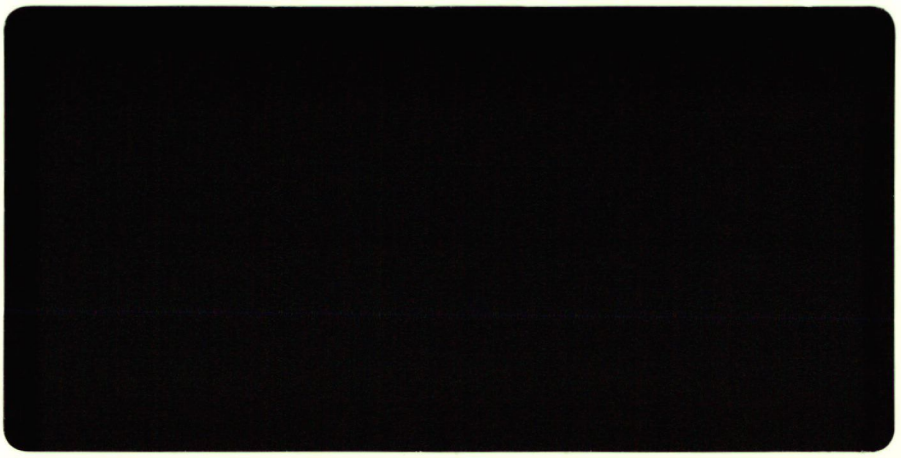
PORT OF BRISBANE
CORPORATION
A155 7013



333.9164099431
WBMO
1994

WBM
OCEANICS AUSTRALIA

PORT OF BRISBANE CORPORATION
A 1557013
LIBRARY

MANGROVE MONITORING
FISHERMAN ISLANDS 1991-94

Prepared for: Port of Brisbane Authority

Prepared by: WBM Oceanics Australia Pty Ltd
99 Leichhardt St.,
SPRING HILL QLD 4004
Telephone (07) 831 6744
Fax (07) 832 3627

Document No: 8100.1.0

333.9164099431
WBMO
1994
copy 1

STORAGE

Record Control Number
5541

WBM OCEANICS AUSTRALIA

DOCUMENT CONTROL SHEET

WBM OCEANICS AUSTRALIA
99 LEICHHARDT STREET
PO BOX 203
SPRING HILL QLD 4004
AUSTRALIA

TELEPHONE: 07 831 6744
International: + 617 831 6744
FAX: 07 832 3627
International: + 617 832 3627

Document No:	8100.1.0
Archive Document No:	00014914
Original Date of Issue:	15/06/94
Project Manager:	S Catchpoole

Title:	Mangrove Monitoring at the Fisherman Islands 1991-94
Author:	S Catchpoole
Client:	Port of Brisbane Authority
Client Contact:	Mr John Dobson
Client Reference:	

Synopsis:

An account of a long-term (September 1991 - May 1994) monitoring study in the mangroves of the Fisherman Islands

REVISION/CHECKING HISTORY

REVISION NUMBER	DATE	CHECKED BY		ISSUED BY		DISTRIBUTION - NO. OF COPIES			
						Client	Other	WBM Inc	WBM Lib
1	20/06/94	R Morton	RM	S Catchpoole	JPC	2	2*		1

* Copies retained by WBM Oceanics Australia

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1.0 INTRODUCTION 1

2.0 REVIEW OF PREVIOUS REPORTS 2

3.0 MONITORING PROGRAMME METHODOLOGY 5

4.0 RESULTS 10
- 4.1 LITTERFALL 10
  - 4.1.1 Annual Production 10
  - 4.1.2 Site differences 10
  - 4.1.3 Seasonal Patterns 11
- 4.2 STEM GIRTH 13
- 4.3 PROJECTIVE FOLIAGE COVER, CANOPY HEIGHT AND VEGETATION STRUCTURAL TYPE 14
- 4.4 PHOTOGRAPHIC RECORD 14

5.0 DISCUSSION 15
- 5.1 LITTERFALL 15
- 5.2 STEM GIRTH 17
- 5.3 PROJECTIVE FOLIAGE COVER (PFC), CANOPY HEIGHT AND VEGETATION STRUCTURE 18

6.0 OVERVIEW AND RECOMMENDATIONS 19

7.0 REFERENCES 20

EXECUTIVE SUMMARY

Fisherman and Whyte Islands, at the Brisbane River mouth, are being developed as a major port facility by the Port of Brisbane Authority (PBA). The expansion of port capacity has necessitated disturbance of intertidal and subtidal lands of the Fisherman Islands, some of which are vegetated by mangroves.

Mangrove communities within Moreton Bay are highly productive and structurally complex. They provide large amounts of plant litter, an important primary food source for aquatic organisms inhabiting mangrove-dominated estuaries. Mangroves are also important nursery and feeding grounds for many fishes and crustaceans, most of which are of direct importance to commercial and recreational fisheries.

Mangroves within the Fisherman Islands study area cover approximately 200 ha. In a regional context, this represents $<2\%$ of the 13900 ha of mangroves in Moreton Bay (Hyland and Butler, 1988).

This document presents the results of a study of the structure and productivity of mangroves in the Fisherman Islands region, commissioned by the PBA and conducted by WBM Oceanics Australia. The study was initiated in September 1991. Final measurements were taken in May 1994. Results presented in earlier progress reports (WBM Oceanics Australia 1992, 1993) are incorporated into this final report.

The data from this study has allowed detailed comparisons of productivity (as measured by litterfall) to be drawn between mangrove monitoring sites and between years, prior to and during reclamation works. Key findings of the studies are:

- the mangroves at the monitoring sites are typical in structure and composition to mangrove communities elsewhere in Moreton Bay
- the mangroves are healthy and not subject to on-going adverse impacts
- annual total litterfall ranged from 5.83 to 8.37 t/ha in 1992/3 and 7.14 to 10.62 t/ha in 1993/4. These values are in the lower half of the range in values reported from temperate to tropical mangrove communities around the world
- stem growth (increase in girth) over the duration of the study was very small and highly variable
- no major structural changes in mangrove communities at the sites were observed over the monitoring period

One mangrove reproductive cycle, in 1993, was recorded during the study. Evidently fruit production by mangroves at Fisherman Islands does not occur every year. This information on the season and frequency of fruiting will be vital to the Port Authority if it plans seed collections for mangrove regeneration projects.

Leaf litterfall production peaked during the growing season of spring through to early autumn. This corresponds with periods of greatest leaf production and shoot growth, as documented in other mangrove studies in Moreton Bay.

No comparable data for stem girth measurements on mangroves in Moreton Bay or in southeast Queensland were found with which to compare the results of this study. However, the small changes in stem girth are thought to indicate that the mangroves are in a mature to over-mature (senescent) stage in their development and thus experiencing slow rates of stem growth.

The monitoring programme has provided one of the longest running data sets on litterfall production for mangroves in Moreton Bay, and possibly the only data on stem girth changes. The data has a wide range of applications, including:

- as detailed baseline data for future mangrove monitoring studies
- effective management of the mangrove resources
- timing of seed collections for mangrove rehabilitation works.

1.0 INTRODUCTION

The Fisherman Islands at the mouth of the Brisbane River are being developed as a major port facility by the Port of Brisbane Authority (PBA). Tidal wetlands (saltmarsh, seagrass and mangroves) occur on and adjacent to the islands.

The PBA has recognised the need to expand the port's capacity to accommodate increases in port usage (PBA 1992). The Moreton Bay Strategic Plan (DEH 1992), designed to ensure appropriate land use within Moreton Bay, designates lands at the Fisherman Islands for port-related activities.

