Ecological research coverage at the Warra LTER Site, Tasmania: a gap analysis based on a conceptual ecological model

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Abstract

A conceptual ecological model for wet forests at the Warra Long-Term Ecological Research Site is presented and used to identify the extent of current or past ecological research coverage. Although coverage is generally good, the model has identified gaps that will need filling in order to facilitate the understanding of ecological processes and the biodiversity functions of Tasmania's wet forests.

Introduction

The Warra Long-Term Ecological Research (LTER) Site in southern Tasmania was established, in part, to facilitate the understanding of ecological processes and the biodiversity functions of Tasmania's wet forests (Brown *et al.* 2001). After seven years of research at Warra, it is instructive to consider the extent to which this aim has been addressed so that future research is appropriately targeted and any critical gaps in coverage can be identified. To facilitate this, a conceptual ecological model has been developed for the wet eucalypt forests and adjacent ecosystems. In the absence of any 'off-the-shelf' models, the model was compiled in consultation with experts from a range of institutions with research interests at Warra (see Acknowledgements section). This paper describes the development of the model.

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Methods

Model design

There is a near-infinite number of ways in which a natural system can be represented conceptually. The approach taken here was to develop a process-based model to try to best represent the flows of energy and nutrients through the system and their relationships with biological and non-biological products or pools. It was expected that the model would reflect the main functional attributes of the ecosystem, and so identify their measurable parameters which could be the target of future research effort. Models of this nature are fractal, which means the more closely they are scrutinised, the more sub-systems appear that could be given a similar level of modelling attention. Furthermore, there is also a vast number of parameters which could be measured, with varying levels of information content. In the model presented here, only some of the major processes are modelled, along with the main ecosystem products, attributes and more informative measurable parameters. Figure 1 shows how each of these features is represented in the model.

Even at this relatively superficial level, the model is too complex to be represented in its entirety on a single piece of paper. Instead, it is divided into four interconnected modules. These broadly cover 'growth' (focussing

on living vegetation and associated processes), 'decay' (focussing on the death and decomposition of vegetation), 'soils' (including litter and aspects of geology) and 'aquatic' (including aspects of geology and catchment hydrology). Each is considered separately but includes embedded linkages to other modules at appropriate places. The major linkages among the four modules are shown in Figure 2, while Figures 3–6 show individual modules in full detail. It is recognised that this is but one of many possible means of division. Nevertheless, it is one that more or less matches some of the main research disciplines in ecology and related areas as they apply to Warra.

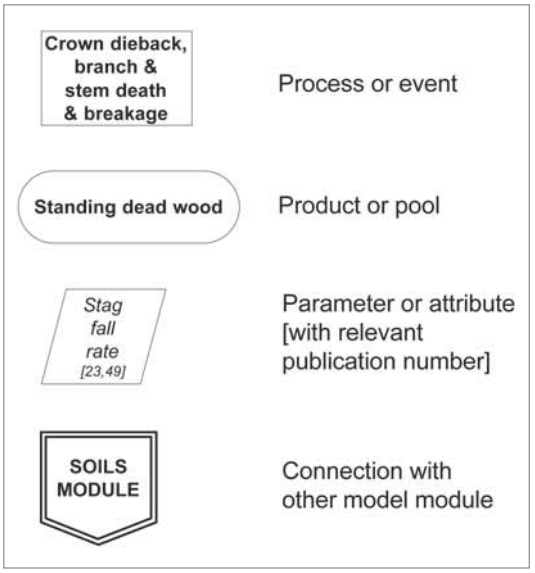

Figure 1. The manner in which components of the Warra conceptual ecological model are represented in Figures 3–6.

