

**Wave data recording program**

**Mackay region**

**For the years 1975 - 1996**



QUEENSLAND GOVERNMENT

**Department of  
Environment and Heritage**

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# Wave data recording program Mackay region For the years 1975–1996

## Abstract

This report provides summaries of primary analyses of wave data recorded in water depths of approximately 25m, offshore near Mackay, north Queensland. Data were recorded using a Datawell waverider buoy, and covers the period from 19 September 1975 to 31 October 1996. The data were divided into seasonal groupings for analysis. No estimations of wave direction data have been provided.

This report has been prepared by the Coastal Management Branch, Department of Environment and Heritage on behalf of the Beach Protection Authority.

## Disclaimer

While reasonable care and attention have been exercised in the collection, processing and compilation of the wave data included in this report, the accuracy and reliability of this information is not guaranteed by the Beach Protection Authority. Neither the Queensland Government nor the Authority accepts liability for any decision or actions taken on the basis of this report.

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## 1 Introduction

The Beach Protection Authority, as part of its long-term data collection program, has maintained a network of wave recording stations along the Queensland coast since 1968.

This report summarises the primary analyses of wave data collected at the Mackay station. It also provides brief details of the recording equipment, the methods of handling raw data and the type of analyses employed.

## 2 Recording equipment

The Beach Protection Authority's wave recording program utilises either of two systems to measure wave data — the waverider buoy or the wave pole system.

### 2.1 Waverider system

The waverider system manufactured by Datawell bv of the Netherlands, uses a buoy to measure the sea surface fluctuations at an offshore location. Both directional and non-directional buoys are presently in operation with the Beach Protection Authority.

Both the directional and non-directional Waverider buoys measure vertical acceleration by means of an accelerometer, mounted on a gravity stabilised platform suspended in a fluid filled plastic sphere located at the bottom of the buoy. The vertical accelerations are then twice integrated to give vertical displacement.

The directional buoy also measures acceleration in the horizontal plane using two additional accelerometers fixed at perpendicular axes. After conversion of these accelerations to horizontal displacements, the direction of the buoy movement is derived by a transformation to north-south and east-west using a bearing from the on-board fluxgate compass.

The vertical buoy displacement, representing the instantaneous water level, and directional data (if present) are then transmitted to the recording station as a frequency modulated high frequency radio signal.

### 2.2 Wave pole system

The wave pole system, manufactured by the Queensland Government Hydraulics Laboratory, consists of a single perforated metal pipe surrounding an inner metal pipe, which acts as a coaxial transmission line to the water, with an enclosed circuit board housing containing an electronic oscillator mounted on the top. This system is mounted vertically on a suitable offshore structure.

Relative wave height measurements are taken based on the principle that a sharp change in the electrical impedance of the wave pole occurs at the fluctuating water surface and the period of oscillation is linearly proportional to the length of the wave pole that is not immersed in water.

Water surface elevations are recorded at the wave pole and are transferred via radio modem to a remote data recording computer.

### 2.3 Station configuration

In the original configuration of the Mackay station, first installed on 19 September 1975, the shore station consisted of a WAREP waverider receiver and an ANMA analogue recording unit. The WAREP receiver controlled the timing of data recording and provided a paper chart of the water level signal.

On 11 March 1985, the ANMA analogue recorder was replaced with a DIMA digital recording unit. Wave data were recorded by the DIMA unit in 20 minute bursts and digitised at 0.5 second intervals (2.0Hz). The data were recorded on digital cassettes and, with the paper charts, transferred to the Brisbane office for processing.

On 7 March 1993, the wave recording system was upgraded to a PC-based system utilising the Datawell DIWAR Waverider receiver/digitiser. The water level data, digitised at 0.39 second intervals (2.56Hz), is recorded in bursts of 4096 points (approximately 26 minutes) and recorded on the PC hard disk.

The Mackay wave recording station was upgraded to a directional waverider system on 7 April 1995. This installation comprises a PC-based system utilising the Datawell WAREC waverider receiver/digitiser. The water level data, digitised at 0.78 second intervals (1.28Hz), is recorded in bursts of 2048 points (approximately 26 minutes) and recorded on the PC hard disk.

The proprietary software running on the PC controls the timing of data recording and processes the data in 'near real time' to provide a set of standard sea-state parameters and spectra that may be accessed remotely via the telephone network. Recorded data and analysis results are downloaded daily to a central computer system in Brisbane for checking, further processing and archiving.

Further information on the operation of the Waverider buoy and the recording systems may be obtained from the sources listed in section 7 of this report.

### 2.4 Laboratory calibration checks

Waverider buoys used by the Beach Protection Authority are calibrated before deployment and after recovery. Normally, a buoy is calibrated once every twelve months. Calibration is performed at the Queensland Government Hydraulics Laboratory using a buoy calibrator to simulate sinusoidal waves with amplitudes of either 2m or 2.8m depending on whether a 0.6m or 0.9m diameter buoy is involved. The calibrator is electrically controlled and the frequency may be varied from 0.016–0.25Hz. It is usual to check three frequencies during a calibration. The following characteristics of the buoy are also checked during the calibration procedure:

- compass (directional buoy)
- phase and amplitude response
- accelerometer platform stability
- platform tilt
- battery capacity
- power output

No adjustment to the recorded wave data in this report due to the laboratory calibration results is done in any way.

## 3 Wave recording and analysis procedures

From 19 September 1975 to 24 January 1982, wave data were recorded twice daily. Each record was of 20 minutes duration, with the timing of recordings set at 0300 and 1500 hours AEST (Australian Eastern Standard Time).

Over the period 25 January 1982 to 6 March 1993, wave data were recorded four times per day at 0300, 0900, 1500 and 2100 hours AEST. During storm events, the recording frequency may have been manually switched by the operator to record eight times per day.

Since 7 March 1993, the PC-based recording system has recorded data at (nominally) hourly intervals. Recorded non-directional wave data are analysed in the time domain by the zero upcrossing method and in the frequency domain by spectral analysis. Spectral analysis of the WAREP/DIMA data was performed by the auto-correlation method providing 50 lags at a spacing of 0.2Hz.

The PC-based non-directional data analysis uses Fast Fourier Transform techniques to give 128 spectral estimates in bands of 0.01Hz.

The directional wave data undergoes initial processing on the buoy, where the datasets are divided into data subsets and each subset is analysed using Fast Fourier Transform techniques. The output from this processing is then transmitted to the shore station where it undergoes further analysis using Fast Fourier Transform techniques to produce 128 spectral estimates in bands of 0.005Hz.

The zero upcrossing analysis is equivalent in both systems.

Wave parameters resulting from this processing include the following:

- S(f) Energy density spectrum Hsig Significant wave height (time domain) — the average of the highest one-third of waves in the record Hmax The highest individual wave in the record (time domain)
- Hrms The root mean square of the wave heights in the record (time domain)
- Tsig Significant wave period (time domain) — the average period of the highest one-third of waves in the record
- Tz The average period of all zero upcrossing waves in the record (time domain)
- Tp The wave period corresponding to the peak of the energy density spectrum (frequency domain)
- Tc The average period of all waves in the record based on successive crests (time domain)

These parameters form the basis for the appendices and tables attached to this report.

## 4 Data losses

Data losses can be divided into two categories — losses due to equipment failure and losses during data processing due to signal corruption. Common causes of data corruption include radio interference and a spurious low frequency component in the water level signal caused by a tilting accelerometer platform in the waverider buoy.

Analysis of data recorded by both the WAREP/DIMA and the PC-based systems includes some data rejection checks. In the case of the WAREP/DIMA data, the length of the record may be shortened to exclude corrupt data points. In the PC-based analysis, a small number of spurious data points may be corrected by an interpolation procedure, otherwise the entire series is rejected.

Details of data losses for the Mackay wave recording station are included in Appendix 1 — Details of wave recorder installation.

### 4.1 Station closures

The Mackay Waverider buoy and recording station were decommissioned on 5 November 1976 and remained inactive until 24 November 1977.

During this period, the following tropical cyclones may have exerted an influence on the Mackay waves:

- Keith — January 1977
- Otto — March 1977

## 5 Wave climate

The wave climate data presented in this report are based on statistical analyses of the parameters obtained from the recorded wave data.

Programs developed by the Beach Protection Authority provide statistical information on percentage of time occurrence and exceedance for wave heights and periods. The results of these analyses are presented in tables 1 to 6 and figures 2, 3 and 4. In addition, similar analyses are carried out on the relationships between the various wave parameters. These are presented in figure 5.

## 5.1 Methodology

As discussed above, the various sources of data losses can cause occasional gaps in the data record. Gaps may be relatively short, caused by rejection of data records, or much longer if caused by malfunction of the waverider buoy or the recording equipment.

In the calculation of wave climate statistics, each record is assigned a total duration equal to half the recording interval on either side of that record. The duration on the side of records adjacent to gaps in the data are limited to a maximum value dependent on the nominal recording interval of that record.

