South-east Queensland Forests Agreement: conservation outcomes for forest fauna

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ABSTRACT

South-east Queensland (SEQ) was the target of 1 of 10 joint Commonwealth-State Governments comprehensive regional assessments (CRAs) conducted in preparation for Regional Forests Agreements (RFAs) in Australia during the 1990s/early 2000s. Work towards a SEQ RFA commenced in 1993, a SEQ Forests Agreement (so called because it did not in the end involve the Commonwealth Government as a partner) was signed in 1999, and is presently being implemented. Forests of SEQ are ecologically significant with high levels of faunal species diversity and endemism. Human population is high, and growing rapidly, placing habitats and species under threat. Improved conservation of forest biodiversity is a major goal of the SEQFA, stated objectives of the process include a world-class conservation reserve system and ecologically sustainable management of forests.

The SEQFA has, on the face of it, achieved its goal. The total area of National Park in the Region has more than doubled with 425,000 hectares of forest changing tenure from State Forest immediately. Logging is no longer permitted in all publicly-owned (i.e. National Park, State Forest and leasehold land) rainforest and almost 100% of wet sclerophyll habitats. It is to be progressively excluded from the remainder of publicly-owned forest over the ensuing 25 years. A commitment to greatly increase the establishment of native species plantations also has some potential to provide additional habitat for native fauna.

However, some compromises were required to reach agreement. Dry sclerophyll habitats were under-represented in National Parks in SEQ prior to the Forest Agreement (at 9% of pre-European extent) and remain so relative to other habitat types (at 20% of pre-European extent). Timber harvesting had traditionally been practised using the relatively conservative single-tree and small-group selection approaches. The Agreement has accepted the adoption of more intense harvesting practices to maintain woodflows to industry from publicly-owned forests (i.e. State Forests) during the phase-out period. Dry sclerophyll forests that comprise the majority of the area where logging is permitted will bear the brunt of this logging with likely short and long-term consequences for habitat quality, especially for hollow-dependent fauna. Native forest habitats on freehold land, where environmental controls on harvesting are less rigorous, are also likely to suffer from increased pressure as the timber industry seeks to counter the declining quality, and ultimately quantity, of logs from publicly-owned native forests. Pressure to maximise timber production from plantations in compensation for declining access to timber from publicly-owned native forests will also negatively impact on the quality of habitat they are able to provide.

Key words: south-east Queensland, forest, fauna, forest agreement, biodiversity.

Introduction

On 16th September 1999, the Queensland Government and the leading stakeholders signed the South-East Queensland Forests Agreement (SEQFA) – so called to distinguish it from Regional Forest Agreements developed in other parts of Australia involving the Commonwealth Government as well as State Governments and stakeholders. The SEQFA set in place a process that will ultimately lead to the complete phasing-out of sawlog harvesting from publicly-owned native forests within the SEQ Region, radically changing the face of native forest management in Queensland. The full text of the agreement is on the web site of the Queensland Timber Board (http://www.qldtimber.com.au).

The stated objectives of the SEQFA are: a world class conservation reserve system; ecologically sustainable management of forests; a competitive and efficient timber industry, and; enhanced economic development and employment prospects for rural communities.

The first two objectives are directed specifically at conserving forest biodiversity, including fauna. In respect of these biodiversity conservation objectives, the agreement provides for: an immediate addition to the conservation reserve system of an estimated 425, 000 hectares (locations as defined in the Agreement), and; a once-only logging of the balance of the area of

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State Forest and Timber Reserve native hardwood (dry and wet sclerophyll eucalypt) forest within the Region, with harvesting from all publicly-owned native forest completely phased out within 25 years.

The agreement also prohibits clear-felling from areas not immediately added to the conservation reserve system, as well as the harvest of woodchip for export (neither of which have been practised on any scale in SEQ publicly owned native forests to date), and the harvest of non-sawlog material and residues other than for products currently produced. Any harvesting is to be conducted according to the accepted Code of Practice for Native Forest Production (Queensland Environmental Protection Agency 2002), including protection of habitat trees and threatened wildlife (as listed under Queensland's *Nature Conservation Act 1992*). Eighty thousand hectares of this remaining area (part A), has been identified as being of higher conservation value to be harvested only when unavoidable and under the relatively conservative harvesting regime in place before the Forest Agreement. Harvesting is permitted in the remainder of the area available (Part B, of approximately 180,000 hectares) under a relatively intense regime that permits the removal of all trees of commercial species with a diameter at breast height over bark (dbhob) of 40 cm or greater (other than trees explicitly protected under the Code of Practice). Previous harvesting permitted a minimum of 60 cm dbhob below which all trees could not be removed.

In addition, the SEQFA provides for the immediate implementation of a strategy to develop substantial native hardwood plantations to enable the industry to move to a plantation-based resource by 2025, or sooner where practicable. While this commitment is targeted at economic and social goals, it has the potential to make an important contribution to biodiversity conservation.

This chapter examines the contribution of the 1999 SEQFA to biodiversity conservation in the SEQ Region with respect to one class of organisms – the terrestrial vertebrate fauna. The biophysical and biological features of the Region are outlined and an assessment is made of the likely consequences of the major commitments of the Agreement for the composition and structure of the region's forests and it's faunal inhabitants. Based on this analysis, conclusions are drawn as to which fauna are likely to be short, medium and long-term 'winners' and 'losers' as a result of the Forests Agreement for South-east Queensland.

Biogeography of the south-east Queensland region

The South-east Queensland Forest Agreement region (Figure 1) (henceforth referred to as "the Region") covers approximately 6.1 M ha, and largely equates to the South-east Queensland biogeographic region. It extends from the border between New South Wales and Queensland in the south, to Gladstone in the north, and from the coast up to 200 km inland. The Blackdown Tableland, located west of Rockhampton in Central Queensland and enclosed by the Brigalow Belt South Biogeographic Region, was also included in the SEQFA due to linked wood supply arrangements and forest type similarities.

The climate is sub-tropical, with a predominantly summer rainfall pattern and a pronounced dry season through the winter. Mean annual rainfall ranges from above 1500 mm on the coastal ranges to around 800 mm in the sub-humid interior (Young and Dillewaard 1999). The major physiographic features are a coastal plain of varying width, hills and ranges, including the major drainage basins of the Brisbane and Mary Rivers, Barambah Creek and the Burnett River, and coastal mainland and island sand masses. The Region borders the Brigalow Belt South biogeographic region (Thackway and Cresswell 1995) to the west and north. The boundary between the two regions is generally diffuse with the exception of the Main Range in the south and Kroombit Tops in the north. Consequently, the western part of the South-east Queensland bioregion is biogeographically closely associated with the eastern section of the Southern Brigalow Belt (Young and Dillewaard 1999).

The Region is well recognised for its high biological diversity, occupying the biogeographical overlap between tropical, temperate and sub-humid vegetation communities. Systematic floristic surveys conducted as part of the Comprehensive Regional Assessment leading up to the SEQFA identified 273 taxa from 63 families as being regionally endemic (Queensland Government 1999a). Five hundred and fifty six species were identified as being on the northern limits of their range and 355 on the southern limits. One hundred and forty five Regional Ecosystems (floristic, structural, climate and geographic associations adopted for biodiversity assessment purposes within Queensland) have been mapped in the Region, of which all but 20 are forest or woodland dominant (see Young and Dillewaard 1999 for detailed description of regional ecosystems and their status).