Discussion

Research coverage

Since the formal establishment of the Warra LTER Site, an average of ten research projects has been initiated each year, building on a tradition of research in the area that goes back several decades. Details of all past and current projects at Warra are given on the Warra website (http: //www.warra.com). Some projects focus on areas other than the subject of this paper (especially native forest silviculture, the other main function of the LTER Site) and are not explored here unless they exhibit some overlap with ecology. Many more projects have addressed discrete parts of the ecological model and have resulted in publications which are also listed on the Warra website. In Figures 3–6, numbers which are derived from the

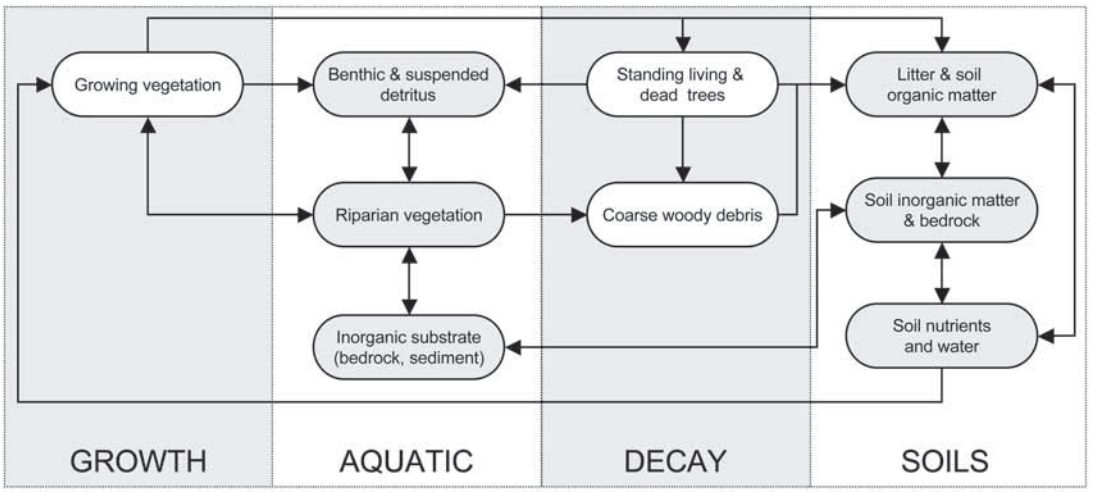

Figure 2. Overview of major relationships among the four modules of the Warra conceptual ecological model.

Table 1. Subject areas identified in the ecological model as lacking research coverage.

Subject areas currently lacking research at Warra	Subject areas with at least recent or on-going (but unpublished) research at Warra
Flowering phenology, pollination, seed production and predation	Climate and weather
Plant–water–soil relations	Dispersal mechanisms and abilities of plants and animals
Litter dynamics	Role of herbivory in seedling survival and vegetation dynamics
Litter physico-chemical properties	Agents of tree decline and mortality
Weathering, erosion and soil formation	Dynamics and biodiversity of ageing trees and stags
Soil biodiversity	Fire impacts on woody debris, organic soils and biodiversity
Erosion and sedimentation in aquatic systems	Influence of riparian vegetation, woody debris and litter in aquatic systems

list of publications at the end of this paper have been inserted into the parameter boxes to which they most closely apply. This does not mean that all aspects of those parameters have been completely measured; it merely means that this is an aspect of the model that has at least been investigated, with the extent of that investigation evident from the contents of the publication.

Broadly speaking, the extent of ecological research coverage at Warra can be gauged by the distribution of model parameters that are or are not associated with publications. On this basis, there is ample evidence of research in many of the model areas that contribute towards understanding ecological processes and biodiversity functions in wet forests (i.e. meeting one of the main objectives of the LTER Site). Nevertheless, some knowledge gaps are evident (Table 1). One half of the table comprises knowledge gaps that are wholly unresearched in the Warra context. The other half comprises knowledge gaps that are at least partially filled by on-going but unpublished research projects, details of which can be found on the Warra website. It is hoped that by identifying these gaps, it will be easier to guide prospective researchers towards them in future, or to approve project proposals in these areas even if they might otherwise seem rather arcane.

Conclusion

The process of designing a conceptual ecological model for Warra has exposed the complexity of the wet forest ecosystem and some of the issues that arise when trying to model it. Nevertheless, the resultant model encompasses what could be considered the main processes operating in and around the wet eucalypt forests. It also sheds light on areas of research that should one day be addressed if the aim of understanding the forest's ecological processes and biodiversity functions is to be more broadly fulfilled. The model remains a work-in-progress and very much a personal interpretation of the Warra system, though one which it is hoped will stimulate further thought. Its publication here reflects a feeling that it has at least reached a stage where it may begin to be put to practical use.