During the period when two records per day were taken, the nominal recording interval was 12 hours. The maximum allowable total duration of a record is equal to the nominal recording interval of 12 hours, with a small tolerance (30 minutes) to account for timing errors. Each duration on either side of a record greater than a nominal six hours (half the maximum allowable total duration), plus the tolerance, is set to the maximum allowable of exactly six hours, and a gap in the data is reported.

During the period when four records per day were taken, the nominal recording interval was six hours. The maximum allowable total duration of a record is equal to the nominal recording interval of six hours, with a small tolerance (30 minutes) to account for timing errors. Each duration on either side of a record greater than a nominal three hours (half the maximum allowable total duration), plus the tolerance, is set to the maximum allowable of exactly three hours, and a gap in the data is reported.

During the period when the nominal recording interval was one hour, the maximum allowable total duration of a record is equal to three hours. Each duration on either side of a record greater than 90 minutes (half the maximum allowable total duration) is set to the maximum allowable of exactly 90 minutes, and a gap in the data is reported.

## 6 Data presentation

No attempt has been made to interpret the recorded data for design purposes or to apply corrections for refraction, diffraction and shoaling to obtain equivalent deep water waves. Before any use is made of this data, it is therefore necessary to note the exact location of the buoy and the water depth in which the buoy was moored. These data are shown on Appendix 1 — Details of wave recorder installation. The non-directional waverider recording system that is utilised by the Beach Protection Authority is designed to record vertical movements of the water surface only and any wave directions must be assigned to the individual wave records by other means. The directional waverider system provides both vertical water surface and directional data.

Although a directional waverider buoy was installed at Mackay in April 1995, the data presented in this report does not include any information on wave directions as it is considered that the data sampling period is too short to provide any meaningful base data.

Whenever major meteorological events such as cyclones have occurred during the recording period, these have been noted and are summarised together with the maximum wave height recorded and any other relevant comments in Appendix 2 — Major meteorological events.

Appendix 3 — Tropical cyclones of the east coast of Queensland, lists the names and dates of all cyclones which occurred during the recording period of this report.

For the purposes of analysis, summer has been taken as the period from 1 November to 30 April of the following year. Winter covers the period 1 May to 31 October in any one year.

## 7 References

- Permanent International Association of Navigation Congresses (1986), *List of Sea State Parameters*  
Datawell, *Operation and Service Manual for the Non-directional Waverider*, (1994)  
Datawell, *Manual of Waverider Receiver type WAREP-mark II*, (1976)  
Datawell, *Manual of the Digital Waverider Receiver type DIWAR*, (1990)  
Datawell, *Manual for Analogue Magnetic Recorder (ANMA)*, (1973)  
Datawell, *Manual of the Digital Magnetic Tape Recorder type DIMA-mark II*, (1979)  
Datawell, *Operations and Service Manual for Directional Waverider from serial no. 30109*, (1991)  
Lawson and Treloar Pty Ltd (1991), *Real Time Wave Analysis Package*  
Bureau of Meteorology, *Monthly Weather Reviews*

## 8 Other reports in this series

- Wave data recording program, Cairns Region  
Report No. W01.1 — 2 May 1975 to 3 Sept 1978
- Wave data recording program, Cairns Region  
Report No. W01.2 — 2 May 1975 to 11 June 1985
- Wave data recording program, Mackay Region  
Report No. W02.1 — 17 Sept 1975 to 5 Nov 1976
- Wave data recording program, Mackay Region  
Report No. W02.2 — 17 Sept 1975 to 23 Aug 1985
- Wave data recording program, Townsville Region  
Report No. W03.1 — 16 July 1975 to 23 Feb 1979
- Wave data recording program, Townsville Region  
Report No. W03.2 — 19 Nov 1975 to 29 Dec 1987
- Wave data recording program, Sunshine Coast Region  
Report No. W04.1 — 5 Apr 1974 to 5 July 1977
- Wave data recording program, Burnett Heads Region  
Report No. W05.1 — 5 May 1976 to 5 Mar 1982
- Wave data recording program, Burnett Heads Region  
Report No. W05.2 — 5 May 1976 to 13 Oct 1988
- Wave data recording program, Abbot Point Region  
Report No. W06.1 — 6 May 1977 to 9 Aug 1979
- Wave data recording program, Weipa Region  
Report No. W07.1 — 21 Dec 1978 to 7 Apr 1983
- Wave data recording program, Gladstone Region  
Report No. W08.1 — 19 Dec 1979 to 16 May 1983
- Wave data recording program, Brisbane Region  
Report No. W09.1 — 30 Oct 1976 to 30 June 1983
- Wave data recording program, Brisbane Region  
Report No. W09.2 — 30 Oct 1976 to 30 June 1994
- Wave data recording program, Brisbane Region  
Report No. W09.3 — 30 Oct 1976 to 28 Feb 1997
- Wave data recording program, Bowen Region  
Report No. W10.1 — 14 Sept 1978 to 15 Nov 1984
- Wave data recording program, Moreton Island Region  
Report No. W11.1 — 15 June 1983 to 12 Apr 1985
- Wave data recording program, Bramston Beach Region  
Report No. W12.1 — 16 Dec 1981 to 28 Oct 1985
- Wave data recording program, Hay Point Region  
Report No. W13.1 — 22 Mar 1977 to 25 May 1987
- Wave data recording program, Gold Coast Region  
Report No. W14.1 — 20 Feb 1987 to 30 June 1994
- Wave data recording program, Gold Coast Region  
Report No. W14.2 — 20 Feb 1987 to 28 Feb 1997
- Wave data recording program, Kirra  
Report No. W15.1 — 25 Aug 1988 to 30 June 1994
- Wave data recording program, Kirra  
Report No. W15.2 — 25 Aug 1988 to 28 Feb 1997
- Wave data recording program, Repulse Bay  
Report No. W16.1 — 2 June 1994 to 22 Oct 1995
- Wave data recording program, Hayman Island  
Report No. W17.1 — 26 Oct 1995 to 14 Oct 1996
- Wave data recording program, Tweed Region  
Report No. W18.1 — 15 Jan 1995 to 28 Feb 1997

## Appendix 1 Details of wave recorder installation

### Buoy locations

See figure 1 for the locality plan of the waverider buoys and receiving stations for the period of this report.  
All water depths are accurate to  $\pm 1$ m.

Co-ordinates: 149° 31' 50"E, 21° 06' 50"S  
Description: 30 km, bearing 90° 17' from Mackay outer harbour.  
Water depth at buoy: 25m relative to Australian Height Datum.  
Period: 19 September 1975–5 November 1976

Co-ordinates: 149° 31' 48"E, 21° 03' 54"S  
Description: 33 km, bearing 80° 20' from Mackay outer harbor.  
Water depth at buoy: 28m relative to Australian Height Datum.  
Period: 24 November 1977–23 August 1985

Co-ordinates: 149° 32' 35"E, 21° 02' 50"S  
Description: 33 km, bearing 77° 25' from Mackay outer harbor.  
Water depth at buoy: 25m relative to Australian Height Datum.  
Period: 24 August 1985–22 May 1988

Co-ordinates: 149° 32' 25"E, 21° 02' 34"S  
Description: 33 km, bearing 76° 28' from Mackay outer harbor.  
Water depth at buoy: 25m relative to Australian Height Datum.  
Period: 23 May 1988–23 June 1991

Co-ordinates: 149° 32' 11"E, 21° 02' 49"S  
Description: 32km, bearing 77° 05' from Mackay outer harbour.  
Water depth at buoy: 25m relative to Australian Height Datum.  
Period: 24 June 1991–03 August 1992.

**Note:** the above buoy locations were calculated using radar ranging and compass bearings to prominent landmarks

Co-ordinates: 149° 32' 01"E, 21° 02' 48"S  
Description: 32km, bearing 76° 54' from Mackay outer harbour.  
Water depth at buoy: 25m relative to Australian Height Datum.  
Period: 4 August 1992–8 June 1993.

Co-ordinates: 149° 33' 15"E, 21° 02' 47"S  
Description: 34 km, bearing 77° 53' from Mackay outer harbour.  
Water depth at buoy: 25m relative to Australian Height Datum.  
Period: 9 June 1993–22 November 1993

Co-ordinates: 149° 33' 12"E, 21° 02' 48"S  
Description: 34km, bearing 77° 44' from Mackay outer harbour.  
Water depth at buoy: 25m relative to Australian Height Datum.  
Period: 23 November 1993–22 November 1994.

Co-ordinates: 149° 32' 00"E, 21° 02' 48"S  
Description: 32km, bearing 76° 53' from Mackay outer harbour.  
Water depth at buoy: 25m relative to Australian Height Datum.  
Period: 23 November 1994–6 April 1995.

Co-ordinates: 149° 32' 12"E, 21° 02' 37"S  
Description: 32km, bearing 76° 28' from Mackay outer harbour.  
Water depth at buoy: 25m relative to Australian Height Datum.  
Period: 7 April 1995–31 October 1996  
(directional waverider buoy).