Forest ecosystems range from small northern relics of cool temperate flora including Antarctic Beech *Nothofagus moreii*, sub-tropical rainforests on coastal ranges and sand masses to extensive open eucalypt forests and woodlands in drier areas (Specht and Specht 1999; Young and Dillewaard 1999). Sclerophyll forests and woodlands are widely distributed within the region, varying in composition and structure along rainfall and soil gradients. Wet sclerophyll forests dominated by Blackbutt *Eucalyptus pilularis*, Tallowwood *E. microcorys*, Sydney Blue Gum *E. saligna*, Flooded Gum *E. grandis* and Small-fruited Grey Gum *E. propinqua* occur on the moist coastal ranges and the more fertile lowland substrates. Paperbark *Melaleuca quinquinervia* and coastal 'wallum' (*Banksia aemula*) heath occur on the less-fertile and poorly-drained coastal lowland soils, while dry eucalypt forests and woodlands dominated by Narrow Leaf Ironbark *E. crebra*, Silver Leaf Ironbark *E. melanaphloia*, Forest Red Gum *E. tereticornis* and Spotted Gum *Corymbia citriodora* subsp. *variegata* are extensive in lower rainfall inland areas. Brigalow *Acacia harpophylla*, *Callitris* spp. and dry vine thickets also occur in sub-humid areas.

The Region supports an equally diverse fauna. It has an equable, temperate climate ensuring fauna a relatively consistent food supply throughout the year. It is situated in the overlap area between the Torresian and Bassian

faunistic zones (Schodde 1986), both of which are rich in vertebrate fauna species (Roberts 1993, Legler and Georges 1993, Longmore 1986, Cogger and Heatwole 1981, Pianka and Schall 1981). Many species are migrants to the Region, originating from either the south or north on the Australian continent. The Region is believed to contain at least 350 species of forest birds, 32 species of bats, 11 species of arboreal marsupials, 49 species of amphibians and 50 ground-dwelling mammals, over 880 vertebrate species in all, including aquatic vertebrates, representing approximately 53% of all species that occur in Queensland (Queensland Government 1999a). Systematic fauna surveys conducted as part of the SEQFA comprehensive regional assessment (CRA) recorded almost 60% of forest dwelling species known from the Region, including 36 amphibian species, 92 reptiles, 296 diurnal birds, 10 nocturnal birds, 19 small ground-dwelling mammals, 11 macropods, five flying-foxes and 27 small insectivorous bats (Queensland Government 1999a).

Land use impacts

Forests in the region have a long history of human use, dating back to early Aboriginal Australians, probably at least 40,000 years. Aboriginal people are known to have lived in and made extensive use of forests in Queensland (Taylor 1994). Fire was central to Aboriginal use of forests. It was used as an ecosystem management tool to facilitate movement, encourage the growth of preferred plant species, and to assist in hunting. Fire, whether from natural ignition (e.g., lightning) or more commonly from Aboriginal burning, has been an important influence on forest dynamics, such as defining the boundary between eucalypt and rainforest communities, and the structural heterogeneity of eucalypt forests (Flannery 1994).

The influence of fire is reflected in the present general distribution of broad forest types within the Region. Tall dense even-aged single species wet sclerophyll forests of thin-barked, fire-sensitive eucalypts (such as *E. grandis*, *E. saligna* and to some extent *E. pilularis*) are restricted in their distribution within the Region (relative to areas further south) to the most sheltered and highest rainfall areas of the coastal ranges with deep rich soils (Young and Dilleward 1999). As has been demonstrated for similar forests in other parts of Australia, the ecology of these forests seems characterised by exposure to occasional high-intensity stand-replacing fires (Florence 1996). Medium and low, open mixed-aged and mixed-species dry sclerophyll forests of fire tolerant species, such as *C. citriodora variegata*, *E crebra*, and *E. melanophloia,* are extensive in the lowlands and drier ranges. These mixed forests are much more dynamic in their disturbance ecology, with fires occurring frequently, but of relatively low intensity leading to the replacement of a comparatively low proportion of trees in the stand with each fire.

European settlement began in 1824, and with it commenced the systematic modification and clearing of large areas of native forest, initially for timber getting and agricultural development, and later for urban development (Catterall *et al.* 1996). Some of the first European settlers were cutters of red cedar *Toona ciliata,* who were attracted by this valuable timber resource that occurred in lowland rainforests. Pastoralists and dairy farmers followed the cedar cutters, clearing extensive areas of native forest, while timber harvesting continued, to supply expanding urban and industrial development needs (Catterall *et al.* 1996). Since the late 1940s, extensive tracts of coastal lowland forests have been cleared for urbanisation, agriculture and exotic Slash Pine *Pinus elliotii* plantations (Catterall *et al.* 1996). The region presently supports a total population of approximately 2.5 m people, or 72% of the total Queensland population, and is expected to grow to 3.7±0.25 million people by 2021 (Department of Local Government and Planning 2001). The population is mostly concentrated in the greater metropolitan areas of Brisbane, the Gold and Sunshine Coasts. The expanding urban population has placed increasing demands on the total forest estate for timber products to supply the housing industry, as well as for recreation, landscape amenity values and watershed protection. By 1999, less than half of pre-European native vegetation of the Region remained (Wilson *et al.* 2002).

The pattern of forest use and disturbance has impacted on its suitability as habitat for forest fauna. Subsequently this has reduced fauna populations which has led to the listing on the schedules of the *Nature Conservation Act 1992*, of 14 amphibian, 25 reptile, 33 bird and 15 mammal forest-dwelling species in the Region by 2002. The Region's native forests are, on the whole, relatively low in timber productivity with a high proportion (approximately 50% of standing stock) of trees unsuitable for timber production (because of species or defective form). This has been reflected historically in the choice of silvicultural practices that have predominantly relied on removal of the larger trees of preferred sawlog species in single-tree or small group, selective harvesting (i.e. harvesting of trees suitable for timber production singly or in small clumps distributed throughout the harvest area). Silvicultural treatment to remove competition on selected regrowth trees of sawlog potential by large, defective older trees of non-preferred sawlog species was extensively practised in public native forests throughout the Region up until the late 1970s (when it ceased largely for commercial reasons) (Ross 1999). Evidence of the impact of these silvicultural practices on stand structure was compiled as part of the South-east Queensland Old Growth Forest Assessment (Kelly 1998) which was completed in the lead up to the Regional Agreement. This evidence supports the view that each of these treatments has contributed to a reduction in the number of large, hollow-bearing trees and a change in the overall species composition, size-class and crown-form composition of the forests.

Harvesting and the silvicultural treatment of publicly owned native forests (i.e. State Forests and Timber Reserves) in the Region has been guided by tree marking rules, which specify recommended spacing by various size classes of trees to optimise the growth of those trees with greatest sawlog potential. Tree marking rules have varied through time in response to improved knowledge from research and to changes in product specifications. Tree marking rules have been amended within the past 10

years or so, in consideration of environmental concerns to, for instance, include requirements for retention of habitat trees (defined as a living tree with at least one hollow over 10 cm in diameter above 2 m height) as specified in the Code of Practice for Native Forest Production (Queensland Environmental Protection Agency 2002), and most recently in consideration of the Forest Agreement outcomes.