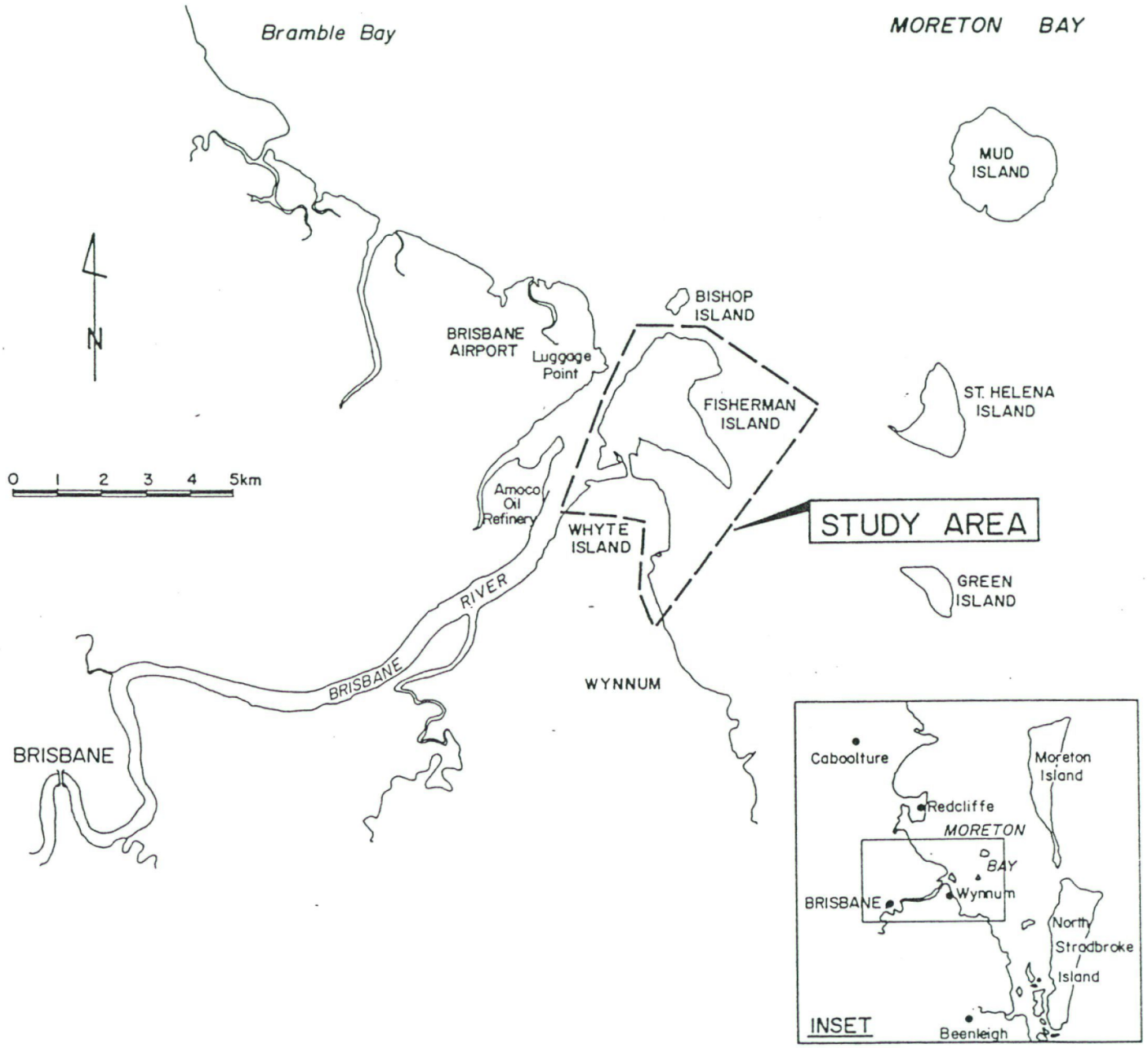
Expansion of the port on the southern side of the Brisbane River mouth will necessitate disturbance of intertidal and subtidal lands at the Fisherman Islands, some areas of which support mangroves.

The PBA commissioned WBM Oceanics Australia to undertake studies of tidal wetlands occurring on and adjacent to the Fisherman Islands, Whyte Island and the Wynnum foreshores. Figure 1.1 shows the extent of the study area.

The present studies are the continuation of mangrove productivity monitoring initiated in September 1991 and reported earlier (WBM Oceanics Australia 1992, 1993).

The results of the present study are combined and compared with previous data to provide the PBA with one of the longest running mangrove monitoring studies ever conducted in Moreton Bay. This will provide a baseline data set against which future monitoring can be compared and contrasted.

This document reports the results of monitoring conducted from September 1991 to May 1994, with reference to the results of previous reports (WBM Oceanics Australia 1992, 1993) to elucidate long term trends.



FIGURE

STUDY AREA

1.1

WBM OCEANICS AUSTRALIA

2.0 REVIEW OF PREVIOUS REPORTS

Study Initiation 1991

The results of initial monitoring were reported in detail in WBM Oceanics Australia (1992).

Initiation of the study in September 1991 involved the selection of six monitoring sites in the Fisherman Islands area by the PBA in consultation with WBM Oceanics Australia. The following structural parameters of the mangrove community at each site were measured:

- projective foliage cover (PFC%)
- canopy height (m)
- stand density (no. of trees/ha)
- stand basal area (tree cross-sectional area at 1.3m above ground level [breast height], m^2/ha)

Mangrove productivity was monitored through collection of litterfall and measurement of changes in stem girth.

Litterfall catchers were installed at four of the six sites to collect plant litterfall. Dendrometers were installed on ten trees at each of the six sites to measure changes in stem girth.

The areas of each tidal community present in the Fisherman Islands region (saltmarsh, mangroves, seagrass) were measured and comparisons made with their regional (Moreton Bay) distribution. The ecological importance of tidal communities was discussed.

Key findings of the study were:

- mangrove communities at the monitoring sites were similar in structure and composition to mangrove communities elsewhere in Moreton Bay.

- the two litterfall collections made over the study duration (17 weeks) were insufficient to reveal any seasonal patterns or trends. However, the average litterfall production from these two collections, when extrapolated to an annual figure, agreed closely with estimates of annual litterfall production from other mangrove communities in Moreton Bay.

- Minimal change in stem girth was recorded over the study's duration. This may have reflected the maturity of the individual trees measured at each site.

- No major structural changes were observed in the mangrove communities at the monitoring sites over the study duration.

It was concluded that longer term monitoring would be necessary to detect any seasonal patterns in litterfall production or larger stem girth changes.

Mangrove productivity monitoring 1992/1993

The second report (WBM Oceanics Australia 1993) provided the results of mangrove productivity monitoring up to May 1993, including and expanding upon the results of earlier monitoring (reported in WBM Oceanics Australia 1992).

Litterfall and stem girth increment were the two aspects of productivity that were monitored.

Key findings of the study were:

- The mangroves were in a healthy condition.

- Sufficient data was collected to calculate a figure for annual litterfall. The range in this figure across the four sites monitored agreed closely with annual litterfall estimates made for mangroves elsewhere in Moreton Bay.

- Larger changes in stem girth were recorded compared with earlier monitoring. However, changes in stem girth were not always positive and were highly variable within sites, despite the uniformity in size of tree stems measured.

- The first fruit production event since monitoring commenced was recorded in autumn 1993. Fruit production in the mangroves of the Fisherman Islands region evidently does not occur every year.

It was concluded that:

- Litterfall monitoring conducted for a further 1 to 2 years would reveal the extent of inter-annual variability in seasonal patterns and total production.

- Initial expectations of stem girth monitoring had not been realised, but with the equipment (dendrometers) already installed, little additional time or expense was required to take further readings.

3.0 MONITORING PROGRAMME METHODOLOGY

The present monitoring programme is a continuation of the mangrove productivity studies initiated in September 1991 and reported on previously (WBM Oceanics Australia 1992, 1993). It was implemented to provide quantitative data on mangrove communities adjacent to the Fisherman Islands prior to, and during, further reclamation works for the Port of Brisbane.