**Note:** the above buoy locations were measured using GPS fixing procedures.

### Location of recording station

East of Mount Bassett near Mackay outer harbour.  
Period: 17 September 1975–3 March 1993  
Co-ordinates: 149° 13' 04"E, 21° 07' 09"S

Slade Point water tower.  
Period: 4 March 1993–27 February 1995  
Co-ordinates: 149° 13' 28"E, 21° 04' 06"S

Bureau of Meteorology, Mount Bassett.  
Period: 28 February 1995–20 November 1995  
Co-ordinates: 149° 12' 58"E, 21° 07' 10"S

Slade Point water tower.  
Period: 21 November 1995–31 October 1996  
Co-ordinates: 149° 13' 28" E, 21° 04' 06"S

### Recording intervals

Two, twenty minute records daily at 0300 and 1500 hours between 19 September 1975 and 24 January 1982.

Four, twenty minute records daily at 0300, 0900, 1500 and 2100 hours between 25 January 1982 and 6 March 1993.

Commencing on 7 March 1993, one hourly samples, each of approximately 26 minutes were taken, giving 4096 water surface elevation measurements for that period. Sea state parameters are calculated and recorded from this data.

During storm events, where the Hsig value exceeds 2m, the frequency of recording is increased to half-hourly intervals.

### Data collection and analysis

Number of records used in analysis:	45 254
Maximum possible analysis days:	7 714
Number of days used in analysis:	5 887
Number of days lost:	1 827

Periods during which four recordings per day were taken:  
31 January 1978–2 February 1978  
23 February 1980  
25 January 1982–7 March 1993

Periods during which eight recordings per day were taken:  
14 March 1992–17 March 1992  
18 August 1992–20 August 1992  
26 August 1992–31 August 1992

**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure  (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded  Notes (1) (metres)	Maximum Hmax recorded  Notes (2) (metres)	Tp  Notes (3) (secs)
High pressure system over Tasman Sea	1024	18-11-75		2.55	3.95	6.99
High pressure system off New South Wales coast	1020	28-11-75		2.03	3.24	6.03
High pressure system over Tasman Sea	1028	27-12-75		2.20	3.34	6.77
Cyclone David	965	19-1-76	300 ESE	2.90	4.39	11.92
Cyclone Alan	994	1-2-76	470 N	#	#	#
Cyclone Beth	993	16-2-76	600 N	2.47	4.53	7.03
Low pressure system over Coral Sea	996	12-3-76		2.14	3.31	6.78
Low pressure system off north Queensland coast	1000	11-4-76		2.37	3.79	6.81
Cyclone Watorea	970	27-4-76	420 NNW	#	#	#
High pressure system over Victoria	1022	12-6-76		2.09	3.56	6.90
High pressure system over South Australia	1032	17-7-76		2.15	3.99	6.80
Cyclone Keith	1002	1-2-77	180 NNW	#	#	#
Cyclone Otto	987	9-3-77	200 NNW	#	#	#
Low pressure system off north Queensland coast	1000	1-2-78		2.58	4.91	6.63
Low pressure system off north Queensland coast	1000	3-2-78		2.66	4.49	7.09
Low pressure system over Coral Sea	1004	1-3-78		2.21	3.73	6.89
High pressure system over Victoria	1032	24-8-78		2.22	3.59	6.89

**Appendix 2**  
**Major meteorological events**  
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Meteorological event	Central pressure  (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded  Notes (1) (metres)	Maximum Hmax recorded  Notes (2) (metres)	Tp  Notes (3) (secs)
High pressure system off Queensland coast	1028	10-10-78		2.78	5.64	7.12
Cyclone Gordon	1000	12-1-79	100 N	3.56	5.61	8.17
High pressure system over Tasman Sea and low pressure system off north Queensland coast	1020 1004	29-1-79		2.82	4.66	7.64
Cyclone Kerry	992	1-3-79 5-3-79	100 NE	4.02 2.24	5.91 3.68	9.19 7.51
High pressure system over Tasman Sea	1020	10-3-79		2.31	3.58	7.02
High pressure system off New South Wales coast	1036	16-7-79		2.11	4.32	6.70
High pressure system over Tasman Sea	1020	29-12-79		2.30	4.13	7.14
Cyclone Ruth	983	14-2-80	670 E	2.44	4.59	7.01
High pressure system over Tasman Sea	1024	13-3-80		2.11	3.97	6.39
High pressure system off New South Wales coast	1020	22-3-80		2.38	3.99	7.08
High pressure system over Tasmania	1028	9-4-80		2.01	3.26	6.71
High pressure system over New South Wales	1020	23-5-80		2.04	3.66	6.02
High pressure system over New South Wales	1032	22-6-80		2.02	3.69	6.42
High pressure system over South Australia	1036	16-8-80		2.15	3.58	6.80
High pressure system over Tasman Sea	1028	8-12-80		2.19	3.45	7.20



**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded Notes (1) (metres)	Maximum Hmax recorded Notes (2) (metres)	Tp Notes (3) (secs)
Cyclone Freda	990	27-2-81	450 NNW	2.73	5.33	7.29
High pressure system over southern Australia	1032	16-5-81		2.19	3.75	6.76
High pressure system over Victoria	1032	16-7-81		1.97	3.53	7.26
High pressure system over Victoria	1032	8-9-81		2.09	3.24	6.41
High pressure system over New South Wales coast	1024	6-10-81		2.36	3.78	6.70
Cyclone Abigail	982	28-1-82	500 E	2.41	3.99	7.71
High pressure system over Tasman Sea	1024	7-2-82		2.60	4.81	7.77
High pressure system over Tasman Sea	1028	16-3-82		2.70	4.91	7.44
Cyclone Bernie	996	6-4-82	1000 E	2.21	3.61	7.07
Cyclone Dominic	997	10-4-82	640 NNE	2.36	4.34	6.66
High pressure system over Victoria	1032	16-5-82		2.36	3.93	6.61
High pressure system over Tasmania	1036	4-6-82		2.08	3.43	6.73
High pressure system over southern Australia	1028	7-8-82		2.11	3.99	6.68
High pressure system over Tasman Sea	1036	20-8-82		2.52	4.55	7.37
High pressure system over southern New South Wales	1028	3-11-82		2.09	3.72	7.29
High pressure system over south-eastern Australia	1028	12-11-82		2.29	3.54	6.19

**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure  (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded  Notes (1) (metres)	Maximum Hmax recorded  Notes (2) (metres)	Tp  Notes (3) (secs)
High pressure system over Tasman Sea	1024	23-12-82		2.95	4.91	7.37
Cyclone Des	997	20-1-83	400 ENE	2.14	3.91	7.17
Cyclone Elinore	981	17-2-83	120 E	#	#	#
High pressure system over southern New South Wales	1028	20-4-83		2.04	3.72	6.75
High pressure system off New South Wales Coast	1032	12-5-83		2.76	4.42	7.33
High pressure system off Victorian Coast	1036	17-5-83		2.54	3.67	7.18
High pressure system over South Australia	1032	21-7-83		2.00	3.22	7.29
High pressure system over southern New South Wales	1032	5-8-83		2.08	3.49	6.52
High pressure system over southern New South Wales	1036	14-8-83		2.19	3.91	7.00
High pressure system over Victoria	1028	26-9-83		2.28	3.25	6.95
High pressure system over Tasman Sea	1024	22-11-83		2.05	3.98	6.30
High pressure system over Tasmania	1024	13-12-83		2.05	3.33	6.63
High pressure system over south-eastern Australia and low pressure system off north Queensland coast	1020 1004	2-2-84		2.65	4.34	7.38

**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded Notes (1) (metres)	Maximum Hmax recorded Notes (2) (metres)	Tp Notes (3) (secs)
Cyclone Ingrid	996	22-2-84	370 NE	1.99	2.89	6.29
Cyclone Lance	996	5-4-84	480 NE	2.43	5.49	7.02
High pressure system over South Australia	1028	30-4-84		2.20	4.34	7.10
High pressure system over south-eastern Australia	1032	21-5-84		2.46	4.19	7.21
High pressure system over Victoria	1036	11-6-84		2.16	3.55	9.71
High pressure system over Tasman Sea	1028	26-7-84		2.19	2.79	5.38
High pressure system over New South Wales coast	1028	16-11-84		2.55	4.46	6.85
High pressure system over Tasman Sea	1028	25-11-84		2.41	5.09	6.52
Cyclone Pierre	985	21-2-85	160 N	#	#	#
Cyclone Tanya	982	31-3-85	650 NNE	2.49	4.24	7.97
High pressure system over Tasman Sea	1036	12-5-85		2.67	4.31	6.94
High pressure system over South Australia	1032	20-5-85		2.07	3.78	6.31
High pressure system over Tasmania	1024	16-6-85		2.10	3.05	6.95
High pressure system over Victoria	1032	25-7-85		2.16	3.05	7.17