The mainstay of the primary post-European settlement pattern within the Region, the pastoral industry, brought with it new fire regimes, clearing or thinning of forests in agriculturally productive landscapes, introduced invasive pasture plants, such as buffel grass *Cenchrus ciliaris*, and altered grazing pressures. Cattle, in particular *Bos indus* breeds, significantly impact on forest floristic composition and structure (Ensbey *et al.* 2000) through browsing and compaction. Cattle are ubiquitous throughout the forest. Livestock grazing is an accepted use of publicly owned forests, provision of grazing is one of the Cardinal Principals of the Forestry Act *1959* under which these areas are managed. It is extremely selective, with pressure greatest on riparian zones and other more productive and biologically diverse parts of the landscape. However, the extent and severity of impact of pastoral management on biodiversity in the Region is not well understood. Anecdotal and indirect evidence exists of changes in forest structure (a process known as "thickening") linked with climate cycles and changes to fire and grazing regimes (Burrows *et al.* 1998; Fensham and Holman 1999) and of direct impacts by grazing livestock on riparian and in-stream habitats of threatened amphibians and various other species (Queensland Environmental Protection Agency 2002).

The Regional Forest Agreements process

Australia experienced a rapid escalation in conflict over the use of forests throughout the 1980s. Queensland forests were notable in a number of these disputes including conflicts over the future of rainforests within the Wet Tropics of North Queensland, the Conondale Ranges of south-east Queensland and over the forests of Fraser Island off the southern Queensland coast (Holzworth 1999). In an attempt to resolve these recurring conflicts, the Commonwealth, State and Territory governments developed and signed a National Forest Policy Statement in 1992 (Commonwealth of Australia 1992). It provided a framework within which the State and Commonwealth governments aimed to cooperatively achieve a vision for sustainable management of Australia's forests. A key element involved a process of regional assessments with the objective of forest-use agreements between the Commonwealth and State governments.

The process for Regional Forests Agreements required that States initiate the development of an agreement through the invitation of Commonwealth Government. Queensland, with its Greater Planning Certainty Policy of 1993, was the first state to initiate this approach. The Greater Planning Certainty Policy was essentially the Queensland Government's response to the National Forest Policy Statement and, as such, provided for a regional forest planning and allocation process to identify and dedicate areas to conservation and other uses, adopt ecologically sustainable forest management practices and introduce long-term timber supply commitments. It identified the South-east Queensland biogeographic region as its first priority (to be completed by 1995), with work to then extend into the Brigalow Belt biogeographic region and other identified forested regions in 1996.

The first Regional Forests Agreement in Australia commenced in early 1994, with Queensland inviting Commonwealth agencies to be part of the Greater Planning Certainty process. Shortly after, the Commonwealth Government became embroiled in a widespread public dispute over continued export woodchip licences (a Commonwealth Government authority under its Constitutional powers over external affairs) with the blockading of parliament house by both supporters and opponents of the industry. Governments looked to the National Forest Policy Statement, and in particular the provisions for regional assessments and Commonwealth-State agreements, as a way of solving this dispute. This forced other states with much greater stakes than Queensland (which did not at that time, and still does not have, an export woodchip industry dependent on native forests) to become parties to the development of Regional Forests Agreements. The Comprehensive Regional Assessment process for South-east Queensland subsequently became subsumed within a nationwide move to Regional Forests Agreements and drifted down in Commonwealth Government priority. This was compounded at that time by political uncertainty at the State level as a consequence of a series of changes of political leadership and Governments within Queensland.

Following a period of relative inaction, progress on a Regional Forests Agreement for South-east Queensland was resumed with inter-Governmental negotiations and eventual signing of a Scoping Agreement in 1997. The Scoping Agreement included a substantial commitment from both Commonwealth and Queensland Governments to new data collection and analysis/interpretation. Fauna-related projects in this package included: a data audit and gap assessment; a systematic fauna survey; an analysis and reserve options; and, an assessment of habitat quality for priority species.

These were completed with the reports being published in 1998 and 1999 (for a compiled summary see Queensland Government 1999a). An inter-Governmental options document was soon published (Queensland Government 1999b). However, differences emerged between the State and Commonwealth Governments, particularly in relation to commitments to maintain a native forest sawlog industry based on publicly owned forests within the Region in perpetuity. The Queensland Government eventually went alone with an agreement, brokered with the peak stakeholder groups – the Queensland Timber Board, the Australian Rainforest Conservation Society, the Queensland Conservation Council and the Wilderness Society.

Regional Forest Agreement outcomes and consequences

The key commitments in the South-east Queensland Forests Agreement that bear on terrestrial vertebrate fauna biodiversity are: an immediate addition to the conservation reserve system of an estimated 425, 000 hectares (locations as defined in the Agreement); once-only logging of the balance of the area of publicly owned native hardwood forest within the Region (under specified conditions), with harvesting from publicly owned native forest completely phased out within 25 years; and, immediate implementation of a strategy to develop substantial native hardwood plantations.

The consequences of these commitments can be assessed in terms of habitats, such as through increased representation in conservation reserves, amended management of publicly owned forest areas outside reserves, or knock-on impacts on management of forest on other tenures, and their impact on specific species or assemblages of fauna.

Consequences for habitats

Regional ecosystems are the primary basis for planning the conservation of biodiversity in Queensland (Sattler and Williams 1999; McAlpine *et al.* 2002a). Regional ecosystems are an integrated entity derived from landscape pattern, geology and landform and vegetation composition, with dominant floristic associations and overstorey structure forming the basis of the vegetation component (Sattler and Williams 1999). The Queensland system incorporates a hierarchical classification of vegetation communities and land types based on biogeographical regions (as defined by Thackway and Cresswell 1995 and modified for Queensland by Sattler and Williams 1999), provinces or sub-regions and regional ecosystems (Sattler and Williams 1999; Wilson *et al.* 2002).

As the major surrogate for biodiversity planning within Queensland, regional ecosystems form a useful first basis for defining habitat types and investigating impacts of policy and management decisions on biodiversity. However, most fauna use more than one regional ecosystem, and there is a large number of regional ecosystems recorded from the Region. Consequently, regional ecosystems here have been aggregated to the level of broad forest habitat type at which it is possible to identify different faunal assemblages. Three broad forest habitat types have been defined: dry sclerophyll, wet sclerophyll and rainforest. These were assessed as containing 72, 17, and 25 regional ecosystems respectively, with a number of non-forest regional ecosystems excluded from further analysis.

Increased representation in conservation reserves

Figure 1 shows the distribution of National Parks and State Forests immediately prior to, and after the SEQFA.