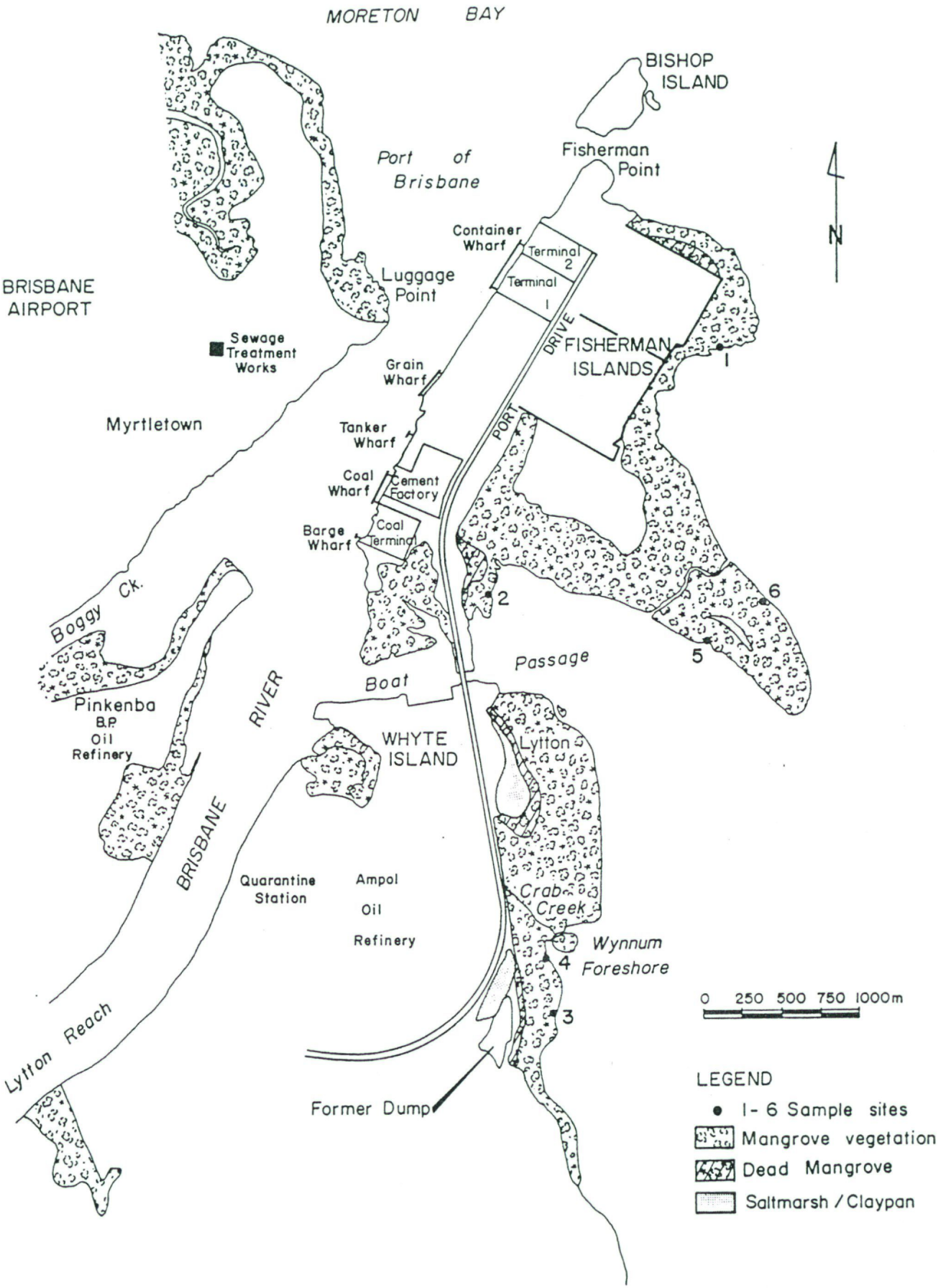
The results of monitoring for the entire study duration (September 1991 to May 1994) are documented in this report.

Monitoring methods were described in detail previously (WBM Oceanics Australia 1992, 1993) and only a brief outline is provided in this report.

A summary of monitoring frequency for each parameter measured is provided below.

Litterfall

Seasonality (trend over time) and rate (production per unit time) of litter production was studied at four sites in the mangroves of the Fisherman Islands region (sites 1, 4, 5 and 6; Figure 3.1). Three mangrove communities were represented at these four sites - low open, low closed and open *Avicennia marina* (grey mangrove) forest. Structural features of these sites are outlined in Table 3.1. In September 1991, fourteen randomly located litter catchers were suspended from canopy branches at sites 1, 4, 5 and 6 to keep them clear of high tides. At each site, litter was collected approximately every two months for 32 months as detailed in Table 3.2.



MANGROVE VEGETATION, FISHERMAN ISLAND 1991

FIGURE 3.1

WBM OCEANICS AUSTRALIA

TABLE 3.1: STRUCTURAL FEATURES OF FISHERMAN ISLANDS AND WYNNUM FORESHORES MANGROVE MONITORING SITES (September 1991)

	Site					
	1	2	3	4	5	6
Vegetation structural form	Open forest	Open forest	Low open forest	Low open forest	Low closed forest	Open forest
Dominant species	*Avicennia marina*	*Avicennia marina*	*Avicennia marina*	*Avicennia marina*	*Avicennia marina*	*Avicennia marina*
Projective foliage cover (%)	62	67	62	62	72	61
Canopy height (m)	10 - 13	10 - 13	8 - 10	8 - 10	8 - 10	10 - 13
Stand density (stems per ha)	334	462	830	876	893	380
Stand basal area (m^2/ha)	24.0	23.1	24.1	28.9	24.1	24.3
Stem girth (cm)*	87.0 ± 4.4 (n=72)	73.5 ± 3.5 (n=68)	56.9 ± 2.5 (n=60)	59.7 ± 3.1 (n=60)	55.9 ± 2.2 (n=60)	86.1 ± 3.5 (n=60)
General description	Tall trees, large girths single-stemmed, widely spaced	Tall trees, moderate to large girths, single or double-stemmed, well spaced	Low trees, small girths, one to a few stems, closely spaced	Low trees, small girths, one to a few stems, closely spaced	Low trees, small girths, one to a few stems, closely spaced	Tall trees, large girths, single-stemmed, widely spaced

* mean ± standard error

WBM OCEANICS AUSTRALIA

TABLE 3.2: TIMING OF LITTERFALL COLLECTIONS
FISHERMAN ISLANDS (1991 - 1994)

Collection Period	Collection Number	Month
1991/92	Installation of litterfall traps	September 1991
	1st	December 1991
	2nd	February 1992
	3rd	May 1992
1992/93	4th	July 1992
	5th	September 1992
	6th	November 1992
	7th	January 1993
	8th	March 1993
	9th	May 1993
1993/94	10th	July 1993
	11th	September 1993
	12th	November 1993
	13th	January 1994
	14th	March 1994
	15th	May 1994

Following collection, the plant litter was sorted into leaf, stem and fruit (including all stages from bud to fully developed propagule) material, oven dried at 80°C, then weighed (± 0.01 g).

Comparison of litterfall between the 1992/3 and 1993/4 collection periods was based on the breakup of collections as shown in Table 3.2. Annual litterfall was expressed in tonnes/ha.

Seasonality and rate of litterfall production was expressed in units of grams per square metre per day. This allowed direct comparison of litterfall rates between collection dates, when collections could not be made at exactly two monthly intervals.

Stem girth

Change in stem girth was monitored by dendrometers installed on 10 trees at each of the six sites (Figure 3.1). A detailed description of the construction and installation of the dendrometers is provided in WBM Oceanics Australia (1992).

Following installation of dendrometers on the 25th October 1991, readings were taken on the following dates:

- 1st Reading February 1992
- 2nd Reading September 1992
- 3rd Reading March 1993
- 4th Reading September 1993
- 5th Reading January 1994

All the dendrometers on the trees at Site 2 were removed by persons unknown some time before the fourth reading. They were not replaced, as it was considered highly probable that they would be removed again. By the fifth reading in January 1994, the markings on the remaining dendrometers had become heavily weathered and no further readings could reliably be taken after this time.

Canopy Height

Canopy height and projective foliage cover were measured at each site. These two parameters are measured to classify vegetation structural type according to the widely used scheme of Specht (1970).

Canopy height was indirectly determined by heighting several trees in the overstorey at each site with a Suunto clinometer and was expressed as a range (m).

Projective Foliage Cover

Projective foliage cover estimates the horizontal cover of a site by the overstorey canopy and provides a measure of a plant community's potential productivity. At each site, projective foliage cover was determined from 50 random point quadrant sitings and was expressed as a percentage.

Photographic record

A photographic record of the mangrove community at each site was made by taking a photo facing each major cardinal point from a fixed reference point.

Photos were taken at the following dates:

- September 1991
- February 1992
- September 1992
- March 1993
- November 1993
- May 1994

These photographs were taken to note any marked changes in seedling populations and general structure of the mangrove community. The photographic record has been provided to PBA separately of this report.

Statistical Analysis

Statistical analysis was carried out using the computer software SPSSPC (SPSS 1988). Mangrove litterfall was compared between sites within each year using a one-way ANOVA in conjunction with the Duncan test with a significance level of 0.05. Mangrove litterfall was compared between years for each site using a t-test for independent samples and Levene's Test for equality of variances.

4.0 RESULTS

4.1 LITTERFALL

The following aspects of litterfall production are examined:

- annual production
- site differences
- seasonal patterns

4.1.1 Annual Production

Total litterfall (leaf, stem and fruit) and leaf litterfall (leaf only) at each site for 1992/3 and 1993/4 is presented in Table 4.1. Data is illustrated as a bar graph in Figure 4.1.