**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure  (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded  Notes (1) (metres)	Maximum Hmax recorded  Notes (2) (metres)	Tp  Notes (3) (secs)
Cyclone Vernon	996	23-1-86	380 NE	2.29	4.14	7.39
High pressure system over Tasman Sea	1024	28-1-86		2.41	4.08	7.45
Cyclone Winifred	996	30-1-86	750 NNW	2.19	4.08	6.97
High pressure system over Tasman Sea	1024	18-3-86		2.10	3.25	6.95
High pressure system over Tasman Sea	1024	23-3-86		2.14	3.96	6.40
High pressure system over Tasman Sea	1028	14-4-86		2.03	3.39	6.56
High pressure system over South Australia	1032	4-5-86		2.35	3.77	6.78
High pressure system over South Australia	1032	31-5-86		2.11	3.53	6.58
High pressure system over Tasman Sea	1024	4-12-86		2.24	4.16	7.05
High pressure system over Victoria	1028	10-3-87		2.27	4.83	7.01
High pressure system over Victoria	1028	1-4-87		2.06	4.17	6.65
High pressure system over Tasman Sea	1028	5-4-87		2.15	4.65	6.75
Cyclone Blanch	990	24-5-87	600 NE	2.05	3.32	6.93
High pressure system over Tasmania	1040	6-6-87		2.29	4.34	6.80
High pressure system over Tasmania	1036	16-6-87		2.15	4.29	6.78
High pressure system over New South Wales	1040	8-7-87		2.99	5.31	7.48

**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded Notes (1) (metres)	Maximum Hmax recorded Notes (2) (metres)	Ip Notes (3) (secs)
Cyclone Ingrid	996	22-2-84	370 NE	1.99	2.89	6.29
Cyclone Lance	996	5-4-84	480 NE	2.43	5.49	7.02
High pressure system over South Australia	1028	30-4-84		2.20	4.34	7.10
High pressure system over south-eastern Australia	1032	21-5-84		2.46	4.19	7.21
High pressure system over Victoria	1036	11-6-84		2.16	3.55	9.71
High pressure system over Tasman Sea	1028	26-7-84		2.19	2.79	5.38
High pressure system over New South Wales coast	1028	16-11-84		2.55	4.46	6.85
High pressure system over Tasman Sea	1028	25-11-84		2.41	5.09	6.52
Cyclone Pierre	985	21-2-85	160 N	#	#	#
Cyclone Tanya	982	31-3-85	650 NNE	2.49	4.24	7.97
High pressure system over Tasman Sea	1036	12-5-85		2.67	4.31	6.94
High pressure system over South Australia	1032	20-5-85		2.07	3.78	6.31
High pressure system over Tasmania	1024	16-6-85		2.10	3.05	6.95
High pressure system over Victoria	1032	25-7-85		2.16	3.05	7.17

**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure  (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded  Notes (1) (metres)	Maximum Hmax recorded  Notes (2) (metres)	Tp  Notes (3) (secs)
Cyclone Vernon	996	23-1-86	380 NE	2.29	4.14	7.39
High pressure system over Tasman Sea	1024	28-1-86		2.41	4.08	7.45
Cyclone Winifred	996	30-1-86	750 NNW	2.19	4.08	6.97
High pressure system over Tasman Sea	1024	18-3-86		2.10	3.25	6.95
High pressure system over Tasman Sea	1024	23-3-86		2.14	3.96	6.40
High pressure system over Tasman Sea	1028	14-4-86		2.03	3.39	6.56
High pressure system over South Australia	1032	4-5-86		2.35	3.77	6.78
High pressure system over South Australia	1032	31-5-86		2.11	3.53	6.58
High pressure system over Tasman Sea	1024	4-12-86		2.24	4.16	7.05
High pressure system over Victoria	1028	10-3-87		2.27	4.83	7.01
High pressure system over Victoria	1028	1-4-87		2.06	4.17	6.65
High pressure system over Tasman Sea	1028	5-4-87		2.15	4.65	6.75
Cyclone Blanch	990	24-5-87	600 NE	2.05	3.32	6.93
High pressure system over Tasmania	1040	6-6-87		2.29	4.34	6.80
High pressure system over Tasmania	1036	16-6-87		2.15	4.29	6.78
High pressure system over New South Wales	1040	8-7-87		2.99	5.31	7.48

**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded Notes (1) (metres)	Maximum Hmax recorded Notes (2) (metres)	Tp Notes (3) (secs)
High pressure system over Tasman Sea	1020	4-2-88		2.15	4.04	6.82
Low pressure system off north Queensland	1004	17-2-88		2.75	3.93	7.40
Cyclone Charlie	990	28-2-88	250 NE	2.74	4.34	7.49
High pressure system over Tasman Sea	1032	22-3-88		2.42	4.51	7.23
High pressure system over Tasman Sea	1024	14-4-88		2.01	3.33	6.41
High pressure system over New South Wales	1028	12-5-88		2.78	5.17	7.27
High pressure system over Tasman Sea	1032	31-5-88		2.12	3.84	6.86
High pressure system over Tasman Sea	1036	2-6-88		2.61	3.99	6.57
High pressure system over New South Wales	1036	26-6-88		2.71	4.83	7.02
High pressure system over Tasman Sea	1036	4-7-88		2.55	5.23	8.72
High pressure system over Tasman Sea	1036	12-8-88		2.47	4.34	6.68
High pressure system over Tasman Sea and low off Queensland coast	1028 1000	7-11-88		2.52	3.90	7.19
High pressure system over Tasman Sea	1028	12-11-88		3.11	5.06	7.99

**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded Notes (1) (metres)	Maximum Hmax recorded Notes (2) (metres)	Tp Notes (3) (secs)
High pressure system over Victoria	1024	13-12-88		3.15	5.42	7.97
Low pressure system off north Queensland coast	1000	31-12-88		2.58	4.53	7.04
High pressure system over Tasman Sea	1024	15-1-89		2.91	5.17	7.54
High pressure system over Tasman Sea	1028	25-1-89		2.48	4.60	6.86
Cyclone Harry	984	15-2-89	800 E	2.12	3.88	6.67
High pressure system over Tasman Sea	1024	24-2-89		2.04	3.67	6.77
High pressure system over Tasman Sea	1028	4-3-89		2.70	4.49	7.31
Cyclone Aivu	996	4-4-89	240 NW	3.51	5.57	7.55
High pressure system over Tasman Sea	1024	21-11-89		2.78	4.78	7.41
High pressure system off New South Wales and low off north Queensland coast	1020 1000	16-12-89		3.34	5.36	8.02
Cyclone Nancy	992	1-2-90	800 SE	#	#	#
High pressure system over Great Australian Bight	1028	27-2-90		2.07	3.70	6.71
Cyclone Hilda	992	5-3-90	600 ENE	2.36	3.99	6.95
Cyclone Ivor	992	17-3-90	760 N	#	#	#
High pressure system over New South Wales	1024	1-5-90		2.09	5.03	6.35
Cyclone Joy	990	27-12-90	250 NNE	3.88	6.41	7.78



**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure  (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded  Notes (1) (metres)	Maximum Hmax recorded  Notes (2) (metres)	Tp  Notes (3) (secs)
High pressure system over Tasman Sea	1020	9-1-91		2.19	3.43	7.64
High pressure system over Victoria and low pressure system off north Queensland coast	1020 1004	1-2-91		2.35	4.51	6.93
Cyclone Kelvin	985	26-2-91	390 N	2.77	4.51	7.25
High pressure system off south Queensland	1024	23-11-91		2.26	3.60	6.57
High pressure system west of Tasmania and low pressure system east of Tasmania	1028 996	14-2-92		2.31	4.58	7.10
High pressure system over Tasman Sea	1028	28-2-92		3.14	5.47	7.37
Cyclone Fran	985	15-3-92	210 SSE	2.56	4.84	9.75
High pressure system over Tasman Sea	1036	3-4-92		2.91	4.86	7.00
High pressure system over Tasman Sea	1032	30-5-92		2.25	3.89	6.48
High pressure system over south-east Australia	1028	13-10-92		2.56	3.77	6.49
High pressure system over Tasman Sea	1024	21-12-92		2.35	3.85	6.81
Cyclone Oliver	965	9-2-93	250 NE	2.41	4.13	7.71
Cyclone Roger	985	14-3-93	760 NE	2.74	5.90	7.24
High pressure system over Tasman Sea	1028	24-3-93		2.04	3.41	6.00
High pressure system over Victoria	1028	10-4-93		2.82	5.32	7.63

**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded Notes (1) (metres)	Maximum Hmax recorded Notes (2) (metres)	Tp Notes (3) (secs)
High pressure system over New South Wales	1028	20-4-93		2.59	4.61	7.39
High pressure system over Victoria	1032	19-5-93		2.09	3.80	6.14
High pressure system over southern Australia	1032	15-6-93		2.06	4.63	6.60
High pressure system over Tasman Sea	1032	30-6-93		2.93	5.90	7.60
High pressure system over Victoria	1032	4-9-93		2.01	4.87	7.42
High pressure system over Victoria	1020	24-9-93		2.26	3.61	7.42
High pressure system off New South Wales coast	1028	27-9-93		2.02	4.15	6.78
High pressure system over southern Australia	1028	13-10-93		2.64	4.59	7.26
High pressure system over Tasman Sea	1024	26-11-93		2.15	4.28	6.85
High pressure system over Tasman Sea	1020	2-11-93		2.29	4.11	6.10
High pressure system over Tasman Sea	1004	10-12-93		2.76	5.84	7.86
Cyclone Rewa	992	19-1-94	980 NNE	2.87	6.20	8.76
High pressure system over Tasman Sea and low pressure system in Coral Sea	1020 1000	25-1-94		2.62	4.82	7.17
High pressure system over Tasman Sea	1024	8-2-94		2.18	3.56	6.46

