NUTRIENT AND ENERGY FLOW IN THE JARRAH FOREST ECOSYSTEM

August 1979-July 1981

RESEARCH AND FINANCIAL REPORT

AFTER TWO YEARS

FOR THE WESTERN AUSTRALIA

GOVERNMENT JARRAH DIEBACK RESEARCH FOUNDATION

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ABSTRACT

Progress towards the objective of developing a basic understanding of the nutrient and energy dynamics in the jarrah forest ecosystem are reported. The multiple watershed approach has been followed to provide quantification to a general theoretical model. Microcatchments in the Yarragil Brook watershed southeast of Dwellingup have been chosen for intensive study. Input-output balances for essential nutrients for the first monitoring year indicate that the study catchments are in an aggrading phase of nutrient cycling following the last control fire. Major effects to the ecosystem integrity is expected following the logging and autumn regeneration burn treatment scheduled for the coming summer. Long term impacts on jarrah forest productivity and tolerance to *Phytophthora cinnamomi* spread could result from major nutrient losses in this management operation.

Vegetation component documentation in the overstorey, understorey and litter layers of the ecosystem continues in advance of the management operation planned for the 4 L microcatchment. The *Banksia grandis* population dynamics computer model developed in cooperation between the W.A. Forests Department and the Department of Botany was used to determine total biomass, energy and nutrient contents for three populations of under storey trees. It is apparent that considerable concentrations of nutrients are sequestered away in the *Banksia* understorey component that could be made available to the jarrah forest overstorey with appropriate management systems.

The dynamics of the litter fall and decomposition cycle are being monitored using litter fall traps and litter decomposition bags. Monthly collection and nutrient analysis provides value information on the potential energy and carbon annual fixed by the forest ecosystem in the Darling Range catchments.

The impact of autumn regeneration burns on soil nutrients and organic matter is illustrated from the re-assessment of soils previously sampled in 1978. The increased levels of essential elements after the control burn are correlated to the increased girth growth in jarrah observed following these crown scorch fires.

Priorities for the coming year relate primarily to the continued pre-treatment documentation to the microcatchments of the Yarragil Brook watershed and the further establishment of ecosystem component data to quantify the basic theoretical model.

Monitary expenditure for the first two years of the project are provided, along with a budget for the coming final year of the current project.

BASIC APPROACH

The major objectives of the project relate to the development of greater understanding of the nutrient and energy dynamics in the northern jarrah forest ecosystem and to the determination of responses of the ecosystem to forest management practices. Special attention is centred on the potential interaction of forest management practices and the impact of *Phytophthora cinnamomi*. Jarrah forest catchments provide Western Australia with major economic resources in timber, bauxite, fresh water and recreation. The establishment of appropriate managerial programmes to protect the long-term productivity of these catchment areas is of supreme importance to the future of Western Australia. The problem of establishing a managerial programme to balance the numerous pressures of industrial, agricultural and domestic use of any diverse region is one of extreme complexity. Given the basic abiotic and biotic complexity of land, the phenomena of succession and retrogression, a multiplicity of managerial goal, and a desire for more efficient use of land, it is obvious that some theoretical framework upon which we can assemble and interrelate these diverse components is a necessity (Bormann and Likens 1969). On one form or another, foresters and range managers have long been aware of this need (Lutz 1957, 1963; Costello 1957). The ecosystem concept provides this framework (Evans 1956).

A basic theoretical model has been developed for the jarrah forest ecosystem (Fig. 1). This model provides a simplified view of the structure of the ecosystem and the framework to understand the components and functional links of the basic system. The ecosystem is a basic functional unit of nature which includes both vigorous and their non-living environment, each interacting with the other and influencing each other's properties, and both necessary for the maintenance and development of the system (Odum 1963).

The watershed approach has been followed to provide quantification to the theoretical model. Although the boundaries of an ecosystem can be defined in numerous ways to meet the pragmatic needs of the investigator, the choice of watershed boundaries confines inputs and outputs to the system itself. The knowledge of these basic input and output relationships in ecosystem studies are necessary to fully understand: (1) energy and nutrient relationships of individual ecosystems; (2) the comparative behaviour of ecosystems; (3) the effect of geological processes such as erosion and deposition, mass wasting and weathering in ecosystem dynamics; (4) the effects of meteorological variation on ecosystem behaviour; (5) the relationship of an individual ecosystem to worldwide biospherical cycles, and (6) the effects of managerial practices on the structure and function of individual ecosystems and in other ecosystems intimately linked to the manipulated system.

Within the watershed the following approach has been followed: (1) define the components of the system and the links, (2) examine the processes that influence transfer rates between structural components, and (3) measure the actual quantities of the various components.

STUDY PROGRESS

Microcatchments of the Yarragil Brook watershed, southeast of Dwellingup have been chosen for intensive study of the impact of the various forest management practices (Fig. 2). The microcatchments of the Yarragil have established hydrological monitoring weirs and a five-year record of water and salt (Na Cl) output. Measurements and the calculation of catchment outputs of total nitrogen, NH_3^+, NO_3^-, total phosphorus, PO_4^-, Ca^{++}, Mg^{++}, K^+ and S have been undertaken under this programme for the past two years. Measurement of nutrient inputs from rainfall are made from collection points scattered over the Yarragil watershed. From the data on rainfall input and stream flow output, it is possible to determine the nutrient budgets for watershed bounded ecosystems (Bormann and Likens 1967). The nitrogen data for 1979 provide an illustration of the information to be gained from the calculation of nutrient budgets in the Yarragil Brook watershed.