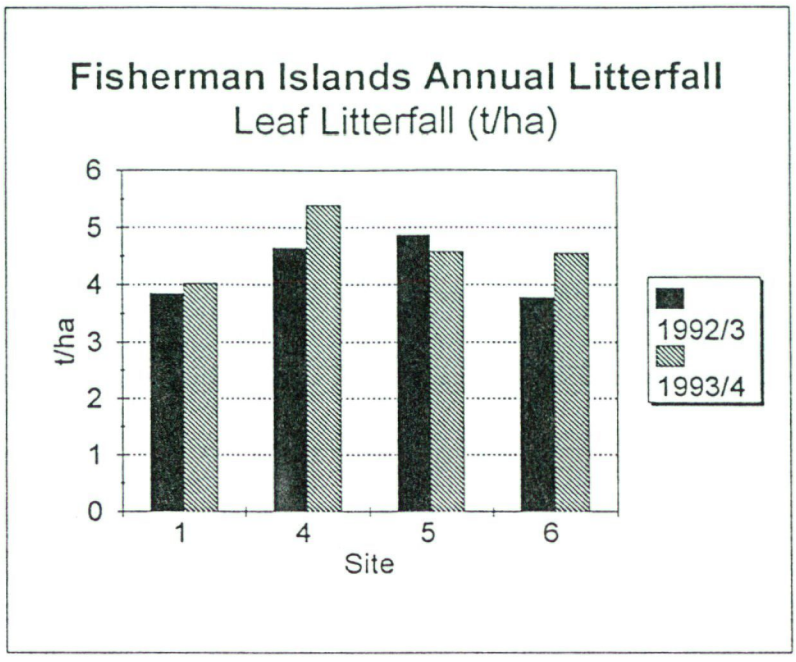
No significant differences in total or leaf litterfall occurred between 1992/3 and 1993/4 at any of the sites except site 4, where leaf litterfall was significantly greater in 1993/4 than 1992/3.

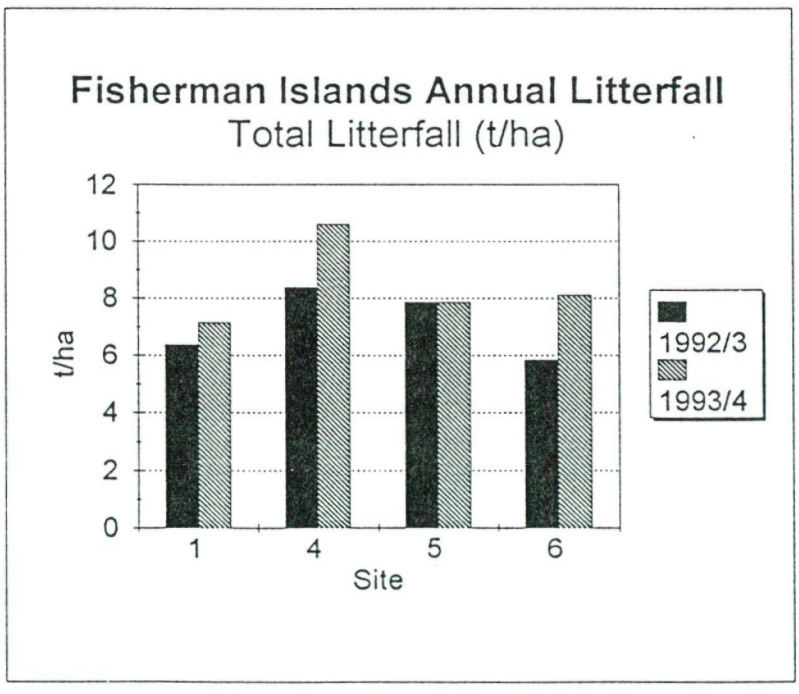
4.1.2 Site differences

Annual leaf and total litterfall was compared between sites for each year, 1992/3 and 1993/4.

Leaf Litterfall

In the collection period 1992/3, leaf litterfall was significantly greater in the low closed forest (site 5), than in the taller, open forests (sites 1 and 6).





Annual Total and Leaf Litterfall, All Sites

FIGURE 4.1

TABLE 4.1: ANNUAL TOTAL AND LEAF LITTERFALL PRODUCTION FOR 1992/93 AND 1993/94

Site	Community Structural Type	Litterfall Component			
		Total (t/ha)		Leaf (t/ha)	
		1992/3	1993/4	1992/3	1993/4
1	*Avicennia marina* open forest	6.36	7.14	3.85	4.02
4	*A. marina* low open forest	8.37	10.62	4.65	5.40
5	*A. marina* low closed forest	7.87	7.86	4.87	4.58
6	*A. marina* open forest	5.83	8.11	3.78	4.56

In the collection period 1993/4, leaf litterfall was significantly greater in the low open forest (site 4) than in the open forest of Site 1 (Table 4.1, Figure 4.1).

Total Litterfall

Since leaf litterfall contributed at least 50% to the total litterfall, between site differences in total litterfall were similar to those seen in leaf litterfall.

Total litterfall in 1992/3 was significantly greater in the low open and low closed forests (sites 4 and 5, respectively) than in the open forests (sites 1 and 6).

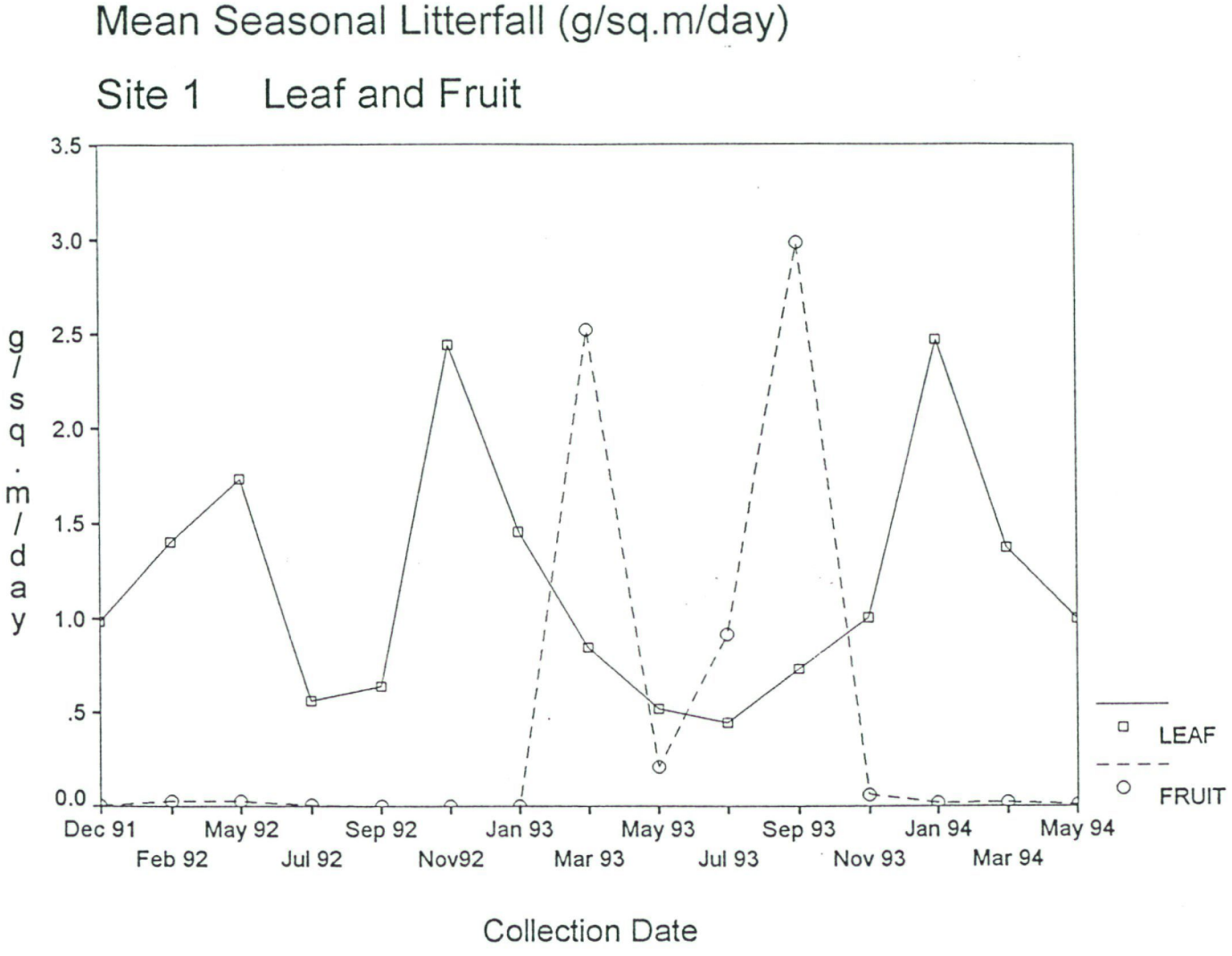
In 1993/4, total litterfall was significantly greater in the low open forest (site 4) than in all other sites (Table 4.1, Figure 4.1).

