Recovery or Transformation? The Ecosystem Property of Resilience May be a Useful Mechanism for Both.

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Abstract
In psychology and ecology, 'resilience' describes a capacity to bounce back from a stress, a capacity gained from repeated exposure to bouts of that stress. Resilience in ecosystem, for example, is conferred by the adaptation of species (over evolutionary time frames) to environmental stress and release from that stress. Yet too often we hear people talking about managing ecosystems in ways that can 'improve resilience to climate change' – even while climate change is an ongoing and increasing stress. Thus the concept of resilience is confused with adaptability - quite a different process more akin to 'transformation' than the resilience/ recovery cycle. Both are about adaptation, but one is slow and gradual, while the other is rapid, with all the cascading effects of rapid change. Why this matters is that confusing the two terms could lead some to mistakenly assume that climate change can be accommodated somehow by historic ecosystems, lessening the need for abatement.

Nonetheless resilience mechanisms in plants and animals can be harnessed, in combination with removal of multiple other stresses, to renew and expand ecosystems in ways that can improve potential adaptation to climate change. Examples include expanding habitat linkages through restoration; as well as reinstating structural patchiness to reduce the effect of large scale wildfires on fauna, an increasing threat accompanying climate change. This presentation illustrates these points with examples of how prescribed fire and weed management can be used to restore and improve the function of habitats – and where combined with harnessing cultural resilience and potential for positive transformation can be used to improve our capacity to adapt to a more sustainable future.

INTRODUCTION

There are strong parallels between resilence as described in the social sciences (particularly psychology) and resilience as described in ecology. In both, the term describes a capacity to bounce back from a stress developed through repeated exposure to bouts of that stress. In ecosystems in particular, it is conferred by the adaptation (through natural selection) of species to environmental stress and release from that stress over evolutionary timeframes. In our personal psyches it is gained through repeated practice at rising to challenges, and in social systems it is confered by social structures that have been developed to ensure the persistence of assets and cultural values after disturbances (including changes to governments, wars, pestilence or environmental disasters). Where the stress is of a totally different nature (or is much larger, or of much higher duration or intensity)to that which an organism or society is adapted), the managed response can only be transformation to the most positive state possible, retaining as much of the earlier values as possible or desirable.

The interactions between society and nature make it impossible to refer to them as entirely separate entities. We depend upon nature and the health of ecosystems now depends largely on the behaviour of humans. One important example, is the traditional land management practices of Indigenous people in which fire is used to manage ecosystems and threats to social survival from wildfire. Another is the modern practice of ecological restoration, in which humans seek to redress past anthropogenic damage and foster the recovery of an ecological community's health to the extent practicable. It is possible to observe and describe differences in function between the social and ecological components of social-ecological systems.

In terms of ecological restoration, there is growing evidence, detected by bush regenerators and others at thousands of property-level sites across Australia, that the capacity for recovery (i.e. resilience) can be higher than initially expected with skilled intervention. This is usually achieved by applying approaches (including assisted regeneration and reconstruction) that are matched to the level of resilience remaining in an ecological community (Fig. 1). Examples include the restoration of Big Scrub rainforest remnants in north coast NSW, extended and linked by plantings (Parkes et al., 2012), extensive sclerophyll community regeneration, plantings in agricultural areas in southern NSW (Lindenmayer et al., 2013), grassland sites and wetlands (McDonald and Williams, 2009). With the cumulative effect of so many projects, landscape level effects such as improvements to connectivity are now starting to emerge, improving potential for adaptation by many plant and animal species in the face of climate change.

In this paper, we report on a project where both regeneration practices and Indigenous burning practices were combined through works carried out by an Indigenous land management team (Minyumai Green Team) on a covenanted wetland on private property on The Gap Road, Woodburn in north coast NSW.