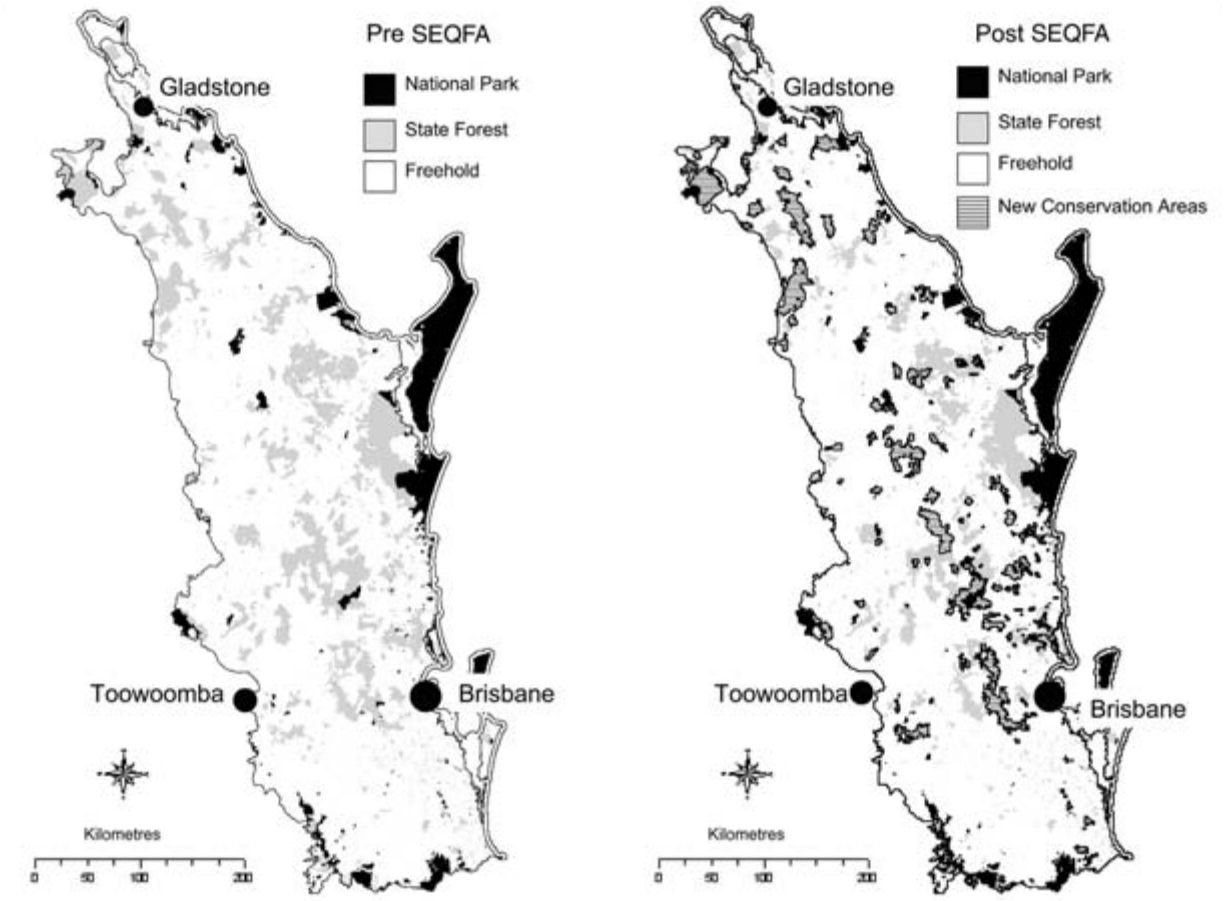

Figure 1. Southeast Queensland Forest Agreement Region – forest tenures immediately before the SEQFA (left hand map) and after (right hand map).

Immediately upon signing of the SEQFA, timber harvesting was no longer permitted in areas agreed to become National Parks. The most direct impact of this was on eucalypt forests with commercial timber production potential. Harvesting had already been progressively excluded from portions of State Forest and Timber Reserve throughout the Region over the previous 10 or so years by prior Code of Practice prescriptions, Tree Marking Guidelines, and local arrangements, protecting watercourse buffers, steep slopes and protected species or ecosystems such as rainforests (Queensland Environmental Protection Agency 2002). The SEQFA immediately excluded timber harvesting from substantial additional areas by virtue of their scheduled conversion to conservation reserves. The management of these newly-reserved areas otherwise remain the same pending the outcome of a planning process presently underway. Grazing and other uses are permitted to continue in the interim although it is probable that consumptive uses such as grazing will be excluded from many of these areas in the medium to long-term.

This commitment had the immediate impact of ensuring the retention of trees that otherwise would have been harvested. Based on harvesting practices that existing immediately prior to the SEQFA, most areas covered by this commitment (other than those excluded under Codes of Practice) would have been harvested at least once within the next 30 years. Many of these forests are known, as a consequence of their long history of deliberate stand manipulation, to be deficient in hollow trees. Ross (1999) found that the average density of live hollow trees in commercial forests throughout the region was 4 per hectare, 30% less than the optimum number for arboreal mammal diversity as estimated by Wormington (2002), and insufficient to even meet the minimum requirement of the current Code of Practice for Native Forest Production, 6 live hollow trees per hectare for most forest types throughout south-east Queensland.

Figure 2. Tree hollows are an important habitat resource for many fauna within the Region. With the impacts of past forest management having made large live trees rare in much of the Region, fauna are forced to rely on standing dead trees that are much more susceptible to destruction by fire or wind.

Harvesting also has an immediate impact on the understorey through physical damage and consequent fire, commonly used to stimulate regeneration or to reduce hazard posed by logging slash. By opening up the canopy, disturbing the soil surface and increasing exposure of the site (including increasing the incidence of low intensity fire), harvesting favours regeneration, particularly of shade intolerant species (Florence 1996). This is not necessarily ecologically undesirable. Disturbance is necessary to maintain the open canopy structure of dry forests and woodlands. At the other end of the spectrum, disturbance is essential to maintain the boundary between the wet sclerophyll and rainforest. The process of rainforest encroachment has been well documented in north Queensland, Harrington estimated that 48% of wet sclerophyll forest in the wet tropics was invaded by rainforest in 50 years up to 1992 (Queensland Government 1999c). While similar studies have not been published for south-east Queensland, there is anecdotal evidence (e.g. unpublished data from long-term native forest inventory plots) of recruitment of rainforest pioneer species into eucalypt-dominated forest in the absence of fire or other disturbance.

In the longer-term, it is expected that the density of old eucalypt trees will increase in reserved areas, along with shade-tolerant, fire-sensitive understorey species to the exclusion of fire-tolerant species such as native grasses in dry forests. Thickening of woody understorey vegetation will, in the absence of appropriate fuel reduction programs, increase the risk of extremely intense stand-replacing wildfires. This has the potential to suddenly and rapidly convert extensive areas of forest, particularly wet sclerophyll, to uniform young age.

Historically, the reservation of National Parks in the Region had been a relatively opportunistic process. Areas reserved tend to be scenic and recreational icons, such as Noosa Heads, Lamington and Bunya Mountains National Parks. This resulted in a network of reserves that were small (and in many cases marginally viable for conserving the Regions biodiversity), relatively fragmented and poorly representative of the diversity of habitats within the Region. With increasing understanding of conserving biodiversity, there had been attempts to expand this network in a more strategic and representative reserve system in recent decades. Figure 3 illustrates the representation of broad habitat types (based on the regional ecosystems as biodiversity surrogates rolled up into broad habitat types) within the National Parks. It reveals clear biases in reserve system representation prior to the Regional Forest Agreement. Rainforests were well represented, with approximately 31% of their estimated pre-European (44% of their present public land) extent in National Parks, while commercial dry sclerophyll forests were less well represented, with approximately 9% of their estimated pre-European (33% of their present public land) extent in National Parks. In addition, as illustrated in Figure 1, with the exception of the coastal islands and the scenic rim on the New South Wales