4.1.3 Seasonal Patterns

Seasonal patterns of litterfall production are examined by components - leaf, fruit, total and stem.

Leaf Litterfall

Three peaks in leaf litterfall were identified over the study duration. These occurred during spring, summer and early autumn months at all sites. The seasonal pattern of leaf litterfall at Site 1 is illustrated in Figure 4.2. Appendix A provides illustrations of seasonal leaf litterfall at sites 4, 5 and 6.



Seasonal Pattern of Leaf and Fruit Litterfall Site 1*

FIGURE 4.2

* N.B. Data for other sites is presented in Appendix A

Peaks in leaf litterfall occurred in:

- February (site 4) and May 1992 (all other sites; late autumn)
- November 1992 (late spring)
- January 1994 (mid summer)

Fruit Litterfall

Fruit litterfall production peaked in March 1993 and September 1993 at all sites, and was generally insignificant at all other times (Figure 4.2).

The first peak in March 1993 comprised flowers and immature fruit, whilst the second peak in September 1993 was of mature fruit.

Total Litterfall

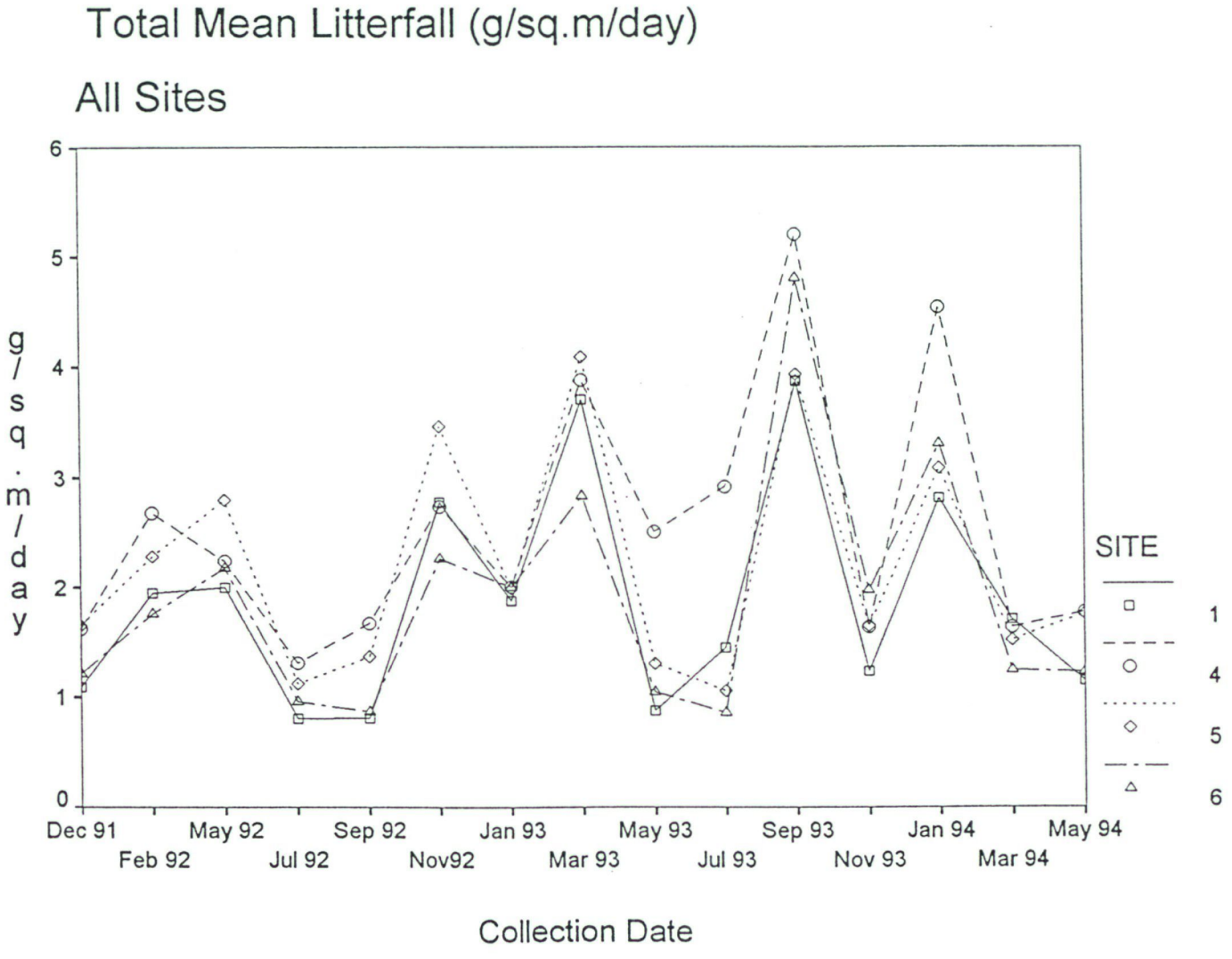
Seasonal patterns in total litterfall production at all four sites are illustrated in Figure 4.3. Patterns in production were generally similar across all sites with least litter being produced in the winter months.

Peaks in total litterfall occurred in:

- late summer-autumn 1992
- late spring 1992
- early autumn 1993
- early spring 1993
- summer 1994

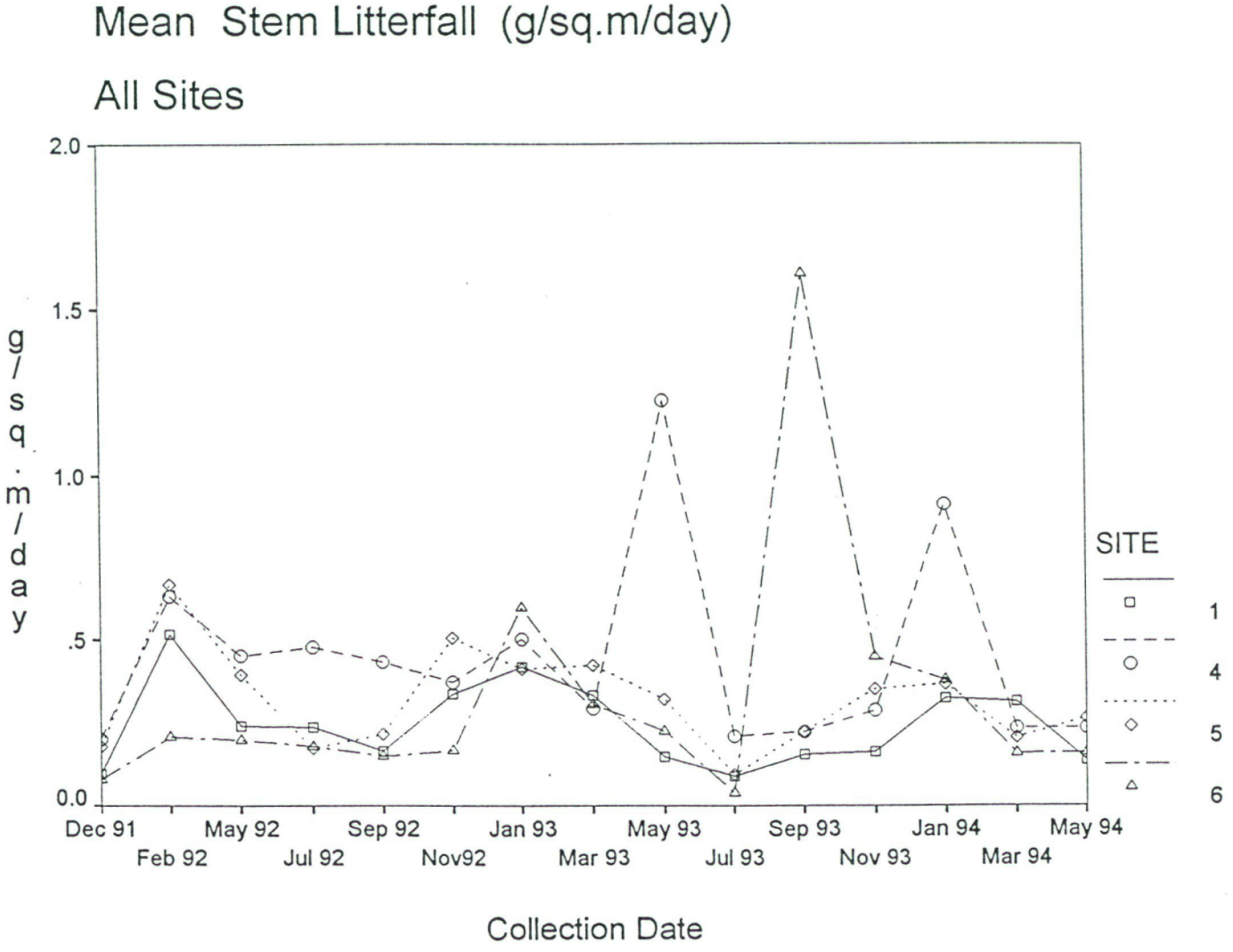
Stem Litterfall

No seasonal pattern in stem litterfall was observed (Figure 4.4). The high variability in stem litterfall within sites is probably due to the less predictable nature of its fall (related to storm and wind events) and high variability in stem size (from twigs to branch sections).



