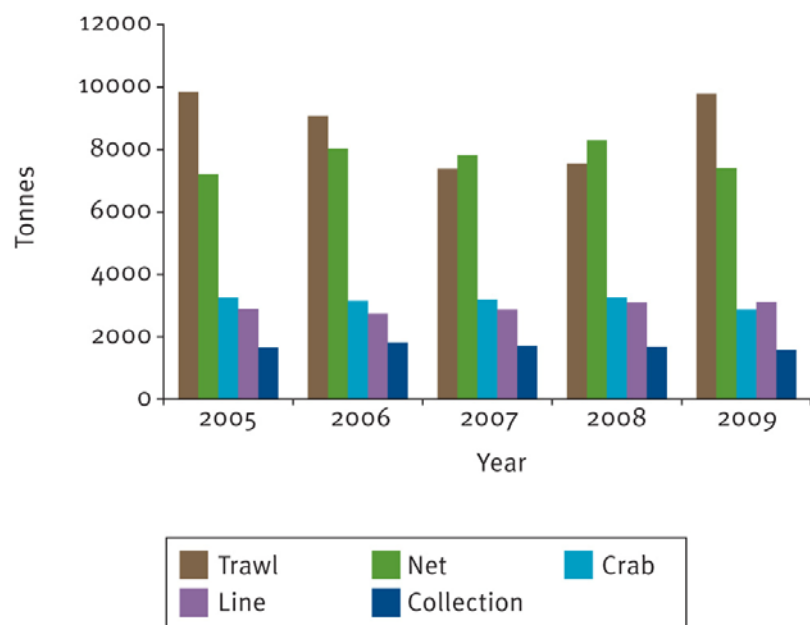
Maintaining sustainable fisheries' resources presents a range of challenges, including the potential for over-exploitation of fish resources to meet an increasing consumer demand. Competing uses of finite marine resources can also create conflict between user groups.

Most Queensland fish stocks are either ‘sustainably fished’ or their exploitation status is ‘uncertain’ or ‘undefined’ due to information deficiencies. Concerns remain for the status of snapper stocks in the Rocky Reef Fin Fish Fishery off southern Queensland (DEEDI, 2011c). New management arrangements were announced in June 2011 and include reducing the recreational bag limit for snapper from five to four, with a maximum of one fish with a total length over 70 centimetres (cm). No changes were proposed for the size and bag limits of pearl perch and teraglin. The new management arrangements for snapper came into effect in September 2011. Once the new measures have been in place for a few years the effect of the new arrangements can be examined.

In 2009, there were 2812 licences held by fishers to engage in commercial fishing in Queensland (ABARE-BRS, 2010). From 2005–09, annual commercial landings were steady, averaging 24 249 tonnes. Figure 24 shows the total seafood landings taken in Queensland.

Recreational catch has increased over time, with retained catch estimates of 21.6, 23.6, 24.1 and 30.5 million fish, prawns and crabs in 1997, 1999, 2001 and 2005 respectively. To some extent, these increases are related to encouraging anglers to report their captures of ‘bait species’ including saltwater yabbies, worms and other invertebrates throughout the second, third and in particular, the fourth survey (McInnes, 2008).

In 2009, 237 charter licence holders reported fishing, landing 706 tonnes and releasing 413 tonnes of fish. In 2010, there were 408 charter fishing licences on issue in Queensland.



Source: DEEDI, 2010b.

**Figure 24. Commercial fishery harvest in Queensland managed fisheries (2005–2009).**

### 3.11.4 Mining

Increasing world demand for mineral and energy resources has led to further emphasis on mineral and energy production in Queensland. While exploration and mining activity can result in significant economic growth for the state and benefits for the community, it also places pressure on the environment. Pressures arising from mining and extractive industries may result from site development, resource demands for energy, land and water, and the extraction, treatment and movement of raw materials.

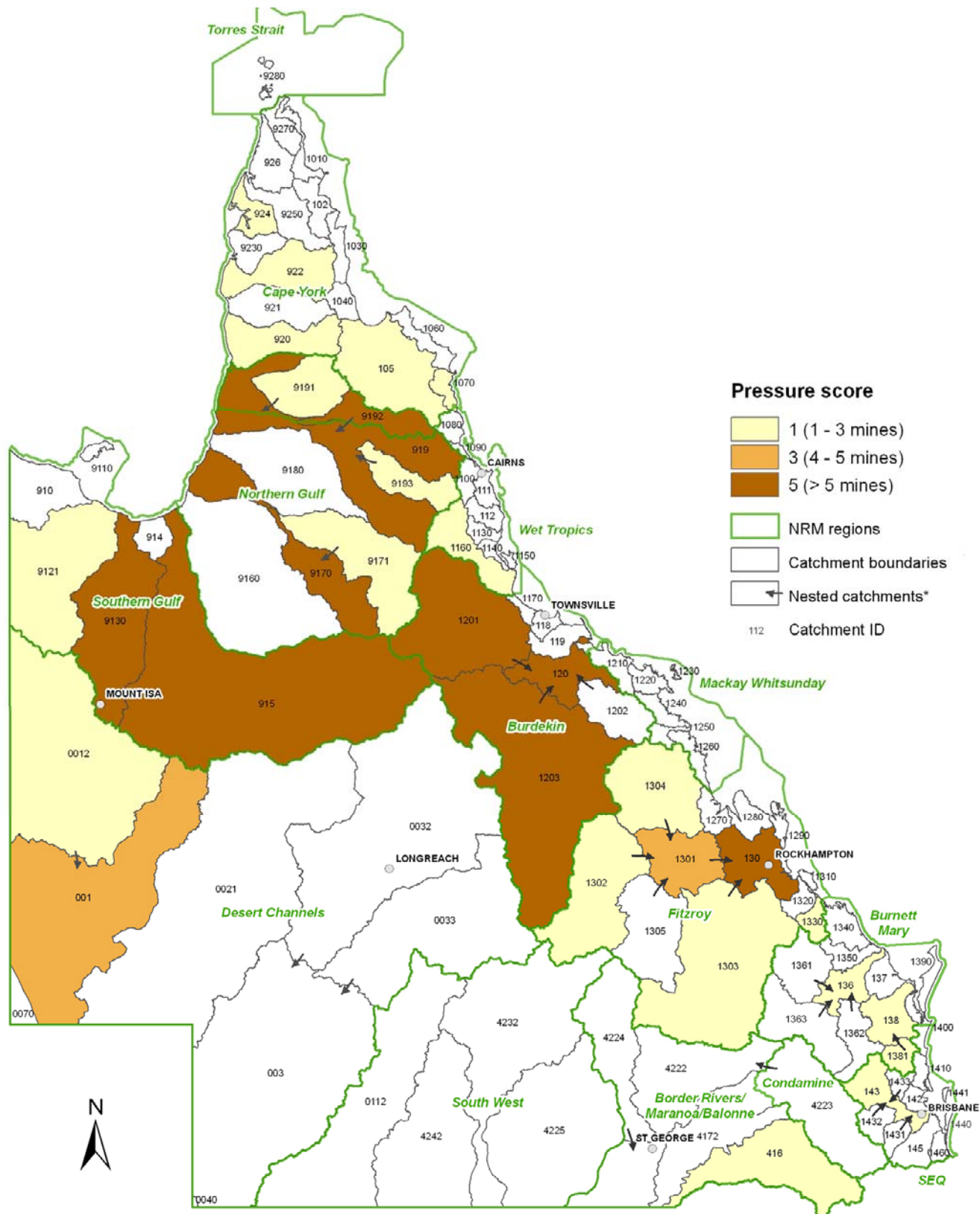
In 2010–11, the value of mineral and petroleum production in Queensland (excluding quarries) was \$35.602 billion providing royalties of \$2.698 billion. Approximately 54 000 people were directly employed in mining during this period and 165 000 were indirectly employed (DEEDI, 2011a).

More than half of Queensland or 96.66 million ha is under some form of granted exploration or production tenure for coal, mineral, petroleum, coal seam gas or geothermal energy. The actual current mining footprint (excluding

coal seam gas) is 160 000 ha or 0.09 per cent of the state. The area affected by mining over the last 150 years is 170 000 ha or 0.1 per cent of the state (DEEDI, 2011a).

There were 55 coal mines, 36 significant mines for metallic and industrial minerals, and numerous smaller gold, industrial mineral, opal and gemstone mines in 2011 (DEEDI, 2011a). A summary of the relative pressure on Queensland's catchments from mines and coal mining is provided in Figure 25a, b (DERM, 2011c).

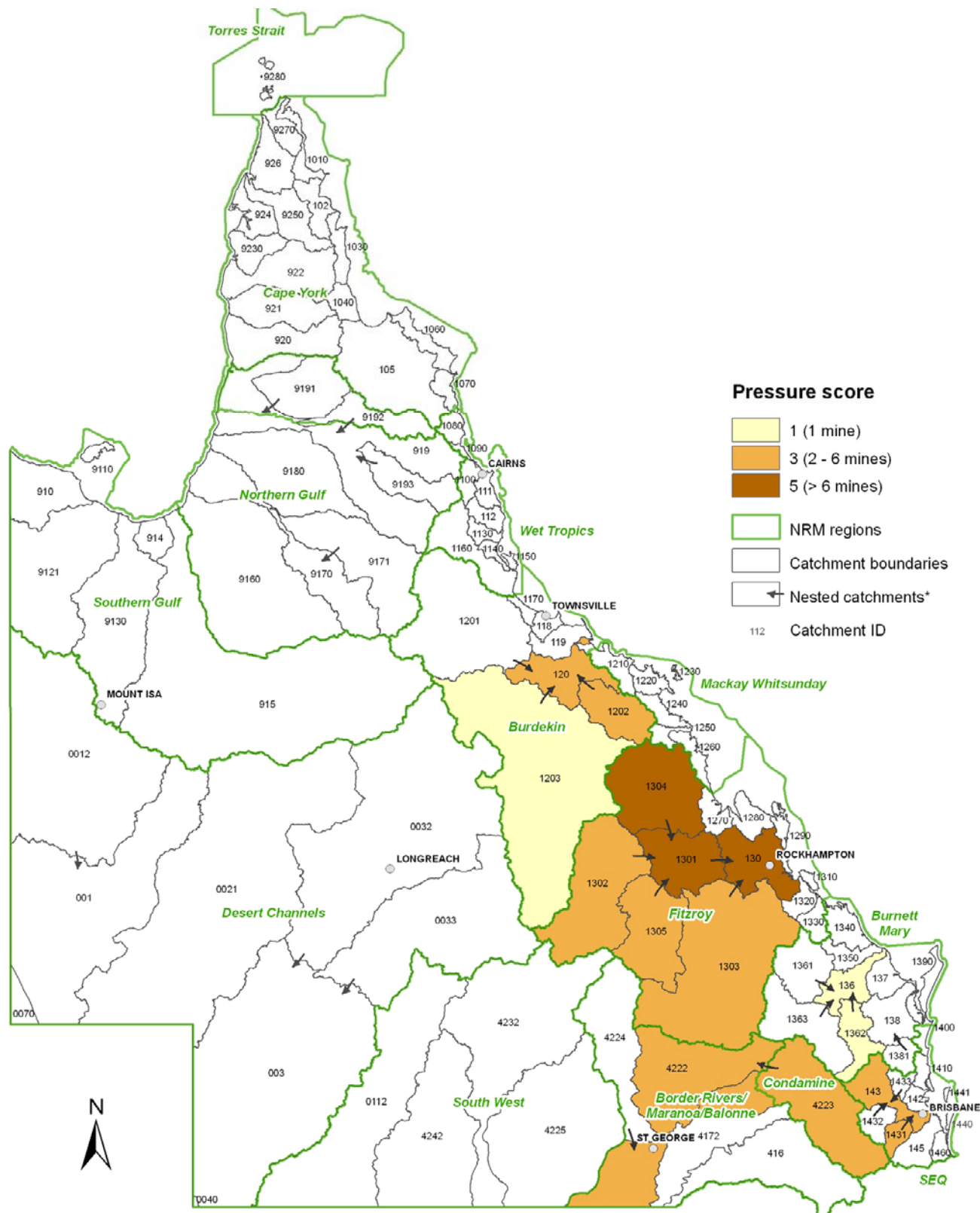
a



Source: DERM, 2011c. Note Catchment ID key is provided below Figure b.

**Figure 25. (a) Catchment pressure scores, ranging from low to high for mines and (b) catchment pressure scores, ranging from low to high for coal mines.**

b



Source: DERM, 2011c. Note Catchment ID key is provided below Figure b.

**Figure 25. (a) Catchment pressure scores, ranging from low to high for mines and (b) catchment pressure scores, ranging from low to high for coal mines.**

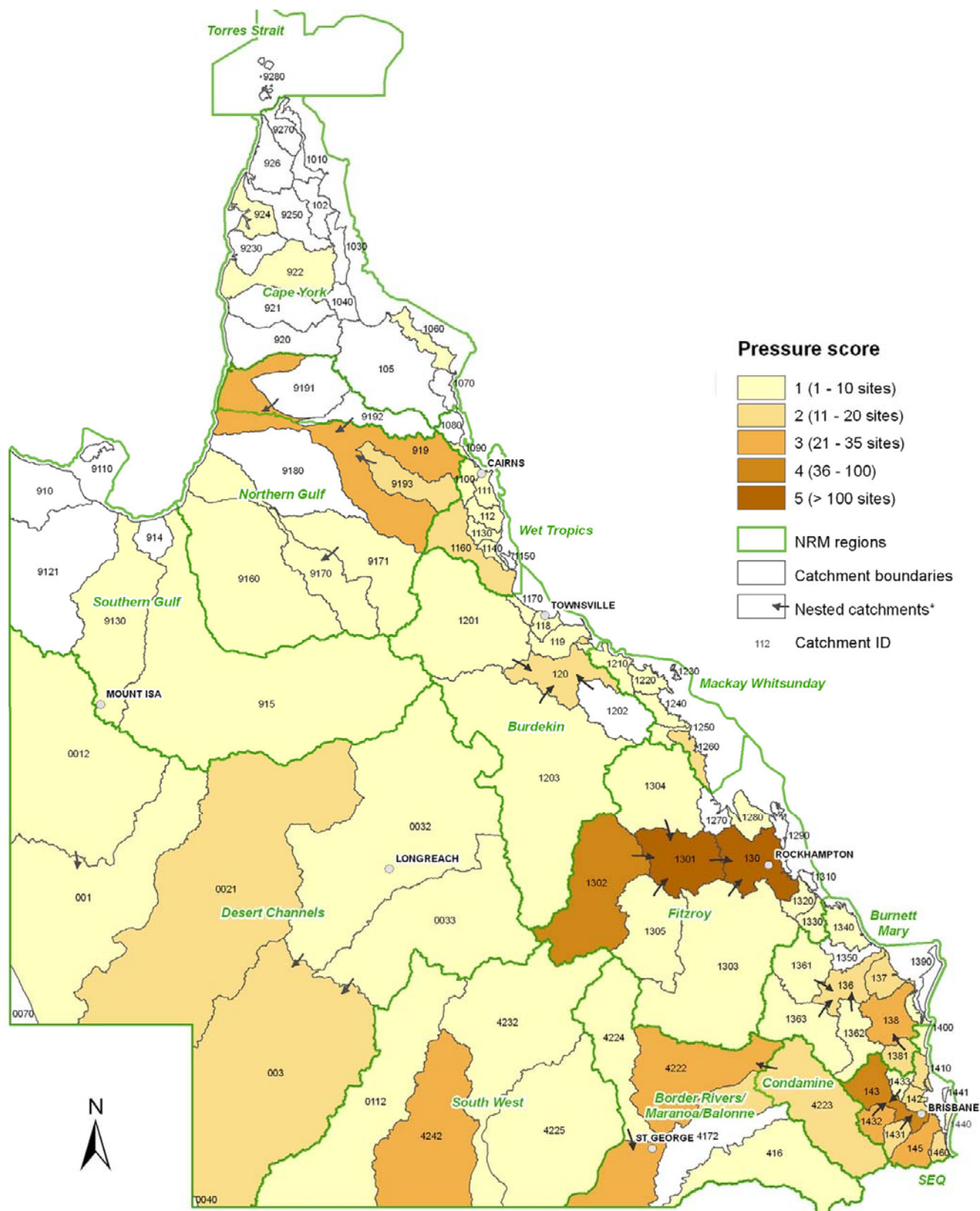


Catchment ID					
001	Eyre Creek	1160	Herbert River	1340	Baffle Creek
0012	Georgina River	1170	Black River	1350	Kolan River
0021	Diamantina River	118	Ross River	136	Burnett River
003	Cooper Creek	119	Haughton River	1361	Upper Burnett River
0032	Thomson River	120	Burdekin River	1362	Barker & Barambah Creeks
0033	Barcoo River	1201	Upper Burdekin River	1363	Boyne & Auburn Rivers
0040	Lake Frome	1202	Bowen River	137	Burrum River
0070	Hay River	1203	Suttor River	138	Mary River
0112	Bulloo River	1210	Don River	1381	Upper Mary River
1010	Jacky Jacky Creek	1220	Proserpine River	1390	Fraser Island
102	Olive & Pascoe Rivers	1230	Whitsunday Island	1400	Noosa River
1030	Lockhart River	1240	O'Connell River	1410	Maroochy River
1040	Stewart River	1250	Pioneer River	142	Pine River
105	Normanby River	1260	Plane Creek	143	Brisbane River
1060	Jeannie River	1270	Styx River	1431	Bremer River
1070	Endeavour River	1280	Shoalwater	1432	Lockyer Creek
1080	Daintree River	1290	Waterpark Creek	1433	Stanley River
1090	Mossman River	130	Fitzroy River	1440	Stradbroke Islands
1100	Barron River	1301	Mackenzie River	1441	Moreton Island
111	Mulgrave River	1302	Nogoa River	145	Logan & Albert Rivers
112	Johnstone River	1303	Dawson River	1460	Coomera & Nerang Rivers
1130	Tully River	1304	Isaac River	416	Border River
1140	Murray River	1305	Comet River	4172	Moonie River
1150	Hinchinbrook Island	1310	Curtis Island	4222	Balonne & Condamine Rivers
		1320	Calliope River	4223	Condamine River
		1330	Boyne River	4224	Maranoa River
				4225	Wallam Creeks
				4232	Warrego River
				4242	Paroo River
				910	Cliffdale Creek
				9110	Mornington Island
				9121	Nicholson River
				9130	Leichhardt River
				914	Morning Inlet
				915	Flinders River
				9160	Norman River
				9170	Gilbert River
				9171	Einiasleigh River
				9180	Staaten River
				919	Mitchell River
				9191	Alice River
				9192	Palmer River
				9193	Walsh River
				920	Coleman River
				921	Holroyd River
				922	Archer River
				9230	Watson River
				924	Embley River
				9250	Wenlock River
				926	Ducie River
				9270	Jardine River
				9280	Torres Strait Islands

### 3.11.5 Extractive industries

Continued population growth in Queensland has increased the demand for extractive resources (construction aggregates), particularly in South East Queensland and along the eastern seaboard. The production of extractive material (sand, gravel, rock and soil) used for constructing roads, ports, airports, bridges, railways, factories, hospitals, schools and homes was nearly 49 million tonnes during the 2010–2011 period (DEEDI, 2011a).

As a high-volume low-cost commodity, extractive material needs to be sourced and processed as close as possible to the communities that use them. Hence, most of this material comes from 240 sites (DEEDI, 2011a). These sites produce more than 5000 tonnes of extractive material a year. Each site, along with associated operations, has the potential to result in pressures such as loss of vegetation, decline in water quality (sediments and contaminants) in any watercourse leaving the site, decline in air quality (dust and diesel emissions) and increases in ambient noise levels (Figure 26).



Source: DERM, 2011c.

**Figure 26. Catchment pressure scores for extractive, industrial mineral and gem mines, and fossicking areas.**

## 3.12 Environmental disturbances and natural disasters

Environmental disturbances include hazard events such as floods, fires, cyclones, storm surges, landslides and oil spills. Hazard events become disasters when, as defined in the *Disaster Management Act 2003*, they cause 'a serious disruption in a community that requires a significant coordinated response by the state and other entities to help the community recover from the disruption'. The Act also notes that a serious disruption means loss of human life, or illness or injury to humans, or widespread or severe property loss or damage, or widespread or severe damage to the environment.

Natural disasters can have a severe impact on the state of the environment. While these occurrences may be an intrinsic part of the natural environment with many positive outcomes, they can also impact in a detrimental way when considered in the context of the multitude of other pressures caused by human activity.

Climate variability is a major driver of natural disasters. Australia has a highly variable climate where droughts and floods are a part of life. This variability is due to the fact that Australia has a small landmass in relation to the expanse of ocean that surrounds it, coupled with its location across tropical, subtropical and temperate climate zones (McKeon, 2006). Australia's rainfall is also influenced by year-to-year variations in sea surface temperatures in both the Indian and Pacific oceans and variations in atmospheric circulation (Drosowsky, 2002, 2005).

The major source of inter-annual rainfall variability in Queensland is due to the El Niño – Southern Oscillation (ENSO) phenomenon across the Pacific Ocean interacting with the Interdecadal Pacific Oscillation (IPO) (McKeon et al., 2004; Folland et al., 2002). El Niño years are often associated with droughts in Queensland whereas La Niña years are associated with floods and a greater likelihood of tropical cyclones making landfall (Callaghan and Power, 2010). On a multidecadal timescale, the negative phase of the IPO is associated with 'wetter' conditions than the positive phase. Importantly, the already enhanced La Niña rainfall and streamflow is even further magnified during La Niña events that occur in the IPO negative phase (Verdon et al., 2004).

### 3.12.1 From drought to flood

The millennium drought commenced in 2001 in regions across Australia (QWC, 2010) and caused major hardship for rural and urban communities. For most of the first decade of the 21st century, drought dominated Queensland's weather and two-thirds of Queensland experienced six consecutive years of exceptional drought (Figure 27a).

The catastrophic impacts in 2010–11 of both the flooding events that devastated Central and South East Queensland, and the destruction wreaked by Tropical Cyclone Yasi saw more than 99 per cent of Queensland declared as disaster affected (Figure 27b).

Year-to-year variability in rainfall places a potential stress on the viability and vulnerability of particular land uses. The millennium drought has resulted in both rural and urban communities being more aware of, and responding with increased sensitivity to, climate variability and change (McKeon, 2006).

There have been a number of flood events following the widespread extended drought period. The above-average rainfall did not occur at the same time everywhere across Queensland. The chronology of rainfall events is documented below:

- In 2006, two tropical cyclones (Tropical Cyclone Larry in March and Tropical Cyclone Monica in April) resulted in above-average rainfall in the north.
- In 2006–07, the drought was broken across west, north and central Queensland by significant rainfall, although parts of western Queensland then returned to drought conditions shortly after.
- In 2007–08, there was above-average rainfall through central and eastern Queensland.
- In 2008–09, well above-average rainfall occurred in northern Queensland, particularly in the Gulf.
- In 2009–10, there was well above-average rainfall in western and southern Queensland. Rainfall was also received in South East Queensland, ending the millennium drought.
- In early 2010–11, significant above-average rainfall led to widespread flooding across eastern Australia. Approximately 99 per cent of Queensland was declared a disaster zone (Figure 27b). It included the effects of the category five Tropical Cyclone Yasi that crossed the far north coast of Queensland on 3 February 2011, leaving in its path a mass of destruction and bringing widespread rainfall to the region.

Natural flooding events help to 'reset' the environment and cause 'booms' in natural cycles. For example, bumper breeding events for birds have been recorded following floods (Porter and Kingsford, 2011). However, the effects of floods can be exacerbated by human activities that have affected natural flood mitigation processes or predisposed the landscape to deliver above natural impacts, for example, through clearing or over-grazing. Water erosion can result in a loss of top soil, streambank erosion, gully expansion, landslips, sediment redistribution, channel redirection and vegetation removal (Gordon et al., 1992). Additionally, flood waters facilitate the downstream flow of pollutants, such as pesticides, as well as weed species. This can affect water quality and potentially cause harm to freshwater, estuarine and marine ecosystems, as well as damage pasture, crops and infrastructure. Harmful algal blooms can also follow floods through the introduction of excessive nutrients into aquatic systems.

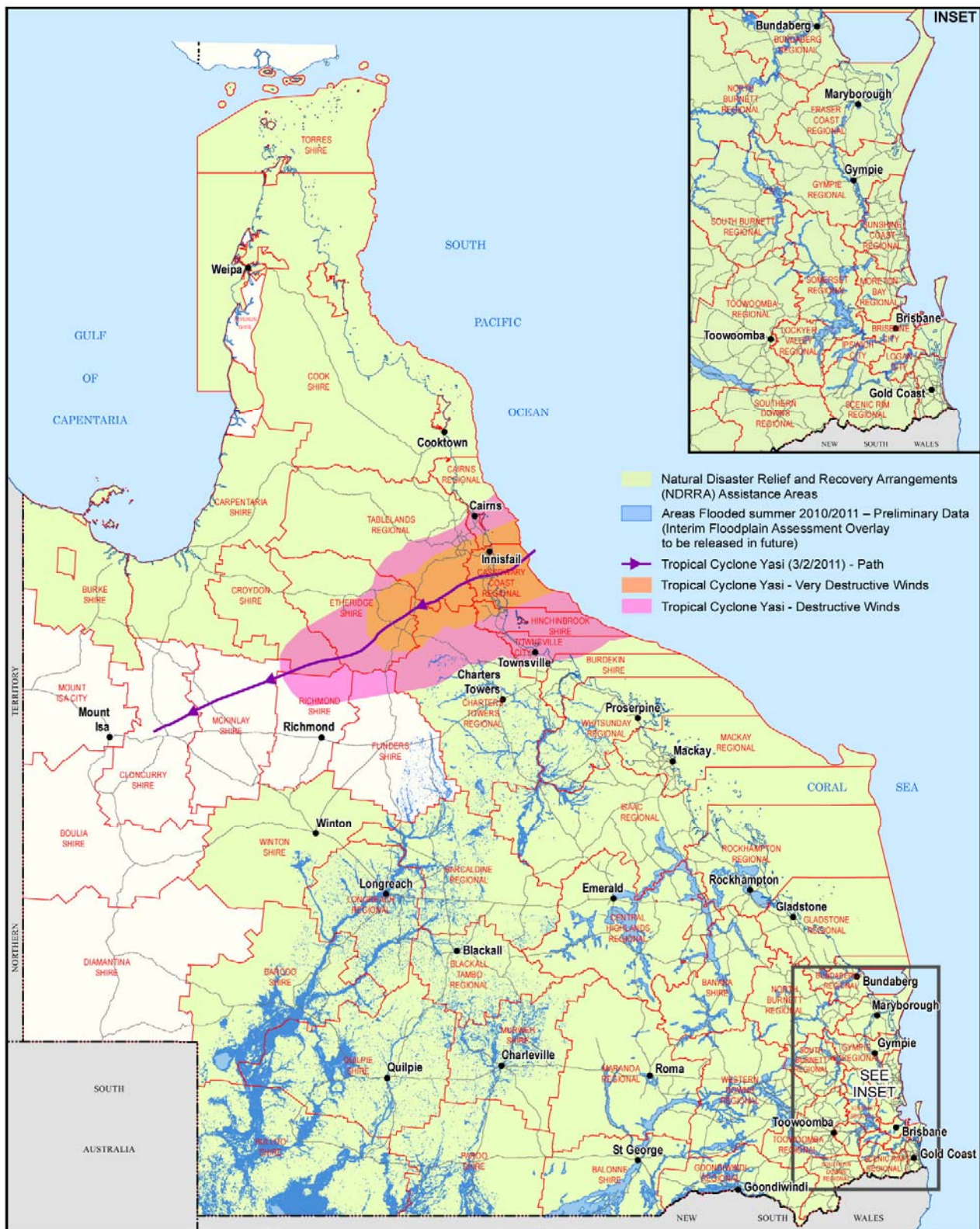
Cyclones, especially severe tropical cyclones such as Tropical Cyclone Yasi, may place pressure on the environment by destroying large tracks of vegetation that form the habitat and food sources of endangered native animals. They may also destroy crops, pastures, infrastructure, facilities and dwellings. The widespread rain following a cyclone may also cause further damage. Tropical Cyclone Yasi, for example, wreaked havoc on the food sources for the mahogany glider, the habitat of the endangered southern cassowary, and resulted in the closing of 16 national parks and partial closing of a further 21 national parks.







b



Source: a) QG, 2007 and b) DERM, 2011e.

**Figure 27. (a) Drought status map for Queensland in March 2007 and (b) flood and cyclone disaster map for Queensland for the 2010–11 summer.**

### 3.12.2 Flood plume effects on marine ecosystems in South East Queensland 2010–11

The 2010–11 floods caused significant damage to waterways and adjacent floodplains in South East Queensland. The greatest damage occurred in the Lockyer, mid and upper Brisbane and Bremer catchments with widespread loss of topsoil, stream bank erosion, gully expansion, landslips, sediment redistribution, channel redirection and vegetation removal.

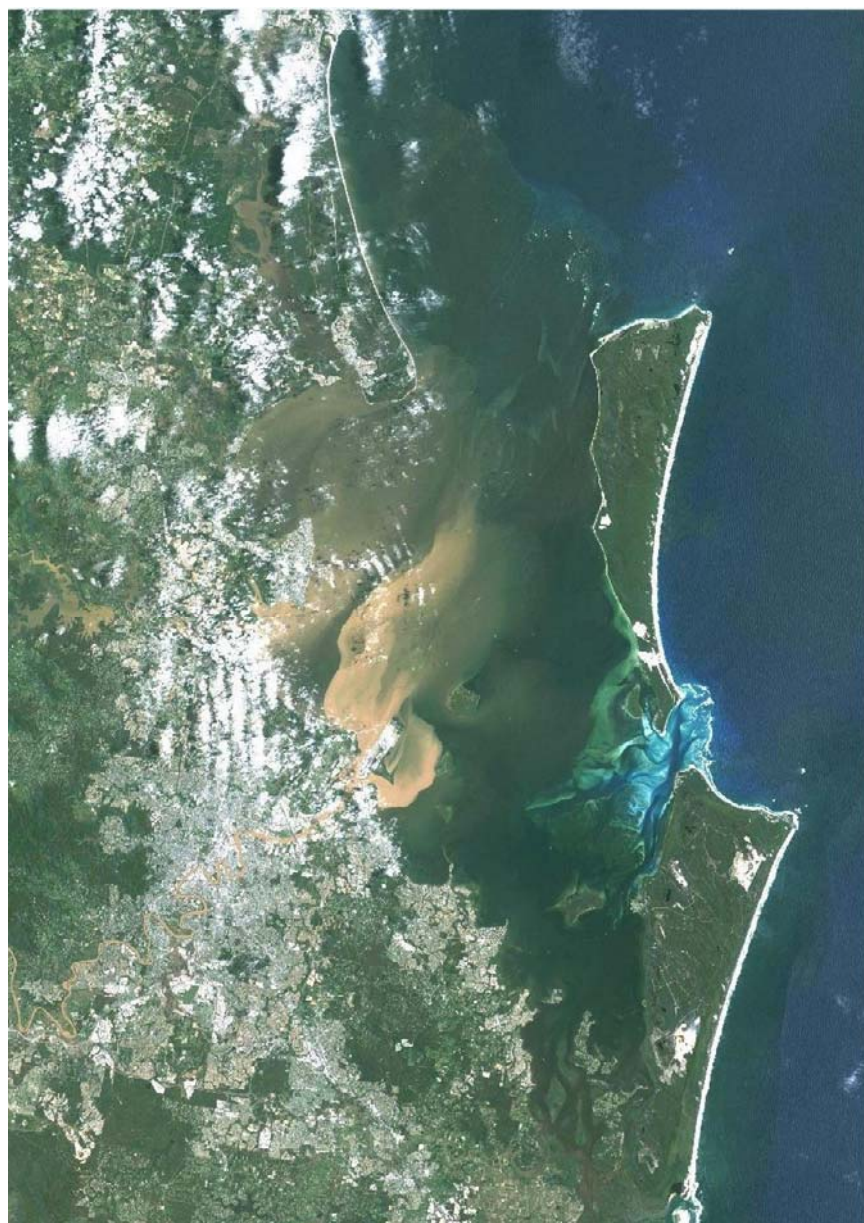
An extensive flood plume made up of nutrient and total suspended solid loads from South East Queensland catchments was generated. The flood plume extended to the north, south and east in Moreton Bay due to tidal influences and river in-flows. During the outgoing tides the plumes extended north beyond Bribie Island and south towards Peel Island, while during incoming tides the plumes contracted toward the mouth of the Brisbane River (Figure 28).

The South East Queensland Event Monitoring Program showed that during the extreme weather events from 6–16 January 2011, just over three times the calculated average annual sediment load was discharged in the 10 days of wild weather. In some catchments, the load was even greater with the Logan catchment delivering approximately 10 times the average annual sediment load (SEQEM, 2011).

Comparisons with catchment modelling estimates of total mean annual loads of sediment run-off from non-urban areas into the bay undertaken in 2011 indicate that just over three times the average annual sediment loads were discharged in these 10 days of wet weather (SEQEM, 2011).

The 2011 floods also created risks to public health due to the overflowing of and damage to sewerage treatment plants located in the Brisbane and Bremer River catchments. Released waters contained debris, chemical waste and untreated sewage, all of which can pose a public health risk. The sewerage treatment plants were restored to full capacity 10 weeks after the flood reducing the human health risk. The flood drew attention to the recreational use of waterways and the need to educate the community about levels of bacteria and viruses in waterways after rainfall events.





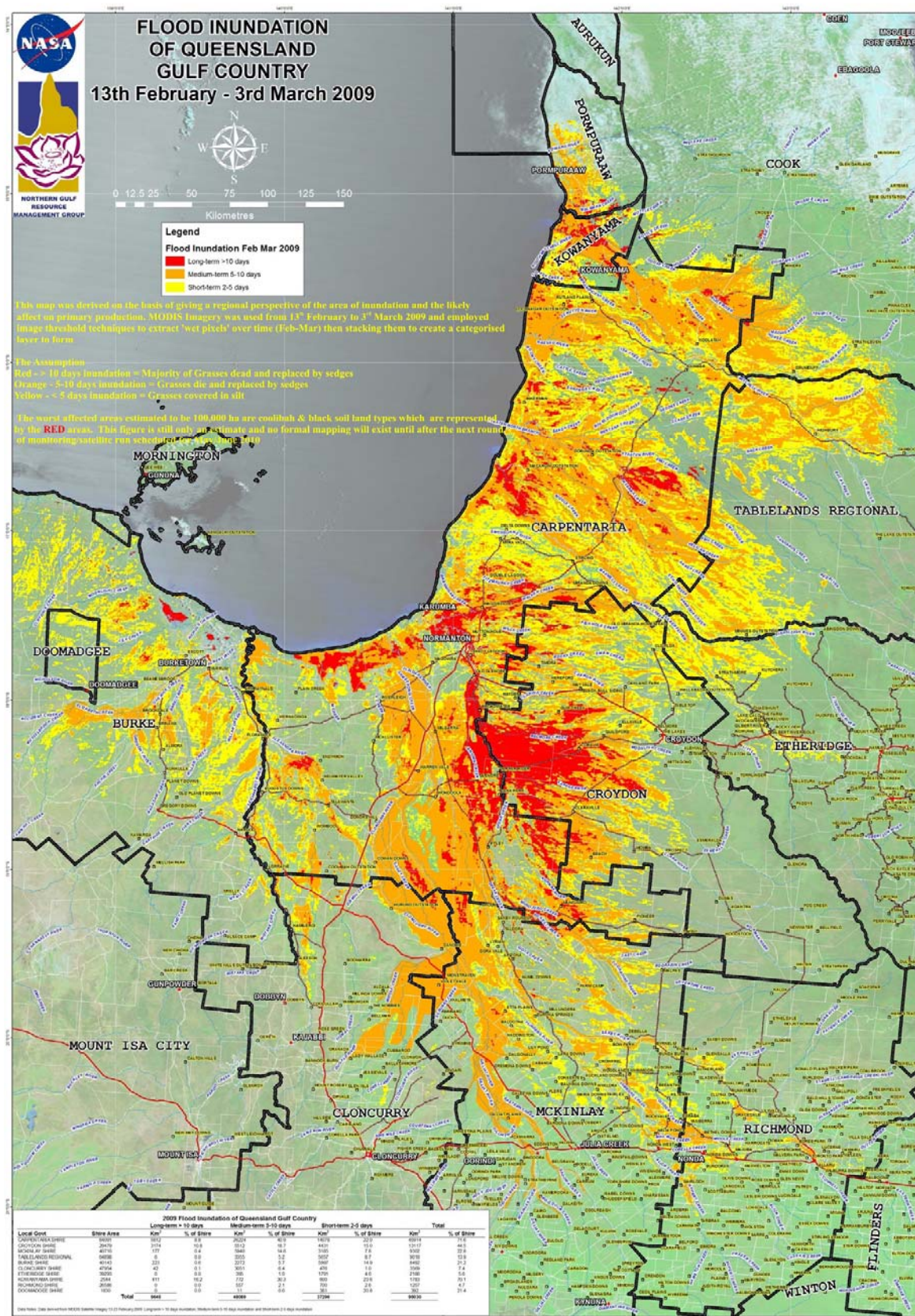
**Figure 28. Landsat satellite image 16 January 2011 showing the flood plume for an incoming tide at the mouth of the Brisbane River into Moreton Bay.**

### 3.12.3 Northern Gulf flood

The Northern Gulf region is a major contributor to Queensland's economy. The estimated value of exports from the gulf area are \$278 million for agriculture, \$69.5 million for the fishing industry, \$50 million for the tourism industry and unaccounted hundreds of millions for the mining industry (NGRMG, 2010, 2009).

In January 2009, the far northern Queensland pasture lands of the Gulf of Carpentaria experienced extreme flooding and long periods (>10 days) of inundation (Figure 29). The effect on the region not only included human and animal welfare issues, but also medium and long-term environmental damage. This included large scale impacts on native savannah habitats and dependent fauna. High mortality of aquatic flora and fauna was compounded by high nutrient loads entering waters over the entire catchment (NGRMG, 2010, 2009).





Source: NGRMG, 2009. Note: Inundation areas are described as: 'long-term' (i.e. >10 days; red); 'medium-term' (i.e. 5–10 days; orange) and 'short-term' (i.e. 2–5 days; yellow).

**Figure 29. Inundation map of the Gulf of Carpentaria region for the period 13 February–3 March 2009.**

### 3.12.4 Floods and cyclones affecting the Great Barrier Reef

Major flooding from December 2010 to January 2011 affected the southern area of the Great Barrier Reef, while Tropical Cyclone Yasi (category five) in early February 2011 caused damage across 89 090 km<sup>2</sup> of the Great Barrier Reef Marine Park (GBRMPA, 2011).

In February and March 2011, the Great Barrier Reef Marine Park Authority (GBRMPA), in partnership with the former Queensland Parks and Wildlife Service (QPWS) and the Australian Institute of Marine Science, and supported by other partners including the tourism and commercial fishing industries, surveyed coral reefs exposed to the destructive force of Tropical Cyclone Yasi (GBRMPA, 2011).

The effect of Tropical Cyclone Yasi on coral reefs was found to be highly variable, ranging from little damage to 90 per cent within the same reef area. In the Great Barrier Reef Marine Park, 15 per cent of the total area incurred some coral damage, while six per cent was severely damaged (GBRMPA, 2011). Most of the damage occurred between Cairns and Townsville. Reefs beyond the northern limit of the destructive wind band (around Port Douglas) appear to have escaped severe damage, although tourism operators reported minor damage at some sites, especially those characterised by high cover of fragile branching and plate corals. Surveys of inner shelf reefs between Townsville and the Whitsundays recorded low levels of recent reef damage.

More than 10 000 km<sup>2</sup> of the Fitzroy Basin was submerged by flooding rains in late 2010 and early 2011. Thousands of homes and businesses were inundated and vast areas of agricultural land were swamped by water (FBA, 2011). The environment suffered significant damage as a result of the flooding and receding water exposed new and large areas of bare ground.

The flood plume event from the Fitzroy and Burnett rivers affected the inshore areas of the Great Barrier Reef, initially off the Capricorn Coast near Rockhampton. The plume spread moved north and offshore from the Fitzroy and Burnett rivers. It extended to the southern end of the Mackay–Whitsunday region with a maximum extent covering up to 11 per cent of the entire reef system.

The degree and severity of impact is expected to be severe, particularly at nearshore reef systems, such as around the Keppel Islands. A record amount of 30 million ML of water discharged from the mouth of the Fitzroy River and carried contaminants, topsoil and debris out to the Great Barrier Reef, placing pressure on this fragile ecosystem (FBA, 2011).

### 3.12.5 The ‘Red Dawn’ dust storm

Commencing on 23 September 2009, a large dust storm swept across eastern Australia, extending along a 2500 km front from the New South Wales–Victorian border to the Gulf of Carpentaria. Driven by an intense low pressure cell, the storm moved across eastern Australia sweeping large quantities of dust from the drought-ravaged rangelands of South Australia, New South Wales and Queensland. At its maximum extent, the dust storm covered approximately one million km<sup>2</sup>, extended to 1.5–2.5 km in height and transported an estimated 12.1–17.5 million tonnes of sediment (Strong, 2011).

The millennium drought experienced across eastern Australia made large areas of rangelands, particularly in South Australia, North West New South Wales and western Queensland vulnerable to wind erosion. The drought, coupled with grazing pressure, reduced vegetation cover below critical levels for wind erosion protection. Once strong winds entrained sediment in South Australia, the rolling dust cloud abraded its way across the country acting in effect like a large broom, easily removing soils from areas with minimal vegetation protection.

In addition to the rangelands, the fine sediments deposited by Channel Country floods earlier in the year also contributed to the dust load. The floods distributed fine sediment over the floodplains and with drying and low vegetation cover, the sediment could be removed with the wind (Strong, 2011).





Source: Photographer K. Walton.

**Photo 4. View from Mt Coot-tha outlook in Brisbane on a clear day and during the 23 September 2009 dust storm.**

### 3.13 Pressures on cultural heritage

Cultural heritage can be physically damaged by a range of natural pressures. These pressures may include seasonal and cyclical variations in weather and climate, natural ageing and breakdown of materials, and natural disasters and hazard events, such as floods, cyclones and fires. In addition, human-induced (anthropogenic) pressures can also affect cultural heritage.

The key anthropogenic pressures on cultural heritage are:

- unauthorised collection
- wear and tear as a result of a place or item being the subject of tourism and recreation pressure
- lack of care and maintenance of known sites and artefacts
- development for residential housing, industry and infrastructure
- land clearing.

These pressures are particularly problematic where there are unidentified heritage places and artefacts, or where there is a minimal understanding about the condition of known heritage.

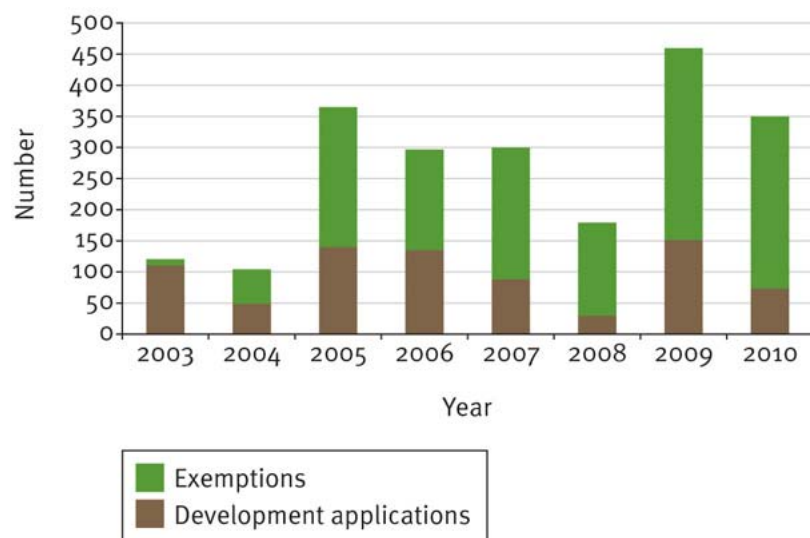
#### 3.13.1 Development activity

Queensland is experiencing rapid growth and this growth results in development pressure on heritage places (Figure 30). The level of development activity fluctuates from year to year, as does the use of exemption certificates, although the number of exemption certificates does seem to have increased since 2003. Exemption certificates are used for works that have a minimal impact on the heritage significance of the place.

Development pressure on heritage places is not consistent across Queensland. Different areas of the state experience different levels of population growth, building construction and mining activity (Figure 31).

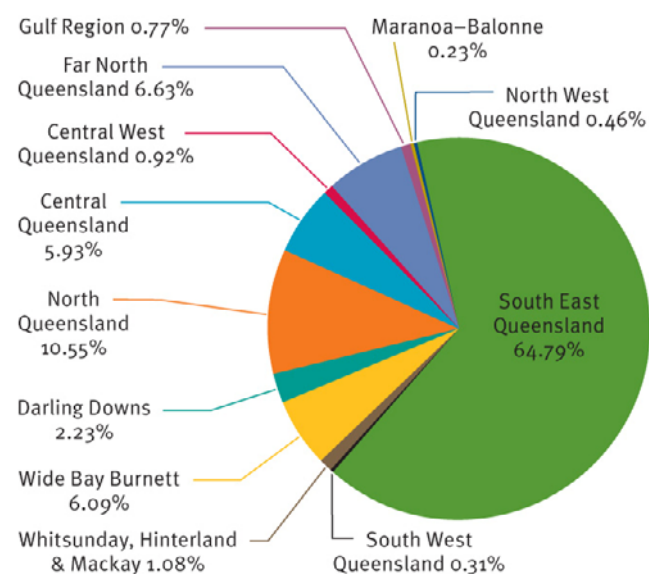
South East Queensland has by far the largest amount of development activity in the state impacting on places entered in the Queensland Heritage Register. This is followed at some distance by North Queensland.

While this generally reflects the level of development activity, it also has close parallels with the number and distribution of places entered in the Queensland Heritage Register. It demonstrates the importance of completing a systematic process for the identification of heritage places across Queensland, so that regional gaps in the Queensland Heritage Register are addressed.



Source: DERM, Queensland Heritage Register.

**Figure 30. The number of development applications and exemption certificates for places entered into the Queensland Heritage Register for the period 2003–2010.**

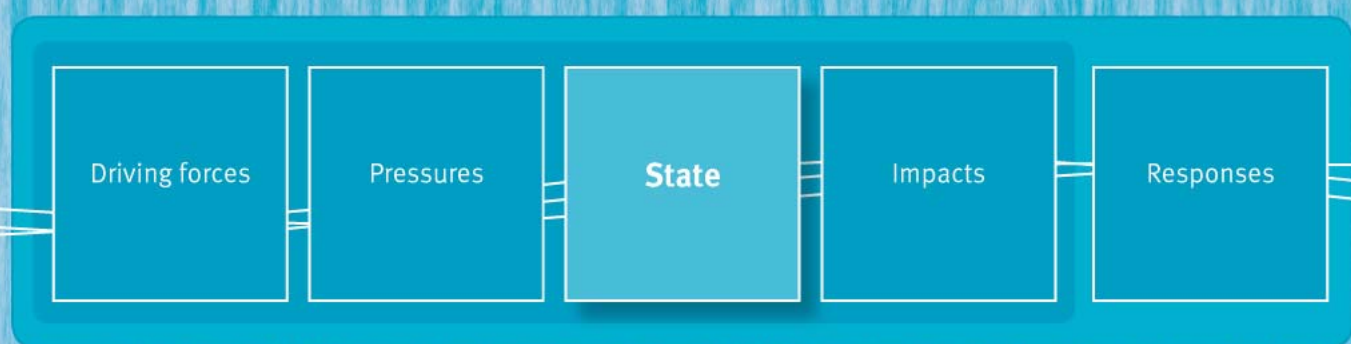


Source: DERM, Queensland Heritage Register.

**Figure 31. Development applications and exemption certificates for places entered in the Queensland Heritage Register (2005–2010) by region.**



## 4 State



The state of the environment refers to its extent, condition, quality and/or quantity at a particular point in time. The state is influenced by current and past pressures, both human-induced and natural, and long-term trends are desirable when assessing state. If the environment has been damaged, benchmarks from which to determine the degree of damage and rates of recovery are also important.

The following section discusses the status of Queensland natural and cultural assets, including atmosphere, water, land and cultural heritage.

## 4.1 Atmosphere

The atmosphere is the envelope of air surrounding the earth. It is essential for life, providing the air that we breathe, regulating climate, and protecting us from the sun's damaging ultraviolet radiation. Presented below is a summary of Queensland's climate variability and air quality.

### 4.1.1 Climate

The earth's climate system is complex and controlled by the exchange and storage of energy through the ocean, land, atmosphere and snow or ice. The climate system is finely balanced and changes to any of these components can lead to significant changes in global and regional climate. Climate is how the atmosphere behaves over long periods of time. It is characterised by the average of variables such as temperature, rainfall and evaporation and how these variables change over years, decades and centuries. Extreme events are infrequent and are often high impact events that fall at the high or low end of the range of values for a particular variable. Extreme events commonly studied include droughts, hot days, extremely high rainfall and tropical cyclones.

Climate variability is the variation in the mean state of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural processes within the climate system or natural or human-induced variations in external factors, such as solar variations or greenhouse gases respectively.

#### 4.1.1.1 Rainfall

Queensland's rainfall is highly variable and is strongly influenced by seasonal variations, such as the summer monsoon, year-to-year fluctuations in the climate system, such as the El Niño Southern Oscillation, and multi-year cycles such as the Interdecadal Pacific Oscillation (IPO). These features of Queensland's climate provide much of the variability observed in Queensland rainfall. For example, El Niño conditions have long been associated with lower than average seasonal rainfall in eastern Australia, and La Niña conditions with above average seasonal rainfall. However, this is not always the case as other features of the climate system, such as the IPO, also influence Queensland's rainfall (Murphy and Ribbe, 2004). The impact of human activities on these climate features and, thus, on rainfall in Queensland, is an area of ongoing research. For example, it is not yet clear how climate change will affect the frequency of El Niño and La Niña years.

The year 2010 was the wettest year on record for Queensland, with a total rainfall of 1110 mm averaged over the state (BoM, 2011c). At the start of 2010, El Niño conditions prevailed in the Pacific Ocean; however towards the end of 2010 there was a shift to a strong La Niña that resulted in higher than average rainfall across the state and South East Queensland and inland areas experienced severe flooding.

Indicators of La Niña conditions showed that this La Niña event was the strongest at least since the mid-1970s and one of the four strongest in the last century. Previous strong La Niña events, such as those in 1973–74 and 1955, were also associated with severe flooding in Queensland.

In 2011, Queensland experienced the seventh wettest year on record. Queensland's area averaged rainfall in 2011 was 826.8 mm (the highest since 2010), 72 per cent of the state had above average rainfall and some locations recorded their highest total rainfall on record. The central west, parts of the southern border districts (east of the channel country), and parts of the south-east coast (such as Brisbane and Coolangatta) had close to average rainfall (BoM, 2012).



#### 4.1.1.2 Cyclones

The linear trend in the number of severe tropical cyclones making landfall over eastern Australia has declined since the late 19th century (Callaghan and Power, 2010). This decline can be partially explained by a weakening of the Walker Circulation and a natural shift to a more El Niño dominated era. The extent to which global warming might be partially responsible for this decline is unknown.

North Queensland experienced its largest and most intense cyclone since 1918. Category five Tropical Cyclone Yasi was 500 km wide with an eye 30 km in diameter.

Tropical Cyclone Yasi crossed the coast near Mission Beach at approximately 00:30 AEST on 3 February 2011. Estimated wind gusts were up to 285 km per hour with maximum recorded winds up to 185 km per hour. The coastal communities of Tully, Mission Beach, Cardwell and Dunk Island in the direct path of Tropical Cyclone Yasi suffered extensive damage.

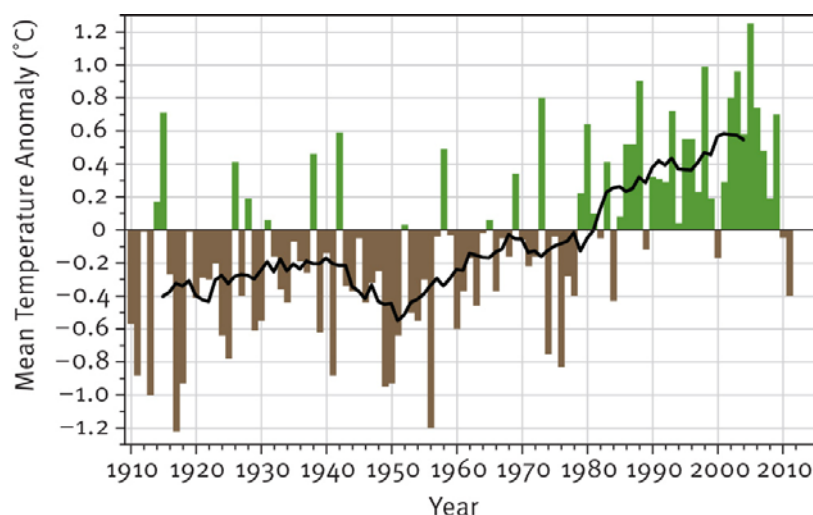
#### 4.1.1.3 Temperature

The 10 years from 2002 to 2011 were Australia's equal-warmest 10-year period on record (BoM, 2012).

In 2011, for the first time since 2002 (also a La Niña year), Australia's annual mean temperature was below the 1961–1990 average (BoM, 2012). Queensland experienced the lowest area-averaged annual mean temperature since 1984, with below average mean temperatures stretching from the west to the coast across the central part of the state. On 9 June, three locations in South East Queensland recorded their lowest daily maximum temperature.

Over the period 1955–2005 the number of hot days (days with a maximum temperature greater than 35°C) and hot nights (nights with a minimum temperature less than 20°C) increased over Australia, while cold days and cold nights decreased (CSIRO and BoM, 2007).

Figure 32 shows the warming trend for Queensland, which is slightly higher than the global trend (BoM, 2011a). The average surface temperature in Queensland has risen by almost 0.9°C since early last century. In the last two decades to 2011, Queensland experienced three years with an annual mean temperature below the 1961–1990 average. Temperatures in Queensland over the decade 2001–2010 averaged 0.52°C above the 1961–1990 mean (BoM, 2011a).



Source: BoM, 2011a. Note: The black line indicates the running 11-year average.

**Figure 32. Time-series (1910–2011) of Queensland's annual mean surface temperature anomalies.**

#### 4.1.1.4 Evaporation

There is large spatial variability in annual evaporation trends across Queensland. The Gulf region has experienced a decline in evaporation, while South West Queensland has experienced an increase. During high evaporation conditions, a small decline in rainfall has a substantial effect on soil moisture and water storages by decreasing water availability.



### 4.1.2 Air quality

Air quality in Queensland is generally good, with very few exceedences of national standards or guidelines for the pollutants monitored by the Queensland Government. There are exceptions where there are significant industrial or transport related emissions and these are discussed below.

Air quality is determined by the quantity and location of the pollutants emitted, chemical transformations in the atmosphere (e.g. photo-chemical formation of O<sub>3</sub>), and the ability of the atmosphere to transport or disperse emissions. In calm, stable conditions the air may remain still, allowing the pollutant to build up to elevated levels. Conversely, windy, turbulent conditions act to disperse the pollutant. Weather conditions cannot be controlled, so management of the pollutant emissions, supported by modelling and forecasting of meteorological conditions, is the key to minimising air pollution.

The Queensland Government's network of 30 ambient air quality monitoring stations measure the concentration of various air pollutants at sites that are target areas near the sources of pollution, as well as at sites that represent background levels of air pollution. Air toxics are a diverse range of air pollutants that are usually present in ambient air in relatively low concentrations but have characteristics, such as toxicity or persistence, which make them a hazard to human, plant or animal health. Concentrations of the pollutants and air toxics are assessed against set standards and goals.

The pollutants measured include those identified as 'criteria pollutants' under the National Environment Protection Measure for Ambient Air Quality 1998 (Air NEPM), photochemical oxidants (measured as O<sub>3</sub>), particles (measured as PM<sub>10</sub> and PM<sub>2.5</sub>), NO<sub>2</sub>, CO, SO<sub>2</sub> and lead. Visibility is monitored for comparison with the visibility objectives in the Environmental Protection (Air) Policy 2008 (Air EPP). Air toxics are sometimes referred to as 'hazardous air pollutants' to distinguish them from 'criteria' air pollutants. Air toxics included under the National Environment Protection Measure for Air Toxics 2004 (Air Toxics NEPM) —benzene, toluene, xylene, formaldehyde and polycyclic aromatic hydrocarbons (PAHs) (measured as benzo(a)pyrene (BAP)), are also monitored. A summary of the trends in levels of air pollutants, visibility and air toxics reported against NEPM standards is provided in Table 3.

**Table 3. Longer term trends in levels of ambient air quality indicators and air toxics reported against Air NEPM standards and Air EPP objectives.**

Indicators	Status
<b>Air pollutants</b>	
Ozone	Ozone is the key pollutant used to quantify 'photochemical smog'. Ozone levels in South East Queensland, Gladstone and Townsville have not exceeded air quality standards in the last five years. This is a result of the absence of weather patterns favourable to the formation of ozone and/or low concentrations of precursor pollutants (VOCs and NO <sub>x</sub> ).
Particles	<p>Particles include dust, dirt, soot, smoke, and liquid droplets. Particle pollution is the major cause of reduced visibility and exposure can lead to a number of health problems including respiratory illnesses. Periods of elevated particle levels have occurred in all areas of Queensland where monitoring takes place, largely as a result of events such as dust storms and bush fires.</p> <p>PM<sub>10</sub> refers to particles with a diameter of less than 10 micrometres (µg). Monitoring of PM<sub>10</sub> is currently undertaken in South East Queensland, Gladstone, Mackay, Townsville and Mount Isa. Breaches of the Air NEPM PM<sub>10</sub> goal (&lt;5 days per year when PM<sub>10</sub> levels were above the Air NEPM standard of 50 µg/m<sup>3</sup>) were caused by major dust storms and/or bushfires during 2002, 2003, 2005 and 2009. While there have been no apparent trends in levels of PM<sub>10</sub> in South East Queensland, background levels were higher during the drier than average years prior to 2010 due to greater amounts of wind-blown dust in the atmosphere.</p> <p>PM<sub>2.5</sub> refers to particles with a diameter of less than 2.5 µg. Monitoring of PM<sub>2.5</sub> for South East Queensland and Gladstone show that exceedences of standards have been low (&lt;5 days per year) and primarily result from smoke from vegetation burning.</p>
Visibility	Overall there has been a downward trend in the number of days with reduced visibility throughout Queensland. Reasons for this improvement include industry emission control requirements, progressive tightening of new motor vehicle exhaust emission standards, greater restrictions on residential backyard burning, coordinated hazard-reduction burning programs and the increasing proportion of sugar cane harvested green.
Nitrogen dioxide	Nitrogen dioxide is an important air pollutant because it contributes to the formation of photochemical smog. The major source is the burning of fossil fuels. In the past decade there have been no exceedences of the Air

Indicators	Status
	NEPM air quality standard anywhere that monitoring is carried out in Queensland. Normal ambient levels have shown static or declining trends, with ambient concentrations rarely reaching half of the Air NEPM air quality standard.
Carbon monoxide	High levels of carbon monoxide are poisonous to humans. It has no taste or smell and cannot be seen. In the past decade there have been no exceedences of the Air NEPM air quality standard anywhere that monitoring is carried out in Queensland. Normal ambient levels have shown static or declining trends, with ambient concentrations rarely reaching half of the Air NEPM air quality standard.
Sulfur dioxide	Sulfur dioxide reacts easily with other substances to form harmful compounds, such as sulfuric acid, sulfurous acid and sulfate particles. In the past decade there have been no exceedences of the Air NEPM air quality standard anywhere that monitoring is carried out in Queensland except Mount Isa, where a major emitter of this pollutant is located. As smelter operations were until recently only controlled to meet <i>Mount Isa Mines Limited Agreement Act 1985</i> air quality limits, sulfur dioxide levels have exceeded the more stringent Air NEPM 1-hour and 24-hour standards on occasions. The 1-hour average sulfur dioxide levels have shown no apparent trends over 30 years of monitoring, with the Air NEPM standard exceeded about 0.5 per cent of the time. Annual average sulfur dioxide levels in residential areas remain consistently below the Air NEPM annual average standard.
Lead	<p>Lead is absorbed if dust or fumes that contain lead are swallowed or breathed in. Small children and unborn babies are most at risk because they are smaller, their bodies are still developing and they can store as much as 50 per cent of the lead that they swallow. Lead used to be added to petrol and this was the source of high levels of lead in the air. Significant reductions in the levels of air-borne lead have been achieved as the result of national legislation to remove lead from petrol.</p> <p>Lead is monitored in Mount Isa and Townsville, the areas where there are industrial sources of lead emissions. There have been no exceedences of the Air NEPM air quality standard for lead in Townsville. There is a downward trend in lead levels measured in Mount Isa since 2003. There have been no exceedences of the air quality limit for lead set in the <i>Mount Isa Mines Limited Agreement Act 1985</i> since 2003 and lead levels complied with the Air NEPM annual average standard at all monitoring sites in Mount Isa during 2010.</p>
<b>Air toxics</b> (measured in South East Queensland and Gladstone)	
Benzene	Annual mean benzene levels have been well below the monitoring investigation level in the Air Toxics NEPM of 3 parts per billion (ppb).
Toluene	Levels for both the 24-hour maximum and the annual mean are far below the monitoring investigation levels in the Air Toxics NEPM of 1000 ppb and 100 ppb respectively.
Xylene	Levels for both the 24-hour maximum and the annual mean are far below the monitoring investigation levels in the Air Toxics NEPM of 250 ppb and 200 ppb respectively.
Formaldehyde	Levels have been well below the 24-hour monitoring investigation level in the Air Toxics NEPM of 40 ppb.
Polycyclic aromatic hydrocarbons	The levels of benzo(a)pyrene (used as a marker for PAHs) were well below the monitoring investigation level in the Air Toxics NEPM of 0.3 ng/m <sup>3</sup> (annual mean).

Source: DERM, 2011f, pers. comm.

## 4.2 Water and aquatic ecosystems

Queensland is a large state with diverse waterways supporting complex and unique ecosystems. Many of these waterways provide water for human uses, including drinking, recreation, agriculture and industry.

Monitoring provides important information to sustainably manage water resources, catchments and the environment. The monitoring programs vary in scale—some provide information at a statewide level, while others focus on regions where there are significant policy and management issues and an associated risk to the waterways. Incident-based monitoring is implemented on a needs basis (e.g. oil spills and mining dam overflows).

### 4.2.1 Wetland distribution and extent

The definition of wetland is synonymous with aquatic ecosystem and will be used throughout this document in that context. Wetlands are widespread throughout Queensland and support the most diverse freshwater fish fauna of any Australian state, as well as 210 species of waterbirds, both resident and migratory, and more than 3000 species of plants.

In 2009, Queensland supported around 6.8 million ha of natural or near natural wetlands, which covered about 3.9 per cent of the state. The total area of wetlands comprised 3.11 million ha of palustrine wetlands (e.g. swamps), 1.92 million ha of riverine wetlands, 1.21 million ha of mangroves and saltflats and 0.55 million ha of non-artificial lacustrine wetlands (e.g. lakes) (Table 4). The greatest area and density of wetlands in Queensland is in the more arid Gulf, Lake Eyre and Bulloo drainage divisions.

Historical loss of wetlands (per cent of pre-clearing extent) across the state was five per cent, although there was a much greater loss of palustrine and riverine wetland systems in coastal areas. Loss of wetlands over the 2001–05 period was 6790 ha, which has reduced to 1890 ha over the 2005–09 period. These net figures included gains in the extent of lacustrine wetlands of 120 ha and 90 ha for each period due to modifications associated with levee construction. The highest losses were in the palustrine (2370 and 800 ha) and riverine (4290 and 1100 ha) systems. These losses were mainly due to draining, clearing and levelling associated with intensive agriculture and urbanisation in lowland parts of catchments.

Changes in wetland condition or health have not been comprehensively monitored. Thus, the extent of wetlands reported here may include areas that have been degraded by grazing, hydrological modification within their catchment, invasion by exotic weed species or other factors that reduce wetland function and value.

Mangrove and seagrass extent has been relatively stable in the recent past, although their condition is declining in some cases and they are at ongoing risk from agricultural run-off and urban and port infrastructure development in certain locations in Queensland. Recent flooding has had a significant impact on both mangroves and seagrass meadows.

#### Wetland systems

- Palustrine (e.g. vegetated swamps) systems are generally wetlands with greater (>) than 30 per cent emergent vegetation cover and less (<) than 8 ha.
- Lacustrine (lakes) systems are wetlands that are >8 ha with <30 per cent emergent vegetation cover (but excluding riverine channels and associated fringing vegetation). Areas of open water <8 ha are classified as lacustrine if the water is >2 m deep. Artificial and highly modified lacustrine systems (mainly dams) are reported separately from the unmodified or less modified lacustrine systems.
- Riverine (and fringing riverine) systems are wetlands that include channels of rivers and other water courses and includes the wetland vegetation that fringes these systems.
- Estuarine systems are wetlands in coastal areas that are tidally inundated and dominated by mangrove or saltflat communities. These wetlands do not include coastal waters and embayments, or other estuarine channels and waters.

Note: subterranean and marine wetland systems have not been included in this section of the report.

(For further information about wetlands, refer to *WetlandInfo* via <[www.ehp.qld.gov.au](http://www.ehp.qld.gov.au)>).

#### 4.2.1.1 Wetland changes by drainage division

At the drainage division scale, historical loss (per cent of pre-clearing extent) by wetland system ranged from 0–30 per cent (30 per cent being palustrine wetland systems in the East Coast drainage division) (Table 4). For all of Queensland, the greatest losses occurred in the palustrine (four per cent) and riverine (seven per cent) wetland systems and occurred in the Murray–Darling Basin (15 per cent) and the East Coast (19 per cent) drainage divisions (Table 4).

Generally there is little change in extent of wetlands compared to the pre-clearing extent in the Bulloo, Lake Eyre, Gulf Rivers and the Cape York (north of Cairns) part of the East Coast drainage divisions (Table 4).

In 2009, in addition to the natural or near natural wetlands, there were approximately 293 200 ha of artificial and highly modified (e.g. dams) wetlands in Queensland. These occur in the greatest density in the Murray–Darling Basin and East Coast divisions. Over the 2001–05 period the area of dams increased by 13 566 ha, mainly in the same divisions, and by a further 4024 ha over the 2005–09 period.

**Table 4. Current (2009) extent , percentage of total area, percentage of pre-clear area and change over the 2001–2005 and 2005–2009 period for wetland systems by drainage division in Queensland\*\*\*.**

Drainage Division	Area, % of area & change (ch)	Estuarine	Lacustrine	Palustrine	Riverine	Total*	Dams
Total (all Qld)	area (ha)	1 213 320	549 080	3 113 750	1 912 000	6 795 140	293 170
	% of total area	0.7	0.5	1.8	1.1	3.8	0.2
	% of pre-clear	97	100	96	93	95	na
	ch 2001–2005 (ha)	-250	120	-2370	-4290	-6790	13 570
	ch 2005–2009 (ha)	-80	90	-800	-1100	-1890	4020
Bulloo	area (ha)	0	20 850	242 190	3 110	266 160	350
	% of area	0	0.4	4.7	0.1	5.1	0
	% of pre-clear	na	100	100	98	99	na
	ch 2001–2005 (ha)	na	0	-17	0	-17	4
	ch 2005–2009 (ha)	na	0	-21	0	-21	4
Gulf Rivers	area (ha)	657 050	18 310	778 590	800 370	2 254 310	21 210
	% of area	1.5	0	1.7	1.8	5.0	0
	% of pre-clear	100	97	100	99	100	Na
	ch 2001–2005 (ha)	0	-5	-270	-180	-460	1 080
	ch 2005–2009 (ha)	0	20	0	-50	-30	500
Lake Eyre	area (ha)	0	437 410	1 598 890	278 020	2 314 320	8 330
	% of area	0	0.9	3.1	0.5	4.5	0
	% of pre-clear	na	100	100	99	100	na
	ch 2001–2005 (ha)	na	15	-40	-90	-110	400
	ch 2005–2009 (ha)	na	0	-10	-60	-70	80
Murray Darling	area (ha)	0	48 680	142 680	136 360	327 720	82 180
	% of area	0	0.2	0.5	0.5	1.2	0.3
	% of pre-clear	na	95	92	83	85	Na
	ch 2001–2005 (ha)	na	-5	-900	-1230	-2140	3930
	ch 2005–2009 (ha)	na	0	-240	-370	-620	790
(North) East Coast	area (ha)	439 180	22 520	318 000	699 900	1 479 600	180 440
	% of area	1.0	0.1	0.7	1.6	3.3	0.4
	% of pre-clear	92	98	70	81	81	na
	ch 2001–2005 (ha)	-250	120	-1140	-2790	-4060	7930
	ch 2005–2009 (ha)	-80	70	-510	-620	-1140	2570
Other**	area (ha)	117 090	1320	33 390	1 240	153 040	650
	% of area	17.1	0.2	4.9	0.2	22.4	0.1
	% of pre-clear	99	100	86	100	96	Na
	ch 2001–2005 (ha)	0	0	0	0	0	230
	ch 2005–2009 (ha)	-10	10	-15	0	-15	90

Source: Wilson and Pennay, 2011; and DERM, Wetlands Mapping, 2009c.

\*Total area does not include: marine wetlands; coastal waters and embayments; estuaries (estuarine channels and waters) or artificial and highly modified wetlands.

\*\* Other division includes Mornington, Torres Strait, Hinchinbrook, Curtis, Fraser, Moreton and Stradbroke islands, as well as many small Islands. It also includes slivers and artefacts resulting from discrepancies in catchment coverages and coastline.

\*\*\* Area figures rounded to nearest 10 hectares.



#### 4.2.1.2 Wetland changes by catchment

At the catchment scale, the historic loss of wetlands (per cent of pre-clear extent) is up to 70 per cent across the Murray–Darling and East Coast catchments. Catchments with the highest loss (<30 per cent of pre-clearing extent remaining, shown as dark blue in Figure 33a, are the South Pine, Bremer, Upper Burnett, Albert, Coomera, and Severn catchments.

Ongoing loss over the 2001–05 and 2005–09 periods continues in similar areas to where these historic losses have occurred. Catchments with the highest ongoing loss (>1 per cent of 2001 extent, as indicated by the red arrows in Figure 33a) include Maroochy, Warrego, Lower Burnett, Maranoa, Mackenzie, Coomera, Caboolture, Belyando and Mossman.

The historic (per cent of pre-clear extent) and current (2001–05 and 2005–09) loss of wetlands has mainly occurred due to drainage/clearing/levelling of lowland parts of catchments associated with intensive agriculture and urbanisation. The greatest losses have occurred in the palustrine and riverine systems. Lacustrine and mangroves/salt flats systems are not shown because of the relatively low loss in these systems, yet small losses in these systems can still have substantial impacts.

Loss of palustrine wetlands as a percentage of pre-clear extent is over 70 per cent in some catchments across the Murray–Darling Basin and East Coast catchment. Many of these catchments with the highest loss are smaller catchments with a high proportion of urban or agricultural land use. Catchments with the highest loss (< 15 per cent remaining, dark blue shaded catchments in Figure 33b, are the Calliope, South Pine, Coomera, Lower Burnett, Bowan and Kolan.

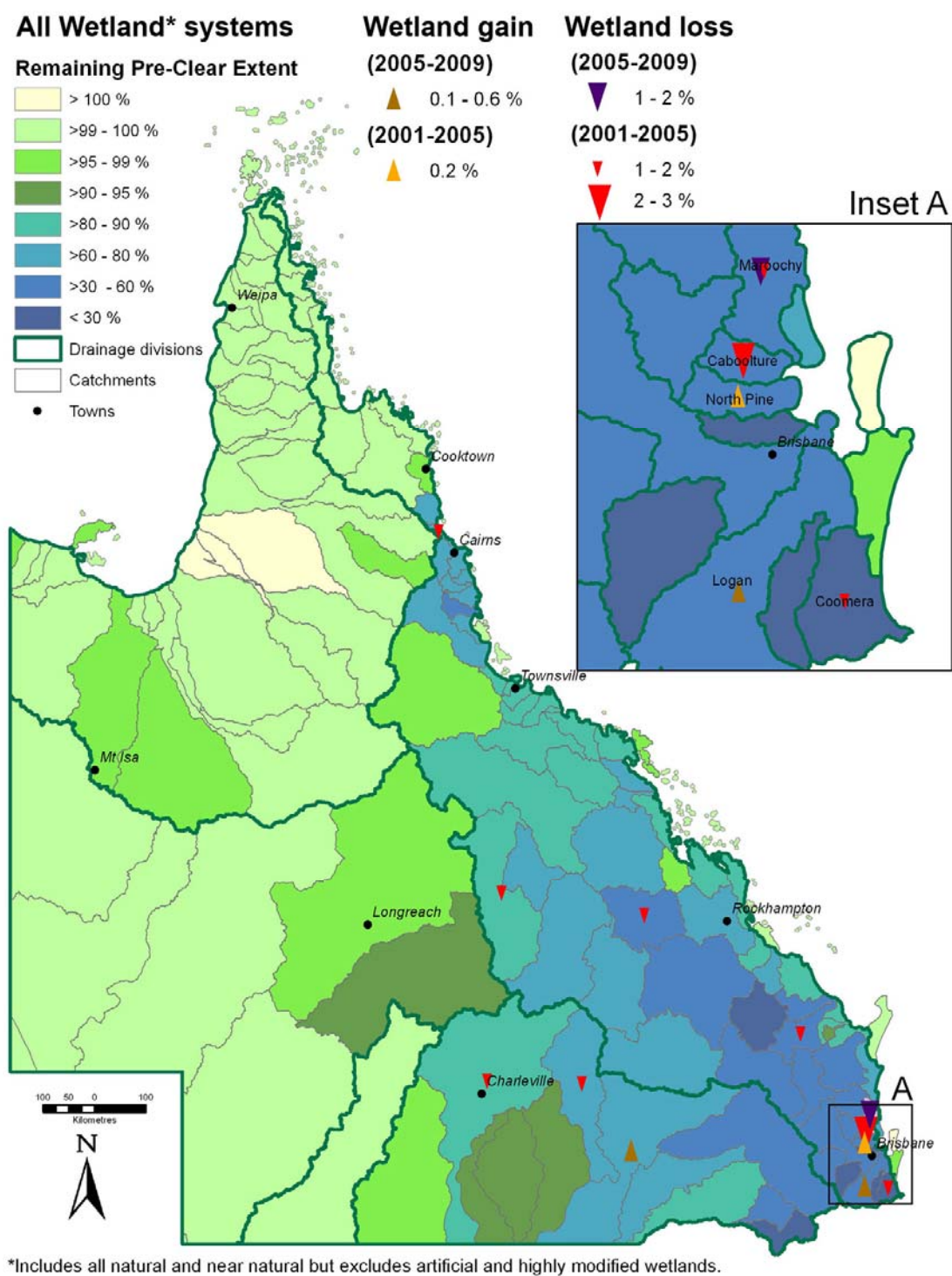
The Styx and Shoalwater catchments along the east coast have greater than 100 per cent of the pre-clearing extent (light yellow shaded areas Figure 33b) of palustrine wetlands remaining. This is associated with conversion of estuarine plains to freshwater wetlands by bunding, which is a common practice in many coastal catchments.

Ongoing loss of palustrine wetlands over the 2001–05 and 2005–09 periods continues in similar areas to where historic losses have occurred. Catchments with the highest ongoing loss (greater than five per cent of 2009 extent) are the Mossman, Caboolture and Coomera catchments, as indicated by the larger red arrows in Figure 33b.

Loss of riverine wetlands as a per cent of pre-clearing extent is over 70 per cent in some catchments across the Murray–Darling Basin and East Coast Division indicated by the dark blue areas in Figure 33c. Catchments with the highest loss (>85 per cent) are the North Pine and Bremer.