**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure  (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded  Notes (1) (metres)	Maximum Hmax recorded  Notes (2) (metres)	Tp  Notes (3) (secs)
High pressure system over Tasman Sea	1024	21-2-94		2.80	5.21	7.18
High pressure system over Tasman Sea	1028	22-3-94		3.46	6.56	8.24
High pressure system over Tasman Sea	1028	16-4-94		2.26	3.96	5.84
High pressure system over New South Wales coast	1028	25-4-94		2.65	5.04	7.87
High pressure system over New South Wales	1028	7-7-94		2.45	4.89	8.01
High pressure system over Tasman Sea	1024	24-7-94		2.16	3.49	6.30
High pressure system over South Australia	1024	11-8-94		2.78	5.64	8.63
High pressure system off south Queensland coast	1028	3-9-94		2.06	4.01	6.58
High pressure system over Tasman Sea	1024	24-10-94		2.23	3.81	7.42
High pressure system over Tasman Sea	1024	6-12-94		2.61	5.14	6.88
High pressure system over Tasman Sea	1024	13-1-95		2.26	3.56	6.88
High pressure system over Tasman Sea	1028	23-1-95		2.65	4.75	7.41
High pressure system over Tasman Sea	1024	11-2-95		2.89	5.33	8.01
High pressure system over Tasman Sea	1024	25-2-95		3.03	5.41	7.48
Cyclone Violet	996	4-3-95	525 NE	2.06	3.49	6.82

**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure  (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded  Notes (1) (metres)	Maximum Hmax recorded  Notes (2) (metres)	Tp  Notes (3) (secs)
High pressure system over Tasman Sea	1020	11-3-95		2.39	4.26	7.70
High pressure system over southern Australia	1024	14-3-95		2.16	3.89	6.94
High pressure system off south Queensland coast	1020	17-3-95		2.09	3.71	6.58
High pressure system over Tasman Sea	1028	14.4.95		2.10	4.32	6.36
High pressure system over Tasman Sea	1028	28-4-95		2.26	3.84	6.99
High pressure system over Tasman Sea	1028	8-5-95		2.54	4.99	6.58
High pressure system over Great Australian Bight	1040	19-6-95		2.33	4.14	6.19
High pressure system over Victoria	1036	22-6-95		2.65	4.62	6.77
High pressure system over Great Australian Bight	1036	7-8-95		2.18	4.76	6.07
High pressure system off New South Wales coast	1032	17-8-95		2.55	5.14	7.33
High pressure system off south Queensland coast	1024	30-8-95		2.33	4.66	6.70
High pressure system off New South Wales coast	1024	10-10-95		2.56	5.18	7.08
High pressure system off New South Wales coast	1032	16-10-95		2.89	5.61	9.36

**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded Notes (1) (metres)	Maximum Hmax recorded Notes (2) (metres)	Tp Notes (3) (secs)
High pressure system over Tasman Sea	1032	13-11-95		2.13	4.26	6.13
High pressure system over southern Australia	1020	14-12-95		2.23	4.83	7.85
Low pressure system over central Queensland coast	996	9-1-96		2.19	4.07	6.81
High pressure system over Tasman Sea	1024	17-1-96		2.21	4.57	6.79
High pressure system over Tasmania	1032	23.2.96		3.20	5.64	7.90
High pressure system over Great Australian Bight	1020	1-3-96		2.07	3.63	6.38
High pressure system over Tasmania and low pressure system in Coral Sea	1020 1004	3-3-96		2.75	5.43	7.12
High pressure system over New South Wales	1024	23-3-96		2.76	5.76	7.13
High pressure system over South Australia	1028	22-4-96		2.71	5.59	7.85
High pressure system over South Australia	1028	29-4-96		2.65	6.16	8.13
High pressure system over southern Australia	1036	25-5-96		2.18	4.74	6.77
High pressure system over Tasman Sea	1032	3-6-96		2.08	3.63	6.60

**Appendix 2**  
**Major meteorological events**  
**Mackay region**

Meteorological event	Central pressure  (hPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded  Notes (1) (metres)	Maximum Hmax recorded  Notes (2) (metres)	Tp  Notes (3) (secs)
High pressure system over Tasmania	1032	13-6-96		2.37	5.06	7.01
High pressure system over northern New South Wales	1024	9-10-96		2.32	4.07	7.09
High pressure system over Tasman Sea	1032	24-10-96		2.73	6.03	7.32

# denotes records unavailable

**Notes**

The Hsig values presented in column 1 and the Hmax values presented in column 2 are the maximum values recorded for each event and are not necessarily coincident in time.

The Tp values presented in column 3 and the Hsig values presented in column 1 are coincident as a single event.

The events listed in the above table include all events with a recorded Hsig value of 2m and greater, and any significant storms.

Highest significant wave height (Hsig) recorded was 4.02m on 1 March 1979 during the passage of tropical cyclone Kerry off the Queensland coast.

Highest maximum wave height (Hmax) recorded was 6.56m on 22 March 1994 coincident with a 1028 hPa high pressure system over the Tasman Sea.

Meteorological information obtained from the Monthly Weather Review published by the Bureau of Meteorology.

### Appendix 3

#### Tropical cyclones of the east coast of Queensland 17 September 1975 to 31 October 1996

Cyclone name	Year	Month
David	1976	1
Alan	1976	1
Beth	1976	2
Colin	1976	2
Dawn-76	1976	3
Watorea	1976	4
June	1977	1
Keith	1977	1
Lily	1977	2
Miles	1977	2
Nancy-77	1977	2
Otto	1977	3
Tom	1977	11
Gwen	1978	2
Hal	1978	4
Peter	1978	1
Greta	1979	1
Gordon	1979	1
Rosa	1979	2
Kerry	1979	2
Stan	1979	4
Paul	1980	1
Ruth	1980	2
Simon	1980	2
Sina	1980	3
Eddie	1981	2
Cliff	1981	2
Freda	1981	2
Abigail	1982	1
Bernie	1982	4
Dominic	1982	4
Claudia	1982	5
Des	1983	1
Elinor	1983	2
Fritz	1983	12
Grace	1984	1
Harvey	1984	2
Ingrid	1984	2
Jim	1984	3
Kathy	1984	3
Lance	1984	4
Monica	1984	12
Nigel	1985	1
Odette	1985	1

Cyclone name	Year	Month
Pierre	1985	2
Rebecca	1985	2
Tanya	1985	3
Vernon	1986	1
Winifred	1986	1
Alfred	1986	3
Manu	1986	4
Namu	1986	5
Jason	1987	2
Blanch	1987	5
Agi	1988	1
Charlie	1988	2
Delilah	1988	1
Harry	1989	2
Aivu	1989	4
Meena	1989	5
Ernie	1989	5
Felicity	1989	12
Nancy-90	1990	1
Hilda	1990	3
Ivor	1990	3
Joy	1990	12
Kelvin	1991	2
Lisa	1991	5
Mark	1992	1
Betsy	1992	1
Daman	1992	2
Esau	1992	2
Fran	1992	3
Nina	1992	1
Oliver	1993	2
Polly	1993	2
Roger	1993	3
Rewa	1993	1
Sadie	1994	1
Theodore	1994	2
Violet	1995	3
Agnes-95	1995	4
Barry	1996	1
Celeste	1996	1
Dennis	1996	2
Ethel	1996	3

**Table 1** Wave statistics  
Wave period/wave height occurrences  
All data, all directions

Significant wave height (Hsig) (metres)	Peak energy wave period (Tp) (seconds)											Totals
	0-2.99	3-4.99	5-6.99	7-8.99	9-10.99	11-12.99	13-14.99	>14.99				
0.00 - 0.19	11.73	6.87	4.86	15.76	25.86	7.69	1.83	0.29			74.90	
0.20 - 0.39	158.19	245.04	61.44	232.53	251.06	56.78	6.21	1.71			1012.96	
0.40 - 0.59	74.53	687.79	113.94	204.55	183.86	43.99	3.08	0.08			1311.83	
0.60 - 0.79	2.39	618.37	156.85	72.70	71.28	18.57	0.83	0.04			941.03	
0.80 - 0.99	*	378.07	219.77	34.07	27.03	7.66	0.08	*			666.69	
1.00 - 1.19	*	166.42	313.50	25.05	15.96	1.62	0.04	*			522.59	
1.20 - 1.39	0.51	50.25	357.97	18.79	4.63	1.71	0.08	*			433.94	
1.40 - 1.59	*	9.63	305.99	16.09	2.13	0.80	*	*			334.65	
1.60 - 1.79	*	0.79	229.80	15.77	2.64	0.42	*	*			249.42	
1.80 - 1.99	*	0.30	122.23	13.17	0.71	0.04	*	*			136.46	
2.00 - 2.19	*	*	80.27	16.00	0.67	*	*	*			96.94	
2.20 - 2.39	*	*	31.17	18.56	1.83	0.04	*	*			51.60	
2.40 - 2.59	*	*	12.07	18.01	1.04	*	*	*			31.12	
2.60 - 2.79	*	*	2.88	10.30	0.21	*	*	*			13.39	
2.80 - 2.99	*	*	0.60	4.19	0.17	0.34	*	*			5.31	
3.00 - 3.19	*	*	0.04	1.35	*	*	*	*			1.39	
3.20 - 3.39	*	*	*	1.17	*	*	*	*			1.17	
3.40 - 3.59	*	*	*	0.71	*	*	*	*			0.71	
3.60 - 3.79	*	*	*	0.25	*	*	*	*			0.25	
3.80 - 3.99	*	*	*	0.25	*	*	*	*			0.25	
4.00 - 4.19	*	*	*	*	0.51	*	*	*			0.51	
4.20 - 4.39	*	*	*	*	*	*	*	*			*	
Totals	247.35	2163.54	2013.38	719.29	589.58	139.67	12.17	2.12			5887.10	