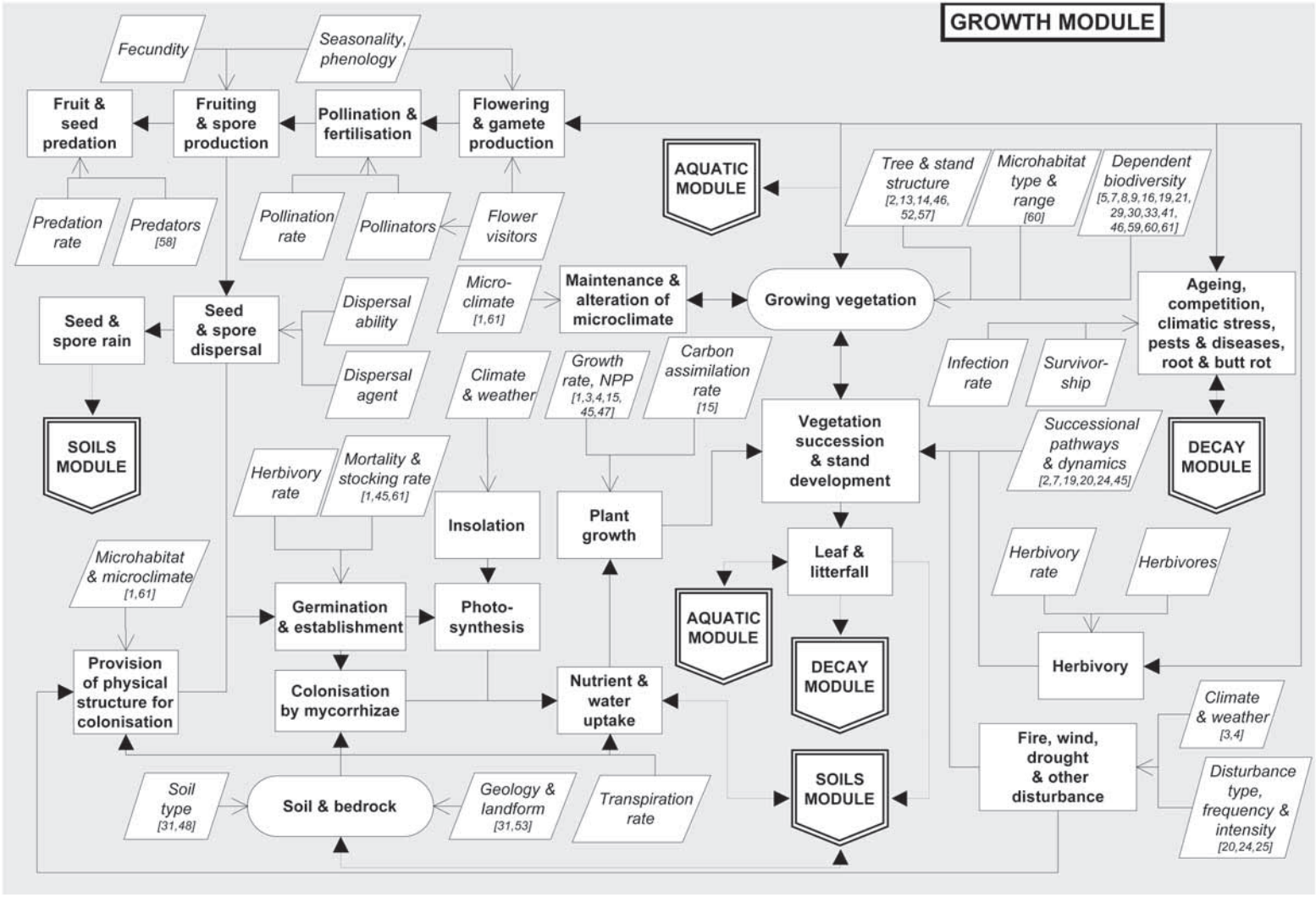

Figure 3. 'Growth' module of the Warra conceptual ecological model. (NPP = net primary productivity)