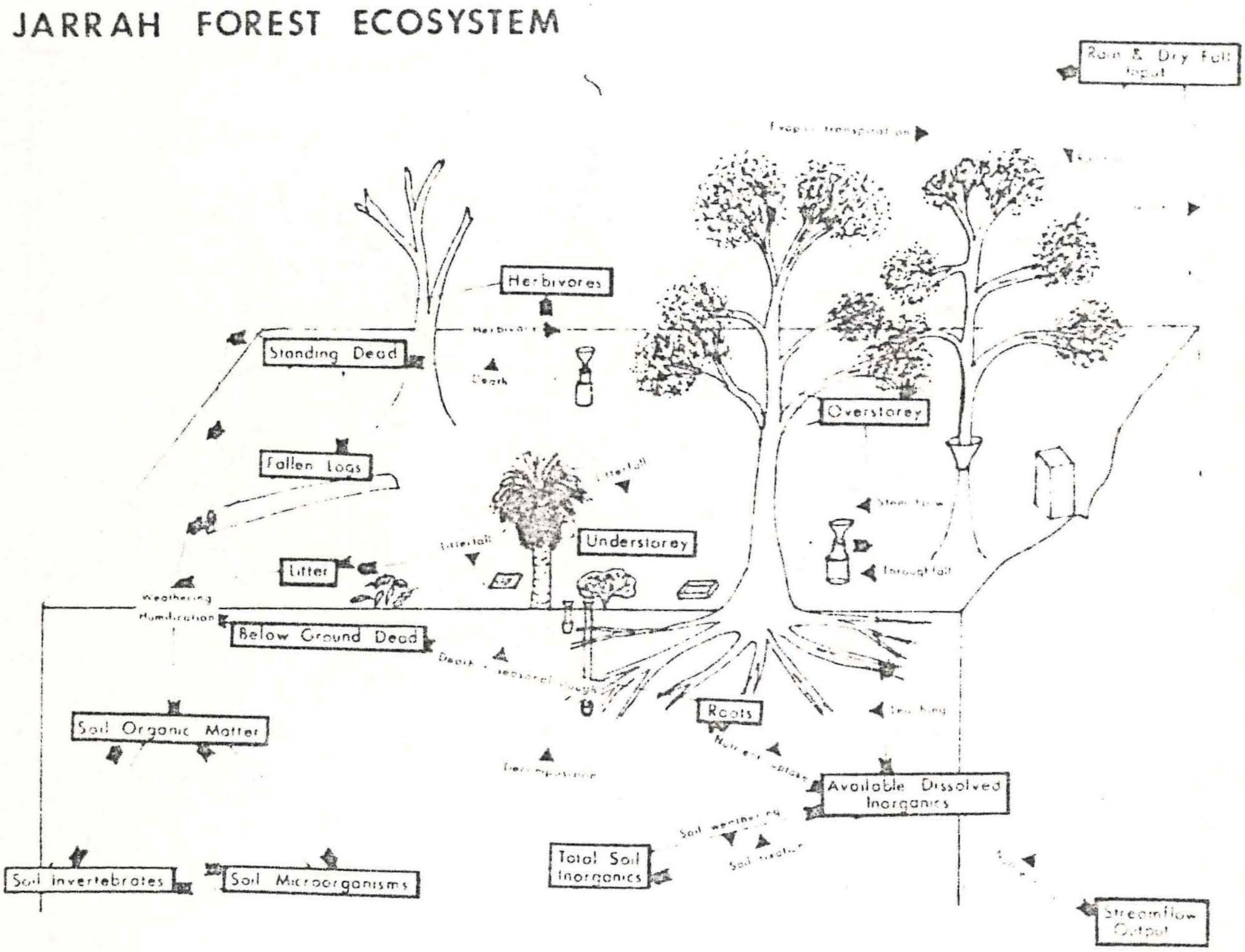

Figure 1. Conceptual model of the jarrah forest ecosystem and diagrammatic representations of field sampling intensive study sites.

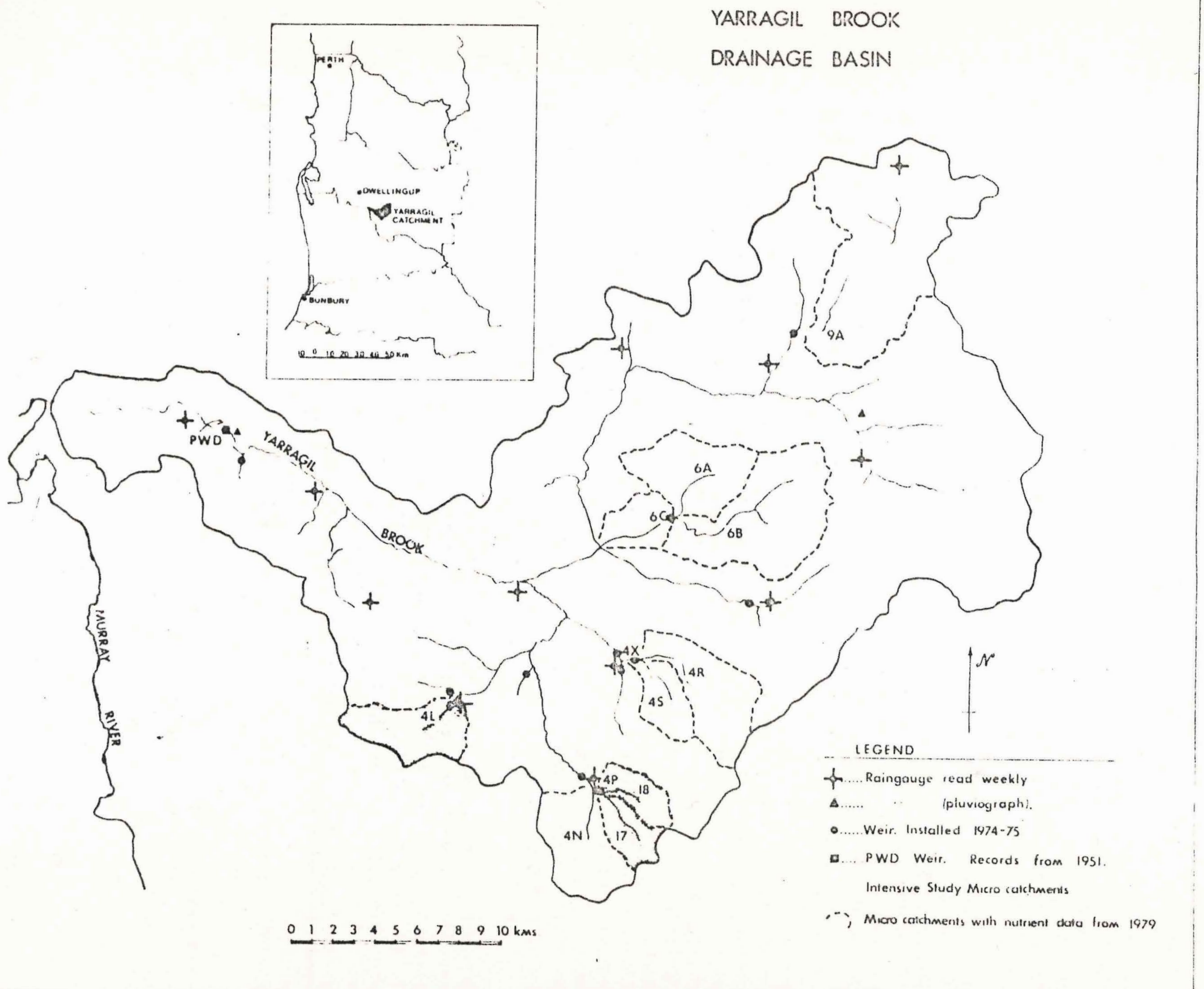

Figure 2. Yarragil Brook Drainage Basin southeast of Perth, Western Australia. Locations of nutrient monitoring catchments, weirs and rain gauges.

Microcatchment Nutrient Budgets

The balance of nutrient input and export provide important data on the integrity of the forest ecosystem (Bormann and Likens 1967). Negative input-output balances tend to occur in early successional vegetation, become positive when net ecosystem production is highest and then tend to achieve a balance between inputs and outputs when net ecosystem production approaches zero (Gorham *et al.* 1979). Accumulating levels in production ecosystems have been measured despite periodic wildfires volatilizing some 80% of the exposed nitrogen (Gessel *et al.* 1973). Documentation of ecosystem nitrogen budgets are complicated primarily because of the predominantly gaseous phase.

