A stand was defined as at least four trees within close proximity (at 1:3,000 scale), and isolated paddock trees were delineated by a single point. During the study isolated trees were noted to be declining in health. These were distinguished from healthy trees by their appearance on the aerial photographs. Healthy trees generally present a well-defined circular canopy, whereas the trees suffering dieback and declining in health appear linear and unevenly shaped. The two properties were ground truthed to confirm the state of health of the isolated trees, as well as undertaking vegetation surveys of native vegetation stands. The on-ground survey of isolated trees largely reflected the aerial photograph interpretation assessment. A separate colour coding was used to distinguish between healthy trees and those suffering from moderate to severe dieback.

Results

The number of isolated paddock trees on both properties decreased greatly during the period between 1972 and 2001 (Appendix 1). Property 1 decreased in number by 199 trees, representing a 40% decrease, and Property 2 by 253 (47%) (Table 1). Similar figures were noted on adjoining properties.

Table 1. Number of Isolated Paddock Trees

Property	1972	2001	Difference	Percentage decrease
1	493	294	199	40 %
2	542	289	253	47 %

Of the remaining trees on the properties in 2001, 31% were in a state of decline at Property 1, and 33% at Property 2 (Appendix 2). This equates to approximately one third of the remaining isolated paddock trees that are predicted to die within the next 5 – 10 years.

Table 2. Isolated Paddock Trees Declining in Health

Property	No. of remaining trees	Trees declining in health	Percentage declining in health
1	294	90	31 %
2	289	96	33 %

An extrapolation can be made from losses of paddock trees during the period 1972 to 2001 to predicted losses over the next 10 years. The figures of Table 1 would indicate a loss at Property 1 of 13% each decade, and 15% at Property 2. There is a significant difference between these figures and the predicted losses of 31% and 33% based on present tree health.

Although the owners of Property 1 have undertaken some revegetation work previously, the majority of native vegetation has been planted under the Heartlands project with funding from the North East Salinity Program. This property has increased its native vegetation cover by 11.8 hectares (Table 3) (Appendix 3).

The owners of Property 2 have been actively planting native trees since 1968, and more recently have accelerated their planting in the Heartlands project. This property has increased its tree cover area by 66 hectares (Table 3).

Table 3. Native Vegetation Cover (hectares)

Property	Native Vegetation Cover (ha) 1972	Native Vegetation Cover (ha) 2001	Increase in Area (ha)
1	16.3	28.1	11.8
2	11.9	77.9	66

Discussion

While neither property has actively undertaken tree removal over the past 29 years, individual paddock trees have decreased in number at Properties 1 and 2 by 40% and 47% respectively. Table 1 presents figures relating to the loss of isolated paddock trees.

It was noted that a large number of the remaining isolated paddock trees were suffering from dieback. It was estimated that, under current management, these trees would most likely be dead in 5 – 10 years, resulting in losses of 31% and 33% at Properties 1 and 2 respectively.

The decrease in the number of paddock trees on both properties can be attributed to various on and off-site impacts. There have been many reports written over the past 20 years on the causes of rural dieback, therefore an explanation will be brief, with an emphasis on dieback factors relevant to the Byawatha Hills environment.

The declining *Eucalyptus macrorhyncha* (Red Stringybark) and *E. polyanthemos* (Red Box) trees are isolated remnants of Granitic Hills Woodland and Grassy Dry Forest Ecological Vegetation Classes (EVCs). EVCs are vegetation types that have been defined according to the ecological processes that occur, which are shaped by factors such as geology, soils, rainfall and landform.

Typically, Granitic Hills Woodland has a low open woodland overstorey, a shrubby understorey with a ground layer of herbs and grasses. Grassy Dry Forest overstorey would exhibit taller trees, fewer shrubs and a grass dominated ground layer (DNRE 2002).

In a natural context, this type of vegetation would provide habitat for a range of native birds, reptiles, marsupials and insects. The complex interactions between plants, animals, fungi and micro-organisms gives the system resilience - a series of checks and balances ensuring that natural systems continue to function. Natural disturbances such as flood, drought and fire have dramatic impacts, but the natural diversity within the systems help repair the landscape. When large scale permanent change occurs, and the repairing processes (eg. natural regeneration) are impaired, this 'balance' is disturbed.

The early large scale clearing of native vegetation in the Byawatha Hills for mining and agricultural pursuits represents an example of such an imbalance. The clearing of a large number of trees, shrubby understorey and, to a degree, native tussocky grasses removed habitat for scores of different species of birds (Day 1980). With competition for reduced habitat, native fauna numbers and diversity reduced dramatically during the extensive clearing periods of the 1870's to 1930's. Changes of land use to cropping and grazing resulted in land degradation issues that landholders are currently tackling.

Figure 4. *Eucalyptus macrorhyncha* suffering dieback

Each of the following factors are likely to contribute to dieback symptoms that Eucalypts are presently exhibiting. Often, a combination of factors are responsible for declining health or, at least, are closely linked to each other.

Salinity

Largescale clearing has been the principle cause of dryland salinity. The process of developing dryland salinity and rising watertables is well documented. Little is known about the role that isolated trees play in recharge control. In many cases across the catchment, paddock trees are the only native vegetation that remains on high recharge hills and slopes. This would indicate some degree of importance in catchment processes.

Figure 5. Salinity discharge area

Change in microclimate

In natural woodland or forested ecosystems the outer vegetation acts as a buffer to extreme temperatures and wind, whereas isolated paddock trees are greatly exposed to such events (Grose 1980; Lambeck 1998).

