Marine and Tropical Sciences Research Facility

Project 2.5ii.3: Understanding the Climate Change Threat to Ecosystems and Ecosystem Processes, and Developing Options for Mitigation

Project Leader: Dr. David W. Hilbert

Institution: CSIRO Sustainable Ecosystems

Progress Report

Milestone 1: Detail of the twelve forest plots established along altitudinal gradients with enumeration and measurement of trees >=10cm diameter [Objective (a)]

As contracted, we established an altitudinal transect of permanent climate-change monitoring plots to assess changes in forest structure and dynamics with climate. Sites were selected using the current Regional Ecosystem digital mapping (Queensland Environmental Protection Agency). Steve Williams' sites (MTSRF Project 2.5ii.4) were plotted onto this map to assess elevation and substrate consistency. Most of Williams' sites could be used in this project although a few new sites needed to be found to ensure consistency in soil fertility that is necessary for botanical monitoring and surveys.

We established twelve monitoring plots, each 50m x 20m as contracted. Each plot is approximately 100m in elevation from the next plot. Within each plot, which was surveyed and permanently marked, all trees >10cm diameter were recorded, given a unique identification tag and spot-painted so that the diameters can be re-measured in the future. Full vascular plant surveys will be undertaken during the Project's life as required to meet agreed MTSRF milestones. Table 1 provides details about the plots and frequency distributions of trees are presented in Figure 1.

The size frequency distributions for all trees on the twelve climate-change monitoring plots (Figure 1) are complex but largely consistent with previously reported analyses from the CSIRO long-term plots that show increasing numbers of very large trees in cooler climates. The regression in Figure 2 is BA=100.0 -2.51 MAT ($p=0.059$, $r^2=0.31$). Basal area in these plots is not significantly influenced by mean annual rainfall. This pattern is consistent with the decreasing basal area and biomass of forests in warmer climates as measured in the CSIRO long-term plots and reported by this Project in April 2007. This supports our previous estimate that global warming will ultimately reduce biomass and carbon stocks in the Wet Tropics. This part of the project is very well on track and additional data will be collected in Year 2 as agreed milestones.

Table 1. Locations, altitude, basal area and number of tress in the twelve, 0.1 hectare plots that are used in this project, both for long-term forest monitoring, weed, mosquito and disease studies.

Plot name	Latitude (GDA)	Longitude (GDA)	Altitude (m)	Basal Area	Number of Trees
Cowley	-17.70	146.04	25	49.06	62
Liverpool	-17.71	145.86	95	35.71	91
Mena	-17.65	145.86	210	39.01	75
Tchupala	-17.60	145.76	440	46.57	83
Kaarru	-17.64	145.72	510	47.15	93
Maple	-17.67	145.71	590	53.46	92
Charappa	-17.70	145.69	720	58.66	128
Koolmoon	-17.74	145.54	800	49.52	125
Charmillan	-17.71	145.52	890	34.64	87
Coochimbeerum	-17.68	145.50	1010	58.78	71
Cheelonga	-17.50	145.54	1100	50.09	72
Longlands	-17.45	145.48	1210	60.79	80

