**Phil Martin – Planning document 2015**

**Denny collapse – stand level work**

* On return the first thing to do for this work is complete the analyses, specifically those relating to ground flora composition and traits. For the paper we need the following figures/tables:
  1. Figure showing location of Denny Wood and layout of transects
  2. Histogram of change in basal area to show different responses of plots
  3. Size distributions of trees in plots in different stages of collapse
  4. Table summarising change in the different stages of collapse
  5. Composite plot of community change over the collapse gradient for trees and ground flora
  6. Composite plot of changes in community weighted trait values for tree and ground flora using Ellenberg values
* We need to decide which journal would be best to submit this to. Adrian has mentioned Journal of Applied Ecology, but it may be useful to discuss others e.g. Journal of Ecology, Ecology, Ecological Applications etc.
* Linked to this we need to decide author order for the publication. Authors need to include Phil, Adrian, Paul, Elena and Ed (any others?).
* Following this the methods and results sections must be edited to reflect figures and modelling results. Statistical tables to show model selection process could go in either main document or more likely supplementary materials to save on space.
* Finally the introduction and the discussion of the paper need to be written. These sections need to frame the work in the context of collapse and/or regime shift. There is a lot of work on the effects of uncontrolled grazing in other contexts (Jorn Fischer’s work in Australia) that will be relevant here.

**Denny collapse – individual trees**

* This work will investigate the mortality of trees over the time period 1964-2014 for the Denny transect. Research questions should specifically include:
  1. How does probability of death from one survey period to another vary by tree DBH?
  2. Does the shape of this relationship change over time?
  3. Does the shape of this relationship vary by species?
  4. Does the distance to dead trees or the number of dead trees within a certain distance (how much?) alter mortality? i.e. Does collapse propagate?
  5. How does the probability of tree fall vary by tree DBH, survey year and species?
  6. How does the probability of trees snapping vary by tree DBH, survey year and species?
* Our initial hypotheses are that probability mortality during the period 1964-1988 is higher than the 1988-1996 and 1996-2014 periods (possibly as a result of drought/storms), with all time periods showing a u-shaped mortality curve, differences in mortality of species are likely to be masked by mortality related to tree size since some species tend to be smaller (e.g. holly).
* Addressing these questions will allow us to investigate how effects of individual tree death can scale up to stand level processes.

**Forest collapse meta-analysis**

* This would comprise a synthesis to look at the effects of changes/collapse of forest structure on biodiversity, ecosystem function and services.
* The logic behind this work runs thus:
  1. There is a concern that there is a potential for non-linear shifts in biodiversity and ecosystem services as a result of forest degradation
  2. We do not know the shape of many degradation-BD-ES relationships so this is currently difficult to do
  3. There are a variety of hypotheses that relate to the general shape of these curves that can be tested and we need to know whether such non-linearities may be common or not
* This could be used to look at cases in which there has been a single discrete event that has led to a change in forest structure e.g. fire, logging, disease.
* It would be interesting to look at modification of biodiversity etc over gradients of change in basal area for a variety of drivers but this is likely to be difficult, because of the large volume of data that would need to be collected.
* Biodiversity would comprise trees and understory plants and could be measured as abundance and richness
* Ecosystem services – the easiest to measures is carbon in the form of biomass, but possibly soil carbon too (though very unlikely to get a good signal of soil carbon change over a gradient)?
* Demographic stuff – change in sapling/seedling stem density and size classes (e.g. large trees)

Interesting questions to investigate would be:

1. How does tree species richness change over a gradient of structural degradation?

* H1 – Species richness shows a linear reduction with change in basal area
* H2 – Species richness initially increases with a reduction in basal area, followed by a reduction after this (intermediate disturbance type relationship).
* H3 – Species richness shows a threshold effect of change in basal area

1. How do specialist and generalist species populations change over a gradient of structural degradation?

* Generalist species linearly increase with degradation, while specialist species are reduced in population
* Generalist species show an initial increase in population before a reduction at higher degradation levels, while specialists show a linear decrease in population