Ongoing loss of riverine wetlands over the 2001–05 and 2005–09 periods continues in similar areas to where historic losses have occurred. Catchments with the highest ongoing loss (greater than two per cent of 2001 extent indicated by the larger red arrows in Figure 33c) are the Paroo and Mossman.

a



**Figure 33. Change in the extent of (a) all wetland systems compared to pre-clearing extent and loss of wetlands over the 2001–2005 and 2005–2009 period for Queensland, (b) palustrine wetlands and (c) riverine and fringing riverine wetland.**

b

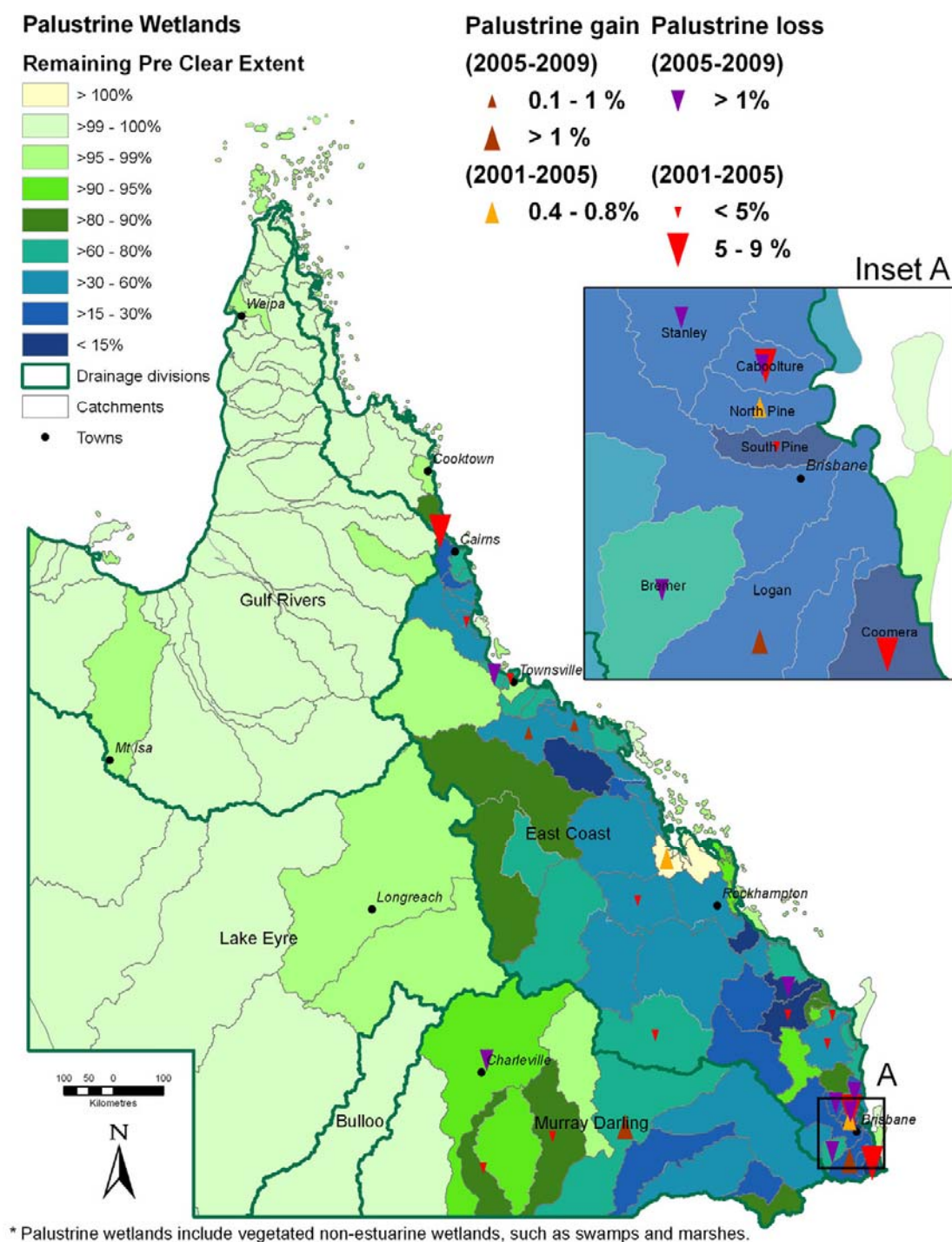
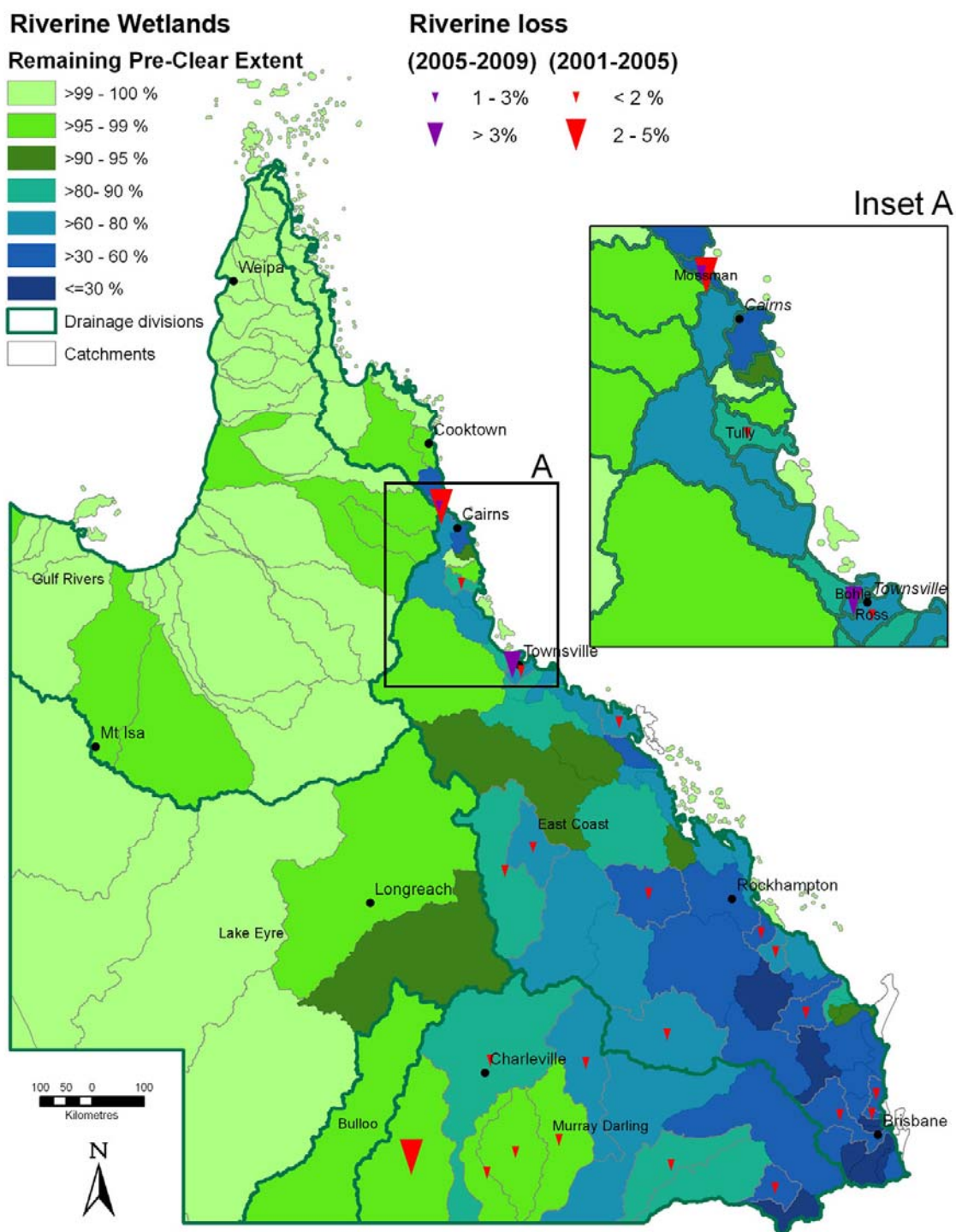


Figure 33. Change in the extent of (a) all wetland systems compared to pre-clearing extent and loss of wetlands over the 2001–2005 and 2005–2009 period for Queensland, (b) palustrine wetlands and (c) riverine and fringing riverine wetland.



c



Source: DERM, 2011g. Wetland Mapping of Queensland (Version 3.0, 2011).

**Figure 33. Change in the extent of (a) all wetland systems compared to pre-clearing extent and loss of wetlands over the 2001–2005 and 2005–2009 period for Queensland, (b) palustrine wetlands and (c) riverine and fringing riverine wetland.**

## 4.2.2 Riparian vegetation

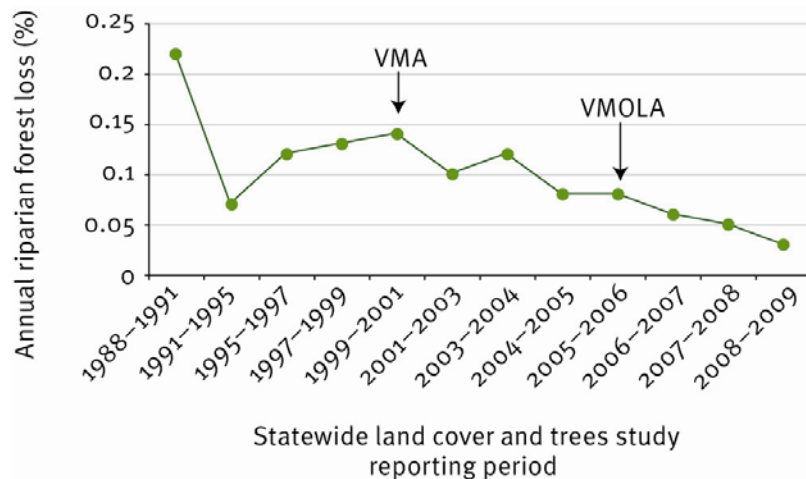
Riparian areas occur along watercourses, such as freshwater creeks, rivers and lakes. Vegetation in riparian areas is important for water quality (bank stabilisation and sediment and nutrient filtration), habitat, and food sources for aquatic and terrestrial fauna, as well as connectivity across the landscape (Barling and Moore, 1994).

Riparian areas were defined by a 50 m buffer around mapped drainage lines, water bodies and riverine wetlands (EPA, 2005) (see Reef Plan (2011) for more information on the methodology and limitations). These areas equate to 20.5 million ha—approximately 12 per cent of the state. Within this area, forest extent and change, as well as ground cover, were analysed. Forest is defined as woody vegetation with foliage projective cover (FPC)  $\geq 11$  per cent (Armston et al., 2009). This is equivalent to approximately 20 per cent canopy cover (Scarth et al., 2008), which is consistent with the National Forest Inventory's definition for forests (Montreal Process Implementation Group for Australia, 2008).

Forest loss in riparian areas was derived using land cover change data from the Statewide Landcover and Trees Study (SLATS) (DERM, 2011d).

In riparian areas with no woody vegetation or open canopies ( $<15$  per cent FPC), ground cover data were analysed. Current methods do not allow for the reliable estimation of ground cover in areas of denser canopies. Ground cover consists of all non-woody plant cover near the soil surface and all litter, including woody litter (Scarth et al., 2006).

In 2009, 66.12 per cent (approximately 13.6 million ha) of riparian areas were forested and areas with  $<15$  per cent FPC had a mean ground cover of 57.59 per cent. Since 1988, losses of riparian forests have generally been reducing annually (Figure 34). The average annual clearing total in the 1988–1991 SLATS reporting period was 0.22 per cent (45 127 ha). After this period, losses of riparian forests significantly declined in 1991–1995 and then peaked before the introduction of the *Vegetation Management Act 1999*. Following 2001, there has been a steady decline in losses of riparian vegetation, particularly after the introduction of the *Vegetation Management and Other Legislation Amendment Act 2004*.



Source: DERM, 2011d. Statewide Landcover and Trees Study (SLATS).

Note: The introduction of the *Vegetation Management Act 1999* in 2000 and the *Vegetation Management and Other Legislation Amendment Act 2004* (VMOLA) prohibiting broadscale clearing has seen a significant decrease in the rate of riparian vegetation clearing.

**Figure 34. Annual riparian forest loss within Queensland catchments.**

### 4.2.2.1 Riparian vegetation changes by major drainage division

Riparian areas in the Lake Eyre and Bulloo drainage divisions have the lowest proportion of riparian forest and ground cover in the state (Table 5). These areas are characterised by arid zone vegetation that have low woody vegetation cover and which may not meet the requirements for definition as riparian forest. Rates of loss of riparian forest in these areas are low, which is indicated in an earlier section of this report by Figure 33c showing the loss of riverine and fringing riverine wetlands (the riverine and fringing riverine wetlands differ as these include the drainage lines and the fringing native vegetation (woody and non-woody) communities immediately adjacent to the



channels, while the extent of these areas is not the same as the riparian areas described here, they are broadly comparable). The East Coast and Gulf drainage divisions have the highest proportions of riparian forests. The riparian areas in these regions are characterised by woody riparian vegetation communities with higher cover.

From 2005–09, the highest proportion of riparian forest loss occurred in the Murray–Darling drainage division with 0.7 per cent (10 711 ha) of riparian areas cleared. This was followed by the East Coast with 0.41 per cent (29 419 ha), Bulloo with 0.11 per cent (425 ha), Lake Eyre with 0.08 per cent (3760 ha) and Gulf with 0.04 per cent (2688 ha) of riparian areas cleared (Table 5).

Ground cover tends to be lower in more arid areas with lower rainfall, such as western Queensland. Table 5 shows that this is also the case for riparian areas.

**Table 5. 2009 riparian vegetation extent and 2005–2009 loss for major drainage divisions.**

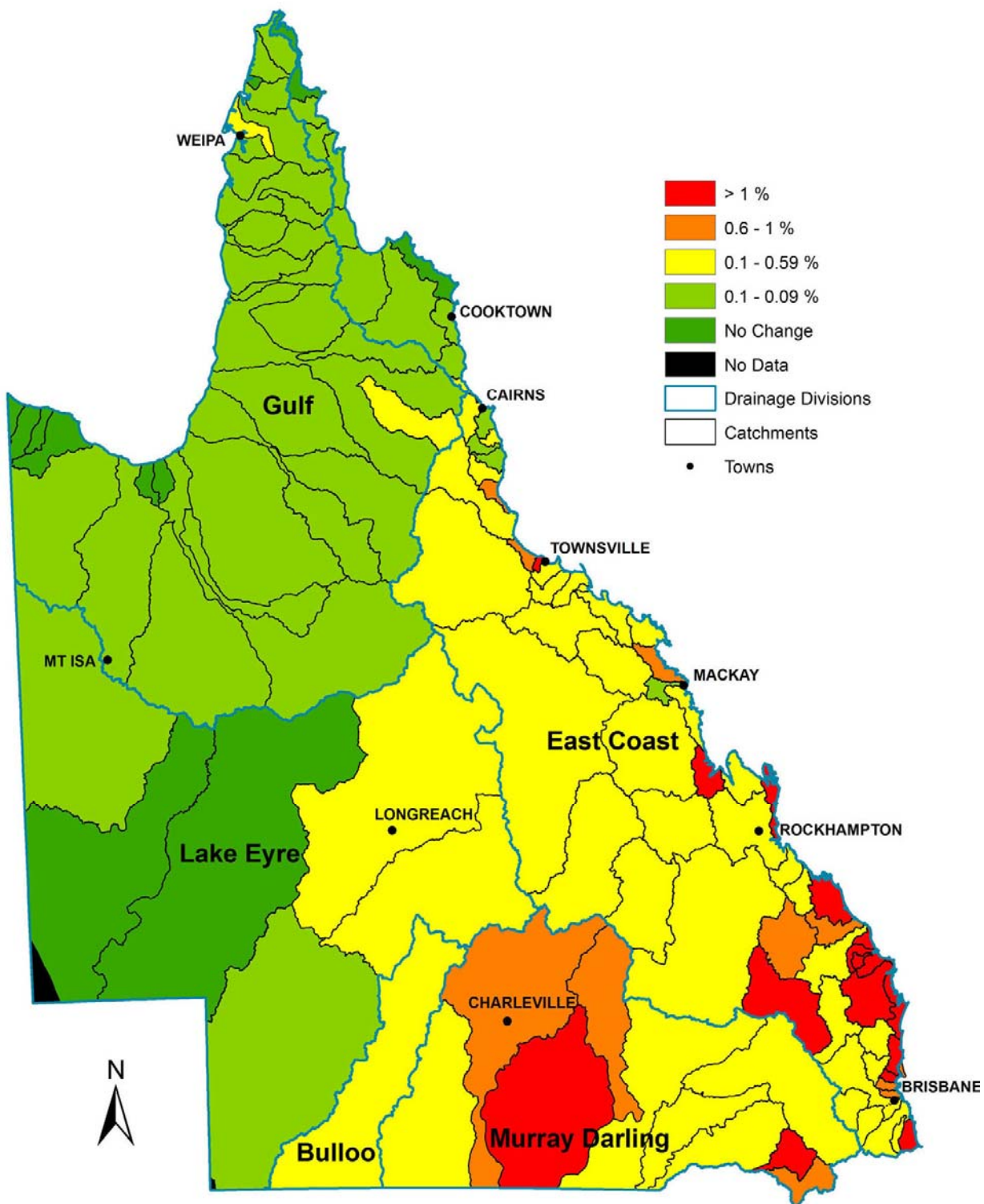
Division	Total riparian area	Forested riparian		Loss of riparian forest 2005–2009		Mean ground cover
	(ha)	(ha)	(%)	(ha)	(%)	(%)
Lake Eyre	4 460 007	1 383 790	31.03	3760	0.08	38.84
Bulloo	384 449	155 332	40.40	425	0.11	38.52
Murray–Darling	1 527 403	916 803	60.02	10 711	0.70	65.97
Gulf	6 889 578	5 419 770	78.67	2688	0.04	64.62
East Coast	7 249 241	5 685 047	78.42	29 419	0.41	79.90
Queensland	20 510 677	13 560 743	66.12	47 002	0.23	57.59

#### 4.2.2.2 Riparian vegetation changes by catchment

The catchments with riparian forest loss of less than one per cent between 2005 and 2009 were predominately found in the south and south-eastern Queensland (Figure 35a). These included Bohle River, Caboolture River, Burrum River, Elliott River, Maroochy River, Waterpark Creek, Wallam Creek, Gregory River, Baffle Creek, Boyne and Auburn Rivers, Macintyre Brook, Styx River, Coomera and Nerang rivers, Lower Mary River, Isis River and Noosa River. Most northern and western catchments had little or no loss of riparian forests.

The catchments with the highest proportion of riparian forests and ground cover were generally located in the north and along the east coast (Figure 35b and Figure 36). The arid south western catchments had the lowest proportion of riparian forest extent and ground cover. However, these catchments have historically had low forest cover and have experienced limited losses (Figure 35a). Within areas of greatest historical forest change (areas of blue in Figure 35b), the Balonne River, Bremer River and Condamine River catchments have the lowest proportion of riparian forests remaining.

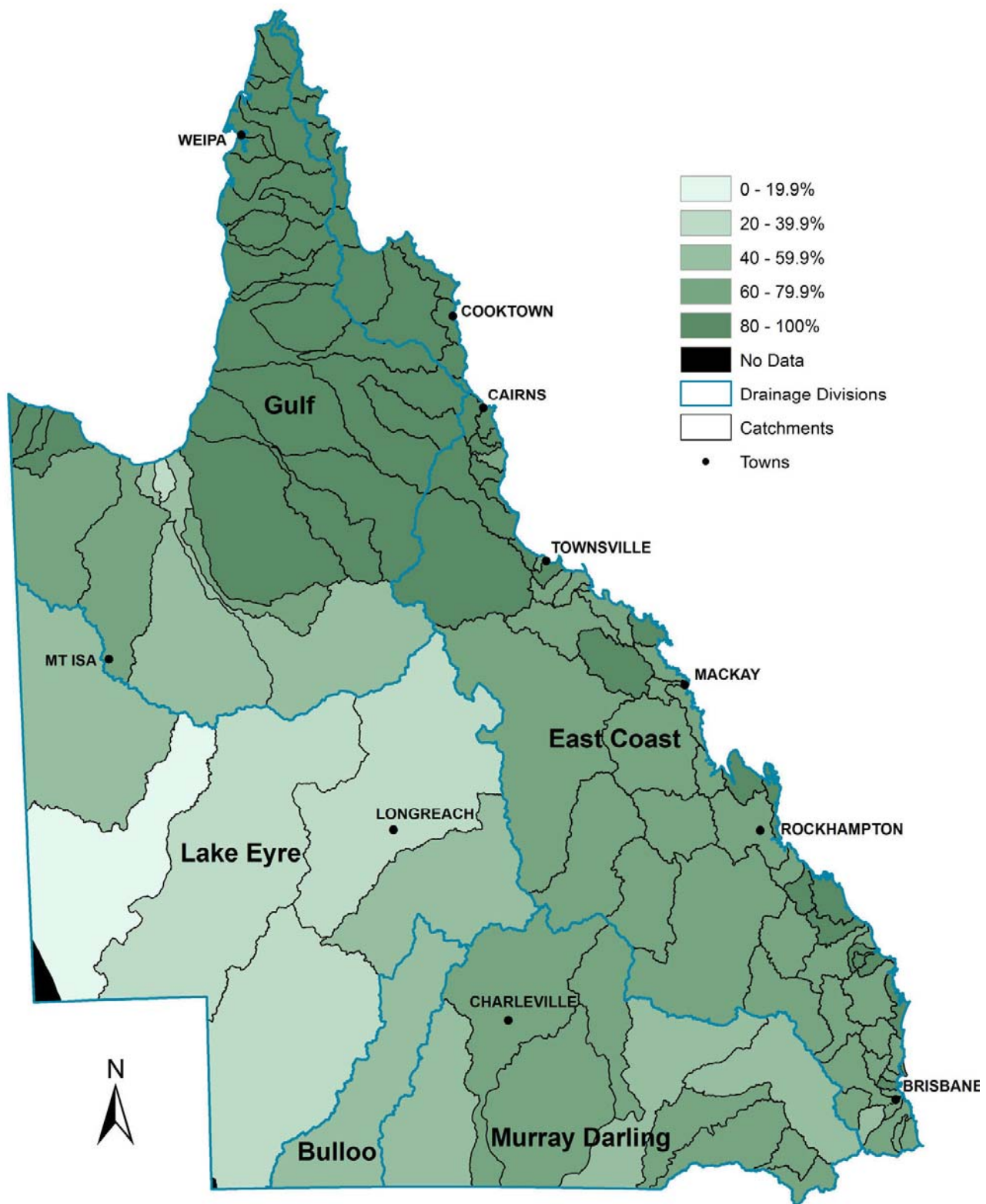
a



Note: Catchments with green represent little or no riparian forest loss and catchments with yellow, orange and red represent higher amounts of riparian forest loss. Source: DERM, 2011d.

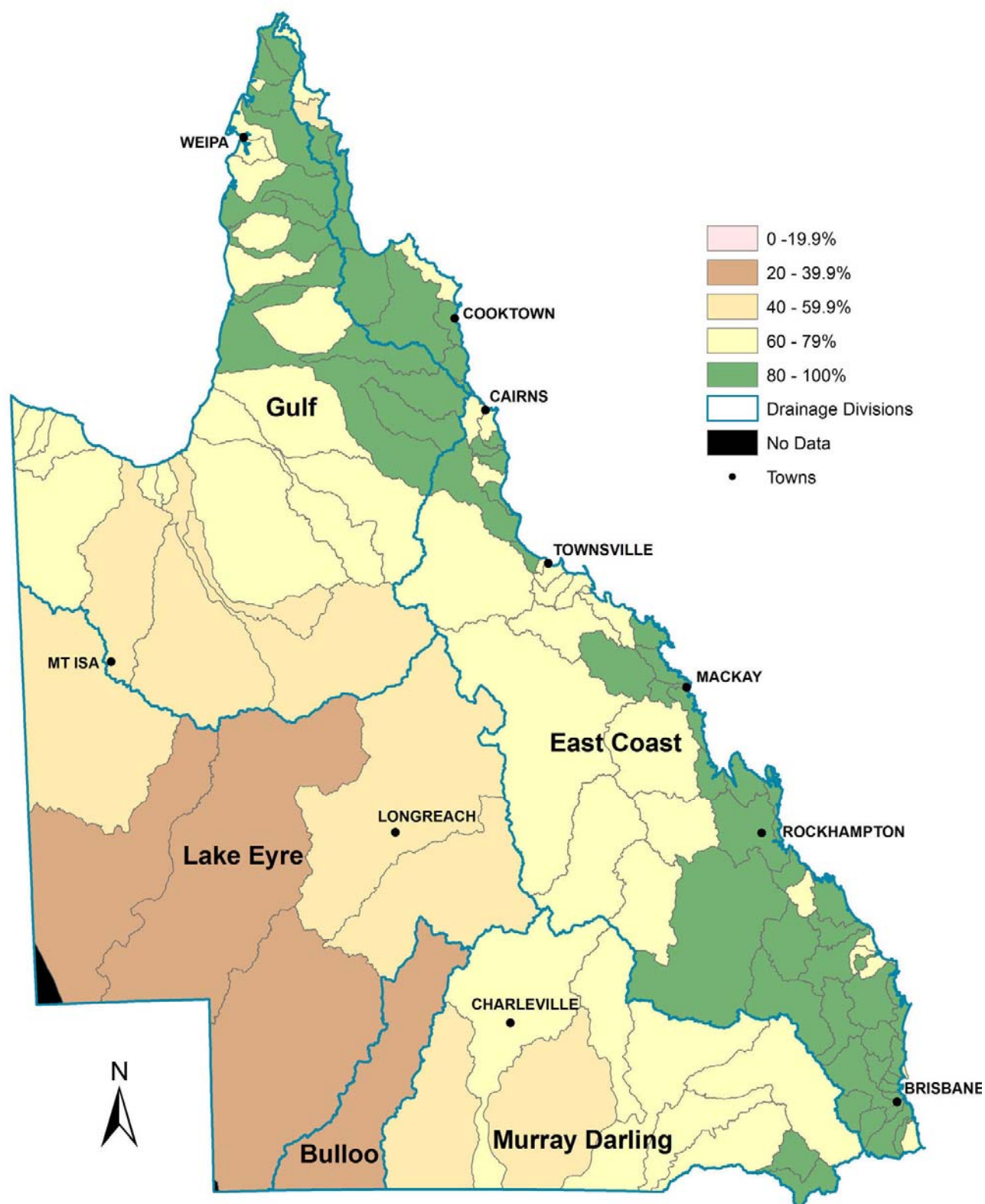
**Figure 35. (a) Riparian forest loss as mapped by the Statewide Land cover and Trees Study (SLATS) 2005–2009 and (b) riparian forest extent 2009.**

b



Source: DERM, 2011d.

**Figure 35. (a) Riparian forest loss as mapped by the Statewide Land cover and Trees Study (SLATS) 2005–2009 and (b) riparian forest extent 2009.**



Note: Ground cover consists of all non-woody plant cover near the soil surface and all litter, including woody litter. The proportions represent the amount of ground cover in riparian areas with no woody vegetation or open canopies (<15% foliage projective cover). Source: DERM, 2011d.

**Figure 36. Riparian mean ground cover for 2009.**



### 4.2.3 Freshwater quality and quantity

There are four major monitoring programs that provide information on the state of freshwater systems for the whole of Queensland. These are the Surface Water Ambient Network (SWAN), the Stream and Estuary Assessment Program (SEAP), the Environmental Flows Assessment Program (EFAP), and the Groundwater Monitoring Network. The results presented below indicate that the condition of aquatic systems in Queensland is variable and dependent on the types of pressures exerted on them. Suspended sediments, modified flow regimes through extraction and barriers to flows, loss and degradation of riparian zones and invasive species have been key pressures.

#### 4.2.3.1 Surface water quality

The Surface Water Ambient Network (SWAN) has been operational since 1990 and provides long-term information from gauging stations on water flow and height and ambient water quality for streams in Queensland.

Water quality is assessed against the Queensland Water Quality Guidelines (QWQG–DERM, 2009b) for slightly-to-moderately disturbed aquatic ecosystems (where available) using electrical conductivity (a measure for salinity), total nitrogen, total phosphorous and turbidity. In provinces that lacked water quality guidelines, interim reference ranges were calculated using available water quality data from appropriate reference sites.

The latest findings from the SWAN show that of the sites where information was available, most sites passed guidelines for turbidity and electrical conductivity (more than 90 per cent of the 192 sites sampled). For total phosphorus, 76 of the 118 sites sampled (or more than 64 per cent) met guideline values. For total nitrogen, 125 of the 154 sites sampled (or more than 81 per cent) met guideline values (DERM, 2011h).

This data is intended to provide an overview of ambient water quality at gauging stations in nine biological provinces in Queensland. The results are based on relatively few samples collected over multiple years at varied flow conditions and can only be considered indicative of the condition of water quality. The findings of ambient water quality for surface waters in nine freshwater provinces are presented below (refer also to Figure 37(a–h)).

**Eastern Cape and Jardine Province:** Current water quality data available for the Eastern Cape and Jardine provinces indicate that gauging stations appear to be influenced by local conditions, rather than broad regional trends that can be ascribed to prevailing climate. Salinity levels are naturally very low, with all condition assessments being within guideline values or classed as uncertain. A greater understanding of this area would be highly desirable, both in terms of data and conceptual understanding, as the ecosystems could be expected to be highly adapted to the very low salinity conditions and, therefore, be highly vulnerable to pollution or changes in flow regime.

**Western Cape and Gulf:** This province comprises a large area with diverse rainfall patterns. There are numerous gauging stations, but not well distributed. Some catchments are exclusively measured in the headwaters or middle reaches, while the large Flinders and Staaten catchments are measured predominantly at end of system gauging stations. Some catchments, particularly the far north west, are not monitored for water quality at all. From the limited available data, water quality within the province appears to be in reasonable condition. There is a wide spatial variability in the magnitude and ranges of both electrical conductivity and turbidity, and although there are some broad regional trends in electrical conductivity, turbidity appears to be dominated by local influences. There is much uncertainty in condition and trend assessments. Significant gaps in both data and conceptual understanding need to be addressed.

**Wet Tropics:** Although turbidity and electrical conductivity were generally within guidelines in the Wet Tropics, total phosphorus regularly exceeded guidelines except on the Atherton Tablelands, which had insufficient spatial and temporal data for assessment. Stream waters are usually of low salinity with stable trends, in some cases probably influenced by prevailing climate. Turbidity is usually moderate to low with stable or falling trends, also indicating probable climatic influence, except in the south, where rising turbidity trends were detected.

**Central:** Central province is a considerably heterogeneous province covering a vast area. The known persistent turbidity and associated high nutrient levels of the western sub catchments were reflected in condition assessments, suggesting the need for the review and possible refinement of local guidelines for these areas. The numerous uncertain condition ratings reflect the high variability of aquatic environments in this province and the need for appropriate datasets to represent environmental processes. The collection of additional data would improve confidence in assessment results. The assessment of electricity conductivity auto-sensor data indicates that



electricity conductivity was generally within expected ranges; however the influence of extreme events did have a noticeable impact.

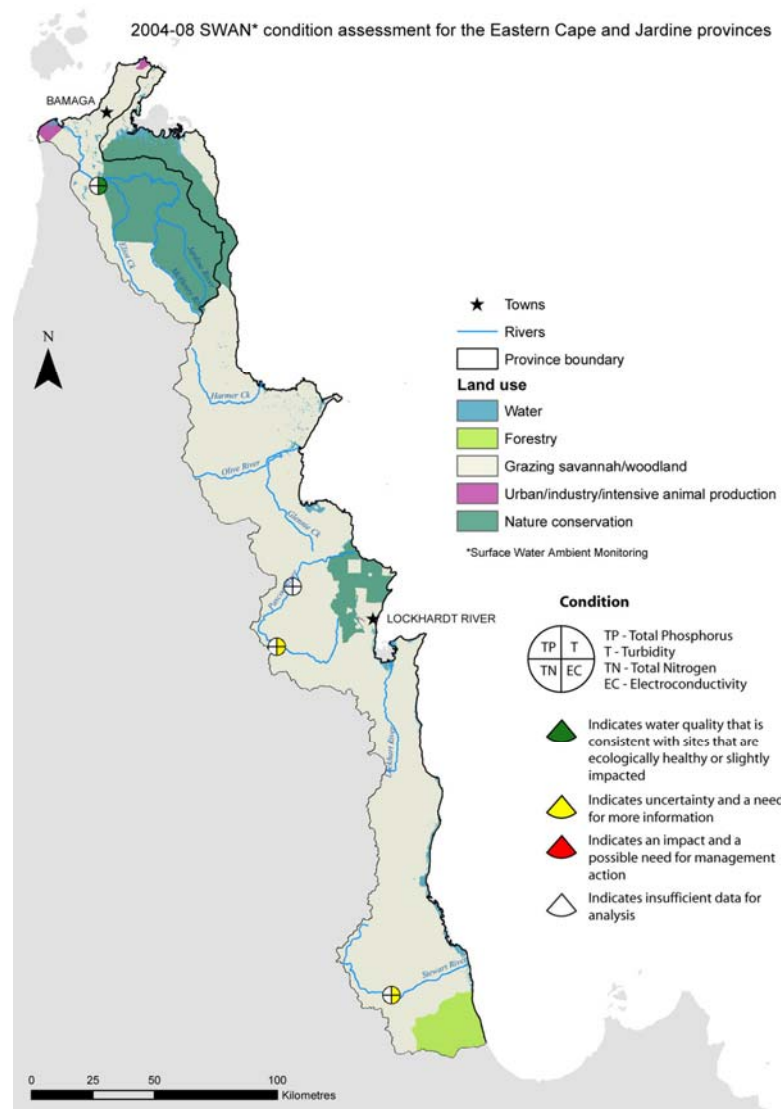
**Lake Eyre and Bullo:** Water quality data available for this province is spatially and temporally limited. Available data representing this very large province did not indicate exceedances of guideline values at monitored gauging stations, although results for turbidity and nutrients were uncertain. Salinity levels appear to be normally low and stable, but subject to occasional high pulses at some sites. Possible climatic influences are variable, with some sites consistent with the regional trend while others are influenced strongly by local processes. Turbidity is naturally very high and subject to varying trends as a result of local influences. Additional data and investigation of catchment processes will be required to fully evaluate water quality effects on the Lake Eyre province.

**Murray–Darling:** Turbidity is generally high throughout this province, whereas electricity conductivity is relatively high upstream in the Condamine sub catchment but declines downstream as the rock types become sandier. Water quality indicators are generally within guidelines in the upper Condamine section of the province, although there is some uncertainty, and nutrient data is deficient in many areas. The uncertainty increased downstream due to limited availability of data. Possible electricity conductivity rises accompanied by falling turbidity in the Border–Moonie sub catchment and in the western section of the province appeared to be reversed in the Balonne and Condamine sub catchments. Most of the electricity conductivity trends were probably influenced by climatic factors, although there is no apparent link between these and turbidity.

**Wallum:** Insufficient data is available at present to fully assess water quality in the Wallum Province. Although there are no indications of guideline exceedances or deteriorating water quality beyond the Maroochy catchment, the natural levels for electricity conductivity, turbidity and nutrients are exceptionally low in a wallum landscape so that the highly adapted aquatic ecosystems are vulnerable to pollution. More extensive data collection would refine estimates of natural variability and aid in protecting these areas, particularly on the sand islands.

**South East:** Water quality was found to generally be uncertain or within guideline values for much of South East province during the 2004–2008 study period. The assessment of electrical conductivity auto-sensor data at two gauging stations, one in a highly regulated system and the other a moderately regulated system, highlights the differences in system response to the extreme drought conditions experienced in South East Queensland. The collection of additional samples would help to reduce variability in assessments and provide additional confidence in assessment results.

## a) Eastern Cape and Jardine



## b) Western Cape and Gulf

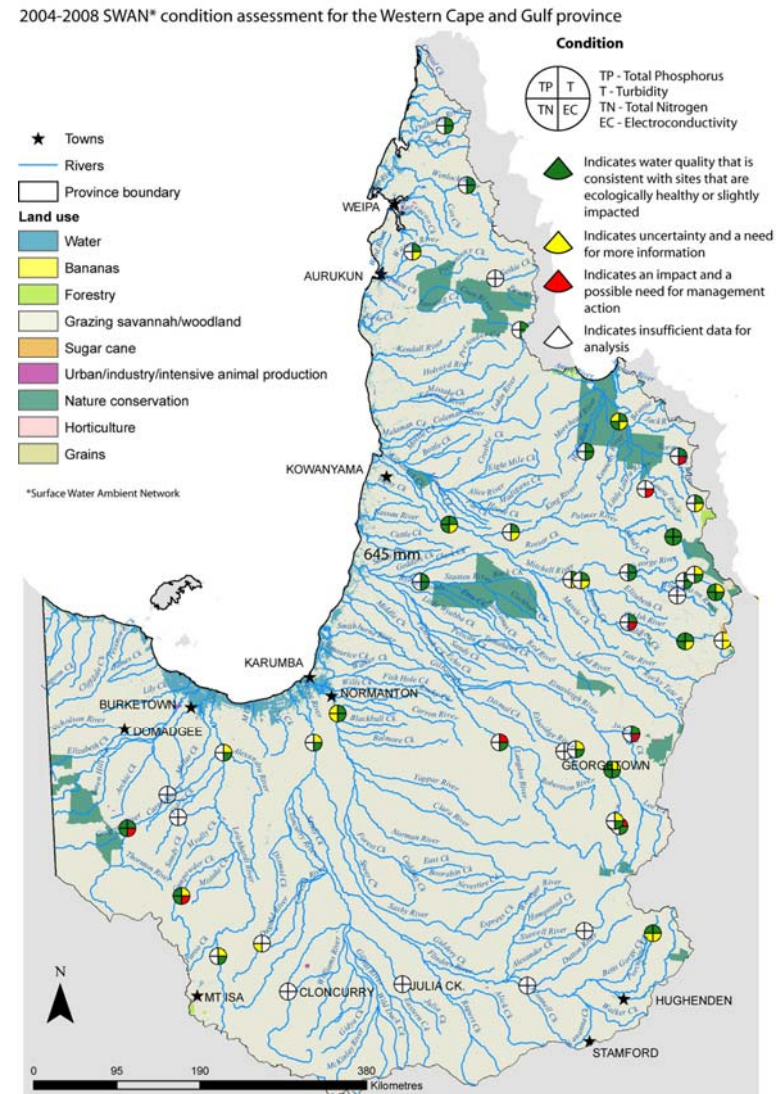
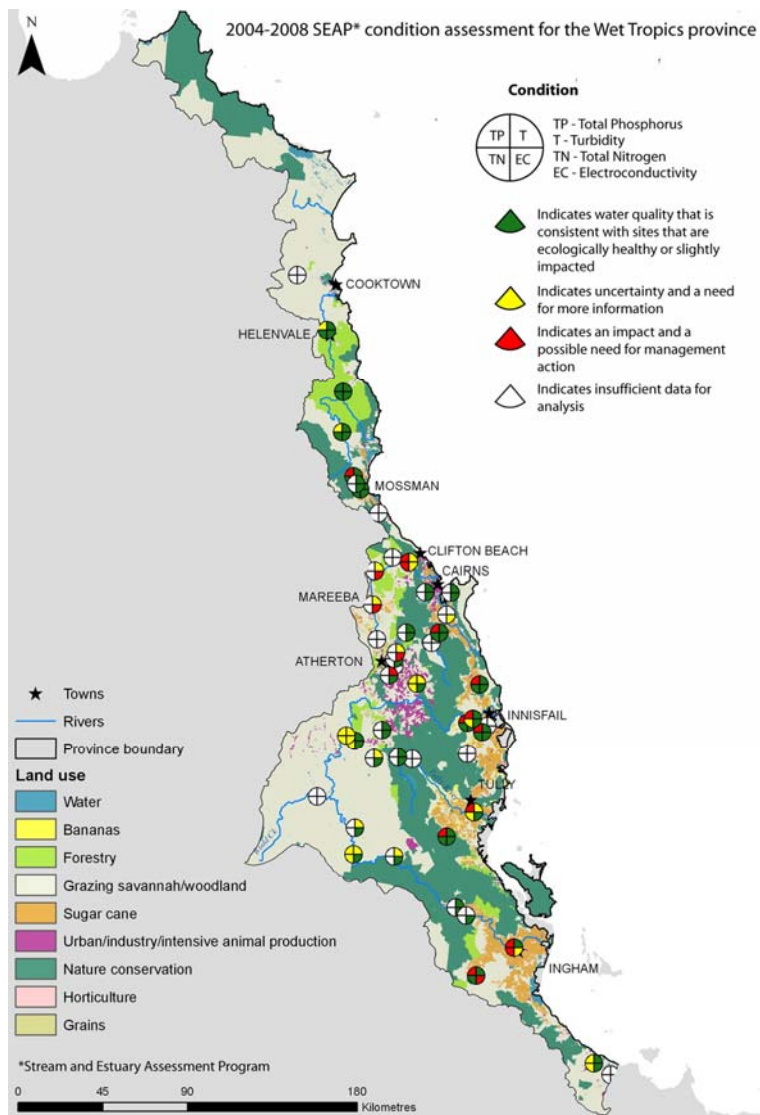


Figure 37. (a–h) Condition of surface water quality for the nine provinces covered under SWAN.

## c) Wet Tropics



## d) Central

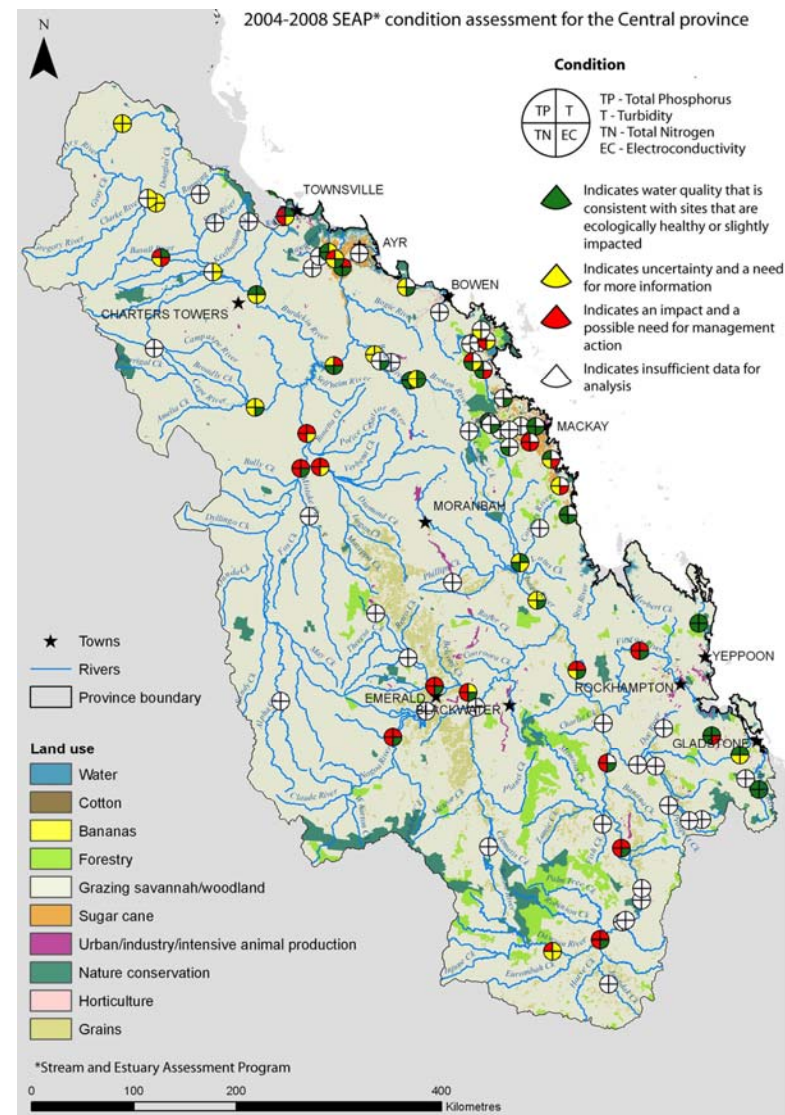
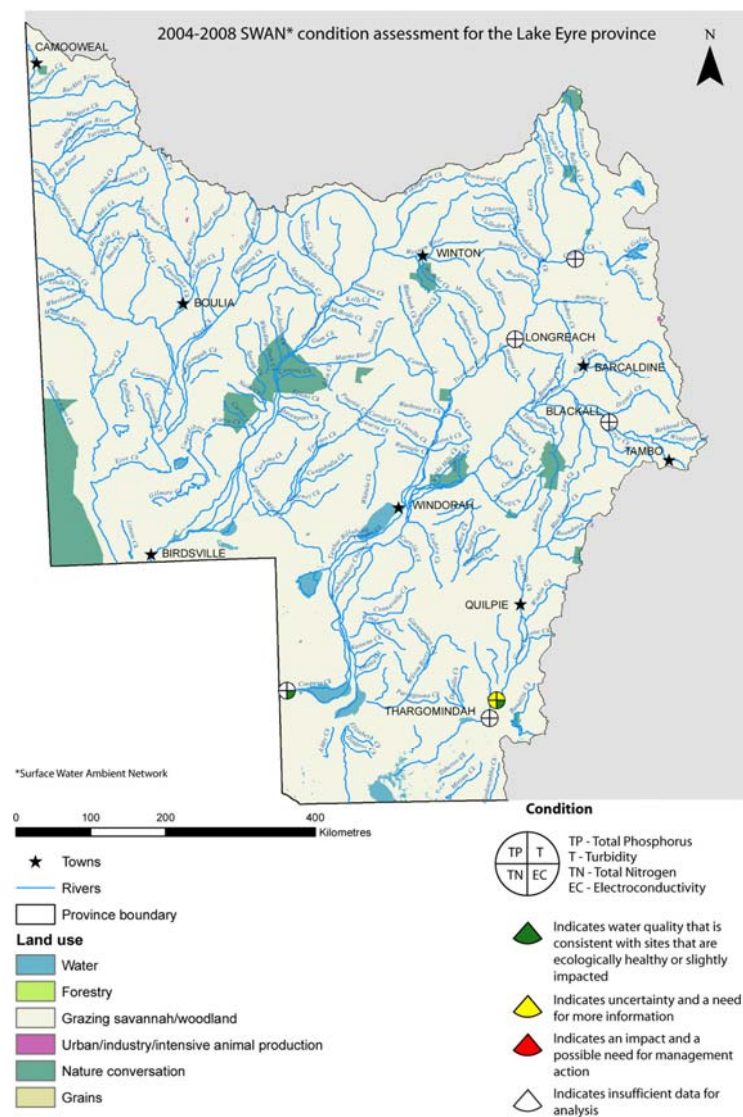


Figure 37. (a–h) Condition of surface water quality for the nine provinces covered under SWAN.



## e) Lake Eyre and Bulloo



## f) Murray–Darling

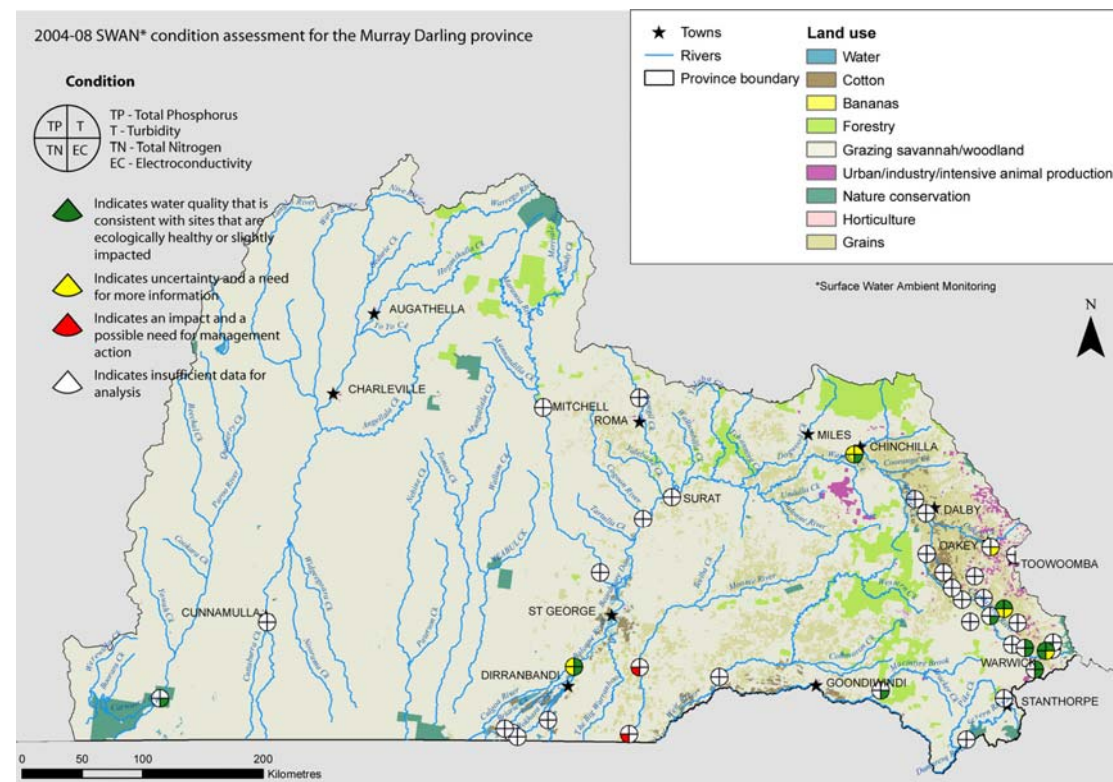
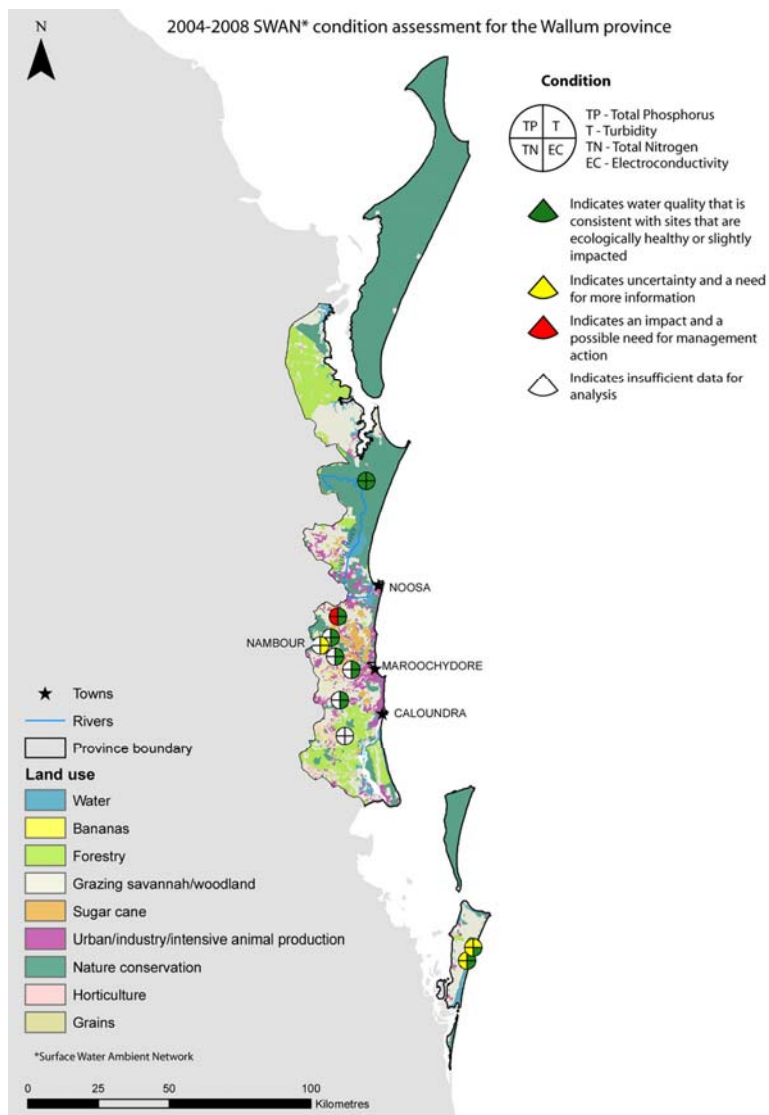


Figure 37. (a–h) Condition of surface water quality for the nine provinces covered under SWAN.

## g) Wallum



## h) South East

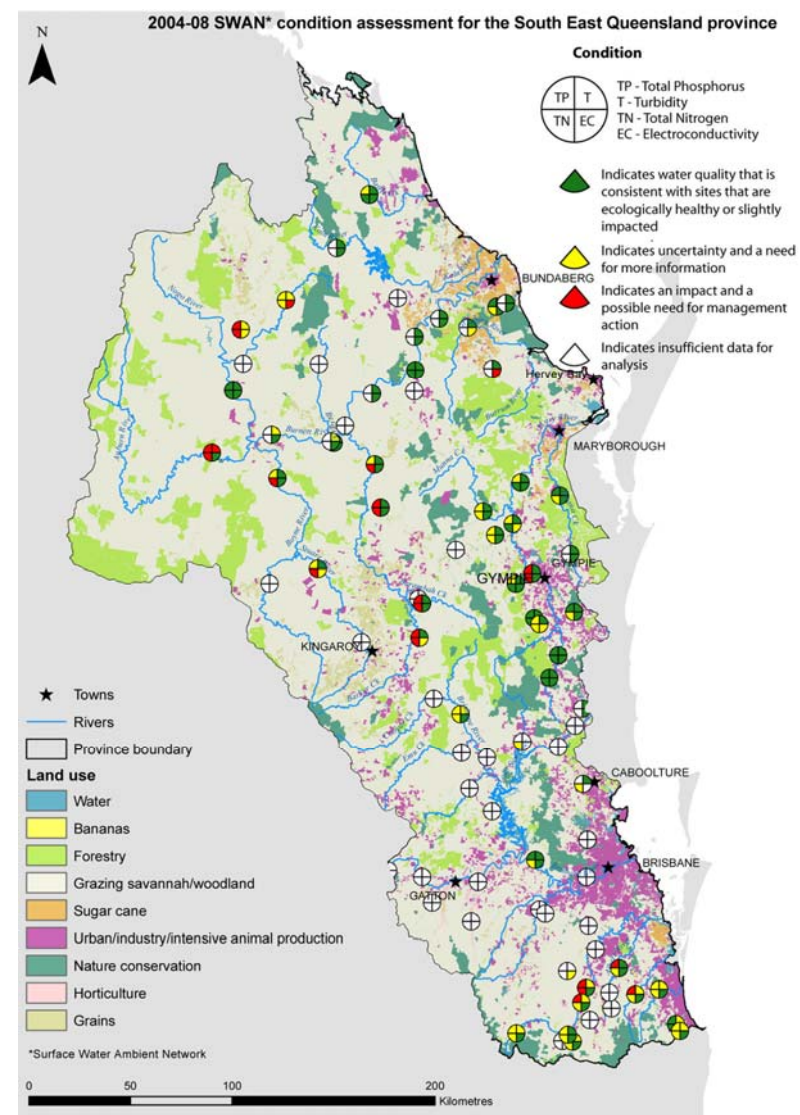


Figure 37. (a–h) Condition of surface water quality for the nine provinces covered under SWAN.



#### 4.2.3.2 Surface water quantity and environmental flows

The Environmental Flows Assessment Program (EFAP) is a statewide monitoring and assessment program to assess the effectiveness of Water Resource Plans and Resource Operations Plans in providing for stated ecological outcomes, particularly in relation to providing critical flow requirements as required by the *Water Act 2000* (DERM, 2011i). It considers the ecological effectiveness of flow management strategies and rules and water requirements of ecological assets.

Results from the EFAP program indicate there is a strong negative correlation between discharge and gross primary production. Some species of fish (e.g. eel-tailed catfish) require low and stable flows for nesting and spawning, and for their nests to be located in slower flowing areas and generally established in shallow waters. The Fitzroy golden perch on the other hand, spawned during elevated flows from November to January and when water temperatures were between 24 °C to 28 °C. The largest samples of eggs and larvae were collected during high flow events that were preceded by smaller flows or freshes.

Monitoring of lungfish spawning indicated that most spawning events were recorded in riverine sites in September and October and most spawning events followed small rises in river level. It appears lungfish spawning is triggered first by the rapid rise in water temperature in late winter or early spring, and subsequently facilitated by small flow events. These flow events provide connectivity to traditional spawning grounds, providing access to food resources which support recruitment.

The spawning activity of golden perch in the Border Rivers of the northern Murray–Darling Basin is also aligned with increased flow and water temperatures. Spawning success and recruitment abundance varied between supplemented and un-supplemented sites, with fewer recruits recorded at supplemented sites.

The amount of water left at the end of a system is a good indicator of the effects of many pressures on waterways, including extraction and impoundments (diversions). The end of system flow indicators presented (Figure 38) are a percentage of pre-development flows. In general, water diversions were greater in coastal areas and in the south east.

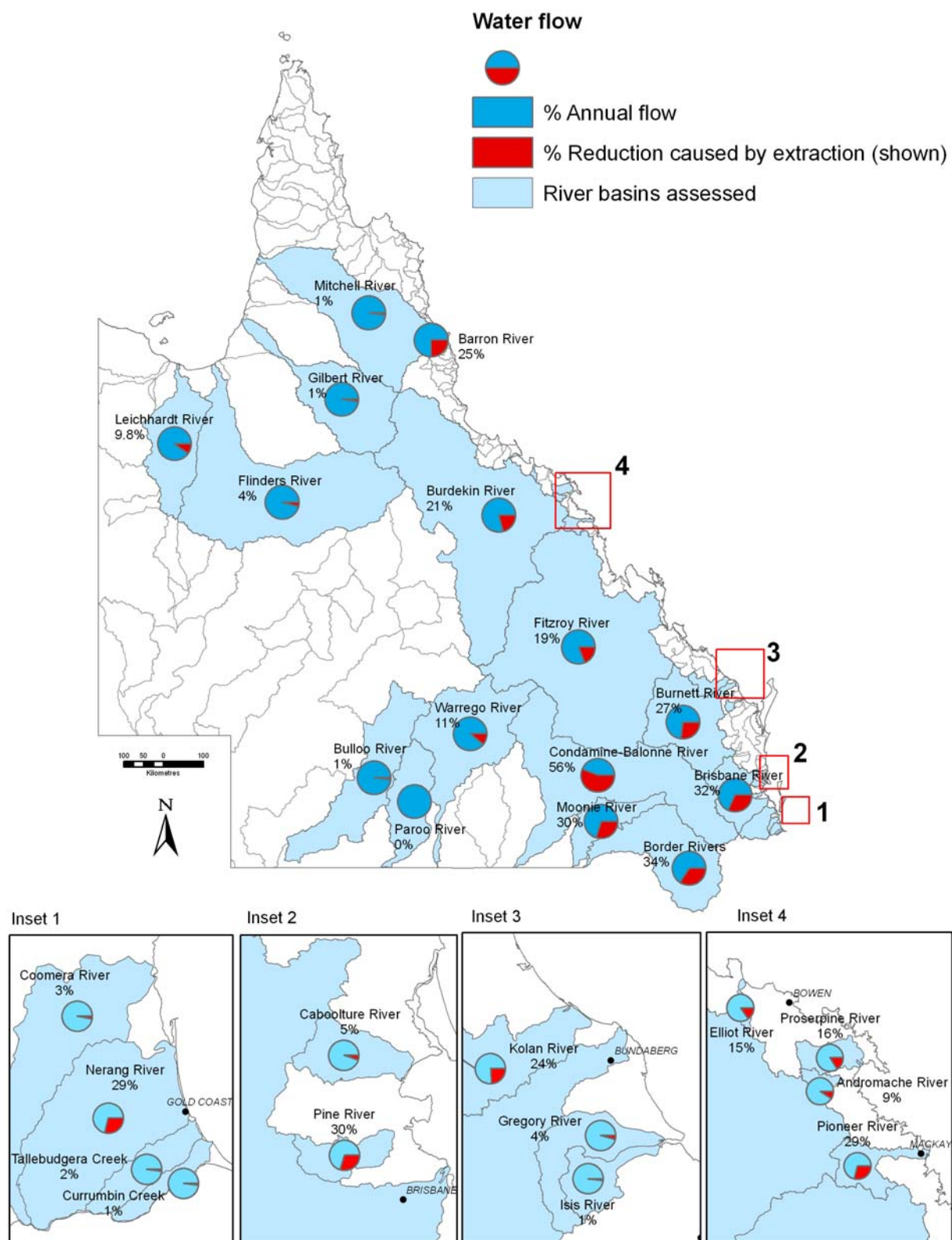


Figure 38. End of system flows for Queensland's river systems.

#### 4.2.3.3 Groundwater water quality and quantity

Groundwater represents a significant resource for Queensland. Groundwater plays an important ecological role, contributing to river flows and supporting ecosystems. In some areas there is a strong connection between groundwater and surface water resources.

The quality of groundwater resources varies considerably and influences how the water is used. The Groundwater Monitoring Network provides information to assist in the protection and sustainable use of Queensland's groundwater resources.

Towns, agriculture and industry often depend on groundwater resources. However, these resources are finite and only renewable to the extent that water inputs balance outputs. About a third of the water used in Queensland is from groundwater. More than half of the national total of groundwater is found in Queensland. With increasing pressures on the state's groundwater systems and the connections with surface waters, groundwater is being integrated into regional monitoring, planning and management frameworks.

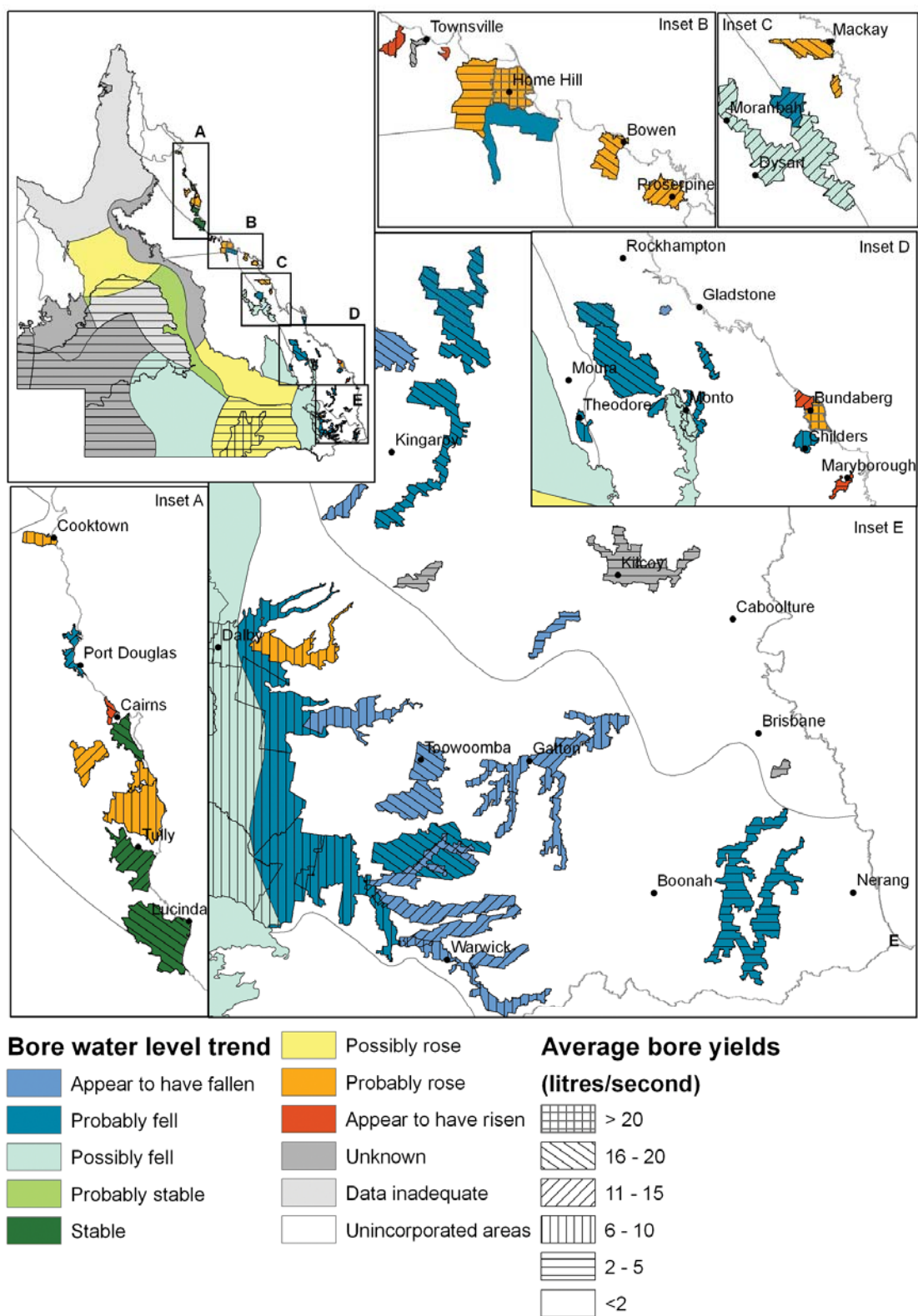
The reporting period 2005–09, represents the final years of a prolonged drought. Groundwater levels (quantity) fell in the long-term over most areas (Figure 39a). The exceptions were aquifers along the coast around Bundaberg and north of Mackay where water tables tended to be stable or rising. The Great Artesian Basin water levels remained relatively stable, except around some intake areas (McNeil and Raymond, 2011).

Also during the reporting period, as indicated by Figure 39b, most aquifers contained moderate to poor water quality. However, the quality is entirely based on the intended use of the water in terms of environmental values (EVs) as defined under the *Environmental Protection Act 1994*. The EVs considered for groundwater included: the aquatic ecosystem health on its mixing with surface water; suitability for drinking, stock and irrigation; and also domestic and general use. Since the physical, chemical and biological processes determining groundwater quality differ from those of surface water, incompatibility with aquatic ecosystems and other EVs supported by surface water are usually natural. Ratings of poor groundwater quality, therefore, are most likely to be due to endemic factors rather than land use as long as conditions have remained stable and as long as the aquifer is not classed as vulnerable because of its susceptibility to pollution (McNeil and Raymond, 2011). It can be seen from Figure 39b that many of the state's aquifers are in stable condition.

The main quality issues identified were: (a) salinity, hardness and scale in most sub-coastal and deeper alluvial aquifers; (b) fresh but corrosive waters in coastal sands and islands or north eastern catchments with high rainfall; or (c) salinity, sodium, corrosiveness, scaling and fluoride levels in various parts of the Great Artesian Basin. The greatest land-use threat appears to be salt-water intrusion, particularly in aquifers with a marine interface, followed by vulnerability to pollution from the surface. It must be emphasised that there are not, at present, sufficient data to comment on the condition of Queensland's groundwaters with a strong degree of certainty, and some areas could not be evaluated.

Subsequent to the period covered by this report, exceptional rainfall occurred over most of Queensland which would be expected to broadly affect both groundwater levels and quality. Preliminary monitoring results by the Queensland Government suggest that as a consequence of the 2011 floods, for the majority of shallow coastal alluvial and sand dune aquifers, the rise in groundwater levels is variable, with recharge between 1–5 m and in some locations the groundwater levels are the highest recorded. For the inland alluvial aquifers (e.g. Callide and Condamine) recharge is generally less than one m and was restricted to isolated areas adjacent to streams. For the fractured rock aquifers (e.g. Atherton Basalt and Main Range Basalt) the rise in groundwater levels was generally between five and 10 m, and again in some locations the groundwater level are approaching historic highs. With respect to these events, this document should be taken as reflecting the state of the groundwater under prevailing land use and prolonged dry conditions, within the level of uncertainty imposed by data limitations.

a

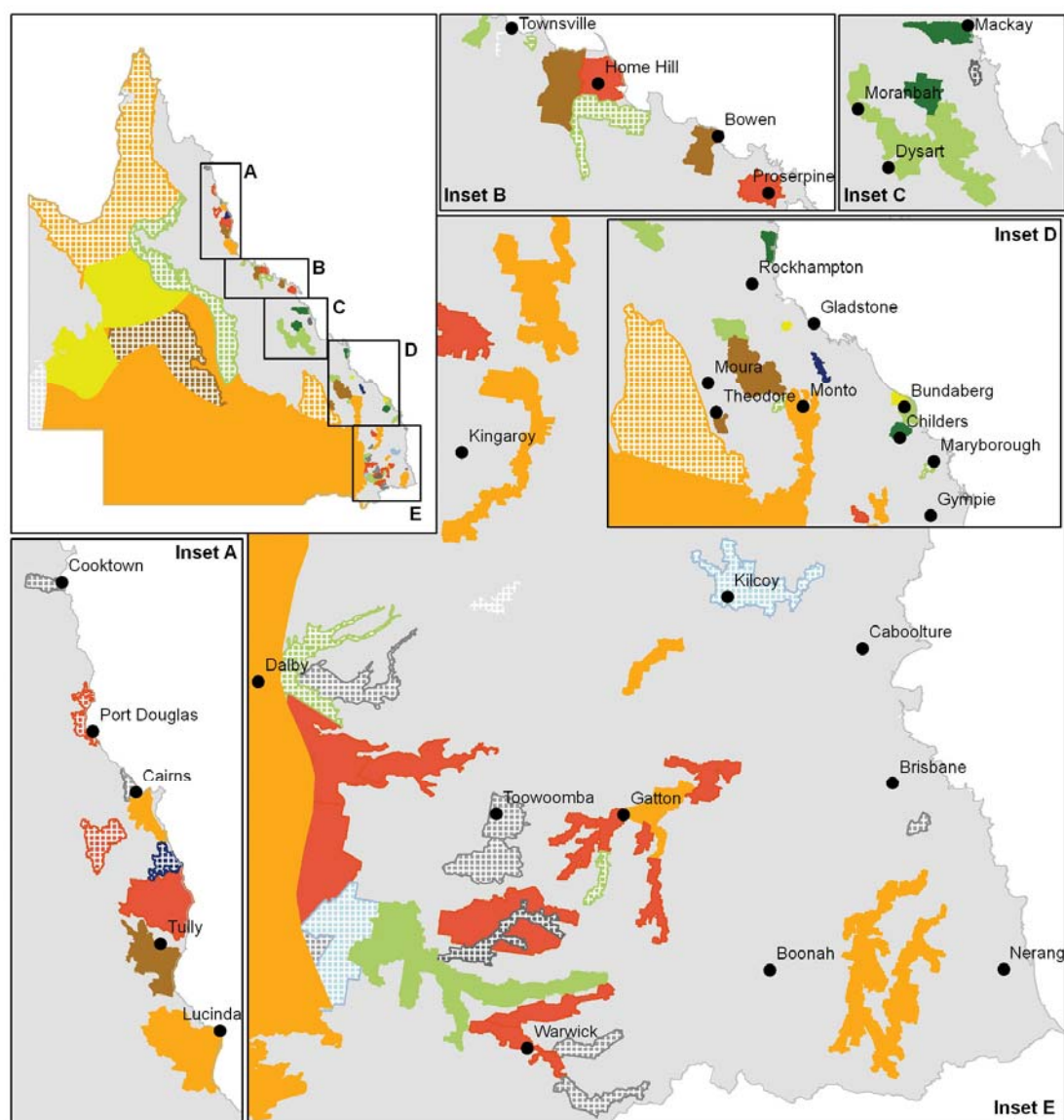


Source: McNeil and Raymond, 2011. Note: Based on four years of data ending 30 June 2009.

**Figure 39. (a) Groundwater quantity statewide and regionally for Queensland and (b) groundwater quality statewide and regionally for Queensland.**



b



### Groundwater Management Unit condition

	Good, stable		Poor, stable
	Good, probably stable but more data required		Poor, probably stable but more data required
	Good, stable but vulnerable		Poor, stable but vulnerable
	Good, vulnerable but more data required		Poor, vulnerable but more data required
	Moderate, stable		Poor, possible issues
	Moderate, probably stable but more data required		Poor, possible issues but more data required
	Moderate, stable but vulnerable		Insufficient data but probably stable
	Moderate, vulnerable but more data required		Insufficient data but vulnerable
	Moderate, possible issues		Insufficient data but possible issues
			Unincorporated areas

Source: McNeil and Raymond, 2011. Note: Based on four years of data ending 30 June 2009.

**Figure 39. (a) Groundwater quantity statewide and regionally for Queensland and (b) groundwater quality statewide and regionally for Queensland.**

## 4.2.4 Aquatic ecosystem health

While the effects of human pressures on the environment are not always easy to quantify, biota such as fish and macroinvertebrates, can be useful indicators of aquatic ecosystem health. The number and conservation status of native fish species across Queensland are unchanged from the previous reporting period, but compared with 2007, the number of exotic species incursions has increased by one with the reporting of tilapia for the first time in the Burnett River catchment.

The Stream and Estuary Assessment Program (SEAP) provides a more detailed assessment of the aquatic ecological condition of rivers across Queensland based on pressure–stressor–response models. It is a statewide initiative that covers nine riverine freshwater biogeographic provinces, which are assessed on a rotational basis with one province assessed per year (Negus, et. al, 2009).

### 4.2.4.1 South East Queensland

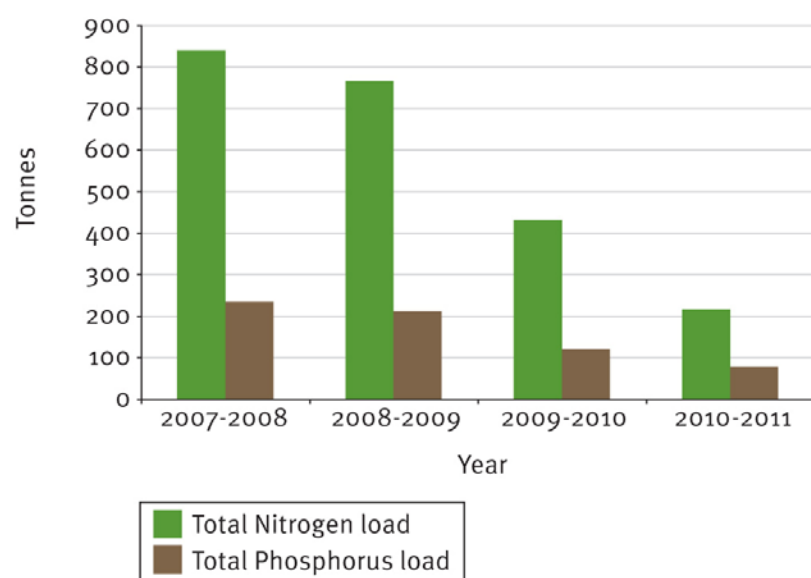
The findings of the Ecosystem Health Monitoring Program (EHMP) show that freshwater rivers and creeks in the South East Queensland region exhibit a wide range of condition, from good in systems such as the Noosa, Stanley and Nerang, to very poor in the Oxley, lower Brisbane and Redlands systems (Table 6). There are no consistent regional trends in annual scores over time, with most freshwater systems showing variability around a common grade and no apparent change in health (Table 6). Only the Bremer River appears to have shown an improvement in health over time. The Noosa River may be in decline. However, this may reflect drought conditions over the second half of the decade.

**Table 6. Ecosystem Health Monitoring Program report card grades for South East Queensland freshwater rivers and creeks 2003 to 2011.**

Freshwater system	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Noosa	A-	A-	A-	A-	B	B	B-	B	B+	B	A-
Maroochy	C+	C+	C	C-	C+	C-	C-	C	C	C	B-
Mooloolah	C+	C+	C	A-	B-	B	B+	B	C	B-	B+
Pumicestone	C	C	B+	C	C+	C-	C-	B+	B	C-	C+
Caboolture	C	C	B+	C-	B-	B-	C+	C+	C	C+	B
Pine	C	C	C	D	C	C	D+	D+	C-	C-	B-
Lower Brisbane	D-	D	F	F	D-	F	F	F	F	F	F
Oxley	D-	D	F	F	D-	F	F	F	F	F	F
Redlands	D	D+	C-	D	F	F	F	F	F	F	F
Nerang	B-	B-	C+	A-	B+	C+	A-	B+	B	B+	B
Albert	D	D+	C-	B	B	B	B-	B-	A-	B-	B-
Logan	D	D+	C-	C	D	D+	D	D	D	D+	C-
Bremer	F	F	D-	D-	D-	D-	D	D-	D+	D+	C
Lockyer	F	F	F	D	D-	D-	D-	F	D	D	D+
Mid Brisbane	C	C	C	B-	C+	C+	B-	B	C+	C	D-
Upper Brisbane	D	D+	D	C-	C-	D	F	D-	D+	C-	C-
Stanley	B-	B-	B-	B	B	B-	C+	B+	B	B-	B

Source: Healthy Waterways, 2012. Ecosystem Health Monitoring Program.

In South East Queensland, there has been a general reduction in total phosphorus loads discharged from wastewater treatment plants over the last four years (Figure 40). The total nitrogen loads have been relatively consistent over the four year period, although an increase in nitrogen loads was observed in 2010–11. This is attributed to the January 2011 floods which affected the operation of some plants. While nitrogen levels have been relatively consistent over the four year reporting period, there has been a significant reduction in nitrogen loads discharged since 2002. This is estimated to have reduced by more than 50 per cent and is due to major wastewater treatment upgrades during that time.



Source: DERM, 2011j, Point Source Database (PSD).

**Figure 40. Total nitrogen and phosphorus loads discharged from major wastewater treatment plants in South East Queensland catchments.**

#### 4.2.4.2 Great Barrier Reef catchments

The Reef Water Quality Protection Plan (Reef Plan) established a baseline against which progress could be assessed. A key finding was that although natural catchment loads occur, most of the loads to the Great Barrier Reef are from human activities (DPC, 2011). The catchment load estimates for nutrients (total nitrogen, dissolved nitrogen, total phosphorus and dissolved phosphorus), sediments (total suspended solids) and pesticides from the First Report Card are presented in Figure 41.

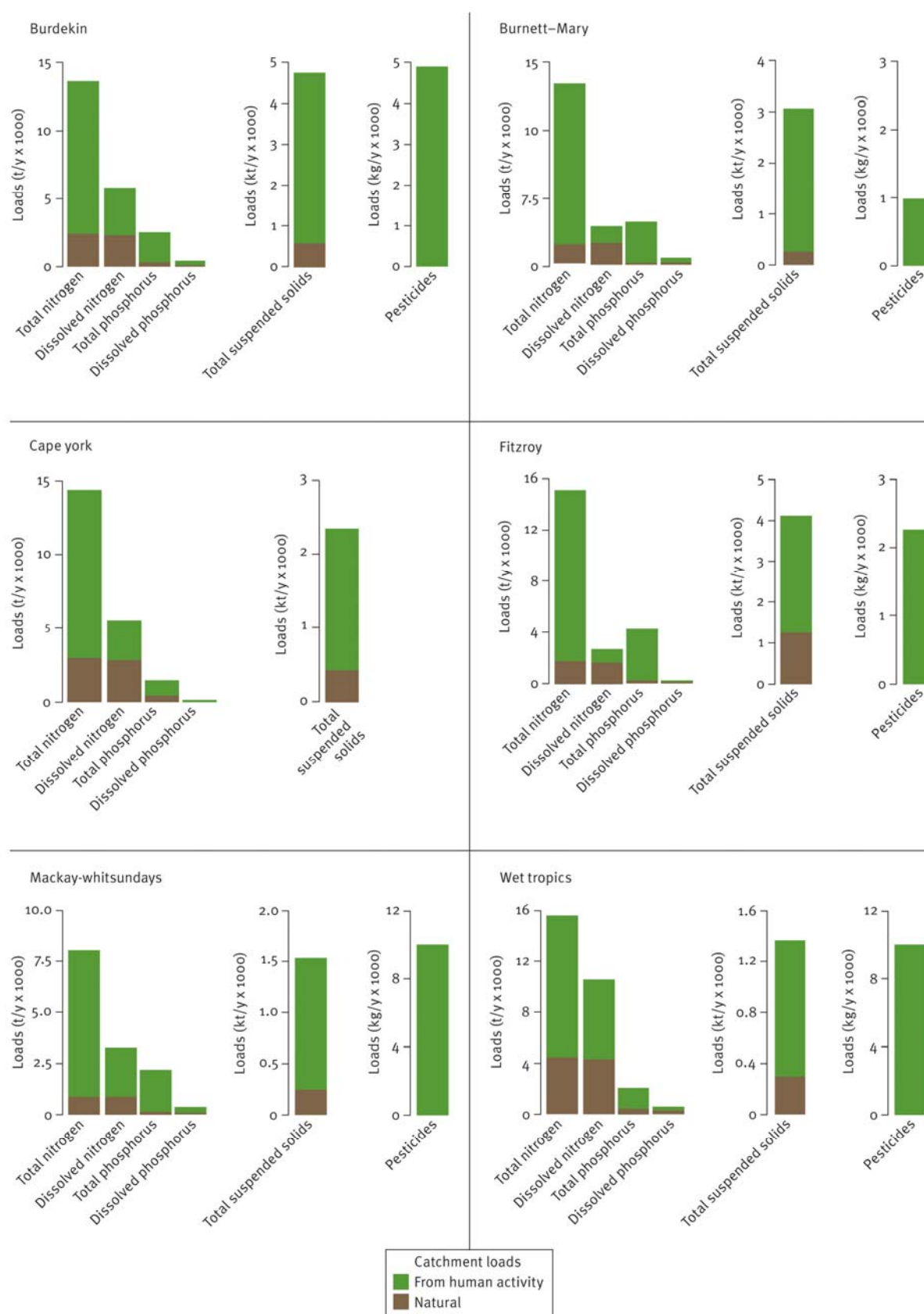
This figure indicates that:

- annual total suspended solid loads (sediment) in 2009 were 17 million tonnes, of which 14 million tonnes was from human activity
- the largest contribution of total suspended sediment load was from the Burdekin and Fitzroy regions (4.7 and 4.1 million tonnes respectively), mainly derived from grazing lands
- agricultural fertiliser use is a key source of dissolved nitrogen and phosphorus run-off; annual loads of dissolved nitrogen are 31 000 tonnes, of which 17 500 tonnes were from human activity
- the highest total load of dissolved nitrogen was from the Wet Tropics region with 11 000 tonnes per year, of which 6300 tonnes were from human activity
- all pesticide loads are from human activities. In 2009, the total annual pesticide loads were approximately 28 000 kg, and the highest loads are from the Mackay–Whitsunday and Wet Tropics regions (approximately 10 000 kg each per year)

- of the pesticide residues most commonly found in surface waters in the Great Barrier Reef region, diuron, atrazine, ametryn, and hexazinones derive largely from areas of sugarcane cultivation, while tebuthiuron is derived from rangeland beef grazing areas (Lewis et al., 2009)
- diuron is the dominant herbicide found in the Wet Tropics, lower Burdekin and Mackay–Whitsunday regions. It is generally associated with areas of sugarcane but is also found in other cropping areas. There is currently an interim suspension of most diuron uses by the Australian Pesticides and Veterinary Medicines Authority (APVMA, 2011).