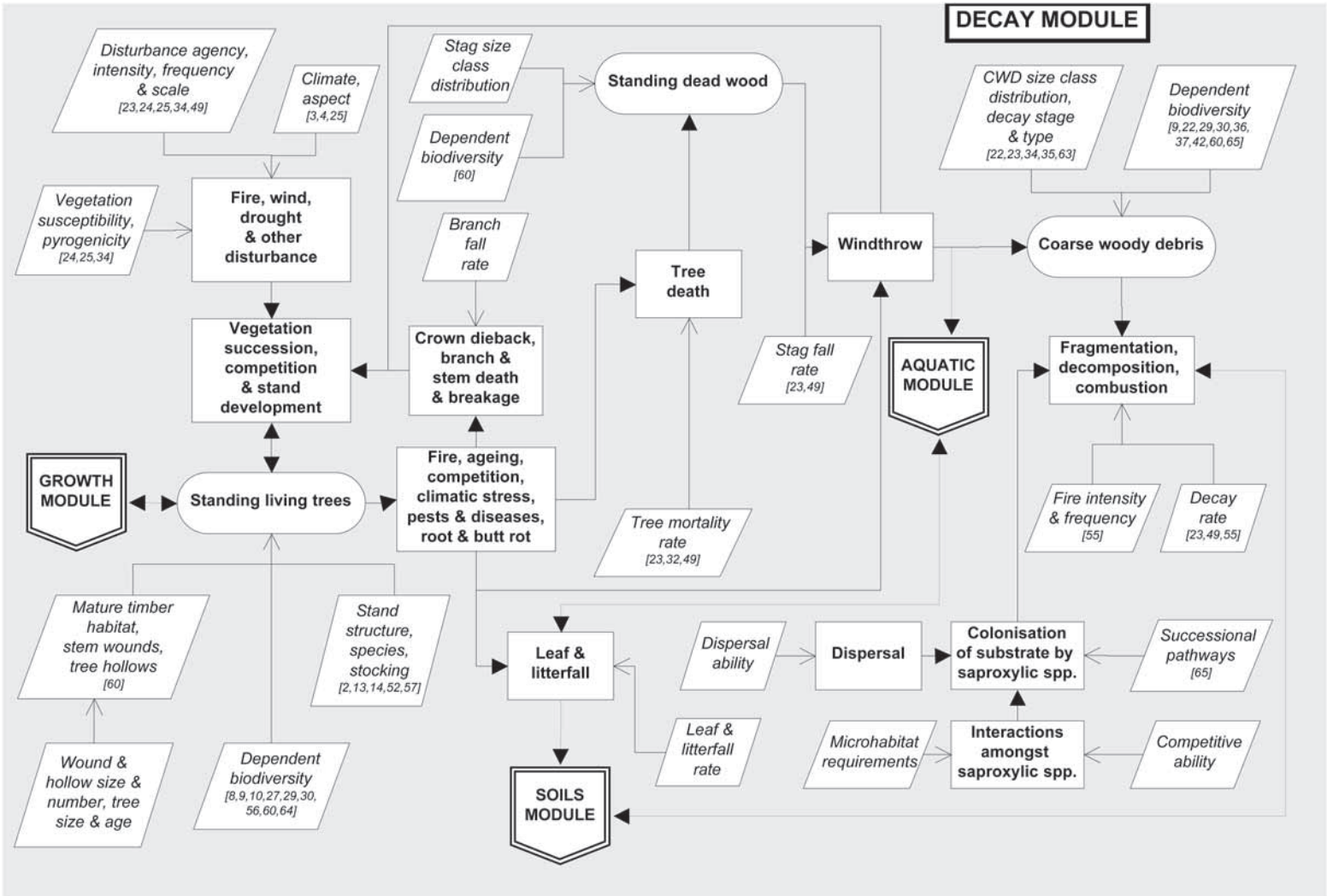

Figure 4. 'Decay' module of the Warra conceptual ecological model. (CWD = coarse woody debris)