FIGURE

Seasonal Pattern of Total Litterfall, All Sites 4.3



FIGURE

Seasonal Pattern of Stem Litterfall, All Sites

4.4

4.2 STEM GIRTH

Changes in stem girth for the ten trees monitored at each of the six sites (Figure 3.1) are summarised in Table 4.2.

By the last measurement in January 1994 (over 26 months since commencement of measurement in October 1991) at least half of the trees at each site had increased in girth.

The largest increases occurred on trees at Sites 3 and 4 (with maximum increases of 17.3 mm and 14.7 mm respectively). Sites 3 and 4 also supported the most number of trees showing girth increases (8 trees at each).

The largest decreases in stem girth and the most trees showing decreases occurred at Site 6, where five trees decreased in girth since the start of measurement, with a maximum decrease of 4.3 mm.

Detailed analysis of average stem increment for each site was not made because of the high within-site variability (standard error of average stem girth change generally >30%). This occurred even though average tree girth at the commencement of measurements was low (<10% standard error).

TABLE 4.2: SUMMARY OF CHANGES IN STEM GIRTH (mm) FOR THE PERIOD 25/10/91 - 14/1/94

Ten trees were monitored for changes in stem girth at each site.

		SITE					
		1	2	3	4	5	6
Average Initial Girth		753 (± 54.6)	754 (± 48.2)	636 (± 32.6)	600 (± 26.8)	773 (± 55.7)	952 (± 62.7)
Average Final Girth		755 (± 55.0)	755 (± 48.2)	643 (± 32.1)	606 (± 27.0)	776 (± 56.0)	952 (± 62.3)
Measurement number	Date	Stem girth change (mm)					
1	7/2/92	-0.8 to 1.8	-2.5 to 0.5	-2.5 to 0.5	-1.0 to 1.3	-2.3 to 1.8	-4.1 to 0.0
2	18/9/92	-1.0 to 2.3	-2.5 to 3.1	-1.0 to 8.6	-0.1 to 5.6	-2.5 to 4.8	-3.6 to 1.3
3	12/3/93	-3.8 to 3.3	-2.5 to 4.3	-0.3 to 4.3	-0.5 to 12.5	-2.5 to 7.1	-3.8 to 3.3
4	8/9/93	-0.5 to 5.8	*	0 to 14.0	-0.25 to 13.0	-2.5 to 8.6	-3.8 to 2.5
5	14/1/94	0 to 5.6	*	0 to 17.3	0 to 14.7	-2.8 to 9.1	-4.3 to 4.1
No. trees increasing in girth size since start		6	5	8	8	7	5
No. trees decreasing in girth size since start		0	2	0	0	3	5

* dendrometers were removed from trees at site 2 sometime after the 3rd measurement by persons unknown.

4.3 PROJECTIVE FOLIAGE COVER, CANOPY HEIGHT AND VEGETATION STRUCTURAL TYPE

Table 4.3 compares the canopy heights and projective foliage cover (PFC) values from their recording in September 1991 to that in January 1994. Together, PFC and canopy height determine the vegetation structural type according to the classification scheme of Specht (1970).

TABLE 4.3: PROJECTIVE FOLIAGE COVER (PFC), CANOPY HEIGHT AND VEGETATION STRUCTURAL TYPE, AT THE START (SEPTEMBER 1991) AND END (MAY 1994) OF THE MONITORING PROGRAMME.

		Site					
Date	Attribute	1	2	3	4	5	6
25/9/91	PFC%	62	67	62	62	72	61
	Canopy height (m)	10-13	10-13	8-10	8-10	8-10	10-13
	Vegetation structural type *	open forest	open forest	low open forest	low open forest	low closed forest	open forest
12/5/94	PFC %	64	60	66	69	70	68
	Canopy height range	10-13	10-13	8-10	8-10	8-10	10-13
	Vegetation structural type *	open forest	open forest	low open forest	low open forest	low closed forest	open forest

*after Specht (1970)

Minor variations in PFC were recorded between the first and the final measurements. The range in canopy heights did not markedly change from the first to the final reading.

4.4 PHOTOGRAPHIC RECORD

The photographic record documents general mangrove community structure at the monitoring sites over the study duration.

The photographic record did not reveal any gross changes in the structure of the mangrove communities at the monitoring sites since the first photos taken in September 1991 until the final photos of May 1994.

5.0 DISCUSSION

This mangrove monitoring programme is the longest conducted in Moreton Bay.

Litterfall production over two complete years was measured and changes in stem girth were monitored over 26 months.

This study provides the Port of Brisbane Authority with:

- baseline data, including photos, against which future comparisons can be made
- an understanding of the natural seasonal and annual variability in litterfall of the mangroves adjacent to the port
- information on periods of fruit production, essential if seed collections for mangrove rehabilitation are planned

5.1 LITTERFALL

Litterfall is commonly used as an indirect measure of primary productivity in mangrove studies as it is more readily obtained than direct measures of primary productivity.

Litterfall was measured in this study to allow comparisons to be made with litterfall estimates derived from other mangrove studies. This will provide the Port of Brisbane Authority with information on the relative productivity of the mangroves adjacent to the port, compared to mangroves from other regions.

Annual Production

Studies of litterfall production in mangrove communities from around the world reveal a wide range in litter production, from 0.8 t/ha/year in a temperate/subtropical mangrove forest in southern Florida, to 28.1 t/ha/year in a mixed species tropical mangrove forest in North Queensland (Hutchings and Saenger 1987). The annual litterfall values from this study fall in the lower half of the range referred to by Hutchings and Saenger (1987). This is to be expected, given the location of the Fisherman Islands in the more temperate parts of the subtropics.

The range in annual total litterfall values (from 5.83 to 10.62 t/ha/year) between the sites of this study illustrates the variation that can occur in the same locality between mangrove communities differing slightly in structure.

Variation in litterfall production between mangrove communities of differing structure was also identified in the study by Davie (1984) on Mud Island, where annual litterfall ranged from 1.94 to 6.42 t/ha/year.

Significantly greater annual total and leaf litterfall was recorded in the low open and/or low closed mangrove forests (sites 4 and 5 respectively) than in taller, open mangrove forests (sites 1 and 6). The greater number of trees in the low open and low closed mangrove forests (higher stem densities) than in the taller, open mangrove forests, would contribute to this difference.

Whilst differences in annual litterfall were evident between sites, few differences emerged between the two complete years of litterfall measurement at individual sites. The only exception was site 4, where leaf litterfall was greater in the second year of measurement (1993/4).

Seasonal Patterns

Leaf Litterfall

Peaks in leaf litterfall have been related to periods of new leaf production and/or shoot growth (Davie 1984). The timing of peaks in leaf litterfall in this study are similar to those recorded for mangroves at the nearby Mud Island. Both this study and that of Davie (1984) recorded strong peaks in spring months (September 1979 and October 1980 by Davie (1984) and November 1992 this study). The absence of a peak in leaf litterfall in the spring of 1993 for this study is thought to be related to a flower and fruit production cycle during this time. A peak in leaf litterfall occurred in January 1994 in this study, following the completion of fruit fall. Davie (1984) also recorded a January peak in litterfall (in 1980), however this was related to increased storm activity.

In both this study and the Mud Island study (Davie 1984) minimums in leaf litterfall occurred during winter months. At the Fisherman Islands, a more pronounced winter minimum in leaf litterfall was recorded for 1993 than for 1992, apparently due to a period of flowering and fruiting. Saenger and Moverley (1985), in a productivity study of mangroves in central Queensland, also recorded a marked depression in leaf production during flowering and fruiting. Similarly, leaf litterfall was at a minimum during a period of high fruit litterfall in the mangroves of Mud Island (Davie 1984).

The seasonal pattern of leaf litterfall for subtropical mangroves in eastern Australia appears to peak in spring months and is at a minimum during winter. When a flowering or fruiting event occurs, the period of minimum leaf litterfall may be prolonged.