This information comes from that gained through the Reef Plan Paddock to Reef Program (DPC, 2009b). The Paddock to Reef program, funded jointly by the Australian and Queensland governments, is a world-leading approach to integrating monitoring and modelling information on management practices, catchment indicators, catchment loads and the health of the Great Barrier Reef.



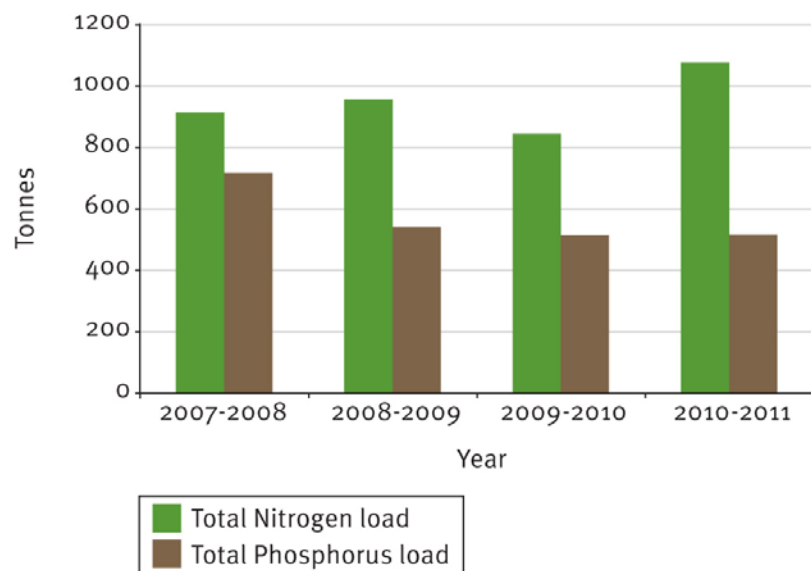


Source: DPC, 2011. Reef Water Quality Protection Plan 2009 – First Report Card. Note: These results, derived from the Reef Plan Paddock to Reef Program, are continuously being improved and updated over time; therefore, subsequent published results will reflect this.

**Figure 41. Loads for the Great Barrier Reef catchments from human activity and natural loads.**

#### 4.2.4.2.1 Point source discharges

Pollutants discharged from major wastewater treatment plants in Great Barrier Reef catchments have been monitored over the last four years. Upgrades in treatment facilities have resulted in a significant reduction in loads of both total nitrogen and total phosphorus over this time (Figure 42).



Source: DERM, 2011j Point Source Database (PSD).

**Figure 42. Total nitrogen and phosphorus loads discharged from major wastewater treatment plants in Great Barrier Reef catchments.**

#### 4.2.4.3 Murray–Darling Basin

The Sustainable Rivers Audit (SRA) provides a long-term assessment of the condition and health of the 23 river valleys in the Murray–Darling Basin. As a basin-wide river health monitoring program, the SRA is implemented jointly by the governments of Queensland, New South Wales, Australian Capital Territory, Victoria, South Australia, and the Australian Government. The SRA report 1 was the first published basin-wide assessment of river health, based on data collected in 2004–07 on three environmental themes including fish, macroinvertebrates and hydrology.

The findings of the river audit for the valleys that occur in Queensland and into New South Wales (Table 7) demonstrate:

- **Ecosystem health:** The health of catchments in Queensland was generally better than southern catchments due to cumulative pressures along the river system. The Paroo Valley was rated in good health, while the Border Rivers and Condamine valleys were rated in moderate health; however the Warrego Valley was in poor health.
- **Hydrological condition:** The Paroo Valley recorded little change in natural flow regime, scoring well for hydrological condition. The Warrego flow values were only slightly changed from the natural regime, although these changes occurred mostly in the lower reaches and are of ecological significance. The Border Rivers and Condamine scored moderate to good, with the lowland areas of the Condamine characterised by reduced flow volumes.
- **Fish community condition:** The Paroo had the highest score amongst all the valleys (New South Wales and Queensland) with 97 per cent of all fish sampled being native and native species making up 78 per cent of the total biomass. The Condamine had the second highest score and the Border Rivers had the third highest, with 86 per cent of fish sampled being native in the Condamine and 63 per cent being native in the Border Rivers. Only seven of the 14 expected native species were recorded in the Warrego, with alien species comprising half the biomass.

- **Macroinvertebrate community condition:** The highest score of all the valleys (Queensland and New South Wales) for macroinvertebrate community condition was recorded in the Border Rivers, with the third highest score in the Paroo. However, the Condamine and Warrego were characterised by less diverse communities which lack many macroinvertebrate families that are sensitive to disturbance.

**Table 7. Murray–Darling Basin 2004–07—trends in ecosystem health, hydrology, fish and macro-invertebrates for Queensland river valleys.**

River valley	Ecosystem health condition	Hydrological condition	Fish community condition	Macro-invertebrate community condition
Paroo	Good	Good	Moderate	Moderate
Borders Rivers	Moderate	Moderate to good	Moderate	Moderate
Condamine	Moderate	Moderate to good	Moderate	Poor
Warrego	Poor	Good	Poor	Poor

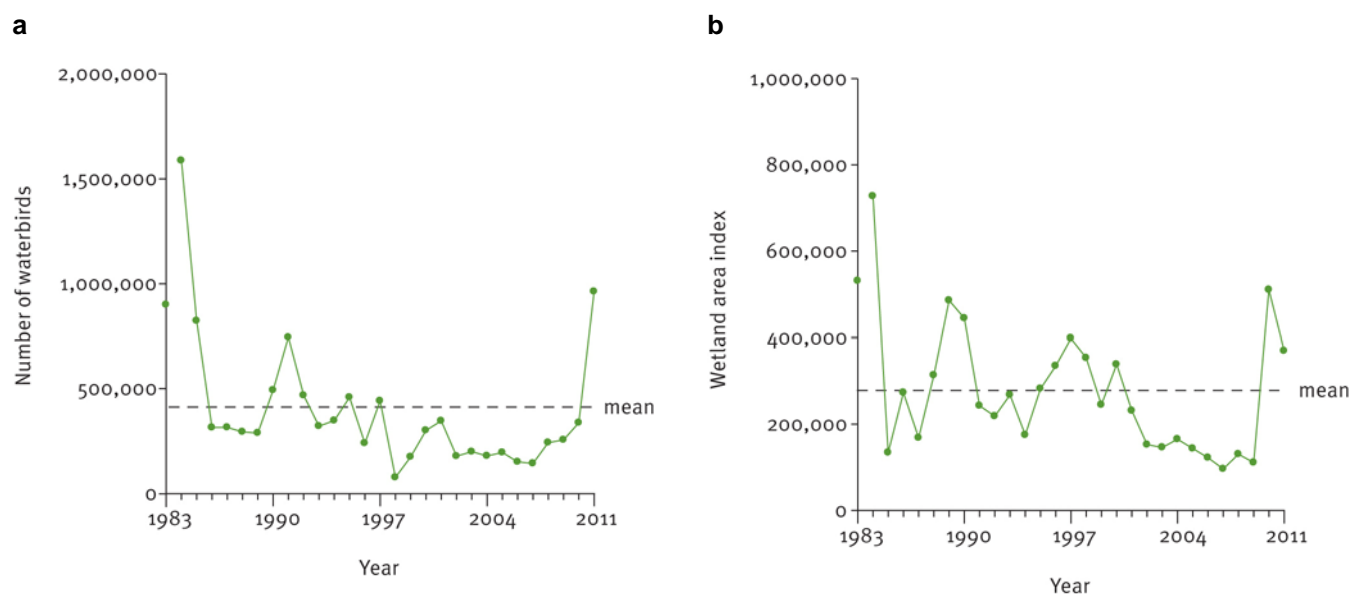
Source: Adapted from Davies et al., 2008. Sustainable Rivers Audit Report 1, page xii.

#### 4.2.4.4 Resident and migratory waterbirds

In Australia, waterbirds have adapted to a highly variable and dispersed resource, as the wetlands they rely on for feeding and breeding are affected by flooding or drought. In response, they are highly nomadic, capitalising on resources wherever they exist. They will often move great distances in search of suitable habitat whether it is inland (e.g. Lake Eyre Basin) or on the coast (e.g. Moreton Bay). Queensland is host, at least in part, to two of the three major river basins that support many of the key wetlands for waterbirds. The flooding of these river basins is the catalyst for occupation, feeding, breeding and successful recruitment of waterbird communities on desert rivers (e.g. Kingsford et al., 2010).

Results from the 2011 eastern Australia aerial waterbird survey showed a significant rebound in numbers of waterbirds following relief from drought conditions (Porter and Kingsford, 2011). Wetland area exceeded the long-term average and the number of birds counted was the highest overall total since 1984 (Figure 43).

An assessment of the long-term trends in shorebird populations in eastern Australia from 1983–2006 found that migratory shorebirds had declined by 73 per cent and Australian resident shorebirds by 81 per cent (Nebel et al., 2008). This long-term decline has been attributed to reduced breeding success and loss of migratory staging habitats in East Asia, and was linked by Nebel et al. to a loss of wetlands in Australia as a consequence of river regulation (mainly an issue in New South Wales). The wetlands identified as the most important for shorebirds were Lake Eyre North, Lake Torquinie/Mumbleberry Lake, Lowbidgee, Lake Galilee, Lake Denison/Jack Smith Lake, Coorong, Paroo River overflow, Cooper Creek wetlands, Lake Cawndilla/Nettleogoe Lake and Mid-Darling River.



Source: Porter and Kingsford, 2011.

**Figure 43. (a) Number of waterbirds over time and (b) wetland area index over time.**

## 4.3 Coastal and marine ecosystems

### 4.3.1 Ecosystem health

Coastal and marine ecosystems are complex systems that are susceptible to a range of stresses, both natural and human-induced. The Queensland Government, Australian Government and universities have active research programs aimed at better understanding the sources of environmental stress, how ecosystems respond to it, trends in ecosystem health and opportunities for recovery and resilience in a variety of coastal and marine ecosystems.

#### 4.3.1.1 South East Queensland estuaries

The Ecosystem Health Monitoring Program report card grades indicate that estuaries in South East Queensland exhibit a wide range of conditions, from very good in the Noosa estuary to very poor in the Bremer, Oxley and Albert estuaries, all of which are subject to point discharges and considerable urban run-off (Table 8). There are no consistent regional trends over time, with most estuaries showing variability around a common grade and no apparent change in health. Only the Tingalpa estuary shows signs of having undergone an improvement over time.



**Table 8. Ecosystem Health Monitoring Program report card grades for South East Queensland estuaries 2000–2010.**

Estuary	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Currumbin				B+	A-	A-	A-	B-	B	B-	C	B-
Tallebudgera				B	A-	A-	B+	B-	B	B	B	B
Nerang	C+	B	B	B-	B	B	B	B	B	B	B-	B-
Coomera	B+	B	B	B	B	B+	A-	B	B	B-	C+	B
Pimpama				C-	C	C	C	C+	C+	C	C	C-
Albert		D	D	F	F	F	F	F	F	F	F	F
Logan		D-	D-	D-	D	D-	F	D-	D-	F	F	F
Bremer	F	F	F	F	F	F	F	D-	F	F	F	F
Oxley					F	F	F	F	D	F	F	F
Brisbane	D	D-	D-	D-	D-	D-	D-	D+	D+	D	D	D
Eprapah							C-	D	C	C	C-	C
Tingalpa					D-	D	D	D+	C	C	C+	C
Cabbage Tree					D-	D-	D-	F	D	F	D-	D+
Pine	D	D+	D+	D+	D+	D	D	C-	C	D+	C-	C
Caboolture	C	C	C	C-	C-	D+	D	D	F	D-	D	C-
Mooloolah	B	B-	B	B-	B-	B	B	B	B	B	B	B-
Noosa	A-	A-	A-	B+	A-	A	A-	A	A-	B+	B+	B+
Maroochy	C+	C	C	D+	D	C	D+	C-	C	D	C	D+

Source: Healthy Waterways, 2012. Ecosystem Health Monitoring Program.

The Southern Bay, Central Bay and Pumicestone Passage all appear to show a consistent decline in health scores (Table 9). Although there has been considerable work done over this period to improve the quality of point discharges, it is thought that the benefits of this are being counteracted by increases in diffuse loads of pollutants resulting from population growth and associated development, as well as rural run-off. In contrast, Bramble Bay may have improved, probably due to upgrades to the Luggage Point sewage treatment plant. Deception Bay, Waterloo Bay and the Gold Coast Broadwater show high variability around a good to moderate level of health. The eastern portion of Moreton Bay (Eastern Banks and Eastern Bay) is in the best health.

There have been some significant trends in individual indicators; in particular total nitrogen has decreased over time in most systems, which reflects the reductions in nutrient loads from sewage treatment plants, largely due to upgrades. Increased rainfall in South East Queensland in 2009 and beyond resulted in a greater connectivity of the catchments and run-off of nutrient rich, turbid water into the estuaries and the bay. This was associated with declines in estuarine and bay health.

It is important to note when examining changes over time, that there have been some changes to the Ecosystem Health Monitoring Program methodology and also to the Queensland Water Quality Guidelines. Changes to the Guidelines in the 2007 report card onward have had an impact on the scores achieved for several water quality indicators as they were more onerous than previous guidelines.

**Table 9. Ecosystem Health Monitoring Program report card grades for Moreton Bay and Gold Coast Broadwater 2000–2010.**

Marine area	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Pumicestone Passage	B-	B	A-	B-	B	C+	B	B-	C	C+	D+	C+
Deception Bay			C-	C+	C+	D+	C-	D	D	D-	D+	D+
Bramble Bay	F	F	D	D	D	D+	D+	D+	C	F	D+	D-
Waterloo Bay	C+	B-	B-	B	B	B-	B-	B+	A	D+	B	B+
Eastern Bay		A-	A-	A	A	A	A	A-	B	B-	B	B-
Central Bay	B	B	A-	A-	A-	B	B-	C	C	D	D	D+
Eastern Banks	B-	C	B	A	A	A	A	A	A-	A	A	A-
Southern Bay	C-	C-	B-	C+	C	D+	D	B-	C	F	F	F
Broadwater				B-	B-	B-	B-	B+	B	C-	C+	B

Source: Healthy Waterways, 2012. Ecosystem Health Monitoring Program.

#### 4.3.1.2 Moreton Bay Marine Park monitoring program

In March 2009, a new zoning plan was introduced for Moreton Bay Marine Park, a haven for wildlife and a valuable public resource. Preparation of the zoning plan involved sections of the marine park being classified as marine national park (green) zones, prohibiting most types of fishing, a major pressure in the park, amongst other activities. As part of the rezoning process, a five-year Moreton Bay Marine Park Monitoring Program was implemented to evaluate the health of the marine park, pre and post rezoning. This monitoring program is a collaborative study between the research sector and the Queensland Government. The results of an interim report released in February 2012 on the preliminary findings of the monitoring program are encouraging and showed the same positive changes with respect to fish and crab populations over time that have been observed in other marine park areas around the world (DERM, 2012). Green zones were also found to be more resilient because of the greater abundance of herbivorous fish that graze algae, which would otherwise have affected corals and other habitats. Studies also suggested that protecting a diversity of connected habitats makes it more likely that fish numbers will increase because many species move between different habitat types.

#### 4.3.1.3 Estuaries from the Fitzroy River to Tin Can Bay

Since 1993, the Queensland Government has been undertaking a long-term program of water quality monitoring of nine estuaries between Rockhampton and the Tin Can Bay Inlet. The focus has been on a range of basic water quality indicators, as per the Ecosystem Health Monitoring Program. The main aims of monitoring were to assess the quality of these waters with respect to both condition and long-term trend. The data collected also serves many other purposes, including input into environmental impact statements, informing licensing decisions, use by regional natural resource management groups and use as baseline data for deriving water quality guidelines.

The overall findings from the program show that the condition of the estuaries varies from near pristine to moderately impacted. Impacts on water quality are caused by both point source discharges and by inflows of catchment pollutant loads (i.e. nutrients and sediments). In many estuaries greater impacts are associated with the restriction of water flow due to the construction of large and small impoundments and other abstractions.

#### 4.3.1.3.1 Water quality trends

The majority of sites show either no trends or small improving trends from 1993 to 2006, with improving trends considerably outweighing the negative trends with most quite minor. The Burnett estuary shows the most consistent improvement across all indicators, largely as a result of improvements to the quality of treated sewage discharges (most of the improving trends observed were related to upgrades in the quality of point discharges).

There are some minor deteriorating trends in nutrients in the Boyne estuary. These are relatively small and the specific cause is not known. In the Mary River system there were some very significant increases in turbidity (i.e. increases in suspended particulates) at mid and to a lesser extent, upper estuary sites. Again, the cause of these is not known but may relate to increased sediment input from the catchment. Increases in total phosphorous are probably related to the increase in suspended particulates (i.e. increased sediment-bound phosphorous).

#### Water quality condition

The findings for compliance with guidelines for a range of indicators are summarised below and demonstrate:

- **Dissolved oxygen:** Median dissolved oxygen values meet guidelines in all water bodies on nearly all occasions, which indicates that none of them are being significantly impacted by organic loads during dry weather. The main exception is the Mary River system where a few sites fail guideline values (by relatively small amounts) due to point discharges to the mid estuary.
- **Turbidity:** Median turbidity values fail guidelines to a limited extent in many water bodies but in most cases these failures are by small margins. The worst case is the Isis estuary where turbidity exceeds guidelines for a majority of the time. This may be related to catchment influences. However, the relatively shallow nature of this estuary may also contribute to this. The long estuaries, the Fitzroy and the Mary, have naturally high turbidity levels and it is difficult to assess the significance of the measured values.
- **Nutrients:** Median nutrient values fail guidelines in the Fitzroy, Burnett and Mary rivers, primarily due to point discharges of treated sewage. In the Kolan, Burrum, Gregory and Isis estuaries there are no discharges and the relatively small exceedences of nutrient guidelines in these estuaries are likely to be related to catchment influences.
- **Chlorophyll-*a*:** Median chlorophyll-*a* values meet guidelines in the majority of water bodies. Exceedences occur in the upper reaches of the Fitzroy estuary due to nutrient rich treated sewage discharges. Median chlorophyll-*a* values also exceed guidelines in the Kolan and, more frequently, in the Isis and Gregory estuaries. The elevated chlorophyll-*a* values in the Gregory, Isis and Kolan systems are presumed to be related to catchment nutrient sources. In the Burnett River, elevated maximum chlorophyll-*a* values may be due to a combination of both point and catchment nutrient sources.
- **pH:** Values that fall below 5.5 provide an indication of acid run-off into the estuary. Minimum pH values did not fall below 5.5 in any of the waters on any occasion, which indicates that acid run-off is not a system-wide issue in any of these waters. However, this does not preclude the possible occurrence of localised acid run-off issues, especially if inappropriate development is allowed to occur. The lowest minimum pH values across the study area occur in the Burrum, Gregory, and Isis estuaries. In the Burrum estuary, this may be related to inflows from the naturally acidic waters of Lenthalls Dam.

#### 4.3.1.4 Burnett–Mary estuarine assessment

The risk and health of 18 estuaries in the Burnett–Mary natural resource management region were assessed and reported on (BMRG, 2009). The process utilised a framework based on a series of defined stressors that allows the reporting of overall health and risk, as well as identifying the individual stressors that were having the greatest impact. The overall health ratings from the study suggest that most estuaries are in fairly good to excellent health, but many are impacted by at least one significant issue.

The main regional issues impacting these estuaries were:

- loss of connectivity between estuaries and freshwater reaches due to dams and barrages
- reduced freshwater inflows due to impoundments
- overfishing of some species, especially crabs
- widespread littering

- seagrass loss
- loss of natural terrestrial vegetation immediately adjacent to intertidal areas.

All estuaries also suffer from the increased loads of sediments and nutrients resulting from clearance of vegetation in most catchments. In most estuaries water quality was not a significant issue.

#### 4.3.1.5 Great Barrier Reef waters

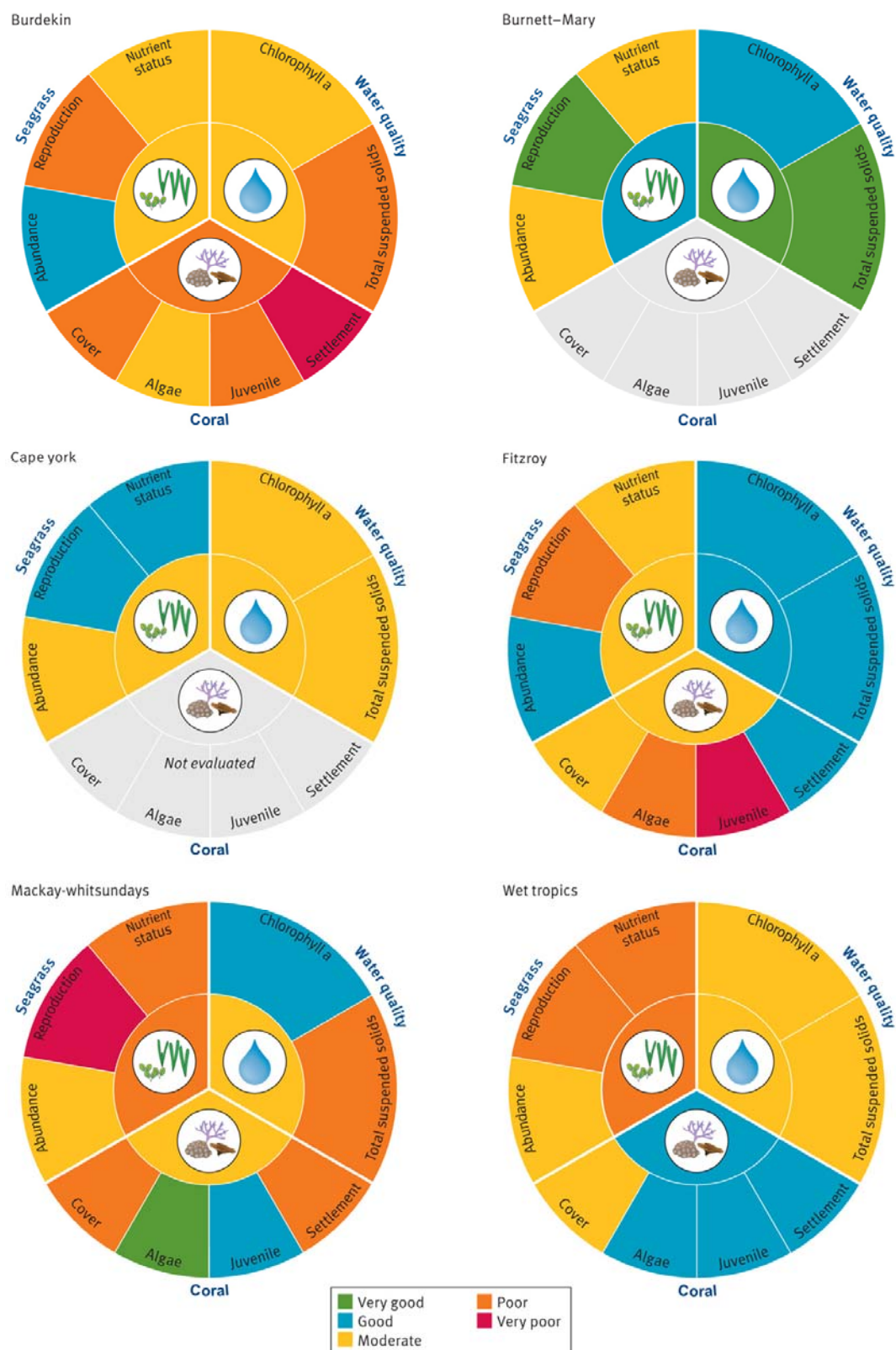
The Great Barrier Reef World Heritage Area is internationally renowned for its ecological importance and beauty. One of the best ways to protect the reef is to reduce stresses on its delicate ecosystem (DPC, 2011).

The condition of seagrass meadows, coral communities and inshore marine water quality are discussed below. This information has been extracted from the Great Barrier Reef Report Card 2009 Baseline, a key output of the Reef Plan Paddock to Reef Program.

The report card results highlight that there are areas of concern that justify the need for accelerated action to improve water quality and build resilience of the Great Barrier Reef (Figure 44). However, despite some poor indicators, the Reef remains in moderate condition overall (DPC, 2011).

The results show:

- **Seagrass:** Seagrass abundance is moderate and has declined over the last five to 10 years in association with excess nutrients. Although the condition of inshore seagrass was moderate overall, the number of reproductive structures was poor or very poor in four of the six regions, indicating limited resilience to disturbance.
- **Water quality:** Inshore water is moderate overall. Concentrations of total suspended solids range from poor (Burdekin and Mackay–Whitsunday regions) to very good (Burnett–Mary region). Chlorophyll-*a* is used as an indicator of nutrient loads in the marine system. Data analysed from satellite imagery showed that inshore waters in the Wet Tropics and Burdekin regions had elevated concentrations of chlorophyll-*a* compared to water quality guidelines.
- Pesticides have been detected at all 13 inshore Great Barrier Reef monitoring sites over the past five years of monitoring. Overall concentrations were lowest in the Fitzroy region and highest in the Wet Tropics region. Pesticide concentrations above water quality guidelines have been detected at least 25 km from the mouth of the Pioneer and O'Connell rivers during monitoring of flood events over the last five years. Concentrations that may have short term effects on the health of marine plants have also been detected up to 50 km from the coast.
- **Coral:** Most inshore reefs are in moderate condition, based on coral cover, macroalgal abundance, settlement of larval corals and numbers of juvenile corals; however corals in the Burdekin region are mostly in poor condition.
- High rainfall in the Great Barrier Reef catchment (particularly in the Burdekin and Fitzroy regions between 2008 and 2009) resulted in large flood plumes to marine waters. This rainfall, as well as the significant flood events of 2011, will continue to strongly influence the quality of water entering the reef, in particular to inshore areas (within 20 km).



Source: DPC, 2011. Great Barrier Reef First Report Card 2009 Baseline – Reef Water Quality Protection Plan. Note: These results, derived from the Reef Plan Paddock to Reef Program, are continuously being improved and updated over time; therefore, subsequent published results will reflect this.

**Figure 44. Results of marine aquatic ecosystem health for the Great Barrier Reef regions.**



### 4.3.2 Communities and populations

While the effects of human pressures on the environment are not always easy to quantify, the level of exploitation of fisheries stocks (e.g. fish, crustaceans and molluscs) with respect to their biological capacity to accommodate harvesting can be an informative indicator. This information can be used to assess and monitor the sustainability of the fishery and of freshwater, estuarine and marine ecosystem health.

#### 4.3.2.1.1 Coastal fishery stocks

Many Queensland fish stocks are either 'sustainably fished' or their exploitation status is 'uncertain' or 'undefined' due to data deficiencies. Concerns remain for the status of snapper stocks in the Rocky Reef Fin Fish Fishery off southern Queensland (DEEDI, 2011c). A summary of the status of fisheries stocks in Queensland is shown in Table 10.

**Table 10. Fisheries Queensland stock status summary 2011.**

Exploitation status category	Definition	Stocks in category
Sustainably fished	Harvest levels are at, or close to, optimum sustainable levels. Current fishing pressure is considered sustainable.	Barramundi (east coast and Gulf), yellowfin bream. Moreton Bay bugs, coral trout (east coast), blue-swimmer crab, mud crab (Gulf), three-spot crab, eel, dusky flathead, Spanish mackerel (east coast), spotted mackerel, banana prawns, eastern king prawns, tiger prawns, saucer scallop, sea mullet, stripey snapper, tailor, blue threadfin, tropical rock lobster, sand whiting, stout whiting.
Not fully utilised	Resource is underutilised and has the potential to sustain harvest levels higher than those currently being taken.	Spanner crab, redthroat emperor (east coast), endeavour prawn, trochus.
Uncertain	There are inconsistent or contradictory signals in the information available that preclude determination of exploitation status with any degree of confidence.	Blue eye trevalla, mud crab (east coast), red emperor, spangled emperor, grey mackerel (Gulf), shark mackerel, spanish mackerel (Gulf), pearl perch, bar rockcod, crimson snapper; goldband snapper, hussar snapper; rosy snapper, saddletail snapper, pencil squid, king threadfin (Gulf), tuskfish.
Overfished	Harvest levels may be exceeding sustainable levels and/or yields may be higher in the long-term if the effort levels are reduced. The stock may still be recovering from previous excessive fishing pressure. Recovery strategies will be developed for all overfished stocks to reduce fishing pressure within prescribed timeframes.	Snapper.
Undefined	Some information is available but no reasonable attempt can be made to determine exploitation status at this time. This may be due to the need for additional information or analyses to adequately determine stock status against the criteria.	Amberjack, Balmain bugs, bonito, cobia (East Coast), cuttlefish, grass emperor; bass groper, javelin, yellowtail kingfish, red champagne lobster, grey mackerel (east coast), school mackerel, mahi mahi, octopus, coral prawn, greasyback prawn, redspot and blue leg king prawn, school prawn, goldspotted rockcod, mud scallop, white teatfish and burrowing blackfish (sea cucumber), sharks, moses snapper (moses perch), tiger squid, teraglin, king threadfin (east coast) trevally.

Source: DEEDI, 2010b.

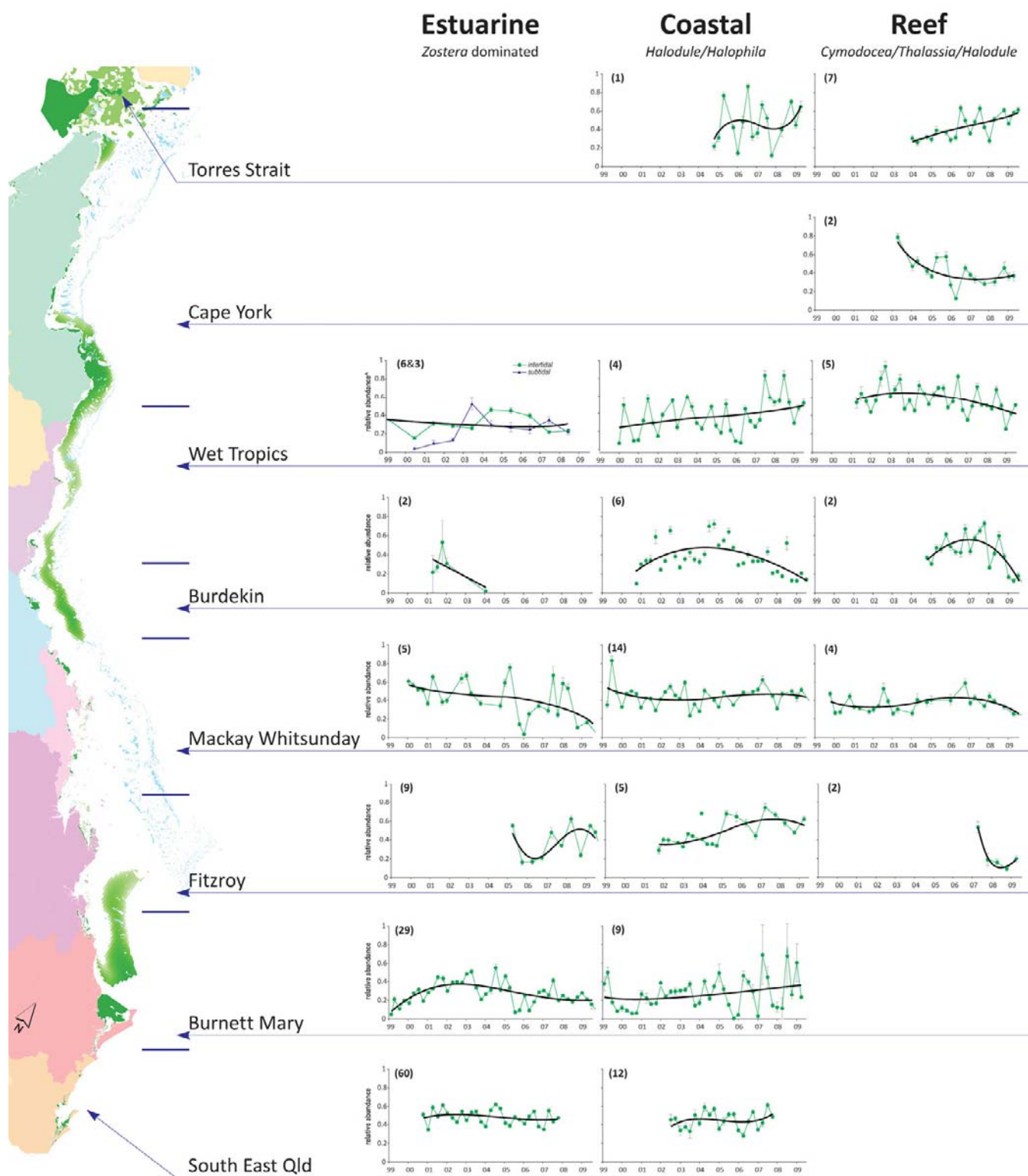
#### 4.3.2.2 Seagrass meadows

There are 15 seagrass species common in Queensland waters, a region that is part of the Indo Pacific centre of seagrass biodiversity. Seagrass is widespread and found from the upper intertidal region, on reef platforms, and

down to 70 m below sea level. They are one of the key habitat types, along with algae and coral, which underpin the biodiversity and productivity of tropical ecosystems and their fisheries.

Fisheries Queensland has assessed the status of seagrass meadows for Queensland based on available data to December 2009 (Mc Kenzie et al., 2010). Seagrass meadows in Queensland and the Torres Strait are mostly variable from year to year but stable in abundance at longer time scales (five to 10 years). The total area of seagrass has changed little over this time (Figure 45).

The threats to seagrass from human activity are not evenly spread and are almost all in the southern half of Queensland. There have been declines in abundance at some locations since 2006. While of concern, these changes are most likely the result of natural variations in climate, particularly tropical storms and flood run-off. More recently seagrass meadows have been adversely affected by the extreme and extensive flooding along much of the Queensland urban coast (Collier et al., 2011).



Source: McKenzie et al., 2010. Note: Relative seagrass abundance (all sites pooled) for intertidal estuarine, coastal and reef habitats within each NRM region along the east coast of Queensland (pooled by season for each year). Long-term trend line is calculated as polynomial. Values in parenthesis are the number of monitoring units (sites or meadows). Seagrass abundance (seagrass percentage cover or biomass as g DW m<sup>-2</sup>) relative to the 95th percentile at each monitoring site to enable standardised comparisons.

**Figure 45. Seagrass trends in Queensland's coastal natural resource management regions.**

#### 4.3.2.3 Estuarine crocodiles

The Queensland Government undertakes abundance and distribution surveys of estuarine crocodiles to inform appropriate management of the species. This includes protecting public safety and maintaining viable populations of estuarine crocodiles in the wild. The results of a survey of estuarine crocodiles undertaken between Cooktown and Maryborough between September 2009 and February 2010 found:

- of a total of 293 crocodiles sighted in 48 representative rivers and creeks, 258 were estuarine crocodiles. The size ranged from 0.3 m to 3.8 m in length, with the population being strongly biased towards immature animals (<2.9 m in total length) and indicative of a recovering population
- no crocodiles or evidence of crocodiles were sighted in any of the waterways surveyed between the Fitzroy River and the Mary River, indicating that there has been no southern drift in species distribution
- hatchlings were recorded in 37 per cent of waterways surveyed within the accepted range of estuarine crocodiles, indicating there is some successful nesting occurring throughout the study area
- all of the crocodiles were recorded in known crocodile habitat and none of the observed crocodiles exhibited behaviour indicative of a crocodile of concern.

#### 4.3.2.4 Marine turtles

Queensland beaches support globally significant breeding populations for four species of marine turtles. The state's coastal waters provide critical foraging areas for these turtles, as well as for additional turtles that migrate to breed in neighbouring countries.

Queensland's marine turtle conservation program has been running for more than 40 years. Over this time, turtle populations have been monitored by conducting annual censuses at key nesting beaches along Queensland's coast and tagging turtles for recapture in later years. Individual turtles have also been fitted with satellite transmitters to learn more about local and regional movement patterns. At other times of the year, turtles have been captured and tagged at shallow water turtle feeding sites, such as Moreton Bay, where growth data and survival data contribute to understanding the species and how they have been responding to management interventions.

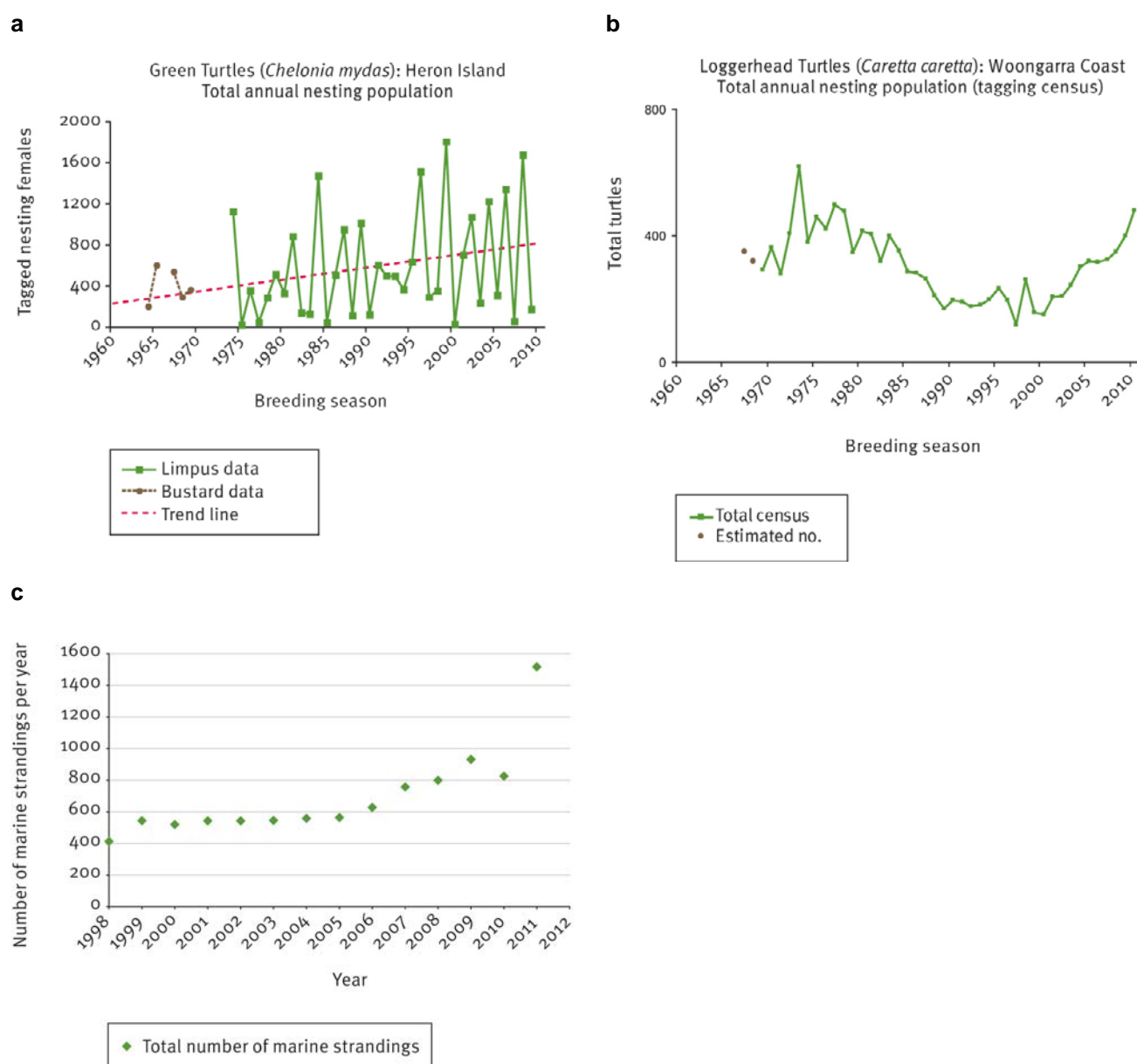
Information from the work has provided a basis for strong management changes, such as the introduction of turtle exclusion devices that became compulsory in 2001 for the east coast trawl and northern prawn fisheries. Evidence generated by the research is being used to change local management practices, such as street lighting near turtle nesting beaches, and zoning plans for Queensland marine parks. A number of 'go slow' zones have been created to reduce the rate of boat strikes in key turtle habitats in marine parks.

This work is also contributing to a better understanding of the state of marine ecosystems. Turtles are indicators of water quality and respond to large scale events, such as floods, as well as localised impacts from changes in water quality. Together this information provides valuable information about the state of Queensland's marine and estuarine ecosystems. Following the 2011 flooding, surveys have confirmed that at least parts of Queensland's immature east coast turtle population was experiencing extreme stress and had poor body condition. Over the long-term, improvements in water quality and reduction of sediment run-off are central to improving the resilience of inshore marine habitats to help dugongs and turtles survive future flood events.

The principal index populations for green and loggerhead turtles have been established from long-term studies at Heron Island and the Woongarra Coast respectively. The results of the findings show recovering populations after decreases as a consequence of human activities, with this recovery likely to be linked to increased protection (Figure 46a, b).

In contrast, the flatback and olive ridley nesting populations of Western Cape York Peninsula have been impacted by long-term intense pig, dog and goanna predation of eggs. Significant, long-term reduction in the loss of turtle eggs to terrestrial predators is identified as the most important management need for these turtle nesting populations of the Gulf coast.

The reduction in seagrass meadows along the Queensland urban coast in 2011 in response to flooding and cyclone damage has however, taken its toll with more than 1500 turtle strandings reported, mostly green turtles, compared with 900, on average, in previous years (Figure 46c).



**Figure 46. Trends in population for (a) green turtles at Heron Island, (b) loggerhead turtles at Woongarra Coast and (c) the number of marine turtle strandings by year up to January 2012.**

## 4.4 Land and terrestrial ecosystems

### 4.4.1 Queensland's terrestrial biodiversity

Biological diversity, or biodiversity, is the variety of all life forms on earth—the different plants, animals and microorganisms, their genes, and the ecosystems of which they are a part (DERM, 2010b). It also includes the processes that maintain these ecosystems (Lindenmayer and Burgman, 2005). Queensland is in the privileged position of being a biologically diverse state and much of this diversity occurs in land (terrestrial) environments.

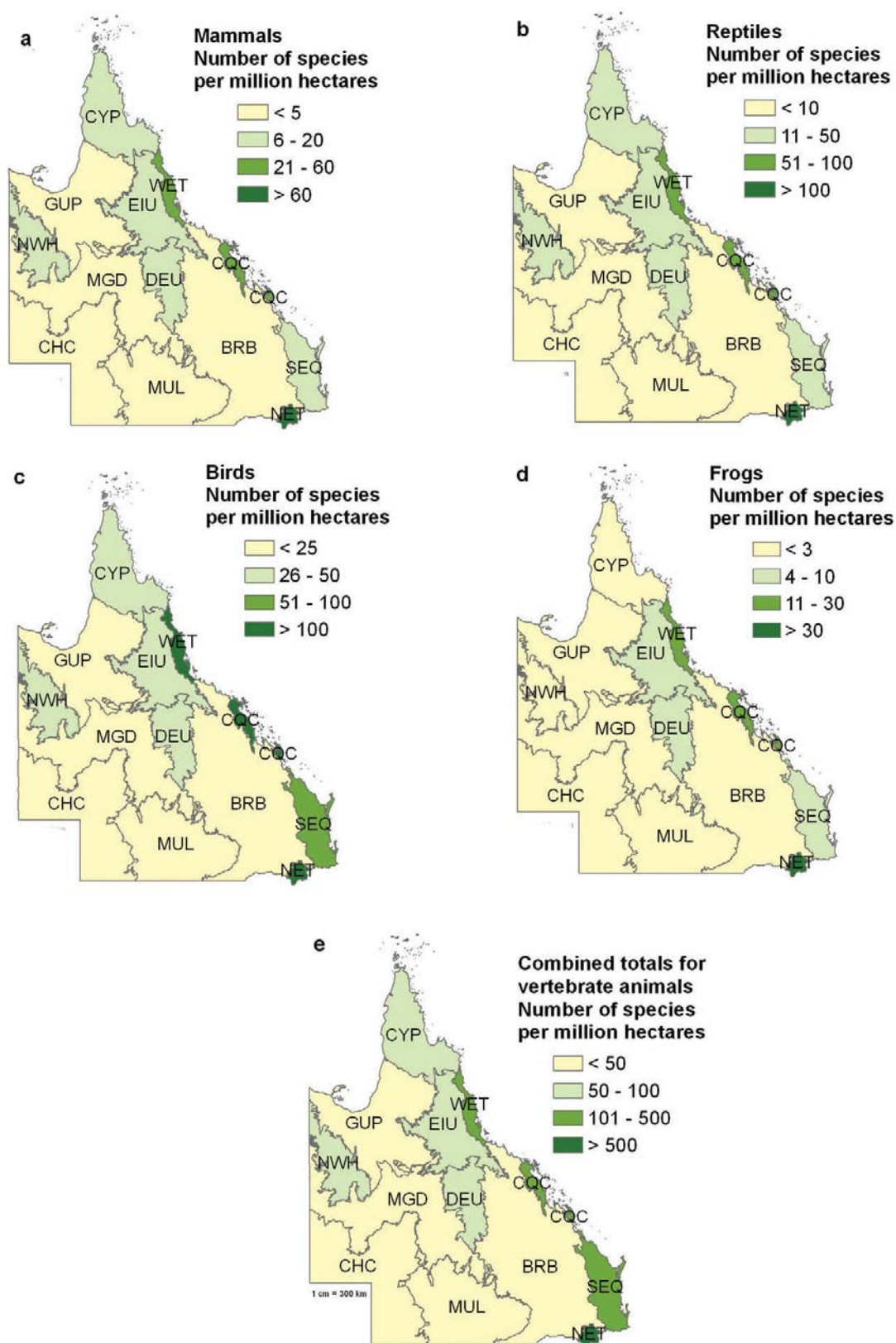
The number of species per million ha by bioregion for terrestrial vertebrate animals and vascular plants is outlined in Figure 47 and Figure 48. With regard to vertebrate animals, species richness per million ha is generally highest in the easterly bioregions of the Wet Tropics, New England Tablelands, Central Queensland Coast and Southeast Queensland. For mammals, reptiles and frogs the number of species per million ha is greatest in the New England



Tableland, followed by the Wet Tropics and Central Queensland Coast. The number of bird species per million ha is largest in the New England Tablelands, Central Queensland Coast and Wet Tropics, followed by Southeast Queensland.

Vascular plant species number per million ha is greatest in the Wet Tropics, New England Tableland and Central Queensland Coast. Flowering plants have the highest number of species, followed by ferns and fern allies and then gymnosperms, e.g. cone producing, non-flowering plants.

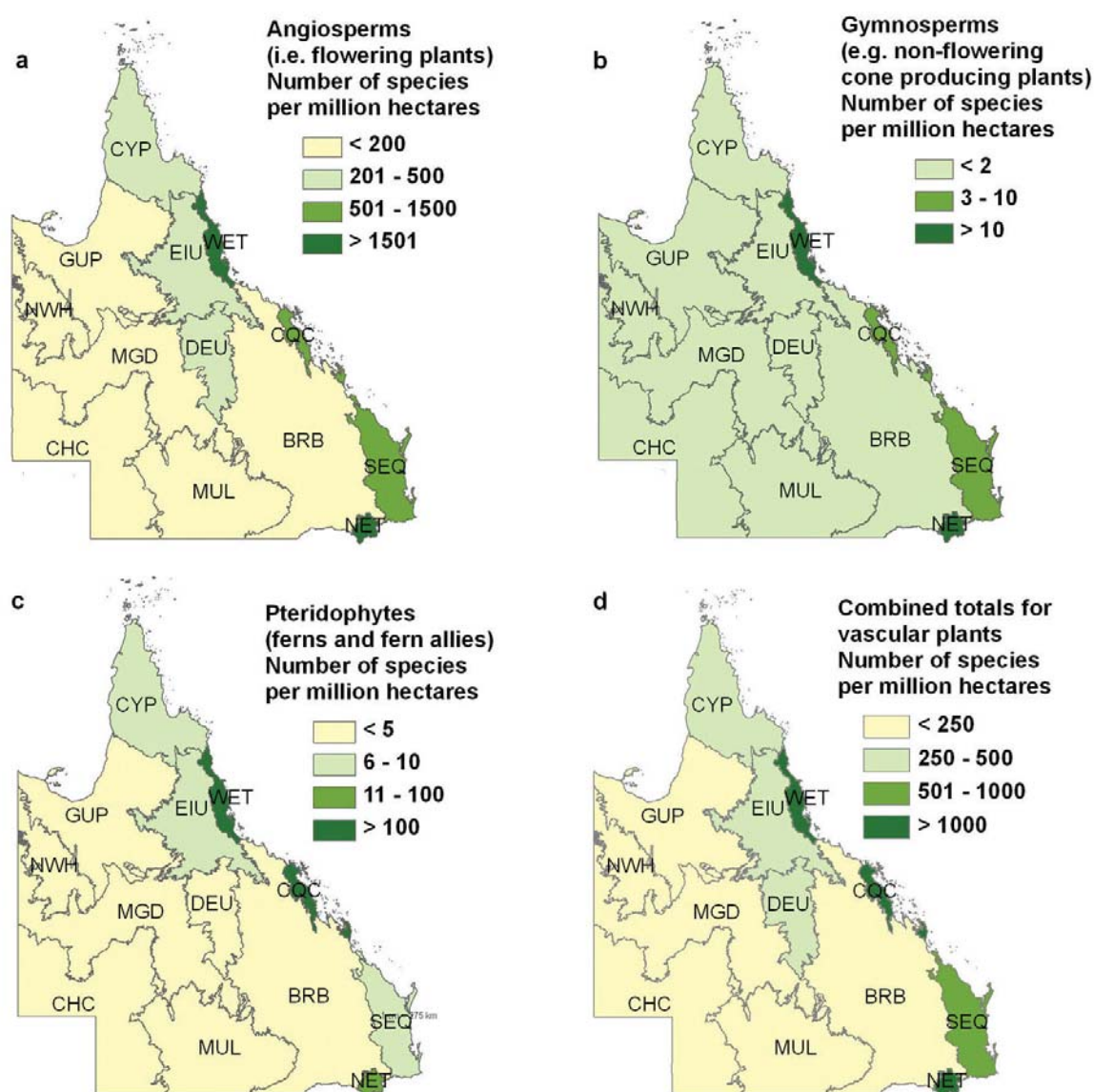
The greatest number of species per million ha for flowering plants occurs in the New England Tableland, Wet Tropics, Central Queensland Coast and Southeast Queensland respectively. For ferns and fern allies, the highest species count per million ha occurs in the Wet Tropics and Central Queensland Coast, followed by the New England Tableland. For gymnosperms, the greatest number of species occurs in the New England Tableland and Wet Tropics, followed by the Central Queensland Coast and Southeast Queensland.



Source: DERM, 2011k. WildNet. (Database). 17/12/2010

Bioregion Key: SEQ - Southeast Qld, WET - Wet Tropics, CYP - Cape York Peninsula, CQC - Central Qld Coast, BRB - Brigalow Belt, EIU - Einasleigh Uplands, MUL - Mulga Lands, NET - New England Tableland, GUP - Gulf Plains, NWH - Northwest Highlands, DEU - Desert Uplands, CHC - Channel Country, MGD Mitchell Grass Downs.

**Figure 47. Number of vertebrate animal species per million hectares by bioregion.**



Source: DERM, 2011k. WildNet. (Database). 17/12/2010

Bioregion Key: SEQ - Southeast Qld, WET - Wet Tropics, CYP - Cape York Peninsula, CQC - Central Qld Coast, BRB - Brigalow Belt, EIU - Einasleigh Uplands, MUL - Mulga Lands, NET - New England Tableland, GUP - Gulf Plains, NWH - Northwest Highlands, DEU - Desert Uplands, CHC - Channel Country, MGD Mitchell Grass Downs,

**Figure 48. Number of vascular plant species per million hectares by bioregion.**

## 4.4.2 Threatened species

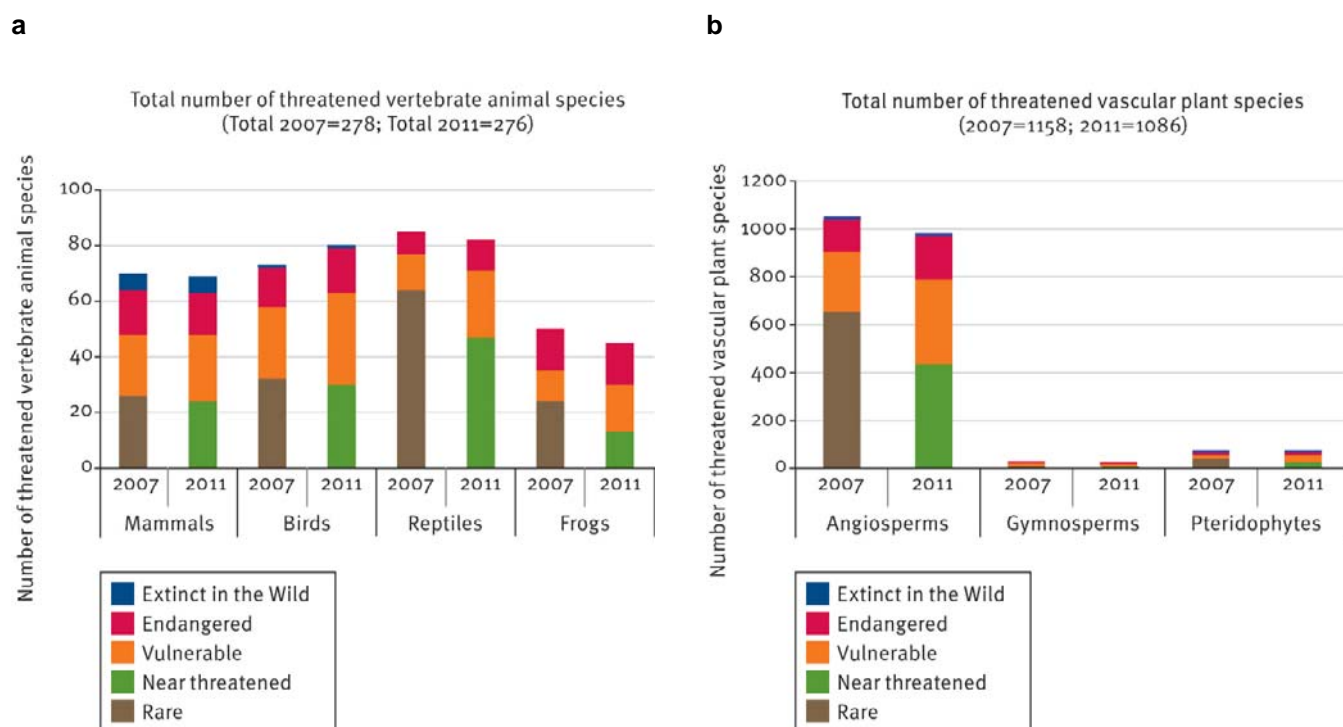
### 4.4.2.1 Statewide trends

Each of Queensland's native plants and animals are an important part of the state's rich biodiversity. Yet, some of these species have declined in number and are threatened with extinction by a range of pressures. The *Nature Conservation Act 1992* provides for species to be listed as of 'least concern', 'near threatened', 'vulnerable', 'endangered' and 'extinct in the wild'. This legal status has implications for management and for actions that can be taken to ensure that further pressure on these species is minimised.

Listing of threatened species is reviewed periodically and the Back on Track species prioritisation framework convenes expert panels, which assess species regardless of their current listed status thereby highlighting species as priorities for assessment in the future. These recommendations are reviewed by a technical panel before being prepared for legislative changes where necessary.

As of August 2011, 1372 species are listed as 'near threatened', 'vulnerable', 'endangered' or 'extinct in the wild' in Queensland under the Nature Conservation (Wildlife) Regulation 2006 (i.e. threatened species). In 2007, 1449 species were listed as 'rare', 'vulnerable', 'endangered' and 'extinct in the wild'. The discontinuation of the 'rare' category since the 2007 reporting period and the introduction of the 'near threatened' category make comparison between the reporting periods challenging.

Of the animal groups listed in 2011 and 2007, reptiles have the highest number of threatened species (Figure 49a). This is followed respectively by birds, mammals and frogs. Amongst the plants, flowering plants contain the highest number of threatened species; however this is also the most species rich of the vascular plant groups examined (Figure 49b). There are many more plant species threatened than animal species for the groups examined.



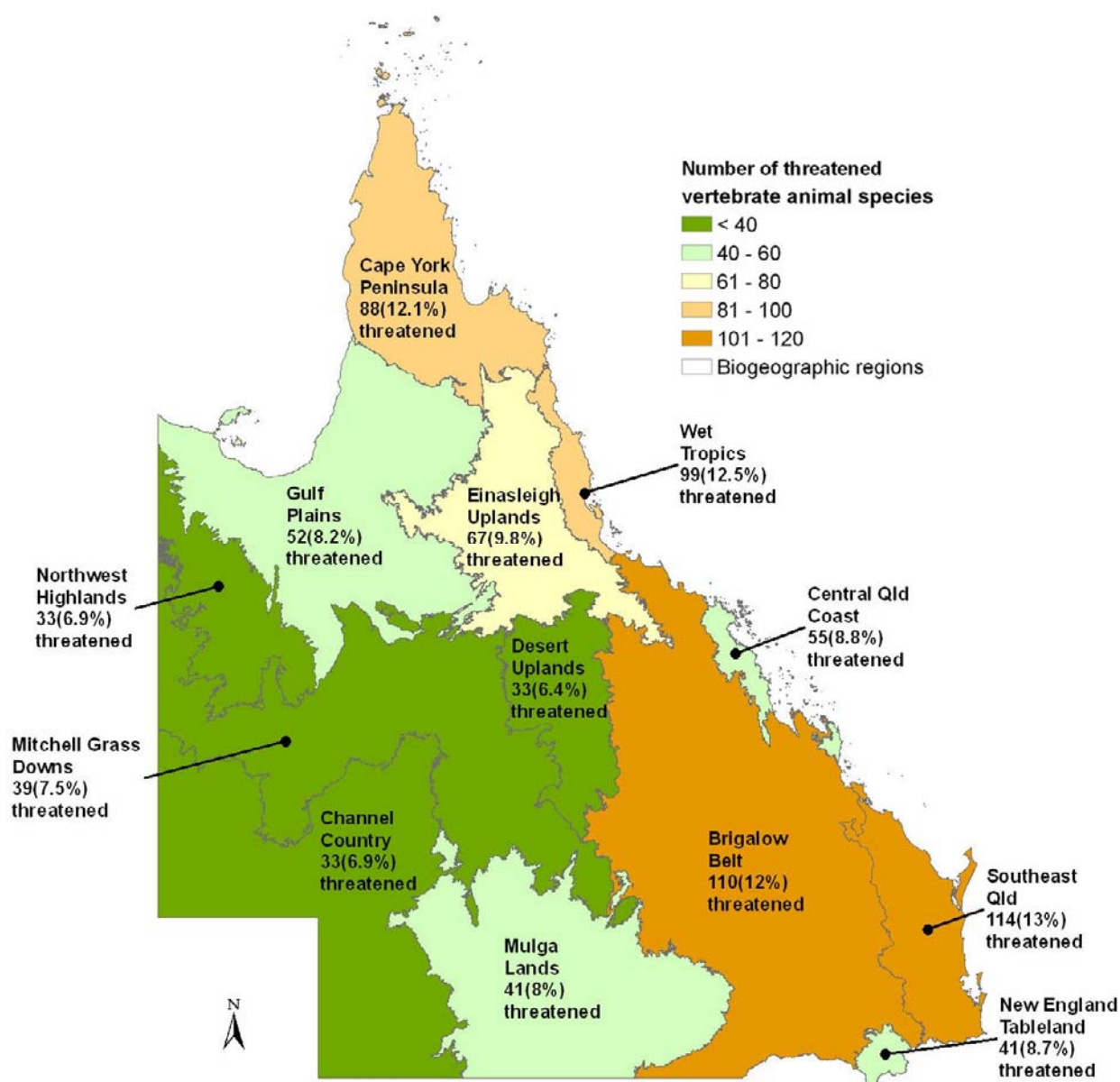
Source: DERM, 2011k. WildNet (Database). 2/8/2011

**Figure 49. (a) Number of threatened vertebrate animal species by taxa in 2007 and 2011; and (b) Number of threatened vascular plant species by taxa in 2007 and 2011.**

#### 4.4.2.2 Trends by bioregion

The highest number of threatened vertebrate animal species for mammals, birds, reptiles and frogs occurs in the Brigalow Belt at 110 and Southeast Queensland at 114 (Figure 50). This is 12 per cent and 13 per cent of the total species count for these bioregions respectively. In the Cape York Peninsula there are 88 vertebrate animal species threatened, while in the Wet Tropics there are 99.

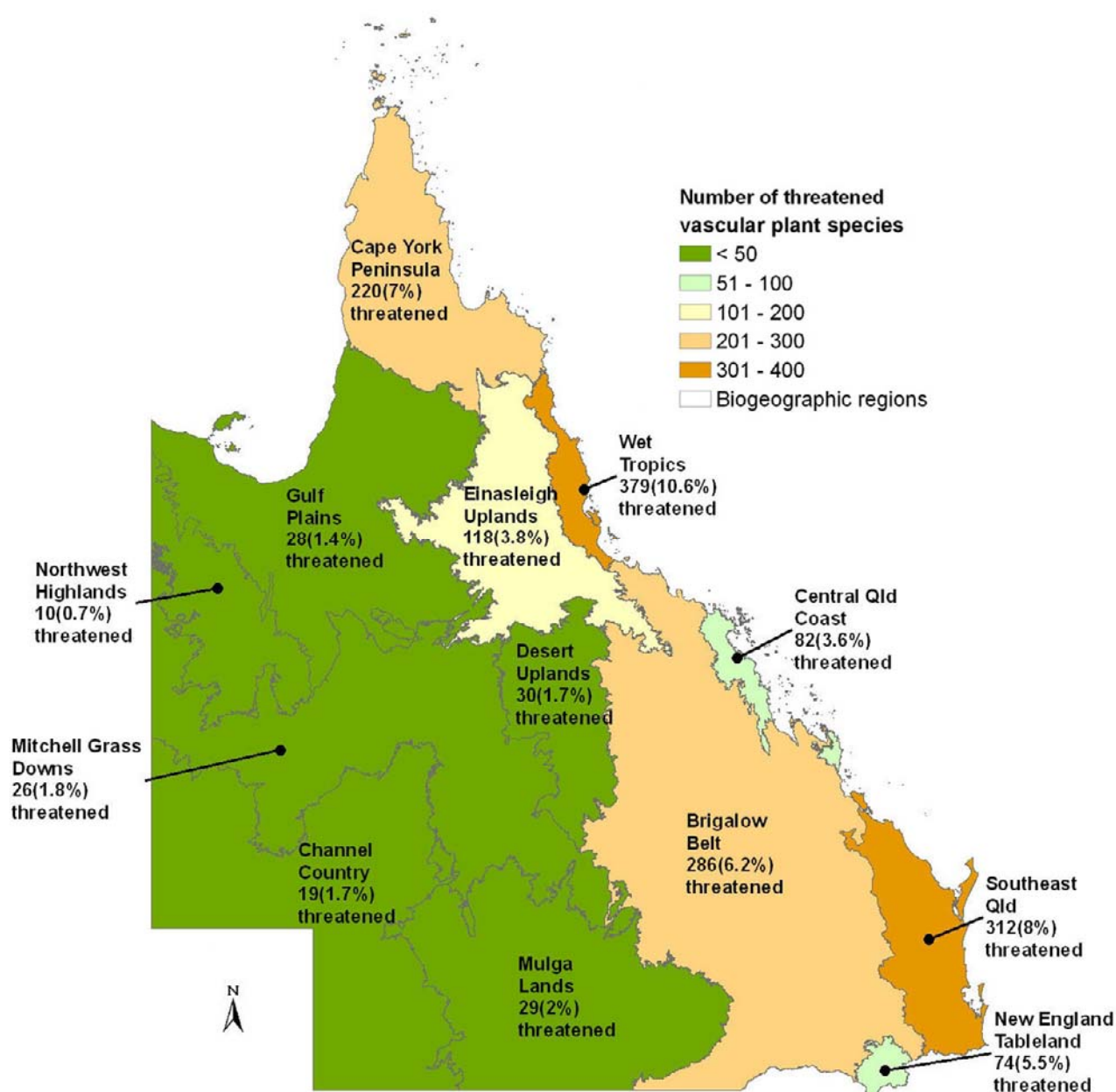
For the vascular plant groups examined, the Wet Tropics and the Southeast Queensland bioregions contain the greatest number of threatened species at 379 and 312 respectively (Figure 51). This is followed by the Brigalow Belt at 286 and the Cape York Peninsula at 220. The highest number of threatened species for vascular plants occurs in the more easterly bioregions of the state and is associated with those bioregions where vegetation clearing has been most extensive.



Source: DERM, 2011k. WildNet. (Database). 14/8/2011

**Figure 50. Number of threatened vertebrate animal species by bioregion.**





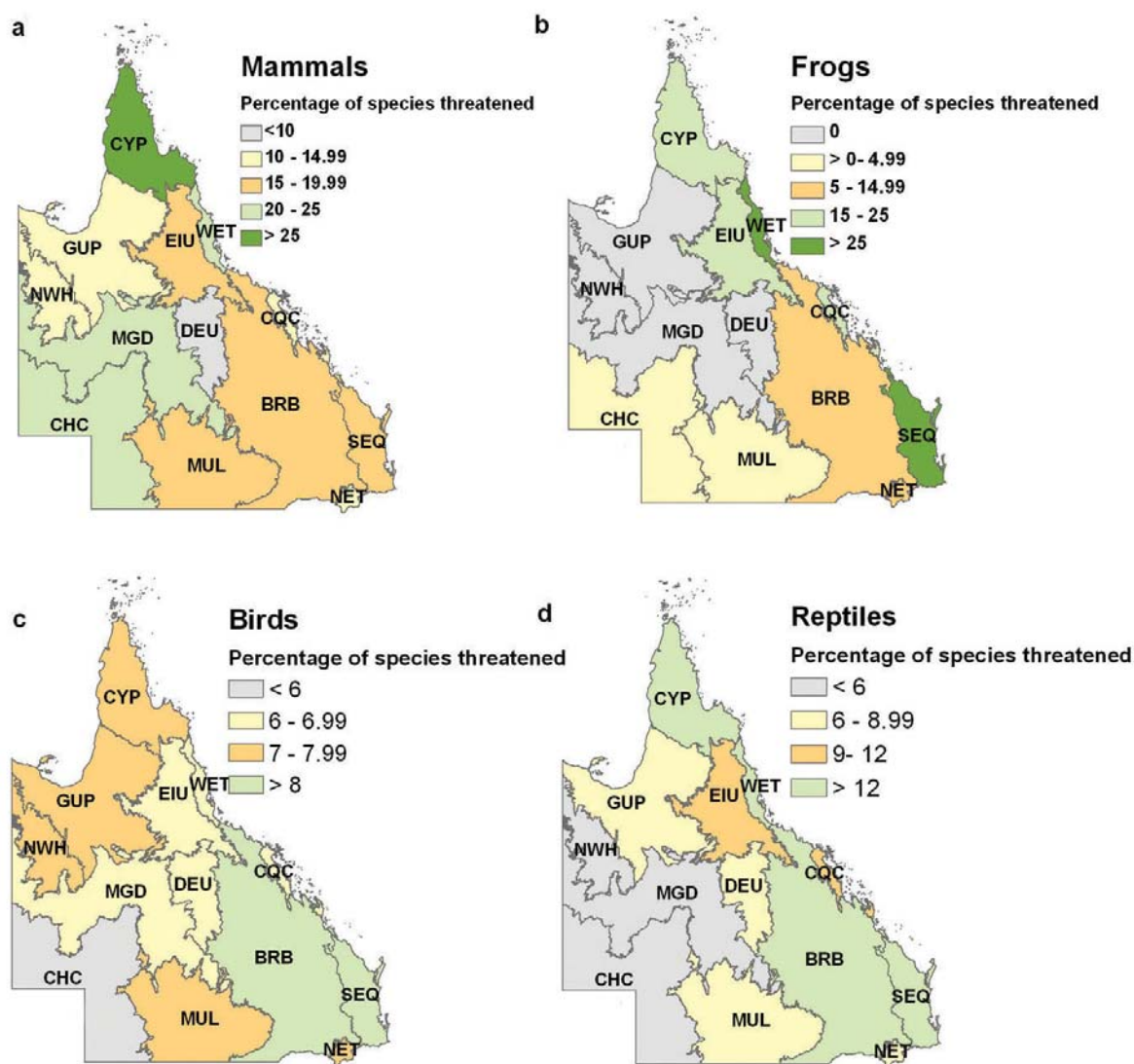
Source: DERM, 2011k. WildNet. (Database). 14/8/2011

**Figure 51. Number of threatened vascular plant species by bioregion.**

For mammals, the greatest percentage of species threatened occurs in the Cape York Peninsula at more than 25 per cent (Figure 52). This is followed by the Wet Tropics, Mitchell Grass Downs and Channel Country at over 20 per cent. Where frogs are considered, the highest percentages of species threatened occur in the Wet Tropics and Southeast Queensland at greater than 25 per cent. This is followed by the Cape York Peninsula, Einasleigh Uplands and the Central Queensland Coast at 15 to 25 per cent. The percentages of species threatened for reptiles are greatest in the eastern areas of the state with more than 12 per cent threatened in the Wet Tropics, Brigalow Belt, Southeast Queensland and Cape York Peninsula. The highest percentage of bird species threatened occurs in the Southeast Queensland and the Brigalow Belt at greater than eight per cent.

The highest percentage of threatened flowering plant species occurs in Wet Tropics and Southeast Queensland at greater than eight per cent (Figure 53). This is followed by the Cape York Peninsula and Brigalow Belt at greater

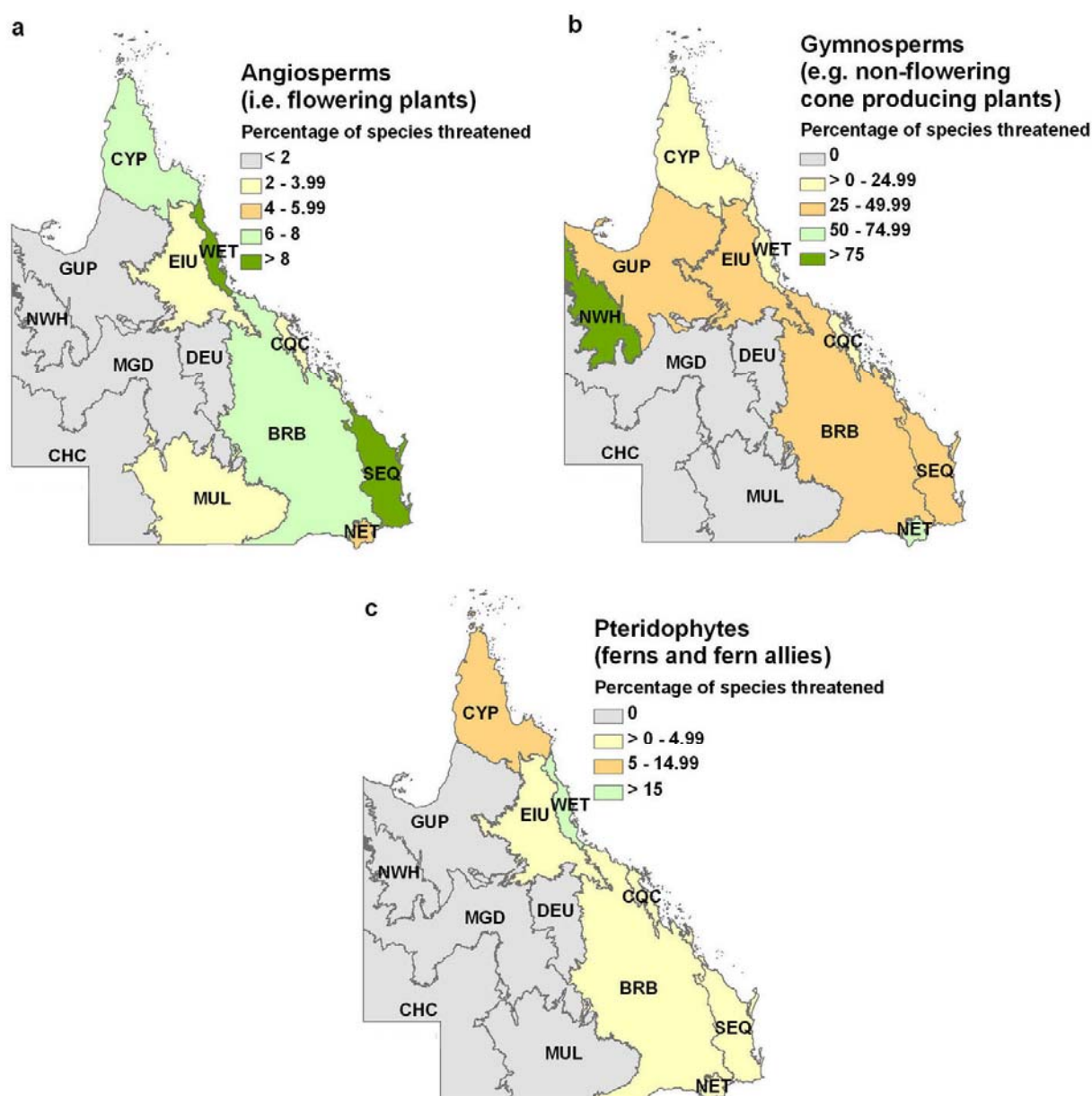
than six per cent. For gymnosperms (e.g. cone producing plants like Bunya Pines), the largest percentage of species threatened occurs in the Northwest Highlands where the sole species, *Cycas brunnea*, is near threatened (100 per cent), while in the New England Tableland greater than 50 per cent are threatened. For ferns and fern allies, the Wet Tropics has the largest percentage of species threatened, followed by the Cape York Peninsula.



Source: DERM, 2011k. WildNet. (Database). 17/12/2010

Bioregion Key: SEQ - Southeast Qld, WET - Wet Tropics, CYP - Cape York Peninsula, CQC - Central Qld Coast, BRB - Brigalow Belt, EIU - Einasleigh Uplands, MUL - Mulga Lands, NET - New England Tableland, GUP - Gulf Plains, NWH - Northwest Highlands, DEU - Desert Uplands, CHC - Channel Country, MGD Mitchell Grass Downs.

**Figure 52. Percentage of threatened vertebrate animal species by bioregion.**



Source: DERM, 2011k. WildNet. (Database). 17/12/2010

Bioregion Key: SEQ - Southeast Qld, WET - Wet Tropics, CYP - Cape York Peninsula, CQC - Central Qld Coast, BRB - Brigalow Belt, EIU - Einasleigh Uplands, MUL - Mulga Lands, NET - New England Tableland, GUP - Gulf Plains, NWH - Northwest Highlands, DEU - Desert Uplands, CHC - Channel Country, MGD Mitchell Grass Downs.

**Figure 53. Percentage of threatened vascular plant species by bioregion.**

#### 4.4.3 Regional ecosystem extent and status

Queensland supports a wide variety of regional ecosystems within its bioregions (Figure 54). The bioregions with the highest numbers of regional ecosystems are those located in the coastal areas of the state, with the Wet Tropics supporting a notable 93 regional ecosystems per million ha.

The Central Queensland Coast, Southeast Queensland and New England Tableland bioregions all support high numbers of regional ecosystems with over 20 regional ecosystems per million ha. Bioregions in central and western Queensland support comparatively lower numbers (less than five regional ecosystems per million ha).

Remnant vegetation has been lost due to clearing. The northern and western bioregions of the state have the highest percentage of remnant regional ecosystems remaining with figures well above 90 per cent. Clearing has been more

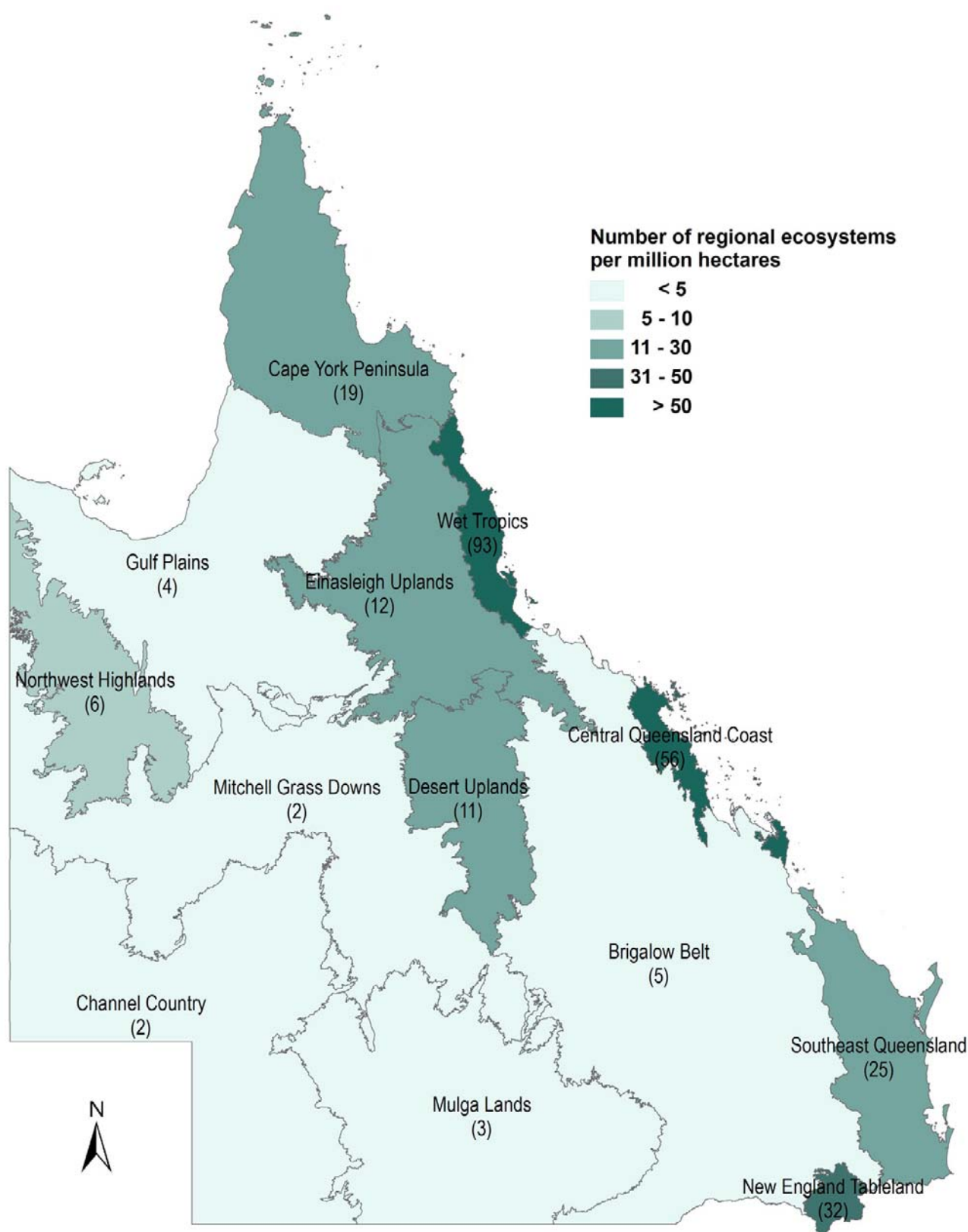
widespread across the east and south of the state with the Brigalow Belt, Southeast Queensland and New England Tableland bioregions retaining less than 45 per cent remnant regional ecosystem cover.