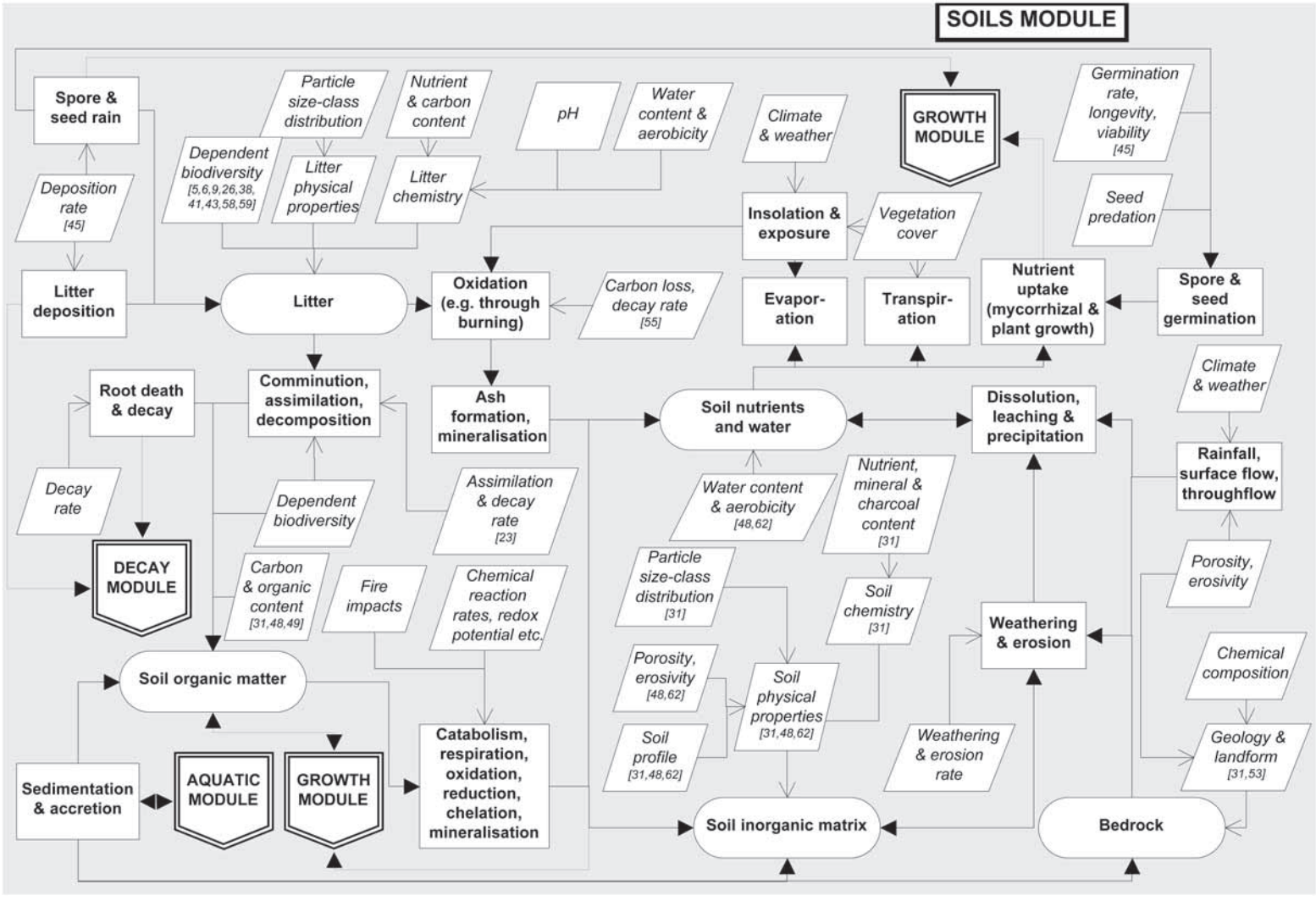

Figure 5. 'Soils' module of the Warra conceptual ecological model.