(Table values are numbers of days for the recording period, rounded to the second decimal place)



**Table 2** Wave statistics  
Wave period/wave height occurrences  
Summer data, all directions

Significant wave height (Hsig) (metres)	Peak energy wave period (Tp) (seconds)										Totals
	0-2.99	3-4.99	5-6.99	7-8.99	9-10.99	11-12.99	13-14.99	>14.99			
0.00 - 0.19	2.69	2.39	0.50	5.17	5.35	1.81	0.17	*	*	18.07	
0.20 - 0.39	64.74	112.06	21.17	124.09	102.03	18.82	1.33	0.50	0.50	444.74	
0.40 - 0.59	30.69	344.98	48.11	122.26	96.54	14.26	1.13	*	*	657.96	
0.60 - 0.79	0.63	290.96	69.03	44.41	40.88	8.01	0.33	*	*	454.25	
0.80 - 0.99	*	172.86	109.45	21.35	16.94	3.60	*	*	*	324.21	
1.00 - 1.19	*	69.43	157.47	13.85	11.40	0.67	*	*	*	252.81	
1.20 - 1.39	*	16.31	190.51	10.31	3.51	0.96	0.08	*	*	221.68	
1.40 - 1.59	*	3.64	157.93	10.58	2.01	0.54	*	*	*	174.70	
1.60 - 1.79	*	0.08	123.40	9.91	2.35	0.42	*	*	*	136.16	
1.80 - 1.99	*	*	75.10	7.87	0.71	0.04	*	*	*	83.72	
2.00 - 2.19	*	*	54.36	9.41	0.67	*	*	*	*	64.44	
2.20 - 2.39	*	*	21.70	15.10	1.83	0.04	*	*	*	38.69	
2.40 - 2.59	*	*	9.14	14.57	1.04	*	*	*	*	24.75	
2.60 - 2.79	*	*	2.06	8.60	0.21	*	*	*	*	10.87	
2.80 - 2.99	*	*	0.35	3.57	0.12	0.34	*	*	*	4.39	
3.00 - 3.19	*	*	0.04	1.35	*	*	*	*	*	1.39	
3.20 - 3.39	*	*	*	1.17	*	*	*	*	*	1.17	
3.40 - 3.59	*	*	*	0.71	*	*	*	*	*	0.71	
3.60 - 3.79	*	*	*	0.25	*	*	*	*	*	0.25	
3.80 - 3.99	*	*	*	0.25	*	*	*	*	*	0.25	
4.00 - 4.19	*	*	*	*	0.51	*	*	*	*	0.51	
4.20 - 4.39	*	*	*	*	*	*	*	*	*	*	
Totals	98.74	1012.72	1040.33	424.77	286.10	49.52	3.04	0.50	0.50	2915.70	

(Table values are numbers of days for the recording period, rounded to the second decimal place)

**Table 3** Wave statistics  
Wave period/wave height occurrences  
Winter data, all directions

Significant wave height (Hsig) (metres)	Peak energy wave period (Tp)(seconds)										Totals
	0-2.99	3-4.99	5-6.99	7-8.99	9-10.99	11-12.99	13-14.99	>14.99	Totals		
0.00 - 0.19	9.05	4.49	4.35	10.59	20.51	5.88	1.67	0.29	56.83		
0.20 - 0.39	93.45	132.98	40.27	108.44	149.03	37.97	4.88	1.21	568.22		
0.40 - 0.59	43.85	342.82	65.83	82.29	87.32	29.74	1.96	0.08	653.87		
0.60 - 0.79	1.76	327.41	87.82	28.30	30.40	10.55	0.50	0.04	486.78		
0.80 - 0.99	*	205.21	110.32	12.73	10.09	4.06	0.08	*	342.48		
1.00 - 1.19	*	96.99	156.04	11.20	4.55	0.96	0.04	*	269.79		
1.20 - 1.39	0.51	33.93	167.47	8.49	1.12	0.75	*	*	212.27		
1.40 - 1.59	*	5.99	148.06	5.51	0.12	0.26	*	*	159.95		
1.60 - 1.79	*	0.71	106.40	5.86	0.29	*	*	*	113.26		
1.80 - 1.99	*	0.30	47.13	5.30	*	*	*	*	52.74		
2.00 - 2.19	*	*	25.91	6.59	*	*	*	*	32.51		
2.20 - 2.39	*	*	9.46	3.45	*	*	*	*	12.91		
2.40 - 2.59	*	*	2.93	3.44	*	*	*	*	6.37		
2.60 - 2.79	*	*	0.82	1.71	*	*	*	*	2.52		
2.80 - 2.99	*	*	0.25	0.62	0.04	*	*	*	0.91		
3.00 - 3.19	*	*	*	*	*	*	*	*	*		
3.20 - 3.39	*	*	*	*	*	*	*	*	*		
3.40 - 3.59	*	*	*	*	*	*	*	*	*		
3.60 - 3.79	*	*	*	*	*	*	*	*	*		
3.80 - 3.99	*	*	*	*	*	*	*	*	*		
4.00 - 4.19	*	*	*	*	*	*	*	*	*		
4.20 - 4.39	*	*	*	*	*	*	*	*	*		
Totals	148.61	1150.83	973.05	294.52	303.49	90.15	9.13	1.62	2971.40		

(Table values are numbers of days for the recording period, rounded to the second decimal place)

**Table 4** Wave statistics  
Wave period/wave height occurrences  
Winter data, all directions

Significant wave height (Hsig) (metres)	Peak energy wave period (Tp) (seconds)										Totals
	0-2.99	3-4.99	5-6.99	7-8.99	9-10.99	11-12.99	13-14.99	>14.99			
0.00 - 0.19	0.20	0.12	0.08	0.27	0.44	0.13	0.03	*			1.27
0.20 - 0.39	2.69	4.16	1.04	3.95	4.26	0.96	0.11	0.03			17.21
0.40 - 0.59	1.27	11.68	1.94	3.47	3.12	0.75	0.05	*			22.28
0.60 - 0.79	0.04	10.50	2.66	1.23	1.21	0.32	0.01	*			15.98
0.80 - 0.99	*	6.42	3.73	0.58	0.46	0.13	*	*			11.32
1.00 - 1.19	*	2.83	5.33	0.43	0.27	0.03	*	*			8.88
1.20 - 1.39	0.01	0.85	6.08	0.32	0.08	0.03	*	*			7.37
1.40 - 1.59	*	0.16	5.20	0.27	0.04	0.01	*	*			5.68
1.60 - 1.79	*	0.01	3.90	0.27	0.04	0.01	*	*			4.24
1.80 - 1.99	*	0.01	2.08	0.22	0.01	*	*	*			2.32
2.00 - 2.19	*	*	1.36	0.27	0.01	*	*	*			1.65
2.20 - 2.39	*	*	0.53	0.32	0.03	*	*	*			0.88
2.40 - 2.59	*	*	0.20	0.31	0.02	*	*	*			0.53
2.60 - 2.79	*	*	0.05	0.17	*	*	*	*			0.23
2.80 - 2.99	*	*	0.01	0.07	*	0.01	*	*			0.09
3.00 - 3.19	*	*	*	0.02	*	*	*	*			0.02
3.20 - 3.39	*	*	*	0.02	*	*	*	*			0.02
3.40 - 3.59	*	*	*	0.01	*	*	*	*			0.01
3.60 - 3.79	*	*	*	*	*	*	*	*			*
3.80 - 3.99	*	*	*	*	*	*	*	*			*
4.00 - 4.19	*	*	*	*	0.01	*	*	*			0.01
4.20 - 4.39	*	*	*	*	*	*	*	*			*
Totals	4.20	36.75	34.20	12.22	10.01	2.37	0.21	0.03			100.00

(Table values are percentage occurrence for the recording period, rounded to the second decimal place)