1. How does recruitment vary over a gradient in structural degradation?

* H1. At low levels of degradation recruitment is increased due to greater availability of light in understory, with reductions at higher levels due to lack of seeds
* H2. Recruitment is reduced linearly with degradation

1. How does the abundance of large trees change over a gradient in structural degradation?
   * H1. Abundance of large trees depends on the type of degradation, with logging causing a greater loss of large trees than other modes
   * H2 – Abundance of large trees changes linearly with degradation
2. How does carbon storage change over a gradient of structural degradation?
   * H1. Carbon storage changes linearly over the degradation gradient
   * H2. Carbon storage declines shows a tipping point at high levels of degradation.
3. How does size structure of forest change over a gradient of structural degradation?

* Need to discuss these questions and general aim of this with Adrian.

Methodological issues that need to be dealt with for this study

* Should studies be limited to those with a particular number of sites/replicated? Studies must have a reference/before forest. Logically each study should have >3 replicates to allow effective fitting of random effect terms. The danger with this approach is that it results in the loss of data from many studies where comparison is treated as a treatment/control comparison (e.g. logging).
* What is the best way to get this data? Should we collaborate with data holders? My current feeling is that collaboration would be the best way as it builds trust and good faith with other researchers. The disadvantage to this is that it slows down publications.

**Paper on recovery time linked to disturbance intensity and matrix**

Linked to the paper above it would be possible to look at what drives recovery time of biomass and other elements of biodiversity.

This work would inform theory on recovery and allow us to look at the relative importance of disturbance intensity and matrix for recovery.

**What is the mechanism underlying apparent tipping points in tree cover?**

Recent papers have suggested that there are a series of tipping points in tree cover driven by differences in precipitation, temperature and fire regimes. However, there is relatively little biology underpinning these papers. One hypotheses that relates climate to tree cover is the hydraulic limitation hypothesis which posits that as water deficit of an ecosystem increases the height which plants can reach before embolism occurs is reduced. Thus at high levels of water deficit it is possible that there is a transition from woody plants to grassy species. Testing this would give us a greater mechanistic understanding of apparent dramatic transitions between forest, savannah and treeless states.

**Lidar work**

* Is there evidence of bimodality in stand structure?
* How does this bimodality change when you use different grain size for analysis?

**Review**

* Review of collapse in forest systems and evidence for non-linear shifts in forests

**Modelling experiments**

* Is the forest undergoing hysteresis? Do experiments within modelling (LANDIS, Netlogo) to induce collapse, and then follow trajectory of recovery?
* Could we look at previous published models to see whether hysteresis has been induced in other systems? Or could we use some existing models in other systems to test this?

**Thoughts on possible MSc projects etc**

* I think there is definitely some scope to look at the effects of post logging liana infestation on succession. There seem to be plenty of studies that look at the change in liana abundance post-logging that could be used for a meta-analysis. Given lianas can constrain recovery you could then look how recruitment varies as a function of liana basal area, or something like that. This needs more thought.

**Activities**

**Denny collapse**

* Get access to ground flora data from Ed
* Finish analysis of Denny gradients and produce final figures for this along with statistical tables
* Decide journal to submit Denny collapse paper to prior to commencing writing
* Decide author list and order for Denny paper
* Write Methods and Results (Phil)
* Write Introduction and Discussion (Phil & Adrian)

**Tree mortality study**

* Come up with better hypotheses based on literature of tree mortality and mode in temperate forests
* Work out how data is to be analysed
* Get data on storms & drought/temperature data that may have influenced mortality to inter causality
* Determine how to account for the different periods of time between surveys and the fact that the enclosed plot has been surveyed at 5 time periods and the unenclosed plot has been surveyed 3 times

**Forest meta-analysis**

* Discuss with Adrian what the aims should be for this piece of work as well as its geographic scope. Currently I think we should use all the data we can get because restricting it to just temperate forest runs the risk of us having a lack of data.