Nitrogen losses in streamflow for selected jarrah forest catchments of Yarragil Brook are shown in Table 1. Despite a history of logging and control burning which has kept these communities from reaching ecological maturity, both inorganic and total nitrogen outputs were extrememly low. The range of NO_3/NO_2 losses from .0000047 to .000413 kg/ha/yr are substantially below the values 0.011 to 0.013 reported for *Eucalyptus radiata* dry sclerophyll forests in north-east Victoria (Flinn *et al.* 1979). Nitrate loss from a diversity of forested streams in the northern hemisphere is also several orders of magnitude higher : 0.03-4.50 kg/ha/yr (Vitousek and Melillo 1979). Nitrogen output in Yarragil Brook microcatchments showed a strong relationship with total streamflow (r = 0.979, Fig. 3). However, streamflow itself was poorly correlated to catchment area or rainfall.

Nitrogen inputs in clearfall and throughfall during 1979 have been estimated for 4 L and 4 P microcatchments (Table 2). Comparative Australian data are, at present, scant and varied. Studies by the Engineering and Water Supply Department of South Australia (Wood 1975) give values similar to those of the present study (total N of 3.19 and 3.69 kg/ha/yr). Westman (1978), however, recorded an annual accession of 60 kg/ha total N, and 0.17 kg/ha NO_3. O'Connell (cited in Congdon 1979) records a figure of 0.7 kg Total N/ha/yr in rainfall at Dwellingup. These differences highlight the need for further Australian studies, though the variation observed may indeed be real, being dependant upon differences in rainfall duration, proximity to industry or to the sea. Clearfall values for total and soluble nitrogen inputs to Yarragil Brook are at the extreme low end of the range reported for overseas by Loehr (1974): 5.6 to 100 kg Total N/ha/yr (the high value including industrial areas); 0.8 to 12.9 kg/ha/yr inorganic nitrogen.

Jarrah forest ecosystems receive very low levels of nitrogen input in rainfall. In turn, losses in streamflow appear correspondingly meagre (<1% of clearfall inputs during 1979). The vagaries of the hydrological cycle in this Mediterranean climate region have an important influence on nutrient budgets for jarrah forest catchments, emphasizing the necessity for long-term monitoring. It may be possible, however, to predict total nitrogen output for more mature Yarragil Brook microcatchments from longer-term streamflow records, given the close relation between these two parameters.

Jarrah forest catchment streams rarely yield more than 15% of annual rainfall input and it is common to have no streamflow for some forested catchments (Shea and Herbert 1977). Lack of water for nitrate transport is one of the main processes delaying or preventing solution losses of nitrate from disturbed forests (Vitousek *et al.* 1979). The development of hardwood eucalypt forests of considerable biomass, growing on old lateritic soils, is the product of centuries of evolution towards efficient nutrient accumulation, retention and recycling. The evolution of a deeply-rooting overstorey dominant capable of transpiring substantial amounts of water throughout the dry summers, serves to reduce ecosystem soluble nitrogen losses.

Nutrient retention in jarrah forest catchments must be considered when judging the long-term impact of various management options. This applies particularly to the proposed use of periodic hot fires (Shea *et al.* 1979) to actively manage site deterioration caused by fungal dieback spread. The rapid recovery following fire by jarrah forest vegetation is well documented (Peet and McCormick 1971, Shea *et al.* 1979, Bell and Koch 1980). However we need to know whether the increased fixation of nitrogen

Table 1. Nitrogen outputs in streamflow for selected jarrah forest catchments of Yarragil Brook during 1979.

Catchment Name	Area (ha.)	Years Since Last Burn	Streamflow Total (m^3)	Weighted Average Rainfall (mm)	Catchment Output: NH_4-N		NO_3/NO_2-N		Organic N		Total N	
					Kgs	Kg/ha/yr	Kgs	Kg/ha/yr	Kgs	Kg/ha/yr	Kgs	Kg/ha/yr
4P-18	52	Before 1972	4885	776.8	.0956	.0018	.0165	.000317	2.2519	.0433	2.3640	.0455
4P-17	78	Before 1972	8224		.1521	.0019	.0322	.000413	2.7882	.0357	2.9725	.0382
4L	123	Spring 1973	No flow - ponded	755.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6C	461	Spring 1972	4460	685.0	.0705	.00015	.0182	.000040	1.9641	.0043	2.0528	.0045
9A	580	Spring 1972	689	648.3	.0088	.000015	.0027	.0000047	0.3593	.0006	0.3708	.0006