**Table 5** Wave statistics  
Wave period/wave height occurrences  
Winter data, all directions

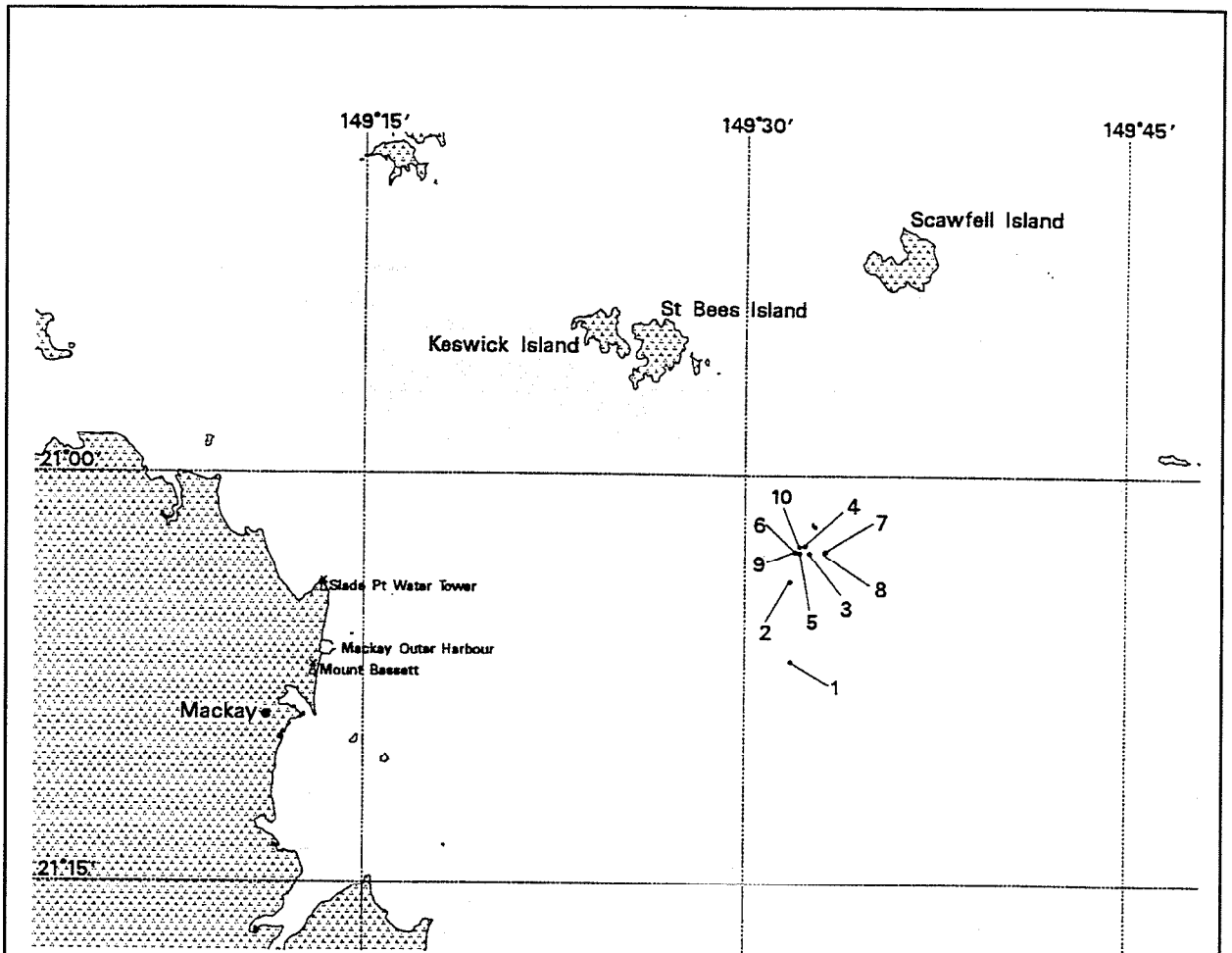
Significant wave height (Hsig) (metres)	Peak energy wave period (Tp) (seconds)											Totals
	0-2.99	3-4.99	5-6.99	7-8.99	9-10.99	11-12.99	13-14.99	>14.99			Totals	
0.00 - 0.19	0.09	0.08	0.02	0.18	0.18	0.06	0.01	*			0.62	
0.20 - 0.39	2.22	3.84	0.73	4.26	3.50	0.65	0.05	0.02			15.25	
0.40 - 0.59	1.05	11.83	1.65	4.19	3.31	0.49	0.04	*			22.57	
0.60 - 0.79	0.02	9.98	2.37	1.52	1.40	0.27	0.01	*			15.58	
0.80 - 0.99	*	5.93	3.75	0.73	0.58	0.12	*	*			11.12	
1.00 - 1.19	*	2.38	5.40	0.47	0.39	0.02	*	*			8.67	
1.20 - 1.39	*	0.56	6.53	0.35	0.12	0.03	*	*			7.60	
1.40 - 1.59	*	0.12	5.42	0.36	0.07	0.02	*	*			5.99	
1.60 - 1.79	*	*	4.23	0.34	0.08	0.01	*	*			4.67	
1.80 - 1.99	*	*	2.58	0.27	0.02	*	*	*			2.87	
2.00 - 2.19	*	*	1.86	0.32	0.02	*	*	*			2.21	
2.20 - 2.39	*	*	0.74	0.52	0.06	*	*	*			1.33	
2.40 - 2.59	*	*	0.31	0.50	0.04	*	*	*			0.85	
2.60 - 2.79	*	*	0.07	0.29	0.01	*	*	*			0.37	
2.80 - 2.99	*	*	0.01	0.12	*	0.01	*	*			0.15	
3.00 - 3.19	*	*	*	0.05	*	*	*	*			0.05	
3.20 - 3.39	*	*	*	0.04	*	*	*	*			0.04	
3.40 - 3.59	*	*	*	0.02	*	*	*	*			0.02	
3.60 - 3.79	*	*	*	0.01	*	*	*	*			0.01	
3.80 - 3.99	*	*	*	0.01	*	*	*	*			0.01	
4.00 - 4.19	*	*	*	*	0.02	*	*	*			0.02	
4.20 - 4.39	*	*	*	*	*	*	*	*			*	
Totals	3.39	34.73	35.68	14.57	9.81	1.70	0.11	0.02			100.00	

(Table values are percentage occurrence for the recording period, rounded to the second decimal place)

**Table 6** Wave statistics  
Wave period/wave height occurrences  
Winter data, all directions

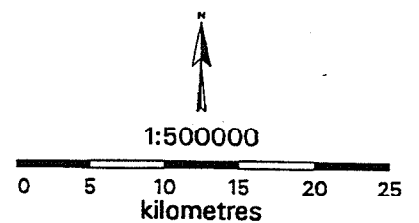
Significant wave height (Hsig) (metres)	Peak energy wave period (Tp) (seconds)										Totals
	0-2.99	3-4.99	5-6.99	7-8.99	9-10.99	11-12.99	13-14.99	>14.99			
0.00 - 0.19	0.30	0.15	0.15	0.36	0.69	0.20	0.06	0.01			1.91
0.20 - 0.39	3.14	4.48	1.36	3.65	5.02	1.28	0.16	0.04			19.12
0.40 - 0.59	1.48	11.54	2.22	2.77	2.94	1.00	0.07	*			22.01
0.60 - 0.79	0.06	11.02	2.96	0.95	1.02	0.36	0.02	*			16.38
0.80 - 0.99	*	6.91	3.71	0.43	0.34	0.14	*	*			11.53
1.00 - 1.19	*	3.26	5.25	0.38	0.15	0.03	*	*			9.08
1.20 - 1.39	0.02	1.14	5.64	0.29	0.04	0.03	*	*			7.14
1.40 - 1.59	*	0.20	4.98	0.19	*	0.01	*	*			5.38
1.60 - 1.79	*	0.02	3.58	0.20	0.01	*	*	*			3.81
1.80 - 1.99	*	0.01	1.59	0.18	*	*	*	*			1.77
2.00 - 2.19	*	*	0.87	0.22	*	*	*	*			1.09
2.20 - 2.39	*	*	0.32	0.12	*	*	*	*			0.43
2.40 - 2.59	*	*	0.10	0.12	*	*	*	*			0.21
2.60 - 2.79	*	*	0.03	0.06	*	*	*	*			0.08
2.80 - 2.99	*	*	0.01	0.02	*	*	*	*			0.03
3.00 - 3.19	*	*	*	*	*	*	*	*			*
3.20 - 3.39	*	*	*	*	*	*	*	*			*
3.40 - 3.59	*	*	*	*	*	*	*	*			*
3.60 - 3.79	*	*	*	*	*	*	*	*			*
3.80 - 3.99	*	*	*	*	*	*	*	*			*
4.00 - 4.19	*	*	*	*	*	*	*	*			*
4.20 - 4.39	*	*	*	*	*	*	*	*			*
Totals	5.00	38.73	32.75	9.91	10.21	3.03	0.31	0.05			100.00

(Table values are percentage occurrence for the recording period, rounded to the second decimal place)



