Conference Proceedings – Speaker Transcript

Where has all the fire gone? Quantifying the spatial and temporal extent of fire exclusion in Byron Shire, NSW

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Link to slides

Today, I'm going to present the findings of some research looking at fire exclusion in the far north coast, using Byron Shire as a case study. So first, I'll provide an overview of the process of fire exclusion and vegetation change. Then I'll outline the GIS analysis methods, and finally the results of the study.

Firstly, three key messages. Nearly half of Byron Shire's biodiversity needs regular fire to maintain suitable habitat. Without regular fire habitats can change quite rapidly and if habitat becomes unsuitable, localised extinctions follow. Fire exclusion following vegetation changes are a worldwide phenomenon, which has been reported for all continents except for Antarctica. This can be divided into two main processes. Firstly, the transition of treeless ecosystems to forest. This has been widely documented for the savannahs of northern Australia and also the heathlands and grasslands of western, southern and eastern Australia. Secondly, the transition of open forest to rain forest, which has been well documented for higher rainfall areas in Tasmania, the greater Sydney basin, and also the wet tropics region.

So looking at the wet tropics region, a 2014 study which mapped around 2 million hectares of vegetation found that 25 per cent, or more than 100,000 hectares of open forest and woodland had irreversibly transitioned to rainforest since the 1950s. Looking at the major open forest types, three of the major types have had more than 70 per cent of their distribution captured by rainforest since the 1950s. Many of these open forest types are now recognised as endangered ecological communities because of this rainforest transition process.

So why is change happening? This diagram (slide 7) represents the development of vegetation through time. In the far north coast, high rainfall and mild temperatures allow full development of the vegetation to rainforest, which is the region's climatic potential. Vegetation is always moving towards this climatic potential unless interrupted by disturbance. However, in our region and throughout the world, fire deflects this development process, and regular fire maintains the vegetation in a narrow band of development along this spectrum.

Most importantly, it is fire interval which determines where along this spectrum the vegetation is maintained. On a given site, for example, a very short fire interval of five years may result in the development of grassland. If it's extended to 20 years then dry sclerophyll forest is a likely community. And if fire is excluded for 100 years or more, then rainforest is likely to develop.

Those communities which are maintained by a specific fire interval, are termed fire dependent vegetation. They're not only fire dependent because the exclusion of fire results in a shift to other vegetation types, but also because most of the species in those communities require fire for their recruitment – and many of them won't recruit at the broader landscape scale unless there's wholesale removal of biomass and exposure of the ground surface by fire.

So now looking at the process of transition from treeless ecosystems to forest, this image (slide 12) is of an endangered heathland restricted to Byron Bay. In the interval between fires, trees recruit into this heathland and historically, at about this time, fire would pass through and remove those trees, restoring the original heathland structure. However, in the continued absence of fire, the trees continue to grow. Were a fire to pass the community at this stage, many of those trees would no longer be removed by fire. So this is the passing of an important threshold where restoration of heathland structure by reinstatement of fire alone has now past.

Continued canopy development occurs above the heathland and shade intolerant heathland plants begin to drop out, as can be seen in the lower right-hand corner of the photograph. With further canopy development again, you start seeing complete suppression of the flammable under storey. So two main things have happened here, you've lost nearly all your original floristic diversity of the community, but also the possibility for an ecological burn in safe weather has essentially been lost from this site.

Looking now at an example of this from the air (slide 17). This image shows an area of sedgeland and wet heathland in Brunswick Heads Nature Reserve. The area bounded by the orange line is treeless vegetation, and then beyond the line is taller shrubland and forest. Moving forward 30 years without fire, and forest and tall shrubland has now displaced much of the heathland in this area. This trend is happening in most treeless ecosystems in Byron Shire.

Looking now at the process of open forest transition to rainforest (slide 18). This diagram represents a typical open forest structure, and most importantly, note the flammable under storey, which is dominated by grass like plants and heathy shrubs. So in between fire, as in the heath land, but in this case rainforest trees recruit into the under storey. Again, historically at this time a fire would pass through the community and remove the rainforest saplings from this vegetation type. However, without fire, they continue to grow, and numerous studies that have shown that around about 80 % of rainforest trees can quickly reach an age where they'll actually survive complete top kill by fire. This is known as the *fire-resistance* threshold. At this point, rainforest trees are no longer removed by fire alone, and to reinstate the original structure would require manual removal, if that was the intent, and the rapid regrowth of the rainforest coppicing after fire quickly resumes the process of rainforest transition.