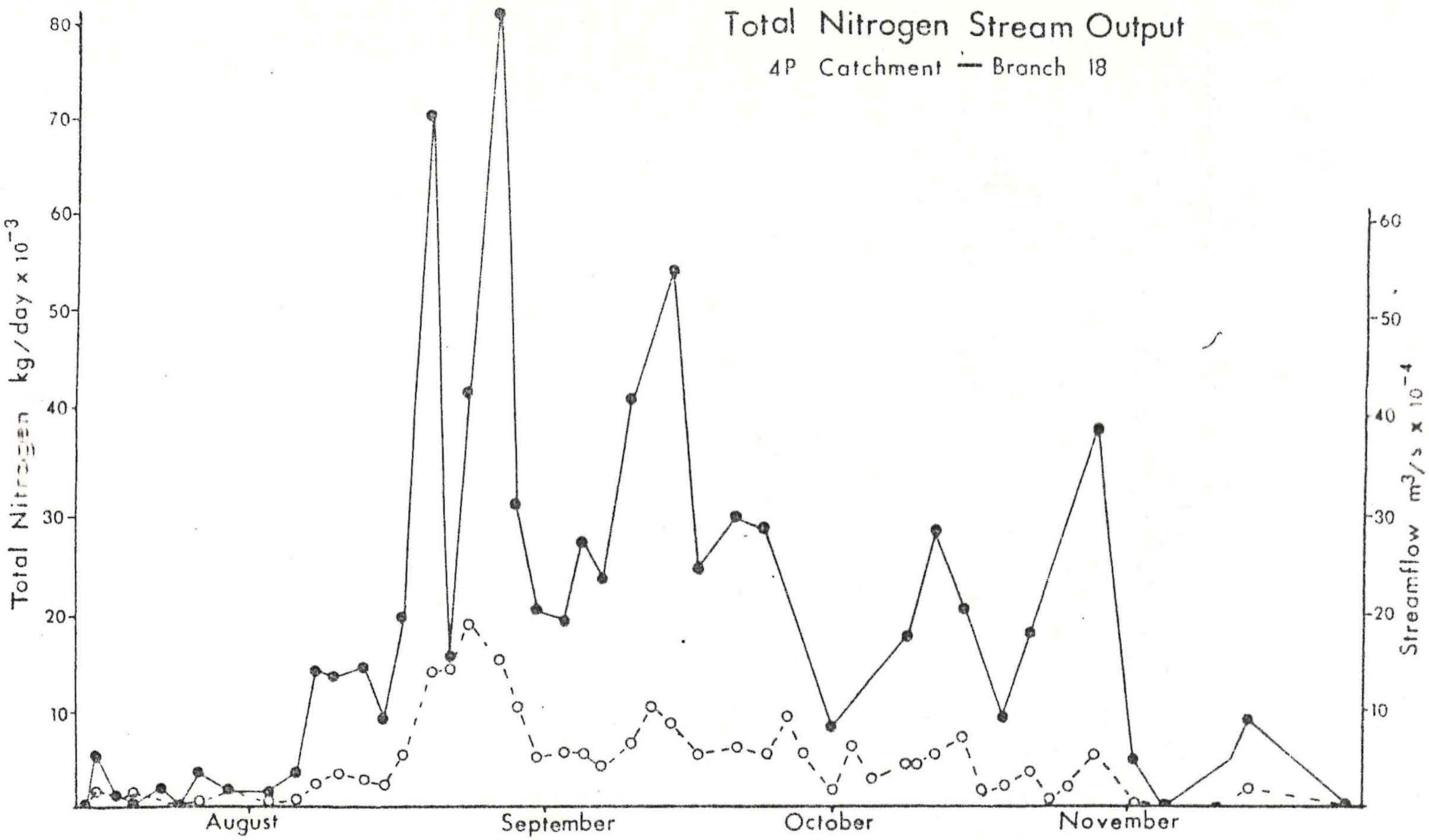

Figure 3. Total nitrogen (open circles) and streamflow (closed circles) output for the Yarragil Brook forested tributary 4P-18 during 1979.

Table 2. Yarragil Brook catchment nitrogen input.

Catchment Name	Sample	Catchment Input (Kg/ha/yr)			
		NH_4-N	NO_3/NO_2-N	Organic N	Total N
4L	Clearfall	0.291	0.211	3.047	3.549
4P	Clearfall	0.395	0.230	3.065	3.691
4L	Throughfall	0.217	0.112	4.120	4.448
4P	Throughfall	0.142	0.068	4.629	4.839

by regenerating legumes is sufficient to balance volatilization and streamflow losses following fire (Raison 1980).

Intensive monitoring and sampling in the 4 L and 4 P microcatchments have been designed to determine the impact of a summer logging operation and autumn legume regeneration burn on the jarrah forest ecosystem (Fig. 2). The logging-burn treatment, originally planned for the summer and autumn of 1980-1981, has now been rescheduled for next summer. The 4 P microcatchment will serve as the control catchment in the paired watershed experiment. The severe impact of this management operation will supply valuable data on the response of these tightly integrated ecosystems to a major change in the structure of the canopy and understorey components. The expectation is for a massive output of nutrients (especially nitrogen) following disturbance (Bormann and Likens 1967).

Vegetation Component Documentation

Intensive monitoring and sampling have been carried out in the 4 L and 4 P microcatchments. In each study catchment, a series of 25 x 25 m plots has been established along a transect line running perpendicular to the stream edge. In each sampling plot the overstorey component has been assessed by measuring the diameter of each tree. The understorey component has been sampled using ten 1 m^2 quadrats from each study plots. Existing levels of litter and standing and fallen logs have also been sampled in each of these plots. To extrapolate the sampled information to the entire watershed, a 10m x 20m overstorey tree diameter class plot was measured at each of approximately 200 points placed on the 100m square watershed sampling grid for the microcatchments established by the Forests Department Research Staff. A watershed-wide sample of the understorey and litter components in the 4 L catchment has been undertaken in cooperation with the Forests Department. Samples in the 4 P catchment have been planned for collection in the spring of this year.

A water-shed estimate of the biomass of the litter and understorey components can be made directly once the survey is complete. Estimates of the overstorey biomass, however, will be made from regression equations developed using destructive samples of trees representing the range of diameter classes. The relationships between diameter and total biomass and the separate components of leaf, twig, branch, bark, and wood are currently being developed. Figure 4 shows the size-class distribution of overstorey jarrah trees in the 4 L catchment samples and the sizes of the trees partitioned to develop the biomass regression equations.

Biomass component values will be converted to nutrient and energy values with data determined by atomic absorption spectrophotometric methods. Most of the materials have been digested and analyzed, but are awaiting the development of a suitable computer programme to handle all the conversions for the watershed overstorey data.

Considerable effort has been made to determine the biomass, energy and nutrient concentrations of populations of *Banksia grandis*. The dense understorey stands occurring in the jarrah forest today are thought to be a response to the period of spring hazard reduction burns. Three areas of *Banksia grandis* dominated understorey have been sampled in cooperation with the Forests Department. The *Banksia* populations represent: 1) a dense stand of young trees (Teesdale), 2) a stand of medium density of a wide range of tree sizes (Marradong), and 3) an open stand of large older trees (Virgin Banksia) (Fig. 5). These stands have been used primarily for development of a *Banksia* population dynamics simulation model to study the impact of management techniques on the populations of these *Phytophthora*-sensitive understorey trees. The stands were also used to determine the amount of biomass, energy and nutrient content contained in this component of the ecosystem. The biomass of each of the stands was estmated from a regression equation between biomass and diameter at breast height determined from a sample