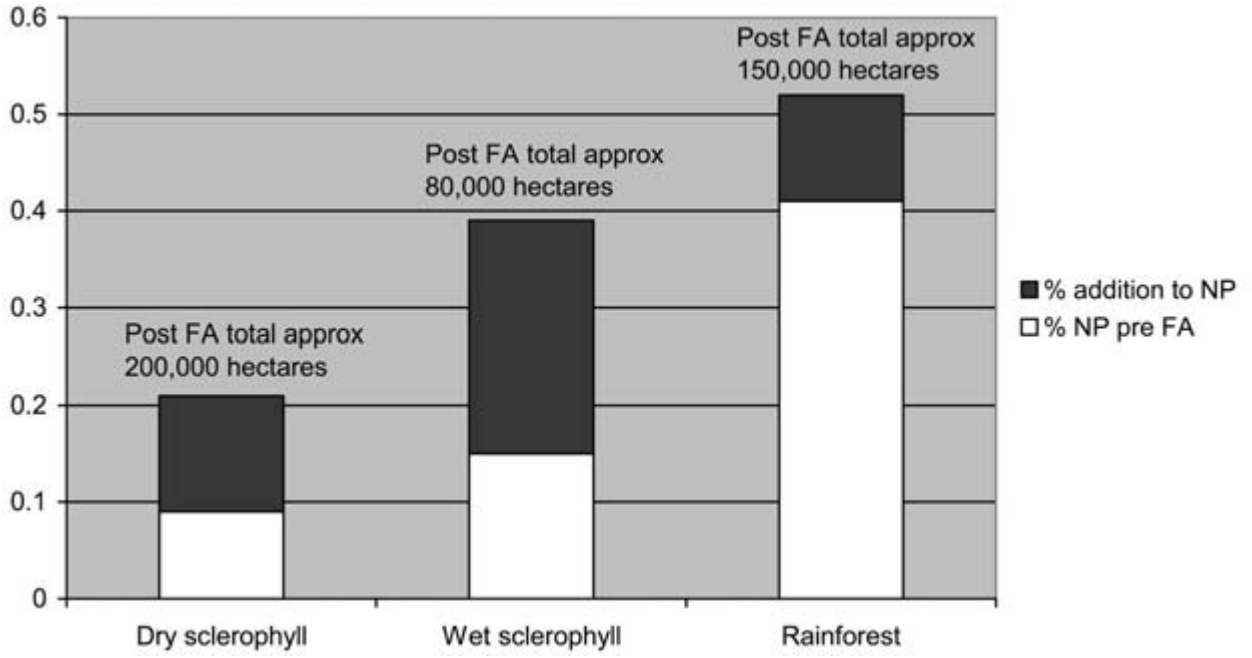

Figure 3. The proportion of the estimated pre-European extent of dry sclerophyll, wet sclerophyll and rainforest currently remaining in the Region within National Parks. The white arm of the histograms show the proportion in National Park before the SEQFA, and the black arm shows the proportion added as a consequence of the SEQFA.

border, National Parks were scattered throughout the Region, and were generally small, isolated, and exposed to external pressures.

The immediate transition of about 67% of State Forest and Timber Reserve into conservation reserve tenure following the Forests Agreement dramatically altered this picture. Figure 1 shows that after the SEQFA, conservation reserves are more extensive, less fragmented and more consolidated, and hence more protected from external pressures arising from surrounding land uses. However, an analysis of representation based on broad habitat types indicates that the skewed representation within Conservation Reserves, that existed before the SEQFA, has been maintained (Figure 3). Regional ecosystems that form rainforest and wet sclerophyll habitats are big winners from the SEQFA, approximately doubling their representation, wet sclerophyll types leading the way with an increase of 22% of estimated pre-European (or 48% of present public land) extent in conservation reserve tenure. Dry sclerophyll types lag well behind with an increase of only 11% of estimated pre-European (or 35% of present public land) extent added to the conservation reserve tenure.

Management of remaining Crown forests available for timber production

Under the South-east Queensland Forests Agreement, approximately 260,000 hectares of State Forest and Timber Reserves remains available for a once-only timber harvesting, much of it under the more intensive 40+ cm diameter cut regime, over the next 25 years. The great majority (approximately 80%) of this area is dry sclerophyll forest, of which approximately 75% of it is commercial regional ecosystem types. Approximately 8% of publicly owned native forest available for timber harvesting is wet sclerophyll forest, all of which is potentially harvestable except where restricted by access, and 12% is rainforest, all of which is excluded from harvesting under present Government Policy (Queensland Environmental Protection Agency 2002).

In the short to medium term, the application of a 40+ cm logging regime will increase the openness of the stand structure and hasten the loss of large old eucalypt trees with hollows. It is also likely to increase the rate of attrition of special tree resources retained after logging, such as feed trees used by Yellow-bellied Gliders *Petaurus australis*. This will degrade the habitat quality for a range of canopy and hollow dependent fauna. The loss of large trees is illustrated in Figure 4, which shows pre- and post-harvest stand tables for two harvest events for a single long-term permanent monitoring plot in St Mary State Forest south-west of Maryborough. The first harvest event was in 1981 under the relatively conservative harvest rules in place before the SEQFA, while the second was in 2001/02 under the revised 40+ cm logging rules introduced after the SEQFA. The plot is in regional ecosystem 12.5.7, a tall woodland of *C. citriodora variegata* and other dry eucalypt species, of which about 6,500 hectares or 64% of the public land extent is outside National Park and available for logging. The data show that less than 15% of trees over 45 cm dbhob, and none of the trees over 50 cm dbhob, were retained following harvesting in 2001/02 under the 40+ cm logging rules. This compares with approximately 80% of trees over 45 cm dbhob retained following harvesting 20 years earlier under the previous harvesting rules.

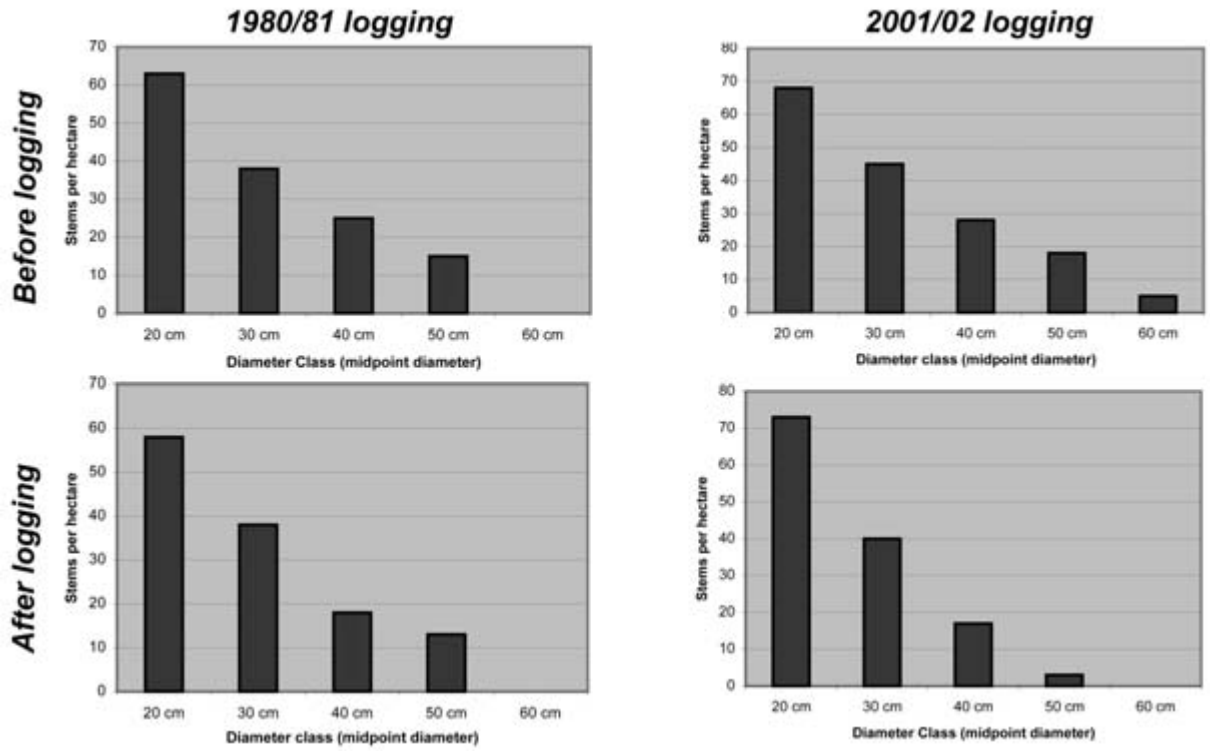

Figure 4. Changes in the size class distribution of stems of a single plot following logging in 1980/81 (left hand graphs) and in 2001/2002 (right hand graphs). The histograms show the number of stems of all species in each size class before logging, in 1980 and in 2001 (top graphs), and after logging, in 1981 and 2002 (bottom graphs). Logging in 1980/81 was carried out using the Tree Marking Guidelines in use before the SEQFA and logging in 2001/2002 was carried out using the Tree Marking Guidelines introduced after the SEQFA. The plot is located in St Mary's State Forest (southwest of Maryborough) in a dry sclerophyll forest type dominated by Spotted Gum *Corymbia citriodora variegata.*