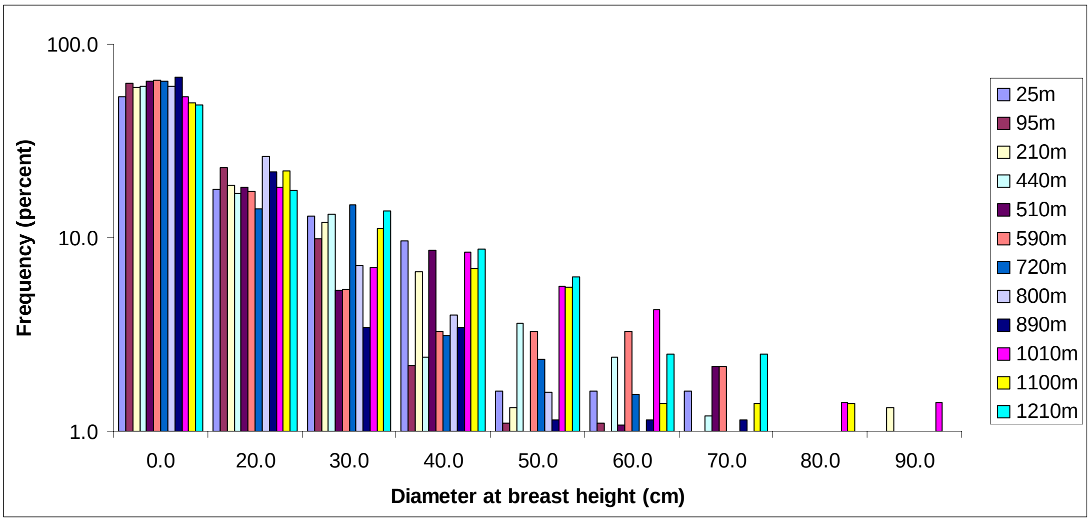

Figure 1. Size frequency distributions for all trees on the twelve climate-change monitoring plots.

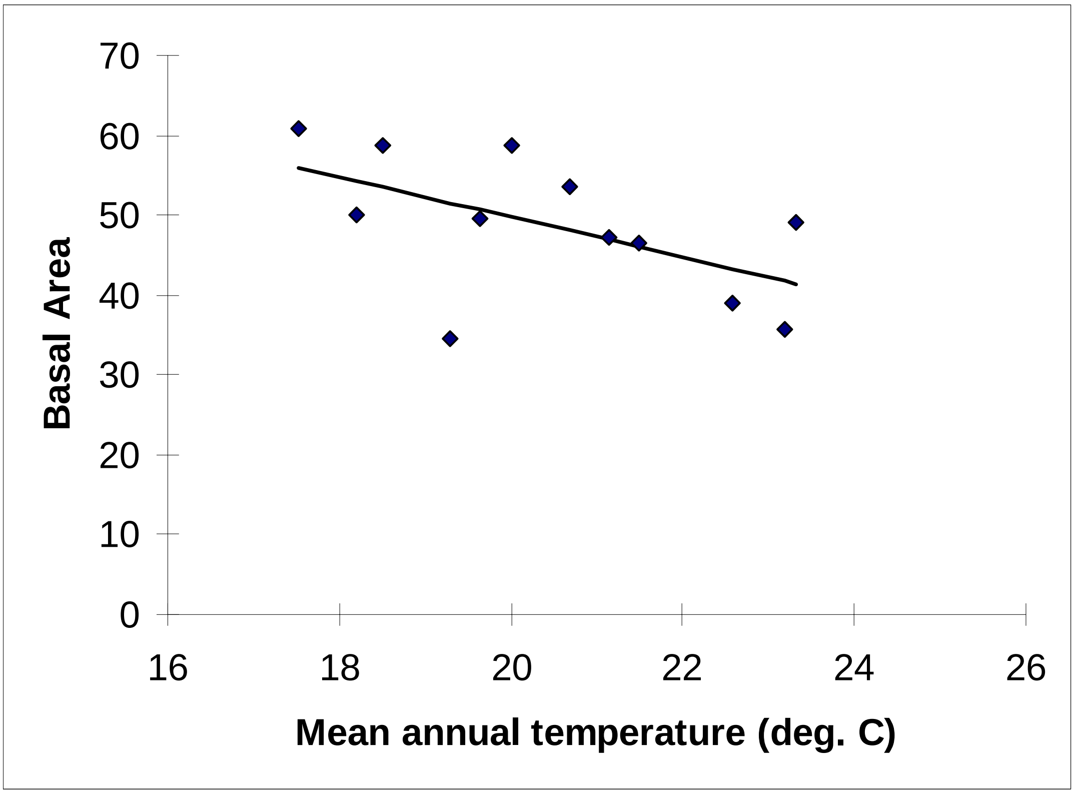

Figure 2. Basal area as a function of mean annual temperature (^{o}C). The plot with the lowest basal area is an outlier that has evidence of extensive logging.