This is evident in the recollection of both landholders, whereby windstorms over the past 30 years have uprooted a large number of mature Eucalypts. This extreme wind damage appears to have increased during the past 5 years (pers. comm. Matt Allen 2002; Sandy Campbell 2002).

Insect attack

A range of different insects attack the leaves, sap and trunks of Eucalyptus trees (Day 1980; Grose 1980). In a similar manner fungal parasites attack Eucalypts though leaf and twig, and stem and root pathogens (Grose 1980).

In a natural ecosystem, episodes of exponential growth in insect numbers would be counter-acted by an increase in fauna that prey on insects.

Figure 6. Insect defoliation

Tree age

The isolated paddock trees are remnants from several clearing events/periods that have occurred over the last 130 years. Whether these were retained as juveniles, emerged as seedlings post clearing, or were retained for shade for stock is uncertain, however they may be nearing the end of their life-span, progressing through a natural senescence process.

Vegetation surveys of both properties indicated that the species *Eucalyptus macrorhyncha* (Red Stringybark) represented a large number of trees that were senescent. It is quite possible that age may be a contributing factor in tree loss in this species.

Drought

Gradual dieback can be attributed to drought in some instances however, the condition of trees that are already stressed from other factors will be exacerbated by drought (Day 1980).

Stock camps

Stock often 'camp' under paddock trees for shade and shelter. There are several generic impacts related to stock camps such as increased nutrient levels from excrement, soil compaction, root exposure, and consumption of lower foliage and bark.

One or two of these factors are enough to impair tree health. The cumulative effect of all these factors along with the ever decreasing number of paddock trees (hence greater pressure on existing ones), result in added stresses.

These factors have influenced the landscape as we see it today – one of struggling isolated paddock trees with linear vegetated road reserves. In a paper written and presented by Dr R J Grose at the 1980 National Conference on the Decline in Trees in the Rural Landscape, Dr Grose reported that, in Victoria, "Decline of trees in agricultural land does not appear to be markedly greater than that of similar aged trees in adjoining road reserves where management practices are quite different." Although not surveyed, the situation in the Byawatha Hills appears not to follow this trend. Some dieback is evident in road reserve Eucalypts, however not to the degree of agricultural land.

Figure 7. Stock camp

Landholders of the Byawatha Hills area have been attempting to combat tree decline by fencing out areas of remnants and revegetating. Onground experience found that fencing remnants with the intention of regenerating naturally from local seed (as opposed to revegetating) had limited success. It has been noted by landholders and agency staff that, in some instances isolated paddock trees cannot regenerate, even when fenced to exclude stock pressure. Day (1980) sums this up by suggesting that the inability of *Eucalyptus* to regenerate may be due to the extent to which the land has degraded. The barriers to natural regeneration include seed supply, soil condition (compaction, loss of top soil, altered chemistry), competition and predation. There are ways to encourage regeneration once the area has been fenced off, including scarifying, reducing competition with grasses prior to seed fall, rabbit control and fire (DNRE 1992). Further research into comparisons between roadside regeneration and fenced paddock tree regeneration is indicated.

Figure 8. Five year old revegetation with mature *Eucalyptus* suffering dieback. Fallen limbs are retained to provide habitat for native fauna.

Figure 8 shows an area of revegetation in the catchment. Properties 1 and 2 have, in recent times, made a concerted effort to revegetate, with financial assistance from the Natural Heritage Trust in the Salinity and Heartlands programs. Property 1 began planting native vegetation over 15 years ago and has greatly increased this activity under the Heartlands project in 2000 – 2002, to its current 5.8% tree cover. In contrast, Property 2 has gradually increased the tree cover area over the past 29 years to the present value of 13.2%.

Landholders of the region first noticed signs of dieback as early as the 1950's. The time-lag between large scale revegetation and the current broad scale dieback gives some indication that there will be a suspended turn-around period before positive catchment changes are noticeable.

Some positive changes are already evident in the catchment. In some of the local groundwater systems, recharge and break of slope plantings have made an impact on ground water tables. A case study quantifying the benefits of trees on farms based one of its study areas in the Byawatha Hills (Howard & McDonald, 2002). The outcomes, as noted by the landholder and recorded using scientific methods, clearly outline the benefits of revegetating sections of farm land with native trees and shrubs. Benefits included increased biodiversity, a lowering of water tables, the economic advantages of increased productivity, and aesthetic values.

Figure 9. Mature revegetation at Property 2

Conclusion

Quantifying changes in the area of native vegetation cover over the period between 1972 and 2001 identified gains in vegetation area on both properties due to intensive revegetation programs. Large decreases in the number of isolated paddock trees were recorded on both properties. A combination of dieback, pressures from stock and senescence have been the major contributors to these losses.

The current number of isolated paddock trees suffering from dieback presents landholders and agency staff with the issue of continued losses. The research results indicate that, within the next decade, a predicted 30% of the present number isolated paddock trees will die. The decrease in the number of paddock trees is likely not to be restricted to the focus properties, but broad-scale across the Byawatha Hills area.

The loss of individual paddock trees is having an impact on local landscapes. The visual decline and loss of landscape amenity is something that the community will need to consider in the near future. Quantifying the losses is one way to raise community and landholder awareness of this problem.

Managing predicted future losses of up to 30% of paddock trees will be a challenge, particularly when surveyed landholders are actively aiming for a goal of 30% revegetation of their properties.