Continuing on without fire, the rainforest mid-storey continues to develop and the increasing shade that is cast causes shade intolerant understorey plants to start dropping out. This is termed the *fire-suppression* threshold. At this point, the understorey is unlikely to carry prescribed fire in safe burning conditions. These understorey and near surface fuels are critical for carrying fire, and even big canopy fires will collapse if there's insufficient understorey fuel. Of course, there's the same loss of understorey diversity in the community.

So is fire exclusion a problem in Byron Shire? To determine this, time since last known fire was compared with fire interval guidelines for mapped vegetation types across the study area. These two data sets were then combined to determine the fire exclusion status across a range of key conservation values. Mapping time since last known fire was a one step process which essentially involved combining the fire records of the NPWS and the Rural Fire Service into a single layer which covered all known fire records for the 40 year period back to 1974.

Mapping recommended fire intervals was a five step process, first of which was combining the vegetation data sets across the study area into a single vegetation layer. Step two involved identifying exotic vegetation, such as camphor laurel forest, which is quite common in our area, and removing that from further analysis, leaving a layer of native vegetation. Step three involved assigning these to one of six vegetation formations. Step four involved determining the fire relationships of these formations by reference to the literature. *Fire-dependent* generally included all grasslands, sedgelands, heathlands, and sclerophyll forest types. *Fire-sensitive* vegetation included rainforest, mangroves, and salt marshes. And the *undetermined* class included areas of mixed regrowth, where there was not enough data to determine the original vegetation type and therefore the fire relationship. The fifth and final stage was assigning recommended fire intervals. We used the 2006 guidelines of Penny Watson, these were used because they're specific to the region, they're recommended by the Northern Rivers Regional Biodiversity Management Plan, and they also specifically factor in the risk of vegetation change resulting from fire exclusion.

So these are the fire interval guidelines used (slide 28). On the left-hand column are the formations, and on the right are the interval recommendations in years. As you can see, the top four formations just have a simple minimum and maximum range. Wet sclerophyll forest is further subdivided on the basis of understorey. Then each of those includes a two tier regime that includes higher frequency but lower intensity understorey fires, but also a less frequent high intensity canopy fires.

The vegetation formations were coded with the maximum interval for the top four and the maximum understorey interval for the wet sclerophyll forest. But understorey was unknown for many areas of wet sclerophyll forest, so those areas were mapped automatically *of-concern* if the fire interval was longer than 20 years, on the basis that we knew some of the areas within the unknown understorey, in fact contain shrubby understorey. This map shows the resulting recommended fire interval map for the study area (slide 29).

So, onto the results. Looking at all fire dependent native vegetation across the Shire you can see that only 10 per cent is within thresholds (slide 31). 61 per cent is fire excluded, and the remainder is of concern. Again, the 'of concern' is known to contain areas that are fire excluded, but the extent can't be mapped because we don't have that vegetation mapping detail in those areas.

Looking at the individual formations here, grassland is 100 per cent fire excluded, and all the remaining types are less than 20 per cent within threshold. And again, the yellow area there is *of- concern*.

Looking now at the endangered ecological communities (slide 32) - fire dependent that is, rainforest is excluded - again only 15 per cent is within thresholds. Now, the important thing is, these are our highest conservation value vegetation types, and by definition, they're endangered, and this study demonstrates that fire exclusion may potentially be a factor in their long-term demise.

Looking at EECs individually, again grassland is 100 % fire excluded, and the remainder have very small amounts within threshold. For coastal wetlands, a similar pattern is evident, only 17 per cent within thresholds. These include both open sedgelands and forested wetlands, and again, are real biodiversity hotspots, providing unique habitat for threatened biodiversity. Coastal koala habitat, has a similar story. As all koala feed trees essentially require fire for widespread recruitment, and as time passes without fire, opportunities may be lost for their recruitment on many sites.

So what about high frequency fire? High frequency fire is listed as a key threatening process, and it's routinely listed as a threat in ecological assessments. Conversely, low frequency fire is not listed, and is rarely considered in ecological assessments. So what is their relative importance in Byron Shire? As you can see (slide 35), high frequency fire is almost mythical in this region, comprising less than one per cent of all areas affected by inappropriate fire frequency.