Milestone 2: Preliminary identification of seed disperser functional types in forest plots [Objective (a)].

Summary

This research builds on CSIRO's investment in forest monitoring for over thirty years. (None of the data analysed here were funded by other agencies, including the Rainforest CRC.) Preliminary analyses of the seventeen long-term permanent rainforest plots, occurring in a broad range of climates in the Wet Tropics Bioregion, suggests that the dispersal type of tree species is not a simple function of mean annual temperature or rainfall. Generally, bird dispersal species dominate in all climates so the potential loss of frugivorous bird species with global warming may be disadvantageous for the majority of tree species and rainforest communities throughout the Wet Tropics.

Methods

All tree species occurring on these plots were classified into three dispersal categories based on their fruit and/or seed characteristics. The three categories are wind dispersed (e.g. samaras), bird dispersed (having fruit characteristics suitable for small to medium sized frugivorous birds) and "other" including species that are not wind dispersed and also have characteristics that would not be amenable for dispersal by most frugivorous birds. The proportions (p) of the trees (>10 cm DBH) in each plot that fell into each dispersal category were calculated and then analysed by simple regression in relation to mean annual rainfall and mean annual temperature of each plot. Logit transformation was used to normalise the proportions where $\text{logit}(p)=\ln(p/(1-p))$ and these values were also regressed with temperature and rainfall.

Results

Figures 3, 4 and 5 present the proportion of trees in each of the three dispersal classes in relation to elevation (Figure 3), mean annual temperature (Figure 4) and mean annual rainfall (Figure 5). Logit transformed data are plotted verses mean annual temperature in Figure 6.

Multiple and single variable, linear regressions of proportions of each dispersal type with the climate variables all failed to reject the null hypothesis that climate does not influence these proportions. Thus, preliminarily, we do not expect that climate change will affect forest's floristic composition in this broad sense. Bird dispersed species generally dominate in all climates. Further analyses, including other variables, may identify factors that favour certain dispersal strategies over others. We do know that, individually, plant species have different distributions that are related to climate and we can confidently infer that climate change will alter the distributions of trees and affect community composition of forests. Future analyses of the climate change plots will focus on this issue.