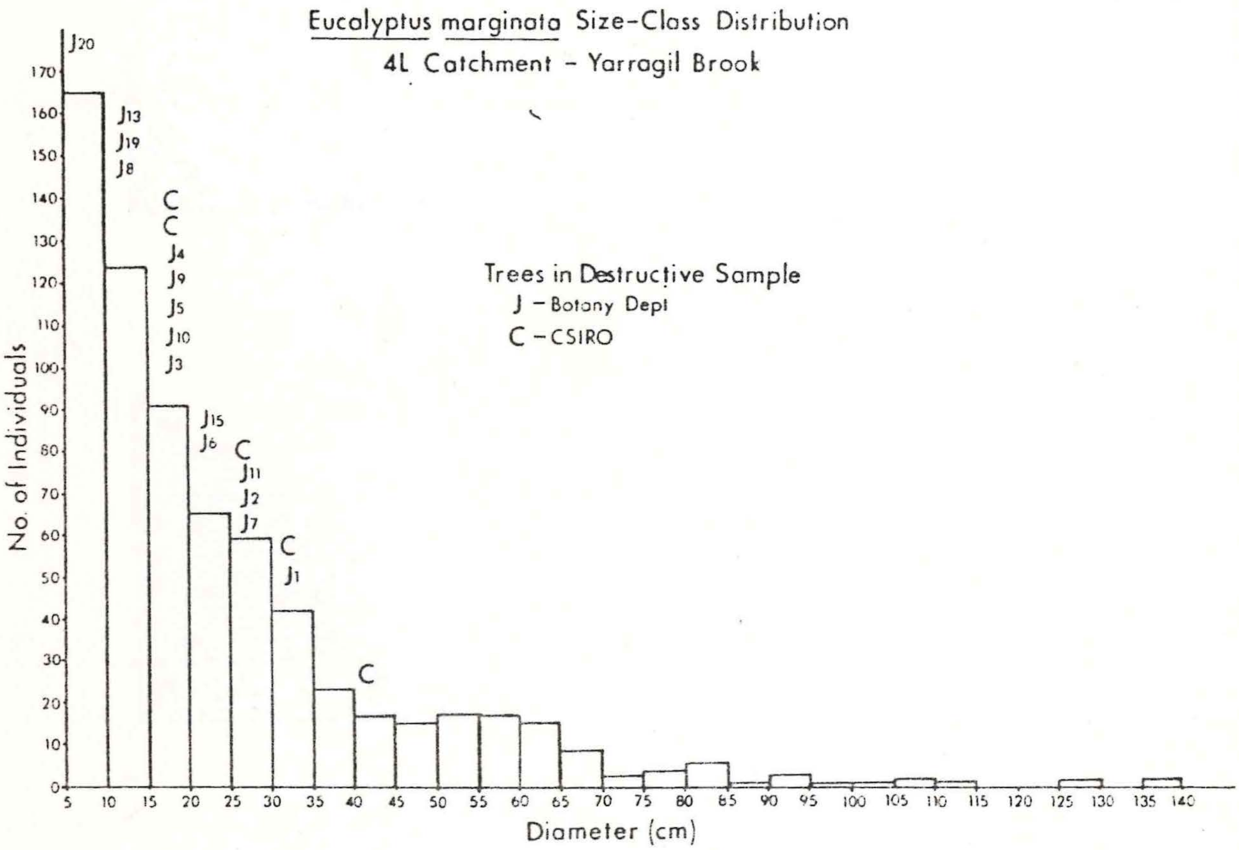

Figure 4. Size class distribution of overstorey *Eucalyptus marginata* trees in the 4 L catchment and the trees incorporated in the destructive sample for biomass and component nutrient and energy data.

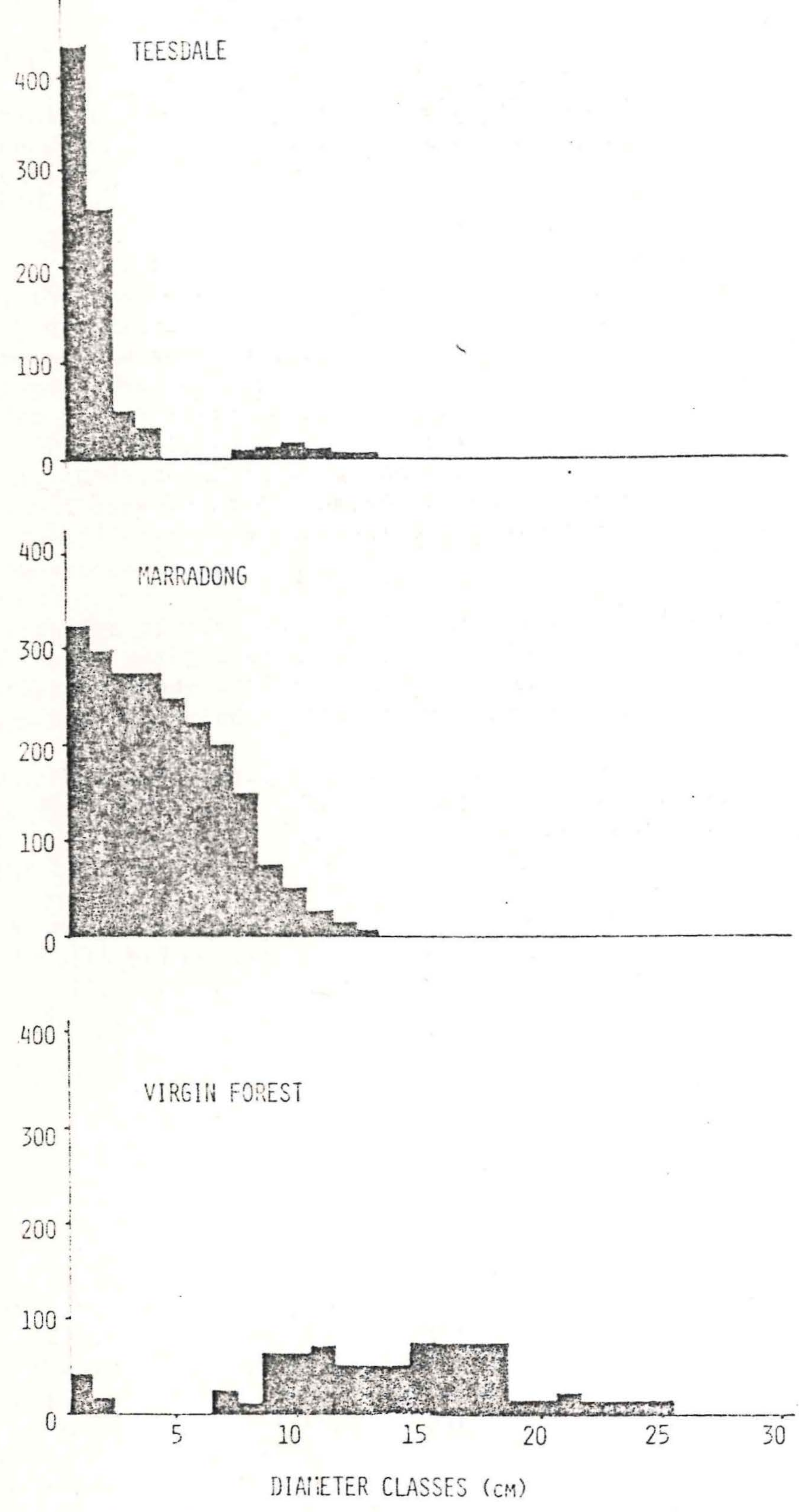

Figure 5. Size class structure for the Teesdale, Marradong and Virgin *Banksia* understorey tree populations.

of thirty-five trees (Fig. 6). The sample of *Banksia* trees was also used for data on the proportion of leaves of the present year, last year and leaves older than two years, wood of these three categories, and regression equations using proportions and diameter at breast height. Also the nutrient and energy content of these components were determined from samples from these trees (Fig. 7). A subroutine of the *Banksia* population simulation model programme was written to determine the biomass, energy and nutrient concentration data for the three *Banksia* populations (Table 3). Once the total biomass, energy and nutrient levels for the canopy trees and non-*banksia* understorey species have been determined, ecosystem values for the vegetation component parameters can be finalized.

Standing litter, annual litter fall and litter decomposition are important components in the jarrah forest ecosystem. Besides being important pools of nutrients and energy, the knowledge of the litter fall and mineralization of an ecosystem is the key to the understanding of overall ecosystem productivity (Charley 1972). This is primarily because a substantial fraction of the energy and carbon annually fixed in forests are contributed to the forest floor as litter (Olsen 1963). Litter accumulation in the jarrah forest ecosystem has been recorded in two previous studies (Hatch 1955, Peet 1971). Annual litter fall and decomposition was also measured by Hatch (1955). Considerable variation from site to site on the jarrah forest and marked seasonal aspects of decomposition which contrast to previously documented systems (Attiwill *et al.* 1978) point to a need for further research into this important ecosystem component.