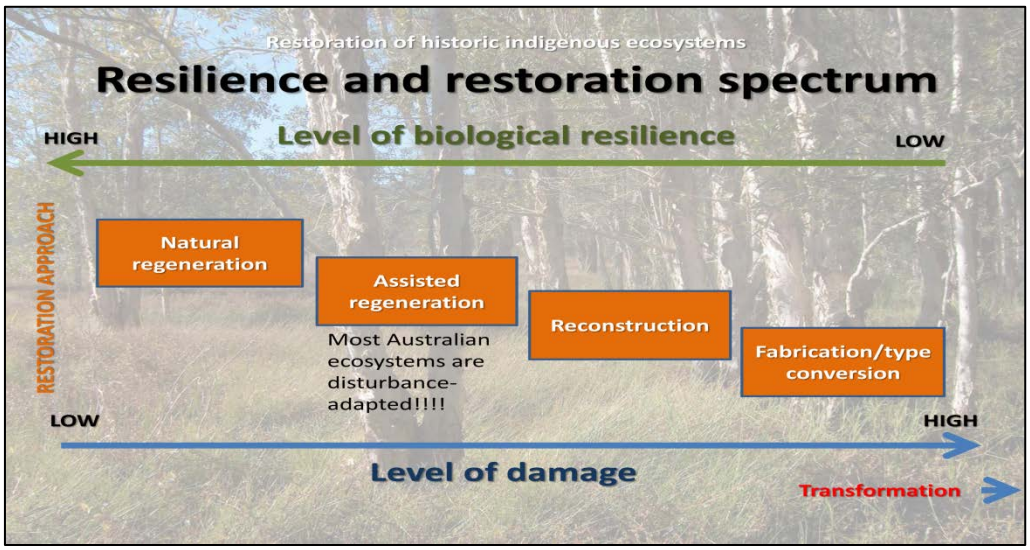

Fig. 1: The 4 main restoration approaches generally used by restorationists seeking to match the level of intervention to the level of resilience remaining in a damaged ecosystem.

The works involved the application of a patch burn, with affinities to traditional Indigenous burning, followed by a series of systematic weed control treatments. We discuss the degree to which this activity is providing additional encouragement and inspiration to Minyumai's program of cultural and environmental recovery, commenting on implications to the most pressing conservation concern of our time; anthropogenic climate change.

GAP ROAD WETLAND REGENERATION PROJECT

This property-level site on The Gap Road, south-west of Evans Head in northern NSW, contains some remnant forested and freshwater wetland patches, including three endangered ecological communities, with substantial clearings from the grazing era (McDonald, 2008) (Fig. 2). Some woody regrowth and hardy ground covers - mainly swamp oak (*Casuarina glauca*), blackwood (*Acacia melanoxylon*), bracken (*Pteridium esculentum*) and blady grass (*Imperata cylindrica*) were colonising the edges of the clearings. When the project commenced, the cleared patches were dominated by exotics, particularly the tall-growing setaria (*Setaria sphacelata*), with a range of other herbaceous weeds and a few common native groundcover species present beneath the setaria cover.

SELECTING APPROPRIATE TREATMENTS

Bush regenerators are familiar with highly weed infested sites recovering after skilled weed control over a period of years (McDonald, 1996).

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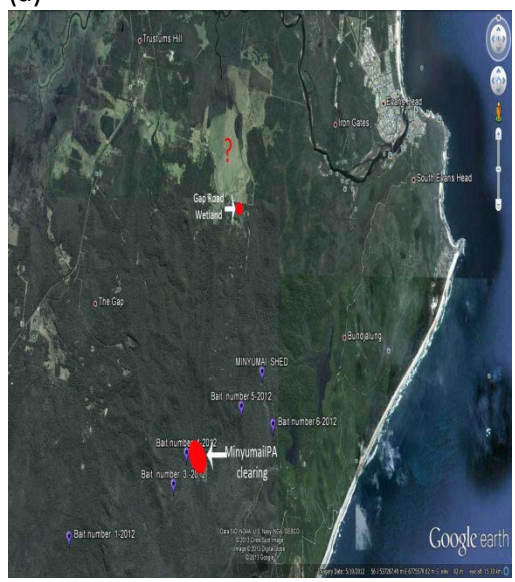