So fire exclusion is spatially extensive, but by how long are thresholds exceeded? This diagram shows the proportion, the bottom axis there shows fire interval or fire return cycles, 10 years is the recommended interval, so most of the community should operate within the grey area there. And beyond 10 years, species and habitat are predicted to decline. However, most areas are more than four times beyond threshold, and in fact, we have no data for most of these communities when they were last burnt. So looking at other formations, you can see most of them are a long way out in the order of two or more times or unknown last time since fire.

Coming briefly to impacts on floristic diversity (slide 38). Nearly 1000 species for all of Byron Shire for flora, 46 per cent of those are restricted to fire dependent communities. As you can see, this breaks them up into different height classes (slide 39), so nearly 84 per cent occurs below 2 metres, and this is the first area that's affected by shading from vegetation change. Therefore a eucalypt community may look healthy, but most of its floristic diversity may in fact be lost even in the early stages of rainforest transition.

So what about the broader region? These maps (slide 40) show an OEH analysis done using the state-wide intervals of Belinda Kenny, Ross Bradstock and others. It shows once again that not many areas are within threshold and many areas are fire excluded. Again, it shows the relative importance of low frequency fire there.

In conclusion, the study demonstrates that fire is a major threatening process affecting Byron Shire's biodiversity, which has been little recognised previously. It's potentially widespread in similar regions along the coast. Restoration of transition sites may be complicated by encroaching trees that have become fire resistant and the loss of the flammable understorey to carry ecological burns. Further research should include *what is the extent of fire exclusion in other regions*, and *how quickly are these thresholds being met in different ecosystems*.

Questions from audience

Q - You looked at the tolerable fire intervals for vegetation and used that to figure out, I guess, how good the current situation is. Would you get a different answer if you looked at fauna and their requirements for fire frequency?

AB - I don't know. There hasn't been recommended guidelines done, sort of, universally for fauna. I guess you may. Different fauna would have different needs there. But I guess there's a bit of an

underlying assumption that you have a plant community which is understood to have a certain fire regime, and that is the underpinning habitat for that fauna. So I think, generally, for many fauna the most important thing is to determine if the habitat is maintained for that fauna. The vegetation community provides many of those habitat traits. So there is an assumption that those vegetation based recommendations are catering for that fauna. But I'm not aware of any work that's looked at fauna groups as a whole. I guess you'd need to look at the assemblages of fauna that occur within each ecosystem.

Q - In your study you removed the non-native vegetation layers, and I was wondering if you did any analysis to determine the benefits or effects of fire exclusion for those non-vegetation areas? Because if you are going to have an area of non-native vegetation and just leave it there with no fire management, what sort of effects happen to that? Or is anyone managing that?

AB - Well, that's definitely beyond the scope of the study. I needed to draw tight boundaries around the study, and so what you're asking is really talking about a whole other issue.

Q - So do you know in Byron Shire of anyone who's managing that non-native veg with fire?

AB – Yes, certainly areas are being managed but not with fire. So I guess the biggest group of vegetation in our study area was camphor laurel forest, and typically that's really capturing ex-rainforest sites. It has no trouble also, of getting into ex-sclerophyll sites, but it really powers up on the red soil, and we've got a huge red soil plateau in our region. So they are being managed, but they're not being managed with fire. I think in some of those areas, of either mixed regrowth or non-native vegetation that were excluded but are on, what was previously sclerophyll vegetation, fire should be considered as a restoration tool. One of Tien McDonald's sites (from earlier presentation), essentially was that. It was non-native vegetation, so it would have been excluded from my analysis, but that fire was being used there as a restoration tool, to stimulate the limited resilience existing n the site. So there are examples. It is definitely another story. If you're using fire to try and restore a community that's got very little existing sclerophyll propagules on the site, it's extremely difficult because most of those things are spread short distances by wind or ants. With rainforest regeneration, conversely, you can usually open the soil up, and seeds can get brought in by birds and bats quite quickly. So a lot of people, sort of, have high hopes for having a completely degraded site with very little resilience left of sclerophyll vegetation and think that burning will just bring it all back. But you need the seed source, it's got to be coming from somewhere. So you know, really fire restoration works best on sites where you've got at least a semi-intact fire dependent community.