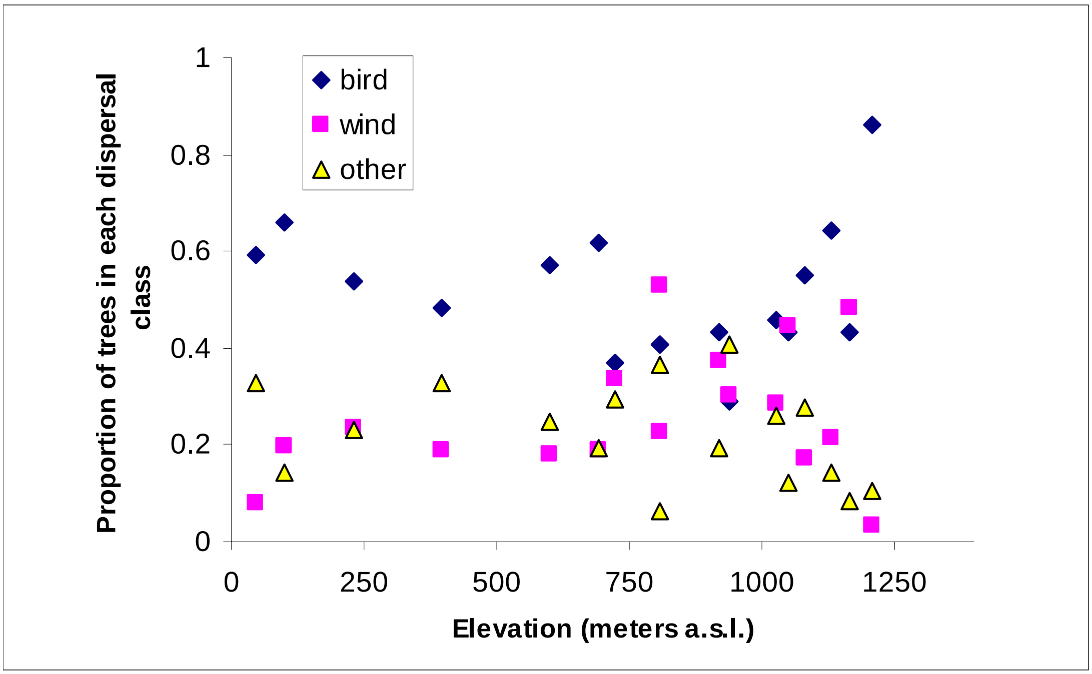

Figure 3. Seed dispersal type in relation to elevation.

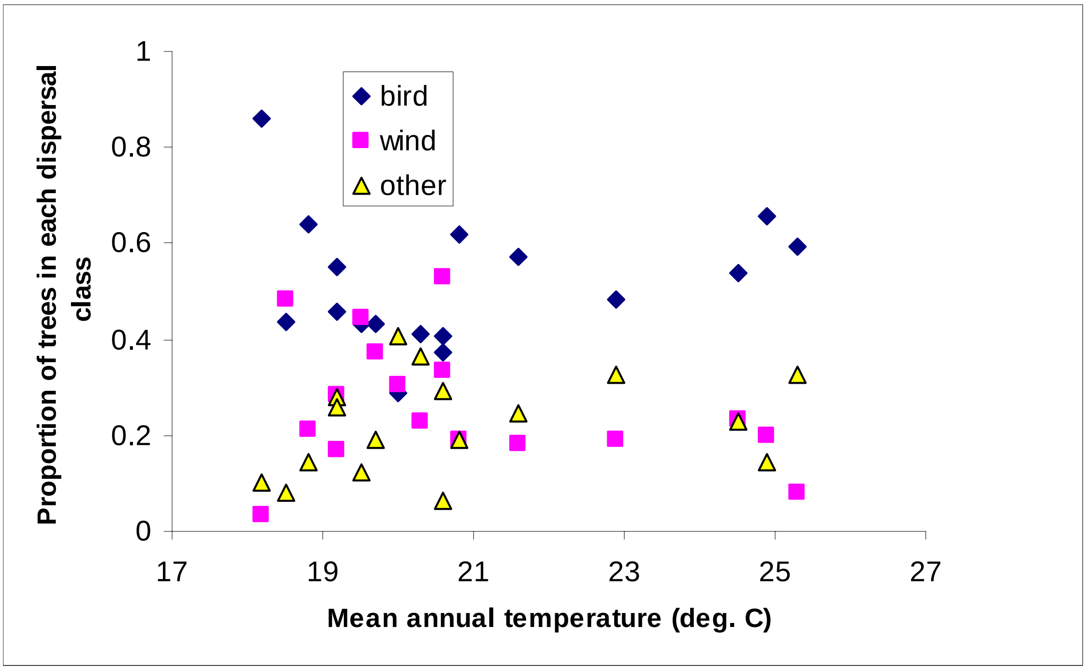

Figure 4. Seed dispersal type in relation to mean annual temperature (deg. C).