The transfer of nutrients in the litter fall and litter decomposition cycle is being assessed using a series of litter fall traps and litter decomposition bags at each intensive study site in the two intensive study microcatchments. The litter traps are collected monthly and separated into the component parts.

Litter bags containing separate samples of jarrah, marri and banksia leaves were placed in the field in March of 1979. Samples are returned from the field every 3 months. The litter tray collections and the litter bag samples are analyzed for nutrient content.

The study of litter decomposition and the role of decomposed organisms in the catchments is being assessed cooperatively with Dr. Jon D. Majer and Mr. Tony Postle of W.A.I.T. A more complete series of decomposition bag mesh sizes and closer interval sampling of decomposition rates and a more detailed assessment of litter and soil organic matter dynamics are being coordinated with the watershed nutrient and energy study.

Soil Organic Matter and Inorganic Nutrients

Primary and secondary minerals are the major pools for some essential plant nutrients. Most of the cations, except phosphorus, are in loose circulation in ecosystems because of the ready availability of these elements for plant growth. Nitrogen and phosphorus are generally, however, very tightly circulated and conserved in the living components of the ecosystem. The jarrah forest ecosystem, because of the very limited availability of soil nitrogen and phosphorus is a system of very low productivity despite rather large biomass for a climate dominated by summer drought. Soils of the 4 L catchment have been analyzed for forms of nitrogen, phosphorus, magnesium, potassium, and calcium. The data from the 4 P control catchment are currently being analyzed. These data and those of Hingston *et al.* (1981) will provide a knowledge of the range of dissolved inorganic nutrients available to the jarrah forest ecosystem.

Of major long-term importance to the jarrah forest ecosystem is the impact of management systems on the available soil nutrients. Soil nutrients were measured in relation to an autumn legumes regeneration burn in the Clinton Block in 1978. Eleven sampling sites were monitored before, and after 2, 30, and 72 days following the fire by a former Honours degree student (Glossop 1978). The sites were

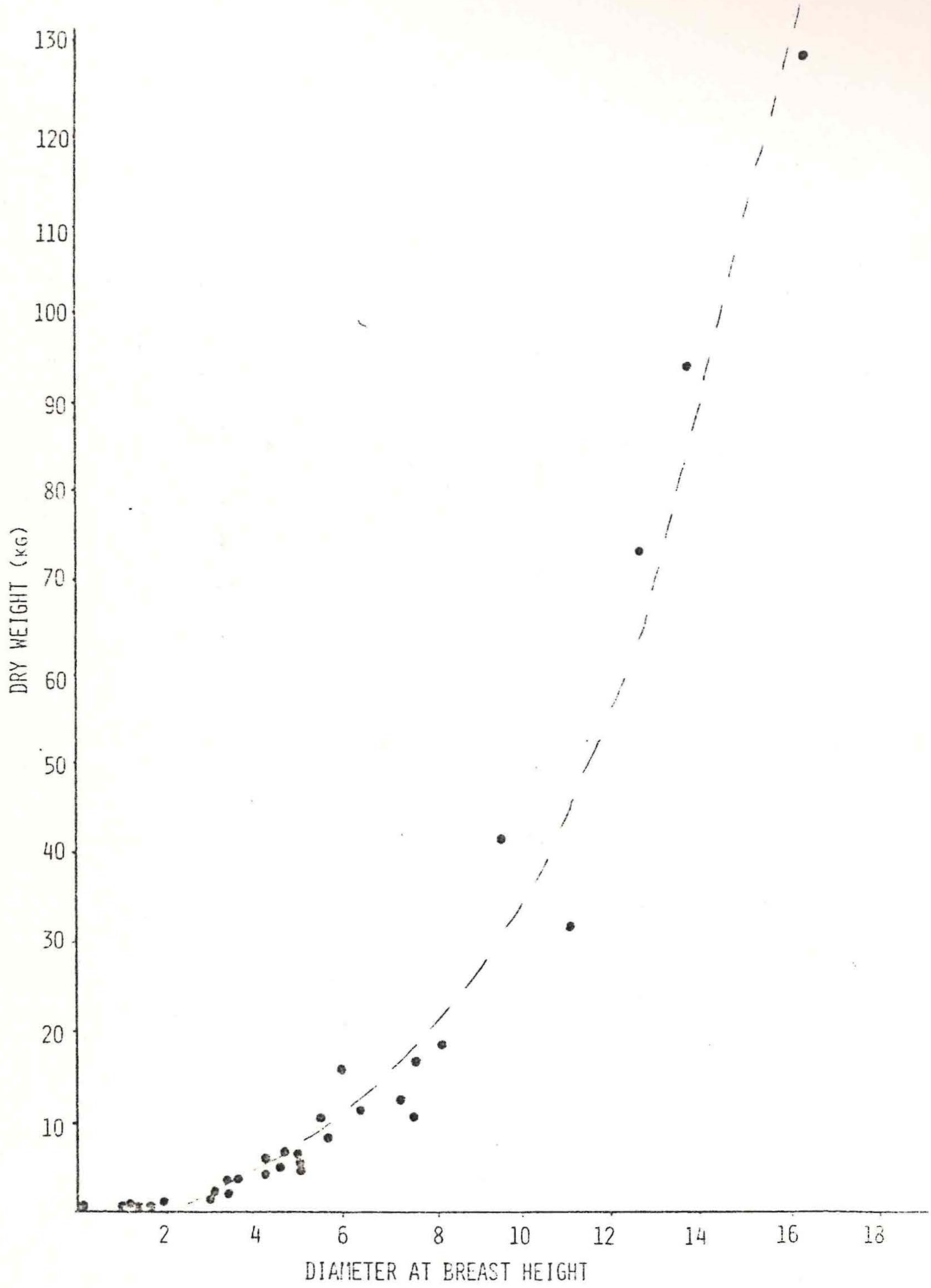

Figure 6. *Banksia grandis* biomass to diameter at breast height relationship. Dash line is the fitted exponential regression equation:
Biomass = $-10.68 + 6.91 \times 1.21^{\text{Diameter at Breast Ht.}}$