Fruit Litterfall

Only one full reproductive cycle was recorded over the study duration. This was displayed as two peaks in the collection periods:

- March 1993 - flowers and immature fruit
- September 1993 - mature fruit

The results of this study indicate that the grey mangroves of the Fisherman Islands region, (and probably the rest of Moreton Bay) do not fruit annually. A similar finding was made in a study of grey mangroves in Westernport Bay where fruit were produced only every second or third year (Clough and Attiwill 1982). The 17 month study of mangroves at Mud Island (Davie 1984) recorded only one major peak in fruit production.

In tropical areas, fruit production is an annual event (Hutchings and Saenger 1987), indicating that the tropical environment is more favourable to frequent mangrove fruit production than the sub-tropical environment of Moreton Bay.

A knowledge of when and how often the mangroves of the Fisherman Islands fruit will be vital to the Port of Brisbane Authority, if it plans to conduct any mangrove regeneration projects requiring seeds in the port's vicinity.

5.2 STEM GIRTH

The small changes in stem girth over the study duration of approximately 26 months (max. increment = 3.9%), indicate that the mangroves in the Fisherman Islands region may be mature and progressing into over-maturity or senescence. During these stages, growth rates decline. The stem girth data of this study support this.

The paucity of studies of changes in stem girth on mangroves elsewhere in Australia prevents a comparison and assessment of the significance of the changes in stem girth recorded in this study. However, the largest changes in girth increments recorded in this study do not appear to be very large for a measurement period of approximately 26 months.

5.3 PROJECTIVE FOLIAGE COVER (PFC), CANOPY HEIGHT AND VEGETATION STRUCTURE

Slight differences in PFC were recorded in the final measurement of this parameter, compared with the measurements taken at the initiation of the study.

However, the mangrove communities had not perceptibly altered in structure since the initial measurements. The change in PFC values could be the result of measurement error, actual increases in foliage cover (which probably does fluctuate through different seasons of the year) or a combination of both.

The range in canopy heights recorded at the end of the study were consistent with those recorded at the study initiation.

6.0 OVERVIEW AND RECOMMENDATIONS

The study provides the Port of Brisbane Authority with a baseline data set on mangrove productivity that is one of the longest running data sets on litterfall production for mangroves in Moreton Bay.

It provides information on the quantity, rate and seasonality of mangrove litterfall. This will be useful for:

- comparison with future mangrove productivity monitoring studies
- comparing the productivity of mangrove communities at the study site to communities elsewhere
- providing input for nutrient budget studies on mangrove ecosystems
- examining long-term responses to changing conditions in the surrounding environment
- timing of seed collections for mangrove rehabilitation works

It is recommended that future monitoring be instigated after the port expansion is completed. Monitoring could include:

- litterfall collections (for 1 year, every 4 to 5 years)
- aerial photography (annually to monitor the health of the canopy, and changes in the mangrove community boundary)

7.0 REFERENCES

Boto, K.G., 1983, Nutrient Status and Other Soil Factors Affecting Mangrove Productivity in North-east Australia. Wetlands 3(1), 45-50

Bunt, J.S. 1982, Studies of Mangrove Litterfall in Tropical Australia. In 'Mangrove Ecosystems in Australia - Structure, Function and Management', Editor B.F. Clough, pp. 223-39. Published by AIMS with ANU Press.

Carron L.T., 1968, An Outline of Forest Mensuration with Special Reference to Australia. Australian National University Press, Canberra.

Clough, B.F. and Attiwill, 1982, Primary Productivity of Mangroves. In 'Mangrove Ecosystems in Australia - Structure, Function and Management'. (Ed.) B.F. Clough. pp. 193-210. Published by AIMS with ANU Press. Pub.

Davie, J.D.S., 1984, Structural Variation, Litter Production and Nutrient Status of Mangrove Vegetation in Moreton Bay. In 'Focus on Stradbroke; New Information on North Stradbroke Island and Surrounding Areas, 1974-84'. Papers Prepared for Royal Society of Queensland Symposium, Point Lookout, North Stradbroke Island, 11-12 August, 1984, R.J. Coleman, J.C. Covacevich and P. Davie (editors). Boolarong Publications, Brisbane, pp. 208-223.

DEH, 1992, Moreton Bay Strategic Plan. Queensland Department of Environment and Heritage.

Hutchings, P. and Saenger, P., 1987, Ecology of Mangroves. University of Queensland Press.

Hyland, S.J. and Butler, C.T., 1988, The Distribution and Modification of Mangroves and Saltmarsh-claypans in Southern Queensland. Queensland Department of Primary Industries, Information Series QJ89010.

PBA, 1992, Key Port Brisbane Strategic Plan to 2005 and Beyond. Port of Brisbane Authority, October 1992.

Saenger P. and Moverley J. 1985. 'Vegetative phenology of mangroves along the Queensland coastline'. Proc. Ecol. Soc. Aust. 13:25 7-65.

Specht, R.L., 1970, Vegetation. In 'The Australian Environment'. (Ed.) G.W. Leeper. Fourth Edition. Melbourne, CSIRO and Melbourne University Press, pp. 44-64.

SPSS Inc., 1988, SPSS/PC+ Statistical Package for the Social Sciences. 444N Michigan Ave, Chicago, Illinois.

WBM Oceanics Australia, 1992, Fisherman Islands, Tidal Wetlands Study. Report prepared for Port of Brisbane Authority by WBM Oceanics Australia

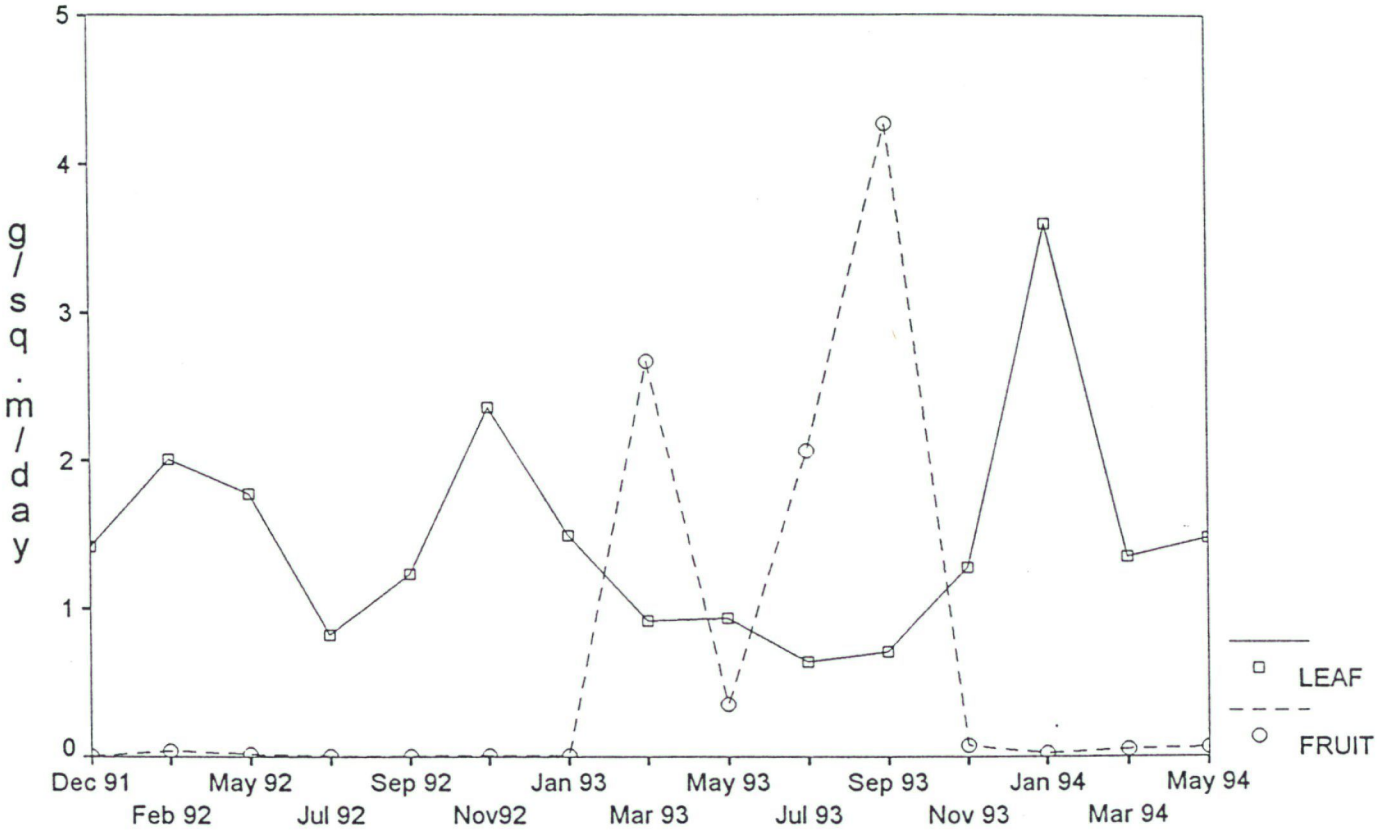
WBM Oceanics Australia, 1993, Mangrove Productivity Monitoring Study. Report prepared for Port of Brisbane Authority by WBM Oceanics Australia.