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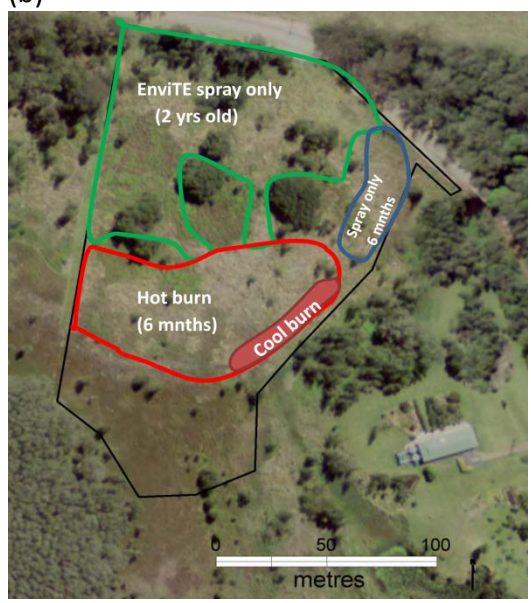

Fig. 2: (a) Location map and (b) works zones at the Gap Road wetland

We are also familiar with the idea of using fire to help trigger regeneration from buried seed banks (Reidy, Chevalier and McDonald, 2005). But what condition was The Gap Road wetland soil seedbank in after decades of grazing and, presumably, spring pasture burns? Was it capable of contributing to full restoration or could we only hope for transformation to some sort of improved state?

When the Minyumai Green Team tendered for the three-year contract to undertake bush regeneration works, the site had already be subject to some 18 months of weed spraying by EnviTE Environment. Primary work had been carried out in half the area and secondary (follow up) works were in train (Fig. 2b). It was clear, however that the high biomass of the setaria was hampering recovery as it provided a thick mulch cover over the ground for many months prior to breaking down sufficiently to trigger regeneration from the soil seed bank. This meant that there was a delay not only for the regeneration of natives but also of weeds - suggesting that the follow up weeding requirement would be prolonged over a number of years, exceeding the time funding was available to assist the landholders.

Undertaking a patch burn on recently sprayed setaria was a logical step, if only to reduce weed thatch and flush weed early enough to complete the follow up within the contract period. If results at other sites are any indication, we thought the fire may also trigger the germination of any native seed that remained in the soil. But it was a risk. We knew nothing about the extent of the native seed bank and very high levels of soil-stored weed seeds were anticipated. Perhaps some of these seeds may be killed by a fire (Weiss, 1983), but the price would be the simultaneous triggering of a massive weed flush (Reidy et al., 2005) requiring a high level of weed control after the burn.

WORKS UNDERTAKEN

After a 2-3m wide firebreak had been cut, a burn was conducted on October 19th 2012 by the landholders, with assistance from the Minyumai Green Team and neighbours, with the local fire brigade on standby (Fig. 2b). While the wetland had good soil moisture reserves, the vegetation and soil surface was dry, due to a very dry preceding three months.

The fire burnt through approximately 0.5 hectares of the setaria-dominated area, most of which had been previously sprayed. The dead setaria burned very rapidly and hot, but a deliberately unsprayed smaller area burned at a slower rate and at a cooler temperature (Fig. 3). After the fire, moisture conditions were ideal for plant growth and the Minyumai and EnviTE teams alternated in the follow up spray of the weeds.

Follow up weeding used systematic spot-spraying with knapsacks, generally using 1:100 glyphosate and Protec Oil. Selectivity was gained through very careful targeting of the weeds, although in the first treatment after the burn, the spray was more akin to a blanket spray. That is, while as many regenerating natives as feasible were covered with paper plates or up-ended planting tubes, the weed was so dense and some natives so small that a decision was made to forego some natives to kill the first flush of weed as soon as possible, i.e. prior to any more natives regenerating. Spot spraying in subsequent treatments was applied with the goals of treating weed while avoiding all natives to the highest extent possible by using skilled operators.

MONITORING

Prior to the burn we had established 6 permanent (3 x 3m) quadrats in each of the three treatment areas: hot burn, cool burn and unburnt. These were recorded one month prior, one month after and five months after the burn.

Fig. 3: The fire was lit from the south-west edge on dusk on the 19th of October 2012 and gained heat rapidly due to dry surface conditions and the dead setaria. At its peak, it crowned into some scattered casuarinas but slowed substantially when burning through the live setaria (J. Coward).