In the long-term, the recovery of dry forests from this more intense logging regime is likely to be constrained by the increased density of small stems <20 cm in diameter from a post-harvest regeneration flush. The resultant high density of small trees will increase competition for limited soil nutrients and water resources and potentially restrict the growth of habitat tree recruits. This problem (known as "lock-up") is already evident to some extent in dry forests throughout the region, including parts of St Mary State Forest, where harvesting and silviculture has been intense (McAlpine 1999).

Another possible consequence of harvesting 40+ cm dbhob trees is deleterious sub-canopy impacts, which may decrease habitat suitability for wet-adapted fauna of the ground layer and understorey (Goodall *et al.* in press). It is likely that opening up the canopy will initially create a more xeric micro-climate as a result of decreased shade from a greatly reduced canopy cover. Later, as a consequence of competition for water from overstocked regeneration, the dryness of the understorey will persist despite increased shading. This may be exacerbated as the Australian continent is subjected to a drier climate cycle associated with the ENSO effect. It is of particular concern that this effect may be felt most significantly in some areas, such as on the Blackbutt Range, north-west of Brisbane, which are strongholds for such wet-adapted and threatened wildlife as the Black-breasted Button-quail *Turnix melanogaster*, listed as Vulnerable under Commonwealth and State legislation.

Hardwood plantations and private native forests

To compensate for the phase-out of native forest harvesting in State Forests in South-east Queensland by 2025, the Queensland Government has committed itself to an accelerated hardwood plantation program. The Plantations, Forests and Future Directions Policy of 1995 (later relaunched in 1999 as the South East Queensland Hardwood Plantation Program) was initially committed to establishing 45,000 ha of native species, hardwood sawlog plantations by 2020 (Queensland Government 1995). Under this program, plantations are being established on previously-cleared private and on publicly owned lands. The Queensland Government has already purchased two land parcels for the program. Private landowners are being invited to join the program through equity joint ventures and leasing arrangements. Minimum planting size is generally 15 ha for equity joint ventures and 30 ha for leasing arrangements. It is estimated that there is 330,000 hectares of cleared agricultural land suitable for commercial tree-growing in the region (Anderson and Halpin 2001).

Establishing hardwood plantations on previously-cleared land could restore a significant amount of biodiversity in the Region, provided the time between planting and harvesting is adequate for habitat to recover and sites are replanted following harvest. Biodiversity can be further enhanced through appropriate management, for example through retaining fallen woody debris and allowing regeneration of a diverse shrubby understorey (Borsboom *et al.* 2002). The long-term wildlife values of these new plantation forests

Table 1. Number of vertebrate fauna species by broad groupings classified by the authors as specialists, dependent on dry sclerophyll, wet sclerophyll/rainforest, and rainforest primary habitat types in the Region. The number of these species that are listed under the *Queensland Nature Conservation Act 1992* are shown in brackets.

	Mammals	Birds	Reptiles	Frogs	All Species
Dry sclerophyll	8 (1)	53 (5)	28 (2)	5 (0)	94 (8)
Wet sclerophyll/rainforest	6 (2)	37 (7)	20 (6)	13 (11)	76 (26)
Rainforest	0 (0)	2 (0)	2 (1)	1 (1)	5 (2)
All types	14 (3)	92 (12)	50 (9)	19 (12)	175 (36)

will depend on the intensity of production once harvesting is phased-out of the remaining State Forest. It is likely that commercial imperatives will then force plantations to be managed intensively to produce sawlogs from short rotations. This will result in structurally simple, young forests with limited value as faunal habitat.

A further issue in relation to habitat maintenance is the impact on the private native forests of reduced sawlog availability from publicly-owned forest. About half of the 2.4 million hectares of native forests in the region is privately owned (Queensland Government 1999b). An inventory of private native forest was undertaken at a coarse level as part of the assessments leading to the South-east Queensland Forests Agreement (Queensland Government 1999a). This inventory confirmed that much of this forest had been neglected and that its condition was poor, both from a production and a conservation perspective.

While the provisions of the Forests Agreement were drafted to maintain a flow of sawlogs from publicly owned native forests to meet specified volume commitments over specified periods, they will require acceptance by industry of a decline in size (and also potentially an increase in the level of allowable defect and compulsory species). There is already an implicit recognition of this in the adoption of the 40+ cm diameter logging rules. It is likely that sawmills will increasingly seek to supplement their public forest allocation (both in quantity and quality) from private forests. With most private forest owners having limited technical knowledge of forest management, and with increasing native sawlog prices providing increased incentive to log, there is a risk of further degradation of private native forests. A current joint project of the Commonwealth and Queensland Governments to conduct a more thorough assessment of the production and conservation values of native forests in the region (Ryan *et al.* 2002) is a step in addressing this concern. At present there are also moves within Queensland to introduce a Forest Practices System for sustainable management of private native forests.

Consequences for fauna

For analysis purposes the authors have grouped fauna species from the Region according to primary habitat specialisation. Of the 880 vertebrate fauna species known to occur in the Region, 94 have been identified by the authors as requiring dry sclerophyll forests as primary habitat, 76 as requiring wet sclerophyll/rainforest as primary habitat, and 5 have been identified as requiring rainforest as primary habitat. Other vertebrate species that occur within the region have been identified by the authors as having primary habitat as either, other forest types, non-forest (eg heathlands), or as generalists with primary habitat across all forest (and possibly non-forest) habitats. Wet sclerophyll forests characteristically exhibit many common features with rainforests (e.g., presence of palms, lianas), and the authors were not able to identify a discrete fauna exclusive to them. Birds and reptiles form a large component of the species diversity identified as requiring dry sclerophyll as a primary habitat, while frogs form a particularly significant component of the fauna identified as requiring wet sclerophyll forest and rainforest as primary habitat. Mammals form a relatively small component of the species diversity identified as discriminating between forest types as primary habitat, although as more information is obtained, in particular related to bats, it is expected that other specialist habitat relationships may emerge.

The relative numbers of these species listed as endangered, vulnerable or rare under the Queensland legislation (*Nature Conservation Act 1992*) reflects a similar pattern to the proportional representation of the various broad forest types in conservation reserves. Thirty six of the species identified by the authors as having primary habitat dependencies are listed under the legislation. Of these, 29 require wet sclerophyll and/or rainforest as primary habitat and only 8 require dry sclerophyll as primary habitat. While this imbalance undoubtedly reflects the comparatively lower diversity of fauna species in dry sclerophyll habitats, it is also likely to reflect the comparatively less scientific interest and attention these habitats have attracted in south-east Queensland (and hence less that is known about their attributes or threats).