APPENDIX A

Seasonal Leaf Litterfall Graphs
For Sites 4, 5 and 6

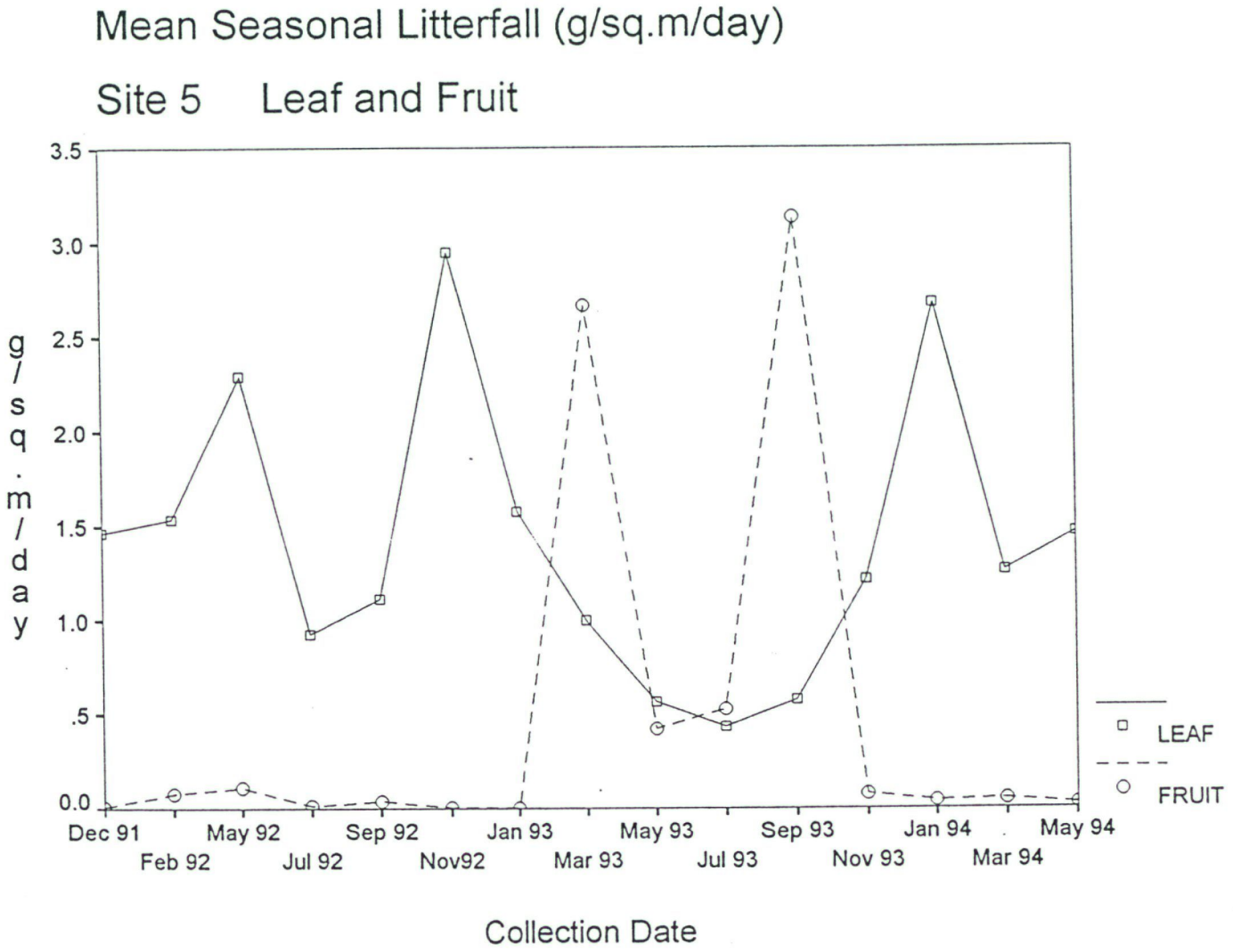
Mean Seasonal Litterfall (g/sq.m/day)

Site 4 Leaf and Fruit



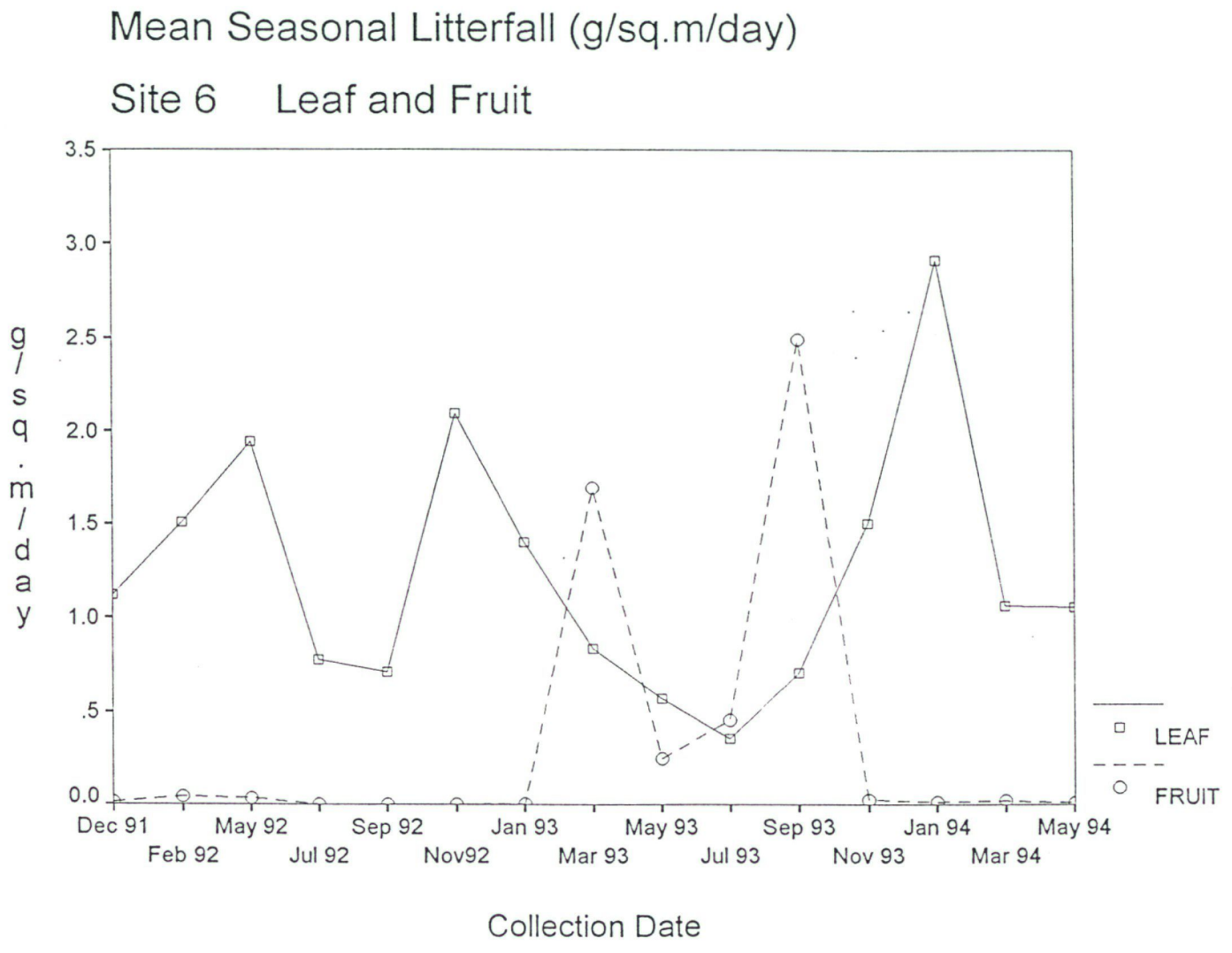
FIGURE

Seasonal Pattern of Leaf and Fruit Litterfall, Site 4 A.1



FIGURE

Seasonal Pattern of Leaf and Fruit Litterfall, Site 5 A.2



FIGURE

Seasonal Pattern of Leaf and Fruit Litterfall, Site 6 A.3