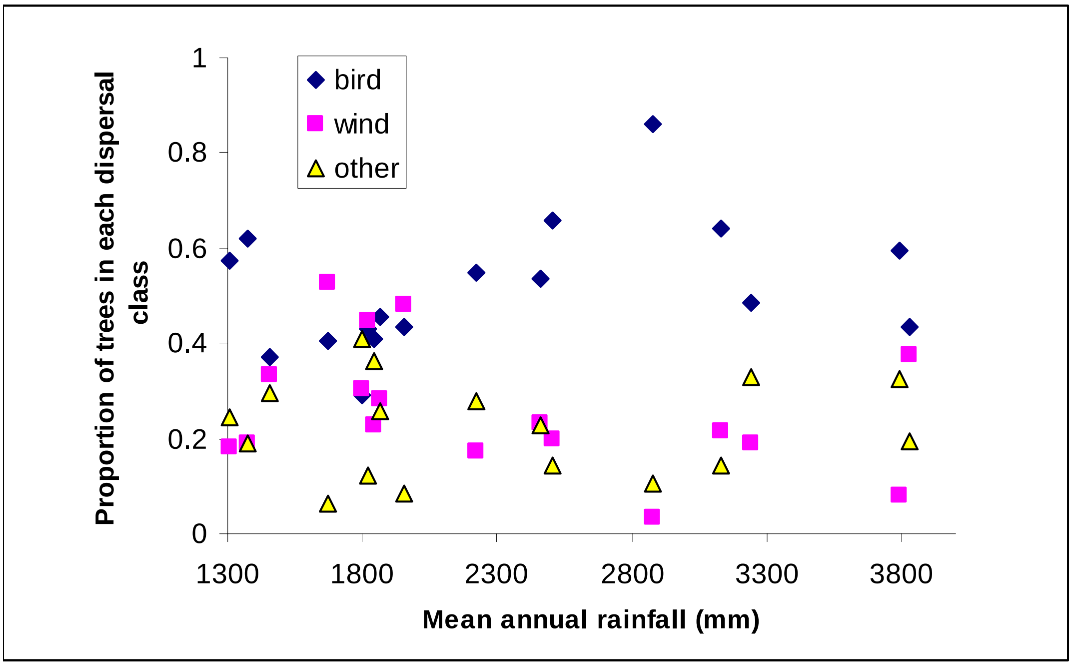

Figure 5. Seed dispersal type in relation to mean annual rainfall (mm).