The *Vegetation Management Act 1999* class for a regional ecosystem is determined based on the pre-clearing and remnant extent of the regional ecosystem:

- ‘Endangered’ regional ecosystems are those where the area of remnant vegetation for that regional ecosystem is less than 10 per cent of the pre-clearing extent, or is 10 to 30 per cent of the pre-clearing extent and less than 10 000 ha in extent.
- ‘Of concern’ regional ecosystems are those where the remnant vegetation extent for that regional ecosystem is 10 to 30 per cent of the pre-clearing extent or, where more than 30 per cent of the pre-clearing extent, the area covered is less than 10 000 ha.
- ‘Least concern’ regional ecosystems are those where the remnant vegetation is more than 30 per cent of the pre-clearing extent for that regional ecosystem and covers more than 10 000 ha.

Figure 55a–c demonstrates an association between the percentage and the number of regional ecosystems in various classes for bioregions. These figures reflect the degree to which the landscape has been modified. Bioregions with historically more intact landscapes such as the Channel Country, Mitchell Grass Downs, Cape York Peninsula, Gulf Plains, Einasleigh Uplands, Mulga Lands and the Northwest Highlands have a lower proportion of ‘endangered’ and ‘of concern’ regional ecosystems.

Bioregions such as the Brigalow Belt, Southeast Queensland, New England Tableland, Central Queensland Coast and the Wet Tropics have a greater number and percentage of regional ecosystems with a class of ‘endangered’ or ‘of concern’. These bioregions have a long history of clearing and related vegetation change.

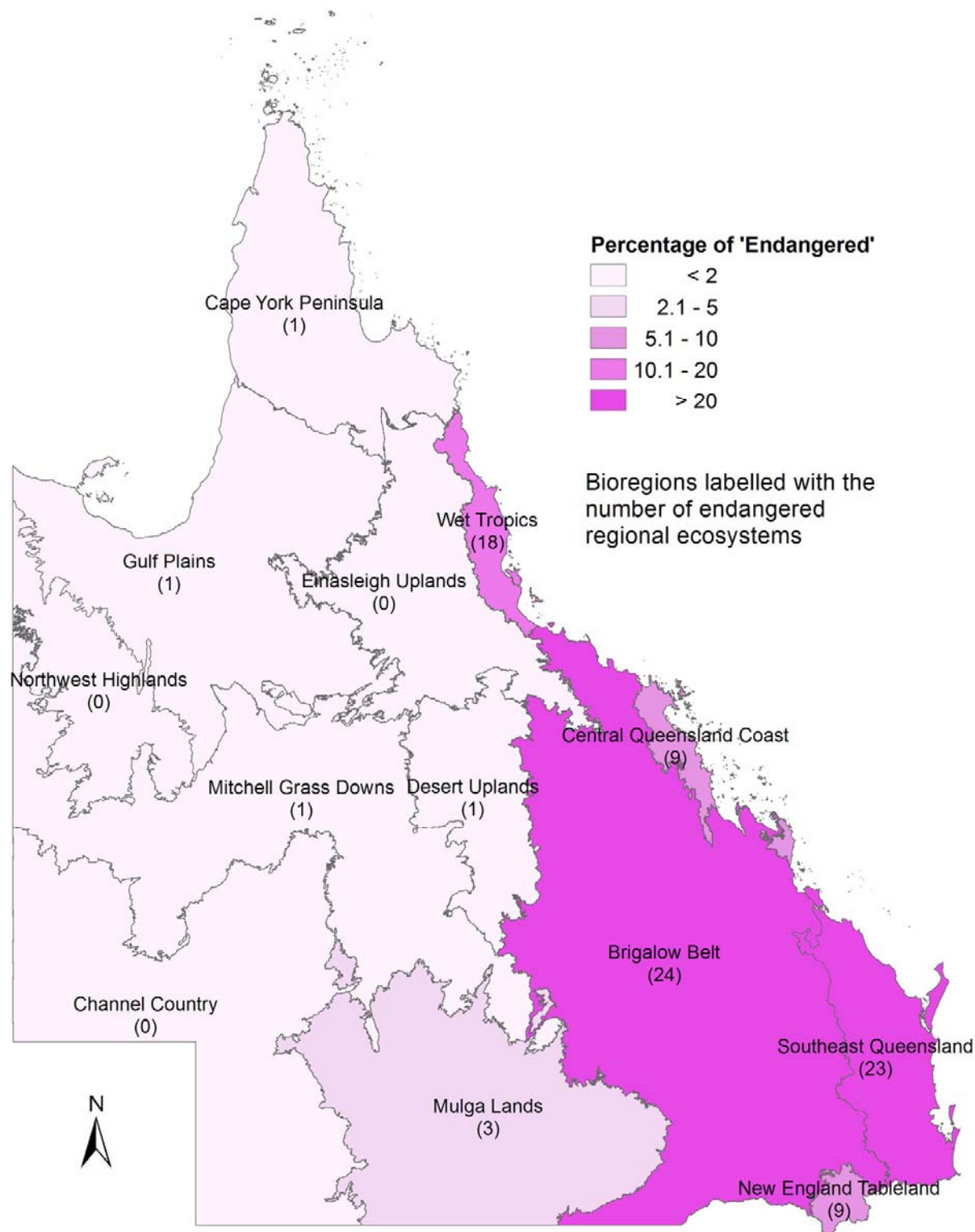


Source: Queensland Herbarium, 2012, in press. Note: Care must be taken in interpretation of these trends as variations in regional ecosystem mapping scale and completeness may confound results.

**Figure 54. Number of regional ecosystems by bioregion per million hectares.**



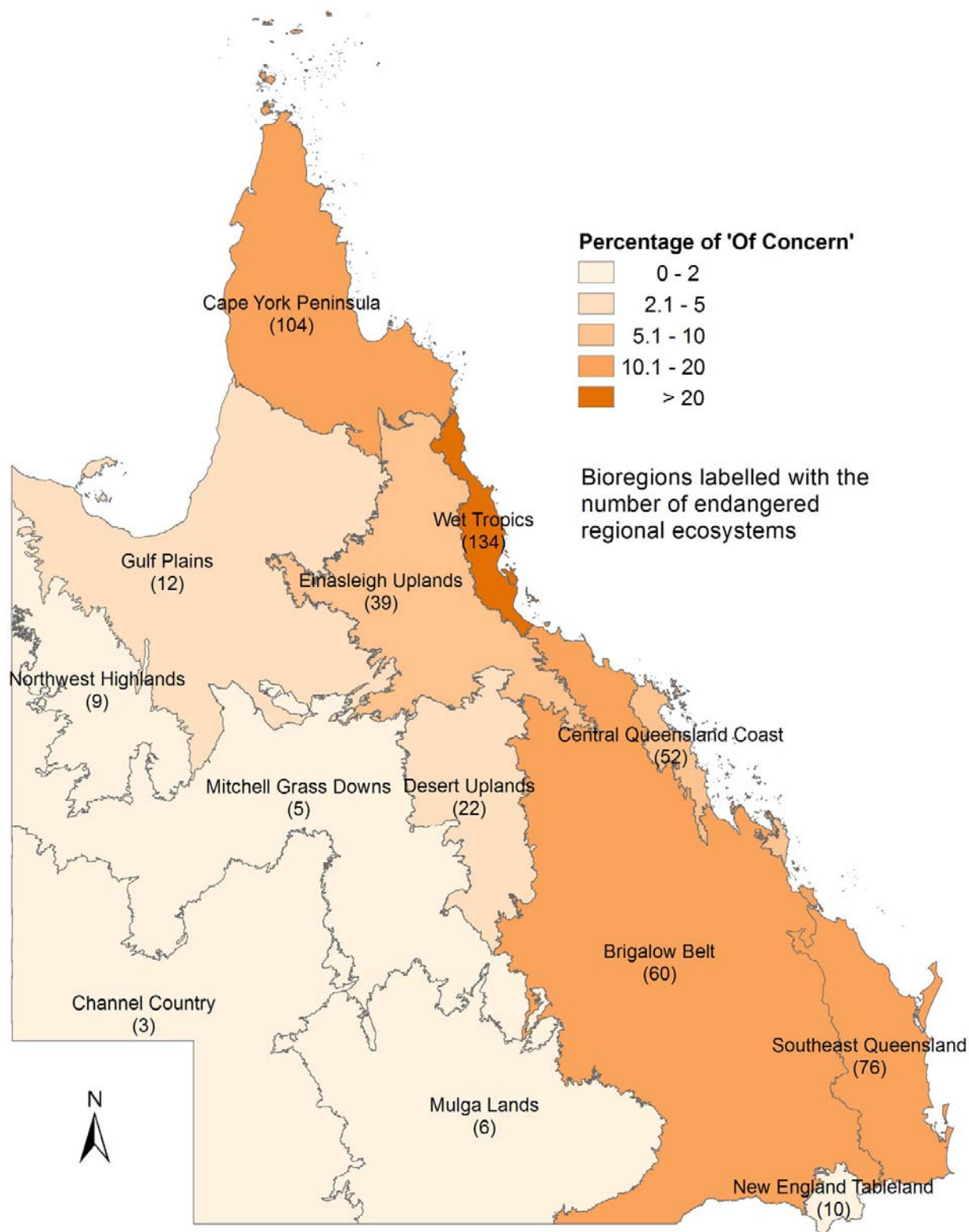
a



Source: Queensland Herbarium, 2012, in press. Note: Care must be taken in interpretation of these trends as variations in regional ecosystem mapping scale and completeness may confound results.

**Figure 55. (a) Number of 'endangered' regional ecosystems by bioregion, (b) 'of concern' regional ecosystems by bioregion and (c) 'least concern' regional ecosystems by bioregion.**

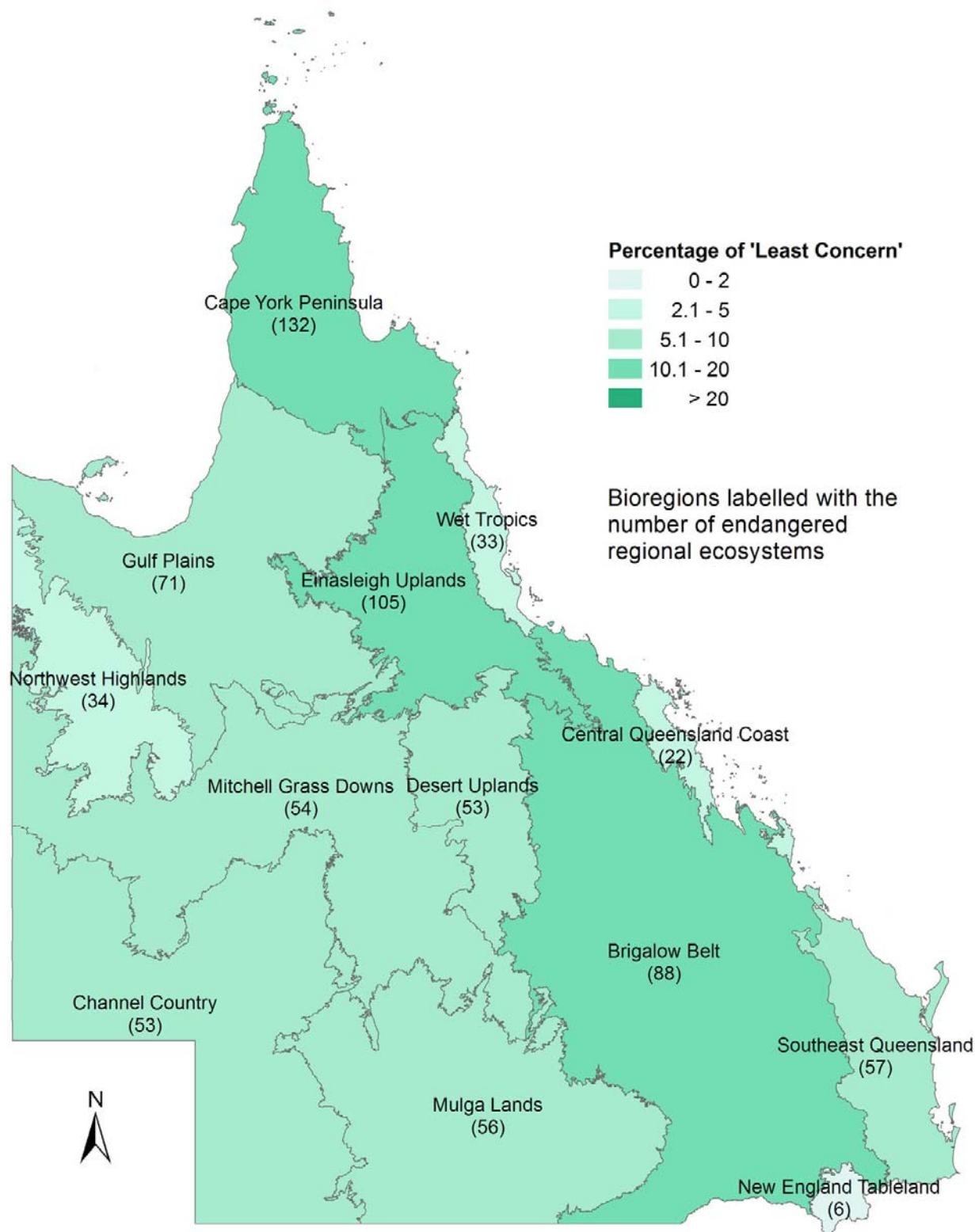
b



Source: Queensland Herbarium, 2012, in press. Note: Care must be taken in interpretation of these trends as variations in regional ecosystem mapping scale and completeness may confound results.

**Figure 56. (a) Number of 'endangered' regional ecosystems by bioregion, (b) 'of concern' regional ecosystems by bioregion and (c) 'least concern' regional ecosystems by bioregion.**

c



Source: Queensland Herbarium, 2012, in press. Note: Care must be taken in interpretation of these trends as variations in regional ecosystem mapping scale and completeness may confound results.

**Figure 56. (a) Number of 'endangered' regional ecosystems by bioregion, (b) 'of concern' regional ecosystems by bioregion and (c) 'least concern' regional ecosystems by bioregion.**

#### 4.4.4 State of protected areas

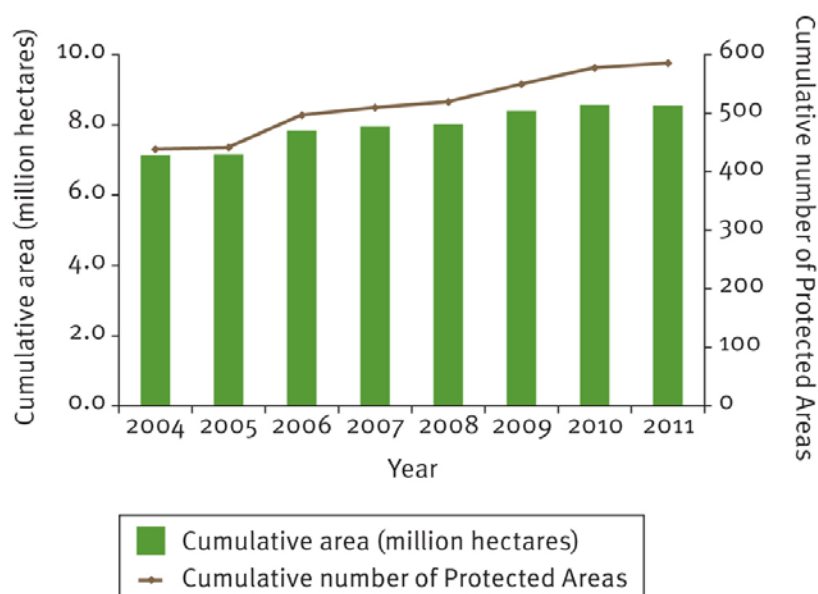
Protected areas, such as national parks are critical to the preservation of our environment, as they include the protection and management of lands for the purpose of conserving natural and cultural heritage values. Protected areas are included as a key component of strategies for the conservation of nature at regional, state, national and international levels.

While protected areas are often considered a response in environmental reporting, they have been included in the state chapter of this report. This is in an effort to go beyond simply reporting on them in the context of a response and begin to evaluate them in terms of other factors, for example the types and percentages of the ecosystems they protect.

In Queensland, protected areas are established under the *Nature Conservation Act 1992* and include state lands managed by the Queensland Parks and Wildlife Service. Five of Australia's 18 World Heritage areas are also located or partially located within Queensland. Listed for their natural values, the five areas include the Great Barrier Reef, Wet Tropics of Queensland, Gondwana Rainforests of Australia, Fraser Island and the Australian Fossil Mammal Site (Riversleigh section).

##### 4.4.4.1 Statewide trends

The protected area estate (as defined under the *Nature Conservation Act 1992* and excluding nature refuges, which are mostly owned and managed by private landholders and are covered in section 4.3.5) has been expanded to conserve the natural and cultural heritage of Queensland. The number of protected areas increased from 437 in 2004 to 587 as at December 2011 and the area they cover increased from 7 141 933 ha to 8 662 744 ha for the same period (Figure 56). National parks, conservation parks and resource reserves in 2011 account for approximately 5.01 per cent of land in Queensland.



Source: DERM, 2011i. Queensland Parks and Wildlife Service Estates Register (database).

**Figure 56. Number and area of protected areas over time.**

#### 4.4.4.2 Trends for bioregions

The percentage and area of bioregions in protected areas for the years 1997, 2001, 2006 and 2011 is presented in Table 11.

The Wet Tropics bioregion has undergone the greatest percentage increase of a protected area since state of the environment reporting began in Queensland. This reflects the continuing transfer of State forests and timber reserves with high conservation values to the protected area estate. It includes high value areas in the Tully Gorge, Paluma and Mount Windsor regions. Cape York Peninsula has also seen a significant increase in the percentage of protected areas in the bioregion, with over two million ha currently in national park and conservation park classes. The Southeast Queensland bioregion has seen a significant increase in the percentage of the bioregion reserved due to the transfer of State forest to protected areas under the South East Queensland Forest Agreement.

**Table 11. Percentage of bioregions in protected areas.**

Bioregion	Extent in protected areas in 2011 (ha)	Percentage of bioregion in protected areas			
	2011	1997	2001	2006	2011
Northwest Highlands*	378 592	5.1	5.1	5.2	5.2
Gulf Plains *	565 577	2.5	2.5	2.6	2.6
Cape York Peninsula *	1 965 220	12.9	13.0	14.8	16.0
Mitchell Grass Downs *	344 874	1.4	1.4	1.4	1.4
Channel Country *	1 561 822	6.7	6.7	6.7	6.7
Mulga Lands	495 735	2.4	2.4	2.4	2.7
Wet Tropics	868 696	17.4	19.6	38.1	43.6
Central Queensland Coast	166 765	5.6	9.7	10.1	11.2
Einasleigh Uplands	290 865	1.8	2.2	2.5	2.5
Desert Uplands	186 779	2.2	2.6	2.6	2.7
Brigalow Belt	880 576	2.1	2.2	2.3	2.4
Southeast Queensland§	834 156	5.2	6.8	9.6	13.3
New England Tableland	27 043	3.5	3.5	3.5	3.5

Note that the protected area classes used in this analysis are national parks, conservation parks and resource reserves, as defined in the *Nature Conservation Act 1992*, § excludes Ex-HMAS Brisbane only (35.4 ha), QPWS Estate Register June 2011, \* denotes mapping of bioregion is incomplete. Source: DERM, 2011.

Of the 1386 regional ecosystems currently recognised in Queensland, 80 per cent are represented in the protected area estate to some extent. This is an increase from 72 per cent in 1997 and 75 per cent in 2003. As at December 2011, Southeast Queensland, Central Queensland Coast and the Wet Tropics bioregions are the bioregions with greater than 90 per cent regional ecosystem representation in protected areas. The Gulf Plains, Mitchell Grass Downs and Einasleigh Uplands bioregions have the lowest representation with 48 per cent, 53 per cent and 63 per cent respectively.



The state of regional ecosystems by *Vegetation Management Act 1999* class (i.e. based on the pre-clearing and remnant extent) has been outlined in section 4.3.3. However, this class may not correspond to the condition of the ecosystem. For example, an ecosystem could be listed as ‘least concern’ but consist largely of areas in poor condition that may warrant conservation effort. The biodiversity status of regional ecosystems, as identified through the Regional Ecosystem Description Database, incorporates a measure of condition alongside extent when determining status.

In Queensland, 75 per cent of the total number of ‘endangered’ regional ecosystems, 80 per cent of the ‘of concern’ regional ecosystems and 81 per cent of the ‘not of concern’ regional ecosystems by biodiversity status are represented in protected areas (Table 12). The bioregions with the higher percentage of regional ecosystem representation in protected areas also have the higher percentage of ‘endangered’ and ‘of concern’ regional ecosystems.

Table 12 shows the number of regional ecosystems with a biodiversity status of ‘endangered’, ‘of concern’ and ‘not of concern’ that are represented in the protected area estate. This number is compared to the number of regional ecosystems of that status (in brackets) found in the bioregion.

**Table 12. Number of regional ecosystems by biodiversity status in protected areas.**

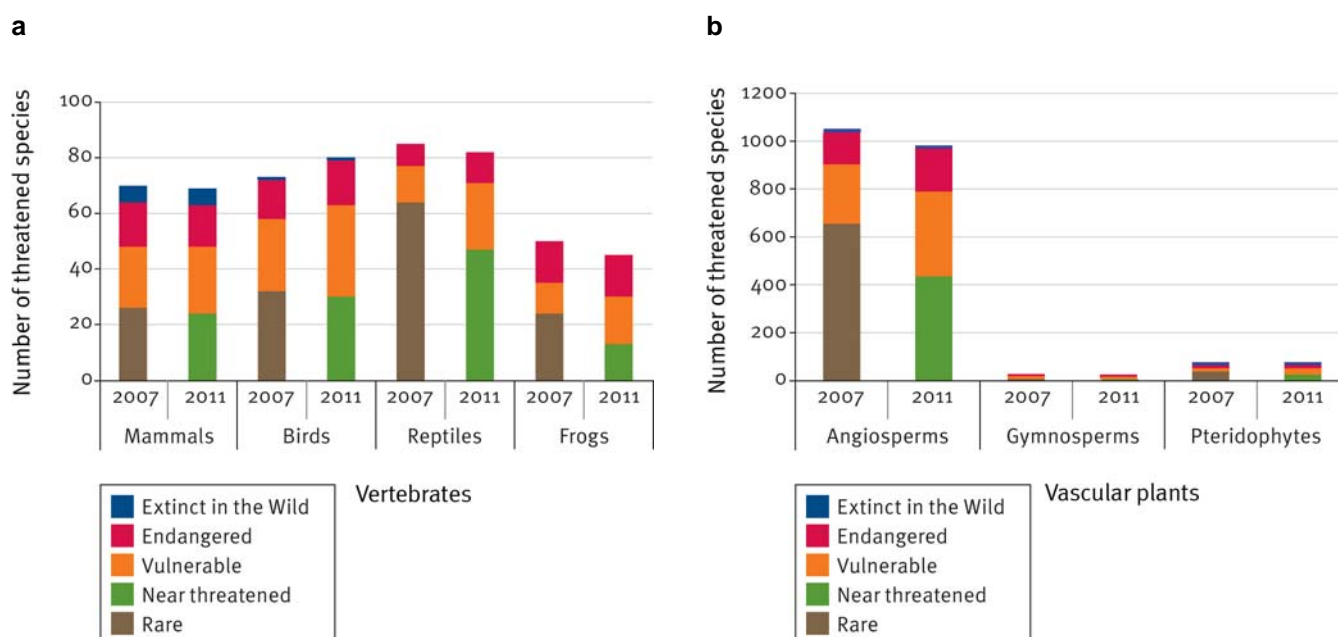
Bioregion name	Number of ‘Endangered’ regional ecosystems in protected areas	Number of ‘Of concern’ regional ecosystems in protected areas	Number of ‘Not of concern’ regional ecosystems in protected areas	Total number of regional ecosystems
Northwest Highlands*	3 (3)	13 (18)	14 (22)	43
Gulf Plains *	1 (3)	15 (32)	24 (49)	84
Cape York Peninsula*	5 (7)	81 (108)	112 (122)	237
Mitchell Grass Downs *	1 (1)	2 (11)	29 (48)	60
Channel Country *	0 (2)	2 (3)	39 (51)	56
Mulga Lands	6 (6)	20 (23)	26 (36)	65
Wet Tropics	71 (79)	85 (87)	19 (19)	185
Central Queensland Coast	19 (22)	45 (46)	15 (15)	83
Einasleigh Uplands	0 (1)	31 (59)	60 (84)	144
Desert Uplands	2 (16)	18 (27)	30 (33)	76
Brigalow Belt	29 (40)	51 (62)	67 (70)	172
Southeast Queensland	22 (28)	81 (82)	46 (46)	156
New England Tableland	9 (15)	6 (6)	3 (4)	25
Queensland	168 (223)	450 (564)	484 (599)	1386

Sources: Queensland Herbarium, 2012. in press. QPWS Estate Register June 2011. \* denotes mapping of bioregion is incomplete.

#### 4.4.4.3 Number of threatened species in protected areas

Inclusion of the habitat of threatened species within protected areas is regarded as an important strategy for conservation of these threatened plants and animals, with evidence in Australia that populations within protected areas are more likely to be stable or improve than those in other areas (Taylor et al., 2011).

In Queensland, 86 per cent of threatened vertebrate animals ('near threatened', 'vulnerable' and 'endangered') have been recorded in protected areas—this includes 81 per cent of mammals, 91 per cent of birds, 68 per cent of reptiles and 100 per cent of frogs (Figure 57a). At least 71 per cent of threatened plants, including 76 per cent of flowering plants, are represented in protected areas (Figure 57b). Note that these figures are based on available confirmed records and it is possible that greater proportions of species occur in protected areas but have not been recorded.



Source: DERM, 2011k. WildNet. (Database). 5/8/11.

**Figure 57. Number of threatened (a) vertebrate animal and (b) vascular plant species in protected areas.**

#### 4.4.5 State of nature refuges

Nature refuges comprise the second largest expanse of Queensland's protected areas estate. Nature refuges are a voluntary agreement between a landholder and the Queensland Government. The conservation agreement that is negotiated for each individual nature refuge reflects the landholder's commitment to conservation, while allowing compatible and sustainable land uses. Nature refuges play an important role in promoting a community-based landscape approach to conservation.

Since the last report—State of the Environment Queensland 2007—194 new nature refuges covering 2 336 298 ha have been established (Table 13). As at June 2011, there were 398 nature refuges in Queensland covering approximately 2 799 393 ha.

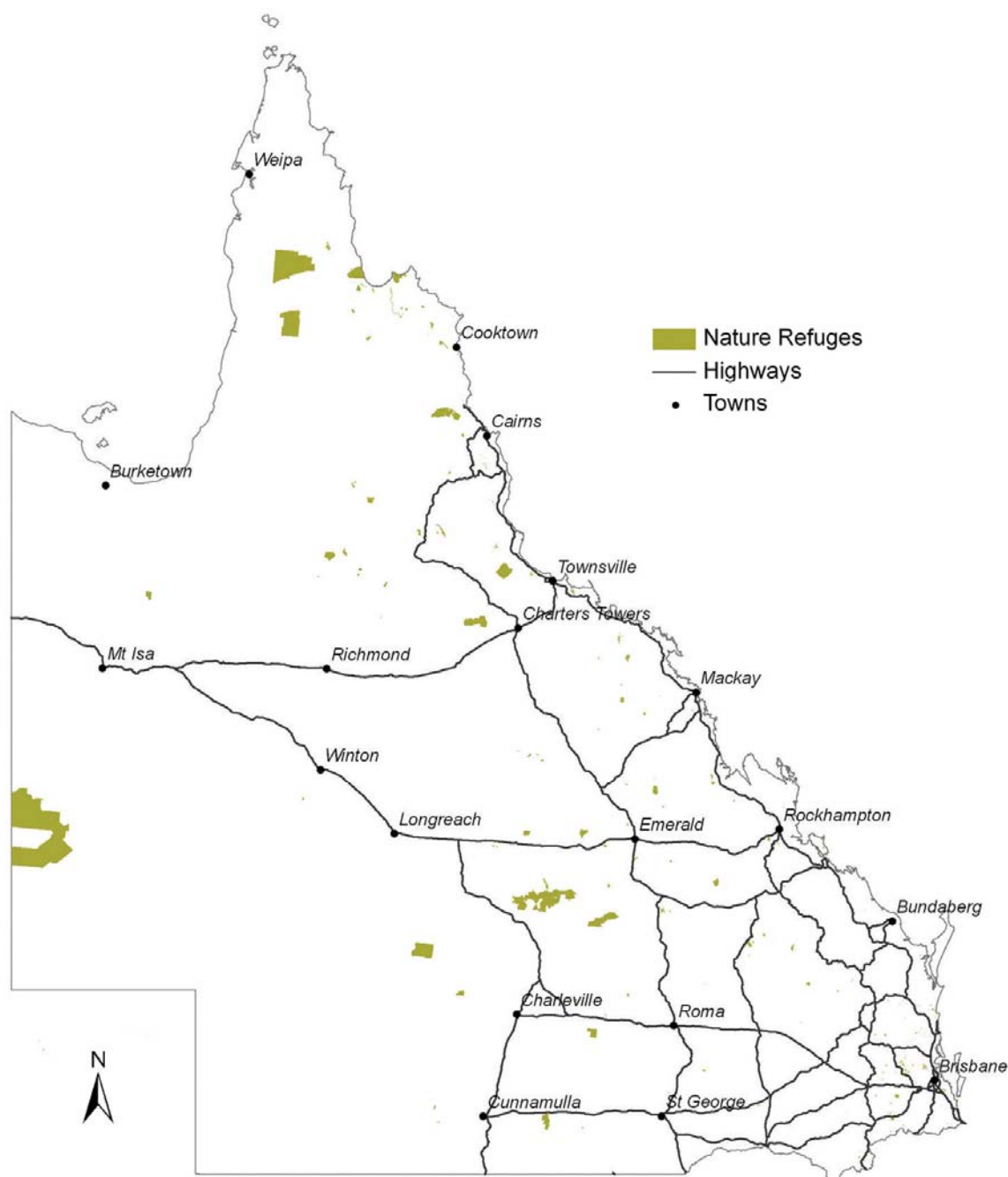
The first nature refuge was gazetted in 1994. At first, the rate of establishment of nature refuges was low; however the rate of nature refuge gazettal has increased dramatically from 2005 to 2011, both in number and area (Figure 58),

**Table 13. Number and area of nature refuges**

Year	Number of nature refuges	Area of nature refuges
2006	204	463 095
2011	398	2 799 393
Change since 2006	194	2 336 298

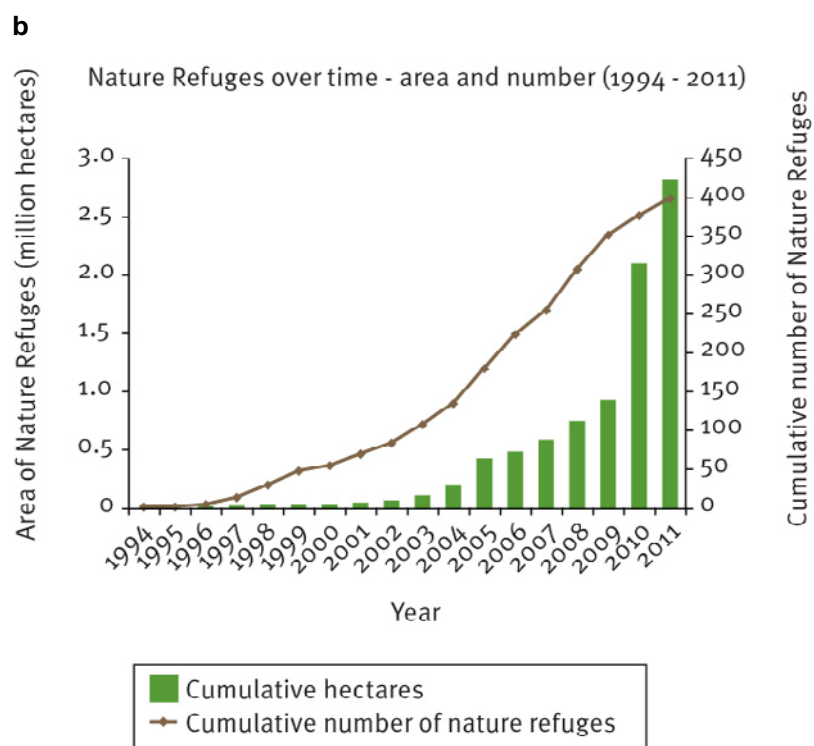
Source: DERM, 2011m. Nature Refuges and Coordinated Conservation Areas. Gazettal data, June 2011.

**a**



Source: DERM, 2011m. Nature Refuges and Coordinated Conservation Areas (includes gazettals up to December 2010).

**Figure 58. (a) Nature refuges across Queensland and (b). increase in nature refuges over time—cumulative hectares and number (1994–2011).**



Source: DERM, 2011m. Nature Refuges and Coordinated Conservation Areas (includes gazettals up to December 2010).

**Figure 58. (a) Nature refuges across Queensland and (b). increase in nature refuges over time—cumulative hectares and number (1994–2011).**

#### 4.4.5.1 Number of threatened ecosystems protected in nature refuges

Nature refuges offer protection for a number of threatened ecosystems and communities. Over 65 per cent of nature refuges contain ‘endangered’ or ‘of concern’ regional ecosystems, as defined under the *Vegetation Management Act 1999* and over 20 per cent of nature refuges contain threatened ecological communities, as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Table 14).

Over 30 threatened ecological communities are recorded in nature refuges including Brigalow, semi-evergreen vine thickets, weeping myall woodlands, mabi forest, white box–yellow box–blakely's red gum, grassy woodland and natural grasslands of the Queensland central highlands and the northern Fitzroy basin.

**Table 14. Number and percentage of ecosystems and communities present on nature refuges.**

Legislation under which communities/ecosystems are listed as threatened	Number of ecosystems/communities present on nature refuges	Percentage on nature refuges
<i>Vegetation Management Act 1999</i> ‘Endangered’ and ‘of concern’ regional ecosystems	222	66
<i>Environment Protection and Biodiversity Conservation Act 1999</i> Threatened ecological communities	69	20

Source: National Conservation Lands Database developed and maintained by the Australian Government DSEWPC, 2011a.

#### 4.4.5.2 Protection of bioregions in nature refuges

Nature refuges protect conservation values in all Queensland bioregions (Table 15). Nature refuges are best represented in the Cape York Peninsula bioregion with 3.77 per cent coverage, followed by the Channel Country bioregion with 3.45 per cent and the Einasleigh Uplands bioregion with 1.45 per cent.

There has been a trend towards the establishment of nature refuges across rangelands in the northern bioregions of Queensland over recent years.

**Table 15. Area of bioregion protected in nature refuges.**

Bioregion	Nature refuge area (ha)	Percentage of bioregion covered
Brigalow Belt	343 383	0.93
Channel Country	805 906	3.45
Central Queensland Coast	5454	0.25
Cape York Peninsula	512 706	3.77
Desert Uplands	24 280	0.35
Einasleigh Uplands	171 322	1.46
Gulf Plains	23 113	0.10
Mitchell Grass Downs	11 694	0.05
Mulga Lands	126 147	0.68
New England Tablelands	875	0.11
Northwest Highlands	6550	0.09
South Eastern Queensland	23 425	0.35
Wet Tropics	21 239	0.92

Data extracted 17 September 2010.

Nature refuges complement national parks in protecting ecosystems to ensure that the coverage of protection is representative. By examining the conservation agreements for Queensland's nature refuges, it is recorded that 24 per cent of nature refuges protect areas that are under-represented in Queensland's protected area estate.

There are 286 regional ecosystems, covering over 800 000 ha, that have low representation (less than four per cent of pre-clearing extent) in the protected area estate. There are 36 regional ecosystems that have no representation in the protected area estate and are only represented in nature refuges (Table 16).

**Table 16. Regional ecosystems protected by nature refuges with little or no representation in national parks.**

Under-represented regional ecosystems protected by nature refuges	Number	Area (ha)
Regional ecosystems having no representation in protected areas	36	280 452
Regional ecosystems having low representation in protected areas	286	819 128

Data extracted November 2009.

#### 4.4.5.3 Number of threatened species protected in nature refuges

The number of nature refuges containing threatened species and their habitat is a measure of the conservation value of nature refuges. Over 84 per cent of nature refuges record the presence of at least one species listed under the



*Nature Conservation Act 1992* and over 81 per cent of nature refuges record at least one species listed under the (national) *Environment Protection and Biodiversity Conservation Act 1999* (Table 17).

More than 400 threatened species are known to be protected on nature refuges; however many more are likely yet many remain unknown due to the scarcity of scientific knowledge on species distribution. Many threatened species are recorded on more than one nature refuge and most nature refuges have more than one threatened species recorded.

**Table 17. Threatened species protected in nature refuges.**

Legislation under which species are listed as threatened	Number of threatened species present on nature refuges*
Queensland <i>Nature Conservation Act 1992</i>	286
Commonwealth Government <i>Environment Protection and Biodiversity Conservation Act 1999</i>	274

Source: National Conservation Lands Database developed and maintained by the Australian Government DSEWPC, 2011a.

In addition to the presence of threatened species, threatened species habitat may also be recorded for nature refuges. Combining the data for both these sets of information reveals that 99 per cent of nature refuges protect threatened species or threatened species habitat (includes critical habitats important for the long-term survival of threatened, migratory, or other priority species listed under the *Vegetation Management Act 1999*, *Nature Conservation Act 1992* and *Environment Protection and Biodiversity Conservation Act 1999*).

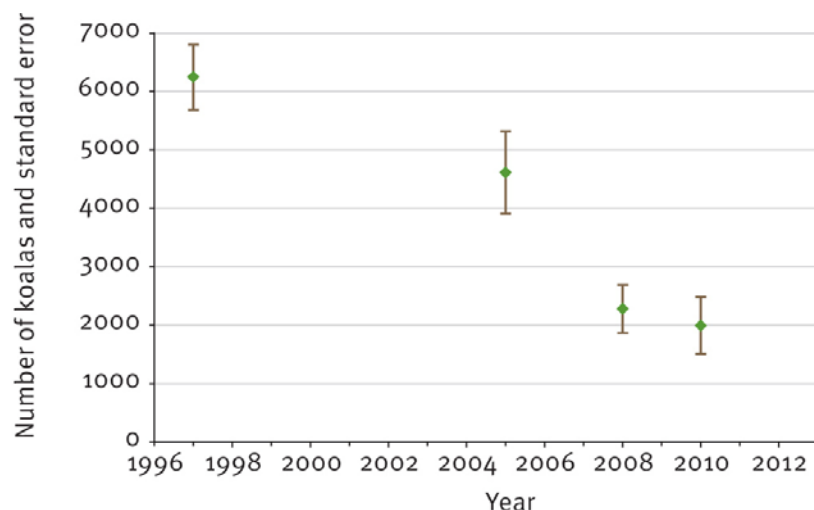
#### 4.4.6 Population estimates for selected species

##### 4.4.6.1 Koala populations in South East Queensland

The Queensland Government has monitored koalas in the Koala Coast (20 km south-east of Brisbane) since 1996. This longitudinal study is now regarded as the most detailed regional study of koalas undertaken in Queensland. A second study also commenced in 2001 in the Pine Rivers area of Moreton Bay Regional Council. Both these study areas contribute to a greater understanding of the population dynamics of the koala in a developing South East Queensland. The methodology utilised in these studies is outlined in detail in Dique et al., 2004 and Dique et al., 2003.

Between 1996 and 1999, the Koala Coast koala population was estimated at approximately 6000 animals (Dique et al., 2004). A follow-up survey of the Koala Coast between 2005 and 2006 indicated that the population had declined by 26 per cent to approximately 4600 animals (EPA, 2007). In 2008, a further survey revealed that the population had declined by 50 per cent, which resulted in a population of approximately 2300 animals (DERM, 2009a). Most recently, in 2010, the population was estimated at about 2000 koalas. This estimate represents a decline of 13 per cent between 2008 and 2010. However, the population estimates between 2008 and 2010 were so close that the change between these two years did not test as statistically significant.

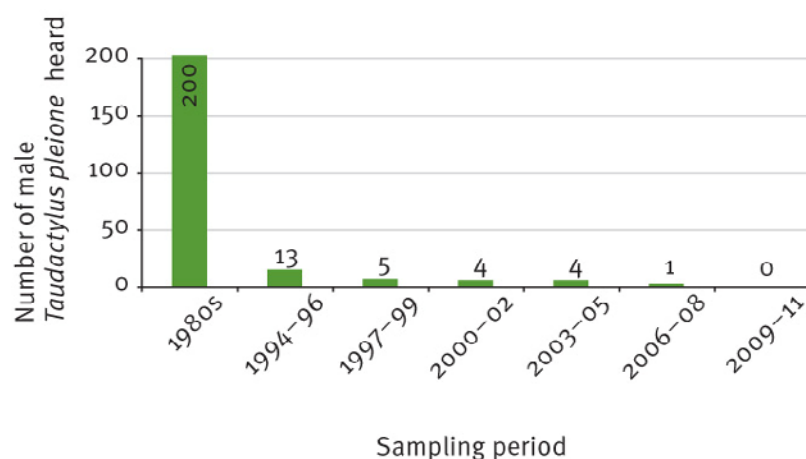
The long-term trend in the Koala Coast illustrates a 68 per cent decline over 12 years from 1996 to 2010 (Figure 59). Research conducted in the Pine Rivers area (north of Brisbane) also signalled a downward trend. Surveys undertaken in the Pine Rivers area between 2001 and 2007 indicated a decline in koala density of approximately 15 per cent in bushland sites and 45 per cent in urban locations. Surveys are now being conducted over South East Queensland to assess the status of koala populations across this significant landscape, in response to concerns that koalas are in decline regionally.



**Figure 59. Koala Coast koala population decline (1996–2010).**

#### 4.4.6.2 Frog declines—Kroombit tinkerfrog

The Kroombit tinkerfrog *Taudactylus pleione* is a critically endangered frog known from only 12 discrete rainforest patches, totalling 596 ha, at Kroombit Tops southwest of Gladstone. Despite all known habitat for the species being contained within Kroombit Tops National Park, its population is in decline, as outlined in section 3.9.3 of this report (Figure 60).



**Figure 60. The decline in number of male Kroombit tinkerfrogs heard on the plateau at Kroombit Tops.**

## 4.5 Productive lands

The major factors driving degradation and recovery in pastures include a changing climate, grazing pressure from domestic livestock and natural and feral herbivores, as well as grazing and vegetation management practices (e.g. grazing management at a paddock scale, pasture burning and woody plant regrowth control). Two measures—landscape function and ground cover—provide an indication of the condition of pasture in Queensland.

### 4.5.1 Landscape function

Landscape function is an integrated measure of the landscape components associated with pasture degradation. This includes composition of desirable (usually perennial) grasses and edible shrubs, soil surface protection (cover), infiltration capacity, soil fertility and capacity to store water.

The 2001–06 drought period was reported in State of the Environment 2007 as severe in terms of impacts on grazing lands and land users. Queensland has received excellent climatic conditions for pasture growth (especially

2009–11), with some regions having had the best season in 121 years. The wetter 2007–11 period has provided the climatic potential for recovery of natural resources and grazing enterprises. However, it brought with it floods and increased potential for weed encroachment and soil erosion. The risk of these potential impacts was reduced by the lower stocking rates reported during the drought period. This allowed pasture species to recover at the start of the wet period and, in turn, provided protection during the ‘big wet’ of 2010–11.

The Queensland Government undertakes detailed modelling and analysis of historical and current climate and grazing industry data to provide the best up-to-date information on seasonal conditions. The centre uses a range of complex models and data supported by advanced spatial simulation techniques and supercomputing facilities.

The landscape function analysis of the rangelands of Queensland by the Queensland Government provides a broad indication of how our rangelands may have changed under different conditions. The previous report (EPA, 2008) indicated that there had been significant loss of landscape function in southern and south-western Queensland from 1991–2005 from a number of contributing causes including drought, fodder clearing, erosion, pests and grazing pressure (Figure 61a).

With pasture condition and stocking rates yet to be fully assessed ‘on the ground’, the landscape function analysis and modelling (Figure 61b) suggests that regions in Central and South West Queensland (19 per cent of state area) have ‘increased’ in function, while 55 per cent of the state was estimated to have ‘no change—stable’ in landscape function, with respect to the previously reported period (1991–2005).

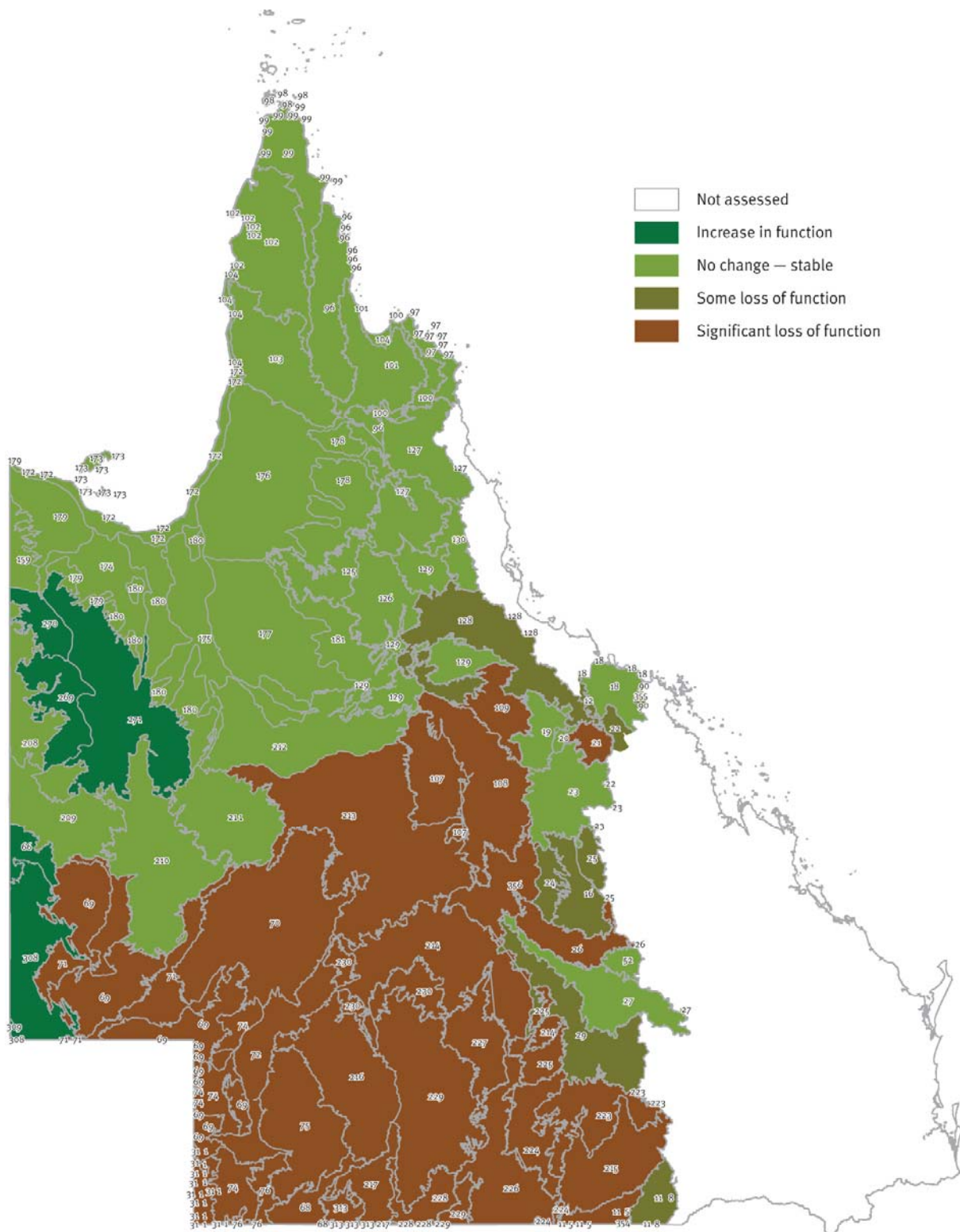
Twenty-three per cent of state area in the far south-west of the state and the inland south-east appear to still be experiencing ‘some losses’ of landscape function, while two per cent of state area is assessed to have a ‘significant’ loss. This suggested loss of function may be as a result of past climate and management events (e.g. South West Queensland and Dalrymple Shire). Full recovery is yet to take place despite reasonable climate sequences and improved land management. Individual land holdings that have not responded as well as neighbouring properties, despite the general above-average climatic conditions, has been primarily attributed to chronically poor land condition.

### **Mitchell grass cover**

The proportion of Mitchell grass cover is regarded as an indicator of land in good condition in Mitchell Grasslands ecosystems. Mitchell grass cover has been severely affected by prolonged drought conditions and recovery has been variable. Recent observations by field officers and graziers have indicated that there has been general land condition recovery in the Mitchell Grasslands following three exceptional seasons across Western Queensland and in the far south-west around Thargomindah.

Some areas of Mitchell grass in the state’s west have not yet responded (including both grazed and ungrazed sites). A number of factors could be responsible, such as pre-drought conditions, species competition following rain (e.g. winter herbage dominance) and variation in soil type.

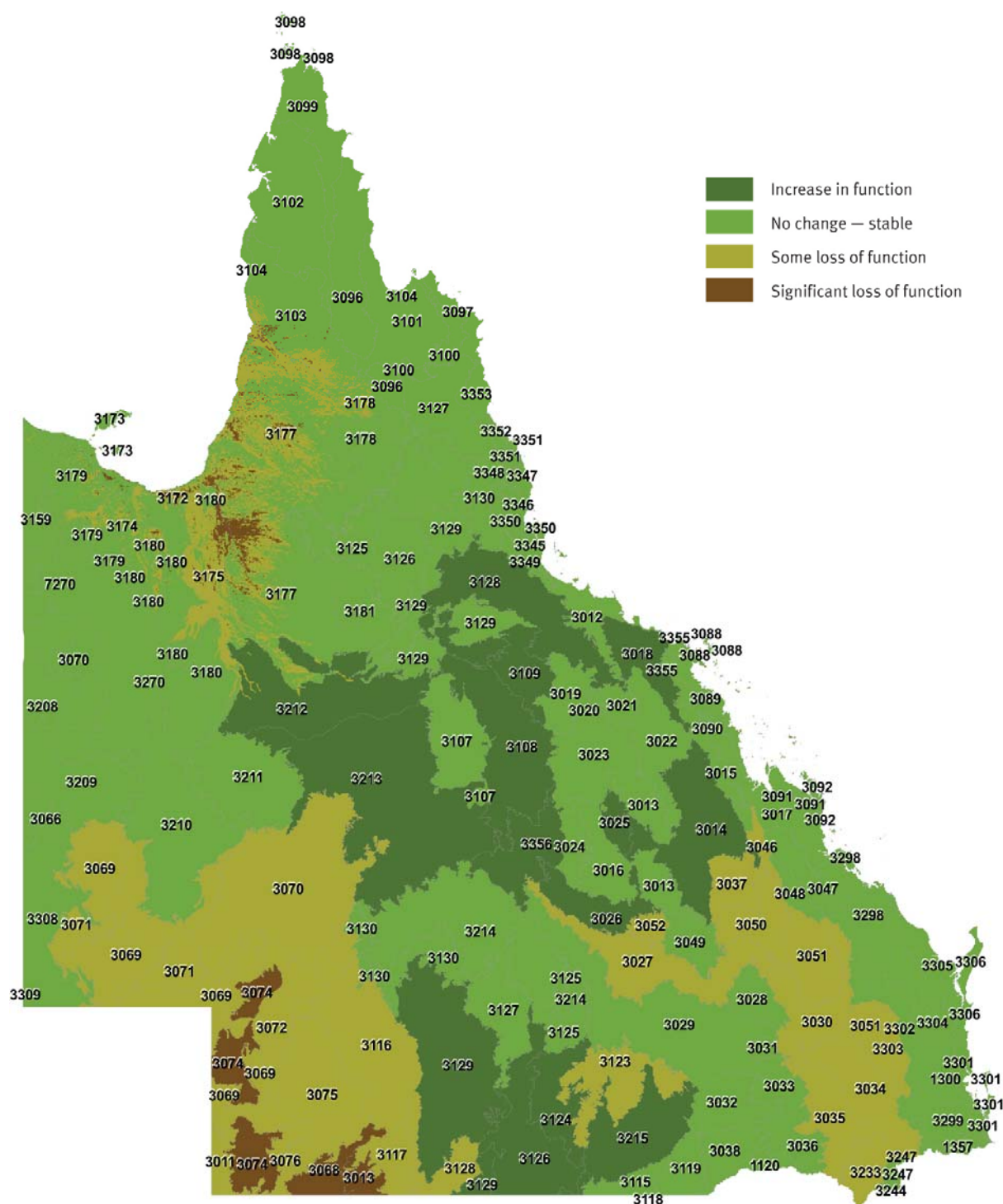
a



Source: QCCCE, 2011

**Figure 61. (a) AussieGRASS estimated landscape function and trend 1991–2005. (b) AussieGRASS estimated landscape function and trend 2007–2011.**

b



Source: QCCCE, 2011

**Figure 61. (a) AussieGRASS estimated landscape function and trend 1991–2005. (b) AussieGRASS estimated landscape function and trend 2007–2011.**

## 4.5.2 Rangeland ground cover

The percentage of ground cover over bare soil is a key indicator of the health of productive lands. Depending upon the nature of the landscape, a sustained lower than original amount of vegetative cover (trees and shrubs and/or



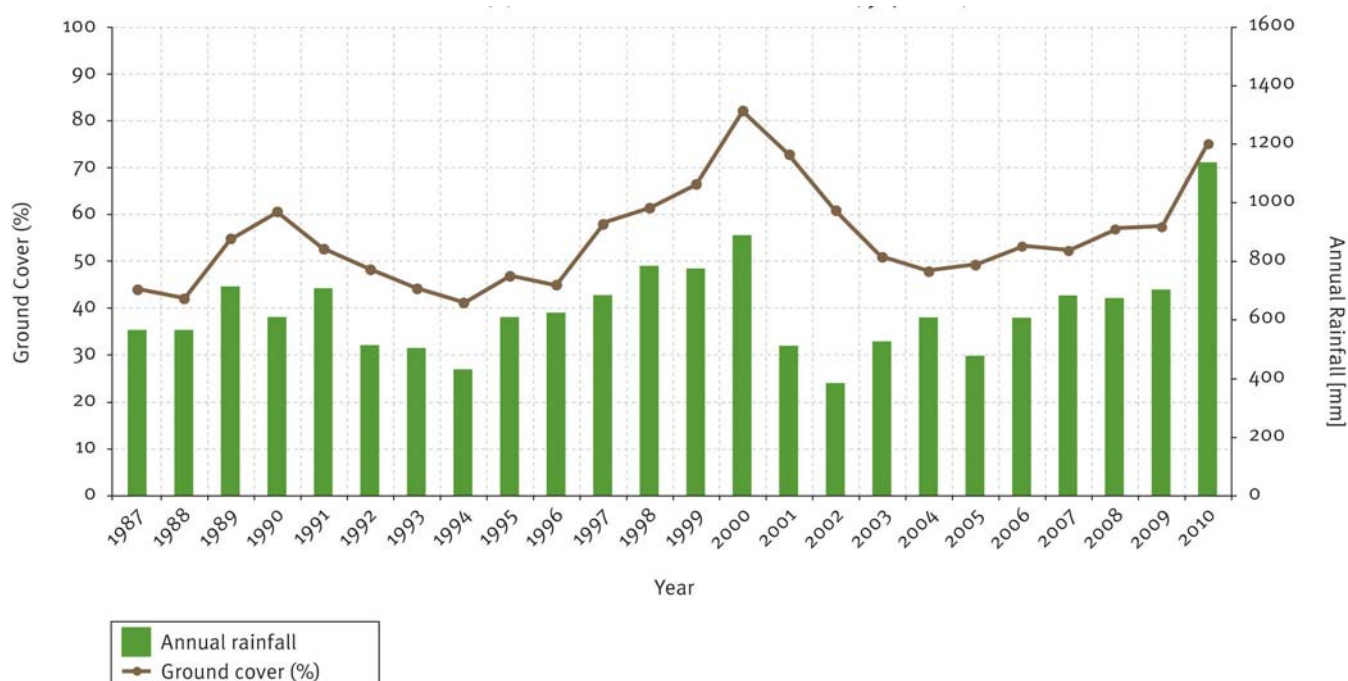
ground cover) is associated with many land degradation issues. In particular, during vulnerable periods, such as the wet season or intense weather events, lower than normal ground cover increases the risk of water and wind erosion that removes soil materials and nutrients, reducing productivity.

Low ground cover can be a region-wide concern emanating from sustained low rainfall conditions, or can be very localised and specific to a land type, the farming system and the management decisions applied to it. Ground cover in Queensland is monitored remotely and modelled using the Ground Cover Index (GCI) (Scarth et al., 2006).

The GCI is a relatively recent addition to the tools that are used to assist with the remote analysis of broad regions, such as Queensland's rangelands. The estimation of ground cover is used in a number of applications informing government programs, such as the implementation of the Delbessie Agreement and Reef Plan. It complements simulations of ground cover produced by AussieGRASS.

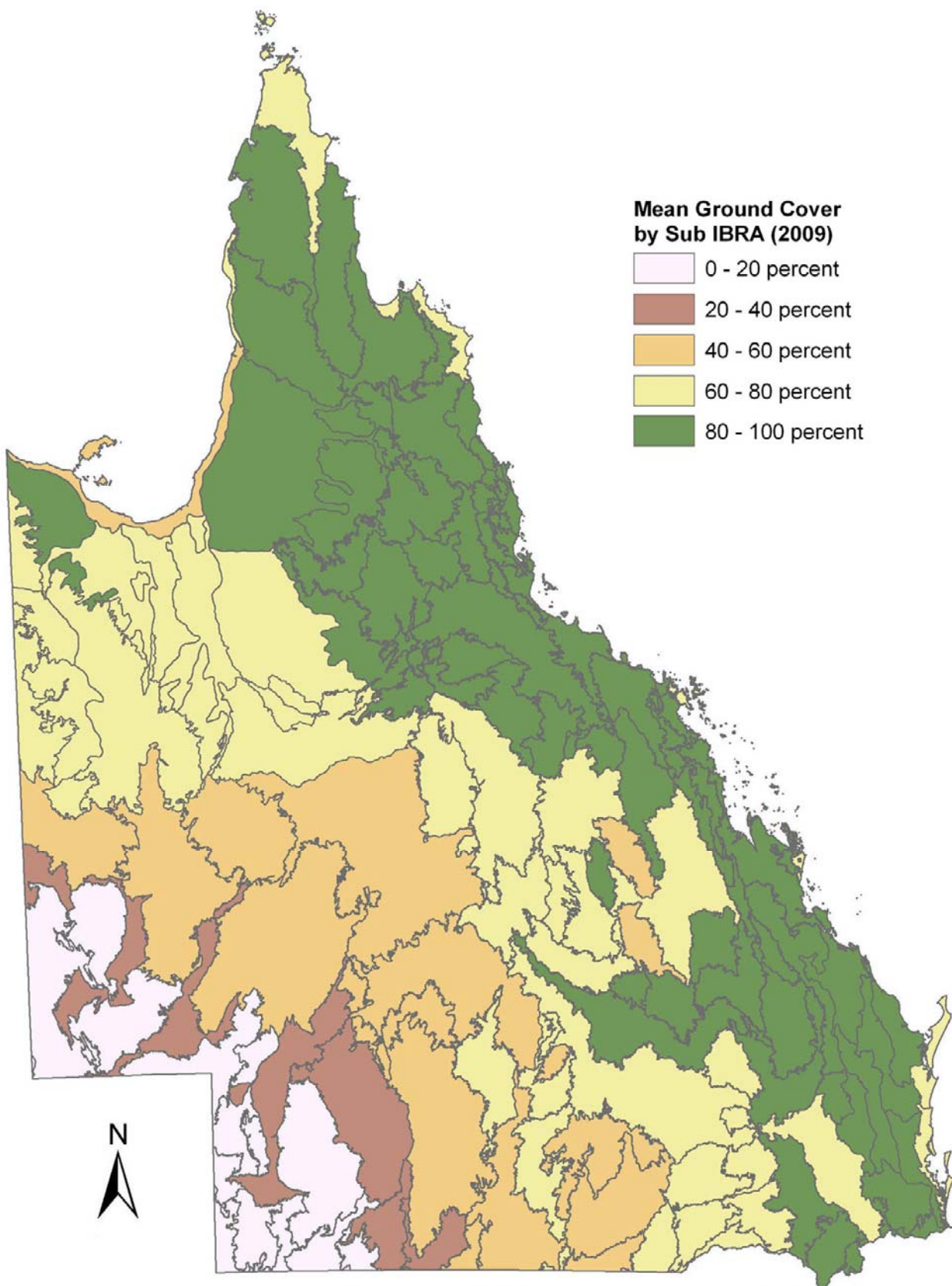
Figure 62 shows the general trend in average ground cover in Queensland in the period 1987–2010. The lowest GCI cover estimates occurred in 1988 and 1994, with the highest cover occurring in 2000 and 2010. The mean ground cover for Queensland during the period of 1987–2010 was 55 per cent. Since 2004, average ground cover has steadily increased from 47.9 per cent to 74.9 per cent across the state. This coincides with increased rainfall and the adoption of improved grazing land management practices by many graziers.

Generally, eastern and northern areas of Queensland receive higher rainfall than central and south-western areas of the state (BoM, 2011c), resulting in a pattern of higher ground cover in these areas (Figure 63). In areas away from the coast, ground cover is much more variable due to the episodic nature of rainfall and drought events. Inland cropping areas, such as the Central Highlands near Emerald and the Darling Downs region of southern Queensland, may appear to have low ground cover. This is due to the presence of fallow or cultivated crops during the dry season when the imagery was acquired. Low average ground cover values also occur in some of the coastal areas, such as Fraser Island, due to the presence of sand blows and beaches.



Source: BoM, 2011a. Note: Rainfall data were obtained with an annual averaging period from January to December..

**Figure 62. Mean ground cover for Queensland derived from annual dry season GCI (Landsat imagery) for the period 1987–2010.**



Note: Sub IBRA – sub-interim Biogeographic Regionalisation of Australia.

**Figure 63. Mean ground cover in 2010 summarised by sub-IBRA.**

The percentage of time during the 1987 to 2010 dry seasons that ground cover was lower than 30 per cent is presented in Figure 64a. In Queensland's south-western corner, ground cover has been below 30 per cent for the majority of these dry seasons (80–100 per cent), with the exception of riparian areas that have grown vegetation since flooding events. A negative consequence of persistent low cover in these areas is the potential to contribute nutrient rich soil to dust storms.

Central and eastern regions of the state have generally had high cover for most dry seasons. In the Mitchell Grass Downs regions, ground cover was below 30 per cent for less than 40 per cent of the dry seasons. This suggests that cover is only a critical factor in this region in years of below-average rainfall or where land management is sub-optimal. Additionally, ground cover along river zones in these areas tends to be lower than that on the adjacent downs grasslands. The cropping zones (Central Highlands and Darling Downs) stand out as being low in cover due to seasonal agricultural practices.

Statistical analysis of ground cover over time can be used to gain a better understanding of the current ground cover level. Figure 64b displays the difference between ground cover levels in the 2010 dry season (for example), compared with the long-term median of dry season ground cover (from 1987). The 'median' (i.e. middle value or 50th percentile) ground cover for the period provides a robust estimate of expected ground cover levels under 'typical' conditions. In the 2010 dry season, the majority of the state was above the median ground cover, while only a few regions were below median ground cover. This is most likely due to above-average rainfall received during the 2009–10 season in Queensland (see Figure 62), while some of the low values may be due to death of ground cover vegetation from prolonged inundation during flood.



a

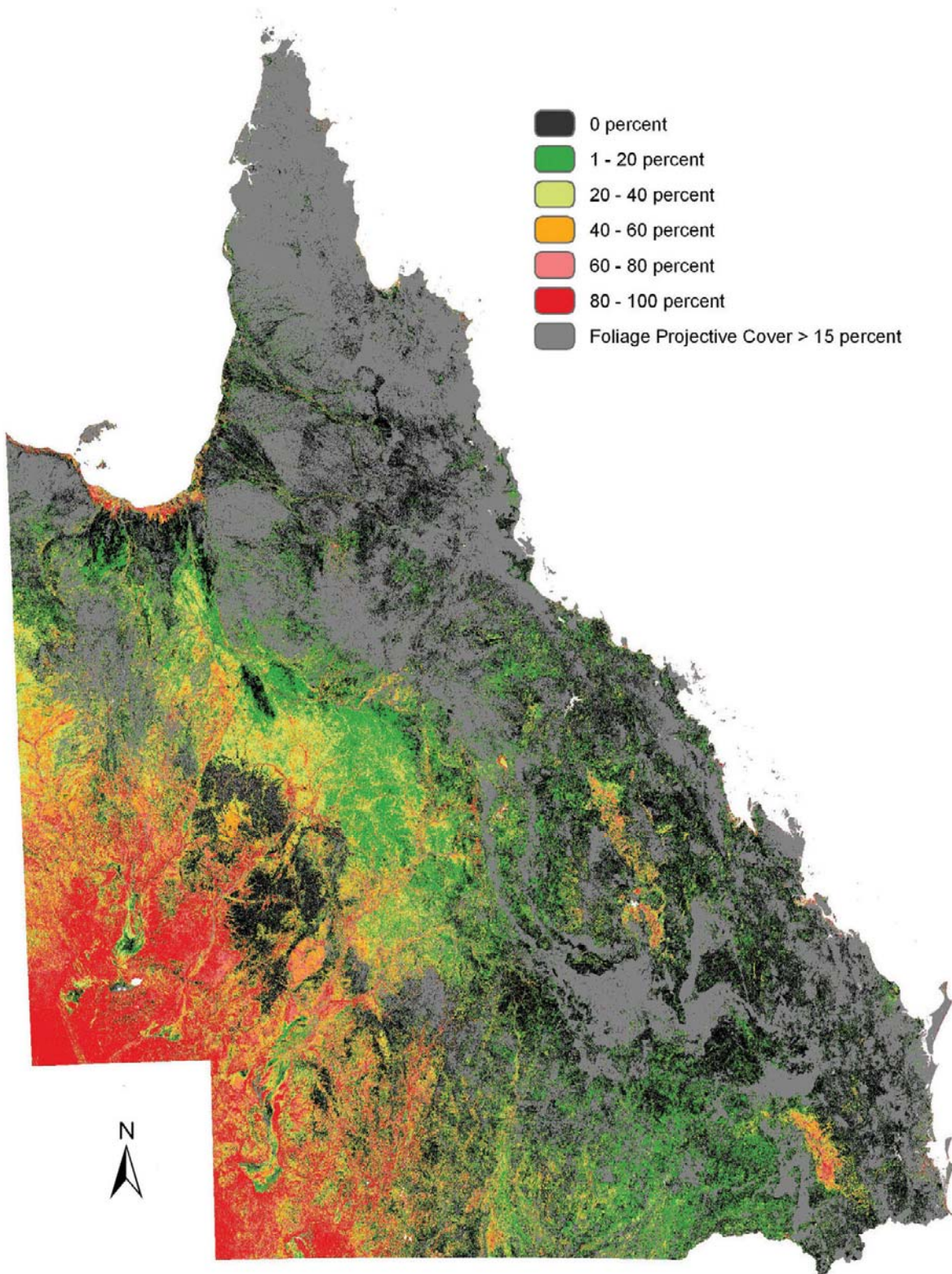
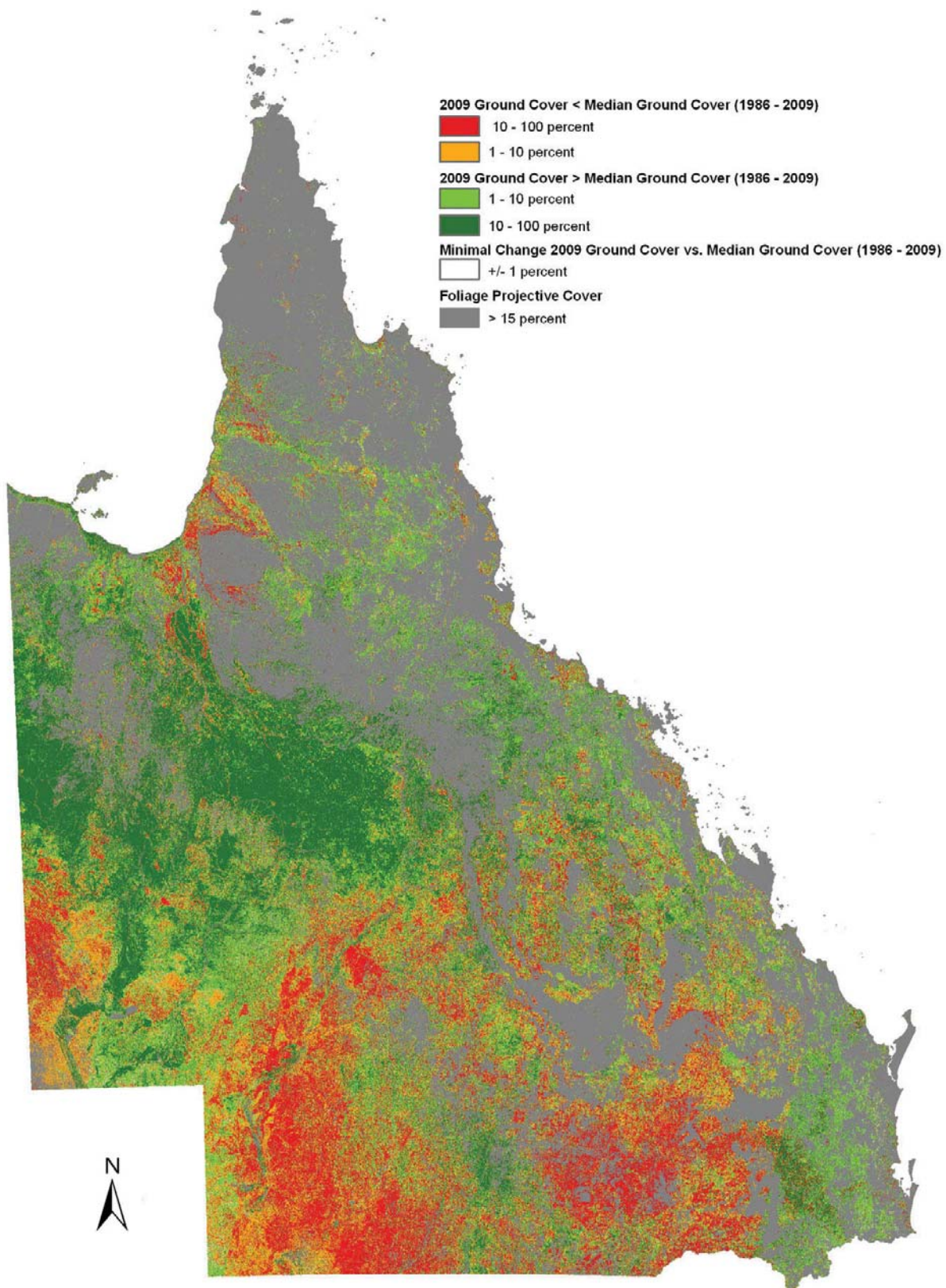


Figure 64. (a) Persistence (% of observations) of ground cover at levels below 30 % during the period 1987–2010 and (b) difference between median ground cover (1987–2010) and ground cover estimated for 2010.

b



Source: QCCCE, 2011. Pers. Comm.

**Figure 64. (a) Persistence (% of observations) of ground cover at levels below 30 % during the period 1987–2010 and (b) difference between median ground cover (1987–2010) and ground cover estimated for 2010.**



### 4.5.3 Dust Storm Index

Wind erosion is widespread in western Queensland, extending into central and southern inland regions. Extreme weather conditions had a significant influence upon wind erosion in the reporting period and land use pressures appear to have accelerated erosion rates in some areas. Overall, improvements in land management appear to be reducing wind erosion rates.

Estimates of land condition in relation to wind erosion are measured by the Dust Storm Index (DSI), which is based upon Bureau of Meteorology (BoM) observations (Figure 65). The most obvious result of the comparison is that in the more humid northern and south eastern areas of the state the DSI values are generally low. During 2007–2009, wind erosion was more active than the long-term average (1960–2009) in seven of the 13 natural resource management (NRM) regions in Queensland (McTainsh and O’Loingsigh, 2011). Increases were observed for the NRM regions of South West, Border Rivers Maranoa–Balonne and Fitzroy, particularly around Taroom. This may reflect changes in land management and periods of intense dust storm activity in September 2009. Erosion decreased significantly in the Southern Gulf and Desert Channels NRM regions.

a

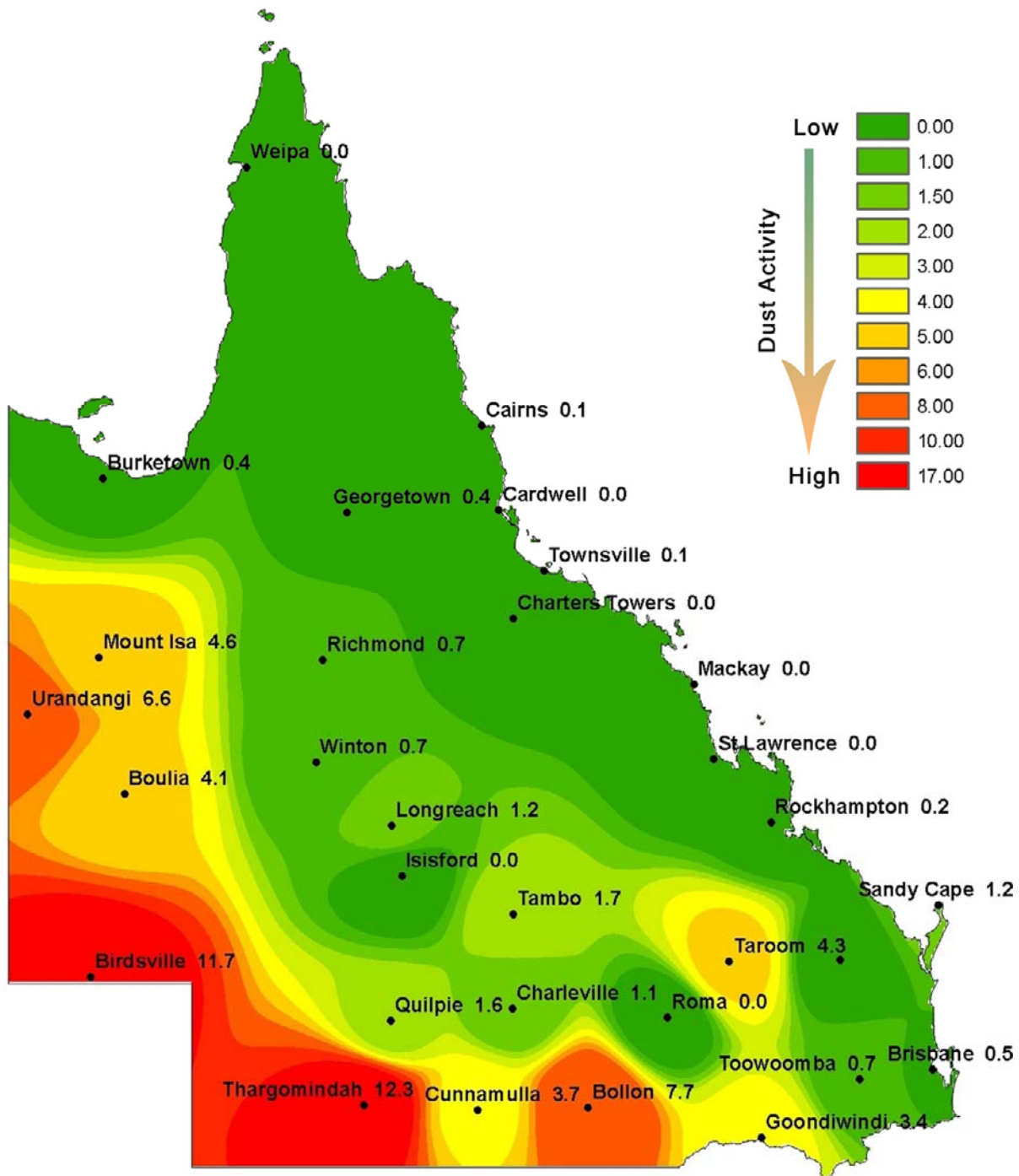
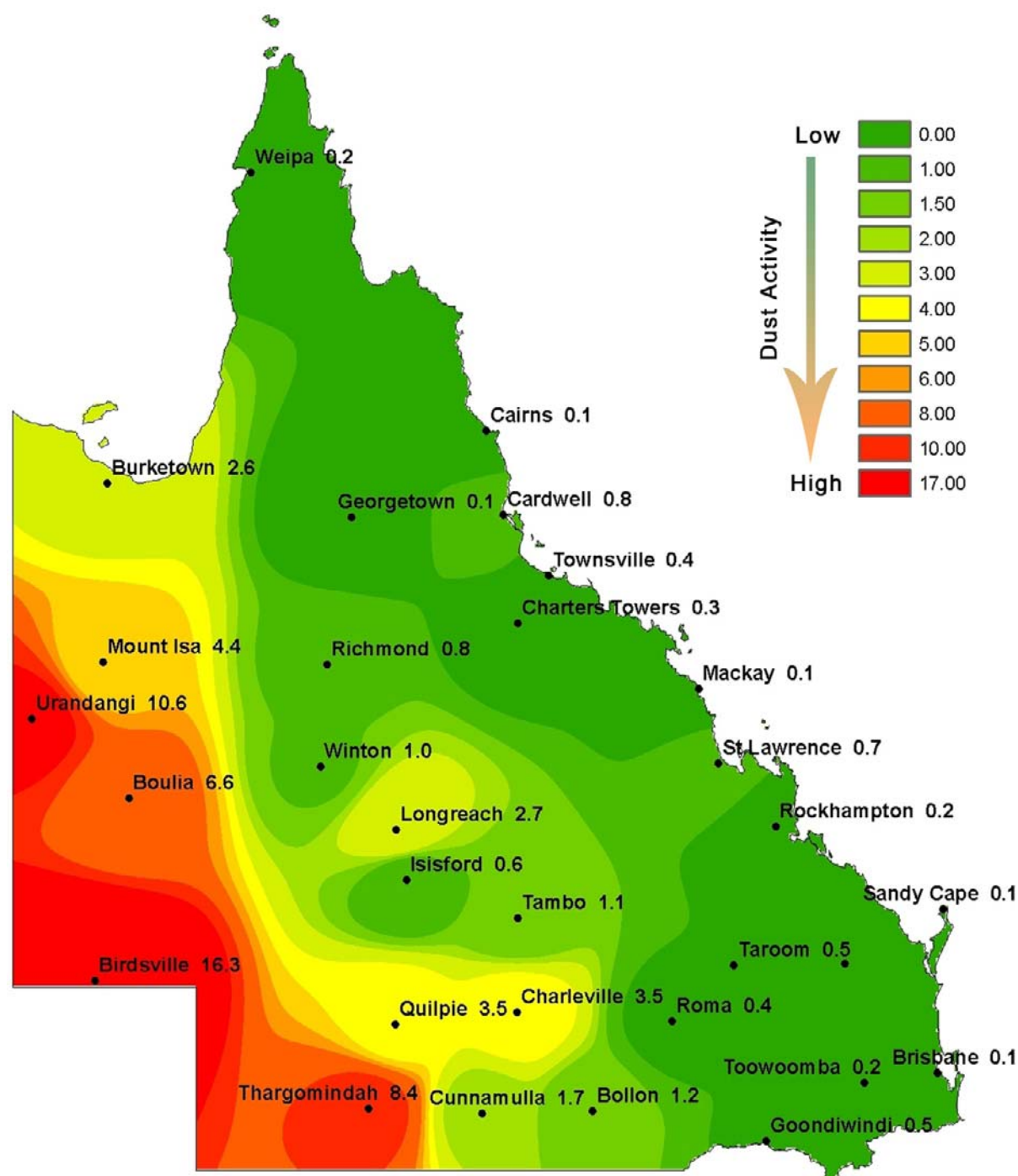


Figure 65. (a) Wind erosion patterns based upon the mean Dust Storm Index for 2007–2009 and (b) long-term wind erosion patterns based upon the mean Dust Storm Index for 1960–2009.

b



Source: McTainsh and O'Loingsigh, 2011 – Adapted from McTainsh and Tews, 2007.