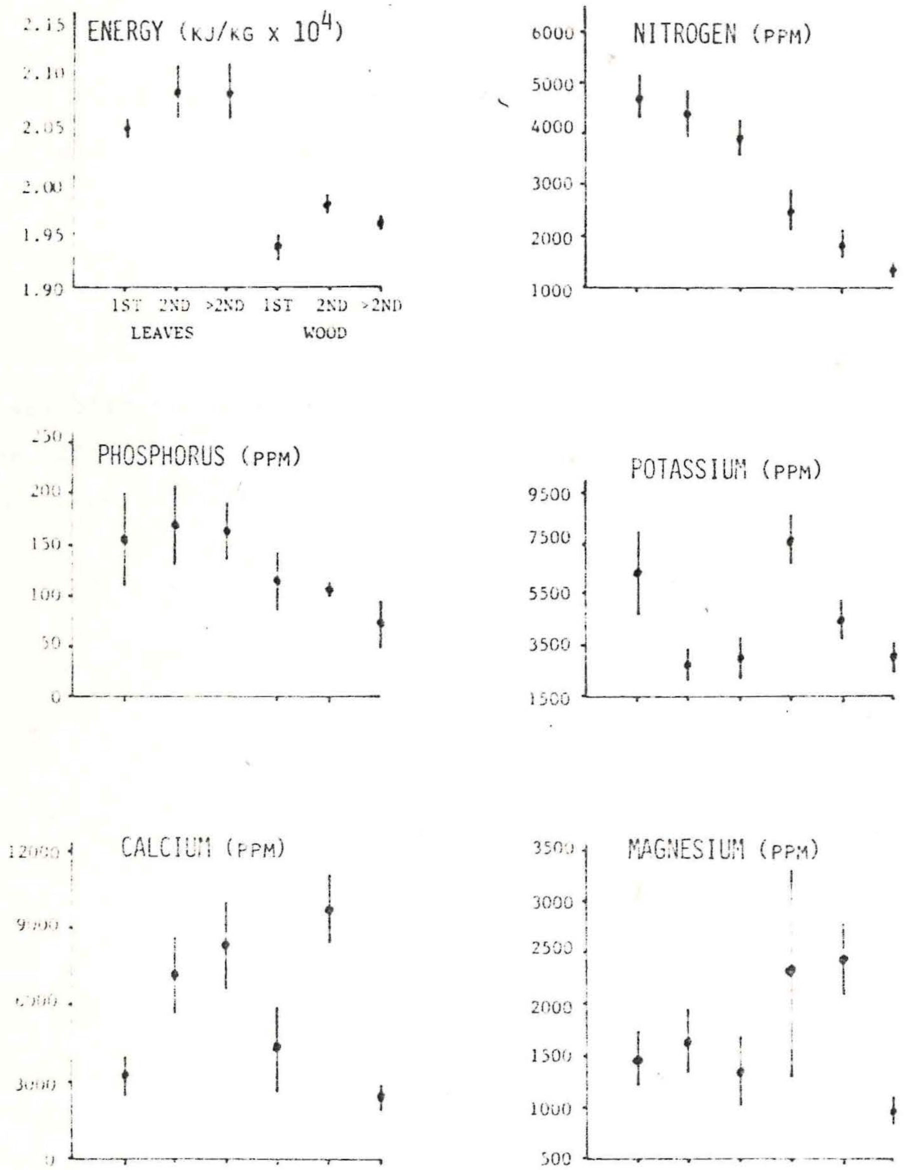

Figure 7. Nutrient and energy content values for *Banksia grandis* leaf and wood components used for conversions in the computer model. The mean and standard deviation are plotted for each component.

Table 3. Biomass, energy and nutrient totals for the understorey *Banksia grandis* populations from Teesdale, Murradong and Virgin Forest areas. Values are approxiate and represent the average of several systems of determination.

	Teesdale	Marradong	Virgin Forest
Total Biomass (kg/ha)	1877	14831	112386
Leaf Biomass (kg/ha)	219	1823	9080
Wood Biomass (kg/ha)	1657	13008	103306
Energy (kjl x 10^6)	35	280	1650
Nitrogen (kg/ha)	3.48	28.20	170.68
Phosphorus (kg/ha)	0.16	1.30	7.95
Potassium (kg/ha)	5.77	46.29	291.73
Calcium (kg/ha)	6.00	48.60	299.21
Magnesium (kg/ha)	2.06	16.55	108.03

resampled in 1980 after 2 years and in 1981, 3 years since the burn. The results provide information on some of the aspects of fires' impact on the soil inorganic nutrients but due to the absence of some of the data from the 1978 study, the story has considerable areas to be re-investigated. In general, considerable site variation was recorded in all soil parameters measured. When the aspects of site were held constant in two- and three-way analysis of variance calculations, however, a number of interesting data are revealed. The expected rise in pH following the fires (Hatch 1960) was observed in the Clinton control burn (Fig. 8). Organic matter in the soil increased following the first rainfall of the season which occurred between the sampling at 2 days following the burn and the 30 days since burn sampling. This probably was due to partially burned organic matter being washed into the upper layers of the soil where the samples were taken. Total phosphorus showed an increase following the fire with a subsequent decline after two and three years. The other soil parameters, total nitrogen, magnesium, potassium and calcium, were not measured in 1978, but all show the decrease from year 2 to year 3 that was apparent in the readings for soil phosphorus. Increased levels of available soil nutrients following autumn burns could be the cause of the increase rates of bole growth documented for jarrah forest trees during the first 4 years following a fire (Kimber 1978). Soil sample locations in the 4 L and 4 P catchments will allow a more complete assessment of the effect of fires on the important component of the jarrah forest ecosystem.

PRIORITIES FOR 1981-1982

Major priorities for the coming year will be related to the continued documentation of the ecosystem components in the 4 L catchment prior to the logging and regeneration burn operation now scheduled tentatively for the summer of 1981-1982. Assessment of components of the ecosystem in the 4 P control catchment will continue now that the 100m watershed sampling grid has been surveyed by the Forests Department staff. Continuation of the digestion and analysis of the nutrient and energy content of the organic component fractions and continual assessment of biomass, nutrient and energy transfers with time are also primary objectives. Cooperation with Dr. Majer will continue on the litter-dwelling invertebrate components of the ecosystem. Sharing of biomass and nutrient concentration data with Dr. Frank Hingston's group at C.S.I.R.O. will continue and the cooperation with Dr. Syd Shea and the Dwellingup Research Staff will, of course, continue.

Future research on forest management impacts on the ecosystem will depend on the choice of catchment manipulation carried out by the Forests Department. In addition to the control catchment and the logging and hot burn catchments currently being studied, the management practices which could be assessed include: logging alone, hazard-reduction spring burn, understorey conversion autumn burn, simulated dieback effects and bauxite mining.

ASSOCIATED RESEARCH

Dieback control and management using intense autumn burns has been under study by the Forests Departmnet for the past few years. In part as a trade for support in collecting water samples for the watershed studies, portions of my technician time, computing funds and my own efforts have been allocated to cooperative research efforts into the research of the Forests Department on the response of the Jarrah forest to these intense research burns. In the past year we have cooperated with Dr. Shea on research on the North-East Road Research Burn and the Hakea Block Burn and the development of a computer model to simulate the impact of narious forest management systems on the populations of understorey *Banksia grandis*. Funds from the Dieback Research Foundation have also been used to publish articles on the impact of the high-intensity burns and jarrah forest rehabilitation research.