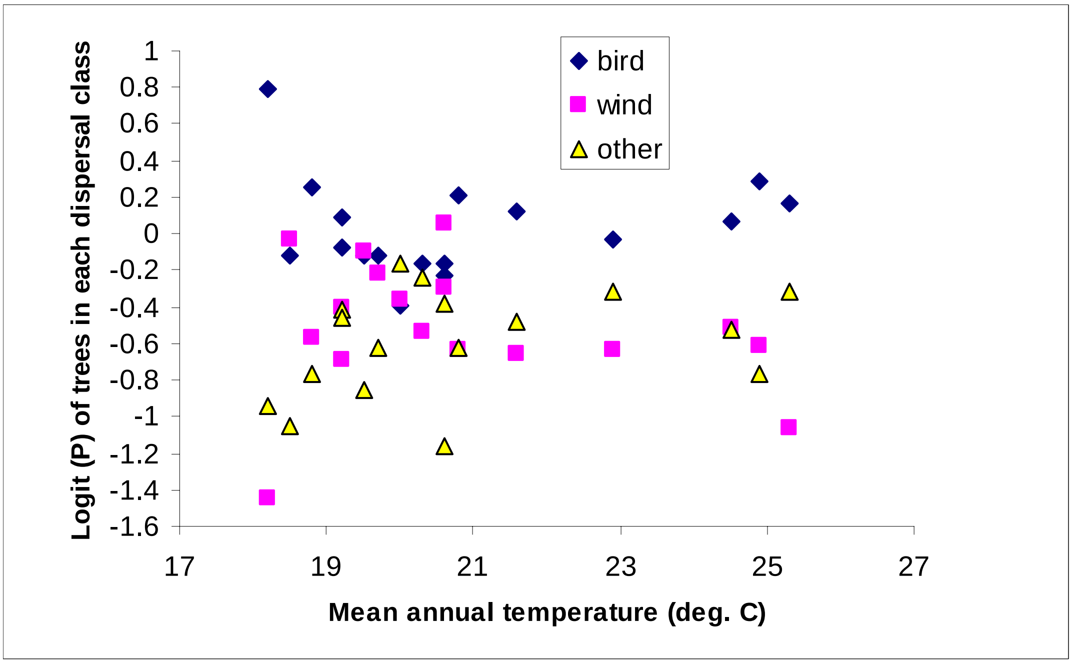

Figure 6. Logit transformed proportions plotted against mean annual temperature.

Milestone 3: Location of installed mosquito traps and progress of sentinel chicken surveys along altitudinal gradients [Objective (a)].

Animal ethics approval has been obtained and permits from Nation Parks (Queensland EPA) are in process. Substitution of sentinel chickens with molecular techniques has been evaluated and appears promising. Recent CSIRO investments and staff recruitment (independent of MTSRF) into these techniques at our centre (CSIRO Sustainable Ecosystems, Tropical Forest Research Centre, Atherton) provide an opportunity to increase this project's outcomes. The required methodologies have been identified and the necessary laboratory equipment has been purchased, largely by other projects (outside of MTSRF).

Mosquito trapping will occur on the twelve plots identified in Table 1 as well as opportunistic trapping at additional sites as resources permit. Thirty "CDC" light traps have been purchased as well as batteries and dry ice containers (used to attract mosquitoes). These traps are the international-standard for mosquito surveys (see Plate 1). Preliminary trapping has been carried out at both lowland and several upland sites (beyond the contract requirements). Expert advice has been acquired about mosquito trapping methods and mosquito identification. Voucher specimens of approximately fifteen mosquito species, all species collected in preliminary trapping, have been preserved. Collaboration with Queensland Tropical Heath is being discussed.

Some preliminary mist-netting of birds has been accomplished with microscopy slides prepared from the drawn-blood and these slides have been used for training in the identification of blood parasites (beyond contract requirements). Methods for storing avian blood for later analysis by molecular methods for malaria and other pathogens have been identified.

Plate 1. Our implementation of the internatio standard "CDC", US Center for Disease Con mosquito trap with a small light and an insula container of dry ice producing CO^2 as attracta

Sentinel Chickens

We now believe that molecular methods (PCR etc.), that will allow the project to test mosquitoes directly for the diseases they carry, are more effective than using sentinel chickens for the same purpose. Nonetheless, we now have animal ethics approval to use sentinel chickens if necessary and we have developed the methodology.

Milestone 4: Modification of the neural network model to meet the needs of the project [Objectives (b), (c), (d)]

The required data and programs appear to be available as reported in Milestones 1 and 2 of this year. However, since the programs were developed on now obsolete computers, operating systems and software compilers it now appears that the programs will need to be re-written to use the current computing environment. This is in progress and is not an extensive task given all the previous development of the model. It is expected that this will be accomplished within this financial year and will not increase costs or delay delivery of milestones for the next financial year.

Milestone 5: Final summary of communication activities undertaken through the course of Year 1 of project.

A wide range of communication activities have occurred during the last year that relate to climate change impacts on ecosystems in the Wet Tropics. Naturally, these have relied on research carried out in the Rainforest CRC as this new MTSRF project has expanded the previous research into new areas that will not provide significant results until the next financial year. A large number of invitations to speak at conferences and public forums have been accepted for the next few months. These will acknowledge MTSRF, the RRRC as well as the Rainforest CRC and CSIRO as appropriate.

Milestone 6: Plan for completion of out year activities.

Since new project plans and proposals were required by DEW in April 2007, this information is available in that document (which supersedes this milestone) and has been reviewed by the RRRC and project stakeholders and subsequently modified. Please see that document for detailed plans for the next financial year and beyond.