**Figure 65. (a) Wind erosion patterns based upon the mean Dust Storm Index for 2007–2009 and (b) long-term wind erosion patterns based upon the mean Dust Storm Index for 1960–2009.**

#### 4.5.4 Recovery of flooded landscapes

The flood events of 2010–11 had a significant impact on Queensland landscapes. Aerial surveys and on-ground monitoring indicated that extensive channel erosion occurred as a result of the flooding, with evidence of significant channel widening and the formation of flood chutes. The presence of isolated trees on banks or low

levels of riparian vegetation was commonly associated with accelerated erosion of the banks. However, more mixed riparian vegetation (trees, shrubs and grass) afforded the channel more protection from stream bank erosion.

In the Lockyer Valley, Condamine and part of Central Queensland grazing lands in poor condition with low ground cover and most creeks and rivers were extensively damaged and scoured. The exception to this occurred where the banks were gently sloping and had high levels of ground cover.

In the Lockyer Valley, Condamine and parts of Central Queensland, areas of high ground cover (>70 per cent) in cropping and pastoral lands prior to the January 2010 flood, afforded protection to hillslopes from sheet and rill erosion. There were no significant impacts on soil conservation banks in upland areas and slopes of the Condamine catchment as compared to similar intensity events in the past, probably due to better vegetation cover (grass and crops). Where cropping lands had low vegetation cover, more severe sheet and gully erosion was observed.

In the south-east, landslips were visible on many steeper slopes, with a number of parallel slips observed at one location. Preliminary analysis suggests that the majority of landslips occurred on the same geology, steeper slopes (> five per cent), and on land that was generally cleared of remnant native vegetation.

## 4.6 Human settlements

Human settlements include the physical, social, cultural and spiritual aspects of a community and encapsulate where people live, work and recreate. Queenslanders live in a range of human settlements including rural towns, major city centres and communities. However, most Queenslanders live in urban environments, typically in low density suburbs. Human settlements both influence and are influenced by the environment in which they are located, and can be viewed as a type of ecosystem.

### 4.6.1 Population size and distribution in Queensland

The size and distribution of Queensland's population is a major driver of resource use, infrastructure development and has a large impact on the land use, hydrology, climate, nutrient cycling and atmospheric chemistry of urban ecosystems. The estimated resident population for Queensland at 30 June 2011 was 4 580 282 (ABS, 2011a), with around 88 per cent of Queenslanders living within 50 km of the coast. The South East Queensland planning region contains the largest concentration of urban development in Queensland and accommodates around two-thirds of the state's resident population.

### 4.6.2 Human settlement patterns

Queensland has an increasing proportion of small households with one or two occupants (Table 18). This is partly due to Queensland's aging population and increase in the number of households without children, at the expense of traditional family households. Older people are also tending to remain in homes built for their families long after their children move out (DIT, 2010).

Growth in the number of households is also occurring at a faster rate than growth in the number of people. While Queensland's population grew by 22.5 per cent (752 000 people) between 1996 and 2006, the number of resident households increased by 25.3 per cent (304 400 households). The average household size was projected to fall from 2.7 in 1996 to 2.6 in 2011.

**Table 18. The total number of lone person and couple without children households, estimated (1996–2006) and projected (2011) for Queensland.**

	1996	2001	2006	2011
Lone person households	248 336	295 523	316 788	417 100
Couple or family with no children	300 630	343 411	392 712	504 600
Percentage of total households	45.6	47.1	47.0	51.1

Source: ABS time series profile, Queensland, 2009, Census; OESR, Household and dwelling projections, 2011d edition. Data are to the 30th of June of each year.

Dwelling approval is an indicator of building activity. It is the final approval step before occupancy and occurs after lot registration and land sale. The total number of dwelling approvals declined in 2008 and 2009, most likely as a consequence of the global financial crisis. Overall, there was no significant change in the proportion of each residential dwelling type with time. Despite a continuing decline in the average number of persons per household, larger detached houses continue to be constructed at a higher rate than attached and semi-detached dwellings (e.g. townhouses, flats, units and apartments). Townhouses, low-rise and high-rise developments were each still less than six per cent of total dwelling approvals.

There was a small increase in the proportion of low-rise developments in South East Queensland, but a decrease in townhouse and high-rise approvals in the Wide Bay–Burnett region. These trends for Queensland are similar to the whole of Australia, with owner-occupied detached houses being the most common housing type for most of the past century (DIT, 2010).

The composition of dwellings in Australia has also been relatively stable over the past decade. However, proportions of housing types are not uniformly distributed. High concentrations of high-rise buildings are usually found close to city centres, with decreasing densities towards outer suburban areas. The exceptions to this pattern can be found in Gold Coast City, where high-rise residential buildings extend along the coastline (DIT, 2010).

Australian homes have the largest average floor size in the world (James, 2009). The average floor area of new residential dwellings built in the 2008–09 financial year in Australia was 214.6 m<sup>2</sup>, with the average floor area of new free-standing houses recently reaching a high of 245.3 m<sup>2</sup>. This is a 4.4 per cent increase over the past five years, and a 13 per cent rise over the past decade.

The average dwelling size in Brisbane is above the national average of 220.5 m<sup>2</sup>, with the average free standing house at 253 m<sup>2</sup>. New South Wales had the largest houses with an average of 262.9 m<sup>2</sup>. This trend has implications for housing affordability, energy and water consumption and associated greenhouse gas emissions, and environmental sustainability.

A study comparing the lifecycle energy consumption of city centre apartments versus suburban dwellings in Adelaide confirmed that more compact housing development provided opportunities for significant reductions in per capita carbon emissions (Perkins et al., 2009). However, apartment dwellings tended to have high building mass, inefficient design for operational energy savings and low occupancy rates. This meant that apartment dwellings often had a higher energy use and greenhouse emissions on a per capita basis than suburban dwellings. Perkins and his colleagues concluded that the most carbon-efficient form of housing were townhouses and villas in inner suburban areas (Perkins et al., 2009).

Another recent analysis incorporating direct and indirect household environmental impacts found there were higher environmental impacts from small households with higher incomes, independent of the dwelling type (Dey et al., 2007).

### 4.6.3 Everyday travel

The environmental effects of transport depend strongly upon the mode of transport used. While public transport is not environmentally benign, it certainly has a more limited environmental impact than many other modes of transport, with walking and cycling producing the least environmental impact.

An increase in car use can result in environmental, economic and social issues. Such issues include increased air and noise pollution, increased need for public expenditure on road infrastructure and significant health problems resulting from a lack of physical activity. The transport sector is one of the major contributors to greenhouse gas emissions (OECD, 2011).

It has been estimated that around 60 per cent of energy consumed in the transport sector is associated with passenger movement dominated by cars, and the remainder with the distribution of goods and services (Sandu and Petchey, 2009).

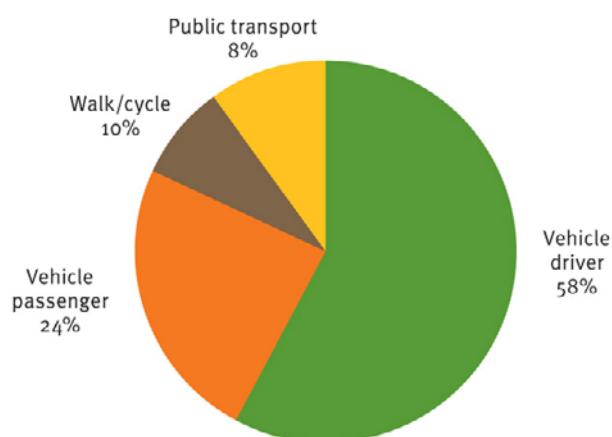
Mode share examines the spread of trips made across the different modes of vehicle driver, vehicle passenger, public transport, cycling and walking. Across South East Queensland private vehicles were used four times more often than walking, cycling and public transport (Figure 66).

In the Brisbane, Gold Coast and Sunshine Coast statistical divisions, private vehicle use increased between 1992 and 2003–04 relative to all other transport modes. Since 2003–04, use of the private vehicle has declined in



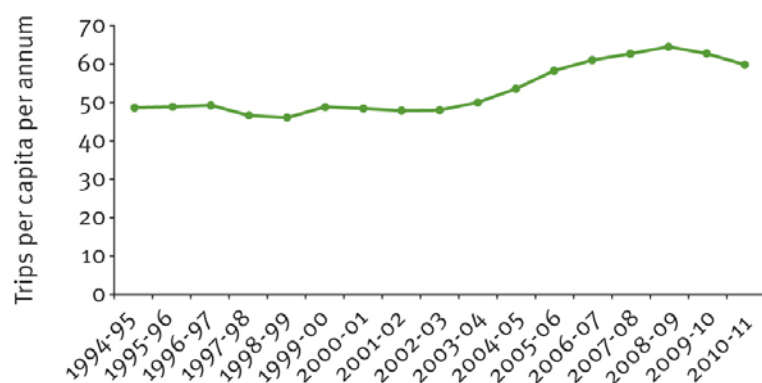
Brisbane, and there was an increase in public transport use. On the Sunshine Coast since 2003–04 there has been a small increase in public transport and cycle mode shares, but also an increase in private vehicle driver mode share. There has been little change in mode share in the Gold Coast since 2003–04.

Public transport trips per person increased significantly in South East Queensland between 2002–03 and 2008–09, peaking at 64.5 public transport trips per capita per annum in 2008–09 (Figure 67). This increase occurred alongside growth in the number of private vehicles on the roads. However, in 2009–10 public transport trips per person began to decline and in 2010–11 the figure dropped to 58.7 trips per capita per annum. This decrease may be temporary and related to a change in data collection and validation methods in 2009–10 and severe weather in 2010–11. During 2009–10, daily, weekly and monthly rail paper tickets were phased out and the go card was introduced, with a subsequent change in the way that patronage totals are calculated. In 2010–11, South East Queensland experienced a severe flooding event.



Source: DTMR, 2010a.

**Figure 66. The average daily mode share in South East Queensland in 2009.**



Source: DTMR, 2012.

**Figure 67. The total number of trips per capita per annum made by passengers on bus, train, and ferry services within the TransLink network in South East Queensland.**

## 4.6.4 Use of resources

### 4.6.4.1 Energy

Queensland's energy sources and energy consumption rates have numerous implications for the environment, including greenhouse gas emissions, resource depletion, and other pollution and landscape degradation associated with the production and consumption of energy. Energy consumption in Queensland has increased since 2005, and most fuel was sourced from non-renewable sources (Table 19).

The use of black coal as an energy source has, however, declined over the last four years due to the uptake of gas as an electricity generation fuel as a result of the Queensland Gas Scheme (Table 19, Figure 68 and Table 20). In Queensland, black coal remains the dominant fuel source, meeting 44 per cent of total energy consumption. Gas has increased its share since 2004–05, now contributing 11.5 per cent of total energy consumption (Table 19).

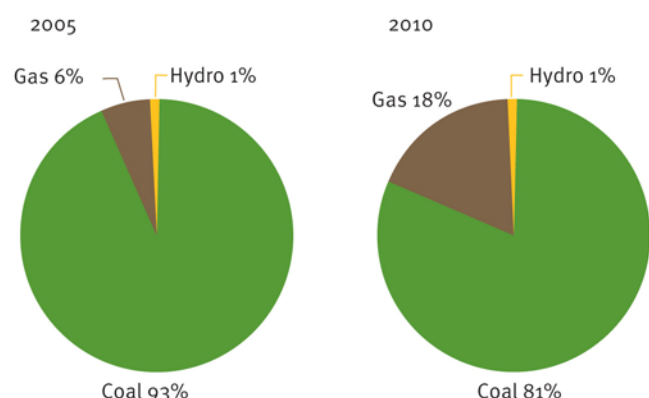
Nationally, black and brown coal supplies 39 per cent of our energy needs, which is down from 41 per cent in 2004–05. Gas use is superseding coal use and its use has increased from 19 to 22 per cent.

**Table 19. Proportion of energy consumption in Queensland and Australia by fuel source, 2004–2005 and 2008–2009.**

Fuel source	Queensland		Australia	
	Percentage in 2004–05	Percentage in 2008–09	Percentage in 2004–05	Percentage in 2008–09
Black coal	48.3	44.2	29.7	28.2
Brown coal	0.0	0.0	12.7	11.4
Petroleum products	34.7	35.8	34.4	34.6
Gas	8.2	11.5	19.4	21.9
Biomass	8.8	8.5	3.7	3.7
Solar	0.0	0.1	0	0.1

**Table 20. Queensland electricity generation by fuel source (GWhs).**

Fuel source	2004–05	2008–09	Per cent change since 2004–05
Coal	48 650	47 944	-1.5
Gas	2035	5404	165.6
Liquid fuel	131	58	-56.0
Hydro	819	816	-0.4
<b>Total</b>	<b>51 635</b>	<b>54 222</b>	<b>5.0</b>



**Figure 68. The contribution of coal, hydro and gas to electricity generation in Queensland in 2005 and 2010.**

In 2008, Queensland's total renewable energy mix was 745 megawatts (MW), comprising more than 50 per cent capacity derived from sugar cane waste (bagasse) energy generation, followed by substantial contributions from hydro (169 MW) and solar hot water (144 MW). An increase of 335 MW in renewable energy generation capacity

has been installed since the launch of the Queensland Renewable Energy Plan on 21 June 2009, taking the total capacity to 1080 MW at 30 June 2011. This equates to almost 7.3 per cent of Queensland's total generation capacity and almost 9.7 per cent of Australia's total renewable energy capacity. Since 2009, the vast majority of gains have been in small scale solar due to the success of programs such as the Solar Bonus Scheme, Solar Hot Water Rebate, Solar Sports and Communities, Solar and Energy Efficiency in State Schools and Solar Kindergartens.

#### 4.6.4.2 Household water usage

Household water use includes any water that is used for human consumption, as well as water used for cleaning and outdoor use (e.g. filling swimming pools). Households were responsible for around nine per cent (308 GL) of Queensland's water consumption in 2008–09 (Pink, 2010), with a per capita household water consumption of 70 kilolitres (KL).

Households are the second biggest user of Queensland's water behind agricultural activities (2296 GL or 69 per cent). Between 2004–05 and 2008–09 there was a 23 per cent reduction in the total water consumed in Queensland, from 4361 GL to 3351 GL.

A survey in South East Queensland during the 2010 winter estimated a per capita average water consumption of 145 L per person per day (or 370 L/household/day). Showering contributed most (29 per cent), followed by clothes washing (21 per cent), general tap use (19 per cent), toilet use (16 per cent) and outside irrigation (five per cent) (UWSRA, 2012).

Many households implemented water saving measures in response to the millennium drought as dam levels decreased and in response to water restrictions that were imposed during the drought. Across Australia, households applied most water conservation measures in the garden (62 per cent) and in the bathroom (59 per cent) (ABS, 2010b). The proportion of Australian households with dual-flush toilets has increased from 55 per cent in 1998 to 86 per cent in 2010, and water-efficient shower heads from 32 to 66 per cent (ABS, 2010b). Family households were found to be the household type most likely to implement water saving measures.

The industries that use most of Queensland's water (e.g. agriculture and electricity production) do so largely to support people living within towns and cities. This means that water conservation requires changing our behaviour at home and work, plus considering the impacts of the goods and services we use.

#### 4.6.5 Waste generation and recycling

Human settlements produce a wide variety of wastes that are generated by households, businesses and public agencies. These wastes are managed by local governments and a range of private sector organisations operating landfills, incinerators, waste treatment, composting and other recycling facilities. Private sector operators manage large proportions of certain waste streams, particularly in South East Queensland.

Recycling of waste materials reduces the volume of waste deposited in landfills and, consequently reduces environmental pollution levels. It can also reduce the amount of greenhouse gas emissions produced by the manufacturing of new products. Many waste managers, including local governments, recyclers, composters and private landfill operators, work to divert wastes from disposal (through recycling and resource recovery).

In 2009–10, 35.4 per cent of waste was diverted from landfill in Queensland, which is lower than the Australian average (42.6 per cent) (ABS, 2011e). Based on data reported to the Queensland Government for 2008–09, waste managers recovered 619 000 tonnes of scrap metal, 693 000 tonnes of paper and packaging materials, 1 116 000 tonnes of other construction and demolition wastes, 813 000 tonnes of green waste, 90 000 tonnes of other domestic wastes, 1 046 000 tonnes of clean fill, 176 000 tonnes of contaminated and acid sulfate soil, 497 000 tonnes of biosolids, 930 000 tonnes of ash, and 306 000 tonnes of other commercial and industrial wastes.

Local governments diverted 2.3 million tonnes of the 4.9 million tonnes of the wastes they received from landfill in 2008–09. They recycled some of this material themselves and forwarded the remainder to composters and other recyclers in Queensland, other states or overseas. Generally, councils in the more densely populated coastal regions were more likely to recover resources than councils in the more sparsely populated and less accessible inland regions.

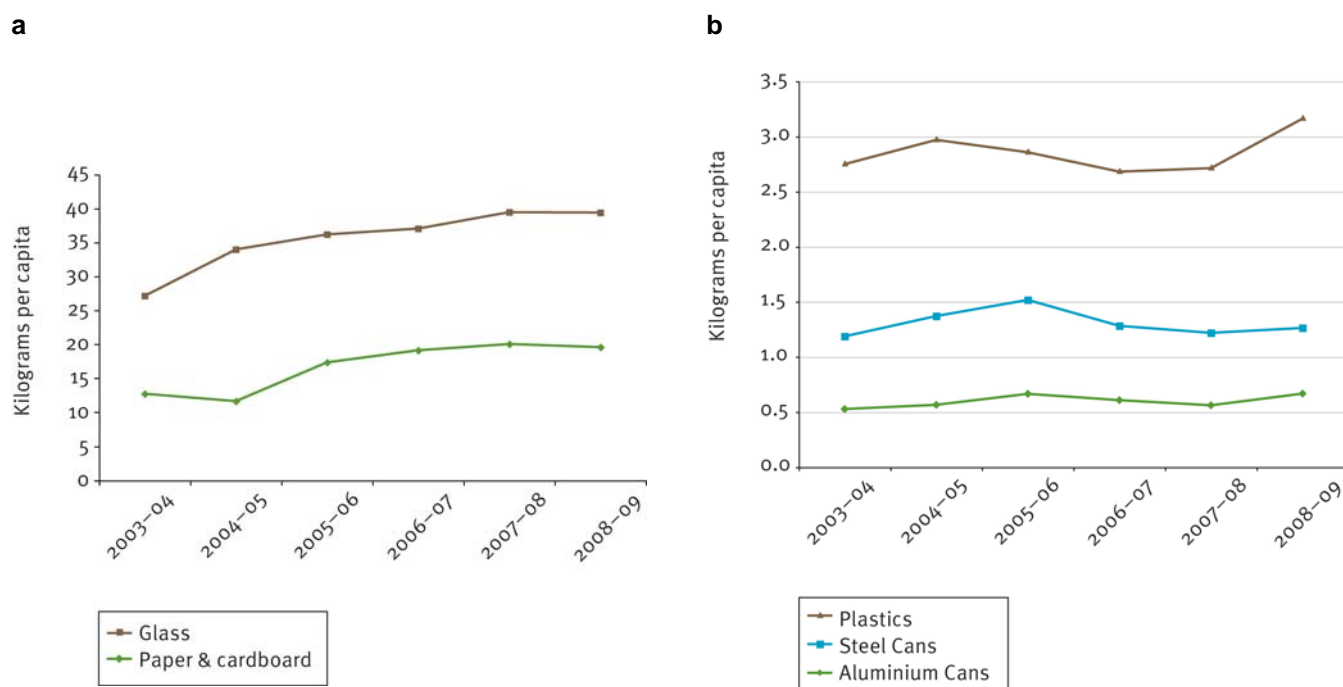
Trends in the rates of recovery for five waste streams by local governments are shown in Figure 69. Local governments have consistently high rates of recycling for segregated wastes (such as green waste), and consistently low rates of recycling for co-mingled wastes (domestic waste and commercial and industrial waste). In comparison,

the recycling rate for construction and demolition waste (potentially easier to separate) by local governments has improved considerably over the six-year period, from about 20 per cent in 2003–04 to close to 60 per cent in 2008–09.

Local governments are the main agent for the collection of used paper and packaging materials from domestic premises for recycling in Queensland. Most large and medium sized councils offer kerbside collection services to their residents, while drop-off points are provided in many smaller centres. As the bulk of paper and packaging collected by local governments comes from domestic premises, the amount reported is a trend indicator for domestic recycling.

Local governments recycled 276 000 tonnes of paper and packaging in 2008–09, or 40 per cent of the total amount reported by all sources. This is a 63 per cent increase on the 169 000 tonnes reported in 2003–04, and reflects an increase in effort (both by councils and residents). The recycling rate for glass increased by 54 per cent from about 13 kg per capita in 2003–04, to about 20 kg per capita in 2008–09 (Figure 69a). Similarly, the recycling rate for paper and cardboard increased by 48 per cent from about 27 kg per capita in 2003–04 to about 40 kg per capita in 2008–09.

There has been less change in the recycling rates for plastic, steel and aluminium containers (Figure 69b). The recycling rate for plastic containers has fluctuated in a range between 2.7 and 3.2 kg per capita, the rate for steel cans has fluctuated in a range between 1.2 and 1.5 kg per capita, and the rate for aluminium cans has fluctuated in a range between 0.5 and 0.7 kg per capita.



**Figure 69. The recycling rates for (a) glass, paper and cardboard, and (b) plastic, steel and aluminium containers (kg/capita) collected by Queensland local governments, 2003–2004 to 2008–2009.**

#### 4.6.6 Liveability

Our health and wellbeing is strongly related to the environment in which we live and the state of that environment. The millennium ecosystems assessment breaks human wellbeing into five main components including the basic material needs for a good life, health, good social relations, security and freedom of choice and action (MA, 2005). The structure of our homes, workplaces and the urban environment all have the potential to influence our physical and mental health, our interactions with the community and our sense of belonging. Links between environment and wellbeing are complex and global interconnectedness means that achieving human wellbeing in one place may be affected by practices elsewhere in Australia or overseas (UNEP, 2007). What is clear is that there are strong relationships between the environment and human wellbeing. Changes in ecosystem condition and function can

influence all components of human wellbeing, with environmental degradation often causing significant declines in human health (MA, 2005).

#### 4.6.6.1 Liveability

Cities considered to have a high degree of liveability tend to have a high level of accessible amenity such as open and green space, and educational, social, cultural and recreational facilities. Liveability encompasses these features of amenity as well as characteristics of the built environment including the arrangement, design and construction of buildings, public transport systems, road networks and public spaces, walkability and accessibility to goods and services, and high quality communication technology. Liveability also refers to the elements of natural environment (e.g. low air pollution, the presence of parklands) and a range of social factors (e.g. political stability, social cohesion).

There have been a range of indices and rankings developed to compare how liveable or environmentally sound a city is. These indices and surveys have been done on an international, national and state basis.

#### 4.6.6.2 Worldwide rankings

The Mercer Worldwide Quality of Living Surveys, developed by The Economist Intelligence Unit, is based on detailed assessments and evaluations of 39 key quality of living determinants including the socio-cultural environment, public services and transportation, recreation, natural environment and economic environment. Their surveys rank Brisbane as a highly liveable city.

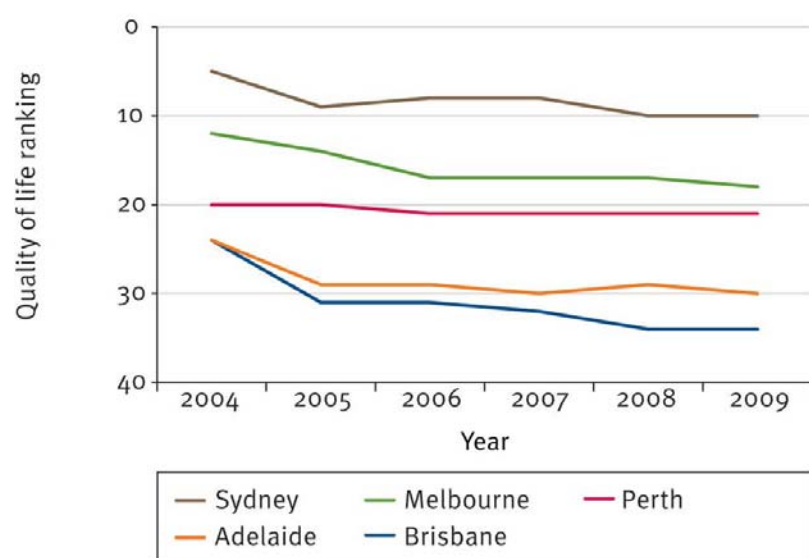
Brisbane has ranked lower than other major Australian cities over the past six years in the Mercer surveys, where 216 cities were compared (Figure 70). Their 2010 survey compared 221 cities, and so this data can not be readily compared to the previous years. However, in 2010, Brisbane still scored well overall, but most other Australian cities ranked higher (Table 21).

Most Australian cities have also slipped in comparison to other international cities, with Brisbane dropping from 24th to 34th place out of 216 cities from 2004 to 2009. The decline in the rankings is thought to be due to other cities investing more in infrastructure, such as transport and housing, than Brisbane (DIT, 2010; Mercer, 2010).

The Liveability Index, also developed by The Economist Intelligence Unit, assesses cities on the basis of stability, health care, education, infrastructure, and culture and environment. As with the Mercer study, while still ranking highly, Brisbane has been slipping down on the list with time, going from 6th in 2004 to 21st in 2011 (DIT, 2010; EIU, 2011). Brisbane scored lower in recent years due to water availability (water restrictions), climate, public transport and infrastructure.

An Eco-cities Index was released for the first time in 2010 (Mercer, 2010). This ranks cities based on water availability and drinkability, waste removal, quality of sewage systems, air pollution and traffic congestion. New York again served as the base comparison with a score of 100. Brisbane fared well in the survey, ranking 23rd; however several Australian cities ranked higher than Brisbane. A high-ranking on the eco-city index is meant to indicate a city that optimises its use of renewable energy sources and generates the lowest possible quantity of pollution (air, water and noise).





Source: Mercer Worldwide Quality of Living Surveys, 2004–2009; and DIT, 2010.

**Figure 70. The Mercer quality-of-life rankings of selected Australian major cities (2004–2009).**

**Table 21. The 2010 Mercer Worldwide Quality of Living Survey results for major Australian cities.**

City	Ranking out of 221	Score
Sydney	10	106.3
Melbourne	18	104.8
Perth	21	104.2
Canberra	26	103.6
Adelaide	32	103.0
Brisbane	36	102.4

Source: Mercer, 2010. Note: The cities are ranked against New York as the base city, which has an index score of 100.

#### 4.6.6.3 National rankings

The Australian Conservation Foundation Sustainable Cities Index (2010) examined Australia's 20 largest cities. This comparative index took into account 15 indicators across three areas—environmental performance, quality of life and resilience. The lower the score the more sustainable the city, with possible scores ranging from 15 (best) to 300 (worst).

The Sunshine Coast, Brisbane and Townsville are all ranked highly. However, there was little spread in the scores for the Queensland cities and all scores were far from the ideal score of 15 for a sustainable city (Table 22).

No Australian city did well across all 15 indicators, with each having its own strengths and weaknesses. The Sunshine Coast and Brisbane had the best environmental performance indicators, whereas Townsville scored best for the quality of life indicators.

A survey published in 2011, measuring Australian residents liveability by the Property Council of Australia found Brisbane was Australia's sixth most liveable city with a score of 60.2 out of 100. The survey found that most residents thought Brisbane had a wide range of recreational outdoor environments (80 per cent) and an attractive natural environment (70 per cent). On the downside, few residents agreed that Brisbane had a good approach to environmental sustainability and climate change (37 per cent), or a good road network with minimal traffic congestion (21 per cent).

**Table 22. A summary of the Australian Conservation Foundation's sustainable cities index results for Queensland cities and the highest ranking city, Darwin.**

City	Sustainable Cities Index ranking (out of 20)	Sustainable Cities Index score
Darwin	1	119
Sunshine Coast	2	121
Brisbane	3	123
Townsville	4	129
Gold Coast–Tweed	8	143
Cairns	9	145
Toowoomba	11	152

Source: ACF, 2010.

#### 4.6.6.4 South East Queensland rankings

An online survey of South East Queensland adult residents was commissioned by the Department of the Premier and Cabinet to investigate attitudes towards population growth and 'liveability' in the region (TNS Social Research, 2010). South East Queenslanders strongly agreed that they enjoyed living in the region (mean score of 83.4 out of 100) and rated their quality of life highly (mean score of 78.7 out of 100).

The factors that were most important to the liveability of South East Queensland were the warm climate, the lifestyle (relaxed and outdoors focused), great accessible beaches, and the sense of community and friendly people. Other strong influences were clean air, ease of getting around, cost of living, education, character of housing, relaxed lifestyle and range of flora and fauna.

#### 4.6.7 Health

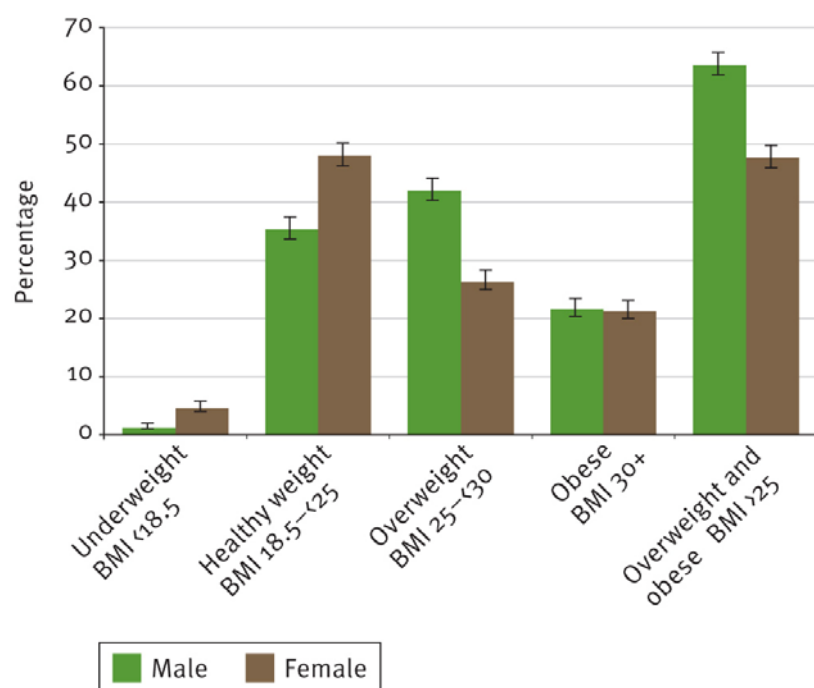
There is increasing evidence that certain environmental factors encourage or deter individuals from being physically active (e.g. Duncan and Mummery, 2005; Ewing et al., 2003). Urban planning, architecture, engineering, land development can all potentially have a positive impact on physical activity levels and health via the design of the built environment (QH, 2010). Such ideas have been incorporated into recent regional plans and transport strategies.

Urban designs can increase physical activity by having open spaces, shops nearby, transit stops in the neighbourhood, footpaths, bicycle facilities, low-cost recreational facilities and opportunities for social interaction (DIT, 2010; WHO, 2004). Well-designed public open space may also be restorative for the community, reducing the mental fatigue and stress of urban living (DIT, 2010).

Incidental exercise associated with the use of public transport can also be substantial. One Australian study has shown that walking to and from public transport added up to about two km per day for the average Brisbane commuter (Burke and Brown, 2007).

In Queensland, the need for an environment that encourages healthy living practices is quite evident. Based on measured body mass index (BMI) in 2007–08, 61 per cent of adult Queenslanders were either overweight or obese and the trend in prevalence of overweight and obesity has been increasing over the past three decades (QH, 2010).

Based on self-reporting of height and weight collected in 2010, 55.6 per cent of Queensland adults were overweight or obese (63.6 per cent male and 47.6 per cent female) (Figure 71). In 2007, high body mass (8.5 per cent) overtook tobacco (7.2 per cent) as the leading cause of premature death and disability in Queenslanders.



Source: QH, 2010. Note: Percentage with 95% confidence intervals are shown.

**Figure 71. Self-reported height and weight transformed into body mass index (BMI) categories involving Queensland adults in 2010.**

### Obesogenic environment

The World Health Organization defines ‘obesity’ as a body mass index (BMI) equal to or more than 30. BMI is a simple index of weight-for-height measured by the weight in kg divided by the square of the height in m ( $\text{kg/m}^2$ ). There is evidence that risk of chronic disease increases progressively from a BMI of 21 (WHO, 1998). Weight gain occurs when energy intake from food and drinks exceeds energy expenditure. With the changes in our way of living such as changes in urban design, increased reliance on cars, increased consumption of energy dense foods and drinks, limited opportunities for physical activity all contributed to weight gain. The World Health Organization has described the effect of these changes as creating or promoting an ‘obesogenic’ environment—an environment that promotes excess weight gain.

## 4.7 Cultural heritage

Progress on the identification and conservation of Queensland's cultural heritage is presented below in three sections—historic cultural heritage, Aboriginal and Torres Strait Islander cultural heritage and cultural heritage in museums.

### 4.7.1 Heritage places

Heritage places are tangible expressions of how people interact with the wider environment. It is intended that the Queensland Heritage Register contain a comprehensive, adequate and representative record of Queensland heritage.

A Statewide Heritage Survey was conducted from 2005–2010 to address regional gaps in the Queensland Heritage Register. The survey process consisted of undertaking a context history, preparing a reconnaissance inventory, consulting with regional stakeholders and identifying places, which were then nominated for entry in the Queensland Heritage Register.

The areas investigated by the heritage surveys were prioritised based on the level of development pressures that may put heritage places at risk, the level of information and/or protection already available for heritage places, and the location of resources available to undertake assessments.

The quality of places identified for registration was high, and this led to an increase in the number of places listed and protected. This has resulted in the Queensland Heritage Register being more representative of the range of heritage places throughout Queensland (Figure 72). For example, 20 new places have been entered in the Queensland Heritage Register in Far North Queensland, 18 in the Mackay–Whitsunday area and 35 in the North Coast area (Figure 72 and Table 23).

The thematic survey of World War II places in North Queensland was particularly successful, resulting in many places being considered for entry in the Queensland Heritage Register (Figure 73). Other North Queensland places identified through the survey that have since been entered in the register include the Majestic Picture Theatre in Malanda, the Malanda Swimming Pool and the Curtain Fig Tree in Yungaburra (DERM, 2010c).

In addition to the results of the Statewide Heritage Survey, the Queensland Heritage Register has continued to evolve with places being added and removed (Table 23). While the funding for the Statewide Heritage Survey finished at the end of 2010, a systematic process for the identification of heritage places will continue to ensure that the Queensland Heritage Register contains a comprehensive, adequate and representative record of Queensland heritage (Blake, 2005; Godden, et al., 2005; Pearce, 2009).

**Table 23. Number of places entered and removed from the Queensland Heritage Register.**

Year	Number of places entered	Number of places removed
2003	63	11
2004	60	8
2005	76	8
2006	43	8
2007	29	2
2008	63	0
2009	42	0
2010	30	0
<b>Total</b>	<b>406</b>	<b>37</b>

Source: DERM, 2010c, Queensland Heritage Register.

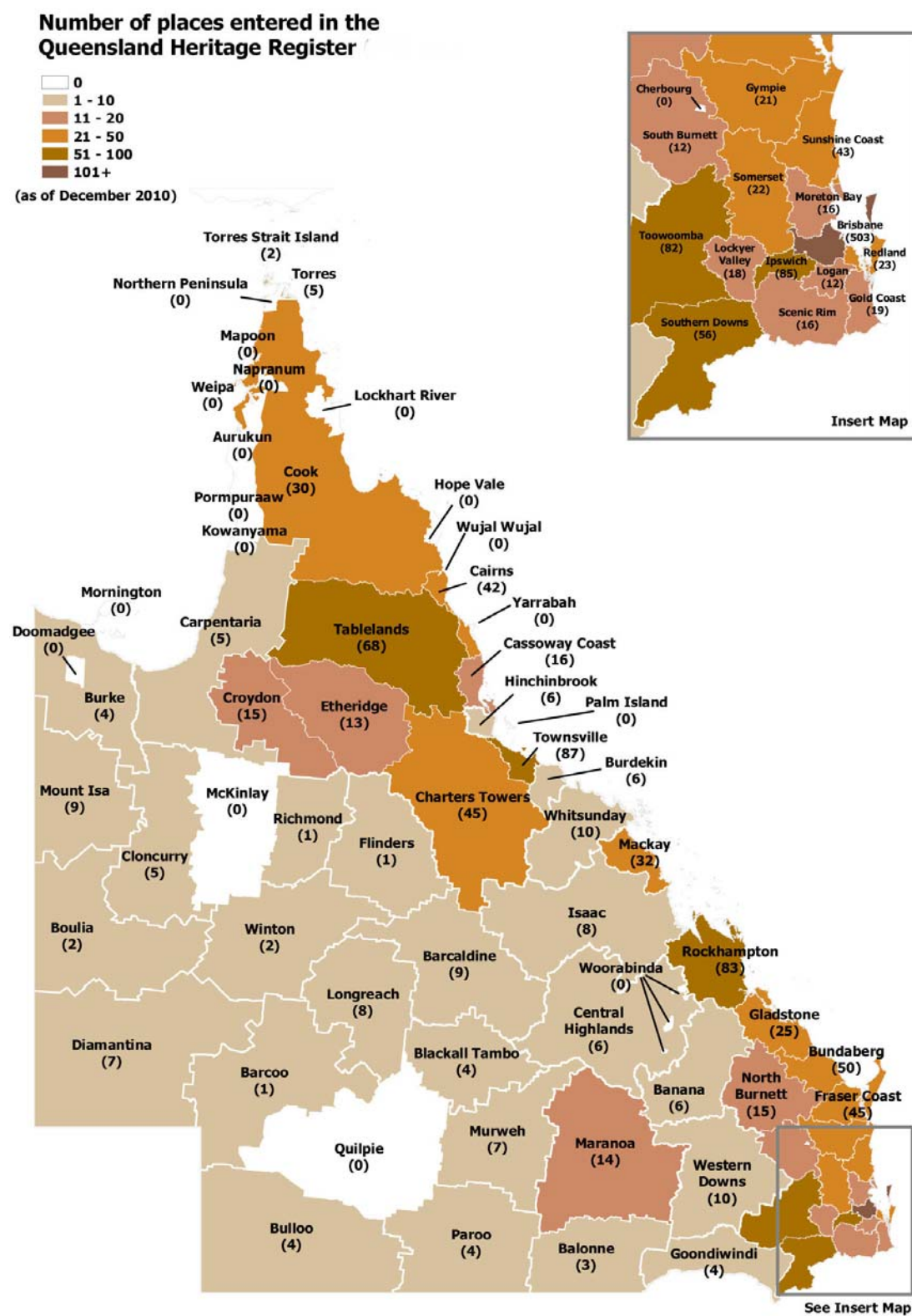
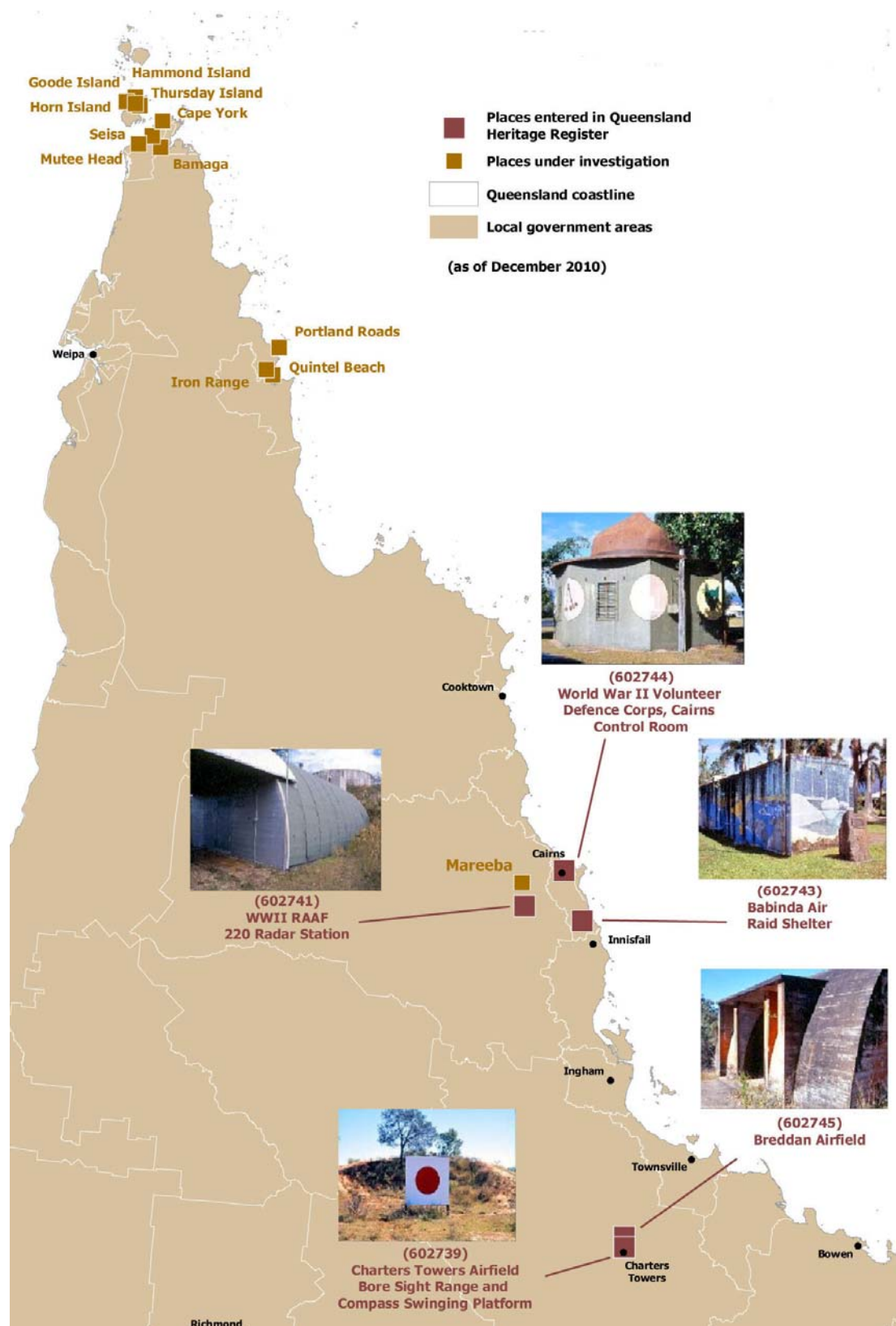


Figure 72. Number of places by region entered into the Queensland Heritage Register.





Source: Pearce, 2009. Data as at December 2010.

**Figure 73. WWII cultural heritage places identified in North Queensland during the Statewide Heritage Survey.**

### 4.7.2 The condition of Queensland heritage places

An audit to determine the condition of places entered into the Queensland Heritage Register has been undertaken. This audit has greatly increased the department's knowledge about the condition of heritage places in Queensland.

As of December 2010, there were 1647 places entered in the Queensland Heritage Register. At that time, approximately 95 per cent of all places entered had been audited. The remaining five per cent are mainly in remote locations and are being addressed through additional site visits.

The condition audit identified that more than seven per cent of heritage registered places were in need of significant repair and maintenance, or were completely destroyed (Table 24).

The majority of issues identified through the condition audit were the result of a lack of maintenance. The owners of the identified places are being contacted to address maintenance issues. Places identified as destroyed or suffering from major damage included properties that were subject to development approvals or had been impacted by severe weather events or fire. Most of these properties were located in the Brisbane area.

**Table 24. The number of places identified in the Queensland Heritage Register audit that have a condition of concern.**

Condition	Number of places	Per cent of register
Poor condition	80	4.86
Very poor condition	24	1.46
Suffered major damage	14	0.85
Destroyed	8	0.48
<b>Total</b>	<b>126</b>	<b>7.65</b>

### 4.7.3 Heritage places identified in local planning schemes

Since 2008, local governments in Queensland have been required to keep a local heritage register. Heritage places and areas are important and highly valued features of established urban and rural environments that enhance regional identity and contribute to a vibrant lifestyle.

South East Queensland and Far North Queensland local governments lead the state in the identification of heritage precincts within their planning schemes (Figure 74). In addition, South East Queensland has the largest number of identified local heritage places, followed by North Queensland (Figure 75).

### Local government areas with precinct provisions in local planning schemes

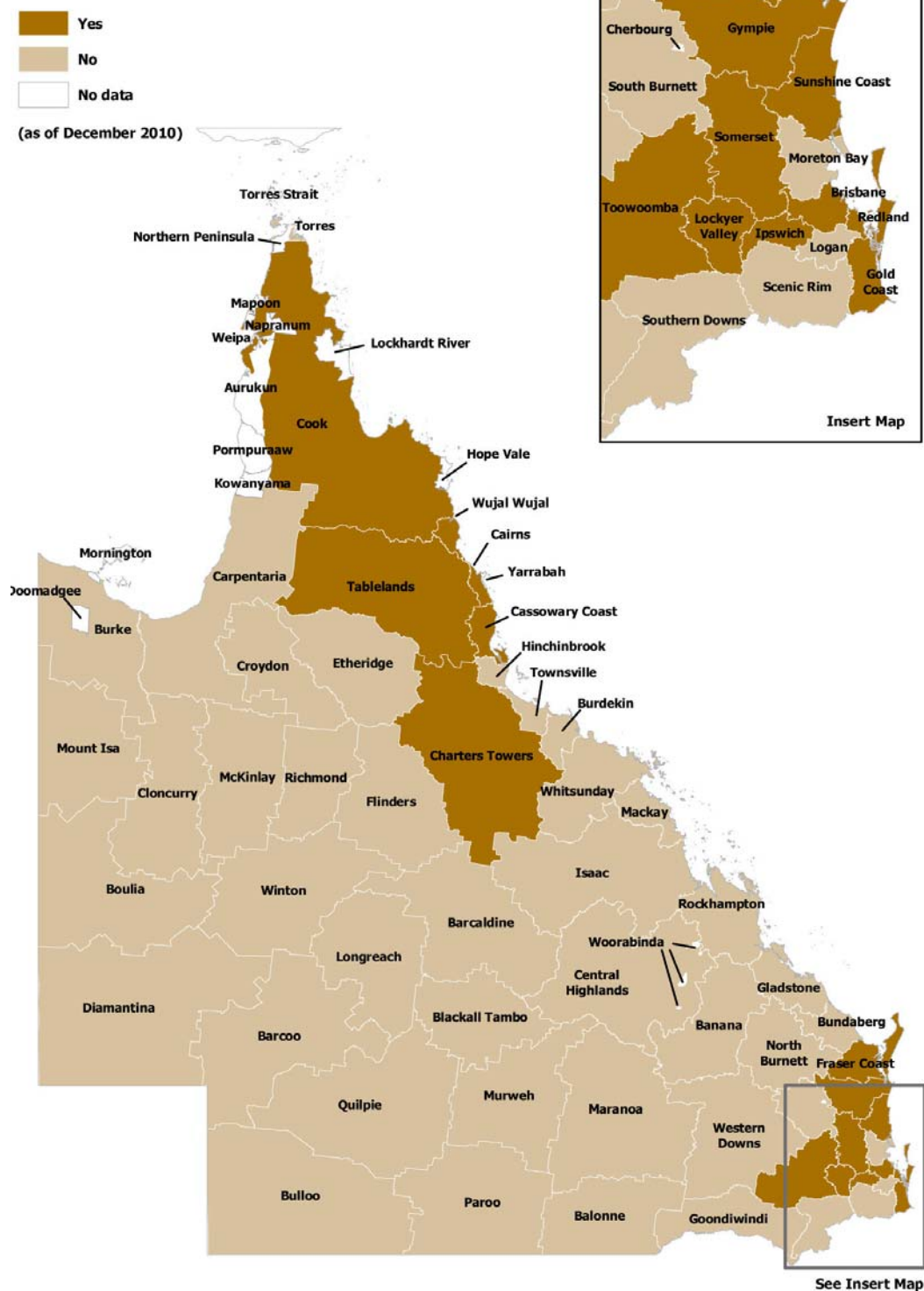
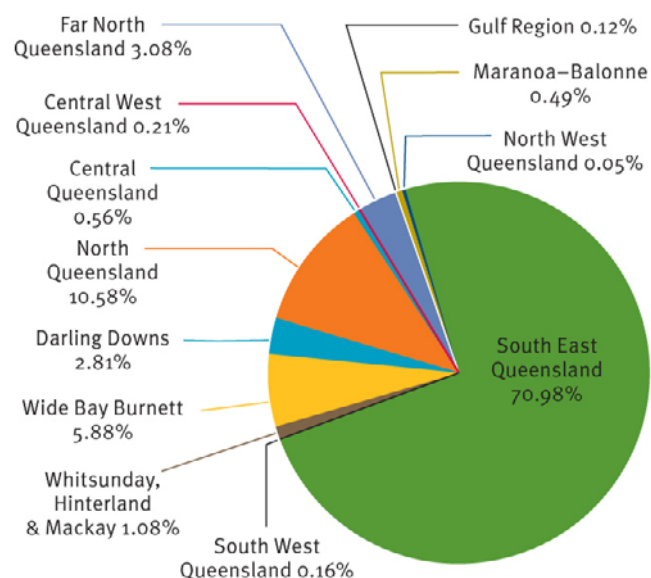


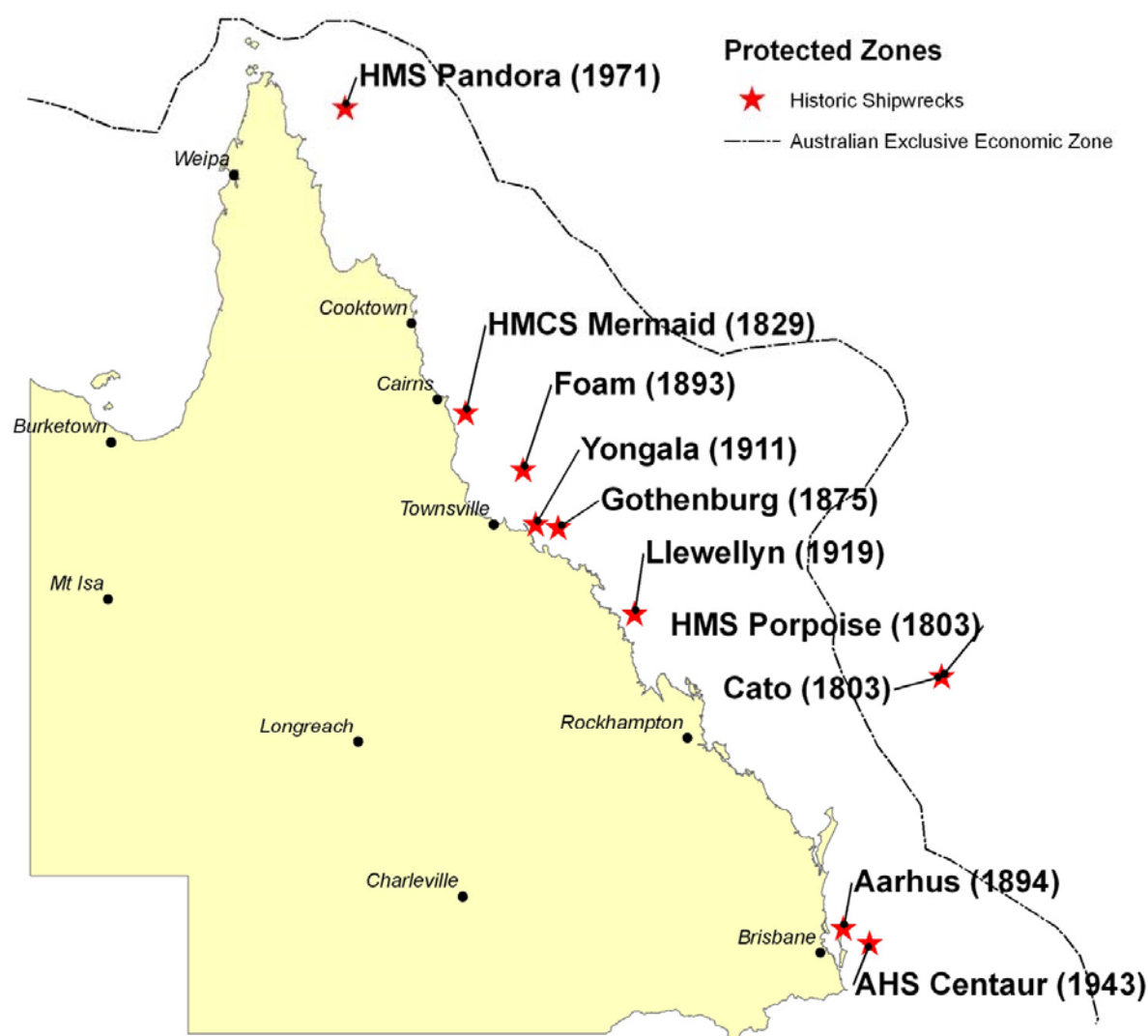
Figure 74. Local government areas with precinct provisions in local planning schemes as of December 2010.



**Figure 75. The per cent of Queensland local heritage places by region.**

#### 4.7.3.1 Historic shipwrecks

Historic shipwrecks are any wreck older than 75 years, or younger wrecks that have been specifically declared historic due to their high significance. There are an estimated 1050 historic shipwrecks along the Queensland coast. Figure 76 shows the protected zones around historic shipwrecks off the coast of Queensland.



**Figure 76. Protected zones around historic shipwrecks off the coast of Queensland.**

In February 2011, severe Tropical Cyclone Yasi caused extensive damage to North Queensland. One of the sites impacted was the wreck of the SS Yongala, which had been lost in a cyclone 100 years earlier. The wreck has become a major artificial reef and dive tourism attraction, but importantly is also the tomb of its 123 victims and a highly significant piece of cultural heritage.

A Queensland Government dive team consisting of an archaeologist, marine park rangers, Great Barrier Reef Marine Park Authority officers, and staff from a commercial dive operator inspected the wreck of the SS Yongala in March 2011 after reports of cyclone damage (Photo 5). The storm surge from the cyclone stripped large patches of soft and hard corals off the top side of the hull and buckled some of the hull plating. The inspection has resulted in a preliminary assessment report, preparation of a management plan and revisions to diving conditions.





**Photo 5. Dive team member investigating cyclone damage to the SS Yongala in March 2011.**

#### **New shipwreck exposed at Ramsay Bay on Hinchinbrook Island**

Tropical Cyclone Yasi also led to the exposure of a shipwreck at Ramsay Bay on Hinchinbrook Island. At least three vessels are known to have been stranded in Ramsay Bay in 1879–1880, some of which were involved in the timber trade. These included the brigantine Belle, and the barques Harriett Armytage and Charlotte Andrews. Heritage experts and marine park rangers teamed up to identify the mystery shipwreck as the brigantine Belle.

### **4.7.4 State of Aboriginal and Torres Strait Islander cultural heritage**

The state of Aboriginal and Torres Strait Islander cultural heritage, like that of historic cultural heritage, is based largely on knowledge of numbers, locations and condition of sites and artefacts.

#### **4.7.4.1 Cultural heritage database and register**

The *Aboriginal Cultural Heritage Act 2003* and the *Torres Strait Islander Cultural Heritage Act 2003* established a Cultural Heritage Register and provision for the continuation of a Cultural Heritage Database. The purpose of the Cultural Heritage Register is to assemble in a central and accessible location, information on cultural heritage studies, cultural heritage management plans and cultural heritage bodies.

Between the end of June 2006 and June 2010, there has been an increase in sites listed in the Cultural Heritage Database from 23 613 to 27 698, an increase of 4085 (approximately 17 per cent) (Table 25). The growth of the database is now sporadic and inconsistent as there is no longer a mandatory reporting requirement under the Acts.

Developers who are proposing an activity in Queensland may request a search of the Cultural Heritage Database for information regarding cultural heritage places in particular areas. The number of search requests made provides some indication of the pressure on Aboriginal and Torres Strait Islander cultural heritage; however there is no way of knowing exactly how many people are undertaking activities but have not requested searches. Between January of 2005 and October of 2006, 7037 searches were undertaken.

**Table 25. Changes in the recorded number of Aboriginal and Torres Strait Islander cultural heritage places in the Cultural Heritage Database for Queensland in 2006 and 2010.**

Type of place	2010	Percentage of records	2006	Percentage of records	Per cent change 2006–2010
Artefact scatter	13 383	48.32	10 194	43.17	5.2
Painting	2 739	9.89	2 733	11.57	-1.7
Shell middens	2 798	10.10	2 689	11.39	-1.3
Scarred/carved trees	2 088	7.54	1 740	7.37	0.17
Hearths/ovens	1 023	3.69	996	4.22	-0.52
Quarries	805	2.91	785	3.32	-0.42
Stone arrangements	733	2.65	726	3.07	-0.43
Burials	696	2.51	665	2.82	-0.30
Engravings	511	1.84	505	2.14	-0.29
Axe grinding groves	452	1.63	436	1.85	-0.21
Story places	443	1.60	409	1.73	-0.13
Cultural sites	457	1.65	383	1.62	0.03
Landscape features	378	1.36	247	1.05	0.32
Resource areas	258	0.93	212	0.90	0.03
Earthen arrangements	197	0.71	189	0.80	-0.09
Weir/fish traps	179	0.65	176	0.75	-0.10
Contact sites	188	0.68	173	0.73	-0.05
Wells	169	0.61	164	0.69	-0.08
Pathways	102	0.37	97	0.41	-0.04
Dwellings	99	0.36	94	0.40	-0.04
<b>Total</b>	<b>27 698</b>	<b>100</b>	<b>23 613</b>	<b>100</b>	

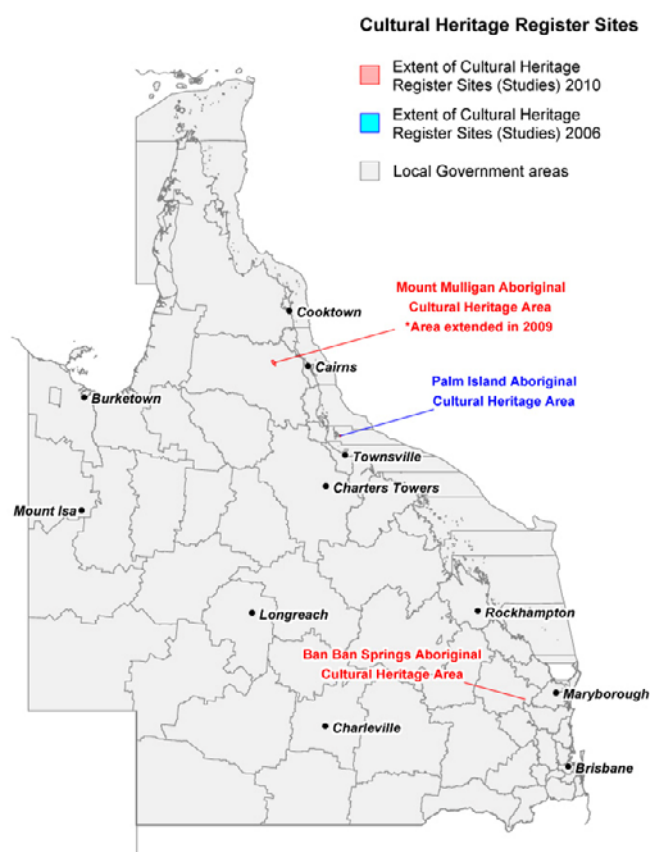
#### 4.7.4.2 Cultural heritage studies

Registration of Aboriginal or Torres Strait Islander significant cultural heritage is undertaken by completing a Cultural Heritage Study approved under Part 5 of the *Aboriginal Cultural Heritage Act 2003* and Part 6 of the *Torres Strait Islander Cultural Heritage Act 2003*. Assessment of the traditional or historical significance of cultural heritage is the responsibility of the Aboriginal or Torres Strait Islander party.

The results of the assessment are registered by the state provided that they are consistent with relevant anthropological, biogeographical, historical or archaeological information. Since the commencement of the legislation in 2004, Ban Ban Springs in the Wide Bay–Burnett region and Narrabullgan (Mount Mulligan) in North Queensland were added to the register and reported in State of the Environment 2007.

An area of Palm Island has also been added to the register since the State of the Environment Queensland 2007 report. The area of Palm Island contains cultural and natural resources that are significant to Manbarra Traditional Owners, and have a definite and tangible link to traditional and more recent aspects of their heritage. It contains artefact scatters, shell middens, scarred trees and a dugout canoe. The sites all indicate a high degree of intactness and interconnectedness (Figure 77).

The number of cultural heritage studies registered is low and has been attributed to lack of guidelines and public education. However, the reasons are likely to be more significant, complex and basic, including lack of funding and no clear indication that undertaking a study will result in long-term management of such places.



**Figure 77. The location of Cultural Heritage Register sites (studies) in Queensland in 2006 and 2010.**

#### 4.7.4.3 Condition

There are many potential impacts on cultural heritage places that can affect their condition in a detrimental way including climate variability, natural disasters, development and tourism. Unfortunately, there are currently no procedures in place for monitoring the physical condition of Aboriginal or Torres Strait Islander places in Queensland.

The initial condition of a site may be recorded when it is first identified. While the impact of human and natural processes on the condition of Aboriginal and Torres Strait Islander heritage places may be recorded and provided to the Queensland Government, there is no mandatory requirement to do so. The majority of places notified since the last state of the environment report have not included information on site condition. The treatment of artefacts is also an important consideration in preserving cultural heritage. Under the *Aboriginal Cultural Heritage Act 2003* and *Torres Strait Islander Cultural Heritage Act 2003*, artefacts can be collected or moved with the agreement of the Aboriginal party as a strategy to mitigate impacts from development. Information about the subsequent deposition or location of artefacts is rarely provided. Since there are no mandatory reporting requirements many artefacts are moved and/or collected without the knowledge of authorities.

### Site impact assessment for the Keppel Islands

The Keppel Islands lie off the coast of Rockhampton, Queensland. Aboriginal people occupied the Keppel Islands from at least 4000 years ago, with the first European residence on South Keppel Island established by 1883. At times, as many as 3000 sheep were grazing on the islands, and goats and possums were also introduced. Tourism developed on the islands from the late 1960s.

Archaeological research commenced on the Keppel Islands in 1978 and continues to this day. Over this period general observations have been made, photographic data and notes maintained and anecdotal information collected. Such information allows for some general impressions of site disturbance and management issues to be identified (e.g. Rowland, 2007, 2008).

Geoindicators are a useful measure of change in coastal processes at a scale relevant to the management of archaeological sites. Geoindicators are measures (magnitudes, frequencies, rates, and trends) in geological processes and phenomena which are subject to changes that are significant in understanding environmental change over periods of 100 years or less. They measure both catastrophic events and those that are more gradual, but evident within a human lifespan.

Examples of coastal geoindicators that have applied include dune formation and reactivation, relative sea level rise and shoreline position. Information from geoindicators have been applied to Wreck Beach–Big Sandhills Beach on South Keppel Island using air photos from 1962, 1992 and 2001 together with anecdotal information collected over a period of more than 30 years.

Most of the changes identified could be attributed to ‘normal’ changes in climate patterns and increasing human impacts. This ‘normal’ process of wind and water erosion has been exacerbated by natural and human induced vegetation removal. Introduced animals have also been a major source of vegetation destruction on the islands. Contrary to expectations, tourists have probably had a limited impact on most sites. Stochastic events such as cyclones and flood discharges from the Fitzroy River have also had significant impacts. At present none of the changes could be attributed to the impact of human-induced climate change

#### 4.7.4.4 Cultural heritage management plans

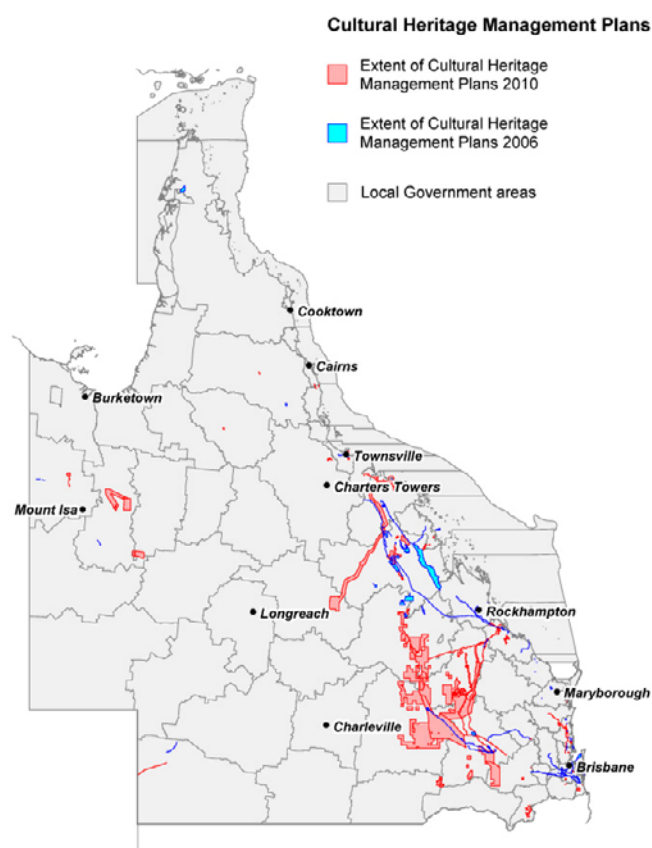
A major element of the *Aboriginal Cultural Heritage Act 2003* and *Torres Strait Islander Cultural Heritage Act 2003* are cultural heritage management plans (CHMPs). A CHMP is an agreement between a land user (‘the sponsor’) and an Aboriginal and Torres Strait Islander party (‘the endorsed party’).

The plan outlines how land use activities can be managed to avoid or minimise harm to Aboriginal or Torres Strait Islander cultural heritage. CHMPs are required for certain high-level impact activities—for example, where an environmental impact statement (EIS) is required under legislation—or where excavation or relocation of cultural heritage is proposed.

A CHMP may be initiated voluntarily to avoid breaching the cultural heritage duty of care. The management of cultural heritage may also be developed under a native title or other agreement. As of 31 October 2006, 68 CHMPs had been proposed and 44 approved (Figure 78). There appears to be some decline in CHMPs over time (Table 26). The lack of mandatory reporting frameworks makes interpretation of this trend challenging. The number of CHMPs per year (20–30) does appear small given the number of major projects that are undertaken each year in Queensland.

**Table 26. Number of registered cultural heritage management plans in Queensland.**

Year	2006–07	2007–08	2008–09	2009–10	Total
Number	44	23	31	29	127



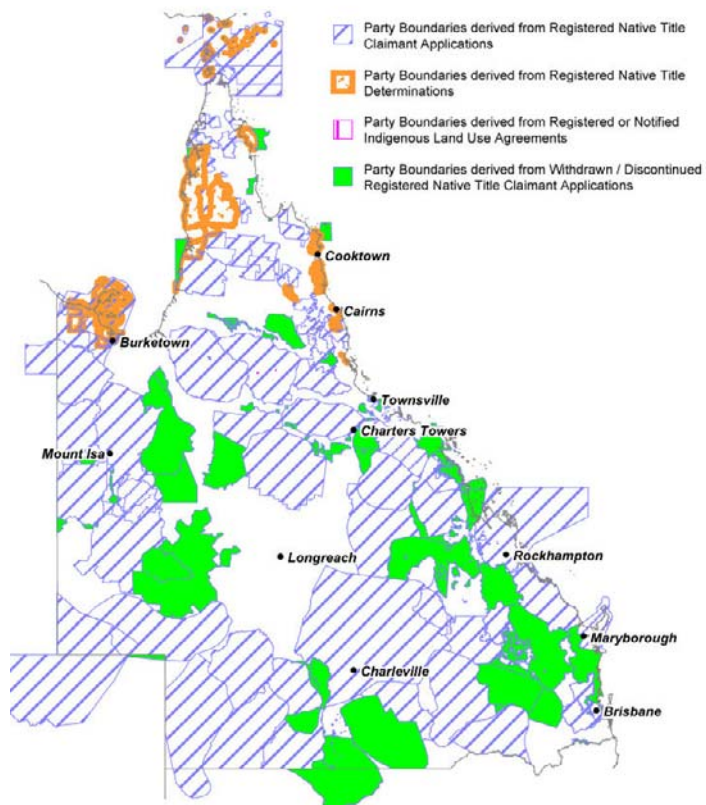
**Figure 78. Area covered by Cultural Heritage Management Plans in Queensland in 2006 and 2010.**

#### 4.7.4.5 Aboriginal and Torres Strait Islander Parties

The *Aboriginal Cultural Heritage Act 2003* and *Torres Strait Islander Cultural Heritage Act 2003* (the Acts) define the relevant Aboriginal or Torres Strait Islander party as being the determined or registered native title holder or claimant. In absence of a native title party, the claimant is the person recognised in accordance with tradition or law as having responsibility for an area or object. The function of an Aboriginal or Torres Strait Islander cultural heritage body is to identify the right Aboriginal or Torres Strait Islander party for people who need to know under the Acts. Party boundaries in Queensland as at July 2010 and the cultural heritage bodies registered in Queensland in 2006 and 2010 are shown in Figure 79.



a



b

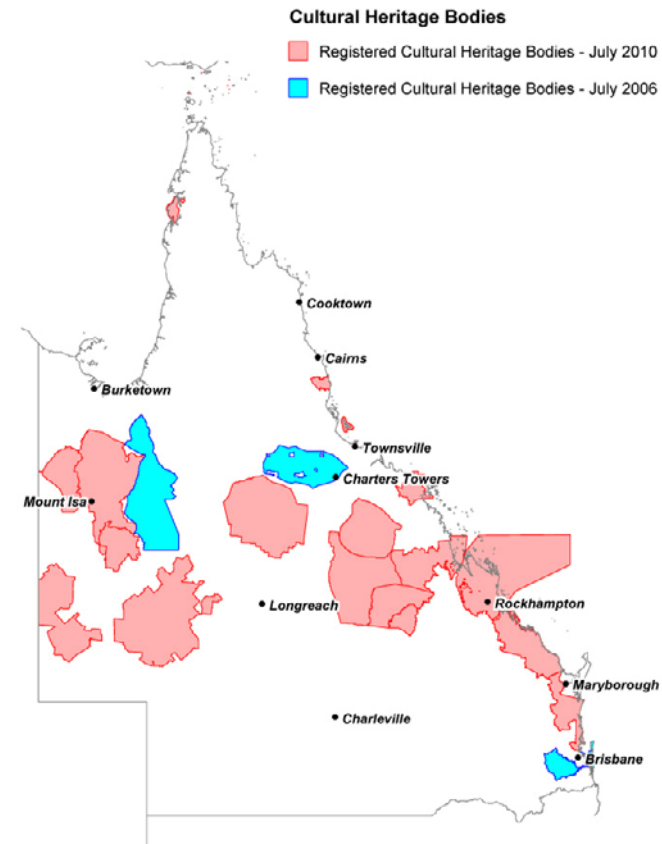


Figure 79. (a) Party boundaries in Queensland as at July 2010 and (b) cultural heritage bodies registered in Queensland in 2006 and 2010.

#### 4.7.4.6 Living culture

Language and culture are inextricably connected. Australia is known for its multicultural heritage and across the nation approximately 400 languages, including Indigenous languages are spoken. These languages connect people to a huge variety of cultural ancestries (ABS, 2010c). The State Library of Queensland supports the preservation by community groups of traditional languages and language diversity in Queensland.

In Queensland, around 50 of the approximate 100 Aboriginal and Torres Strait Islander languages are still spoken, with less than half of these used as a first language. The loss of traditional languages is a detriment to Queensland as with it comes a loss of traditional knowledge and the culture built by the people living on this land for over thousands of years.

Art, songs, dance and stories are passed on to the younger generation by Aboriginal people from six Aboriginal language groups (Wuthathll, Kuuku Ya'u, Kanthanumpn, Uutaalnganu, Umplla and Kaanju) in the Lockhart region (DEWHA, 2009). The adoption of these practices in many traditional areas has become a significant attraction on the state's tourism agenda.

Employment of Traditional Owners in the management of our protected areas helps maintain the health of the country and cultural traditions. The number of Indigenous people employed in Aboriginal and Torres Strait Island cultural heritage is low, as are the overall figures for employment in cultural heritage generally.

There are increasing opportunities for Aboriginal and Torres Strait Islander people to be involved in the joint management of national parks (Aboriginal land) and other protected areas such as the Cape York Peninsula Aboriginal Land (CYPAL) and Carnarvon Gorge National Park. The Wild River Rangers Program and the GhostNets Australia program are other examples of successful programs that integrate Traditional Owners into management of significant areas of Queensland for the future benefit of the culture, as well as the environment.

##### 4.7.4.6.1 National parks

The management of national parks in Queensland is undertaken by the Queensland Parks and Wildlife Service. Although the use of traditional methods has been limited in the past, many parks are now employing local Traditional Owners as rangers or on advisory committees. Traditional Owners have been helping to apply traditional land management knowledge and practices, which are both environmentally and culturally beneficial (DERM, 2009d).

Carnarvon Gorge National Park is located south-west of Rockhampton and is recognised as a place of significant natural beauty, as well as containing numerous important historic and Indigenous cultural heritage sites.

Carnarvon Gorge and the surrounding land are culturally significant to the local Bidjara and Garingbal/Kara Kara people. This is due to the abundance of natural resources and spiritual connections that are present.

Many tangible cultural heritage sites and artefacts of Traditional Owners are present in the park, including rock art, burial sites and evidence of occupation. There are also intangible sacred stories connected to the area that are an equally important part of cultural heritage and connection between the Traditional Owners and their ancestors (EPA, 2005).

The area was explored by Sir Thomas Mitchell in the 1840s. It then experienced a period of gold mining which included the temporary settlement of Chinese immigrants. Since the 1930s there has been increasing visitation from tourists for recreation and adventure.

The Carnarvon Gorge National Park Management Plan focuses on the conservation of both natural heritage and cultural heritage. The plan relies on the knowledge and input of Traditional Owners, local historians and Queensland Parks and Wildlife Service employees. Many traditional land management practices are now in use in the park (e.g. fire management).

Wooroonooran National Park, 115 km south of Cairns, features the Mamu Rainforest Canopy Walkway. This walkway is in the traditional country of the Ma:Mu Aboriginal people. Many generations of Ma:Mu people have lived in the mamu rainforest and they have a strong and enduring connection with their rainforest country. They have witnessed immense changes to their traditional rainforest country and culture. Today, they are reconnecting with their culture in modern ways while still respecting the older ways. They are involved in bush tucker gardens, revegetation programs and tourism ventures.

The Mamu Rainforest Canopy Walkway passes through one of the largest remaining continuous stands of complex vine forest on basalt soils in the Wet Tropics, and it gives visitors the opportunity to explore the rainforest from the forest floor to the canopy. Visitors are able to enjoy close-up views of rainforest plants, insects and birds, and take in sweeping vistas of World Heritage rainforest landscapes, while information signs explain the rainforest's complex web of life and the rich culture and history of the area.

More than 40 000 people visited the walkway in the first year of operation, well exceeding expectations. In August 2009, a small ceremony was held to mark the occasion and end of the first year. Dean Purcell, Chairperson of the Ma:Mu Aboriginal Corporation, spoke about the importance of the walkway to the Ma:Mu people:

‘Our cultural integrity is inextricably related to land, native title and natural resources. The walkway has been designed to have minimal impact on the land and environment, to allow the world to share in its beauty and serenity and also to showcase our story, the Ma:Mu story, our culture and our heritage. Aboriginal people believe that we are the natural custodians of the land—the land gives life to all living things, with or without human intervention. As traditional custodians, we can create a solid economic base and develop economic security through education, through increasing people’s knowledge of our culture and heritage—the historical stories of our people, the Ma:Mu people. Now, with the Mamu Rainforest Canopy Walkway, we can share our beginning, our heritage, with all.’

### **Cape York Peninsula Aboriginal Lands**

The *Cape York Peninsula Heritage Act 2007* was proclaimed as a land management initiative with consultations involving the Queensland Government, people of Indigenous and non-Indigenous backgrounds and the conservation and development sectors. The Act promotes joint land management with Traditional Owners on national park (Aboriginal land) or Cape York Peninsula Aboriginal Land (CYPAL). It also allows for traditional community uses and practices, as well as economically viable pursuits such as pasture. CYPAL is advised by two groups, the Cape York Peninsula Regional Advisory Committee and the Cape York Peninsula Regional Scientific and Cultural Advisory Committee.

The joint management of the areas means that Traditional Owners are employed as rangers and have park management responsibilities at all levels. They work with non-traditional owners to develop policies and plans for visitor and resource management using traditional methods (DERM, 2009d).

### **Wild River Rangers program**

The Queensland Government’s Wild River Rangers program cares for and promotes the natural values of wild rivers. At the end of June 2011, there were 40 Indigenous wild river rangers contracted through the program, which actively contributes to building economic opportunities for remote parts of the state through sustained and diverse investment in land and sea management.

The rangers form part of a strong and stable Indigenous workforce, supporting livelihoods and increasing the skill base of local people. The rangers ensure the unique ecologies of wild river systems are better managed and preserved by preventing bushfires, managing invasive weeds and feral animals, reducing land disturbance and water pollution, and supporting wildlife management and recovery.