RESPONSE OF WEED AND NATIVES TO FIRE AND FOLLOW UP WEED SPRAYING

The response to the treatments showed remarkably high recovery of native herbaceous ground cover in the hot burnt area after 5 months, with the cooler burnt areas also containing valuable levels of natives, although of more common species than in the hotter burnt area (Fig. 4 - 6).

The unburnt area is also on the way to high native cover levels, although this is clearly due to the area selected being naturally lower in elevation and colonised by freshwater wetland matting plants that are colonising the decomposing setaria litter – a process not occurring in the larger and older unburnt but sprayed areas where the litter has broken down.

(a) Prior to burn but after spraying the setaria.

(b) Immediately after the burn, with all vegetation burnt.

(c) Weed flushes three weeks after the burn.

(d) The same view five months after the fire, showing high levels of native cover.

Fig. 4: Before and after sequence of part of the hot burn site, looking towards the paperbark swamp (J. Coward and T. McDonald).

The fire did not kill the setaria in the cool burn area (as it was unsprayed) which meant rapid regrowth of setaria in that area. The cool burn area is taking substantially longer for weed to flush and reduce compared to the hot burnt area in which weed species richness is already decreasing (Fig. 7). Weed density is also still very high in the older sprayed but unburnt areas. The reduction in weed in the hot burn area is likely to be due to high regeneration of weed and its subsequent spraying prior to substantial regeneration of natives (Fig. 8). Also, after the third treatment, the time required to complete detailed spot spraying compared to the other treatments was substantially reduced.

The most surprising result, however, has been recruitment at the site (particularly the hot burnt site) with scores of individuals of four tree species, *Melaleuca quinquenervia, Melaleuca alternifolia, Casuarina glauca, Callistemon salignus* and *Persoonia cornifolia*. This was not expected at such an early stage in the recovery process, because tree seed is not stored for long periods in the soil and mature specimens of these species (except for swamp oak) were not in the immediate vicinity. Contributing factors to the success are likely to be the creation of an ash bed followed by high wind storms, two of which occurred in the first three months after the burn and would have been capable of carrying fine seed of these species.

Fig. 5: Visible floristic differences between the cool burn strip (closest to the casuarinas) which contains ferns and more common natives - and the hot burn area (in the foreground) which contains more wetland sedges, particularly *Cyperus polystachyus*).

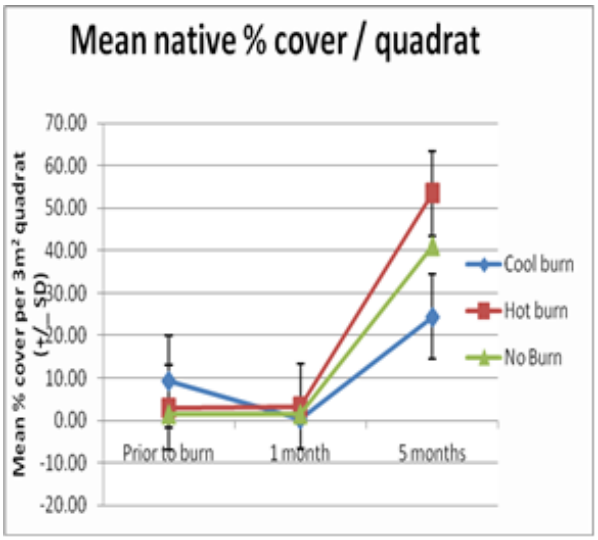

Fig. 6: Changes in percent cover of native species over time after three fire treatments at Gap Road wetland. The hot burn has achieved substantially higher percent cover than the cool burn.