Increased representation in conservation reserves

The "big winners" from the commitment of more forests to National Parks are the wet sclerophyll/rainforest specialists. Rainforest specialists became advantaged to a lesser degree because their primary habitat was already well represented in National Parks before the Forest Agreement, and because rainforest was also already excluded from harvesting where it occurred in State Forest. One exception is the Black-breasted Button-quail *Turnix melanogaster,* which is listed as vulnerable. Some critically important known habitats of this species, particularly the vine scrubs in the Blackbutt-Yarraman area (Smith and Lees 1999), have been overlooked in the selection of areas for inclusion in the reservation program (McDonald *et al.* 1999). While logging had already been excluded from these ecosystems, they are still threatened by fire and weeds.

A commitment of additional area to National Parks will have little immediate impact on fauna dwelling in watercourse buffers, on steep slopes or in rainforests, as these are protected by Codes of Practice (Queensland Environmental Protection Agency 2002), irrespective of which tenure they lie within. However, it will have

consequences for fauna, such as the Plumed Frogmouth *Podargus ocellatus plumiferus*, that inhabit ecotone wet sclerophyll forests containing eucalypt emergents with a rainforest understorey (Smith *et al.* 1998). These habitats would have been available to be logged in State Forests and Timber Reserves before the Forests Agreement. A much larger proportion is now in National Parks

Continued grazing and other high impact uses such as motorised recreation are likely to have detrimental ecological impacts on some parts of the forest within the new reserve system, particularly along streams, where disturbance-sensitive frogs occur. Without a commitment to monitoring and adaptive management of grazing regimes, there can be little scope for positive conservation outcomes if the impacts go unchecked. There is already concern that cattle impacts in streams of Goomburra State Forest are having deleterious results for breeding *Mixophyes fleayi* a large frog of rainforest and wet sclerophyll forest (H. Hines personal communication).

On the other hand, it is likely that the suitability of native forests for grazing will decrease as a consequence of reduced disturbance by logging and fire following conversion to National Park. Reduced disturbance results in an increase of shade-tolerant, fire-sensitive woody understorey species of low forage-value, to the exclusion of fire-tolerant species of high forage value, such as native grasses. Management to reduce grazing pressure and less frequent fire will tend to maintain this change. This scenario could produce large accumulations of fuel which could ultimately lead to much higher intensity but less frequent fires. The impacts of changed fire regimes on fauna are complex and variable. In a study in dry sclerophyll forest at Bauple State Forest, Hannah *et al.* (1997) found that the diversity and abundance of ground-dwelling reptiles decreased significantly in areas that were burnt frequently to protect adjoining plantations. Other studies have found some fauna species are disadvantage by long-term absence of fire, for example the golden-shouldered parrot *Psephotus chrysopterygius,* an inhabitant of tropical savanna woodland in northern Queensland (Garnett and Crowley 1997).

Management of remaining publicly owned native forests available for timber production

The increasing intensity of harvesting in remaining production forests is likely to reduce the biodiversity of vertebrates in the short to medium term. Recent analyses suggest that the diversity and abundance of fauna such as reptiles may be suppressed as a consequence of normal harvesting pressure (Goodall *et al.* 2003). Should these forests regenerate in such a way as to establish a dense stand of small trees that suppress growth and hence stagnate, then overall biodiversity of the vertebrate fauna may never again reach pre-harvest levels. Since 70% of remaining publicly owned native forests available for timber harvesting is dry sclerophyll, the impact of the 40+ cm dbhob logging rules will be borne disproportionately by dry sclerophyll fauna specialists which is comprised mainly of birds and reptiles.

Hollow-dependent fauna are likely to be further disadvantaged both in the short and long term. Increasing the intensity of harvesting will increase incidental damage to habitat trees and is likely to immediately reduce the number of old eucalypt trees with hollows. The impact of reducing the number of large trees will be felt in the longer term, with up to 190 years required to recruit a habitat tree in dry sclerophyll forest (Queensland Department of Natural Resource 1998).

Of all known SEQ fauna, 23 insectivorous bat species, 13 arboreal and ground dwelling mammals and 63 bird species have been recorded using tree hollows. At least 35 reptile and amphibian species also use hollows (Smith and Lees 1998). Relatively few hollow-dwelling species from south-east Queensland have been listed under the State or Commonwealth legislation (no arboreal marsupials and about 13% of the birds) but with the number of hollow-bearing trees continuing to diminish this is expected to change. Recent research in the region (Wormington 2002) makes the case that hollow availability is limiting the populations of a number of species in dry sclerophyll forest, in particular larger arboreal marsupials such as Greater Glider *Petauroides volans*. Harvesting a substantial proportion of the total remaining suitable habitat for these species (approximately 15% is in publicly owned forest available for logging) threatens their already limited resource of tree hollows (Smith and Lees 1998, Lamb *et al.* 1998, Gibbons and Lindenmayer 2002), particularly with the more intense 40+ cm dbhob regime introduced after the SEQFA. Eyre and Smith (1997) found that old spotted-gum/iron bark stands in St Mary State Forest provided valuable dens for Yellow-bellied Gliders. Further loss of hollow bearing trees will disadvantage this species, especially if the area of suitable habitat falls below a critical threshold of 40% of the total forest area (Eyre 2002, McAlpine and Eyre 2002; McAlpine *et al.* 2002b).

Figure 5. Greater Glider *Petauroides volans,* a herbivorous arboreal marsupial of the Region dependent on large tree hollows.

Management of plantation and private forests

Research in the SEQ region (Borsboom *et al*. 2002) has demonstrated that Gympie messmate *Eucalyptus cloeziana* plantations, 1.5 to 10.5 ha in size, established on cleared land, had significantly higher vertebrate diversity than cleared, grazed improved pasture (Figure 6). Vertebrate diversity was found to increase with plantation age and was highest in ungrazed plantations 38 to 40.5 years of age that had a structurally complex shrubby understorey, were connected to native forest, had a good leaf litter layer, logs, stumps, fewer grass, sedge and herb species, and no evidence of intense fires.

A total of 175 vertebrate species were recorded in the Gympie messmate plantations, about 30% of forest-dwelling species in the region. Dry sclerophyll specialists predominate in this list, with the most diverse fauna component recorded from plantations being birds, with 100 species. All other groups contributed to the remaining 75 vertebrate species, arboreal marsupials contributing least, with only 3 species. Bird abundance was significantly higher in the plantations compared to cleared, grazed improved pasture, with the highest abundance in the 38 to 40.5 year old plantations. Plantation forests may exclude those fauna species that depend on characteristics of "old growth" forests, such as hollow trees, unless some effort is made to incorporate these features into these young forests such as by installing artificial hollows (Smith and Agnew 2002).

Some vertebrate species using *E. cloeziana* plantations are viewed as pests. Of the eight rodent species recorded, seven can be minor or major pests, although none is a pest in eucalypt plantations (Borsboom *et al.* 2002). Two, the introduced black rat *Rattus rattus,* and the house mouse *Mus musculus,* can be serious pests in the region. In addition, several vertebrate species occurring in *E. cloeziana* plantations are known to damage planted eucalypts. These include the swamp wallaby *Wallabia bicolor*, the red-necked wallaby *Macropus rufogriseus*, the brush-tail possum *Trichosurus vulpecula*, the introduced European hare *Lepus capensis*, and the yellow-tailed black cockatoo *Calyptorhynchus funereus* (Lees 2000).