‘Kids look up to us, looking after Country, and we are proud of what we do. This Wild River Rangers (program) opens us up to even more opportunities. I love this job. I just love everything about this job.’ Head Senior Ranger Paul Richardson, Normanton.

Key environmental outcomes of the program include greatly reduced predation of marine turtle nests by pigs, improved management of weeds and other threats to the state’s wild rivers, fuel reduction and ecological burning, collection of valuable information on local species and habitats, better protection of cultural heritage, disaster recovery efforts and enhanced visitor management. These activities have widespread benefits, for example, preventing bushfire reduces carbon pollution and can contribute to greenhouse gas reductions.

Environmental outcomes are not the only benefits of the program. Rangers are demonstrating an improved ability to manage a work-life balance and deal with interpersonal conflicts, and are reporting improved mental and physical health. Rangers are using their new skills and confidence to train and mentor other members of their

community, including those employed through the Commonwealth Development Employment Projects and local school children.

### GhostNets Australia

The work of Indigenous rangers along the Western Cape York coast is helping to address the effects of ghost nets on local marine life, and raising awareness of greater efforts needed in the region to address a global issue. Ghost nets are fishing nets that are accidentally lost or deliberately discarded, mostly arriving from South East Asia (94 per cent) and that are fouling the coastline of the Gulf of Carpentaria. The appellation ‘ghost nets’ refers to the derelict action of the net—fishing indiscriminately ‘as if by an unseen hand’, as they travel the oceans of the world with the currents and tides. Under the *Environment Protection and Biodiversity Conservation Act 1999*, marine debris (including ghost nets) is considered a key threatening process for many marine species (DEWHA, 2008a, b).



Photo: W. Strevens  
Northern Peninsula Area Rangers, from left to right: Francis Salee, Jimmy Panuel, and Christo Lifu.

**Photo 6. Northern Peninsula Area Rangers freeing turtles prior to recording information on hand held computer.**

#### 4.7.4.7 Traditional ecological knowledge

The hunter-gatherer economies of Aboriginal and Torres Strait Islander people in Australia are based upon an enormous body of knowledge about all facets of local environments, passed between generation through practical experience and through ritual and cultural expressions such as songs, stories, dance and painting (Bowman and Davies, 2006). Only recently have scientists and land managers begun to recognise the great value and depth of traditional ecological knowledge. The integration of traditional and modern principles into environmental and resource management is a key step towards achieving sustainable future outcomes, and encourages the reestablishment of connections between humans and their landscape. A Centre for Ethnobotany has been established at the Australian Tropical Herbarium in Cairns to enhance the effectiveness of these connections.

#### 4.7.5 Cultural heritage in museums

Museum collections and exhibitions provide a tangible link to the past, both ancient and recent by offering an authentic link through objects. Historic perspectives on environmental problems offer opportunities to understand and reflect on changes in the past, and can inform research into further understanding these problems. Issues including and associated with invasive species, sustainability, recycling and reuse, water and energy, human responses to climate change and changes in ecology, can all be investigated by looking into the context of objects through historical records and their past environmental settings.

#### 4.7.5.1 Number and nature of museums

Throughout Queensland, 294 institutions self identify as museums out of 352 listed museums, galleries, historical societies, and other cultural heritage sites (M&GSQ, 2009) (Table 27). The remainder of collections are kept predominantly within historical societies, cultural centres, galleries and historic houses (Figure 80).

Queensland Museum (QM) is the state museum and consists of a network of four public facilities, including the Queensland Museum and Sciencentre Brisbane, Museum of Tropical Queensland in Townsville, Cobb+Co Museum in Toowoomba and The Workshops Rail Museum in Ipswich. QM is also affiliated with the Museum of Lands, Mapping and Surveying in Woolloongabba.

The museums in the QM network are included in the number of listed museums together with museums at university campuses, specialist museums such as the Telstra Museum in Brisbane, the Mount Isa Underground Hospital and Museum, and locally run regional museums such as the Chillagoe Heritage Museum and the Calliope River Historical Village.

There are also a large number of diverse organisations that retain collections of heritage objects including libraries, archives, schools, Indigenous and multicultural community groups, and sporting, military and religious organisations, as well as private collectors (Tranter, 2007). This crossover has seen libraries holding object collections, and museums retaining more documentary collections.

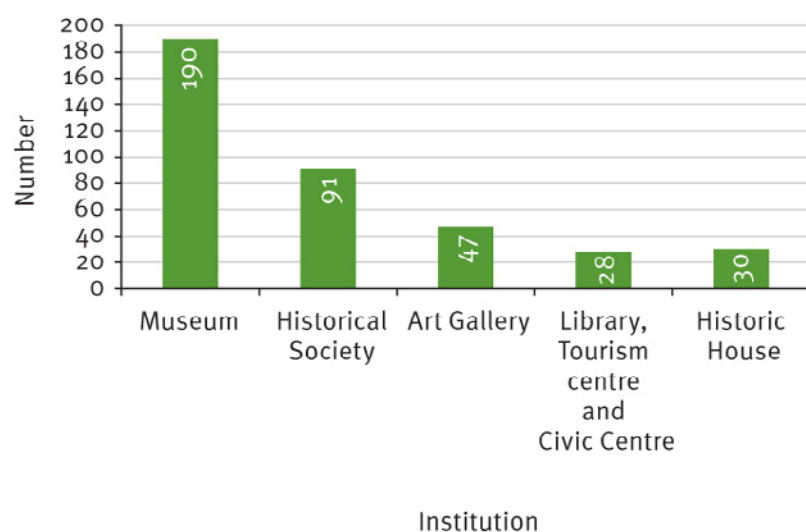
The Queensland Museum supports regional collecting organisations through its Museum Resource Centre Network staffed by six museum development officers. Located in five regional centres, the museum development officers support significant collections of Queensland's cultural heritage artefacts, photographs and documents and provide professional advice and support to collecting organisations across the state on a range of projects ranging from strategic planning, collection management and conservation, to exhibition development and display, and public programs. The museum development officers have commenced thematically mapping heritage collections across the state, with a view to completing this project in June 2013.

**Table 27. Distribution of museums in Queensland by region.**

Region	Number of museums
South Western Queensland	21
Western Queensland	11
Central Western Queensland	15
Tropical Queensland	33
North Queensland	26
Central Queensland	45
Fraser Coast	33
Darling Downs	46
Southeast Queensland	64
Sunshine Coast	17
Greater Brisbane and City	38
Gold Coast	3
<b>Total</b>	<b>352</b>

Source: M&GSQ, 2009.





**Figure 80. The range of institutions holding collections.**

#### 4.7.5.2 Collections

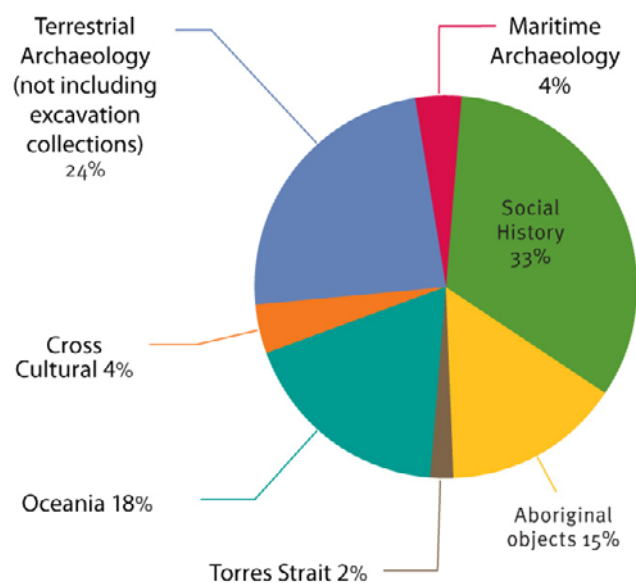
A voluntary survey in 2008 mapped 284 collections in museums. The collections range from land maps and surveys, photos, objects, historical documents, artefacts and scientific specimens.

##### 4.7.5.2.1 Collection composition for the Queensland Museum

The Queensland Museum's cultural heritage collection is composed of objects from Torres Strait Islander, Aboriginal, Australian South Sea Islander, and Pacific and Melanesian cultures. This is accompanied by objects relating to the history of Europeans and other cultural groups in Queensland, and collections emphasising science and technology and archaeology (Figure 81).

In its archaeological collection, the Queensland Museum holds collections of individual artefacts from terrestrial and maritime archaeology, as well as collections from 1386 archaeological sites across Queensland. The majority of these (1375) are from Aboriginal or Torres Strait Islander sites. These span up to 40 000 years of Aboriginal and Torres Strait Islander ancient history and illustrate the capacity of Indigenous Queenslanders to adapt to all of Queensland's environment types.

The remainder of the archaeological collections held by Queensland Museum (11) are from historical archaeological sites. These are also drawn from around Queensland and include two Chinese (or Chinatown) sites from north Queensland, as well as two ephemeral camp sites in western Queensland associated with the Shearer's Strike of 1891. There are also a range of industrial, government and refuse disposal sites from Brisbane, including the convict-built Commissariat Store and Commandant's Cottage.



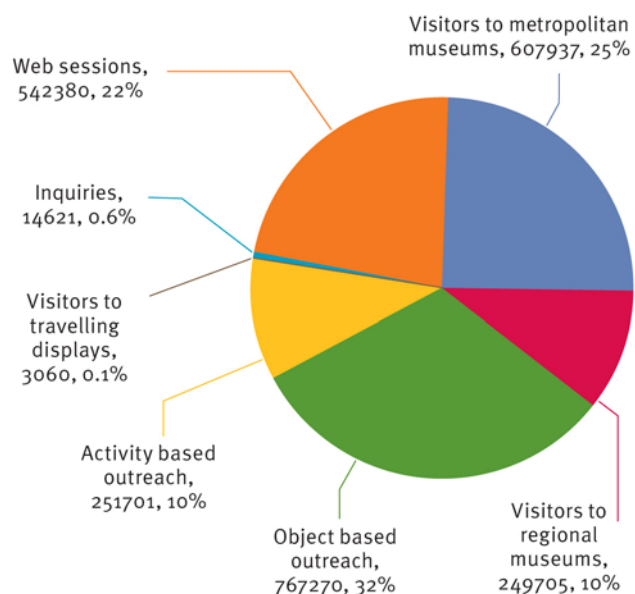
**Figure 81. The composition of Queensland Museum's cultural heritage collection.**

#### 4.7.5.3 Accessing Queensland Museum collections

Access to Queensland Museum collections is achieved through a number of pathways. This includes physical visitation to exhibitions, as well as outreach through the Queensland Museum website, public programs, travelling exhibitions, education projects, inquiry programmes and the Queensland Museum education loans programme. Online access to the collection via Queensland Museum's website allows access to collection items, exhibition content and research from the Cultures and Histories, Biodiversity and Geosciences research programmes (Figure 82).

Visitors accessing the museums and their collections and knowledge base within the Queensland Museum network are trending upwards, with over 2.4 million people annually accessing Queensland Museum through physical visits, on-line visits, loans and other outreach programs collections.

Special interest groups and researchers can also access the collection, providing improved knowledge of the collection and enhanced research experience for these groups. Queensland Museum lends collection materials to community, state, national and international institutions and organisations for the purposes of display and interpretation. Loans of archaeological material are also available to researchers under strict conditions. Queensland Museum has an educational loans program that gives remote and rural community access to its collections.



**Figure 82. Forms of visitor access to Queensland Museum collections outside of museum visits.**

#### 4.7.5.4 The Queensland Museum's education loans

Queensland Museum Loans is part of the Queensland Museum Regional Services program delivering museum services to Queenslanders, irrespective of where they live in Queensland. In 2009–2010, Queensland Museum Loans distributed 82 000 specimens and artefacts. Thirty-seven per cent of these kits went to people in regional Queensland, gaining access via the Queensland Museum Loans network of 30 regional loans depots.

Loan kits are primarily used by children, however adults are also accessing these objects through activities, such as library displays. The Queensland Museum also produces learning resource kits that link to Science and History curricula. Resources in the Queensland Museum Loans collection include specimens and artefacts that reflect Queensland Museum research in areas of Biodiversity and Geosciences, Science and Technology, Cultures and Histories.

In 2009–2010, Queensland Museum Loans produced 40 new kits covering topics including Telecommunications, the Jurassic period, the marsupial lion *Thylacaleo*, Active Earth, Queensland House Design, Queensland Emblems and Cultural Celebrations. Two of these kits contained artefacts from diverse cultures such as Cultural Celebrations—Feasts encourages learners in P-3 classrooms to identify and compare decorations different families use when they share a special meal. Cultural Celebrations—Seasons is a kit that enables middle school learners to explore and compare ancient origins of diverse cultural celebrations. This makes Queensland Museum Loans one of the largest museum lending services in the world, reaching 729 500 Queenslanders annually.



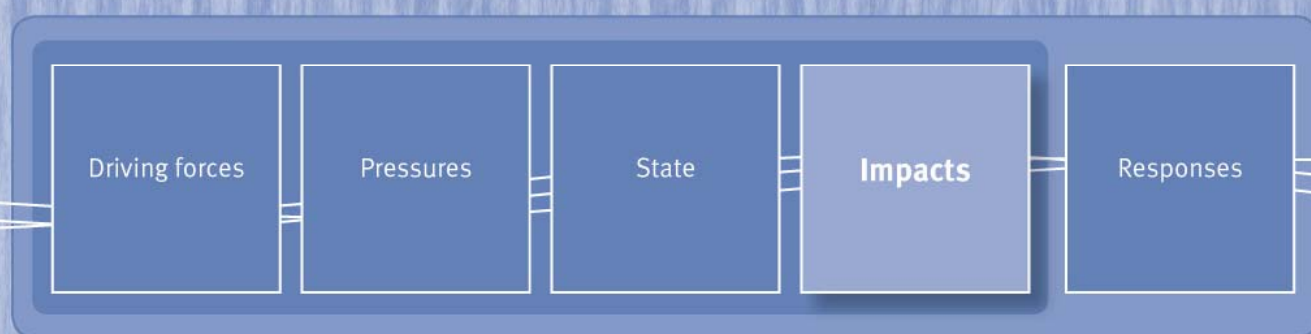
**Photo 7. Objects from Queensland Museum's Cultural Celebrations: Feasts loan kit.**

#### 4.7.5.4.1 Aboriginal and Torres Strait Islander people

Queensland Museum seeks to embrace Aboriginal people and Torres Strait Islanders as full partners in delivering museum experiences. The Queensland Museum currently engages with Indigenous communities through a number of avenues, including repatriation, reconciliation, and provision of community access to collections and creation of research partnerships. Involvement of Aboriginal staff members in the care of secret sacred objects, establishing protocols for dealing with Aboriginal cultural material and Torres Strait Islander cultural material and facilitating repatriation efforts helps strengthen ties to communities and building relationships of mutual trust and respect.

Visitors to the Queensland Museum for repatriation purposes have taken advantage of their visits to see the displays of cultural material and access objects and historic images in the collection that are not on display. In some instances, this has led to transmission of cultural knowledge with elders using the opportunity to teach younger members of the party about the use, tradition and cultural meaning of objects held in the collection. Communities regularly access collections including objects and photographs held in Anthropology for research and cultural purposes.

## 5 Impacts





Changes in the state of the environment can result in detrimental environmental impacts, as well as affect human health and the economic and social performance of society (Kristensen, 2004). There are many costs associated with environmental degradation (e.g. TEEB, 2010). The examples below highlight some of these, as well as the importance of effective responses to alleviate future costs.

## 5.1 The cost of impacts

### 5.1.1 Controlling weeds and pest animals

The Queensland Biosecurity Strategy 2009–14 (DPIF, 2008a) states that:

‘Biosecurity is resource intensive and there can never be enough funding to adopt a zero risk approach and either rid Queensland of all pests and diseases or stop the entry of new ones.’

Invasive species can impact on Queensland’s environment, economy and society. Economic impacts can be difficult to quantify and estimates can vary significantly. Additionally, the cost of many environmental and social impacts can be impossible to determine.

Terrestrial weeds are conservatively estimated to cost Queensland \$600 million annually in lost primary production (DEEDI, 2010c). Economic impacts can include:

- competition with crops and pasture
- toxicity to stock
- loss of ecotourism value
- diversion of resources towards control and eradication efforts.

Environmental impacts can include:

- competition with native flora
- toxicity to native fauna
- degradation of habitat
- increased fuel loads for fires
- reduced biodiversity
- reduced water quality.

Social impacts may include harm to human and animal health, as well as loss of amenity and landscape value.

Pest animals are conservatively estimated to affect two per cent of Queensland’s total agricultural production (DNRM, 2002), which is valued at \$10.77 billion annually (DEEDI, 2011d). This suggests pest animals cost Queensland approximately \$215 million annually in primary production losses.

More specifically, estimates of the economic cost of pest animals in Queensland include \$22–67 million annually caused by wild dogs (DEEDI, 2010d), \$106 million annually caused by feral pigs (DPIF, 2008b), \$98 million annually caused by rabbits (Gong et. al. 2009) and the equivalent of \$20 million annually, based on mice plagues occurring once every 10 years (McLeod, 2004).

### 5.1.2 Animal management

Animal management issues have been identified as having a significant impact on health, societal and environmental values in many Aboriginal and Torres Strait Islander communities. Feral animals threaten important environmental habitats and traditional food sources, and unmanaged domestic animals, such as wild dogs, have resulted in attacks on community people and other animals. To address these issues, the Feral and Domestic Animal Management and Welfare Program was established in 2007 with an annual investment of \$1.7 million.

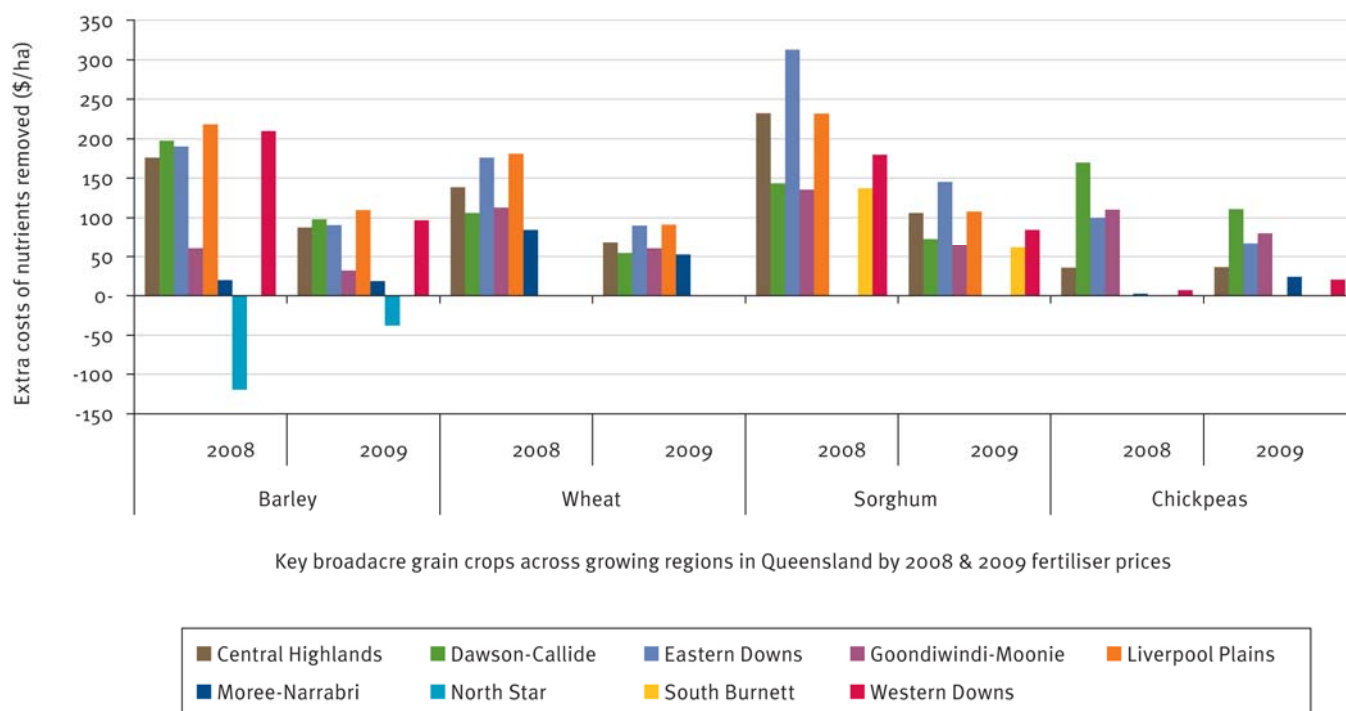
This program has seen the employment of 30 animal management workers who work with community members to educate them about health and care of domestic animals, enforce state legislation and local laws regarding cats and

dogs and organise veterinary care for the animals in the community to limit breeding and improve health. The major improvements to date are a reduction in overall numbers of domestic animals in communities (mainly dogs) and improvements in their health and wellbeing.

### 5.1.3 Depletion of soil reserves

In a study by Bell et al. the health of soil reserves (soil fertility) was assessed by sampling cropped and uncropped paired sites across the main grain growing regions of Queensland. This study found that they were severely depleted of nutrients (carbon, nitrogen, phosphorus and potassium) (Bell et al., 2010). As part of their investigation, they estimated the annual nutrient replacement cost of meeting these deficits (and zinc and sulfur) with fertilisers. The results clearly show the significant cost of nutrient depletion that will need to be met by future grain-producing systems (Figure 83). The average additional cost per ha of replacing these nutrients was \$106 per ha for barley, \$89 per ha for wheat, \$153 per ha for sorghum and \$47 per ha for chickpea, with these costs often doubling in the higher production regions.

Based upon the estimated areas grown for these crops (DEEDI, 2011e), this replacement cost for the 2011-12 growing season equates to an approximate \$144 million/annum cost to industry. Additional fertiliser input costs (from this depletion in nutrients and the increasing cost of inorganic fertilisers) represent a threat to the economic viability of these cropping systems. Bell et al. recommend considering a change to grain farming systems to include a higher legume frequency and resultant reduced use of nitrogen fertiliser as a way to reallocate the dollars invested in fertilisers to increase phosphorus use and start using potassium and sulfur fertilisers to address this nutrient deficit.



Source: Bell et al., 2010.

**Figure 83. Cost of replacing nutrients removed in harvested product from the districts of the northern grains region of the agricultural industry.**

## 5.2 Positive spin-offs and flow-on effects

One of the most rewarding consequences of putting in place initiatives for driving positive change for the conservation of our natural and cultural heritage is to achieve outcomes way beyond the scope of the project.

### 5.2.1 GhostNets Australia

GhostNets Australia (GNA) is an alliance of 22 Indigenous communities from coastal northern Australia that supports Indigenous rangers to remove ghost nets (fishing nets abandoned or lost by fishing boats at sea) from the ocean. This prevents the nets from causing further environmental harm to marine species. Stemming from the GNA project has been the development of a novel industry, which provides income from artwork. An entire cottage industry is being developed (GhostNet Gear) in which ghost net debris is fashioned into baskets, bags, wall hangings and an array of other imaginative tangibles.

Indigenous women and men are gaining new livelihood skills in Aurukun, Pormpuraaw, Mapoon Hammond, Moa, Erub and Sabai islands. Recent exhibitions at the Cairns Indigenous Art Fair, Floating Lands Festival, Sunshine Coast, and Garma Festival in the Northern Territory, brought more than just sales to these artists, media recognition and regional, statewide and international education about the ghost nets issue was also highlighted.

This newly developed GhostNet Gear enterprise has attracted the attention of the Centre for Remote and Rural Mental Health Queensland. GhostNets Australia is now working with health professionals to provide creative recovery workshops that use craftworks, in this case basket weaving and net sculpture, for improved mental health.



Photo: K. Trapnell, courtesy of Arts Queensland.

**Photo 8. Collaborative installation created at the Cairns Indigenous Art Fair 2011 made of bamboo and cane, ghost nets, buoys and floats.**

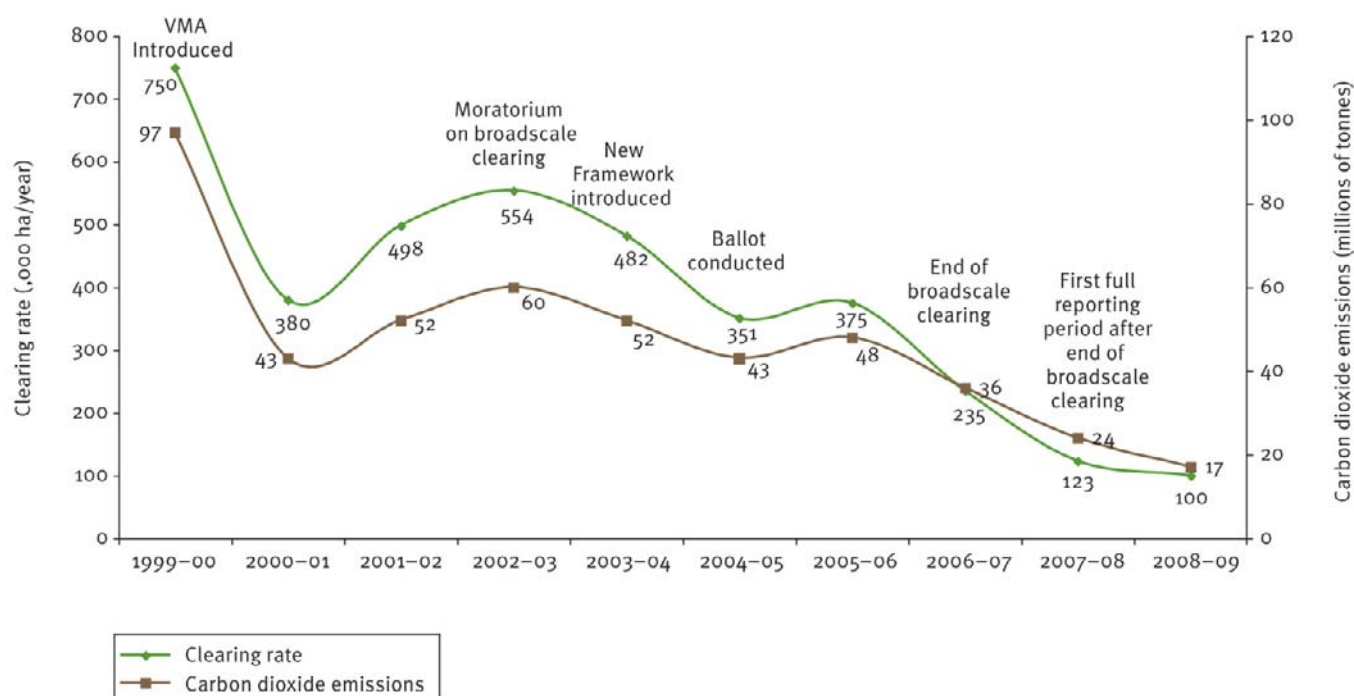
### 5.2.2 Vegetation reforms

Reforms to Queensland's vegetation management, in addition to being a significant milestone for the protection of natural resources in Queensland, have led to a reduction in CO<sub>2</sub> emissions. This reduction is helping Australia meet its international obligations under the Kyoto Protocol.

Queensland has achieved the highest annual decrease in emissions of any state in Australia. Total emissions have declined by about nine million tonnes (Mt) from 2008 to 2009 and remain below the 1990 level (DERM, 2011n).

Carbon dioxide emissions arising from vegetation clearing have been decreasing since 2002–03. From 2002–03, CO<sub>2</sub> emissions arising from clearing of vegetation have decreased from approximately 60 Mt to 17 Mt in the 2008–09 period, a reduction of 43 Mt. This reduction is equivalent to removing around 11.5 million medium-sized vehicles off the road for a year—a significant achievement considering there are currently around 3.4 million registered vehicles in Queensland.

The history of vegetation clearing, CO<sub>2</sub> emissions and legislative reform in Queensland are shown in Figure 84.



Source: DERM, 2011d. Statewide Landcover and Trees Study report.

**Figure 84. Summary of woody vegetation clearing rates and carbon dioxide emissions in relation to Vegetation Management Act 1999 (VMA) reforms.**

## 5.3 Responding to impacts

Queensland is no stranger to harsh weather and its damaging effects. Preparing for the impacts of these is a key role for government in partnership with the community.

Natural hazards (floods, cyclones, earthquakes, heatwaves, windstorms, landslides and bushfires) are a part of everyday life in Queensland. Direct and indirect losses associated with natural hazards and natural disasters include loss of life, physical and emotional suffering, damage to property, reduced productivity, loss of species and habitats, damaged infrastructure, weakened economy, destabilised community coherence, political situations, and reduced quality of life.

The flooding events of the 2010–11 summer have brought to the fore the importance of emergency risk management for safer, sustainable communities in the face of hazards. The importance of managing the interface between communities and the natural environment in relation to where people live, where infrastructure facilities are placed, where chemicals and wastes are stored, and agricultural and industrial practices have been highlighted.

The Australian Government has recently developed a National Strategy for Disaster Resilience (NEMC, 2011). The purpose of the strategy is to provide high-level guidance on disaster management to federal, state, territory and local governments, business and community leaders and the not-for-profit sector.

### 5.3.1 The Queensland Reconstruction Authority

The Queensland Reconstruction Authority was established in February 2011. Seven separate disaster events—including three cyclones and widespread flooding—swept across the state, leaving all 73 local government areas disaster declared.

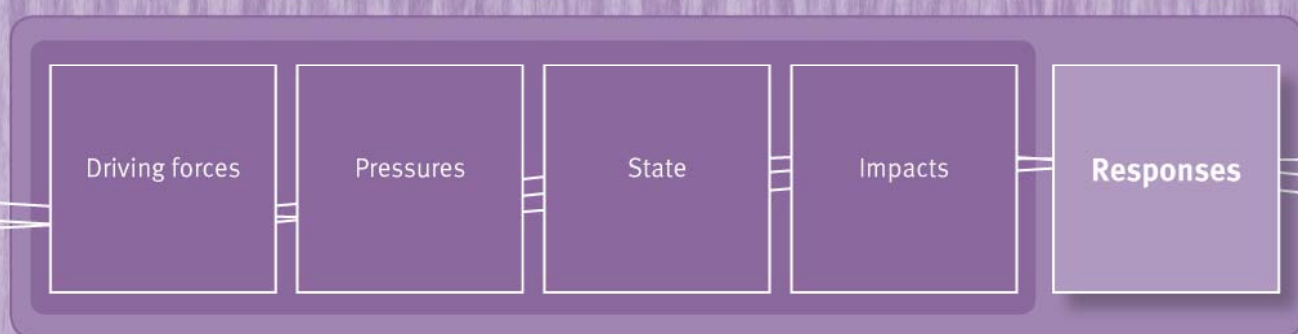
The *Queensland Reconstruction Authority Act 2011* legislates the authority to manage and oversee the almost \$7 billion reconstruction of public infrastructure damaged by the disasters administered under joint state and federal natural disaster relief and recovery arrangements.

There are six lines of reconstruction which include human and social, economic, environment, building recovery, roads and transport, and community liaison and communication. Each line of reconstruction is headed by a reconstruction committee represented by key state government departments and non-government agencies.

As at December 2011, more than \$3 billion was in the program of reconstruction works which included more than \$700 million in completed projects, more than \$1.96 billion underway, and a further \$834 million being prepared for delivery.



## 6 Responses



Responses refer to the actions or initiatives undertaken to prevent, mediate or adapt to changes in the environment. Responses are generally developed in reaction to the observed or anticipated pressures, impacts, or the state of the environment. Responses act in a multitude of ways, either individually, or more often in concert with one another to bring about environmental change. They protect the environment from damage or further harm; they encourage recovery through rehabilitation and remediation, they facilitate the transition from harmful or damaging behaviours to more sustainable ones, they encourage the adoption of more efficient practices; they seek to resolve conflicts of interest in an equitable manner and/or they pave the way for adapting to major shifts in circumstances.

The *Environmental Protection Act 1994* (EP Act) establishes the obligations for managing the environment responsibly through its objective of ecologically sustainable development defined as:

Protecting the environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.

The EP Act specifies that every person has a general environmental duty to take all reasonable and practicable measures to prevent or minimise environmental harm from their activities.

Protecting, maintaining and restoring the environment is a responsibility shared by many, including government at all levels, industry, natural resource management groups and non-government organisations, landholders and individuals. Complementing the wide range of initiatives for environmental planning and management, are environmental literacy initiatives including education and awareness projects, scientific studies and monitoring and reporting programs.

The responses in place in Queensland during the 2011 state of the environment reporting period cover a wide range of statutory and non-statutory initiatives including legislation, policies, plans, strategies, programs, projects, codes and guidelines. This chapter provides an overview of these responses.

## 6.1 Conserving natural assets

A range of responses are needed to slow or reverse the decline in biodiversity and increase the resilience of species, ecosystems and ecosystem processes.

### 6.1.1 Biodiversity

Since the State of the Environment Queensland 2007 report was produced, the Federal Government, in collaboration with the states and territories, set a national framework for biodiversity conservation over the next decade, Australia's Biodiversity Conservation Strategy 2010-2030. This contains national targets for addressing declining biodiversity. At a state level, the Building Nature's Resilience—A Biodiversity Strategy for Queensland was developed to meet the requirements under the *Nature Conservation Act 1992* for an integrated and comprehensive conservation strategy for the whole of the state. Three primary objectives are articulated within the strategy including building protected areas, conserving species and managing extent, condition and connectivity. Supporting actions for these objectives are valuing biodiversity, building knowledge and managing responsively.

The whole-of-landscape approach recognises protected areas as cornerstones within a connected and healthy landscape. Connectivity between protected areas may be achieved through a combination of mechanisms, such as the voluntary allocation of land to nature refuges, land conserved under the Delbessie Agreement and improved biodiversity values on land achieved through the use of sound management practices by individual landholders.

Along with the biodiversity strategy, Protected Areas for the Future—Cornerstones for Terrestrial Biodiversity Conservation (DERM, 2010d) was released as a companion document. This document outlines a process for the selection and acquisition of new protected areas throughout the state.

### 6.1.2 Aquatic ecosystems and the coast

Initiatives in the reporting period included legislative amendments to ensure the sustainability of industries, while other mechanisms were centred on the provision of information systems, partnerships, education and awareness raising. The Reef Water Quality Protection Plan (Reef Plan) 2009 identified actions to improve the quality of water

entering the Great Barrier Reef, and incorporates an integrated monitoring and evaluation program to measure progress and inform decision-making.

The coastal zone has seen renewed focus in this reporting cycle with the release of the Queensland Coastal Plan. Wild river areas were declared to ensure pristine environments receive adequate protection, while allowing for sustainable use. The Great Artesian Basin Sustainability Initiative is working at improving past management approaches and bringing them into line with best environmental practice.

The Queensland Wetlands Program and the application of Aquatic Conservation Assessments provided vital tools to assist with the planning, management, information delivery and awareness raising in relation to aquatic environments. Regionalised approaches are of interest in key focal areas such as the Lake Eyre Basin, Murray–Darling and in South East Queensland. Further integration of waterway programs through the Queensland Integrated Waterway Monitoring Framework will complement these initiatives.

#### 6.1.2.1 Legislation, policies and plans

A range of legislative instruments guide the management of aquatic ecosystems in Queensland which includes the *Water Act 2000* (Water Act), *Environmental Protection Act 1994*, Environmental Protection (Water) Policy 2009 and *Sustainable Planning Act 2009*. Under the Water Act, subordinate water resource plans (WRPs) provide a catchment-level framework for allocating and managing water through secure water entitlements for consumptive uses, while ensuring adequate flows to maintain key environmental assets. The WRPs define environmental flow requirements and provide for the establishment of secure and tradeable water entitlements. They also consider cultural requirements for water.

The statutory requirement, under the *Statutory Instruments Act 1992*, for a review of WRPs before their 10 year life, ensures an adaptive management approach. As understanding of the ecology and hydrology of the catchment improves, and as social, cultural and economic issues change and become better understood through more effective consultative processes, the plans can be adapted to account for this information.

Ninety-two per cent of key catchment systems in Queensland are covered by WRPs as of January 2012 (Figure 85). The process of reviewing WRPs as they reach the end of their 10 year life, as required under the *Statutory Instruments Act 1992*, and to include priority groundwater systems within these plans is underway

Resource operations plans (ROPs) implement WRPs by setting out day-to-day operational arrangements. The ROPs include, among other things, rules for environmental management, seasonal water assignment, and water sharing, and a process for granting unallocated water to which the WRP applies. The implementation of each WRP is monitored and reported on through the Annual Report for Queensland's Water Resource Plans.





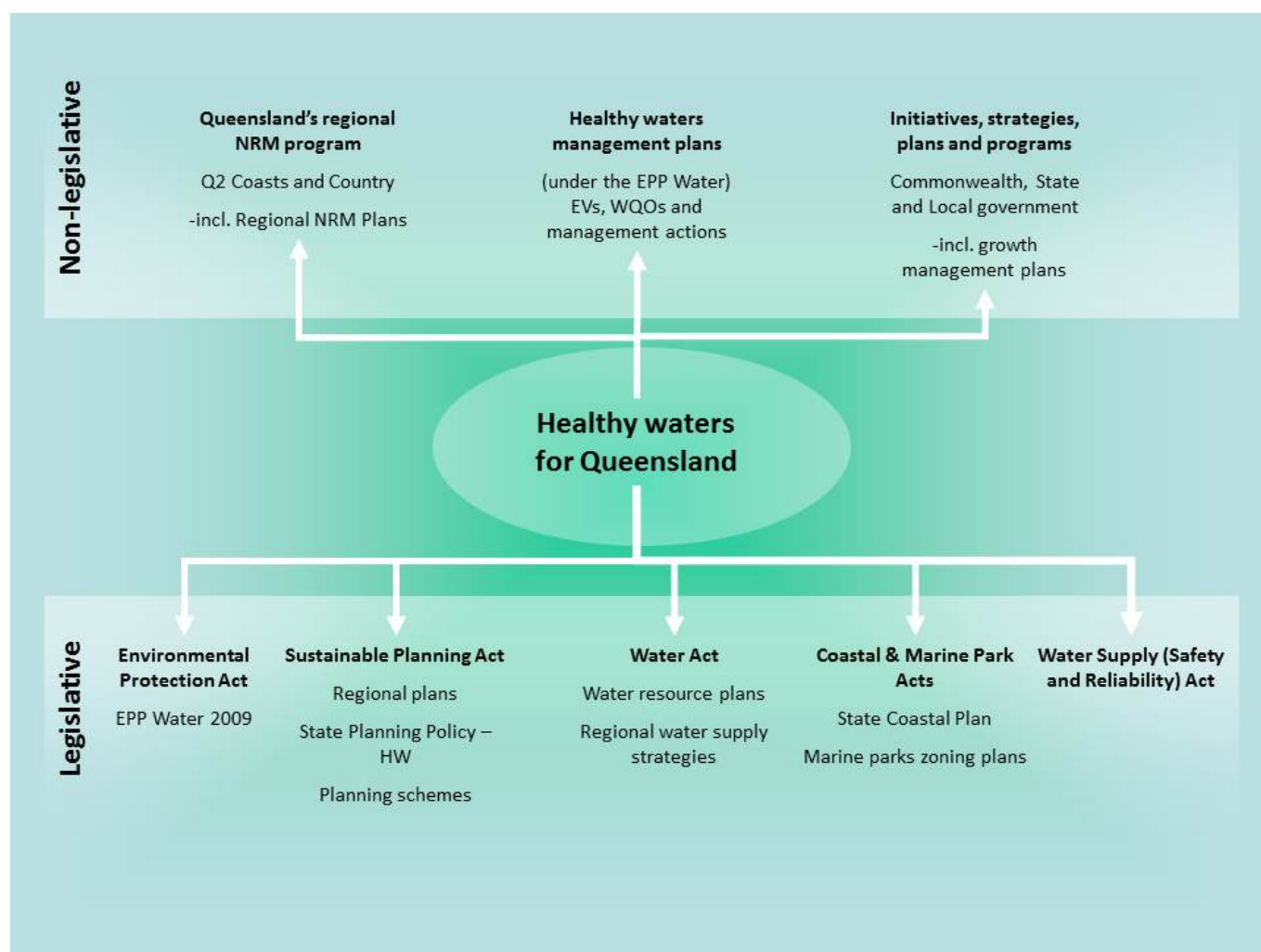
Figure 85. Queensland water resource planning areas.

The Environmental Protection (Water) Policy 2009 (EP Water Policy) is subordinate legislation under the *Environmental Protection Act 1994* (EP Act). It seeks to achieve the object of the EP Act in relation to Queensland waters (for example, rivers, streams, wetlands, aquifers, estuaries and coastal areas). The purpose of the EP Water Policy is achieved within a framework that includes identifying environmental values (EVs) for aquatic ecosystems and for human uses (for example, water for drinking, farm supply, agriculture, industry and recreational use) and determining water quality guidelines (WQGs) and water quality objectives (WQOs) to enhance or protect the EVs identified.

The EVs for water are the qualities that make it suitable for supporting aquatic ecosystems and human water uses. These values require protection from threats such as habitat alteration, waste releases, contaminated run-off and changed flows to ensure healthy aquatic ecosystems and waterways that are safe for community use.

WQOs are the measure of particular indicators of water quality to help protect the aquatic ecosystem health and human use EVs. WQOs are derived from site specific scientific studies for the water, the Queensland Water Quality Guidelines 2009, the Australian and New Zealand Guidelines for Fresh and Marine Waters 2000 and other documents published by a recognised entity.

The EVs and WQOs have been scheduled in the EP Water Policy for the waters of Moreton Bay (South East Queensland), Mary River Basin (Great Sandy Region), Daintree and Mossman basins (Wet Tropics), and Trinity Inlet and coastal waters. Figure 86 provides an outline of the legislative and non-legislative framework helping to promote healthy waters for Queensland.



Source: DERM, 2011o. Healthy Waters Management Plans Guideline, page 2.

**Figure 86. Healthy waters for Queensland framework.**



### 6.1.2.1.1 State planning policies

State planning policies are instruments that the state government can use to protect things that are of state interest. When a local government is developing their local planning scheme, they must ensure that the planning scheme reflects the elements outlined in state planning policies. If there is a discrepancy between a local government planning scheme and a state planning policy, the state planning policy overrides the planning scheme.

Sustained high urban population growth rates in Queensland have led to increasing impacts on urban stormwater quality. Urban stormwater run-off is a significant threat to protecting environmental values in many Queensland urban catchments. The State Planning Policy 4/10: Healthy Waters ensures that development for urban purposes under the *Sustainable Planning Act 2009*, including community infrastructure, is planned, designed, constructed and operated to manage stormwater and waste water in ways that protects the environmental values prescribed in the EP Water Policy.

The State Planning Policy 4/10 Guideline: Healthy Waters provides advice and information on interpreting and implementing the state planning policy. The Urban Stormwater Quality Planning Guidelines 2010 assist urban developers, catchment managers and government decision-makers to better manage urban stormwater quality and flows to waterways. Specific information is provided on urban stormwater management, small-scale waste water management and non-tidal artificial waterways (urban lakes).

Under the *Sustainable Planning Act 2009*, the State Planning Policy 3/11: Coastal Protection sets out criteria for land-use planning, coastal activities and development assessment, enabling Queensland to manage development within the coastal zone, including within coastal waters. The policy also informs regional plans, as well as local government planning schemes and decisions on development applications.

In May 2010, temporary planning and development laws under the *Sustainable Planning Act 2009* were introduced to protect freshwater wetlands of high ecological significance in catchments that flow to the Great Barrier Reef. The laws focus on the effects of high impact earthworks that may alter surface water flows and groundwater levels in and around wetlands.

The State Planning Policy 4/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments identifies development that is required to be assessed. It also describes the requirements for protecting freshwater wetlands of high ecological significance for local government and regional planning purposes.

### 6.1.2.2 Coastal planning

The *Coastal Protection and Management Act 1995* (Coastal Act) provides a framework for the coordinated management of the diverse range of coastal resources and values in Queensland's coastal zone. It incorporates the principles of ecologically sustainable development and a commitment to managing the 9500 km of coastline.

The Queensland Coastal Plan replaced the previous State Coastal Management Plan implemented in 2002 and describes the state policies that protect and manage Queensland's coasts (DERM, 2011p). The Queensland Coastal Plan focuses on core coastal resource matters, including development in coastal hazard areas, conservation of coastal biodiversity, coastal-dependent development, dredging and reclamation, public access, scenic amenity and settlement patterns in the coastal zone. The Queensland Coastal Plan addresses management of the coast and planning for future urban development in the coastal zone through the State Policy for Coastal Management and the State Planning Policy 3/11: Coastal Protection.

The State Policy for Coastal Management provides direction and guidance about the management of coastal lands in Queensland to achieve the objectives of the Coastal Act. The overall policy outcomes being sought for the management of the coastal land are to protect, conserve and enhance coastal resources, maintain natural physical coastal processes through appropriate design of works and structures or by setting them back from vulnerable areas, ensure infrastructure and services facilitate managed public use of the coast without having significant adverse impacts on ecological values or physical coastal processes, ensure that management actions on state or local government coastal land are consistent with the policy outcomes of the Queensland Coastal Plan and encourage public participation in the management of public coastal land, collaborative actions, knowledge sharing, community awareness and the monitoring, review and reporting of the effectiveness of management.

### 6.1.2.3 Reef Water Quality Protection Plan

The Reef Water Quality Protection Plan 2009 (Reef Plan) was created to improve the quality of the water entering the Great Barrier Reef through improved land management in reef catchments. The plan is a joint Australian and Queensland Government initiative that sets quantitative targets around land management practice change and reductions in catchment pollutant loads to relieve the pressure they place on this World Heritage asset. Accompanying the Reef Plan, the *Great Barrier Reef Protection Amendment Act 2009* introduced regulations to improve the quality of water entering the Great Barrier Reef.

### 6.1.2.4 Strategic assessment of the Great Barrier Reef World Heritage Area

Strategic assessments offer the opportunity to consider a series of new proposals or developments over a much larger scale and timeframe than is possible using a project-by-project approach. A strategic assessment of the Great Barrier Reef World Heritage Area has been proposed. It would be one of the largest and most complex undertaken in Australia due to the reef's spatial scale, the number of different land uses in the coastal zone, and the strong connection between the terrestrial and marine systems.

Strategic assessments offer the potential to deal with the cumulative impacts of development and to look for both conservation and planning outcomes at a much larger scale. A strategic assessment would focus on where decisions may impact on the outstanding universal value of the area and other relevant matters of national environmental significance under the *Environment Protection and Biodiversity Conservation Act 1999*.

### 6.1.2.5 Protecting marine environments

Queensland has three state marine parks which include the Great Barrier Reef Coast, Great Sandy and Moreton Bay marine parks. Queensland's marine parks are protected under the *Marine Parks Act 2004* and zoning plans are developed to manage marine parks to clearly identify the different zones within each park. The Marine Parks Regulation 2006 or relevant zoning plan usually states the objectives for each zone and lists the activities that are classified as unrestricted, authorised with a permit and prohibited in these areas. Under the Offshore Constitutional Agreement, the Commonwealth Great Barrier Reef Marine Park covers from the offshore boundary of state waters to the low water mark from Baffle Creek to the tip of Cape York.

Marine zoning plans may also be developed to provide a planning framework. This framework guides how an area may be utilised. Green zones (no-take areas) form the core of Queensland's marine protected area estate. The extent of Queensland's coastal waters marine park system in 2010 was 7 206 000 ha.

The International Convention on Biological Diversity (of which Australia is a signatory) states that at least 10 per cent of each habitat type should be effectively conserved. In 2008, the area of green zones in Moreton Bay Marine Park increased from 0.5 per cent to 16 per cent of the total area of the marine park. This compares with approximately 33 per cent and four per cent for the Great Barrier Reef Coast and Great Sandy Marine Parks respectively. A further 6.46, 13.28 and 7.51 per cent of the Great Barrier Reef Coast, Great Sandy and Moreton Bay Marine Parks are Conservation Park Zones, which are also considered highly protected areas.

### 6.1.2.6 Wild rivers

Queensland has a number of river systems that are relatively untouched by development and are, therefore, in near natural condition with all, or almost all, of their natural values intact. The Wild Rivers Act was introduced in October 2005 (*Wild Rivers Act 2005*) to protect the natural values of these rivers. Development can proceed in declared wild river areas providing the development does not impact on the natural values of the river system.

### 6.1.2.7 The Queensland Wetlands Program

The Queensland Wetlands Program, a joint initiative of the Australian and Queensland Governments, commenced in 2003 with the objective of developing projects and programs that will result in long-term benefits to the sustainable use, management, conservation and protection of Queensland's wetlands.

The program meets the four objectives of the strategy for the Conservation and Management of Queensland's Wetlands 1999 to avoid further loss or degradation of natural wetlands, unless overriding public interest can be shown to ensure a comprehensive and adequate representation of wetlands in the conservation reserve system, to base the management and use of natural wetlands on ecologically sustainable management and integrated

catchment management practices and to develop community awareness of, and respect for, the values and benefits of wetlands, and involvement in their management

The program has delivered tools to address all aspects of wetlands management from policy and planning, mapping and classification through on ground works, to monitoring and reporting. Queensland is one of the only states in Australia with such tools. The website *WetlandInfo* has been developed to meet wetland information requirements of stakeholders and the community.

Some of the tools developed or enhanced since the State of the Environment Queensland 2007 include mapping of wetland extent, development of a framework for assessing wetland condition and a toolbox for identifying the policy and legislation relating to wetlands. In addition, a range of guidelines have been delivered to assist with defining and delineating wetlands, buffer planning, rehabilitation and the management of wetlands in farming systems. Wetland management profiles and conceptual models further enhance knowledge and understanding of wetland systems. The ability to update the wetlands mapping and the development of tools for monitoring risk and condition means that Queensland is one of the few states with the ability to monitor wetland extent, risk and condition changes and assess the effectiveness of policies.

#### **6.1.2.8 Assessing conservation values of wetlands**

The Aquatic Biodiversity Assessment and Mapping Methodology is a comprehensive methodology developed for assessing conservation values of wetlands in Queensland. The method identifies relative wetland conservation values within a specified study area (usually a catchment), using available data to produce an Aquatic Conservation Assessment. Aquatic Conservation Assessments contribute to available baseline ecological information providing a decision support tool for natural resource management and planning processes. The methodology was first applied in the Burnett River Catchment in 2005–06. Aquatic Conservation Assessments have been completed for the catchments flowing into the Great Barrier Reef, as well as the Condamine River Catchment and Brisbane City Council Local Government Area.

#### **6.1.2.9 Integrated waterway monitoring**

The Queensland Integrated Waterway Monitoring Framework was established in 2010 to improve the coordination and comprehensiveness of waterways monitoring programs and enhance data sharing. A range of projects are underway to improve water quality and ecosystem health monitoring activities in priority regions and address statewide issues such as information management and reporting.

#### **6.1.2.10 South East Queensland Healthy Waterways Strategy**

The South East Queensland Healthy Waterways Strategy 2007–2012 is an integrated set of action plans that aim to maintain and improve the health of the waterways and catchments of South East Queensland. The need for the strategy arose due to the rapidly increasing population in the South East corner of Queensland and the associated pressures that accompany this growth. Water Quality Objectives have been established for Moreton Bay, all South East Queensland estuaries and some freshwater systems.

#### **6.1.2.11 The Great Artesian Basin Rehabilitation Project**

The Great Artesian Basin Rehabilitation Project commenced in 1999 as a joint strategy by the Australian and Queensland Governments to assist landholders to rehabilitate bores and replace bore drains with piped systems. Two programs, the Great Artesian Basin Sustainability Initiative (GABSI 1999–2014) and the Blueprint for the Bush plan, provided financial assistance to landholders to rehabilitate bores and replace bore drains with piped systems. Collectively, these initiatives have helped reduce wastage resulting from uncontrolled bores in Queensland and contributed to Great Artesian Basin pressure stabilisation. At the completion of Phase 2 in Queensland in 2009, under GABSI and its predecessor programs 563 uncontrolled bores had been rehabilitated, 280 bores had their bore drains replaced with pipeline reticulation systems, approximately 10 700 km of bore drain had been shut down permanently and approximately 170 000 ML per annum of flow from the Great Artesian Basin had been saved (GABCC, 2011).

#### 6.1.2.12 Supporting sustainable industries

Water management is a particularly important issue in relation to the petroleum and gas (particularly coal seam gas) industry. The industry extracts large volumes of water as a by-product of their activities. The EP Act was amended in 2010 to require coal seam gas operators submit, as part of their environmental authority application, an environmental management plan that specifically details the volume of water expected to be generated, the quality of the water, the proposed management of the water (including the use, storage, treatment and disposal of the water), as well as criteria to measure the effectiveness of this water management (which must be reported on annually).

In addition, the Water Act was amended in 2010 to introduce a framework for managing the impacts of underground water extraction as part of the petroleum and gas (particularly coal seam gas) industry. This framework requires operators to undertake baseline assessments of private water bores (to determine water level and test water quality), develop an underground water impact report that identifies potentially affected aquifers and springs as a result of extraction, imposes groundwater monitoring requirements and requirements to enter into make good agreements relating to any potentially impacted private water bores.

The *Water Supply (Safety and Reliability) Act 2008* was amended in December 2010 to introduce a regulatory framework for managing coal seam gas water discharges (to aquifer and/or surface waters) to ensure public health is protected.

#### 6.1.2.13 Healthy HeadWaters in the Murray–Darling Basin

As part of its 10 year Water for the Future Initiative, the Australian Government has agreed in principle to fund priority water projects in MDB states. The Queensland projects are known collectively as the Healthy HeadWaters Program.

The Queensland's Healthy Headwaters program aims to help Queensland's Murray-Darling Basin (QMDB) irrigation communities deal with climate change and reduced consumptive water availability, help QMDB's irrigation communities maintain their water-dependent economic vibrancy and ensure the long-term viability of ecological assets by making more water available for the environment.

The Healthy HeadWaters Coal Seam Gas Water Feasibility Study to be completed in 2012 is examining the opportunities for, and the risks and practicability of, using coal seam gas water to address water sustainability and adjustment issues in the QMDB. These issues include transitioning irrigation communities to lower water use and securing the viability of ecological assets. The study has developed frameworks for assessing salinity risk in coal seam gas water irrigation proposals and for assessing impacts to aquatic ecosystems from coal seam gas water discharges. It has also investigated the feasibility of injecting treated coal seam gas water into the Central Condamine Alluvium, and has developed a software tool to forecast the production of coal seam gas water over space and time as the industry develops.

#### 6.1.2.14 Sustainability of the Lake Eyre Basin

The Lake Eyre Basin Agreement is a joint undertaking of the Australian, Queensland, South Australian and Northern Territory Governments. The purpose of the agreement is to ensure the sustainability of the Lake Eyre Basin river systems, in particular, to avoid or eliminate cross-border impacts. The Lake Eyre Basin Five-Year Action Plan (2009–2014) lists key policies and strategies for enhanced decision making and improved data access, amongst others. These include aligning inter-jurisdictional planning and policy, coordination of water monitoring and integration of assessment outcomes.

#### 6.1.2.15 Fitzroy River water quality

In 2008, flooding in the western areas of the Fitzroy River catchment breached the Ensham Resources Coal Mine levee bank system to inundate open-cut coal pits. The subsequent release of high salinity water into the Nogoa River affected drinking water for communities downstream of the mine. A number of actions have been undertaken to reduce the impact of mine dewatering on water quality in the future. These include a study of the cumulative impacts on water quality of mining activities in the Fitzroy River Basin, the development of a model of the cumulative impacts of mine releases to be used in the review of licensing arrangements, development of new model licence conditions for the coal mines in the Fitzroy, providing more flexibility for mining companies and reducing

environmental risk, streamlining of the process for Transitional Environmental Program applications so that water is discharged more quickly during flows, before water quality deteriorates and the creation of EVs and WQOs, which provide improved localised water quality guidelines for the Fitzroy Basin.

### Balancing industrial development and environment health in Gladstone Harbour

During the latter half of 2011, concerns over the health of fish in Gladstone waterways were raised with the Queensland Government. Investigations into fish health and water quality in Gladstone Harbour are being undertaken. These investigations were instigated in response to evidence of poor fish health.

Monthly monitoring of water quality has been undertaken, including testing for dissolved metals, since September 2011. The results for the six months to February 2012 show only normal variation in water quality with no clear link between water quality and fish ill-health, or any link between dredging operations and concentrations of dissolved metals. Extensive sampling and testing of fish from the area and surrounding waters has been undertaken. Tests have showed infestation of a parasitic flatworm (*Neobenedenia* sp) in barramundi, as well as a different type of parasitic flatworm on sharks, and common shell erosion on some crustaceans, but there has been no common cause identified in other fish species tested so far.

An expert panel has reviewed all relevant information and proposed some extensions to the existing investigation program. The Queensland Government has accepted the recommendations and is implementing them through an Integrated Aquatic Investigation Program for Gladstone Harbour, which builds on the work already undertaken by the Queensland Government agencies and aims to identify the cause(s) of the fish health issues being experienced in the Gladstone region through further monitoring and research. The Queensland Government is also continuing to oversee the dredging operations in Gladstone Harbour to ensure compliance with the strict environmental conditions placed on the Gladstone Ports Corporation activities.

## 6.1.3 Terrestrial ecosystems

Queensland's terrestrial (land-based) biodiversity continues to decline from the effects of a wide range of pressures. A number of responses have been developed to address these pressures and conserve terrestrial ecosystems. Key responses focus on building and managing a protected area estate and forming partnerships with landholders to achieve good and/or improved conservation outcomes.

To complement these landscape-scale approaches, strategies have been developed and targeted projects undertaken to improve the status of threatened species. Legislation, including the *Nature Conservation Act 1992* and the *Vegetation Management Act 1999*, has played an important role in the protection of terrestrial ecosystems.

### 6.1.3.1 Protecting vegetation from clearing

Land clearing represents the greatest threat to biodiversity through the loss and fragmentation of habitats. The *Vegetation Management Act 1999* and associated framework regulates the clearing of native vegetation to conserve terrestrial remnant vegetation, prevent the loss of biodiversity and maintain ecological processes. The 2008–09 period recorded the lowest annual clearing rate since the introduction of the *Vegetation Management Act 1999*.

### Clearing in priority Great Barrier Reef catchments and areas of high-value regrowth

In April 2009, a six-month moratorium on clearing of endangered regrowth vegetation and in riparian areas of priority river catchments flowing into the Great Barrier Reef was introduced to reduce the high rates of clearing of non-remnant woody vegetation (regrowth). The moratorium was replaced by new regrowth laws on 8 October 2009, providing long-term regulation of regrowth vegetation on agricultural and grazing leasehold land, freehold land and Indigenous land through a performance based compliance code.



The laws apply to all native woody regrowth within 50 m of mapped watercourses in the priority Great Barrier Reef river catchments and mapped high-value regrowth. Clearing of woody vegetation in reef catchments has reduced from 118 740 ha per year in the 1999–2000 period to 10 700 ha per year in the 2008–09 period. This is a 91 per cent reduction.

### 6.1.3.2 Offsetting environmental impacts

The *Environmental Protection Act 1994* was amended in 2011 to create a legislative framework for placing conditions on environmental licences to allow for environmental offsetting. Offsets provide a framework to ensure that economic and social development can take place without overall environmental degradation. The policies include the overarching Environmental Offsets Policy, the Queensland Biodiversity Offset Policy, the Policy for Vegetation Management Offsets and the Offsets for Net Gain of Koala Habitat in South East Queensland Policy.

The Queensland Biodiversity Offset Policy was released in 2011, to protect Queensland's significant biodiversity values. The policy will guide decision making when offsets are required as a result of decisions under the *Sustainable Planning Act 2009*, *Environmental Protection Act 1994*, *Nature Conservation Act 1992*, *Coastal Protection and Management Act 1995* and the State Planning Policy 1/11: Protecting Wetlands of High Ecological Significance in Great Barrier Reef Catchments. It recognises that while legislation is in place that requires developers to avoid and minimise their impact on natural ecosystems, in exceptional circumstances, impacts to biodiversity cannot be avoided. In this scenario, an offset may be required as a condition of the approval.

### 6.1.3.3 Protected areas

Protected areas, such as national parks, are critical to the conservation of nature and the state of protected areas in Queensland has been presented in section four. To achieve their purpose, protected areas require management. Key aspects of management of these areas relate to fire, pest management and sustainable use.

**Fire:** The Queensland Parks and Wildlife Service Fire Management System is a comprehensive system that sets standards and operational aspects for planned burns and bushfire responses in protected areas, forests and other areas of land. The Fire Management System also encompasses fire management operational policies and procedures, environmental principles and incident control system.

**Pest management:** A statewide pest management system guides planning and on-ground activities and encourages an integrated approach to the management of pests. The annual Queensland Parks and Wildlife Service Strategic Pest Management Program provided funding for enhanced pest management for positive environmental outcomes.

**Sustainable use:** A key goal of the Queensland Parks and Wildlife Service is managing the sustainable use of protected areas, while protecting their natural and cultural values. The department's permit system is one method used to regulate visitor use of protected areas. The number of visitors to Queensland national parks is tallied from the number of camping nights booked in national parks. Camping nights increased by 15.9 per cent between 2007 and 2010, suggesting an increase in the number of visitors to national parks. In contrast, the number of non-camping permits issued in 2008, 2009 and 2010 has remained reasonably stable. The majority of these permits issued are for commercial activities (for example, filming and photography).

The Great Walks of Queensland are a world-class system of walking tracks throughout the very best of Queensland's protected area estate, including four of Queensland's five magnificent World Heritage areas. The great walks program provides visitors with positive nature-based experiences, clear conservation messages and promotes an appreciation and awareness of Queensland's outstanding natural heritage values.

#### 6.1.3.3.1 Joint management

In 2007, a new class of protected area called National Park (Cape York Peninsula Aboriginal Land) was created. This allows for existing and proposed national parks to become Aboriginal land and also be dedicated and managed as national parks. It allows for joint management by Traditional Owners and the Queensland Government.

#### 6.1.3.4 Nature refuges

Nature refuges are established through a voluntary agreement between a landholder and the Queensland Government. They acknowledge a commitment to manage and preserve land with significant conservation values while allowing compatible and sustainable land uses to continue. In a vast state bearing a diverse array of species, ecosystems and significant sites, nature refuges fill an important niche in promoting a community-based landscape approach to conservation. The number and area of nature refuges in Queensland has significantly expanded since the last state of environment report as discussed previously in section 4.4.5.

#### 6.1.3.5 Threatened species recovery

The Back on Track species prioritisation framework (Back on Track) prioritises Queensland's native species to guide conservation management and recovery, enables the strategic allocation of limited conservation resources for achieving greatest biodiversity outcomes and increases the capacity of government, regional NRM groups and communities to make informed decisions by making information widely accessible.

##### 6.1.3.5.1 Addressing declining koala populations in South East Queensland

The Koala Response Strategy was developed to halt the decline of South East Queensland koala populations and achieve a net gain in mature and actively regenerating koala habitat across South East Queensland by 2020. A range of initiatives have been rolled out under the Koala Response Strategy to address habitat loss and mortality arising from disease, dog attacks and vehicle strikes.

Key aspects of the response include:

- **Koala conservation state planning instruments:** The South East Queensland Koala Conservation State Planning Regulatory Provision and State Planning Policy 2/10: Koala Conservation in South East Queensland together aim to ensure that the planning process and development assessment within the South East Queensland Koala Protection Area is contributing to a net increase in koala habitat and assisting in the long-term retention of viable koala populations in South East Queensland.
- **Koala habitat offset policy:** The Offsets for Net Gain of Koala Habitat in South East Queensland Policy was designed to ensure that environmental offsets for unavoidable impacts on high quality koala habitat contribute to a net gain in Bushland Koala Habitat in South East Queensland.
- **Protected additional koala habitat:** By the end of 2011 over 30 000 trees had been planted and 379 ha of land purchased for protected koala habitat across the region.
- **Koala habitat programs:** Under this program eligible landholders receive financial assistance to revegetate, rehabilitate and manage koala habitat on their land in Koala Protection Areas in South East Queensland. This occurs through the Koala Nature Refuge Program. In addition, expressions of interest from landholders have been sought from those who may wish to sell their property to the Queensland Government. Properties will be protected from development and have their koala habitat values enhanced.
- **Freeze on clearing:** The state land freeze on koala habitat clearing was replaced with the State Government Supported Community Infrastructure Koala Conservation Policy, which ensures koala habitat is protected and rehabilitated.
- **Koala habitat mapping project:** The most comprehensive koala habitat mapping exercise ever undertaken in Queensland was recognised by being awarded the Queensland Spatial Excellence (Industry) Award by the Queensland Spatial Information Council in September 2009 and won the Environment and Sustainability Award at the 2009 Asia Pacific Spatial Excellence Awards.
- **Dog attacks:** To help protect koalas from dog attack, an animal management model local law has been released to provide local governments with the tools to restrict how dogs are kept.
- **Safe koala movement:** A guideline for establishing koala safety fencing and measures for safe koala movement has been created. The Koala Safety Fencing and Measures Guideline (draft) provides a framework to guide assessment managers and developers on maximising safe koala movement through areas subject to development.

- **Road crossings:** A trial on retrofitting existing bridges and culverts with structures that allow koalas safe passage has been created. This is being conducted on state-managed hot-spot roads in South East Queensland to reduce koala strikes.
- **Road design:** The Department of Transport and Main Roads has been locating and designing koala-friendly state-managed new roads and the upgrading of existing roads to minimise impacts on koala populations.
- **Disease:** A Koala Disease Research Fund has been established to support high quality research into mitigating the effects of disease on wild populations of koalas.

#### 6.1.3.5.2 Northern hairy-nosed wombat conservation

A second colony of northern hairy-nosed wombats has been created to assist the recovery of this threatened species. This colony was needed to reduce the risks inherent to only having a single colony remaining of this species in Epping Forest National Park (Scientific). The colony has been established on a nature refuge near St George based on the location of historical records of the species, as well as suitable soil and vegetation characteristics. The establishment of the Richard Underwood Nature Refuge was sponsored by Xstrata in collaboration with the Queensland government and the landholders, Ed and Gabi Underwood. During 2009–2010 15 animals were introduced to the site at the nature refuge. The re-introduction survival rate has been good and, as of May 2011, 10 of those animals have survived. Two of the female northern hairy-nosed wombats have since given birth to healthy joeys.

#### 6.1.3.5.3 Working together to conserve the Kroombit tinkerfrog

Since the mid-1990s there has been ongoing research on the Kroombit tinkerfrog (*Taudactylus pleione*), including a FrogSearch in most summers. FrogSearch relies on volunteers to assist with surveying and monitoring of the species. Through FrogSearch, knowledge of the species and of threats to it has increased substantially. Surveys have been undertaken at many sites at Kroombit Tops National Park and in rainforest in the ranges nearby. Despite the significant effort over many years, the breeding biology of Kroombit tinkerfrog remains unknown – only four females have been observed and the eggs and tadpoles have never been found.

Reducing the impacts of introduced animals, especially feral pigs, on the critical habitat of the Kroombit tinkerfrog is essential to the long-term conservation of the species. Efforts to control pigs have been hampered by the difficulty in accessing some areas, non-uptake of free feed as a prelude to baiting and limited resources. Research into alternative baits is currently underway and monitoring of feral animal presence, numbers and impact has been expanded. These measures will enable more effective and targeted control efforts.

Ecological research is continuing through collaborative work with Griffith University and Currumbin Wildlife Sanctuary, with financial support from the Fitzroy Basin Association and the Zoo and Aquarium Association of Queensland. The focus of this work is on improving tinkerfrog population monitoring, as well as the understanding of calling behaviour and breeding biology. Captive husbandry skills are also being developed, using the closely related Eungella tinkerfrog.

The current conservation effort for the Kroombit tinkerfrog is an example of the adaptive management framework in action. Information gained from research and monitoring of biological values and threats is fed back into the park management cycle, improving the efficiency and effectiveness of conservation management actions.

#### 6.1.3.6 Assessing biodiversity and identifying areas of significance

Biodiversity Planning Assessments are being generated for each of Queensland's bioregions to assess biodiversity values and identify areas of significance for biodiversity. The assessments are undertaken using the Biodiversity Assessment and Mapping Methodology and are useful in a variety of contexts, including environmental impact assessments, local government planning schemes, and identifying areas for offsets and park acquisition.

In this reporting period, Biodiversity Planning Assessments have been completed for the Channel Country, Mitchell Grass Downs and Einasleigh Uplands. The Brigalow Belt and Mulga Lands assessments have also been updated.

In addition, areas of ecological significance (AES) mapping was developed to spatially represent the state's biodiversity interests for land use planning and development assessment purposes. The AES mapping has been

used in the preparation of state planning instruments under the *Sustainable Planning Act 2009*. Local governments have also been encouraged to use the mapping to inform the biodiversity components of their planning schemes.

#### 6.1.3.7 Managing fire

Fire has played an important role in shaping much of Australia's landscapes and ecosystems. Manipulating fire regimes to create or protect desirable landscape features and habitats has become of primary importance at all levels of land management. Fire is used to protect property and infrastructure assets, to promote good grazing land, enhance timber values and to maintain 'natural' landscape and biodiversity values. Some ecosystems require particular fire regimes to persist, while others thrive in the absence of fire.

The Fire Guideline Project aims to develop and disseminate fire management information to maintain the ecological values of Queensland's regional ecosystems. Guidelines outlining fire regimes are based on a combination of information on best season, interval between burns, intensity of burn and coverage of burn (with other relevant information included where available). Guidelines have been established for the following bioregions, New England Tableland, Southeast Queensland, Central Queensland Coast, Wet Tropics, Cape York Peninsula, North West Highlands, Brigalow Belt, Mulga Lands and Channel Country.

The South East Queensland Fire and Biodiversity Consortium (SEQFBC) focuses on translating science into practice for improved fire management and biodiversity conservation in South East Queensland. Established in 1998 by Griffith University, a number of state agencies and local government authorities, the SEQFBC is a network of land managers and stakeholders devoted to providing a coordinated response and best-practice recommendations for fire management, fire ecology and the conservation of biodiversity in the South East Queensland region.

The primary aims of the SEQFBC are to engage with and educate land managers, private landowners and stakeholders in fire management planning for biodiversity, while ensuring life and property protection and safety, encourage and participate in applied fire ecology and fire management research for biodiversity conservation, provide a central location for the dissemination of information on fire ecology and fire management for biodiversity and maintain partnerships and establish new links with relevant programs and activities throughout Australia. Focus is on achieving outcomes through education, community engagement and applied research.

A number of key publications and documents have been produced by the SEQFBC, providing general information about fire ecology and the response of flora and fauna to fire. More detailed publications for developing fire management plans for individual properties, plus strategic planning and monitoring documents for land managers have also been developed.

#### 6.1.3.8 Partnerships for natural resource management

The 14 community-based regional NRM groups operating in Queensland provide the crucial link between government and the local community in managing the high priority environmental issues confronting Queensland. Regional NRM groups play a key role in NRM planning and program delivery by mobilising and undertaking on-ground work, strengthening partnerships, providing incentives, sharing knowledge, planning for regional NRM and monitoring the health of natural resources and the outcomes of this collaborative work. The priority areas include biodiversity, aquatic ecosystem management (including wetlands and water quality), coastal risk, sustainable agriculture and weeds and pest animals.

A Regional NRM Framework has been developed that sets out the organisational structure and administrative system within which Queensland continues to develop and deliver regional NRM arrangements. The framework is intended to:

- integrate and align natural resource management effort at the landscape level
- define how priorities are set for regional NRM investment
- identify opportunities for improvement of NRM arrangements.

The Q2 Coasts and Country program delivered investment in all aspects of social, economic and environmental wellbeing through the regional NRM process. The priority investment areas were developed from the major projects and state NRM policy drivers. Coordination and prioritisation for the delivery of regional NRM is also being addressed through the statutory regional planning process currently being rolled out in Queensland. The

statutory planning process allows stakeholders to align effort to deliver against the agreed Desired Regional Outcomes documented in the statutory regional plans.

### Condamine Catchment Grey Network

The Condamine Alliance established the Condamine Catchment Grey Network to bring together the large number of retired and semi-retired scientists, who have lengthy histories of involvement in NRM and are highly respected in their fields, with land managers.

Advice provided by the members of the 'Grey Network' to the Condamine catchment community has led to improved knowledge of soil health and nutrition, managing soil carbon, ground cover and climate change and other issues that were identified as constraints to productivity and sustainability. Collectively, the growers working with the 'Grey Network' manage 45 000 ha of cropping lands and changes in practice as a result of this initiative have currently been identified across 5000 ha. One of the key benefits of the network is that it has facilitated intergenerational knowledge transfer and ultimately, improved natural resource management.

Land for Wildlife is a voluntary program that aims to encourage and assist private landholders to provide habitat for native plants and animals on their properties, even though the properties may also be managed for other purposes. With more than 90 per cent of bushland managed for purposes other than wildlife conservation, private landholders play an important role in preserving Australia's unique wildlife.

Volunteer groups play a major role in conserving Queensland's wildlife. Examples of volunteer action through groups such as the Wildlife Preservation Society of Queensland include the assorted fauna 'watch' activities it undertakes, such as Echidna Watch, Platypus Watch, the Quoll Seekers Network, the Queensland Glider Network and many more. Queensland Water and Land Carers act as a peak body for NRM volunteers in Queensland representing and supporting them through advocacy, promotion, networking and insurance administration. Other groups, such as Birds Queensland, maintain long-term data sets that assist with determining the presence and abundance of species across Queensland.

Local governments play a major role in environmental management. The *Local Government Act 2009* is the legislation that governs councils in Queensland. The Act gives councils flexibility in how they make decisions and deliver services. Local governments work across a broad range of environmental areas, including environmental planning, management and restoration.

**Aboriginal People and Torres Strait Islanders:** The traditional ecological knowledge held within Queensland's Aboriginal people and Torres Strait Islanders is an important resource. For thousands of years the Aboriginal and Torres Strait Islander people of Australia have actively managed their natural environment. The integration of traditional and modern principles into environmental and natural resource management is a key step towards achieving future sustainable outcomes, and encourages stronger connections between humans and their landscape.

There are increasing opportunities for Aboriginal people and Torres Strait Islanders to be involved in the joint management of protected areas. The Queensland Indigenous Land and Sea Ranger and the GhostNets Australia programs are examples of successful approaches that facilitate Traditional Owners taking an active role in the management of significant areas of Queensland for cultural and environmental benefit.



### The handover of Lakefield National Park to Traditional Owners

As of June 22, 2011, the land of Cape York Peninsula's largest national park, Lakefield National Park, was transferred to the Traditional Owners with an agreement of joint management responsibilities between the Queensland State Government and the Rinyirru Land Trust. The handover will ensure that the land is managed in way that protects the culture and future lifestyles of the Traditional Owners, which includes 75 key families and nine language groups.

The national park was renamed the Rinyirru (Lakefield) National Park (Cape York Peninsula Aboriginal Land) to recognise the culturally significant story place at Jeanette Hill, as well as links with the historic cattle industry and Lakefield Station. It is the third national park in Cape York to be handed back to Traditional Owners.

As well as being culturally important country, the park also protects significant wetland and river systems, as well as being habitat for a number of endangered species, such as the golden shouldered parrot, the Lakeland Downs mouse, the spectacled hare wallaby and the speartooth shark.

#### 6.1.3.9 Environmentally-sensitive infrastructure

The impact on the biodiversity resources of state-controlled road reserves is managed through road planning, design, construction and maintenance measures and monitoring the effectiveness of these measures. Some of the approaches used include:

- **Planning:** development of guidelines to encourage best environmental practice and implementation of habitat offsets where necessary.
- **Engagement:** community engagement in planning to reduce road kill, involving potential changes to signage, rumble strips, line-marking and speed zones.
- **Habitat management:** enhancing the road reserve, including through revegetation and rehabilitation, fire management that is considerate of nature conservation, and pest management.
- **Fauna and flora monitoring research programs:** undertaken in conjunction with government agencies, community and universities to determine the effectiveness of fauna structures that have been implemented.
- **Koala retrofit crossing program:** focusing on existing infrastructure to ensure koala safety, activities included installing fauna exclusion fencing, a koala-specific trial overpass to assist with koala movement, drainage retrofitting, weed control and revegetation at a number of locations. Monitoring activities included GPS tracking of koalas, road kill surveys and visual observations.

## 6.2 Sustainable use of natural resources

### 6.2.1 Sustainable fisheries

Fishery management arrangements in Queensland employ a mix of input and output controls depending on the fishery. Input controls regulate the number of vessels that can be operated in a fishery (all Queensland commercial fisheries are limited entry), the quota of fishing days held by individual boats, seasonal and permanent closures to fishing (applies to both commercial and recreational fishers) and/or the type and specification of both vessel and gear. Output controls regulate level of catch (bag limits for recreational fishers and daily limits or trip limits for some commercial fisheries), or regulate gender, size or the breeding condition of species that can be harvested (applies to commercial and recreational fisheries).

Queensland fisheries resources are managed under the *Queensland Fisheries Act 1994*, Fisheries Regulation 2008, Fisheries (Coral Reef Fin Fish) Management Plan 2003, Fisheries (East Coast Trawl) Management Plan 2010 and Fisheries (Asian Bag Mussel) Disease Regulation 2007.

Since 2007, new management arrangements have been developed for the East Coast Inshore Fin Fish Fishery that have been implemented through legislative amendments during 2008 and 2009. New management arrangements for

the Gulf of Carpentaria Inshore Fin Fish Fishery were implemented in late 2011 and a review of the East Coast Trawl Management Plan commenced in 2010. In 2011, management changes to support sustainable snapper harvesting were implemented.

The Queensland Fisheries Strategy 2009–2014 was developed to ensure freshwater habitat protection, maintain fish passage along Queensland's waterways and integrate pest fish control with Queensland's Biosecurity Strategy (DEEDI, 2009).

The *Queensland Fisheries Act 1994* covers both freshwater and marine species and recognises the importance of maintaining habitats in sustaining inshore fisheries. Declared Fish Habitat Areas protect inshore and estuarine fish habitats from direct physical disturbance and coastal development. In 2010, 1 134 288 ha of tidal land was under the protection of Fish Habitat Areas (DEEDI, 2010e).

Fisheries development approvals for marine plant disturbance and works in declared Fish Habitat Areas are administered under the Fisheries and Sustainable Planning Acts and through the Integrated Development Assessment System. Offsetting the impacts of coastal development is a key component of development assessment. Since 2005, the total number of applications for, and amendments to, legislative approvals for marine plant disturbance has been stable at 213 to 228 per year. The Environmental Offsets Policy 2008 incorporates the Marine Fish Habitat Offset Policy. This framework ensures that economic and social development take place without an overall degradation of marine habitats that support fisheries production.

### Rocky Reef Fin Fish Fishery

New management arrangements were announced in June 2011. They included reducing the recreational bag limit for snapper from five to four, with a maximum of one fish with a total length over 70 cm. No changes were proposed for the size and bag limits of pearl perch and teraglin. The new management arrangements for snapper came into effect in September 2011. Once the new measures have been in place for a few years the effect of the new arrangements can be examined.

### Restoration of Fish Passage

Work has been undertaken to restore fish passage throughout Queensland by designing fish friendly instream structures for dams, weirs and culverts and installing fishways and fishlifts on existing barriers. Several fishways have been completed on new dams and weirs as required under the *Fisheries Act 1994*. These include at the South Maclean Weir and Cedar Grove Weir on the Logan River and Hinze Dam on the Nerang River.