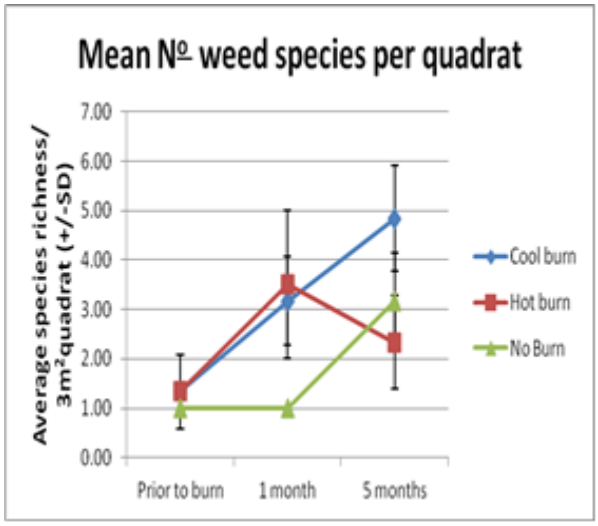

Fig. 7: Numbers of weed species were still increasing in the cool burnt and unburnt quadrats at 3 months, whereas they were decreasing in the hot burnt quadrats.

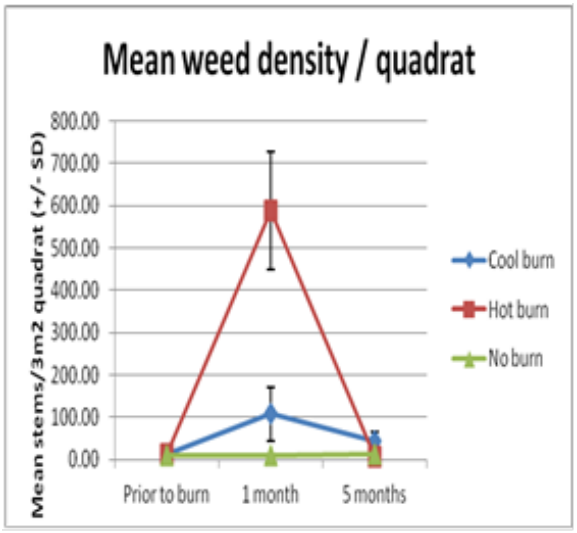

Fig. 8: this reduction is likely to have been achieved by the far greater flushing of the weed seed bank after the hot burn, weed that was subsequently killed with herbicide.

HOW UNUSUAL IS THIS REGENERATION WHAT ARE THE IMPLICATIONS FOR BIOLOGICAL AND SOCIAL RESILIENCE?

Ecological Implications

At the commencement of the project we did not know whether the site would regenerate with any significant level of similarity to the pre-existing vegetation. The lack of residual vegetation in the cleared patches, history of grazing and distance from mature trees suggested low resilience. After the trial, however, it is clear that the hot fire (achieved by spraying the setaria to create a more combustible fuel) resulted in the germination of about 35 species of forbs, sedges, some grasses and trees. This range of species suggests that a high degree of floristic similarity to surrounding historic ecosystems is likely to occur over time, if there are no unforeseen impacts such as frosts.

This result is significant locally as the Minyumai team is now encouraged to trial a similar approach on a 15 hectares previously grazed clearing in our nearby Minyumai Indigenous Protected Area (IPA), similarly dominated by setaria (Fig 2a). With larger clearing size, however, tree recruitment cannot be relied upon and arrangements are being made to supplement regeneration with planting. Importantly, the burning at Minyumai IPA is not just to achieve native regeneration of the degraded areas, but also to develop fire management skills that we can then extend other parts of our property. The aim of burning in healthy bushland is to maintain species diversity and to create a patchwork of age classes; as well as to try to break up the fuel to reduce the amount of extensive wildfires that have been occurring in the past 50 years or so in our whole precinct including Bundjalung National Park. This is particularly important as extensive wildfire is highly destructive to many of our native animal species. A problem likely to worsen with the increased wildfire risk predicted to occur with global warming.

The Gap Road wetland project also provides a model for potential application

to adjacent cleared and grazed (setaria dominated) lands which have the potential to link Bundjalung and Broadwater National Parks should these areas ever be acquired in the future for addition to the conservation estate. This improved connectivity would have a very important effect on improving corridors for climate change adaptation.