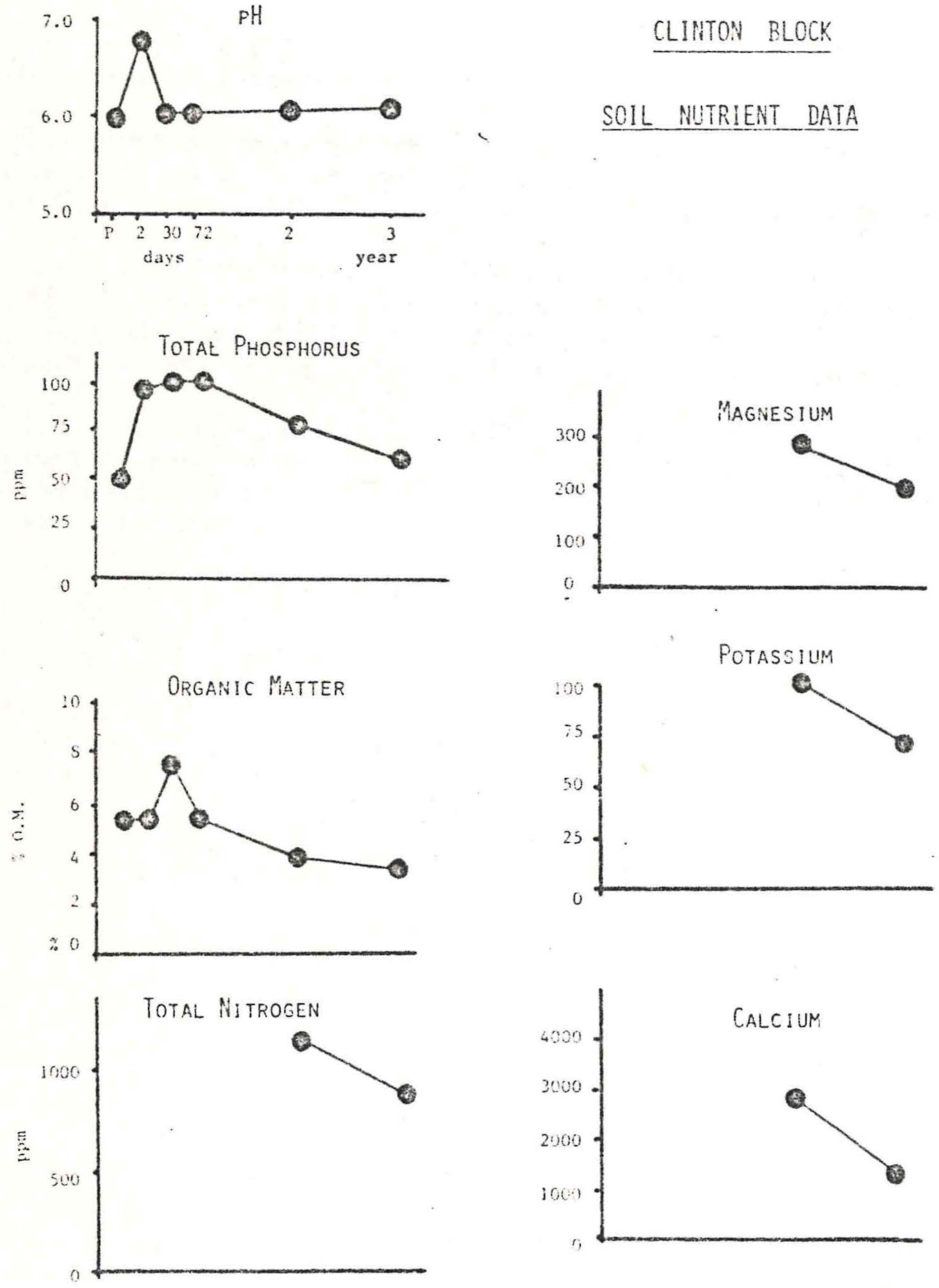

Figure 8. Clinton block soil parameters measure prior to the March 1978 fire (P), 2, 30, 72 days and 2 and 3 years after the burn. Values are overall means.

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FINANCIAL REPORT

First Year Financial Statement

The allocation of funds for the first year (1979-1980) of the research project and the expenditures are reviewed below:

Financial Year 1979-1980

	Salary	Equipment	Maintenance	Computing	Travel	Total
Credits	12000.00	4000.00	1800.00	600.00	600.00	19000.00
Debits	8976.64	1897.00	1604.34	0.00	762.82	13240.80
	3023.36	2103.00	195.66	600.00	(162.82)	5759.20
Outstanding Debits	$409.11		Carry over to 1980-1981		=	5350.09

The difference between the estimated and actual expenditures on salaries represented primarily the lag in the time required to find and hire a competent technical assistant. Miss Linda Watson now fills this position and I find her assistance extremely valuable. As outlined in a letter to Mr. Hammond on November 6, 1979 and approved by Mr. Beggs on November 14, 1979, we transferred $4,750.00 into part-time salaries to analyse water samples during the winter river-flow period. From July 1980, we began to spend this salary allotment which was saved by purchasing two automatic water samplers on an A.R.G.C. Grant. The low expenditures during financial year 1979 for equipment and (in part) salaries reflected the anticipation of the part-time assistance during July - September 1980. Maintenance and Travel expenditures were approximately as estimated. We did not use any of the computer allocation from the Dieback Foundation Grant but were able to begin establishing the computer based storage and retrieval systems for the research data using related grant funds and teaching allocations.

Second Year Financial Statement

Financial allocations to sections of the Dieback Foundation Account were outlined in my letter to Mr. Hammond on 27 June 1980. Transfers to salaries were made during the year as funds from other grants became available to cover some of these anticipated costs. Allocations of credits and expenditures are reviewed below:

Financial Year 1980-1981

	Salary	Equipment	Maintenance	Computing	Travel	Total
Allocation	12000.00	500.00	1800.00	200.00	1500.00	16000.00
From 1979	5126.36		223.73			5350.09
	500.00	-500.00				
	180.10			-180.10		
Credits	17806.46	0.00	2023.73	19.90	1500.00	21350.09
Debits	18089.12	0.00	1497.13	19.90	491.01	20097.16
	(282.66)	0.00	526.60	0.00	1008.99	1252.93

Expenditure on salaries reflect the added temporary assistance during the winter river-flow period to cover nutrient analyses. Outstanding debits in maintenance and travel will reduce the carryover to the final year of the programme.

Third Year Financial Estimate

Allocations for the third year are outlined below:

Financial Year 1981-1982

Salary	Equipment	Maintenance	Computing	Travel	Total
13000.00	0.00	1500.00	0.00	600.00	15100.00

David T. Bell

Dr. David T. Bell
Lecturer in Plant Ecology

THE UNIVERSITY OF WESTERN AUSTRALIA

W.A. FORESTS DEPARTMENT - DIEBACK RESEARCH FOUNDATION GRANT - DR. D.T. BELL

STATEMENT OF INCOME AND EXPENDITURE FOR THE YEAR ENDED 30TH JUNE, 1981

INCOME

Balance brought forward from 30th June, 1980.		$5,759.20 Cr.
Funds received		16,000.00
Total funds available		$21,759.20

EXPENDITURE

Salary	$18,089.12	
Computing	72.84	
Maintenance	1,795.50	
Travel	491.01	20,448.47
Balance as per ledger 30th June, 1981		1,310.73
Less Outstanding Commitments		601.80
Balance of account as at 30th June, 1981.		$ 708.93 Cr.

A.P.H

A. PRITT,
For Bursar.