NRM groups have also installed a number of small fishways in streams in the Burdekin, Mackay–Whitsunday, Murray–Darling and Fitzroy regions. Each NRM group has incorporated fish passage rehabilitation as an objective of their future regional investment plans.

## 6.2.2 Ecologically sustainable aquaculture

Aquaculture proposals require approvals under the *Sustainable Planning Act 2009*. Depending on the nature of the proposed development, an aquaculture proposal may trigger a range of state legislation including the *Coastal Protection and Management Act 1995*, *Marine Parks Act 2004*, *Environmental Protection Act 1994*, *Vegetation Management Act 1999*, *Land Act 1994* and *Fisheries Act 1994*. Additionally, for development proposals declared to be of state significance, assessment is carried out in accordance with the *State Development and Public Works Organisation Act 1971*.

In the marine environment, or on unallocated state coastal land, a resource allocation authority is required before a development application can be made. Where Commonwealth interests are affected, such as in the Great Barrier Reef Marine Park, or where matters of national environmental significance under the *Environment Protection and Biodiversity Conservation Act 1999* might be impacted, separate Commonwealth approvals may also be required.

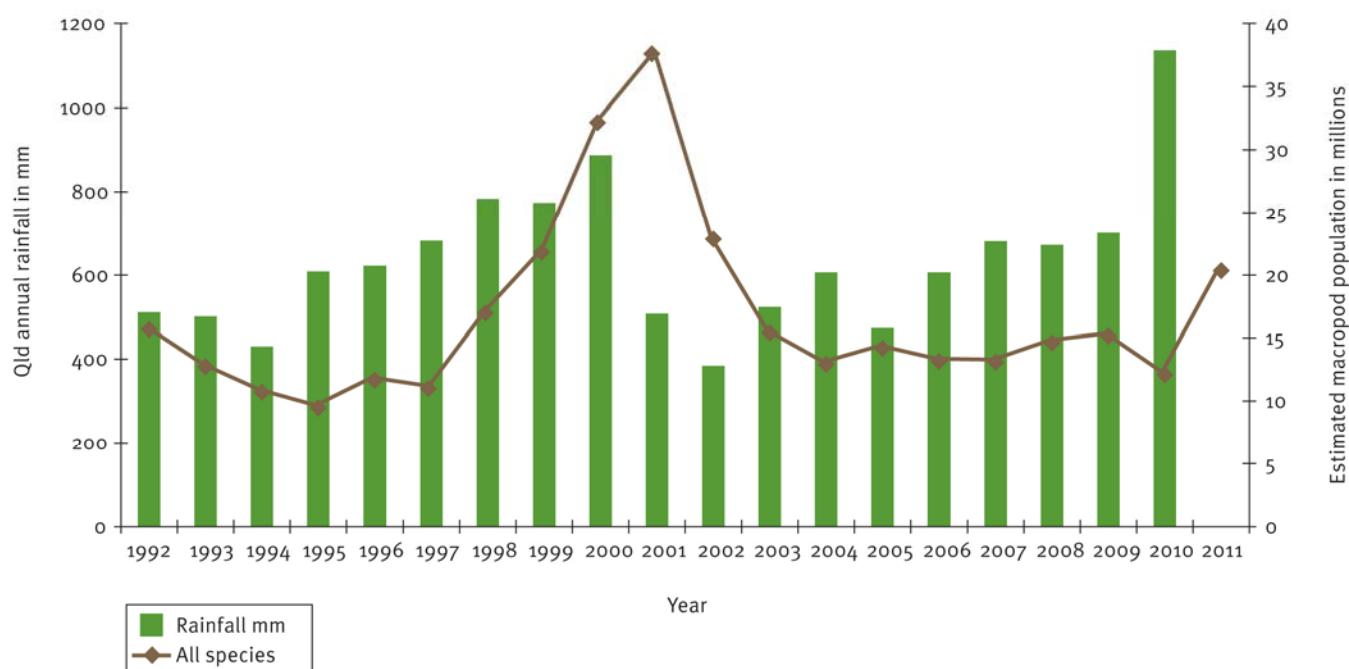
## 6.2.3 Sustainable harvesting of kangaroos and wallaroos

The commercial harvest of kangaroos and wallaroos in Queensland provides a good example of sustainable wildlife use in practice. Three species of macropods are commercially harvested in Queensland for meat and skin products. These are the red kangaroo (*Macropus rufus*), eastern grey kangaroo (*M. giganteus*) and common wallaroo (*M. robustus*).

The Queensland Government administers the commercial harvest of macropods in Queensland. There are three main aspects to the commercial macropod management program which are the monitoring of populations, the setting of sustainable of harvest quotas and the management of the commercial harvest.

Populations of commercially harvested macropod species in Queensland have been aerially monitored for nearly 30 years. Monitoring surveys are utilised to obtain density and population estimates that inform harvest quotas. The use of quotas enables the numbers of macropods available to be harvested to be set at sustainable levels. The harvesting of macropods commercially is managed through a licensing system. It includes a harvest period notice, which declares the opening and closing of the harvest period.

Macropod populations are affected by a variety of factors, such as rainfall that influences food and water availability, harvesting and predation. Since 1992 estimated numbers of the commercially harvested macropod species generally increased statewide to a peak around 2001. This was attributed to above average rainfall in the late 1990s (Figure 87). Numbers of all three species declined sharply following the commencement of the millennium drought in 2001 and have remained around this density, which is close to the 20-year average. Estimated macropod populations were reported to have increased in 2011; this is likely to be linked to rainfall patterns and subsequent food availability.



**Figure 87. Queensland macropod population estimates for harvest areas.**

## 6.3 Land management and use

### 6.3.1.1 Duty of Care

Under the *Land Act 1994*, all lessees, licensees and permittees have a duty of care for the land. If a lease is issued for grazing, agriculture or pastoral purposes, the lessee has a duty of care to take all reasonable steps to avoid

causing or contributing to salinity, conserve soil, conserve water resources, protect riparian vegetation, maintain pastures, maintain grassland free from encroachment; manage any declared pests and conserve biodiversity.

The Federal and Queensland Governments have a range of mechanisms to assist landholders with their obligation of duty of care for the land. The Queensland Rural Adjustment Authority administers state and federal government financial programs and services to increase the productivity, profitability and sustainability of rural enterprises. Regional NRM groups offer funding incentives to landholders for on-ground works, such as fencing of different land types or riparian areas, grazing management and weed control. Additional support to promote sustainable land practices is provided from tax deductions and rebates, creating property plans, and entering into statutory covenants that ensure that land and other important resources are not diminished in the future.

### 6.3.1.2 Land management and use frameworks

The occupation of land in Queensland may be defined under two broad tenure headings—freehold and non-freehold. Freehold land is purchased from the state and non-freehold land is land under the control of the State of Queensland but which may be subject to a lease, permit or licence, reserved for a community purpose, dedicated as a road or subject to no tenure at all.

The Queensland Government administers about 70 per cent of the state under the *Land Act 1994*. Commonly referred to as State land, this excludes freehold land, Commonwealth land and land administered under the *Nature Conservation Act 1992*. Leases and licences are granted over State land for specific purposes, including grazing, agriculture, industry and tourism. They are subject to a range of conditions to ensure they are managed appropriately.

The object of the *Land Act 1994* requires land administered under the Act to be managed for the benefit of the people of Queensland by having regard to seven principles which include sustainability, evaluation, development, community purpose, protection, consultation and administration. The provisions of the Commonwealth and State Native Title Acts must be satisfied before any dealings under the Land Act can be undertaken in relation to non-freehold land. In addition, the provisions of other relevant legislation that may apply to an administrative decision under the Land Act must be considered (e.g. *Local Government Act 2009*, *Nature Conservation Act 1992* and *Contaminated Land Act 1991*).

The *Land Protection (Pest and Stock Route Management) Act 2002* regulates the use of the stock route network. These networks provide pastoralists with a means of moving stock ‘on the hoof’ around the state’s main pastoral districts, as an alternative to trucking and other contemporary transport methods. The management of stock routes is currently under review.

The Delbessie Agreement (also known as the State Rural Leasehold Land Strategy) is a framework of legislation, policies and guidelines, introduced in 2008, to support the environmentally sustainable, productive use of rural leasehold land for grazing and agriculture. The Delbessie Agreement clarifies the duty of care obligations of all holders of rural leasehold land, however its primary focus is on the sustainable management of rural leases with terms of 20 years or more and covering an area of 100 ha or more.

The Delbessie Agreement assists land managers to balance use of the land profitably with the maintenance of healthy land condition. It also assists them to adapt land management practices to address challenges, such as climate change. Using a mixture of incentives and legal remedies, the framework introduces benefits to stakeholders by providing security of tenure through longer lease terms, clarifying duty of care where this has previously not been defined, enabling lease land condition to be assessed using scientifically-based guidelines, introducing land management agreements to guide ongoing land management; promoting voluntary conservation agreements and Indigenous access and use agreements and clarifying what will happen if land is identified as having significant environmental values that should be conserved within the protected area estate (for example, future national parks).

Strategic cropping land is an important, finite resource that is subject to competing land uses from the agriculture, mining and urban development sectors. To strike a balance between these sectors, maintain the long-term viability of food and fibre industries, and support economic growth for regional communities, a new legislative framework has been introduced. The framework, which includes the *Strategic Cropping Land Act 2011* and the State Planning Policy 1/12: Protecting Queensland’s Strategic Cropping Land, aims to protect and manage the impacts of development on strategic cropping land through planning and development assessment processes. Developments

such as open-cut mining, coal seam gas, underground coal gasification, long-wall/underground mining, urban development and industrial development will be assessed under the legislation.

The Reef Water Quality Protection Plan (Reef Plan) was designed to improve the quality of water entering the Great Barrier Reef through improved land management in reef catchments. The plan is a joint Australian and Queensland Government initiative that specifically focuses on non-point-source pollution from broadscale land use.

The *Great Barrier Reef Protection Amendment Act 2009* inserted a new chapter 4A of the *Environmental Protection Act 1994*. The amendments are designed to regulate cane farming and cattle grazing within the Wet Tropics, Mackay–Whitsunday and Burdekin Dry Tropics regions to reduce their impact on the quality of water entering the reef, and contribute to achieving water quality improvement targets for the reef under agreements between the state and the federal government. It does this by requiring all reasonable actions to prevent over-fertilisation of sugarcane crops, loss of soil through over-grazing of cattle and losses to waterways of weed poisons. This involves up to 5000 agricultural operations on around 13 million ha of reef catchment in the areas with a major impact on reef health. As of 1 January 2010, operators of all such activities must comply with strict requirements regarding the use of fertilisers (calculating and applying no more than the optimum amount of fertiliser using a regulated method) and pesticides, including such things as the rates, method and timing of application, and the keeping of relevant records. Certain higher risk operators must also submit environmental risk management plans, setting out plans to continually reduce their risk of losing soil, nutrients and pesticides to reef waters by all reasonable and practical measures.

Reef Rescue Package: Reef Rescue is a key component of Caring for our Country, the Australian Government's initiative to restore the health of Australia's environment and improve land management practices. Reef Rescue's objective is to improve the water quality of the Great Barrier Reef lagoon by increasing the adoption of land management practices that reduce the run-off of nutrients, pesticides and sediments from agricultural land.

### 6.3.1.3 Regional natural resource management

The regional NRM groups provide significant on-ground support to landholders to foster healthy regions where the environment, society and the economy are in good condition and working together. Their main focus is on mitigating and adapting to climate change, promoting good stewardship of the land by maintaining biodiversity and adopting sustainable practices, and controlling pests and weeds. They offer funding incentives to landholders for on-ground works, such as, fencing off different land types or riparian areas, grazing management and weed control. Planning, education and workshops are also used to complement their on-ground actions.

In the period from 2007–2010, the regional NRM groups:

- protected, enhanced, rehabilitated or revegetated 46 702 626 ha of native vegetation
- implemented pest plant and animal controls over 11 458 372 ha
- adopted 2023 new or improved natural resource monitoring programs
- entered into 1588 conservation agreements protecting 1 185 386 ha
- carried out 11 373 biophysical studies
- developed 8471 sub-regional plans
- conducted 9399 awareness raising events for 386 512 participants
- hosted 6145 training events attended by 77 612 participants
- were involved in 18 717 community groups
- assisted projects and entered into 11 459 collaborative arrangements.

### 6.3.1.4 Mining

Mining activities are authorised under the *Mineral Resources Act 1989*. Technological advances and changing market conditions in recent decades have facilitated the development of many new mines and increased production at existing mines.

The mining industry regulatory framework is responsible for the regulation of the environmental management performance of the state's mining industry through the provisions of the EP Act.



The State Planning Policy 2/07: Protection of Extractive Resources aims to limit encroachment of sensitive development in close proximity to extractive resources, thereby protecting these resources from sterilisation and assisting in the preservation of environmental amenity for the community.

Major projects since 2007 include a 50 per cent upgrade of the capacity of the existing Lime Dosing Water Treatment Plant to treat contaminated open-cut pit water from the former Mount Morgan Mine site; installation of seepage management works at the former Federation Mine at Croydon to minimise acid rock drainage discharges into the local stream, earthworks and installation of covers over mineralised stockpiles at the former Mount Oxide Mine site to minimise acid rock drainage discharges into local streams and the ongoing historic shaft-capping programs at Gympie and Charters Towers. In addition, historic shafts have been investigated and made safe at Herberton, Croydon, Mount Garnet and in the Ipswich area.

### 6.3.1.5 Forestry

Queensland has by far the largest forested area of all Australian states with approximately 52.8 million ha of forest covering almost one-third of the state. The commercial forestry opportunities in state-controlled native forests are dictated by many factors including tenure access rights even on the state leasehold lands, proximity to markets, timber species and yield. The area of native forest on state forests, timber reserves and other state-controlled lands identified for commercial native forest timber production is currently in the order of 3.2 million ha. Approximately one million ha of State leasehold lands are available for native timber harvesting under similar rules to State forests.

The *Forestry Act 1959* provides for forest reservations, the management, silvicultural treatment and protection of State forests, the sale and disposal of forest products and quarry material and the property of the Crown on State forests, timber reserves and on other lands and for other purposes.

The Queensland Government is responsible for managing, native forest timber production and the sale of quarry materials from State forests, timber reserves and other State-controlled lands across Queensland under the *Forestry Act 1959*.

Forestry Plantations Queensland Pty Ltd, a company owned by Hancock Queensland Plantations, manages, harvests and re-establishes plantation timber on approximately 300 000 ha of State forest through a 99-year licence agreement granted by the Queensland Government. The licence was entered into as a result of the sale of State plantation forest timber rights to Hancock Queensland Plantations on 30 June 2010. Forest Plantation Queensland has approximately 300 000 ha of State forest as opposed to Government-owned lands. The Queensland Government continues to act in the role of regulator/contract administrator to ensure the licensee complies with conditions of the plantation licence and a range of deeds of agreement that underpin the sale. One of the Queensland Government's key responsibilities is to ensure continued access by the public and relevant entities to State plantation forest lands under certain occupational permits and also for lawful activities such as recreation, stock grazing and beekeeping.

The Code of Practice for Native Forest Timber Production on State lands was introduced in 2007 to guide timber harvesting over State forests, timber reserves and forest entitlement areas, and wherever State-controlled timber operations are conducted across the leasehold land estate. The Queensland Parks and Wildlife Service audits the timber harvesting activities against the requirements of the Code.

The Queensland Timber Plantation Strategy 2020 (DEEDI, 2010f), released in 2010, outlined a plan for timber plantation development concentrating on five focus areas including establishing a land-use planning framework, legislative and policy reforms, investment initiatives, targeted industry development support and community education.

### 6.3.1.6 Tourism

As reported in the 2008–09 Tourism Satellite Accounts, tourism contributed \$17 billion to the Queensland Gross State Product and employed over 220 000 people (STCRC, 2009; TQ, 2011).

Ecotourism is a growing sector of Queensland's tourism industry and visiting national parks is one of the most popular activities for international and domestic visitors to Queensland. Approximately 16 million visits to Queensland's national parks are made each year. Visitors who include a national park as part of their itinerary spend a total of \$4.4 billion in Queensland, of which \$749 million is spent exclusively in national parks.

The tourism industry in these areas is reliant on the natural resources upon which their business is based and, as such, is acutely aware of managing any pressures associated with visitation.

The Queensland Government tourism portfolio, which comprises the Department of Tourism, Major Events, Small Business and the Commonwealth Games, and Tourism Queensland, a statutory body under the *Tourism Queensland Act 1979* set up to facilitate the promotion, marketing and development of tourism to and within Queensland, also have important and complementary roles in driving ecologically sustainable tourism.

For example, Tourism Queensland aims to ensure tourism operators, tourism industry members, consumers and the wider community are aware of the way in which they can mitigate their impacts on the environment. Two key initiatives in 2011 assisted Queensland's tourism operators to understand their impact on the environment and ways to mitigate these impacts and include:

#### **Tourism Queensland's Environmental Indicators Research**

Being more environmentally sustainable leads to increased profitability through better management of resources, reduced consumption and having environmental credentials. Knowing this, Tourism Queensland developed a suite of environmental indicators to measure and manage the impact of tourism on the environment.

In 2010, research was conducted with Queensland tourism operators to help measure and manage the impact of tourism on the environment. This included determining tourism operator uptake of energy, water and waste management initiatives.

#### **Tourism Queensland's Sustainable Regions Program**

In 2009–10, Tourism Queensland's Sustainable Regions Program pilot series was completed. In the pilot, 68 Queensland tourism businesses committed to and progressed towards sustainability. In 2010–11, stage two of the Sustainable Regions Program was undertaken on the Capricorn Coast, Gold Coast and the Whitsundays. A hybrid Sustainable Regions project was also delivered on the Sunshine Coast incorporating EarthCheck management, which was completed on October 2011. This program also has a component that focuses on consumers, specifically the development and distribution of a region-specific pocket guide to visitors.

The portfolio encourages tourism operators to become eco-accredited. Ecotourism Australia provides support and certification for ecotourism businesses. All businesses with the ECO Certified logo have been assessed and audited under Ecotourism Australia's world-leading certification program.

## **6.4 Understanding and adapting to Queensland's changing and variable climate**

Much of Queensland's natural environment, community and business activities, particularly agriculture, are climate-sensitive. Effective risk management requires good information to assist in making the best decisions in times of uncertainty. In recognition of this need, the Queensland Government invests in science to better understand climate variability, climate change and extreme events through the Queensland Climate Change Centre of Excellence. A range of activities are also being undertaken to enhance resilience to the impacts of a changing and variable climate.

These include improving energy and water efficiency and improvements in disaster management capability and preparedness. The Queensland Government has committed to respond to all the recommendations of the Queensland Floods Commission of Inquiry, which aim to leave Queensland better prepared to deal with future extreme weather events, such as those experienced across the state over the past three years.

## **6.5 Responding to invasive species and diseases**

Biosecurity means mitigating the risks and impacts to the economy, the environment, social amenity or human health associated with pests and diseases. Biosecurity is important to Queensland as pests and diseases can have a long-term impact on the profitability of primary industries, and Queensland's unique biodiversity and way of life. Queensland is a frontline state for biosecurity in Australia, mounting more major responses than any other state.

A National Biosecurity Committee was established in 2008 to provide strategic leadership in managing national approaches to emerging and ongoing biosecurity policy issues across jurisdictions and sectors. It oversees the National Environmental Biosecurity Response Agreement, which provides for cost sharing between jurisdictions to respond to new pest incursions with primarily environmental impacts and lays down the criteria for this funding to be made available.

Biosecurity Queensland, launched in 2007, coordinates efforts to prevent, respond to, and recover from pests and diseases that threaten the economy, society and the environment. The Queensland Biosecurity Strategy 2009–14 (DPIF, 2008a) seeks to prevent exotic pests (animals and plants) and diseases from entering, spreading or becoming established in Queensland; ensure significant pests and diseases already in Queensland are contained, suppressed or managed; and contribute to the maintenance of Australia's favourable national and international reputation for freedom from many pests and diseases, market access for agricultural commodities, product safety and integrity, and diverse ecosystem sustainability.

### Myrtle rust

Myrtle rust (*Puccinia psidii* s.lat.) is a serious fungal disease from South America that was first detected in Australia on the central coast of New South Wales in April 2010. The rust infects species of the Myrtaceae family (for example, paperbarks, eucalypts, lilly pillies) and can cause deformed leaves, heavy defoliation of branches, dieback, stunted growth and even death of the plant. The rust quickly spread along the NSW coast and was detected in South East Queensland in December 2010. It is now established and widespread from Rockhampton to the NSW border and west to Toowoomba and is expected to spread further along the Queensland coast. It has infected over 100 native species of Myrtaceae in Queensland, including listed threatened species (for example, *Gossia gonoclada*, angle-stemmed myrtle, endangered).

Myrtle rust cannot be contained or eradicated as it produces a large number of spores that are easily spread by wind, human activity and animals. An integrated surveillance program is being conducted, providing a diagnostic service, as well as advice and information about the disease and its management. A strategy to obtain more information and knowledge about the disease and to develop longer term management strategies to help minimise the disease's impacts on the economy and the environment is also being implemented. This includes screening of Myrtaceae species for Myrtle rust susceptibility, gene sequencing of the rust, investigating fungicide treatments, understanding the genetic basis for host plant resistance, and investigating the establishment of a resistance screening facility.

### Managing Hendra

Hendra virus is a zoonotic disease, which means it can transfer from animals to humans. Flying foxes are a host reservoir of Hendra virus. Sporadic 'spillover' of Hendra virus from flying foxes to horses occur. However, the factors associated with spillover events are not fully understood and research is ongoing. The virus can spread from flying foxes to horses and, rarely, from horses to humans with devastating consequences.

Biosecurity Queensland is the lead agency in relation to the management of animals during a Hendra virus response and will take actions necessary to limit the spread of the virus and prevent disease transmission to humans. Robust and proven strategies include implementing biosecurity measures, animal movement control, laboratory testing, destruction and sanitary disposal of infected horses and terrestrial animals and environmental decontamination as required. One of the most significant issues arising from the outbreaks is the management of conflict within the community over the location of flying fox roost sites. Attempts to disperse flying fox roosts are often not successful and are only considered as a last option.

## 6.6 Maintaining liveability

The Queensland population is expected to grow by close to one million people during the next 10 years. Two-thirds of that growth is expected within South East Queensland. This increase in population growth leads to a greater demand for space for living, working and recreation, placing pressure on the environment.

### 6.6.1 Urban, peri-urban and regional planning

Well planned and densely populated urban development is considered to have less impact on the environment than suburban sprawl (UNEP, 2002; MA, 2005). Well planned urban development can concentrate any impacts into a smaller area, reduce the need for land conversion, provide opportunities for energy saving and make waste recycling more cost effective (MA, 2005). State and local governments have been adopting planning policies that encourage greater urban consolidation. Urban consolidation is one way of achieving a number of environmental objectives, including reduced competition for land, lower resource use, reduced greenhouse gas and air pollution emissions from transport, reduction in waste generation and improved health outcomes through an increase in active transport (e.g. cycling) (DEWHA, 2006; DIT, 2010).

Growth Management Queensland was established in May 2010 to bring together growth program coordination, planning policy, planning services, building and development, transit orientated development, and infrastructure program management functions. Growth Management Queensland oversees and aims to deliver a more coordinated approach to growth management in Queensland, better linkages between land use planning, infrastructure delivery, economic development, protection of environmental assets, expansion of greenspace and affordable housing and a complementary approach to regional planning and regionalisation.

The *Sustainable Planning Act 2009* seeks to achieve ecological sustainability, with ecological sustainability defined as a balance that integrates the protection of ecological processes and natural systems at the local, regional, state and wider levels, economic development and the maintenance of the cultural, economic, physical and social wellbeing of people and communities. The Act establishes the framework for the management of population growth and its related economic, environmental and social impacts, including matters that affect, or are affected by, human settlements. The Act also establishes the scope and hierarchy of state and local planning instruments that coordinate the different aspects of planning.

Strategic components of QPlan include regional plans and state planning policies (DIT, 2010). Numerous statutory and non-statutory regional plans were developed for Queensland including the South East Queensland Regional Plan 2009–2031, the Far North Queensland Regional Plan 2009–2031, Mackay, Isaac and Whitsunday Regional Plan 2011–2031, the Wide Bay Burnett Regional Plan and the Surat Basin Regional Planning Framework (2011).

A regional plan provides an integrated planning policy for a designated region and is developed by the Queensland Government in partnership with local governments, the community and stakeholders. Regional plans identify desired regional outcomes, policies and actions for achieving these outcomes, the future regional land use pattern, regional infrastructure provision to service the future regional land use pattern and key regional environmental, economic and cultural resources to be preserved, maintained or developed.

Several of the regional plans also address peri-urbanisation. The South East Queensland Regional Plan 2009–2031 acknowledges that there are a diverse range of land uses within peri-urban areas of South East Queensland, and that these areas are not well suited to traditional planning or rural land management approaches. The plan aims to stop land being further allocated for rural residential development, and to restrict further rural residential development to the current rural living area and urban footprint. The Mackay, Isaac and Whitsunday Regional Plan 2011–2031 has similar objectives, ensuring that rural residential development does not compromise good quality agricultural land or areas of ecological significance. The plan also aims for future rural residential development to be buffered from land used for agricultural production, and contained within the existing supply of rural residential land.

Residential infill development is included as an objective of several initiatives. The South East Queensland Regional Plan 2009–2031 includes targets for the minimum number of infill and redevelopment dwelling in each local government administration. The Brisbane City Council Urban Renewal initiative aims to create vibrant living and working environments. Urban renewal projects that include infill development and multiple dwelling developments have occurred or are planned for over 1000 ha in various Brisbane suburbs including Fortitude Valley, New Farm, Teneriffe, Newstead and Bowen Hills. The State Planning Policy 3/11: Coastal Protection

favours infill and redevelopment of existing urban localities and the minimisation of the expansion of the development footprint in the coastal zone. It is expected that infill multiple dwelling activity will increase as policy reform and increased market acceptance takes hold and as availability of broad hectare land declines (DLGP, 2011). There are various state infrastructure projects planned that are supportive of infill development (DLGP, 2011).

The *Urban Land Development Authority Act 2007* provides for particular parts of the state to be declared as urban development areas and establishes the Urban Land Development Authority to plan, carry out, promote, coordinate and control the development of land in these areas. The main purpose of the Act is to facilitate the following in urban development areas such as the availability of land for urban purposes, the provision of a range of housing options to address diverse community needs, the provision of infrastructure for urban purposes, planning principles that give effect to ecological sustainability and best practice urban design; and the provision of an ongoing availability of affordable housing options for low to moderate income households.

The *Queensland Building Act 1975* regulates building development approvals, building work, building classification, building certifiers and pool safety inspectors, and provides for particular matters including swimming pool safety and sustainable buildings. Several changes were made to the Act, including the introduction of sustainability declarations that identify a property's environmental and social sustainability features.

The Queensland Development Code sets out the technical building standards for the state as outlined in the Building Code of Australia. It includes both legislative requirements as set out in Schedule 1 of the *Queensland Building Act 1975*, as well as advisory standards to guide development.

## 6.6.2 Recreational areas

People need the right sorts of places to participate in their preferred outdoor recreation activities. Outdoor recreation activities, services and facilities are supplied and managed by the Queensland Government, local government, private businesses and community groups.

The Queensland Greenspace Strategy 2011–2020 was developed to help secure and provide better public access to greenspace in Queensland. 'Greenspace' broadly describes the 'great outdoors' and includes the open spaces and landscapes we use as a community to connect to nature and enjoy an active, healthy outdoors lifestyle.

Queenslanders recognise that access to greenspace influences the character and liveability of the places where they choose to live, work and play.

Greenspace provides many ecological and social benefits, and can greatly improve the liveability of a region, city or suburb. Greenspace can help regulate air temperatures, filter air, reduce noise, sequester carbon, attenuate stormwater flows and provide essential habitat.

'Community greenspace' is land or water that provides community access for outdoor recreation, sport and leisure. To respond to the key challenge of population growth, the Queensland Greenspace Strategy focuses on coordinating those strategies, plans and programs most likely to secure more greenspace for public recreation to protect lifestyles into the future, and to protect the environment. Mechanisms include the direct acquisition or allocation of land for community greenspace, and working across levels of government and community to provide more recreation opportunities on land with suitable values. The development of regional Greenspace Network Plans will be a key planning tool to identify and secure the preferred future network of community greenspace to meet the needs of a growing state.

Simply securing large areas of land is not the complete answer. Community greenspace needs to be located close to where people live, and able to be used for a range of activities. It also needs to be cost-effective to develop and maintain. Planning for community greenspace needs to capitalise on the opportunities for co-location with other community facilities and enhance the connectivity of bikeways and walking trails. In urban areas where residential densities are increasing, community greenspace needs to integrate with urban sub-tropical design, taking advantage of the Queensland climate to provide seamless connections between the outdoors and the built environment.

The South East Queensland Outdoor Recreation Strategy was approved in 2010. Outdoor recreation activities, services and facilities are supplied and managed by the Queensland Government, local governments, private businesses and community groups. The strategy focuses on coordinating these entities to ensure these places and activities are managed for safety, sustainability and compliance with relevant laws. The strategy covers many types



of outdoor recreation activities, including bushwalking, kayaking, fishing, cycling and waterskiing. The strategy contributes to ecologically sustainable outcomes in that, areas potentially suitable for outdoor recreation use are assessed against the protection of environmental, scenic, cultural and recreational amenity values.

The South East Queensland Regional Recreational Trails Program came into action in 2007 and aims to guide investment in recreation trail planning, development and management. Recreational trails range from urban bicycle paths to canoe trails on rivers or rugged hinterland trails, which when combined can provide for activities including walking, horse riding, cycling and canoeing/kayaking.

Use of recreation trails by residents and visitors has quantifiable benefits in physical and psychological health, social and environmental terms. The program contributes to ecologically sustainable development by requiring that the suitability of a potential trail is assessed, among other principles, against the protection of environmental, scenic, cultural and recreational amenity values during trail development and use.

Some of the recreation trails currently being developed include the Brisbane Valley Rail Trail and the Boonah to Ipswich Trail. These trails will deliver recreation, social and health benefits to users, and enable users to experience and appreciate a major part of South East Queensland's landscape.



**Photo 9. Urban greenspace, such as this park in Bundaberg, provide a range of benefits to the community and contribute to the liveability of an area.**

### 6.6.3 2 Million Trees – our urban forest

Trees are important to the environment, especially in expanding urban environments. Trees provide many benefits, including the removal of CO<sub>2</sub> from the atmosphere, reduction of stormwater run off and moisture evaporation, the provision of shade, cooling of the air and surface temperatures and the provision of habitat for wildlife.

Brisbane City Council's 2 Million Trees program is part of Council's vision for a greener, healthier and more liveable city, and contributes to its 2026 target of ensuring 40 per cent native tree cover across the city. The project's objective is to restore native habitat upon a range of land types including degraded farmland, disused landfill sites, and parkland. The project also focuses on restoration of bushland and areas purchased under Council's Bushland Acquisition Program that provides land for habitat and linkages to enable wildlife movement.

Brisbane City Council committed to planting two million trees across the city by March 2012 through actions such as large scale bushland restoration, revegetating landfill sites and degraded farmland, street and park tree plantings, and greening infrastructure sites.



Source: Brisbane City Council.

**Photo 10.** An example of one of the sites undergoing revegetation as part of the 2 Million Trees project, Queensland Corrective Service land at Wacol.

#### 6.6.4 Industrial development and practices

Industrial activities are essential for the provision of goods and services that support transport, infrastructure and development, as well as the day-to-day materials for homes and workplaces. Equally, industrial activities can cause impacts from air, noise and odour emissions, as well as issues associated with the production and disposal of hazardous materials. Industrial activities can also impact on sensitive land uses nearby. Appropriate planning is necessary to maintain a balance between the health and wellbeing of communities and individuals, and industrial development.

The potential impacts of most industrial land uses, including the impacts from air, noise and odours are currently managed on a site-specific basis through approval processes under the *Sustainable Planning Act 2009*. This approval process includes assessment against the Environmental Protection (Air) Policy 2008 and the Environmental Protection (Noise) Policy 2008 under the *Environmental Protection Act 1994*. In addition, facilities that store hazardous materials are managed under the *Dangerous Goods Safety Management Act 2001*.

The State Planning Policy 5/10: Air, Noise and Hazardous Materials is a statutory instrument under the *Sustainable Planning Act 2009*. It seeks to ensure that local planning instruments, structure plans and master plans protect the health, well being, amenity and safety of communities and individuals from the impacts of air, noise and odour emissions, as well as from the impacts of hazardous materials. Additionally, it requires local planning instruments, structure plans and master plans to strategically plan and manage the interface between land zoned for industry and land zoned for sensitive uses to support and protect industrial uses in appropriate places.

This is achieved by acquiring planning instruments to allocate appropriate locations for industrial land uses and sensitive land uses, prevent them from encroaching on each other, and to stipulate appropriate processes for assessing the impact of industrial emissions on sensitive land uses when development applications are assessed.

### 6.6.5 Cleantech industry

The ‘cleantech’ industry comprises a range of businesses that use technologies, products, services and processes that measure, avoid, reduce or remediate negative environmental impacts. Its component sectors include sustainable water, clean energy, environmental services, green building, resource (waste) recovery and recycling, and sustainable transport.

Queensland’s cleantech industry has established strengths in water and wastewater management, environmental services and green building, and emerging strengths in clean energy, resource recovery and recycling, sustainable transport and bio-based industrial products. These businesses are strengthening the state’s economy by helping to transform the ecological sustainability of traditional industries like mining, energy generation and agriculture and developing new green businesses with a strong focus on innovation

The Queensland Cleantech Industry Development Strategy 2010–2015 (DEEDI, 2011f) outlines opportunities to attract further investment in clean energy, water, resource recovery and recycling, environmental services, green building and sustainable transport.

## 6.7 Moving people and freight

### 6.7.1 Everyday travel

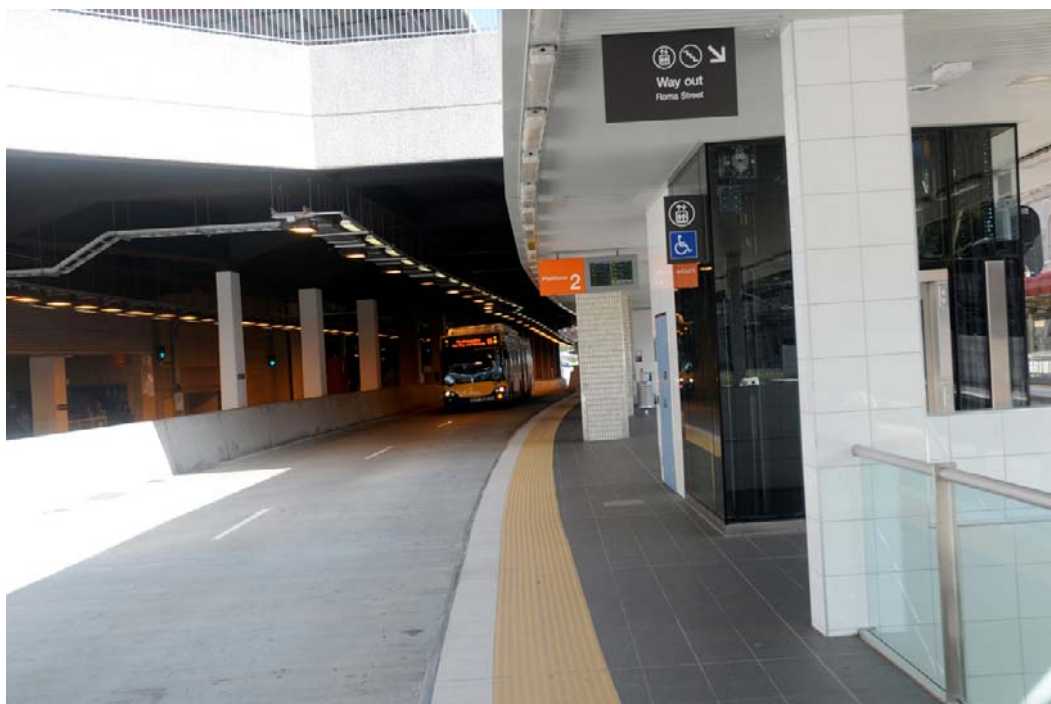
TravelSmart is a behaviour change program that encourages people to use more sustainable and active travel modes, such as public transport, walking, cycling and carpooling, rather than single occupancy travel in a car. It does so by raising awareness through campaigns and improving access to information regarding travel alternatives. TravelSmart is the signature brand used by a number of State Governments. In Queensland, TravelSmart is managed by the Department of Transport and Main Roads. TravelSmart aims to decrease traffic congestion on roads; reduce greenhouse gas and air pollution emissions; and help people change the way they travel by saving time and money, improving their health and the environment. The TravelSmart program is made up of three targeted projects: TravelSmart Communities, TravelSmart Schools and TravelSmart Workplaces and Events.

#### TravelSmart Schools

More children are being driven to school, with the percentage of primary school children being driven increasing from 55 per cent in 1992 to 72 per cent in 2007 (DTMR, 2010a). TravelSmart Schools aims to reduce the number of children driven to school in private vehicles. Participating schools receive a range of tools and support from the Department of Transport and Main Roads including site assessments, journey planning and the development of school activities. In 2011, one third of parents and students who participated in the TravelSmart Schools project said that they changed the way their child travels to and from school as a result of the project (DTMR, 2010b).

The original South East Queensland Integrated Regional Transport Plan was released by the State Government in 1997 as a 25 year plan to develop and manage the transport system. It established the framework for the delivery of some of the region’s most significant transport projects, such as the busways network which is continuing to expand. The busways have been highly successful with the South East Busway carrying more than 150 000 passengers per day. Connecting South East Queensland 2031: An Integrated Regional Transport Plan for South East Queensland proposes a transport system to service the population, economic growth and the pattern of development that is covered in the South East Queensland Regional Plan 2009–2031.





**Photo 11. Public transport in South East Queensland has been improved by the construction of the busways network.**

**TransLink Network Plan:** TransLink was established in July 2004 to deliver an integrated public transport system across South East Queensland. TransLink became a statutory authority in July 2008, with the objective of further improving and expanding public transport services. The TransLink Network Plan sets out a long-term strategy and a detailed one-year program of service and infrastructure improvements (TransLink Transit Authority, 2010). Key initiatives to be delivered in the 2011–12 financial year includes new train services, a new rail station, new low-floor, air conditioned, environmentally friendly buses, new and upgraded park ‘n’ ride facilities, high frequency bus routes, increased frequency and coverage of bus services, expanding the number of prepaid bus services operating within the network, and increased retail network for go-card purchases and top-up facilities (TransLink Transit Authority, 2011).

**Integrated ticketing:** TransLink introduced an integrated ticket for the first time in 2004, enabling passengers to travel on bus, train and ferry services using a single ticket. In 2008, TransLink introduced a reusable electronic smartcard. TransLink’s go card is now the primary ticket product for the TransLink network with over 83 percent of all trips on bus, train and ferry services now being made using a go card. The go card ticketing system has meant faster boarding times and better on-time performance. It also allows data to be easily collected on public transport patronage and used to plan future improvements.

Transit oriented development is a planning concept and a key policy of the South East Queensland Regional Plan 2009–2031 and the Far North Queensland Regional Plan 2009–2031. Transit orientated development promotes high-quality, medium to high density mixed-use development within a comfortable 10-minute walk of established or planned rail and busway stations (a radius of about 800 m). These communities incorporate a mix of residential, commercial and retail uses, including affordable housing, shops, offices and other facilities. Transit orientated development has the potential to increase physical activity levels by giving preference to pedestrians over vehicles. The main characteristics of a transit oriented development precinct are a rapid and frequent transit service, high accessibility to the transit station, a mix of residential, retail, commercial and community use, high-quality public spaces and streets which are pedestrian- and cyclist-friendly, medium to high density development within 800 m of the transit station and reduced rates of private car parking.

The South East Queensland Regional Plan 2009–2031 policy on compact settlement describes six types of transit oriented development precincts (for example, city centre, suburban, activity centre) categorised in terms of the role they play in the regional network. Development in each precinct will be influenced by local conditions.

## 6.7.2 Freight movement

As the standard of living improves in Queensland, more goods and a greater variety of food are being consumed, increasing the demand for freight in South East Queensland.

The Integrated Freight Strategy for Queensland, released in December 2011 aims to guide actions to sustainably manage current and future freight demands across all transport modes to support industry, consumers and broader economic, social and environmental outcomes. The key objective of the strategy is to ‘move freight efficiently’ by the most effective and sustainable means.

The South East Queensland Regional Freight Network Strategy 2007–2012 (DTMR, 2007) aims to facilitate freight moving efficiently across the transport network in a manner that enhances economic development, safety, quality of life and environmental sustainability. The strategy describes the existing freight demands and freight network, examines the region’s future demands and challenges and provides direction for future policy, planning, infrastructure design, operations and institutional arrangements to encourage the effective and efficient end-to-end delivery of freight.

## 6.8 Reducing and managing waste and pollution

### 6.8.1 Waste management

Waste management in Queensland faces many challenges, including a growing population, increasing scarcity of suitable landfill sites, a carbon-constrained environment and long transport distances. The Environmental Protection (Waste Management) Regulation 2000 outlines how particular types of waste are to be managed in Queensland and the process for approving a resource for beneficial use. It includes the devolution of some administrative matters to local government. The policy identifies environmental values and the management hierarchy for waste and contains the detail about matters to be considered for assessment and approvals concerning waste. The EP Act contains various compliance and enforcement tools to ensure that the requirements of the EP Act are complied with. Waste management policies in Queensland are under review.

#### 6.8.1.1 Municipal and industrial wastes

There are a range of initiatives that aim to reduce resource usage, increase reuse, use resources more efficiently, increase recycling and encourage more appropriate disposal of wastes.

The Waste Reduction and Recycling Strategy 2010–2020 (DERM, 2010e) aims to minimise waste generation, optimise resource recovery and recycling, and develop sustainable waste industries and jobs.

#### 6.8.1.2 E-waste

The volume of E-waste produced is increasing due to rapid technological change, shorter life-spans of products and increasing ownership of electronic products. Nationally, the volume of televisions and computers reaching their end-of-life is expected to grow to 181 000 tonnes (44 million units) by 2027–28 (DSEWPC, 2011b). There is a growing need for increased collection and recycling of computers, televisions and mobile phones. The National Television and Computer Product Stewardship Scheme consultation paper, released in March 2011, outlines options for a national collection and recycling scheme for television, computer and computer peripherals. The primary goal of the scheme is to lift collection rates to 80 per cent of end-of-life televisions, computers and computer peripherals for the purposes of recycling by 2021.

### 6.8.2 Land contamination

Managing potentially contaminating activities and known contaminated sites in Queensland helps prevent environmental and health risks. Land can become degraded through the accumulation of hazardous substances (contaminated land) or when acid-sulfate soils are disturbed.



Contaminated land refers to land contaminated by hazardous substances (such as arsenic, DDT, or oil), which may pose a risk to human health or the environment. Land contamination can occur as a result of poor environmental management and waste disposal practices, or accidental spills in industrial or commercial activities. In the past, land has been contaminated by activities not known to be dangerous at the time, often involving chemicals which have since been banned or are now subject to much stricter controls. Activities identified as being likely to cause land contamination are listed as 'notifiable activities' in Schedule 3 of the EP Act. Common land uses that can cause contamination include service stations, cattle dips, tanneries, wood treatment sites, fuel storage, and refuse tips.

Under the EP Act, the Queensland Government provides guidance to local government, industry, and the community on legislative and technical requirements for contaminated land matters, reviews contaminated site investigations and approves site management plans. Additionally, two public access registers containing land-use planning information are also maintained: the Environmental Management Register and the Contaminated Land Register

Under the EP Act, polluters of a site are primarily responsible for any contaminated soils that are generated on a property as a result of their activities. The Queensland Government actively supports the national target of a 50 per cent reduction in waste going to landfill and promotes on-site remediation as the preferred option for dealing with contaminated soils where appropriate. In the hierarchy of remediation options, disposal to landfill should be used only when no other method of dealing with the contaminated soil is available and the operator of the landfill agrees to the disposal. Where contaminated soils require removal and disposal to an off-site location a permit is required.

Acid sulfate soils cover approximately 2.3 million ha of land in Queensland and occur naturally along the coast. When disturbed, these soils affect urban, transport, tourism, agricultural and industrial land uses. A range of initiatives are in place to prevent environmental harm, including the:

State Planning Policy 2/02: Planning and Managing Development Involving Acid Sulfate Soils sets out the state's interests concerning development involving acid sulfate soils in low-lying coastal areas. The potential effects of disturbing acid sulfate soils need to be addressed when planning for, or undertaking, development. A suite of non-statutory best practice guidelines for acid sulfate soils in Queensland has also been produced.

### 6.8.3 Chemicals

Chemicals including some metals, organochlorine and organophosphorous pesticides, herbicides, dioxin-like chemicals, phytoestrogens, phthalates, cadmium, lead, mercury, polycyclic aromatic hydrocarbons, polychlorinated biphenyls and endocrine disrupting chemicals, have the potential to significantly impact on the environment (EPA, 2008). Persistence and toxicity of chemicals in the environment is a major concern. Reducing environmental release of chemicals through source reduction and other practices to reduce the creation of pollution is being addressed through the following:

- The Strategic Approach to International Chemicals Management promotes global actions that aim to make chemicals safer for humans and the planet (EPHC, 2006). This initiative recognises that persistent and toxic chemicals will continue to be widespread in the environment in the near future, with potentially serious impacts on the environment and human health, an issue highlighted in the OECD Environment Outlook to 2020 report (EPHC, 2006).
- International conventions: Australia is party to two major environmental chemicals related conventions, namely the Stockholm Convention on Persistent Organic Pollutants (POPs) and the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC). The Stockholm Convention on POPs commits governments to reducing, or where feasible, eliminating the production and environmental release of specific persistent organic pollutants (for example, Aldrin, Chlordane, DDT, Heptachlor, Mirex, Toxaphene, Polychlorinated Biphenyls, Dioxins and Furans).
- The National Plan of Implementation has been developed in Australia in response to the Stockholm Convention, and the measures outlined in this plan will significantly reduce the potential for any environmental harm posed by the Stockholm Convention listed chemicals. The Stockholm Convention also provides for the addition of new POPs through an open, transparent, science-based process. A POPs Review Committee of experts recommended inclusion of nine additional chemicals in the Convention and Australia is currently progressing the ratification process for these nine chemicals.

- The Standing Council on Environment and Water (SCEW) oversees environmental management of chemicals throughout their life-cycle; where chemicals are generally assessed and registered or listed under separate schemes according to their end use (i.e. industrial, agricultural/veterinary, therapeutic (pharmaceuticals and medicines) and food related).
- Through the National Chemicals Environmental Management (NChEM) framework, the SCEW is focusing on improving environmental and health outcomes for industrial chemicals as a priority. The focus is the implementation of three recommendations (environmental labelling, standard-setting and performance measurement) from a study conducted by the Productivity Commission and endorsed by COAG. It is expected that implementation of the COAG endorsed projects will ensure that adverse environmental implications from industrial chemical use are kept at an acceptable low level.

The petroleum and gas (particularly coal seam gas) industry undertakes fracking as a part of their petroleum activities. Fracking is the process of creating cracks in underground coal seams to increase the flow and recovery of gas out of a well. Fracking involves the use of mostly water and sand and small amounts of chemicals.

The use of BTEX (Benzene, Toluene, Ethyl-benzene and Xylene) in the additives within fracking fluids is regulated. The standards have been set in the Environmental Protection Regulation 2008 and are the standards from the Australian Drinking Water Guidelines (for Benzene) and the Australia and New Zealand Environment Conservation Council (ANZECC) Guidelines for Fresh and Marine Water Quality (for Toluene, Ethyl-benzene and Xylene). These apply to all petroleum and gas operators as a condition of their environmental authority.

In addition, all new applicants must undertake a hydraulic risk assessment that includes an assessment of the geological formation, the chemicals to be used, the toxicity of the chemicals and any potential environmental impacts as a result of these chemicals. There are also strict regulatory requirements in place for the storage of the fracking fluid, including any flowback, to ensure that contamination of land or waters does not occur.

## 6.8.4 Noise, air and water pollution

### 6.8.4.1 Noise pollution

The noise levels in most towns and cities in Queensland are likely to stay the same or increase with time without strategies that aim to reduce noise levels or preserve quiet spaces. Urban renewal projects, residential infill development and continued reliance on motor vehicles and machinery will all contribute to the noise levels people experience on a daily basis.

Noise pollution and complaints are currently covered by several pieces of legislation in Queensland including: Environmental Protection (Noise) Policy 2008 made under the *Environmental Protection Act 1994*, Noise Code of Practice 2004—Workplace Health and Safety Queensland, the former Department of Justice and Attorney-General, State Planning Policy 1/02: Development in the Vicinity of Certain Airports and Aviation Facilities and Road Traffic Noise Management Code of Conduct. The State Planning Policy 5/10: Air, Noise and Hazardous Materials also addresses noise pollution related to industrial practices.

### 6.8.4.2 Air pollution

The major contributors to air pollution are transport, industry and bushfires. There is an integrated suite of strategies for dealing with transport to reduce motor vehicle emissions and demand for transport, as well as incentive programs to encourage the adoption of alternative transport options (for example, cycling, walking and using public transport). These are discussed under 'Climate change' and 'Moving people and freight'. The initiatives that monitor and manage air emissions are discussed below.

The Environmental Protection (Air) Policy 2008 identifies environmental values, quality objectives, indicators and the management hierarchy for the air environment. It operates under a framework for making consistent and fair decisions about managing the air environment by identifying environmental values to be enhanced or protected and specifying air quality indicators and goals to protect those values.

The State Planning Policy 5/10: Air, Noise and Hazardous Materials helps protect the health, wellbeing, amenity and safety of communities and individuals from the impacts of air and odour emissions by effectively managing the placement of industry in appropriate locations.

Hazard reduction and agricultural burning is the subject of continued efforts to coordinate burning with suitable meteorological conditions. The Bureau of Meteorology dispersion models and current air quality from the Queensland Government's web-based system is used to confine burning to periods when conditions are appropriate for dispersion of the pollutants. In Queensland, the Permit to Light Fire system has been established to aid landholders, communities and industry to use fire as a land management tool. This is legislated under the *Fire and Rescue Service Act 1990*. The Queensland Fire and Rescue Service, through its network of volunteer Fire Wardens, are responsible for the issuing of permits.

Clean and Healthy Air for Gladstone was a collaborative project undertaken by the Queensland Government with input from community and industry in Gladstone (DERM, 2011q). It was initiated in response to community concerns about the cumulative impact of possible health effects of coal dust emissions, mineral processing and chemical manufacturing industries. The summary assessment of air quality, based on the results of the air monitoring program supplemented by modelling, was that the ambient air quality in the Gladstone area meets current health based standards and guidelines. The findings are consistent with expectations for an urban Australian airshed with an industrial base. Notwithstanding that, this study has found no obvious health risks identifiable in the ambient air assessment; the nature of the existing concentration of heavy industry in the Gladstone region presents the need for active management. A key recommendation of the final report was that current development approvals be amended to bring about an integrated approach to regulating air emissions and emission monitoring across the Gladstone area. Model development approval conditions with regard to air quality will now be developed and a thorough review of existing development approvals will be undertaken.

### Review of the Air National Environment Protection Measure

To meet legislative requirements, a review of the Air National Environment Protection Measure (NEPM) has been conducted with the final review report being published in 2011. Prioritisation of, and response to, the final report's 23 recommendations will be progressed through the development of a National Plan for Clean Air through the COAG Standing Council on Environment and Water. It has been proposed that the National Plan for Clean Air will bring together into the one strategy both the response to the review of the Air NEPM (incorporating an exposure reduction framework), a set of cost effective emission reduction actions, and implementation arrangements.

## 6.8.4.3 Water pollution

### 6.8.4.3.1 Managing domestic and industrial wastewater

In Queensland, most wastewater is treated at sewage treatment plants. Some water may undergo further treatment to produce water suitable for re-use, including for industry and human consumption. Wastewater is transported to sewage treatment plants from domestic or industrial sites through a system of sewers and pump stations, known as sewerage reticulation, to a sewage treatment plant. Local governments, as their corporate entities, build, maintain and operate most sewage treatment plants.

Wastewater treatment plants are mainly concentrated in coastal areas of Queensland and release treated wastewater to estuaries, bays and open coasts. Approximately two-thirds of major wastewater treatment plant discharges in coastal Queensland are in South East Queensland. Levels of treatment include primary (removal of suspended and organic matter), secondary (removal of biodegradable organics, suspended solids and nutrients) and tertiary (removal of residual suspended solids, nutrients and pathogens). In Queensland, most treatment plants use secondary or tertiary treatment with some type of disinfection.

In unsewered areas, local governments may require householders to install individual or household sewage treatment systems to treat domestic wastewater from toilets, kitchens, bathrooms and laundries. Most stormwater receives no treatment. In some new subdivisions, treatment of some stormwater to remove litter, sand and gravel has begun using gross pollutant traps.

## Coal seam gas water management

Queensland is seeing the development of a liquefied natural gas industry supplied by the production of coal seam gas. Exploratory work for coal seam gas is being undertaken on agricultural lands across southern and central Queensland, with water an essential part of its production. A regulatory framework, including amendments to legislation and requirements to support decisions made under legislation, have been introduced. This has included amendments to the *Environmental Protection Act 1994*, *Water Act 2000* and *Water Supply (Safety and Reliability) Act 2008*.

### 6.8.4.3.2 Managing run-off

The Reef Water Quality Protection Plan 2009 (Reef Plan) is designed to improve the quality of water entering the Great Barrier Reef through sustainable land management in reef catchments.

The South East Queensland Healthy Waterways Strategy 2007–2012 aims to maintain and improve the health of the waterways and catchments of South East Queensland. These action plans consist of high level targets to reduce the loads from point sources and rural pollution into Moreton Bay.

A key means of monitoring and evaluating the success of management actions undertaken to implement the strategy is the South East Queensland Event Monitoring program and similar local-scale programs run by regional councils. These programs monitor nutrient and suspended sediment loads during ambient (low-flow) and event (high-flow) conditions to estimate annual loads. This, combined with catchment source modelling, provides a powerful natural resource management tool. In the future, the scope of the program is likely to be expanded from examining only rural diffuse contaminant sources to include all major sources of contaminants.

The success of the South East Queensland Healthy Waterways Strategy 2007–2012 is evaluated through the production of an annual report card based on freshwater, marine and estuarine data gathered through the Ecosystem Health Monitoring Program. In addition to measuring performance, the findings are also used to advise councils and land managers about areas of declining health, and to report on the effect of different land uses and management actions.

The strategy has achieved a number of successful achievements that include local and state government investment in upgrading 25 wastewater treatment plants, reducing the nitrogen loads to waterways by approximately 40 per cent; the completion of urban stormwater or catchment management plans for all major catchments in South East Queensland and significant additional investment for repairing riparian zones in South East Queensland catchments.

Other relevant planning and policy documents include the State Planning Policy 4/10: Healthy Waters, Healthy Country Program and the South East Queensland Natural Resource Management Plan 2009–2031. Each of these contains elements that will contribute to reducing contaminants in run-off water.

## 6.9 Delivering water security

In addition to natural storage, the potential water storage capacity provided by dams and weirs across the state is extensive and estimated to total 9149 462 ML. The millennium drought, coupled with the recent flood events, has highlighted regional challenges in water resource management. This section deals primarily with the initiatives related to water security for human settlements.

### 6.9.1 Water supply regulation

The *Water Supply (Safety and Reliability) Act 2008* provides a regulatory framework for supplying water and sewerage services in the state. Drinking water quality in Queensland is regulated by the *Water Supply (Safety and Reliability) Act 2008*, the *Public Health Act 2005* and their accompanying regulations and guidelines. These Acts provide a framework for managing and ensuring the quality and safety of drinking water supplies.

Queensland supports the implementation of the National Urban Water Management Principles, which state that the service level for each water supply system should specify the minimum service in terms of water quantity, water quality and service provision (such as reliability and safety).

The *Water Supply (Safety and Reliability) Act 2008* and the *Public Health Act 2005* also establish a regulatory framework to ensure that recycled water (including coal seam gas) schemes produce water of a quality that is suitable for its intended use.

The *Water Supply (Safety and Reliability) Act 2008* was amended in December 2010 to introduce a regulatory framework for managing coal seam gas water discharges (to aquifer and/or surface waters) to ensure public health is protected.

## 6.9.2 Water resource planning and water security

The National Water Initiative (NWI, 2011) is an inter-governmental agreement between the Australian Government and all states and territories. The overall objective of the National Water Initiative is to achieve a nationally compatible system of managing surface and groundwater resources for rural and urban use—a system that optimises economic, social and environmental outcomes and is based on markets, regulations and planning. In Queensland, the *Water Act 2000* establishes a statutory planning framework for the sustainable allocation and management of the state's water resources.

### 6.9.2.1 Regional water resource planning

Regional water supply strategies are prepared in priority regions outside of South East Queensland and facilitate the achievement of appropriate short and long-term water supply security taking account of likely population and economic growth and predicted climate change scenarios. These strategies are developed in partnership with local governments, water service providers, industries and community groups.

The need to consider water supply solutions on a regional basis and over the long-term has evolved as areas of the state became more intensively developed and options to augment water supply in these areas become less available. In recognition of the importance of meeting the community's future water supply needs and possible impacts of climate change, regional water supply strategies covering much of the state are being prepared. In each case, preparation of the Regional Water Supply Strategy is based on key principles including the need to conserve water supplies, to be prepared for the future and to manage supplies efficiently. Where demand projections indicate current or likely shortfalls in supply, options are presented to address the shortfalls. Regional Water Supply Strategies have been developed or are under development, for the Far North Queensland, North West Queensland, North Queensland, Central Queensland, Wide Bay–Burnett, and Mackay–Whitsunday regions (Figure 88).

### 6.9.2.2 Long-term water security planning

There is strong evidence to suggest that Queensland may experience future droughts worse than the millennium drought. We need to ensure that there is an appropriate level of water supply security to cope with future droughts that may be worse than those we have experienced to date and increasing demand from a growing population. An ability to cope with drought is critical to maintaining regional lifestyles and prosperity and to progressing sustainable economic development opportunities.





Figure 88. Regional water supply strategy areas in Queensland.

### 6.9.3 Water management in South East Queensland

The Queensland Water Commission was established in 2006 as an independent, statutory authority responsible for achieving safe, secure and sustainable water supplies in South East Queensland and other designated regions.

The commission aims to deliver sustainable water supplies by developing long-term water supply strategies, managing water demand and providing advice to the Queensland Government on regional water security and institutional arrangements for the water industry. The commission also has responsibilities for assessing the cumulative impacts on groundwater levels from coal seam gas water extraction by petroleum tenure holders in declared Cumulative Management Areas.

The commission operates under a legislative framework defined in the *Water Act 2000* and works with a number of stakeholders including government departments, agencies and water service providers.

#### 6.9.3.1 South East Queensland Water Strategy

The Queensland Water Commission released the South East Queensland Water Strategy in 2010 to ensure that water is managed on a sustainable and integrated basis, and provide secure and reliable supplies of acceptable quality for all users for the long-term. The millennium drought changed the way the South East Queensland community thinks about and uses water and the strategy reflects this changed attitude. The strategy was developed considering climate change, climate variability, population growth and uses hydrologic models to assess water supply and demand balances over time.

The strategy challenges South East Queensland residents to do even better than the planning assumption of an average residential consumption of 230 L per person per day, maintaining average residential consumption at or below 200 L per person per day (target 200). The strategy's aim is to achieve this target without significantly changing the lifestyle that South East Queensland residents enjoy, including the ability to sustain healthy, water-wise gardens.

The South East Queensland Water Strategy's vision is to meet level of service objectives, which relate to the expected frequency, duration and severity of restrictions during future droughts. This means future investments in the water supply system will be made so that sufficient water from the South East Queensland Water Grid will be available to meet average regional urban demand of up to 375 L per person per day, including an allowance of up to 230 L per person per day for residential uses and to ensure that frequency of restrictions, which would be much less than in the recent drought, will be no more than once every 25 years on average. The commission reviews the strategy annually, providing an update on the sufficiency of water available to meet needs, and reports on actions and preparedness to respond to emerging circumstances, whether driven by demand, drought or other issues. Major reviews of the strategy are aligned with reviews of the South East Queensland Regional Plan 2009–2031 (QWC, 2010).

#### 6.9.3.2 South East Queensland Water Grid

A water grid has been built to service the water supply needs of the South East Queensland region. The South East Queensland Water Grid connects water supplies, storages and treatment plants across South East Queensland.

The water grid allows risk to be managed on a regional level, rather than on an individual storage or system basis, delivering material benefits for security, quality and reliability. Prior to the creation of the water grid, South East Queensland was supplied from eight largely discrete water supply zones, with differing levels of security and reliability and, until 2008, different owners and operators. Due to the lack of connection, restrictions were applied in some parts of the region, while dams in other parts were full or overflowing. Bulk water interconnections are a key feature of the water grid. The interconnections bring together most of the 50 water treatment plants and more than 50 sources, including two major climate resilient water sources, the Western Corridor Recycled Water Scheme and the South East Queensland (Gold Coast) Desalination Plant (QWC, 2011).

#### 6.9.3.3 Western Corridor Recycled Water Scheme

The Western Corridor Recycled Water Scheme, located in South East Queensland, has the capacity to supply up to 84 680 ML per year of recycled water to industry and power stations and for replenishing Wivenhoe Dam. With the provision of additional infrastructure and appropriate commercial arrangements, water could also be made available for supply to irrigators in the Lockyer Valley and below Wivenhoe Dam when not required for urban purposes. The

scheme comprises three advanced water treatment plants at Luggage Point, Gibson Island and Bundamba that treat wastewater from six wastewater treatment plants. Since coming online in August 2007, through to April 2012, the Western Corridor Recycled Water Scheme supplied more than 46.7 billion L of water into the South East Queensland Water Grid.

#### 6.9.3.4 South East Queensland (Gold Coast) Desalination Plant

The Gold Coast Desalination Plant started producing water in November 2008. The plant, which is located at Tugun, can provide up to 133 ML of water a day of new drinking water to residents and businesses in South East Queensland. The desalinated water mixes with treated water from Hinze Dam at reservoirs and water treatment plant tanks before it is supplied to the South East Queensland Water Grid. The desalination plant played a crucial role in supplying water during the January 2011 floods in South East Queensland. It was activated to ensure an adequate water supply to residents while the Mt Crosby Water Treatment Plant was non-operational.

#### 6.9.3.5 Brisbane's WaterSmart Strategy

The WaterSmart Strategy is an initiative of the Brisbane City Council that sets the direction for managing water sustainably and supporting the liveability of Brisbane. It aims to achieve a water smart community, a well-designed, subtropical city, a healthy river and bay and sustainable water use. To date 61.6 km of waterway corridors have been rehabilitated and maintained, in partnership with catchment groups, \$30.9 million (2009–10) was invested in the maintenance and rehabilitation of flood mitigation channels and stormwater drainage infrastructure, 92 000 free online flood flag maps have been provided through the council's website, overland flow paths have been mapped and this information made available to industry and the public and additional specialist erosion and sediment control staff have been employed in Council's Development Assessment Branch.

## 6.10 Understanding and protecting cultural heritage

There are a number of initiatives underway in Queensland that are enhancing understanding of cultural heritage and helping to protect cultural heritage. A key response to date has been the increased effort to identify heritage places for protection, care and maintenance. Work continues as more sites are recognised as significant to Queensland's heritage, particularly in respect to Aboriginal and Torres Strait Islander cultural heritage.

The National Trust of Queensland is a community organisation that works to identify and conserve Queensland's heritage. It operates within the national framework of the Australian Council of National Trusts under the provisions of the *National Trust of Queensland Act 1963*. It has a large membership across the state and owns and interprets heritage properties that it opens to the public. Much of the care of heritage places and artefacts is undertaken by private owners, community groups, historical societies and museum networks.

### 6.10.1 Historic cultural heritage

#### 6.10.1.1 Protection

The *Queensland Heritage Act 1992* aims to provide for the conservation of Queensland's cultural heritage for the benefit of the community and future generations. The Act does not apply to heritage places solely through association with Aboriginal tradition or Island custom, as these places are protected under specific separate legislation.

The Act has been written to reflect the spirit of The Burra Charter (ICOMOS, 2000), and establishes the Queensland Heritage Council and the Queensland Heritage register.

The Burra Charter and its accompanying guidelines were prepared by the Australia International Council on Monuments and Sites, a non-government professional organisation closely linked to UNESCO. The Charter establishes best practice principles and guides heritage conservation in Queensland.

A review of the *Queensland Heritage Act 1992* resulted in substantial amendments that came into force in March 2008. The amendments include several provisions relating to the identification and protection of historical archaeological places in Queensland, including the inclusion of a new archaeological place category in the Queensland Heritage Register. The protection of historic shipwrecks in Queensland waters has also aligned with the Commonwealth shipwrecks' provisions.

### 6.10.1.2 Queensland Heritage Council

The Queensland Heritage Council works to identify and protect places that have special cultural value to the community and future generations. The Queensland Heritage Council acts independently and in the public interest, and is the key decision-maker on places of cultural heritage significance to Queensland. It decides what places are entered into and removed from the Queensland Heritage Register (QHC, 2009).

### 6.10.1.3 The Queensland Heritage Strategy

The Queensland Heritage Strategy: a ten-year plan came into effect in 2009 and explains the importance of Queensland's heritage, outlines how heritage is managed and identifies issues of concern (DERM, 2009e). The strategy has been built around five key directions which includes improving the way Queensland understands and values its heritage, embedding heritage in mainstream policy and planning, strengthening Queensland's investment in managing and conserving its heritage, leading and partnering with government, community and industry to conserve Queensland's heritage, and building the capacity of government, community and industry to conserve Queensland's heritage.

### 6.10.1.4 Shipwrecks

Queensland's maritime and underwater heritage is protected and managed under the provisions of the *Queensland Heritage Act 1992* and the Commonwealth *Historic Shipwrecks Act 1976*. The two Acts provide protection for all shipwrecks and associated artefacts older than 75 years and apply to all wrecks located along Queensland's coast and in bays, lakes and inland waterways. All other forms of maritime and underwater heritage, such as aircraft, jetties and lighthouses, are protected by the Queensland Heritage Act either by entry in the Queensland Heritage Register or under the discovery provisions.

## 6.10.2 Aboriginal and Torres Strait Islander cultural heritage

Native title describes the rights and interests of Aboriginal people and Torres Strait Islander people under their traditional laws and customs. The *Native Title (Queensland) Act 1993* recognises and protects native title. It is administered by the state government, who also has a primary responsibility for implementing the Commonwealth *Native Title Act 1993* in Queensland. The Commonwealth Native Title Act provides for Indigenous land use agreements between native title holders or claimants and other interested parties about how land and waters in the area covered by the agreement will be used and managed in the future. Native title is important both in the context of community and cultural heritage, as well as for the protection of the local environment. As at 31 December 2011, there were 101 active native title claimant applications. In 2011, 10 native title claims were resolved through consent determination, which brings the total number of claims resolved in Queensland to 63.

The *Aboriginal Land Act 1991* and *Torres Strait Islander Land Act 1991* have been reviewed and the resultant *Aboriginal Land and Torres Strait Islander Land and Other Legislation Amendment Act 2010* was proclaimed on 9 September 2010. The review was prompted by the many significant changes that have occurred since the introduction of the original Acts 19 years ago.

The amended legislation seeks to improve the workability of the legislation. Its broad objectives are to provide more options when it comes to transferring land, to reduce the need to create new entities to hold land and to improve the governance arrangements for existing land trusts. It also seeks to enable the recognition of the rights of the Aboriginal traditional owners of land subject to Torres Strait Islander deeds of grant in trust at Seisia, Bamaga and Hammond Island. Each community has different needs and faces different challenges. This necessitates a range of options to transfer land as no single solution will suit all communities. It includes the option of a perpetual town lease for communities.

The *Aborigines and Torres Strait Islander (Land Holding) Act 1985* was created to deliver private home ownership to Aboriginal people and Torres Strait Islanders residing on Indigenous Deeds of Grant in Trust or reserve. It allowed residents of these lands to apply for perpetual or other suitable leases for residential or commercial purposes (e.g. farming, grazing or tourism). This Act is currently being reviewed so that it can be amended to provide better outcomes for Indigenous communities.

The *Aboriginal Cultural Heritage Act 2003* and *Torres Strait Islander Cultural Heritage Act 2003* recognise Aboriginal and Torres Strait Islander people as the primary authority on Aboriginal and Torres Strait Islander



cultural heritage—aiming to facilitate the continuation of Aboriginal and Torres Strait Islander culture, traditions and customs. Both Acts have Duty of Care provisions that mean that any person who carries out an activity must take all reasonable and practicable measures to ensure that the activity does not harm Aboriginal or Torres Strait Islander cultural heritage. These Acts are under review to determine if they are working as planned and fulfilling their main purpose.

**Breaches of the Acts:** The extent of non-compliance with Duty of Care provisions under the Acts provide an indication of impacts on Indigenous cultural heritage. The Compliance Information Register Management System (CIRMS) recorded 79 (2007) notifications related to cultural heritage in the previous reporting period and one prosecution had been undertaken for unlawful possession of Aboriginal cultural heritage.

**Cultural Heritage Management Plans:** A major element of the *Aboriginal Cultural Heritage Act 2003* and the *Torres Strait Islander Cultural Heritage Act 2003* are Cultural Heritage Management Plans (CHMP's). A CHMP is an agreement between a land user and an Aboriginal or Torres Strait Islander party. The plan outlines how land use activities can be managed to avoid or minimise harm to Aboriginal or Torres Strait Islander cultural heritage. A CHMP is required for certain high-level impact activities, for example, where an Environmental Impact Statement is required under legislation, or where excavation or relocation of cultural heritage is proposed. As of October 2006, 68 CHMP's had been proposed and 45 approved, as reported in the State of the Environment Queensland 2007. There appears to have been a minor decline in Cultural Heritage Management Plans over time. Since there are no mandatory reporting requirements, the reasons for this are difficult to assess. The number of CHMP's per year (20-30) does, however, appear small given the number of major projects that are likely to be undertaken each year in Queensland.

**Archaeological heritage knowledge transfer:** A greater quantity of archaeological work is being undertaken due to legal compliance requirements in Queensland, however the 'public good' outcomes of such work could be further utilised. Integration of the *Aboriginal Cultural Heritage Act 2003* and the *Torres Strait Islander Cultural Heritage Act 2003* into the *Sustainable Planning Act 2009*, as has occurred with the *Queensland Heritage Act 1992*, offers one solution, leading to an increased understanding of Aboriginal and Torres Strait Islander cultural heritage.

#### 6.10.2.1 Review of the cultural heritage database

The cultural heritage database provides only a sample of the true distribution and type of Aboriginal and Torres Strait Islander places in Queensland. There are a number of biases in the recorded geographic distribution of Aboriginal and Torres Strait Islander cultural heritage places on the database. These biases may be interpreted in a number of ways including:

- reflecting the distribution of people undertaking the recording and the ease of access to certain areas
- areas of development (more sites have been recorded in areas of urban development in the south east and in mining operations in central Queensland)
- the attraction of certain site types, such as rock art (Rowland, 1989, 1991).

A further impediment to the collection of relevant information for the database occurs because there are no provisions, regulations or guidelines in the Acts that make express requirements for the production of reports as part of the management process.

In view of concerns about the suitability of the database to meet the Queensland Government's ongoing obligations under the Acts, a review of the database was undertaken in September 2009. This review recognised an urgent need to upgrade the database to enable development proponents and other land users to quickly and efficiently gain access to up-to-date information about the location of cultural heritage sites and places in Queensland and assist them in meeting their duty of care obligations as required by legislation.

#### 6.10.3 Museums

Museums provide access to research and heritage objects. This knowledge and understanding can link people to the contemporary political and ideological landscape of Queensland. It can also inform community values, improve understanding of cultural differences and facilitate informed engagement with regards to Aboriginal and Torres Strait Islanders rights and reconciliation. Such positive impacts enhance the cultural capital of society.



The Queensland Museum is a statutory authority of Arts Queensland, governed by a Board of Trustees under the provisions of the *Queensland Museum Act 1970*. The object of this Act is to contribute to the cultural, social and intellectual development of all Queenslanders. The Queensland Museum plays a key role in the dissemination of information to a wide range of audiences, using many different communication pathways. The Museum also seeks to deliver experiences co-created in partnership with communities, which further encourages community ownership of their museum.

### The repatriation of Ancestral remains

The close relationship that the Queensland Museum has built with Aboriginal people and Torres Strait Islanders has led to the repatriation of Ancestral remains. This is an important step towards reconciliation because it allows Aboriginal people and Torres Strait Islanders to carry out their custodial responsibility for the care of their Ancestors or Old People. This responsibility is part of their identity and spirituality. Not being able to care for their people is considered to have brought suffering and sorrow to people and Spirit. Repatriation allows the Old People to return to their land. It also ensures that traditional culture is preserved throughout the generations.

The return of nine Ancestors to North Stradbroke Island from the Queensland Museum, the John Tonge Centre and Austria's Natural History Museum was undertaken with traditional ceremony in 2010. The remains of nine Old People were placed in traditionally woven baskets made from reeds and covered with leaves from the cotton tree and lilly pilli. Elders sat with the remains throughout the night before the ceremony. The reburial highlights the continuity and dynamic nature of living cultures of Aboriginal peoples, with both Traditional and Christian components included in the ceremony.



Source: Queensland Museum, photo reproduced with kind permission of Traditional Owners Elders and Yulubirribah Dancers.

**Photo 12. Song and dance ceremony for reburial on North Stradbroke Island.**

## 6.11 Managing disturbances (hazard events) and disasters

Environmental disturbances include hazard events, such as floods, fires, cyclones, storm surges, landslides and oil spills; and are addressed by several policies. Hazard events become disasters when, as defined in the *Disaster Management Act 2003*, they cause 'a serious disruption in a community that requires a significant coordinated response by the state and other entities to help the community recover from the disruption'. The Act also notes that a serious disruption means loss of human life, illness, injury to humans, widespread or severe property loss or damage or widespread or severe damage to the environment.

State Planning Policy 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide aims to ensure that natural flood, bushfire and landslide hazards are adequately considered when making decisions about development under the *Sustainable Planning Act 2009*. This state planning policy also seeks to mitigate potential adverse ecological impacts resulting from human settlements by shaping planning and development decisions and by creating settlement patterns that are less vulnerable to flood, landslide or bushfire events. In the context of this state planning policy, mitigation means measures taken to reduce the severity of, or eliminate the risk from, a natural hazard. Mitigation is usually thought of in terms of prevention and community preparedness. The state planning policy came into force in September 2003 and applies to new development and redevelopment occurring after this date. To comply with policy, local government assessment managers should impose conditions on development approvals to minimise risk from natural hazards and should not approve development applications that do not satisfy the policy.

State Planning Policy 3/10: Acceleration of Compliance Assessment provides a code for reconfiguring a lot (for example, subdividing one lot into two) and associated operational works that require compliance assessment. A compliance permit is necessary for development requiring a compliance assessment. Some of the provisions of the state planning policy includes prohibiting the creation of new lots on land that is subject to flooding, limiting the reconfiguration of lots in bushfire prone areas and prohibiting the creation of new lots on land where the existing slope of the land is 15 per cent or greater (that is, landslide prone).

### 6.11.1 Recovering from the disasters of 2010-2011

The natural disasters that struck Queensland between November 2010 and February 2011 saw more than 99 per cent of Queensland declared as disaster affected. Tragically, 37 deaths occurred that were directly related to flood or cyclone events. The Queensland Reconstruction Authority was established to lead the reconstruction effort in the state. Its mission is to reconnect, rebuild and improve Queensland, its communities and economy.

Operation QUEENSLANDER (the State Plan) sets out the strategic road map to guide the ongoing reconstruction work necessary in the months and years ahead. It is centred on six lines of reconstruction which include human and social, economic, environment, building recovery, roads and transport and community liaison and communication. This state plan provides strategic level guidance for all levels of government, non-government organisations, industry, businesses, local community groups and individuals. It also sets the framework for district and local planning for reconnecting, rebuilding and improving Queensland.

## 6.12 Environmental compliance

The Department of Environment and Heritage Protection has in place a regulatory compliance program to achieve its legislated obligations. It is founded on a targeted and transparent approach to compliance, supported by a modern and strong enforcement program. The department carries out two main types of compliance activity to ensure risks are being managed appropriately:

- The department responds to reports about incidents that affect the environment and natural resources. These reports can come from members of the public, industry self-reporting or from monitoring programs. This responsive work drives remedial and/or enforcement action on a site-by-site basis.
- The department plans a variety of compliance activities throughout the year aimed at addressing risks before they become problems, many of which would be irreversible.

### 6.12.1 Reactive and proactive reporting

Responsive compliance activities are ones where the environmental concerns of the community are reported directly to Queensland Government business areas. There were 18 504 matters reported regarding complaints related to perceived breaches of the *Environmental Protection Act 1994* over 2010–2011. These complaints were made to various state departments and local government departments.

Reactive compliance activities are those where either the community or industries advise the Queensland Government of an ‘incident’ that could cause serious or material harm. In excess of 1500 compliance incidents are reported every year, with the distribution geographically linked to population and industry locations (e.g. compliance incidents per year responded to by then Department of Environment and Resource Management regional offices during the period 2006–08 to 2009–10 ranged from 269–342 per year for Brisbane, 324–728 per year for Cairns and 48–140 per year for Gladstone). These incidents related mainly to water issues including algal blooms, chemical/ oil/ fuel spills, dumping/ litter, effluent/ sewage, fish kills, liquid waste, pump station overflows, silt/ turbidity and paint spills.

Major compliance incidents are those that are regarded as severe and become priority matters for the Queensland Government. The distribution of major incidents across the state varies according to the types of industries, their potential risks, and the environmental impacts of the activities that are undertaken. The main centres where major incidents have occurred are Cairns, Brisbane, Mt Isa, Townsville, and Ipswich. Major incidents have most often impacted upon water resources, with most problems associated with effluent and waterway damage.

The Queensland Government engages in proactive compliance activities, which are targeted towards addressing emerging, large scale, or ongoing environmental threats.

- Regulating environmentally relevant activities: Mineral exploration, waste, water, sewage, chemical storage, motor vehicle workshops, and oil and gas processes comprise the primary areas of regulation. Consequently, the major activities that are permitted are for mining/ mineral exploration and extraction; transport and treatment of regulated waste; chemical storage; motor vehicle workshop activities; sewage treatment; concrete batching, and soil composting.
- Annual compliance plans set out the proactive compliance activities in each of the areas that it regulates. The plans include programs linked to the key regulatory areas of coastal and inland waters, environmental management, Queensland heritage conservation, Indigenous heritage conservation, land management, estate management, vegetation management, wildlife and ecosystems; and water supply. The CSG /LNG Annual Compliance Plan 2011 sets out the proactive compliance activity for the CSG to LNG industry. The plan identifies compliance activities to address the key areas of the CSG to LNG industry that have the potential to affect the environment and natural resources. In particular, the focus has been on establishing strong monitoring programs and ensuring effective management and response to reports or complaints concerning the impacts of the industry.
- Planned compliance inspections are conducted at a number of sites that require registration certificates under the *Environmental Protection Act 1994*. These comprise those localities that undertake activities that are considered to be 'high risk', where the environmental significance demands particular attention, where emerging problems or trends pose new risks which need to be managed and where public interest and concerns demand focused attention. Inspections are concentrated upon industrial estates activities and hazardous wastes activities such as recycling, storage, transport and disposal of regulated wastes around the Cairns, Gold Coast, Mackay, and Townsville areas. During 2010–2011 the former Department of Environment and Resource Management undertook 1131 planned inspections of licensed activities, focusing primarily on inspections of licensed sites posing the greatest environmental risk.