We use the term 'adaptation' advisedly because too often we hear people talking about managing ecosystems in ways that can 'improve resilience to climate change'. We believe this is incorrect as resilience, by definition, occurs only after the release of a stress; whereas climate change is an ongoing and increasing stress unless we can reverse it. This distinction is important as confusing resilience and adaptability in this highly politicised climate could reinforce a tendency for many of us to grasp at straws that might reassure us that global warming can somehow be accommodated by historic ecosystems, lessening the need for abatement.

Cultural Implications

Minyumai's proposed patch burning activities are to be carried out in collaboration with the Nature Conservation Council's innovative Firesticks project which is designed to assist Indigenous land managers with reinstating patch burning on their lands. This collaboration has strong potential to help renew ecosystems, as well as Indigenous culture. We cannot overstate how important renewal of culture and identity are to Aboriginal groups such as ours, struggling to keep our culture alive in a modern world.

At Minyumai, through owning the land once again, and self managing it, we have started using similar 'resilience' principles in our language and land management programs to try and recover as much Aboriginal culture as possible while managing the land (Table 1). That is, we now operate on the basis that active reinforcement and renewal of knowledge where it is strongest (not weakest) is going to be more effective; focusing on working with adults who have high levels of motivation and existing knowledge; then creating new opportunities for cultural transfer to younger people.

Table 1: Social regeneration principles inspired by ecological regeneration principles – both based on using resilience to rebuild health.

Social Regeneration Principles	Ecological Regeneration Principles
1. Focus active reinforcement and renewal of knowledge where it is strongest (not weakest)	1. Work from good bush outwards
2. Work at a rate matching rate of recovery (ensuring lots of follow up support!)	2. Work at a rate dictated by the rate of recovery of the bush
3. Set each challenge a little higher but not too high	3. Neither under- nor over-disturb

Like at The Gap Road wetlands, we are also starting to understand the importance of follow up i.e. coming back repeatedly to reinforce and support individuals with their growth and performance. Similarly, we are also undertaking our cultural regeneration at a rate that matches the potential for uptake of those changes by our people - attempting to make sure that the challenges we set ourselves are stimulating but not discouragingly overambitious.

IS IT RECOVERY OR TRANSFORMATION?

We recognise that we operate within a social-ecological system, but can see that our ecosystems are at a different stage to our culture. That is, our property is largely still intact ecologically, set amid extensive native vegetation; while our culture has been experiencing extreme extinction pressures since the 1830s. So it is safe to say that our biodiversity work is aiming for 'restoration', even in the face of climate change. But much of our cultural work is 'transformation' rather than restoration; finding new ways of translating old values.

While the grief of loss of culture is enormous and the stresses upon us are still great, our forebears have taught us to be proud of the culture we retain and urged us to grow stronger over time as individuals and families, bringing all our people with us. Sometimes this involves fostering recovery or reintroduction of cultural practices that have survived for thousands of years (like patch burning, kinship and behavioural rules, use of language etc.); while at other times it means adapting to European ways. What is actually happening, though, is that we are transforming our lifestyles into a hybrid culture; which is part old culture, part dominant culture and some entirely new elements that we can say are uniquely Aboriginal. This draws on resilience in many ways, and builds resilience. As such, it can be seen as an exciting transformation process which we hope might inspire non-Aboriginal people to also transform.

TAKE HOME MESSAGE

Indigenous groups have a lot to offer other Australians, particularly a respect for land which should be seen as our kin, rather than resources that we can keep exploiting without consequences. Our involvement in The Gap Road restoration project has helped us gain more understanding of how we can continue to practice parts of our culture in the modern world, as well as to transform our culture to include restoration practices such as weed control, which are not part of our traditional culture. Just as Aboriginal people can only recover and transform as a people if extinction pressures are removed, ecosystems can only recover and positively transform if the damaging pressures (including climate change) are reduced and stopped if at all possible. This means the whole of society transforming to a more positive state. Our vision of this positive state is of an Australian culture that takes nature more seriously, that better understands our ecosystems and the role fire plays in them, that limits our impact to levels within natural resilience, and embraces restoration wherever possible, (undertaking restorative transformation where necessary). Such a transformation can draw on traditions as well as create new solutions that draw on old resilience and build new resilience to ensure the values persist through whatever shocks the future brings.

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BIOGRAPHY

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