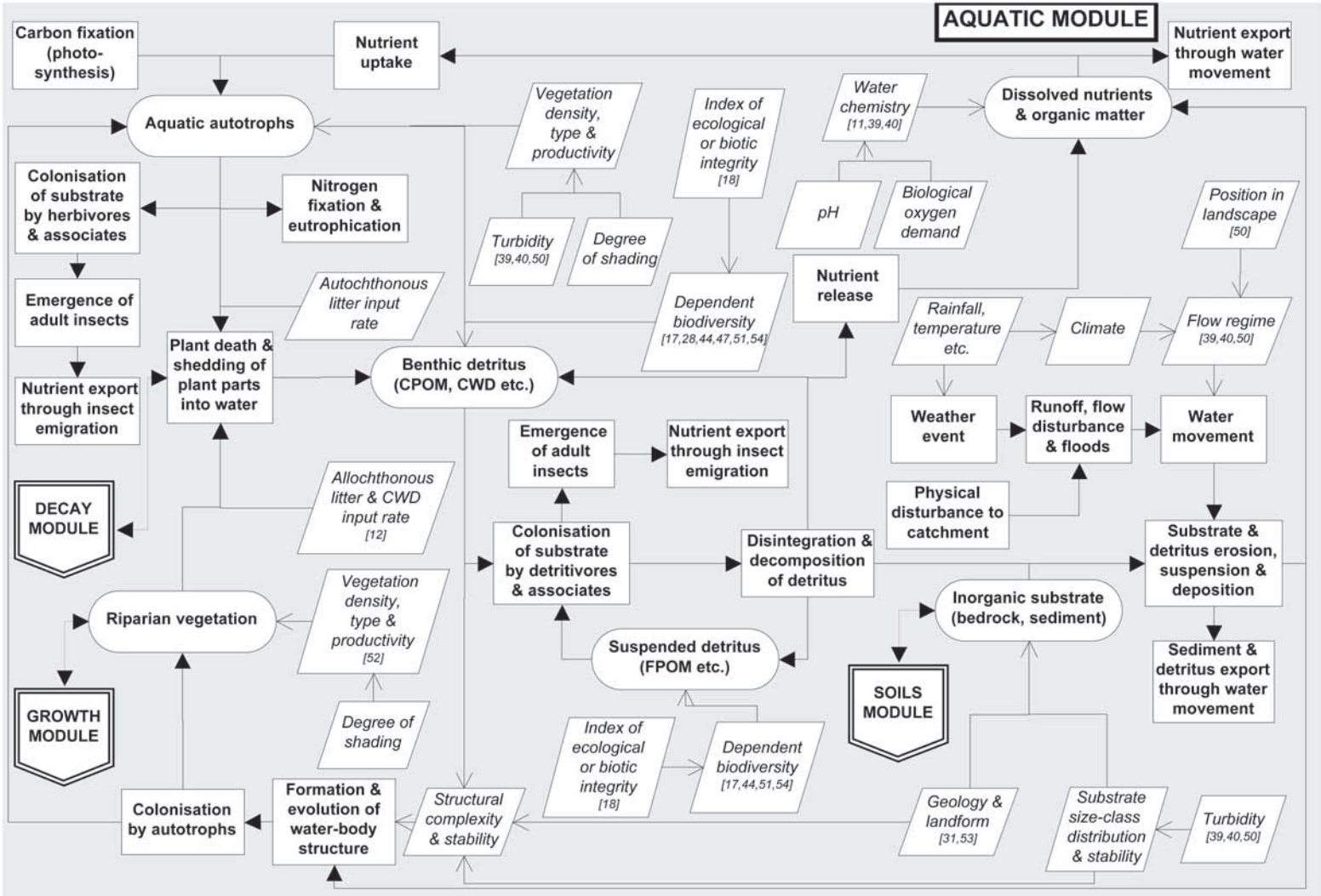

Figure 6. 'Aquatic' module of the Warra conceptual ecological model. (CPOM = coarse particulate organic matter, FPOM = fine particulate organic matter)

Acknowledgements

Discussions and a framework for an ecological model of Warra were initiated several years ago by Dr Peter Davies (Freshwater Systems), Associate Professor Alastair Richardson (University of Tasmania), and Dr Tim Wardlaw and Dr Mick Brown (both of Forestry Tasmania). Their input and that of Ms Marie Yee and Dr Philip Pennington (both CRC for Sustainable Production Forestry) is gratefully acknowledged. The model has also been modified following peer review.

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Note: the number assigned to each publication in this list appears in the ecological model at points relevant to the research detailed in the publication.

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