### Erosion and Sediment Control Compliance Project

Diffuse fine sediments are a major factor in the decline of South East Queensland's waterways. Studies have confirmed that run-off from urban areas contribute the highest per ha source of sediments into Moreton Bay. In particular, sediments are generated during the construction phase of urban development. To address this, the state government, in partnership with eight South East Queensland local governments undertakes compliance inspections at infrastructure and private development sites. Joint inspections under the South East Queensland partnership commenced in the second half of 2010.

The **Erosion and Sediment Control Compliance Project** approach to compliance is to assess environmental performance based on water quality. Sites are regulated under the *Environmental Protection Act 1994* (s440ZG) where it is an offence to 'unlawfully' (as defined in s493A) deposit 'prescribed water contaminants' in waters, roadside gutters, stormwater drainage, or at another place where the contaminant could reasonably be expected to move into these areas.

The Department of Environment and Heritage Protection engages other state Government departments, public infrastructure providers, and public utility providers to lead by example, demonstrating best practice.

To date, the level of compliance in the Sunshine Coast has increased for linear infrastructure (roads and railways) and large residential developments. Through initial risk assessment visits and enforcement measures, such as Environmental Protection Orders, erosion and sediment control planning has improved at construction sites. A cultural change has been observed in the construction industry, where more consideration is given to potential unlawful water contamination by developers and contractors.

### 6.12.2 Investigations of breaches

Where inspections identify breaches of obligations, investigations are carried out to determine the facts of the matter, whether there is evidence of non-compliance and to determine an appropriate response.

The majority of investigation activity has been directed to vegetation, water, trespass, land protection and cultural heritage matters. The highest levels of investigation activity occur in the south east, south west and central west regions of the state.

The main offences occurring in protected areas, such as national parks and forest parks, related to camping, domestic animals, vehicle use, wildlife interactions, wildlife (macropod) harvesting and fires. Most offences occurred on Fraser and Bribie Islands, with Inskip, Moreton Bay, and Byfield National Park also recording high levels of non-compliance. There was also an apparent escalation in offences in Byfield National Park and D'Aguilar National Park, and a decline at Coochin Creek State Forest Park, Cooloola National Park, and at Inskip and Moreton Bay.

### 6.12.3 Imposition of penalties

Once it has been determined that a breach of legislation has occurred, either through public reporting and vehicle database confirmation, on site identification by a department staff member, following planned inspections, or verified through a more complex investigation process, a penalty is imposed. These are set out in legislation and can comprise warnings, penalty infringement notices, management program stipulations, statutory orders, court orders and negotiated resolutions.

The most serious matters can proceed to prosecution so that a court can determine whether an offence has been committed and impose a penalty. Due to the time and resources required to take a matter to court, only those matters that are determined on social, economic, environmental, and legal grounds to be the most serious matters are dealt with in this way.



## 6.13 Science informing policy and management actions

Underpinning Queensland's environmental management systems is a robust scientific knowledge and evidence-gathering effort. Both short-term intensive studies to understand specific events or processes and long-term continuous monitoring programs are needed to detect cumulative impacts occurring over time scales of years to decades. Highlights of the scientific effort over the reporting period are featured below.

### 6.13.1 Shorter term studies and programs

#### 6.13.1.1 Addressing acute community concerns

The Clean and Healthy Air for Gladstone Project was established in July 2007 with input from community and industry in Gladstone. It was initiated because members of the Gladstone community raised concerns about the possible cumulative impact of coal dust emissions, minerals processing and chemical manufacturing industries on human health.

The objectives of the project were to:

- gain a better understanding of emissions of air pollution in the Gladstone region
- investigate how these emissions affect the quality of the outdoor or open air in Gladstone (or 'ambient air')
- identify any potential risks to public health that may be associated with air pollutants.

The results of this project were used to provide factual information to the community as a baseline and for the development of further management or monitoring actions. The study concluded that ambient air quality in the Gladstone area met current health based standards or guidelines, although it was possible that some people with particular susceptibilities, including asthma, may be affected by current air quality, at least on an intermittent basis.

A number of other short to medium term investigations are being undertaken to address intense community concerns in relation to other environmental concerns in Queensland including:

- reports of fish ill-health in Gladstone waterways received in the latter half of 2011
- mutations of fish held at an aquaculture facility north of Brisbane and possible links to pesticide use nearby
- interactions between people and dingoes on Fraser Island
- reported high levels of lead in the Mt Isa environment.

### Floods and impacts on ecosystem health

In response to the high rainfall events and flooding that occurred in 2011, a comprehensive and integrated monitoring program of the flood plumes from Moreton Bay to Cooktown was undertaken. The monitoring informed management options by assessing the impact of the floods on marine ecosystems and measuring the recovery of water quality and ecosystem health.

Commencing in January teams of scientists visited the marine plumes associated with the catchments of Brisbane, Burnett/Mary and Fitzroy, Burdekin, Thompson and Tully to sample water affected by the flood. The data gathered on the impacts and challenges being faced by the marine environment as a result of the flooding events will inform decisions on further programs and management strategies to support marine life that is at risk and ensure the resilience of Queensland's marine environment.

This monitoring and research program is a collaborative effort involving the Queensland Government, the Healthy Waterways Ltd, CSIRO, Great Barrier Reef Marine Park Authority, University of Queensland, Griffith University and James Cook University and natural resource management groups. The research team successfully captured images of the flood plumes that are used as the basis for the analyses.





Photo: Adam Creed, DEHP.

**Photo 13. Sampling water quality in Moreton Bay after the January 2011 flood.**

#### 6.13.1.2 Adapting to climate change

A number of studies are being conducted to inform climate change adaptation. They include carbon sequestration programs that assist landholders to prepare for and manage change. For example, CSIRO, with input from the Queensland Climate Change Centre of Excellence, identified key Queensland opportunities for carbon sequestration in the landscape.

At the national level, the Federal Government's Carbon Farming Initiative will provide landholders with the capacity to establish reforestation projects on their properties to generate carbon credits. Queensland has substantial potential for carbon capture by native forest regrowth, which would benefit rural producers and native biodiversity.

#### 6.13.1.3 Promoting innovation

The Queensland Sustainable Energy Innovation Fund (QSEIF) was established to reduce energy and water consumption by promoting the development of new innovative sustainable technologies or processes. A wide range of technologies have been developed as a result of QSEIF investment in water supply and waste treatment, bio-fuels, lighting, refrigeration, food drying, solar power, remote area power supply, water heating and road transport.

A state-of-the-art wireless sensor network has been installed alongside the World Heritage listed Springbrook National Park through a collaborative project between the Queensland Government, CSIRO and the Australian Rainforest Conservation Society. The project aims to enhance knowledge of rainforest restoration and its effectiveness at recovering biodiversity, as well as to develop an efficient tool for monitoring biodiversity and its condition. The network consists of a collection of miniature devices called sensor nodes, each connected to several sensors. These sensor nodes collect a variety of information about the environment and transfer their data wirelessly to a central hub before being sent over the internet to a database. There are now close to 200 sensor nodes and over 700 individual sensors deployed at Springbrook monitoring temperature, humidity, rainfall, cloud, fog, light, leaf wetness, soil moisture and wind. This network is one of the largest continuously operating wireless sensor networks of its kind.



**Photo 14. Wireless monitoring equipment at Springbrook.**

#### 6.13.1.4 Understanding the community

Developing an understanding of the social and economic characteristics of a community, its capacity, diversity and health, opportunities for growth and barriers to change, is important to the success of any environmental management program. Qualitative interviews, focus groups and surveys produce rich information that assists in the design and implementation of environmental management programs. The development and implementation of the Reef Protection legislation is complemented by the work of social scientists investigating the impact of the legislation, the capacity of the community to comply with increasing legal obligations and, where opportunities exist, to assist stakeholders in meeting these obligations. Findings from this research will inform future policy and legislative decisions and the development of support resources to increase voluntary compliance with legislation.

In 2010, a survey was conducted to ascertain the degree of compliance, the environmental outcomes and the effectiveness of the implementation program for the Code Applying to a Native Forest Practice on Freehold Land. The survey involved sending out 3200 letters to landholders, remotely assessing some 623 properties and undertaking 51 ground surveys. The ground surveys indicated that 83 per cent of landholders were effectively compliant with the Code. A further 13 per cent needed some improvement and four per cent were non-compliant.

The National Water Compliance Framework was designed to contribute to the sustainability of water use by improving and harmonising water laws around Australia. A key component of the Queensland project has been the investigation of the social barriers to compliance with water laws, to better understand the social and economic reasons for non-compliance. This involves extensive qualitative interviews and focus groups.

The Queensland Parks and Wildlife Service conduct community surveys approximately every four years to understand the motivations, visitation patterns, annual visitor estimates, needs and values of the Queensland community in relation to national parks and the performance of the Queensland Parks and Wildlife Service. This information is used to improve the management of Queensland national parks to enhance visitor experiences, while maintaining environmental values of the parks.

Prior to the new zoning plan for the Moreton Bay Marine Park (that commenced on 1 March 2009), a five year monitoring program was established to evaluate the health of the marine park. An important part of the monitoring program is to gain a better understanding of the socio-economic implications of the revised marine park. This will assist with adaptive management of the park, and the results will be regularly communicated to the public so that they are informed about the zoning progress and the species and ecosystems in Moreton Bay.

### 6.13.1.5 Securing threatened species

Recovery programs for threatened species are implemented hand-in-hand with scientific monitoring and specialist research programs. For example, the koala habitat mapping project in South East Queensland provides crucial baseline information for koala management. The project was awarded the Queensland Spatial Excellence (Industry) Award by the Queensland Spatial Information Council in September 2009 and won the Environment and Sustainability Award at the 2009 Asia Pacific Spatial Excellence Awards. A Koala Disease Research Fund was also established to support research into ways of mitigating the effects of disease on wild koala populations. In North Queensland programs were implemented to track the local movements of cassowaries, while on Fraser Island a satellite tracking project assisted the local dingo management program. Other projects have been implemented by, or in collaboration with, regional NRM groups. These have utilised funding provided through national threatened species programs.

#### 6.13.1.5.1 Recovery of the 'endangered' cave fern

Ferns are a very ancient group of plants, the majority of which occur in Queensland (380 out of 462 known Australian species). The cave fern (*Tectaria devexa* var. *devexa*) is endangered and is known from just two places to the north of Rockhampton. Prior to the introduction of the recovery project, the population of the cave fern was very low and estimated at 24 plants.

To address the decline of this species, a recovery team was formed in 2006 with the aim of improving the conservation status of this species. The team consisted of personnel from the Queensland Government, Greening Australia, Heatons Wholesale Fern Nursery, Society for Growing Australian Plants, Kershaw Botanic Gardens, the owners and staff at Olsen's Capricorn Caves and Griffith University.

The recovery project has shown that spores of this endangered fern can be easily germinated and will produce viable sporophytes and the sporophyte generation matures quickly when provided with suitable conditions. However, the introduction of these cultivated cave ferns into the natural environment proved challenging, mainly due to the very specific habitat requirements needed to promote plant survival and growth. After some adjustments to the micro-climate, including the introduction of a watering system, the survival of cultivated cave ferns now stands at about 75 per cent.

The most likely benefit of this project is the supplementing of the natural spore 'bank' to provide a safety net, with a subsequent increase in naturally occurring plants over time.

#### 6.13.1.5.2 Richmond birdwing butterfly

The Richmond birdwing butterfly (*Ornithoptera richmondia*), which has been identified as a critical priority under the Back on Track species prioritisation framework, once occurred from the Maryborough area south to Grafton in New South Wales. However, habitat loss and fragmentation have reduced its range to approximately one-third of its original distribution. Fragmentation of habitat leads to in-breeding of local butterfly populations, reflected by poor survival rates of eggs and larvae and, ultimately, to local extinction. Only isolated populations now occur in the Sunshine Coast and Gold Coast of South East Queensland and in Northern New South Wales.

A close collaboration between government and the community is taking steps to restore lost populations of the Richmond birdwing butterfly through a carefully planned reintroduction program. To redress the problems of reduced genetic diversity caused by in-breeding of wild populations, two separate populations are being reared in captivity, one sourced from butterflies in the Gold Coast area and one from the Sunshine Coast.

Trial releases of the specially bred caterpillars conducted at the Dangerbridge Nature Refuge, Cootharaba in 2010 has yielded good results. Six months after the reintroductions, natural breeding of Richmond birdwing butterflies was detected at the release site and on two neighbouring properties for the first time in 16 years, and up to 20 adult butterflies have been observed flying and feeding in the local area after an absence of 17 years. Future releases of out-bred caterpillars are planned for this site and other selected sites in 2011.

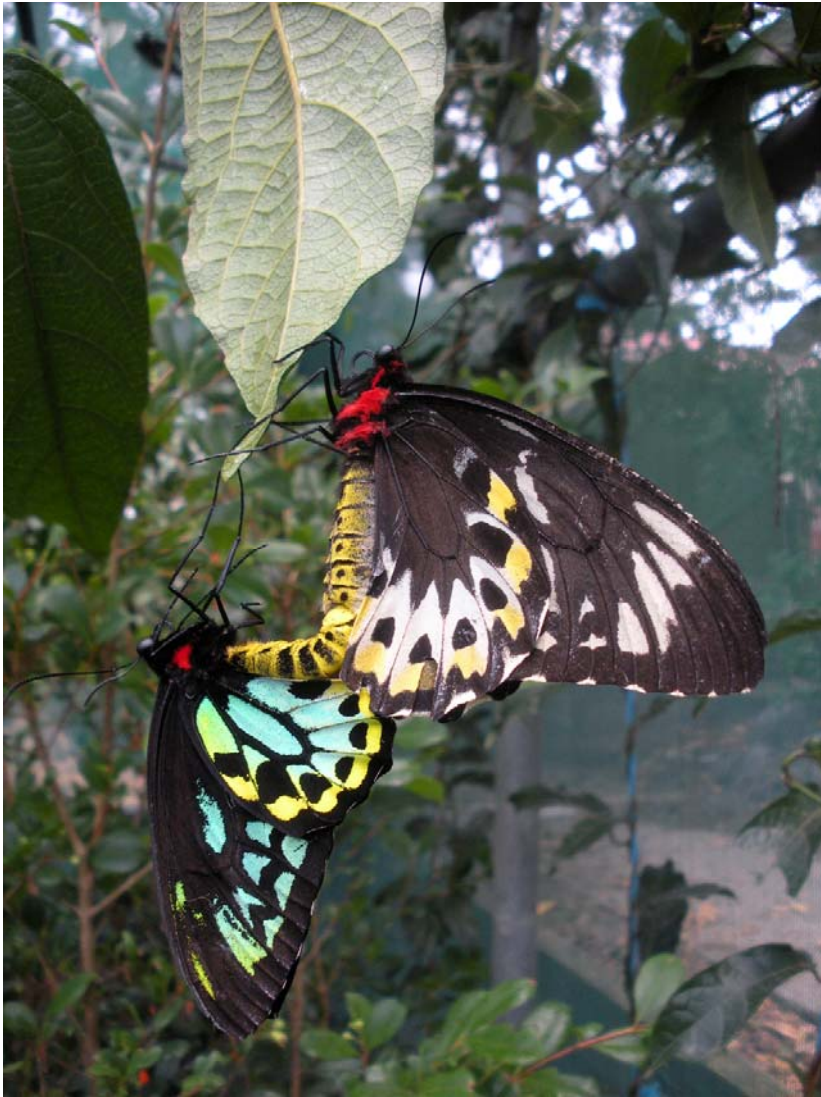
The reintroduction program complements another important component of the Richmond Birdwing Conservation Network's efforts to conserve this species, namely the reinstatement of corridors and stepping stones of the butterfly's essential food plant, the vine *Pararistolochia praevenosa*, in order to link existing remnant habitat and isolated butterfly populations. The state government is involved in planting these vines at sites, such as Kin Kin Creek within Great Sandy National Park.



This work to assist the recovery of the Richmond birdwing butterfly has captured the enthusiasm of people across all levels of government and the community.



**Photo 15. Cave fern re-introduction.**



**Photo 16. Adult Richmond birdwing butterflies mating in captivity.**

#### 6.13.1.6 Invasive species research

Sixteen pest animal research projects have been initiated since 2007 in the government's efforts to find control methods that are practical, cost-effective, humane and target-specific. Research is directed to species that cause or have the potential to cause the greatest impacts on Queensland. Queensland collaborates and gains funding from a variety of organisations including federal government departments and the Invasive Animals Cooperative Research Centre (DEEDI, 2010c). One of these projects involved a new toxin, called PAPP. It is being field tested on wild dogs for its effectiveness for Australian Pesticides and Veterinary Medicines Authority registration purposes. This toxin is considered more humane than current poisons used (DEEDI, 2010c). Another project aims to establish landholder-driven, scientifically monitored rabbit control programs in the Darling Downs area. This research will provide data to more accurately assess rabbit damage and the value of maintaining the rabbit-proof fence and will encourage landholders to control rabbits (DEEDI, 2010c).

There have also been 32 terrestrial pest plant research projects initiated since 2007, many involving collaborating and obtaining funding support from a variety of organisations, including Meat and Livestock Australia and the Australian Centre for International Agricultural Research (DEEDI, 2010c). One of these projects is investigating the ecology of Captain Cook tree (*Caschabella thevetia*), a poisonous Class 3 weed. A sound knowledge of the weed's ecology may improve the efficacy of current control techniques as plants can be more susceptible to



herbicides at different ages (DEEDI, 2010c). Another project is investigating potential biological control agents for bellyache bush (*Jatropha gossypifolia*); a Class 2 weed (DEEDI, 2010c).

### **Molecular probes for marine pest species**

In 2010, Biosecurity Queensland began using molecular technology on plankton tow samples to determine the presence of Asian green mussel larvae. This technique involves screening the water sample for the presence of Asian green mussel DNA. This technology is a significant advancement in marine pest surveillance: it has a high level of accuracy, is cost effective and safe for personnel (DEEDI, 2010g). Previously, Asian mussel surveillance involved divers visually inspecting a sample of sites. This method can be inaccurate because the mussels can be difficult to identify from non-invasive species. It is also expensive and dangerous because the waters where these inspections are conducted are a habitat for animals, such as estuarine crocodiles and stinging jellyfish.

The Queensland Herbarium aims to improve botanical, faunal and ecosystem knowledge through the discovery, research and mapping of plant, algae, lichen, fungal and faunal species and ecosystems. The Herbarium team is working with other agencies, to research invasive alien plant species that pose a threat to native ecosystems and agriculture. The Herbarium plays a lead role in the detection and monitoring of the invasion and distribution patterns of such species.

The Queensland Herbarium, in collaboration with Biosecurity Queensland, has established the Queensland Weed Spotter Network. The Network of 500 participants focuses on early detection of new and emerging weeds through harnessing and fostering community interest and knowledge of invasive plants. The Queensland Museum plays a similarly important role in identifying the presence of alien animal species.

#### **6.13.1.7 Recovering ecosystem processes**

Scientific studies support ecosystem recovery programs by building knowledge of the underlying mechanisms that drive ecosystems and biodiversity. For example, ecological models developed by government scientists are being used to predict the influence of water allocation and management on long-term population viability of key species (such as the Golden Perch). The models were used in the evaluation of the Fitzroy Basin Water Resource Plan. Waterways have also been used as indicators of land degradation in highly cleared catchments.

In dryland rivers, such as the Moonie River in the northern Murray–Darling Basin, rainfall is sporadic and river flow often stops, sometimes for extended periods. In the Moonie River in South West Queensland individuals of four common fish species were tagged and monitored using a network of acoustic receiver stations installed in refuge pool, river channel and anabranch sites along an 85 km reach of the river. Findings highlight that fish in these systems utilise networks of waterholes that need connectivity and movement opportunities at the catchment scale for populations to survive and to maintain ecosystem functioning.

North Stradbroke Island in Queensland's south east is the second largest sand island in the world. Due to its highly permeable sands, a large proportion of the rain that falls on the island penetrates the surface forming aquifers. This substantial groundwater resource supports over 70 wetland systems including lakes, swamps and sedgelands, salt marshes, perennial streams and estuaries, many of these have high cultural significance and are home to threatened and endemic species. Government scientists were able to inform water resource planning processes by using their understanding of the dependencies of these wetlands upon the island's regional aquifer. The outcome is a balance between utilising water from the aquifer for South East Queensland drinking water supply while leaving enough water for these highly valued wetland systems.



Photo: Lana Baskerville.

**Photo 17. Perched lake on North Stradbroke Island**

### 6.13.1.8 Protecting cultural heritage

Science is also used for the protection of sites of high cultural heritage significance. Archaeological research on the Keppel Islands near Rockhampton (for example, Rowland, 2007, 2008) has used geoindicators to measure change in coastal processes at a scale relevant for the management of archaeological sites. These islands have been occupied by Aboriginal people from at least 4000 years ago, with the first European residence on South Keppel Island established by 1883. Geoindicators are measures (magnitudes, frequencies, rates, and trends) in geological processes and phenomena, which are subject to changes that are significant in understanding environmental change over periods of 100 years or less. They measure both catastrophic events and those that are more gradual, yet evident within a human lifespan. Examples of coastal geoindicators that have been applied include dune formation and reactivation, relative sea level rise and shoreline position. Information from geoindicators have been applied to Wreck Beach-Big Sandhills Beach on South Keppel Island using air photos from 1962, 1992 and 2001, together with anecdotal information collected over a period of more than 30 years.

Most of the changes identified could be attributed to 'normal' changes in climate patterns and increasing human impacts. This 'normal' process of wind and water erosion has been exacerbated by natural and human induced vegetation removal. Introduced animals have also been a major source of vegetation destruction on the islands. At times, as many as 3000 sheep were grazing on the islands, and goats and possums were also introduced. Tourism developed on the islands from the late 1960s. Contrary to expectations tourists have probably had a limited impact on most sites. Stochastic events, such as cyclones and flood discharges from the Fitzroy River, have also had significant impacts. At present none of the changes could be attributed to the impact of climate change.

## 6.13.2 Longer term continuous programs

### 6.13.2.1 Air quality monitoring

Air quality has been monitored in South East Queensland since 1978 and information from the region's monitoring stations has been used to identify current and long-term trends. The Queensland air monitoring network now consists of over 30 stations around the state containing approximately 90 instruments recording and storing weather and air pollutant data. Data are downloaded from the monitoring stations at regular intervals and uploaded to the Department of Environment and Heritage Protection's website.

The National Environment Protection (Ambient Air Quality) Measure (Air NEPM) provides a framework for monitoring, assessing and reporting on ambient levels of the six 'criteria pollutants'—CO, lead, NO<sub>2</sub>, SO<sub>2</sub>, O<sub>3</sub> and particles (PM<sub>10</sub> and PM<sub>2.5</sub>). These pollutants are emitted from a wide range of sources, including domestic, commercial, industrial, transport, agricultural and natural sources, and high concentrations can affect health and the environment. Under the Air NEPM, air quality standards are set in terms of maximum concentrations over a specified averaging period. The Air NEPM also specifies the number and location of monitoring stations necessary to demonstrate compliance with the goals.

The National Environment Protection (Air Toxics) Measure (Air Toxics NEPM) provides a framework for monitoring, assessing and reporting on ambient levels of five air toxics—benzene, formaldehyde, toluene, xylene and polycyclic aromatic hydrocarbons (PAHs)—to assist in the future development of national air quality standards for these pollutants and has established ambient monitoring methodologies and monitoring investigation levels for these toxic chemicals.

Air pollution forecasts for South East Queensland are produced to provide the public with advanced information on likely air quality. The forecasts are put together using past research information plus current weather forecasts from the Bureau of Meteorology. Each morning and evening, Queensland Government Air Quality scientists send an air pollution forecast to the Bureau of Meteorology, which issues it to the media along with the weather forecast.

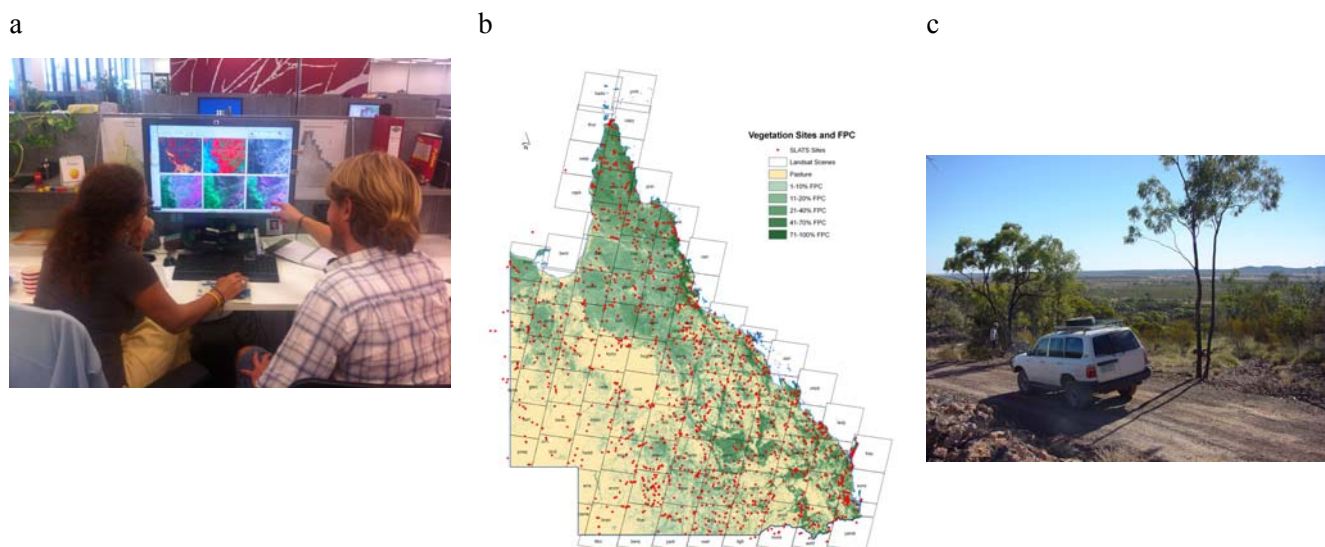
Through the National Pollutant Inventory information of actual and estimated emissions of chemicals of concern to human health and the environment is collected from industry, validated by the states and territories, and uploaded to a national database managed by the Australian Government. Members of the community use the National Pollution Inventory database to compare the relative performance of companies and industry sectors and inform targeted pollution reduction campaigns. Government agencies and industry use the National Pollutant Inventory database to inform policy and strategy development and to better target auditing of environmental performance.

#### 6.13.2.2 Preventing land degradation

The Queensland Government's soil and land mapping, modelling and monitoring are critical to understanding land productivity and land degradation risk. For example, the Queensland Land Use Mapping Program provides information on land use and land management practices that can affect water quality and catchment, soil erosion, acidification, nutrient decline and carbon losses. It has also helped in assessing agricultural productivity and opportunities for diversification, conducting cost benefit-analyses for major natural resource investments and trade-offs from land-use change, developing solutions for sustainable land management, and using integrated modelling to predict the behaviour of a catchment under different management options. The Queensland Government also provides acid sulfate soils and coastal hazard maps.

Ground cover in Queensland is monitored remotely and modelled using the Ground Cover Index (Scarth et al., 2006). The Ground Cover Index is a relatively recent addition to the tools that can be used to assist with the remote analysis of broad regions, such as Queensland's rangelands. The estimation of ground cover informs various government programs including the Delbessie Agreement, Reef Plan and the Reef Protection Program and complements simulations of ground cover produced by AussieGRASS.

The Statewide Land-cover and Tree Study (SLATS) is a major vegetation monitoring initiative. The SLATS uses satellite imagery over the entire state to estimate wooded vegetation cover and woody land cover change information to inform vegetation management, planning and compliance and for greenhouse gas inventory purposes.



**Photo 18. Some of the components of SLATS: (a) reconciling field and satellite information, (b) a map of the field sites and (c) conducting field work to ground truth and validate information.**

The Queensland Government assesses leasehold land condition under the Delbessie Agreement. A systematic site-based assessment methodology records seven pasture, three soils and 10 biodiversity indicators, together with indicators for salinity, declared pests, riparian vegetation and natural water resources to determine the land condition on a lease. This information is then used to develop a land management agreement with the lessee to guide the future management of the lease.

#### 6.13.2.3 Mapping ecosystems and monitoring species

Regional ecosystem mapping provides the foundation for biodiversity conservation in Queensland. These are fine scale maps (1:100 000) showing the extent of 85 per cent of the state's vegetation communities (DERM, 2010f) and contain information on the extent of vegetation both pre- and post-clearing. This foundation information layer is used for a wide range of purposes by both government and non-government agencies and is central to Queensland's vegetation management framework.

Regional ecosystem mapping is supported by a site-based method to assess the condition of native vegetation. The BioCondition assessment manual outlines a framework for measuring how well a terrestrial ecosystem is functioning for the maintenance of biodiversity values (Eyre et. al., 2011). This enables vegetation condition to be assessed against benchmarks and be monitored as part of various land management regulatory processes and offset programs.

At a species level, routine monitoring of threatened species ranging from the critically endangered northern hairy-nosed wombat to estuarine crocodiles and marine turtles is undertaken.

#### Queensland Turtle Conservation Program

Queensland's marine turtle conservation program has been running for more than 40 years. Over this time turtle populations have been monitored by conducting annual censuses at key nesting beaches along Queensland's coast and tagging turtles for recapture in later years. Individual turtles have also been fitted with satellite transmitters to learn more about local and regional movement patterns. At other times of the year, turtles have been captured and tagged at shallow water turtle feeding sites, such as Moreton Bay, where growth and survival data contribute to the understanding of these species and how they have been responding to management interventions.



Information from the work has provided a basis for strong management changes, such as the introduction of turtle exclusion devices that became compulsory in 2001 for the east coast trawl and northern prawn fisheries. Evidence generated by the research is used to change local management practices, such as street lighting near turtle nesting beaches and zoning plans for Queensland marine parks are influenced by knowledge created by the turtle conservation program. A number of 'go slow' zones have been created to reduce the rate of boat strikes in key turtle habitats in marine parks.

This work contributes to a better understanding of the state of marine ecosystems. Turtles are indicators of water quality and respond to large scale events, such as floods, as well as localised impacts from changes in water quality. This information provides valuable information about the state of Queensland's marine and estuarine ecosystems. Following the flooding that occurred in 2011, surveys have confirmed that at least parts of Queensland's immature east coast turtle population was experiencing extreme stress and had poor body condition. Improvements in water quality and reduction of sediment run-off are central to improving the resilience of inshore marine habitats helping dugongs and turtles survive future flood events.

#### 6.13.2.4 Protecting the community

A network of 25 storm tide gauges along Queensland's coastline monitor flooding from the sea, usually associated with storm surge during tropical cyclones. This network is vital in helping communities to prepare for extreme events. The storm tide gauges are built to withstand severe weather and storm surge and house instruments to record the rise and fall of the tide automatically at regular time intervals in digital format. The storm tide network provides sea level information in near real time. The monitoring information and storm tide maps showing the extent of coastal land vulnerable to tidal inundation are vital when considering the evacuation of communities during cyclone events.

A number of Waverider buoys are used to measure the height of waves along the Queensland coast. Wave reports are generated 'on-line', describing wave conditions at various locations along the Queensland coast (Brisbane, Cairns, Central Moreton Bay, Emu Park, Gladstone, Gold Coast, Hay Point, Mackay, Mooloolaba, North Moreton Bay, Townsville and the Tweed River). Wave data are collected, stored and analysed to help short and long-term investigations of natural coastal processes, including accretion (deposition of sediments) and erosion (loss of sediments). This information is used to monitor the type and variability of wave conditions. Sea surface temperature is collected at the same time as wave height and direction. When a cyclone is approaching the coast, advice is provided to the State Counter Disaster Organisation on the potential impact of waves on coastal communities, while maritime organisations use wave data to plan port activities and to support navigational information.

#### 6.13.2.5 Ongoing challenges arising from complex and interrelated environmental issues

The Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (Paddock to Reef program) integrates information from across a range of scales to provide a link between management actions and water quality outcomes for the Great Barrier Reef. The program measures the status of land management, water quality and ecosystem health in paddock, catchment and marine areas. Progress towards the goals and targets of Reef Plan are assessed through the program and form the basis of the Annual Reef Report Card. The program is based on a philosophy of continuous improvement which will help improve data confidence over time.

#### 6.13.2.6 Monitoring ecosystem health

The Queensland Integrated Waterway Monitoring Framework aims to improve the coordination and comprehensiveness of waterway monitoring programs and enhance how data is shared and used to improve water quality and ecosystem health. The framework is implementing a range of projects designed to advance the integration of government monitoring activities in priority regions, as well as addressing statewide issues, such as information management and reporting. There are six long-term monitoring programs that provide information on the state of Queensland's waterways. These are the: Surfacewater Water Quality Network, Stream Gauging Station Network, the Stream and Estuary Assessment Program, the Environmental Flows Assessment Program, Groundwater Water Levels Network and the Groundwater Water Quality Network.



Regional monitoring programs are supported in priority areas where there are significant policy issues and associated risks to waterways. These programs include the Ecosystem Health Monitoring Program (EHMP), and the Moreton Bay Marine Park monitoring program in South East Queensland (DERM, 2010g), the Sustainable Rivers Audit in the Murray–Darling Basin, the estuarine monitoring programs from the Fitzroy to Tin Can Bay and the Burnett–Mary, as well as water quality monitoring under the Reef Plan in catchment areas draining into the Great Barrier Reef lagoon.

The EHMP is one of the most comprehensive marine, estuarine and freshwater monitoring programs in Australia. It delivers a regional assessment of the ambient ecosystem health (or pulse) for each of South East Queensland's 19 major catchments, 18 river estuaries, and Moreton Bay.

The EHMP is managed by Healthy Waterways on behalf of its various partners and is implemented by a large team of experts from Government, universities and CSIRO. The information collected in the EHMP is used to advise councils and land managers about areas of declining health, report on the effects of different land uses, and evaluate the effectiveness of management actions aimed at improving and protecting aquatic ecosystems. The results provide an assessment of the responses of aquatic ecosystems to human activities, such as catchment alterations and point source discharges taking into account natural processes like rainfall.

The AussieGRASS Environmental Calculator is a national simulation framework for Australian grasslands developed in collaboration with agencies from New South Wales, South Australia, Western Australia and the Northern Territory. AussieGRASS was initially developed as a tool to assess drought conditions and is also used to support the Queensland Rural Leasehold Land Strategy (Delbessie Agreement) process, providing grass fire risk products for rural fire services, reporting on rangeland condition change to the Australian Collaborative Rangelands Information System and helping to estimate greenhouse gas emissions.

#### 6.13.2.7 Harvesting fish sustainably

Science plays a key role in ensuring that harvesting of valuable fish and wildlife from Queensland's ecosystems is sustainable. Relevant information about fish stocks and the fisheries they support is continuously collected to enhance their sustainability. Data are regularly collected from fishery-dependent and fishery-independent sources including:

- daily logbook returns from all commercial fishing boats, documenting target and by-product species and species of conservation interest
- regular recreational fisher surveys
- a statewide observer program that monitors the composition and quantity of the catch and bycatch
- a long-term biological monitoring program collecting fishery-dependent and independent data for scientific assessment of key species.

Annual fisheries status reports outline information on the operation of the fishery, trends in catch and fishing effort, impacts on ecosystems and management regimes in place.

#### 6.13.2.8 Facilitating decision making

Science programs are the foundation for a number of support systems used to assist decision making. One example is WildNet, the Queensland Government's corporate application for wildlife information and survey data across Queensland. The application stores a range of information, including survey data, wildlife sightings, species lists, species descriptions and statuses under various legislation. It also stores treaties, planning documents, reports, brochures, images, project and data source metadata, as well as links to websites. The application has been operational since March 1997 and supports a range of government and non-government decision making processes.

## 7 Challenges for the future





The object of the *Environmental Protection Act 1994*, which requires the preparation and release of Queensland's state of the environment reports, is to

'protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development).'

The challenges in ensuring the protection, maintenance and restoration of Queensland's environment, while providing a healthy and prosperous life for all Queenslanders, are significant. Part of achieving this balance lies in recognising not only the intrinsic value of nature but the value of ecosystem services in terms of what we get from a healthy environment, as well as how to protect and maintain these benefits in the context of supporting an increasing population and economic growth.

Monitoring and reporting programs play a key role in assessing the status of the environment, including the pressures on it, and for informing evidence-based decision-making. Monitoring allows the setting of benchmarks and improves our capacity to ascertain whether the environment is improving, staying the same, or deteriorating over time. Monitoring may also assist with the identification of thresholds, beyond which environmental loss and degradation accelerates. The findings from monitoring programs can feed into an adaptive management approach and allow responses to be tailored to halt the decline and improve the state of the environment.

In the realm of continuous improvement the adaptive management framework provides a structured and iterative process to assist natural resource planners and managers. It results in the gradual decrease in uncertainty and improved management by learning from outcomes. The framework is intended to be flexible and responsive to new knowledge gained by targeting research to management needs. Monitoring, evaluation, review and reporting of progress are core components, as is continually improving stakeholder capacity, skills and learning.

This report has outlined predominantly public sector initiatives in relation to environmental performance. However, it is acknowledged that this is matched by a range of private sector activities and it is hoped that future reports will draw on these further. There remain many gaps in terms of what can be reported on in assessing the state of the environment. Targeting these gaps in future reporting cycles and integration of existing monitoring initiatives will help improve the comprehensiveness of state of the environment reporting.

Many programs are incorporating monitoring, evaluation and reporting into their business and using these to inform such products as report cards and outlook reports. Further alignment with state of environment reporting will enhance capacity to report on overall environmental performance. One of the biggest issues remains that of the collection or access to the long-term data sets needed to be able to confidently set baselines and monitor trends over time.

Key responses to the state of the environment going forward include effectively managing protected areas, such as national and marine parks, and assisting landholders in sustainable land management. Additionally, developing strategies and undertaking targeted projects that address the environment at a range of scales, for example catchment, landscape, ecosystem and species specific, are crucial. Appropriate regulation and compliance are also essential, as are planning and management tools to guide decision-making. The achievement of good environmental outcomes can not be done without knowledge and by one party alone, education and partnerships are vital.

The complex and interrelated nature of many of the issues associated with the environment are further confounded by the fact that the state of the environment and the success of initiatives addressing it are often not immediately obvious due to time lags. Thus, the role of ongoing long-term monitoring programs and the assessment of the initiatives through such processes as state of the environment reporting becomes apparent. It is just as important that response initiatives are assessed for their efficiency and effectiveness, as it is to monitor the state of the environment. Both are essential for evaluating environmental performance.

In this reporting cycle the role of episodic natural hazards (e.g. floods, tropical cyclones and bushfires) that can form part of life in Queensland, and their escalation into natural disasters, has also brought to the fore the importance of emergency management for safer, sustainable communities. This has emphasised the importance of managing the interface between communities and the natural environment in relation to where people live, where infrastructure facilities are placed, where chemicals and wastes are stored and what agricultural and industrial practices are used. Technological advances may help offer alternative approaches to both managing environmental performance, as well as assisting in the restoration of Queensland's environmental assets.

Food security and protection of prime agricultural land is emerging as an issue of local, national and international concern. The preservation of productive farming lands is crucial for future food production, as is the management of challenges arising from multiple uses by mining and energy sectors. This requires increased monitoring of resource condition to inform future policy development.

Many of the key challenges discussed in this report are likely to form part of the discussion in the next reporting cycle due to their ongoing, complex and interrelated nature. Arresting the decline in biodiversity; enhancing sustainable practices that help with the achievement of ecologically sustainable development; adapting to a highly variable and changing climate; implementing planning and regulatory frameworks that assist with managing the many different uses for our water and land; and protecting, maintaining and restoring our significant natural and cultural assets all fall into this category.

While Queensland faces a number of challenges into the future, these challenges also represent opportunities.

## 8 References





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## Units and measurements

<b>µm</b>	micrometre, a unit of length equal to one millionth ( $10^{-6}$ ) metre
<b>cm</b>	centimetre, a unit of length equal to one hundredth ( $10^{-2}$ ) metre
<b>CO<sub>2-e</sub></b>	carbon dioxide equivalent. The amount of carbon dioxide that would cause the same amount of global warming as the greenhouse gas under discussion
<b>FPC</b>	Foliage Projective Cover
<b>global hectares (gha)</b>	used to measure ecological footprint, equals one hectare of biologically productive space with world-average productivity
<b>gigalitre</b>	a unit of volume equal to one thousand million ( $10^9$ ) litres
<b>gigawatt hour (GWh)</b>	unit of electrical energy equal to one thousand million ( $10^9$ ) watt hours
<b>ha</b>	hectare, a unit of area equivalent to ten thousand ( $10^4$ ) square metres. There are 100 ha in one km <sup>2</sup>
<b>kg</b>	kilogram, a unit of weight equal to one thousand ( $10^3$ ) grams
<b>kg/DM/ha</b>	kilograms of dry matter per hectare
<b>KL</b>	kilolitre, a unit of volume equal to one thousand ( $10^3$ ) litres
<b>km</b>	kilometre, a unit of length equal to one thousand ( $10^3$ ) metres
<b>km<sup>2</sup></b>	square kilometre, a unit of area equal to one million ( $10^6$ ) square metres
<b>KW</b>	kilowatt, a unit of power equal to one thousand ( $10^3$ ) watts
<b>L</b>	litre, a unit of volume equal to one thousand ( $10^3$ ) millilitres
<b>m</b>	metre, a unit of length equal to one hundred ( $10^2$ ) centimetres
<b>m<sup>2</sup></b>	square metre, a unit of area equal to one thousand ( $10^3$ ) square centimetres
<b>m<sup>3</sup></b>	cubic metre, a three-dimensional unit of volume equal to one million ( $10^6$ ) cubic centimetres
<b>ML</b>	megalitre, a unit of volume equal to one million ( $10^6$ ) litres
<b>mm</b>	millimetre, a unit of length equal to one thousandth ( $10^{-3}$ ) of a metre
<b>Mt</b>	mega tonne, a unit of weight equal to one million ( $10^6$ ) kilograms
<b>MW</b>	megawatt, a unit of power equal to one million ( $10^6$ ) watts
<b>ppb</b>	parts per billion
<b>ppm</b>	parts per million
<b>t</b>	tonne, a unit of weight equal to one thousand ( $10^3$ ) kilograms
<b>VKT</b>	vehicle kilometres travelled
<b>y or yr</b>	year

## Terms and abbreviations

<b>ABARE</b>	Australian Bureau of Agricultural and Resource Economics
<b>ABS</b>	Australian Bureau of Statistics
<b>ACF</b>	Australian Conservation Foundation
<b>acid sulfate soils</b>	soil or sediment containing highly acidic soil horizons or layers affected by the oxidation of iron sulfides (actual acid sulfate soils) and/or soil or sediment containing iron sulfides or other sulfidic material that has not been exposed to air and oxidised (potential acid sulfate soils)
<b>ACNT</b>	Australian Council of National Trusts
<b>ACRIS</b>	Australian Collaborative Rangeland Information System
<b>AES</b>	Areas of ecological significance
<b>AgForce</b>	a peak organisation representing Queensland's rural producers, ensuring long-term growth, viability, competitiveness and profitability of cattle, grain, sheep and wool industries in Queensland
<b>AHD</b>	Australian Height Datum
<b>Air EPP</b>	Environmental Protection (Air) Policy 2008
<b>Air NEPM</b>	National Environment Protection (Ambient Air Quality) Measure (1998)
<b>air toxics</b>	a range of pollutants, mainly organic compounds that cause or are suspected of causing long-term health effects in humans
<b>Air Toxics NEPM</b>	National Environment Protection (Air Toxics) Measure 2004
<b>algal bloom</b>	a concentration of phytoplankton sufficient to impair water quality
<b>alien species</b>	a species occurring in an area outside its historically known natural range as a result of intentional or accidental dispersal by human activities (including exotic organisms, genetically modified organisms and trans-located species)
<b>alluvium</b>	sedimentary material deposited or in transit as a result of erosional processes, usually by flowing water
<b>ambient</b>	environmental conditions surrounding an organism or area. Usually indicates normal or modified environmental conditions
<b>ametryn</b>	herbicide used to control broadleaf and grass weeds in crops
<b>AMLPL</b>	Abandoned Mine Lands Program
<b>anthropogenic</b>	produced or caused by human activity <i>see also</i> <b>biogenic</b>
<b>ANZECC</b>	Australian and New Zealand Environment and Conservation Council
<b>APLC</b>	Australian Plague Locust Commission
<b>APVMA</b>	Australian Government. Australian Pesticides and Veterinary Medicines Authority
<b>aquaculture</b>	the commercial culture of aquatic plants or animals in fresh or salt water
<b>aquifer</b>	rock or sediment in a geological formation capable of being permeated so that it can transmit and store water <i>see also</i> <b>groundwater</b>



<b>arid zone</b>	a dry and hot area, with little rainfall (less than 300 mm per annum). In some arid landscapes the vegetation cover is sparse or absent
<b>artificial waterways</b>	an artificial channel, lake, harbour or embayment intended for ornamental, recreational or engineering purposes
<b>atmosphere</b>	composite layer of colourless, odourless gases, known as air, surrounding the Earth; it shows distinct vertical zonation <i>see also</i> <b>stratosphere</b>
<b>atrazine</b>	herbicide which can be used both pre and post-emergence for the control of grass and broadleaf weeds in crops
<b>AussieGRASS</b>	Australian Grassland and Rangeland Assessment by Spatial Simulation. A computerised spatial simulation (model) of the condition of Queensland's grasslands developed through the Land and Water Resources Research and Development Corporation
<b>bagasse</b>	fibrous by-product of the sugar milling process
<b>ballast water</b>	water carried in tanks to maintain stability in a ship. It is normally discharged when the ship is loaded with cargo
<b>barrage</b>	construction across a watercourse to increase the depth of water to assist navigation or irrigation
<b>base flow</b>	stream flow entering from groundwater seepage into a stream or river
<b>basin</b>	geographical land area draining into a lake or river, also referred to as drainage basin or watershed
<b>BCC</b>	Brisbane City Council
<b>benzene</b>	a toxic chemical found in coal tar and cigarette smoke and used as an industrial solvent, as a petrol additive, and in some paints or varnishes; a known carcinogen
<b>benzo(a)pyrene</b>	C <sub>20</sub> H <sub>12</sub> a mutagenic and highly carcinogenic, crystalline yellow solid, found in coal tar, in automobile exhaust fumes, tobacco smoke, wood smoke and in chargrilled food
<b>biocapacity</b>	the capacity of a given biologically productive area to generate an ongoing supply of renewable resources and to absorb its spillover wastes
<b>biodiversity</b>	the variety of all life forms: the different plants, animals and micro-organisms, the genes they contain and the ecosystems they form
<b>biological control</b>	controlling a pest by the use of its natural enemies, for example, predators, parasites and disease-producing organisms
<b>biological provinces</b>	support distinct assemblages of organisms, different community structures, and different levels of production in polar, subpolar, subtropical, and tropical regions. Many species overlap near the edges of provinces in transition regions and coastal boundary currents
<b>biomass</b>	total mass of an organism or organisms living in a particular area, for example the biomass of all the trees, grasses and shrubs
<b>bioregion (biogeographic region)</b>	an extensive region distinguished from adjacent regions by its broad physical and biological characteristics
<b>biosecurity processes</b>	programs and structures in place to prevent entry by, or to protect people and

	animals from, the adverse impacts of invasive species and pathogens
<b>biosolids</b>	organic products from the treatment of <b>sewage</b> ; also known as sewage sludge
<b>biota</b>	all the organisms in a given area
<b>BMRG</b>	Burnett Mary Regional Group
<b>BoM</b>	Bureau of Meteorology
<b>bore</b>	a hole drilled in the Earth's surface to access groundwater
<b>bycatch</b>	species taken incidentally in a fishery where other species are the target; often discarded
<b>by-product</b>	any commercially valuable product inadvertently created while targeting the primary product
<b>carbon sequestration</b>	processes to remove carbon from the atmosphere, involving capturing and storing carbon in vegetation, soil, oceans or another storage facility
<b>carrying capacity</b>	maximum stocking rate that an area of grazing land can support throughout the greatest period of stress each year
<b>catchment</b>	the area within which rainfall contributes to run-off to a particular water body
<b>CBD</b>	Convention on Biological Diversity, Montreal
<b>CCSP</b>	Climate Change Science Program
<b>CEC</b>	Commission for Environmental Cooperation, Canada
<b>census</b>	periodic process of obtaining a population count and information about every member of the population
<b>Chain volume measure</b>	derived by linking together movements in volumes, calculated using the average prices of the previous financial year, and applying the compounded movements to the current price estimates of the reference year (see <a href="http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/MSB/feature/chain">http://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/MSB/feature/chain</a> )
<b>chlorophyll-a</b>	plant pigment (used as a measure of algal concentrations in water)
<b>CHMP</b>	Cultural Heritage Management Plan
<b>CIRMS</b>	Compliance Information Register Management System
<b>cleantech</b>	clean technology
<b>climate variability</b>	the natural year-to-year and season-to-season variation of the climate system
<b>CNG</b>	compressed natural gas
<b>CO</b>	carbon monoxide
<b>CO<sub>2</sub></b>	carbon dioxide, an odourless, colourless gas produced during respiration, decomposition of organic material and combustion
<b>COAG</b>	Council of Australian Governments
<b>coast</b>	all areas within or neighbouring the foreshore
<b>Coastal Act</b>	<i>Coastal Protection and Management Act 1995</i>
<b>Coastal Management Plans</b>	plans that establish coastal management; include protection, conservation,

	rehabilitation, management and ecological sustainable development of the coastal zone
<b>coastal resources</b>	the natural and cultural resources of the coastal zone
<b>coastal waters</b>	Queensland waters to the limit of the highest astronomical tide
<b>coastal zone</b>	coastal waters within 5 km of the coastline or 10 m above sea level (AHD) in which there are physical features, ecological or natural processes or human activities that affect, or potentially affect, the coast or coastal resources
<b>community</b>	a group of people, plants or animals living in a particular local area
<b>construction and demolition waste</b>	non-putrescible waste arising from construction or demolition activity; has the potential for resource recovery. It may include materials such as brick, timber, concrete and steel
<b>contaminant</b>	an undesirable or harmful impurity
<b>contaminated land</b>	land contaminated by a hazardous substance
<b>Contaminated Land Register (CLR)</b>	a register of proven contaminated land ('risk' sites) that is causing or may cause serious environmental harm
<b>CRC</b>	Cooperative Research Centre
<b>CSG</b>	coal seam gas
<b>CSIRO</b>	Commonwealth Scientific and Industrial Research Organisation
<b>cyanobacteria</b>	microscopic, photosynthetic aquatic organisms; commonly referred to as blue-green algae
<b>CYPAL</b>	Cape York Peninsula Aboriginal Land
<b>DCCEE</b>	Australian Government, Department of Climate Change and Energy Efficiency
<b>declared pest</b>	animals are declared a pest and managed under the <i>Land Protection (Pest and Stock Route Management) Act 2002</i> and Regulations 2003. Pest animals are assessed as declared or non-declared and assigned to Class 1, 2 or 3
<b>declared weed</b>	the <i>Land Protection (Pest and Stock Route Management) Act 2002</i> provided a framework and powers for improving management of weeds. Through this Act weeds are assessed as declared or non-declared and classed (Class 1, 2 or 3)
<b>DEEDI</b>	Queensland Government, Department of Employment, Economic Development and Innovation
<b>degradation</b>	a decline in the quality of an environment or habitat
<b>Delbessie Agreement</b>	also known as the <b>State Rural Leasehold Land Strategy</b> , is a framework of legislation, policies and guidelines supporting the environmentally sustainable, productive use of rural leasehold land for agribusiness
<b>DERM</b>	Queensland Government, Department of Environment and Resource Management
<b>desalination</b>	production of fresh water by removing salt from seawater or other saline (salty) solutions
<b>DETA</b>	Queensland Government, Department of Education, Training and the Arts
<b>development</b>	carrying out building work; carrying out plumbing or drainage work; carrying

	out operational work; reconfiguring a lot; or making a material change of use of premises
<b>DEWHA</b>	Australian Government, Department of Environment, Water, Heritage and the Arts
<b>DFHCSIA</b>	Australian Government, Department of Families, Housing, Community Services and Indigenous Affairs
<b>diffuse source</b>	(pollution) from a broad area or many small sources, such as run-off from fields or urban areas <i>see also</i> <b>point source</b>
<b>dioxins</b>	chemical compounds largely formed as waste products or by-products in the manufacture of other chemicals. Some are hazardous to humans at relatively low levels
<b>DIP</b>	Queensland Government, Department of Infrastructure and Planning
<b>diuron</b>	herbicide and algaecide used for pre and post-emergent control of both broadleaf and grass weeds in agriculture. It is also used to control weeds and algae in and around water bodies and is a component of marine antifouling paints
<b>dissolved oxygen</b>	amount of oxygen dissolved in water
<b>dissolved nitrogen</b>	amount of nitrogen dissolved in water
<b>dissolved phosphorus</b>	amount of phosphorus dissolved in water
<b>DIT</b>	Australian Government, Department of Infrastructure and Transport
<b>DLGP</b>	Queensland Government, Department of Local Government and Planning
<b>DNRM</b>	Queensland Government, Department of Natural Resource and Mines
<b>domestic animals</b>	animals directly managed by humans <i>see also</i> <b>feral animals</b>
<b>domestic waste</b>	waste resulting from ordinary domestic use or occupation of a dwelling
<b>DPC</b>	Queensland Government, Department of Premier and Cabinet
<b>DPIF</b>	Queensland Government, Department of Primary Industries and Fisheries
<b>DPSIR</b>	driving forces-pressures-state-impacts-responses
<b>drainage division</b>	an identified water catchment; Australia has been classified into 12 drainage divisions
<b>dredging</b>	using plant or equipment to gather materials or objects from the bed of any waters
<b>DSEWPC</b>	Australian Government, Department of Sustainability, Environment, Water, Population and Communities
<b>DSI</b>	Dust Storm Index
<b>DTMR</b>	Queensland Government, Department of Transport and Main Roads
<b>dune</b>	a ridge of sand created by the wind; found in deserts or near lakes or oceans
<b>East Coast Otter Trawl (ECOT)</b>	trawling in eastern Queensland coastal waters using otter trawling techniques (a particular type of equipment used to capture prawns and scallops)
<b>East Coast Trawl Fishery</b>	trawls along the eastern Queensland coastal waters targeting a variety of



<b>(ECTF)</b>	species, including prawns and scallops, depending on the type of equipment used
<b>EBFM</b>	Ecosystem Based Fisheries Management
<b>ecoBiz</b>	the EPA's signature partnership program with Queensland business and industry. Assists businesses by identifying efficiencies in waste, water and energy for financial and environmental benefits
<b>eco-efficiency</b>	maximising efficiency of production processes while minimising impact on the environment
<b>ecological footprint</b>	a measure of how much productive land and water an individual, a city, a country, or humanity requires to produce all the resources they consume and to absorb all the waste they generate, measured in global hectares
<b>ecosystem</b>	a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit
<b>ecosystem services</b>	goods and services provided by natural ecosystems that benefit, sustain and support the wellbeing of people
<b>EEA</b>	European Environment Agency
<b>EFAP</b>	Environmental Flows Assessment Program
<b>effluent</b>	a discharge or emission of a waste product
<b>EHMP</b>	Ecosystem Health Monitoring Program
<b>EIU</b>	Economist Intelligence Unit
<b>electrical conductivity</b>	a measure of the ability of a solution to conduct an electric current between electrodes placed in solution; the value obtained relates to the nature and amount of salts present in solution and increases with concentration
<b>El Niño</b>	a warm water current that periodically flows southwards along the coast of Ecuador and Peru in South America, replacing the usually cold northwards-flowing current. The name refers to the Christ child as the current usually appears around Christmas. The opposite phase is called <b>La Niña</b>
<b>emission</b>	gaseous or liquid discharge given out by a source
<b>endangered species</b>	a plant or animal that is in danger of becoming extinct or whose survival in the wild is unlikely if threatening processes continue
<b>endemic</b>	native to a particular area and found (naturally) nowhere else
<b>ENSO El Niño-Southern Oscillation</b>	a regional climate pattern in the Pacific characterised by fluctuations of surface pressure and mean sea levels and sea temperatures between the east and west Pacific. These fluctuations take place over time scales of 3–7 years and cause changes in average rainfall, wind speed and temperature in Pacific and South American countries, but also have an influence on weather patterns outside this region as far as Africa. ENSO causes drought conditions over eastern Australia. <i>See also</i> <b>El Niño</b> and <b>La Niña</b>
<b>entitlement</b>	an approval or authority to take a product
<b>Environmental Impact Statement</b>	a report containing both the beneficial and adverse (environmental, social and economic) impacts potentially arising from a project; measures to minimise adverse impacts; feasible alternative ways of carrying out the project; a

	proposed environmental management plan; and any other information needed by administering authorities to make a regulatory decision
<b>Environmental Management Plan</b>	a document that proposes conditions and mechanisms to manage the potential environmental impact of a project
<b>Environmental Management Program</b>	a specific program that, when approved, achieves compliance with the EP Act for specified matters by reducing environmental harm, or detailing the transition to an environmental standard
<b>Environmental Management Register (EMR)</b>	land use planning and management register that provides information on historical and current land use, including whether the land has been or is currently used for a notifiable activity, or has been contaminated by a hazardous contaminant
<b>Environmental Protection Order</b>	an order issued by an administering authority requiring an individual to take action or to desist from an activity
<b>environmental value</b>	a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety, or another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation
<b>environmentally relevant activity</b>	an activity which when carried out will or may release into the environment contaminants that will or may cause environmental harm. ERAs are prescribed in Schedule 1 of the Environmental Protection Regulation 1998; they can be of level 1 or level 2, depending on their risk to the environment
<b>EP Act</b>	<i>Environmental Protection Act 1994</i>
<b>EP Reg</b>	Environmental Protection Regulation 2008
<b>EPA</b>	Queensland Government, Environmental Protection Agency
<b>EPBC Act</b>	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cwlth)
<b>EPHC</b>	Environment Protection and Heritage Council
<b>ESD</b>	ecologically sustainable development is development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends
<b>estuary</b>	area of a coastal river mouth, characterised by tidal effects and mixing of fresh with sea water
<b>eutrophication</b>	over-enriched by nutrients, primarily nitrogen and phosphorus, stimulating excessive growth of organisms and depletion of oxygen concentration
<b>exceedence</b>	an occasion when a goal, guideline or standard is exceeded
<b>existing urban areas/localities</b>	areas currently developed for urban purposes, areas with current approvals to be developed for urban purposes, and areas identified to be developed for urban purposes in currently approved planning instruments such as local government planning schemes
<b>exotic species</b>	a non-native species that has been introduced to a region
<b>fauna</b>	all of the animals found in an area <i>see also</i> <b>flora</b>
<b>FBA</b>	Fitzroy Basin Association
<b>feral animals</b>	animals that have reverted to a wild state from domestication <i>see also</i> <b>domestic</b>

	<b>animals</b>
<b>fern</b>	any of numerous flowerless, seedless vascular plants having roots, stems, and fronds and reproducing by spores classified in the Division Pteridophyta (of the phylum <i>Filicinophyta</i> )
<b>fern allies</b>	pteridophytes of other classes than Filicopsida
<b>flora</b>	all of the plants found in an area <i>see also</i> <b>fauna</b>
<b>flowering plant</b>	a seed-bearing plant whose ovules, and hence seeds, develop within an enclosed ovary (angiosperm)
<b>forb</b>	A non woody plant other than a grass, sedge, rush etc
<b>formaldehyde</b>	a highly toxic, carcinogenic, colourless, pungent chemical used as a disinfectant and preservative
<b>fossil fuel</b>	any hydrocarbon deposit that can be burned for heat or power, such as coal, oil and natural gas; produces carbon dioxide when burnt
<b>FPC</b>	Foliage Protective Cover
<b>fragmentation</b>	when used in the context of vegetation or habitat, refers to division and isolation of vegetation/habitat by vegetation clearing, isolating species and limiting genetic flow
<b>GABCC</b>	Great Artesian Basin Coordinating Committee
<b>GABSI</b>	Great Artesian Basin Sustainability Initiative
<b>GBR</b>	Great Barrier Reef
<b>GBRMPA</b>	Great Barrier Reef Marine Park Authority
<b>GBRWHA</b>	Great Barrier Reef World Heritage Area
<b>GCI</b>	Ground Cover Index
<b>GCR</b>	Global Change Research
<b>global warming</b>	a rise in world temperature expected from increased concentrations of greenhouse gases
<b>GNA</b>	GhostNets Australia
<b>Great Artesian Basin</b>	the largest system of groundwater aquifers in Australia
<b>green waste</b>	garden, food and wood wastes that are compostable and/or can be shredded and used for mulching
<b>green zone</b>	marine national park areas which people can access, and where non-extractive activities like boating, swimming and snorkelling are allowed. All types of fishing, including trawling, and all collecting and extractive activities are prohibited
<b>greenhouse gas (GHG)</b>	gas occurring naturally or produced or by human activity which enhances the natural ‘greenhouse effect’. Greenhouse gases include carbon dioxide, methane, halocarbons, nitrogen oxides, ozone and water vapour
<b>gross domestic product (GDP)</b>	total value of goods and services produced by a nation’s economy during a period of one year

<b>gross state product (GSP)</b>	total market value of all final goods and services produced in a state in a given year, equal to total consumer, investment and government spending, plus value of exports, minus value of imports. Also measures the sum of incomes earned
<b>groundwater</b>	water occurring below the ground surface <i>see also</i> <b>aquifer</b>
<b>gully erosion</b>	a form of erosion involving the formation of deep, steep-sided channels or gullies which cannot be removed by cultivation <i>see also</i> <b>rill erosion, sheet erosion</b>
<b>gymnosperm</b>	a seed-bearing plant with the ovules borne on the surface of a sporophyll
<b>habitat</b>	the place where an animal or a plant normally lives and reproduces
<b>HDI</b>	Human Development Index
<b>hexazinone</b>	herbicide used to control broadleaf and grass weeds and woody plants in crops
<b>hydrocarbon</b>	an organic molecule containing hydrogen and carbon, the major components of petroleum
<b>IBRA</b>	Interim Biogeographical Regionalisation for Australia
<b>ICOMOS</b>	International Council for Monuments and Sites
<b>IHDI</b>	Inequality-adjusted Human Development Index
<b>indicator</b>	a parameter such as pH that can be used to provide a measure of the quality or condition of the environment
<b>industrial waste</b>	waste produced by business and commerce; includes waste from schools, restaurants, offices, retail and wholesale businesses, and manufacturing industries
<b>infill and redevelopment</b>	development occurring in existing urban areas
<b>infill development</b>	new development that occurs within established urban areas where the site or area is either vacant or previously been used for another urban purpose
<b>inlet</b>	an opening through which ocean waters enter and leave an enclosed body of water
<b>intertidal</b>	between the levels of low and high tide
<b>invasive species</b>	an exotic species likely to cause environmental, economic or social harm
<b>invertebrates</b>	group of animals without a backbone composed of vertebrae, that is, segments or bone comprising a column through which the spinal cord passes, not including protozoans <i>see also</i> <b>vertebrate</b>
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>IPO</b>	Interdecadal Pacific Oscillation
<b>IRTP</b>	Integrated Regional Transport Plan
<b>K</b>	potassium
<b>Kyoto Protocol</b>	an amendment to the international treaty on climate change, assigning mandatory emission limitations for the reduction of greenhouse gas emissions
<b>La Niña</b>	the opposite of an <b>El Niño</b> phase; occurs when the SOI is strongly positive. La Niña phases are associated with higher than usual rainfall in eastern and



	northern Australia
<b>Lacustrine wetlands</b>	large, open, water-dominated systems (for example, lakes) larger than 8 hectares. This definition applies to modified systems (for example, dams) which are similar to lacustrine systems (for example, deep, standing, or slow moving waters)
<b>lagoon</b>	a body of shallow water separated from deeper waters by a shallow or exposed sandbank, coral reef, or similar feature
<b>landfill</b>	a specially engineered site for disposing of solid waste on land
<b>levee</b>	a constructed embankment designed to prevent flooding
<b>Local Government Area (LGA)</b>	a geographical area under the responsibility of an incorporated local government council, or an Aboriginal or Island Council in Queensland. Larger LGAs incorporate smaller Census collection areas, including Statistical Local Areas (SLAs) and Collection Districts (CDs)
<b>LULUCF</b>	Land Use, Land Use Change and Forestry
<b>lyngbya</b>	<i>Lyngbya majuscula</i> , a native cyanobacterium that can form blooms which are toxic to humans
<b>M&amp;GSQ</b>	Museum and Gallery Services Queensland
<b>MA</b>	Millennium Ecosystem Assessment
<b>macro-invertebrates</b>	animals without backbones, visible to the naked eye
<b>macropods</b>	marsupials belonging to the Family Macropodidae, which includes kangaroos, wallabies, tree-kangaroos and pademelons
<b>mangroves</b>	tropical plant species that grow in wetlands at the edge of the ocean
<b>marine</b>	relating to the saltwater of seas or oceans, coastal zones and tidal areas
<b>MDB</b>	Murray–Darling Basin
<b>methane CH<sub>4</sub></b>	a major greenhouse gas produced by rice paddies, some fossil fuel combustion, and enteric fermentation in ruminant animals <i>see also</i> <b>greenhouse gas</b>
<b>migration</b>	periodic movement of a species from one area to another, often a response to seasonal change
<b>Montreal Process</b>	the informal agreement by the Montreal Process Group of countries (currently 12 including Australia) to work towards the implementation of a comprehensive set of criteria and indicators for forest conservation and sustainable management
<b>N</b>	nitrogen
<b>n/a or n.a.</b>	(in tables) where not otherwise specified, means not applicable or not available
<b>National Pollutant Inventory (NPI)</b>	publicly accessible database containing information on the types and amounts of pollutants being emitted to the Australian environment
<b>naturalised (pest)</b>	a pest that has a self-sustaining population in the environment to which it has been introduced
<b>naturalised species</b>	a species introduced to an area outside its natural range and that has established self-sustaining populations

<b>Nature Refuge Program</b>	a program protecting particular species and ecosystems where landholders actively pursue management for sustainability and the rebuilding of natural capital
<b>NchEM</b>	National Framework for Chemical Environmental Management
<b>NEMC</b>	National Emergency Management Committee for the Council of Australian Governments
<b>NEPM</b>	National Environment Protection Measure
<b>NGRMG</b>	Northern Gulf Natural Resource Management Group Ltd
<b>no.</b>	number
<b>NO<sub>2</sub></b>	nitrogen dioxide
<b>NOAA AVHRR</b>	National Oceanic and Atmospheric Administration Satellite and Information Service with Advanced Very High Resolution Radiometer
<b>non-remnant vegetation</b>	is vegetation that fails to meet the structural and/or floristic characteristics of remnant vegetation. It may include regrowth, heavily thinned or logged and significantly disturbed vegetation, and cleared areas. Non-remnant vegetation may retain significant biodiversity values and includes areas mapped as 'high-value' regrowth
<b>NO<sub>x</sub></b>	Oxides of nitrogen. Nitrogen monoxide (NO) and nitrogen dioxide (NO <sub>2</sub> ) are the most common
<b>NRM</b>	natural resource management
<b>NSW</b>	New South Wales
<b>nutrients</b>	substances such as nitrogen and phosphorus, required for the growth of animals and plants
<b>NWC</b>	Australian Government, National Water Commission
<b>obesogenic environment</b>	an environment that promotes excess weight gain
<b>observant telemetry system</b>	enables the monitoring and control of a wide range of farm infrastructure by combining software with solar powered telemetry units
<b>OECD</b>	Organization for Economic Cooperation and Development
<b>OESR</b>	Office of Economic and Statistical Research
<b>organic matter</b>	compound containing carbon derived from living organisms, plant and animal residue
<b>outbreak</b>	a sudden occurrence or increase in a pest population which may result in environmental damage
<b>Ozone (O<sub>3</sub>)</b>	a gas made of three oxygen atoms which occurs naturally in the atmosphere, where it protects the Earth from solar ultraviolet radiation
<b>P</b>	phosphorus
<b>Palustrine wetlands</b>	primarily vegetated non-channel-environments of less than 8 hectares. They include billabongs, swamps, bogs, springs and soaks and have more than 30% emergent vegetation
<b>pathogen</b>	a micro-organism capable of causing disease in another organism

<b>Pb</b>	lead
<b>pest</b>	a general term for organisms which may cause illness or damage or consume food crops and other materials important to humans. An organism that is considered a nuisance to humans
<b>pH</b>	a measure of acidity or alkalinity, expressed on a logarithmic scale from 1 to 14. 1 is most acid, 7 is neutral and 14 is most alkaline
<b>PHC</b>	petroleum hydrocarbon
<b>photochemical oxidants</b>	air pollutants formed by the activation of sunlight on oxides of nitrogen and hydrocarbons
<b>plague</b>	a rapid and destructive increase in numbers of a population
<b>PM<sub>10</sub></b>	particles with an equivalent aerodynamic diameter of 10 micrometres
<b>PM<sub>2.5</sub></b>	particles with an equivalent aerodynamic diameter of 2.5 micrometres
<b>point source</b>	source of pollution that can be pinpointed such as a drain or chimneystack <i>see also</i> <b>diffuse source</b>
<b>pollutant</b>	any substance that causes harm to the environment
<b>polycyclic aromatic hydrocarbons (PAHs)</b>	are a group of more than 100 carbon-based chemicals which contain at least two benzene (six sided) rings. PAH are formed by the incomplete combustion of coal, oil, petrol, wood, tobacco products, garbage and other organic materials. PAH are also produced by char-grilling meats. A few PAH are used in medicines and to make dyes, plastics and pesticides (e.g. naphthalene). Benzo(a)pyrene is the best studied and one of the most toxic of the PAH. It is usually found in combination with a large number of other PAH and can be used as an indicator for this group of air pollutants. PAH may irritate the eyes, skin and respiratory tract. Acute exposure to high levels may cause headaches, nausea, vomiting and abdominal pain
<b>porous</b>	having interconnected pores or small holes, allowing the passage of water or gases
<b>QCCCE</b>	Queensland Climate Change Centre of Excellence
<b>QG</b>	Queensland Government
<b>QH</b>	Queensland Government, Queensland Health
<b>QHC</b>	Queensland Heritage Council
<b>Qld</b>	Queensland
<b>QMDB</b>	Queensland Murray–Darling Basin
<b>QPWS</b>	Queensland Parks and Wildlife Service
<b>QSEIF</b>	Queensland Sustainable Energy Innovation Fund
<b>QT</b>	Queensland Government, Queensland Transport
<b>quality objective</b>	a numerical concentration limit or narrative statement that will achieve, protect and enhance designated uses and environmental values at a specific site
<b>QWC</b>	Queensland Water Commission
<b>rabbit calicivirus</b>	also known as rabbit haemorrhagic disease; a virus introduced to Australia as a

	biological control agent for rabbits
<b>Ramsar</b>	Convention on Wetlands of International Importance Especially as Waterfowl Habitat, entered into force in 1975. The Convention, including the List of Wetlands of International Importance established under it, is administered by the IUCN
<b>RE</b>	Regional Ecosystem
<b>recharge</b>	downward flow of water through soil and underlying rock to an aquifer
<b>recycling</b>	the activity of recovering used materials from the solid waste stream for use as a substitute for raw materials in the manufacture of new products including, for the purposes of this report, energy recovery
<b>Reef Plan</b>	Reef Water Quality Protection Plan
<b>rehabilitation</b>	restoration, repair or improvement of specific ecosystem services in a degraded ecosystem or habitat
<b>remnant vegetation</b>	is defined as vegetation where the dominant canopy has greater than 70 per cent of the height and greater than 50 per cent of the cover relative to the undisturbed height and cover of that stratum and dominated by species characteristic of the vegetation's undisturbed canopy
<b>repatriation</b>	process of returning a person back to one's place of origin
<b>reservoir</b>	pond, basin, or lake, either natural or artificial, for the storage, regulation and control of water
<b>rill erosion</b>	a form of erosion involving formation of shallow gutters which may be removed by cultivation <i>see also</i> <b>gully erosion, sheet erosion</b>
<b>riparian</b>	relating to the bank of a river or other water body
<b>riverine</b>	relating to, similar to, or formed by a river, stream or creek
<b>riverine wetland</b>	all wetlands and deepwater habitats within a channel. The channels are naturally or artificially created, periodically or continuously contain moving water, or connecting two bodies of standing water
<b>run-off</b>	the portion of rain not immediately absorbed into the soil which becomes a surface flow
<b>salinity</b>	concentration of mineral salts dissolved in water, can be measured using electrical conductivity <i>see also</i> <b>electrical conductivity</b>
<b>saltmarsh</b>	an intertidal plant community complex dominated by herbs and low shrubs
<b>savannah</b>	a vegetation type with scattered trees over a grassland, usually found in subtropical areas
<b>SCEW</b>	Standing Council on Environment and Water
<b>SEAP</b>	Stream and Estuary Assessment Program
<b>sediment</b>	matter that settles to the bottom of a water body
<b>SEEA</b>	System of Environmental-Economic Accounts
<b>senescence</b>	the growth phase in a plant or plant part (as a leaf) from full maturity to death
<b>SEQ</b>	South East Queensland



<b>SEQEM</b>	South East Queensland Event Monitoring
<b>SEQFBC</b>	South East Queensland Fire and Biodiversity Consortium
<b>serious environmental harm</b>	environmental harm that causes actual or potential harm to environment values that is irreversible, of a high impact or widespread or of an area of high conservation value or special significance. Serious environmental harm may also be harm that causes or potentially causes loss, damage, or clean-up of property of a value of \$50 000 or more
<b>sewage</b>	waste matter discharged into a <b>sewerage</b> system
<b>sewerage</b>	a system for collecting, treating and disposing of wastewater and refuse, usually with underground pipes and fittings
<b>sheet erosion</b>	the removal of a fairly uniform layer of soil from the land surface by raindrop splash and/or run-off <i>see also</i> <b>rill erosion, gully erosion</b>
<b>SLATS</b>	Statewide Landcover and Trees Study
<b>SO<sub>2</sub></b>	sulfur dioxide
<b>sodicity</b>	the amount of sodium held in a soil
<b>SoE</b>	state of the environment
<b>soil acidification</b>	a gradual increase in the acidity of soil as a consequence of a variety of natural processes and management actions
<b>spawning</b>	the process by which an organism produces others of its kind
<b>SPP</b>	state planning policy
<b>SRA</b>	Sustainable Rivers Audit
<b>STCRC</b>	Sustainable Tourism Cooperative Research Centre
<b>stochastic event</b>	cannot be predicted with certainty but the relative frequency with which they occur in a long series of trial remains stable
<b>storm surge</b>	a long gravity wave with a length scale similar to the size of the generating tropical cyclone, which lasts for several hours depending on the cyclone size and speed of movement. The surge usually consists of a single passing wave that elevates or depresses the still water height
<b>stormwater</b>	body of water that goes into storm drains and empties into rivers, creeks, wetlands and oceans such as the portion of rainfall that does not infiltrate the soil and some household waste water
<b>stratosphere</b>	the region of the atmosphere roughly 15 to 20 km above the Earth's surface <i>see also</i> troposphere
<b>stratospheric ozone</b>	where the ozone layer occurs naturally <i>see also</i> <b>ozone layer</b>
<b>supplemented (flow)</b>	water flow that has been 'supplemented' by releases from a storage upstream
<b>suspended solids</b>	suspended particles in a water body <i>see also</i> <b>turbidity</b>
<b>sustainable development</b>	development that ensures the preservation and protection of resources and the environment today that does not damage prospects for use by future generations
<b>SWAN</b>	Surface Water Ambient Network

<b>tebuthiuron</b>	herbicide used to control weeds, woody and herbaceous plants, and sugar cane
<b>TEEB</b>	The Economics of Ecosystems and Biodiversity
<b>terrestrial</b>	land based
<b>threatened species</b>	a plant or animal that is endangered, vulnerable or presumed extinct
<b>threshold</b>	a fixed location or value where an abrupt change is observed
<b>toluene</b>	a clear toxic water-insoluble liquid, an additive for engine fuels and contained in exhaust gases, also used as an industrial solvent
<b>topsoil</b>	means the surface (top) layer of a soil profile, which is more fertile, darker in colour, better structured and supports greater biological activity than underlying layers. The surface layer may vary in depth depending on soil forming factors, including parent material, location and slope, but generally is not greater than about 300mm in depth from the natural surface
<b>toxicity</b>	effect of any substance that harms living organisms, described as acute (short-term) or chronic (long-term)
<b>TQ</b>	Tourism Queensland
<b>tropical cyclone</b>	a tropical depression of sufficient intensity to produce sustained gale force winds (at least 63 km/h). A 'severe tropical cyclone' produces sustained hurricane force winds (at least 118 km/h). Severe tropical cyclones correspond to the hurricanes or typhoons of other parts of the world
<b>turbidity</b>	optical measure of light-absorbing materials in a water sample; surrogate measure of suspended solids
<b>UNDP</b>	United Nations Development Programme
<b>UNEP</b>	United Nations Environment Programme
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>UNSD</b>	United Nations Statistics Division
<b>unsupplemented flow</b>	water flow that is not supplemented by releases from upstream storage
<b>urban footprint</b>	identifies land predominantly allocated to accommodate urban development up to 2026
<b>urbanisation</b>	process by which a country's population shifts from primarily rural to urban areas
<b>UWSRA</b>	Urban Water Security Research Alliance
<b>vertebrate</b>	an animal with a backbone composed of vertebrae, that is, segments or bone comprising a column through which the spinal cord passes see also invertebrate
<b>VOC</b>	volatile organic compound. An organic compound with a boiling point between 50 °C and 260 °C
<b>Walker Circulation</b>	highly variable air circulation patterns that occur on a vertical plane at the equator, and are strongly related to the El Niño-Southern Oscillation
<b>water used</b>	water actually 'consumed', by, for example, the irrigation of crops
<b>wetland</b>	areas of permanent or periodic/intermittent inundation, with water that is static or flowing fresh, brackish or salt, including areas of marine water, the depth of

	which at low tide does not exceed 6 metres
<b>WHA</b>	World Heritage Area
<b>WHO</b>	World Health Organization
<b>WMO</b>	World Meteorological Organization
<b>World Conservation Union</b>	formerly the IUCN International Union for Conservation of Nature and Natural Resources
<b>WQG</b>	Water Quality Guidelines
<b>WRP</b>	water resource plan
<b>WWF</b>	World Wildlife Fund
<b>xylene</b>	an aromatic hydrocarbon emitted into the atmosphere through combustion of organic matter such as wood, coal, and petroleum products. Motor vehicle emissions are the predominant source of xylenes in the urban air environment
<b>zoonotic</b>	a disease of animals that may be transmitted to humans under natural conditions