Plantations also are used by species listed under the *Nature Conservation Act 1992*, with Borsboom *et al.* (2002) recording two rare reptiles, one rare frog and one vulnerable frog species in *E. cloeziana* plantations. If harvesting was restricted by the presence of such listed species (as may currently be mandated under some legislation), tree planting and management practices that increase biodiversity within plantations would be discouraged. Where listed species occur in a plantation, there is no reason why the impact of timber harvesting and other management activities cannot be ameliorated through a co-operative and voluntary program with growers. For instance, where a rare or threatened bird is nesting in a plantation tree ready for harvest, consideration could be given to delaying harvest of the tree until nesting is complete. In general, however, it is unlikely that plantation management will permit the development of habitat conditions that will be suitable to many listed fauna.

Fauna species, whose preferred habitats occur predominately on private lands, are not protected by any of the commitments under the SEQFA. An example is the koala *Phascolarctos cinereus*, which has a distribution closely aligned with that of its preferred food trees, dry sclerophyll forest trees such as coastal swamp mahogany *E. robusta* and *E. tereticornis* (J. Callaghan personal communication). Both trees occur primarily on fertile coastal and alluvial landscapes, which are predominately privately owned. Past clearing of alluvial *E. tereticornis* native forests and woodlands for agriculture and grazing (Catterall *et al.* 1996), coupled with more recent clearing of coastal *E. robusta* and *E. tereticornis* forests for urbanisation, are the major factors driving koala

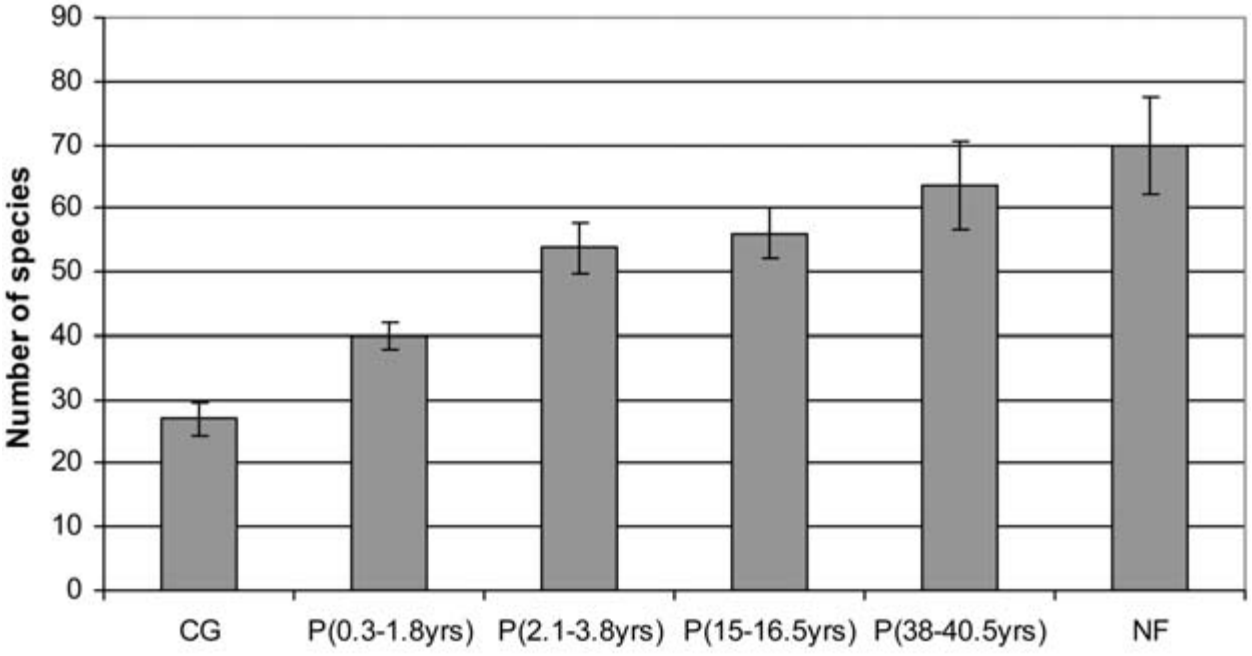

Figure 6. The mean numbers of vertebrate fauna species surveyed from, cleared grazed land, four ages of Gympie messmate *Eucalyptus cloeziana* plantation, and native forest, in the Region (from Boorsboom *et al.* 2002)

population decline in the region. Smith and Andrews (1997) found that koala distribution and abundance was sensitive to logging disturbance in Pine Creek State Forest, in northern New South Wales. The SEQFA commitment to an expanded reserve system will therefore help protect koala populations on public land from logging disturbance, but fail to protect the large proportion of koala populations that occur on private urban and rural lands. Further, hardwood plantations are unlikely to provide significant supplementary koala habitat as the major plantation species, *C. citriodora* and *E. cloeziana* are of marginal forage value to the koala, while preferred forage species *E. robusta* and *E. tereticornis* are considered unsuitable for plantations.

Conclusions

The SEQFA has changed the face of native forest management in the Region. The outcomes are, in general, beneficial for the conservation of vertebrate fauna, particularly wet forest specialists, in the short to medium term. However, there are some notable exceptions, depending on where they are located and which habitat type they depend upon. Furthermore, sustaining these benefits in the long-term will be contingent on continuing increased resources for managing conservation reserves.

The commitment of 425,000 ha of publicly owned native forests previously available for logging to conservation reserves has greatly consolidated the system of reserves, increasing its connectivity and its protection from external pressures. While substantially increasing the level of reservation of all habitat types, this has done little to redress previous biases in the representation of broad habitat types in reserves. Dry sclerophyll habitat types are still represented in reserves at levels much lower than wet sclerophyll and rainforest.

Logging has been excluded from the majority of the Region's wet eucalypt forests. In the medium-term this will increase the proportion of old growth within wet eucalypt forests, which will favour hollow-dependent fauna. However, without a commitment to fire management, there will be an increase in the density of woody understorey vegetation, with an increased long-term risk of intense stand-replacing fires or conversion of wet sclerophyll forest to rainforest.

Much of the remaining State Forests and Timber Reserves will be subject to more intensive harvesting. The great majority of these are dry sclerophyll forests. In the short-term, increased harvesting pressure will reduce the number of old eucalypt trees with hollows and hence degrade the habitat quality for a range of canopy and hollow-dependent fauna. It will also possibly induce microclimate change below canopy level thereby impacting on ground-dwelling fauna. In the long-term, recovery of dry forests from increased logging disturbance is likely to be constrained by the increased density of small stems, with consequent restricted development of habitat trees in these nutrient-poor and moisture-limited forests. This increase in canopy density will have a detrimental impact on reptiles in particular.

A commitment to accelerated development of plantations of native tree species on previously-cleared land will benefit biodiversity. The extent of this benefit will depend on the subsequent management of these plantations, including the length of rotation, retention of woody debris, development of floristically and structurally diverse understorey, and on the size, shape and proximity to native forest or other plantations. While some fauna species may benefit from the plantation program in some circumstances, commercial production imperatives for intensive management of plantations are expected to limit this benefit.

A clear objective of the SEQFA was to enhance biodiversity conservation within the Region. There is little doubt that the conservation of terrestrial vertebrate fauna within the forests of the Region has benefited from the outcomes of the SEQFA, at least in the short to medium term. It is apparent however, that more could be achieved with: review and refinement of the management of the newly-acquired conservation reserves; revision of the once-only harvest regime that is currently being applied to remaining harvestable publicly owned native forests, and; continued development and application of measures to protect biodiversity values in private native forests in the Region. Measures such as these will need to be adopted to secure benefits for biodiversity from the SEQFA in the long-term.

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