Waverider buoy sites	
1.	19-09-1975 to 05-11-1976
2.	24-11-1977 to 23-08-1985
3.	24-08-1985 to 22-05-1988
4.	23-05-1988 to 23-06-1991
5.	24-06-1991 to 03-08-1992
6.	04-08-1992 to 08-06-1993
7.	09-06-1993 to 22-11-1993
8.	23-11-1993 to 22-11-1994
9.	23-11-1994 to 06-04-1995
10.	07-04-1995 to 31-10-1996

- Waverider buoys
- ⚓ Recording stations



### Locality Plan

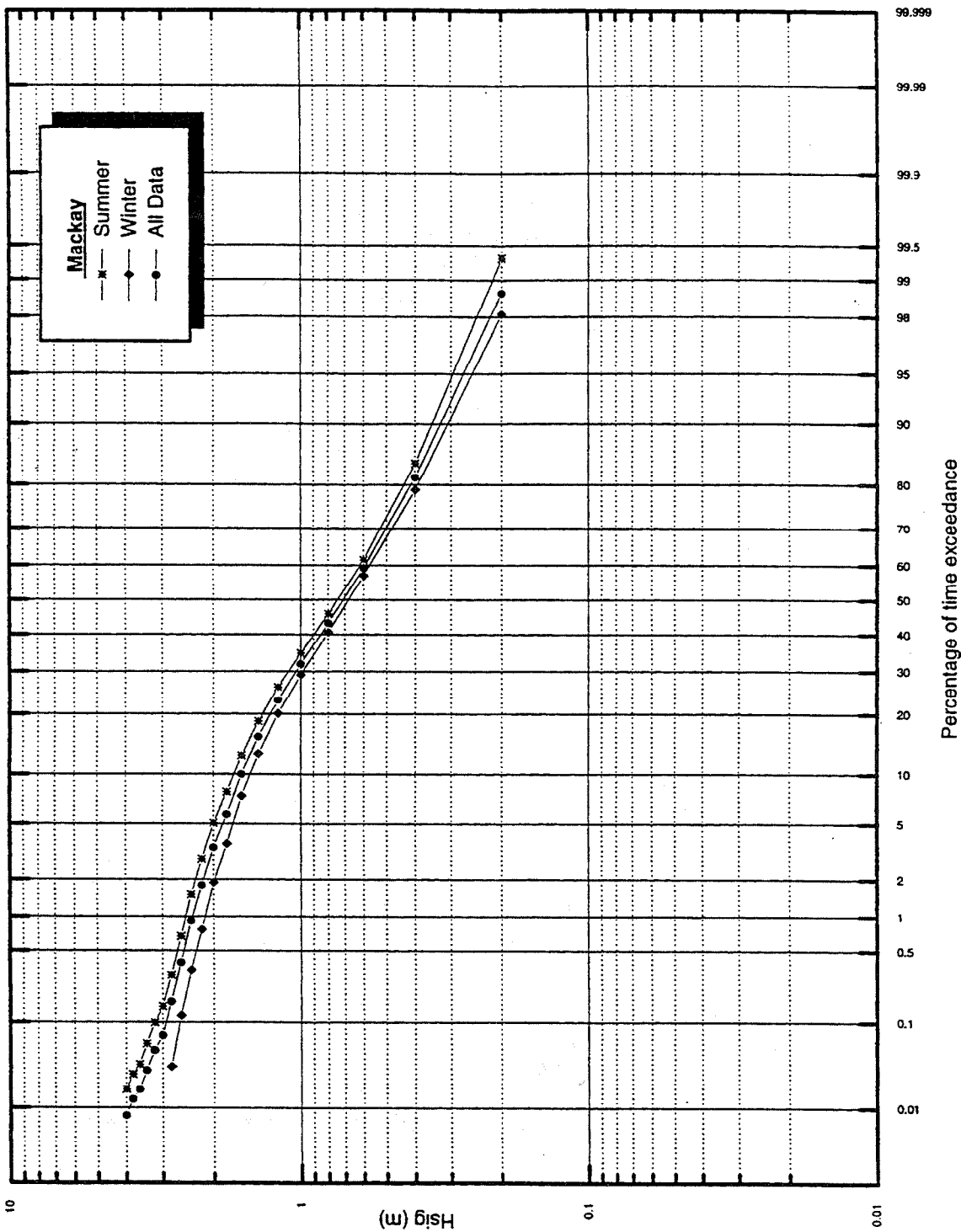


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**Figure 1**



Percentage (of time) exceedance of wave heights ( $H_{sig}$ ) for all periods ( $T_p$ )  
19 September 1975 to 31 October 1996

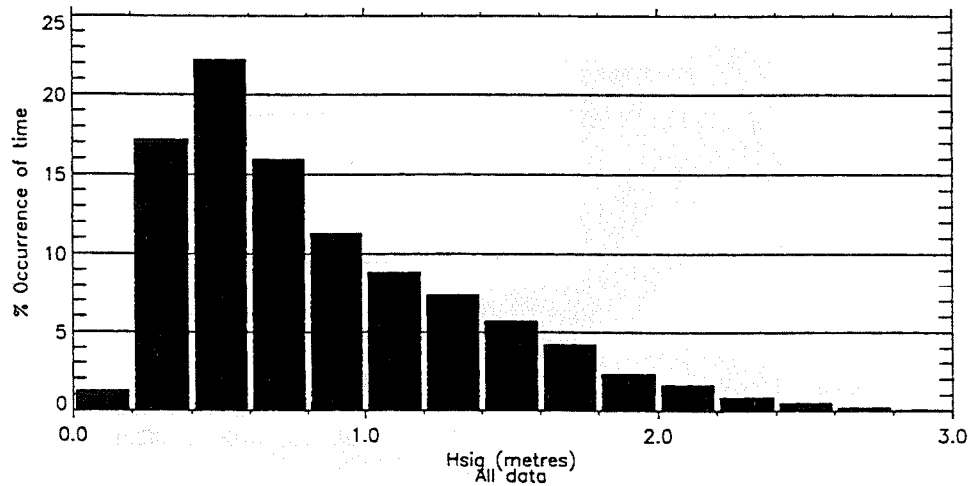
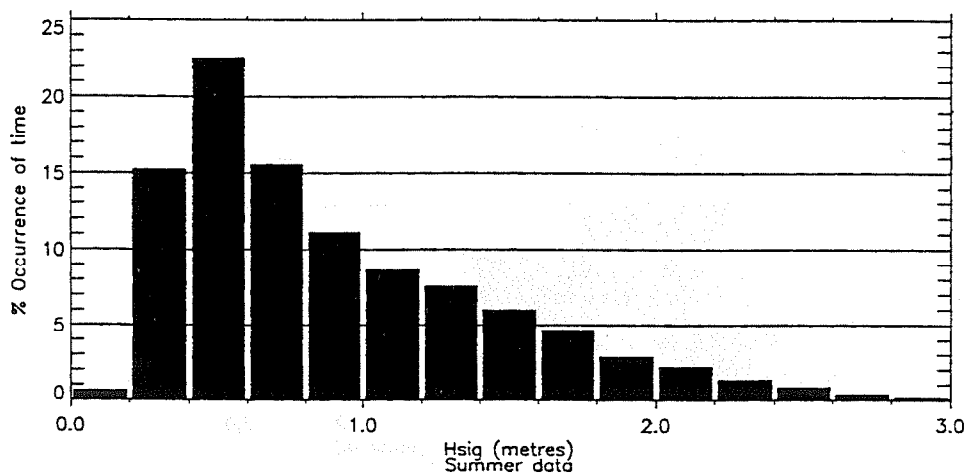
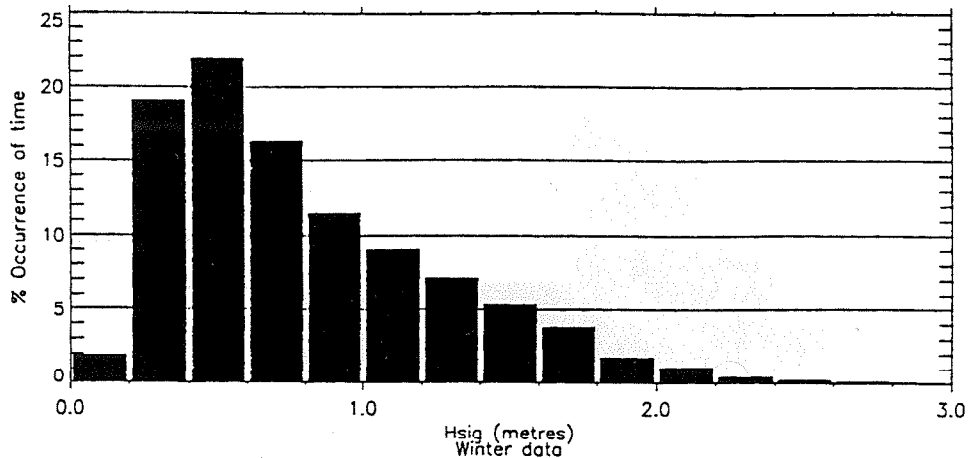


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**Figure 2**



**Histogram percentage (of time)  
occurrence of wave heights (Hsig)  
for all wave periods (Tp)**



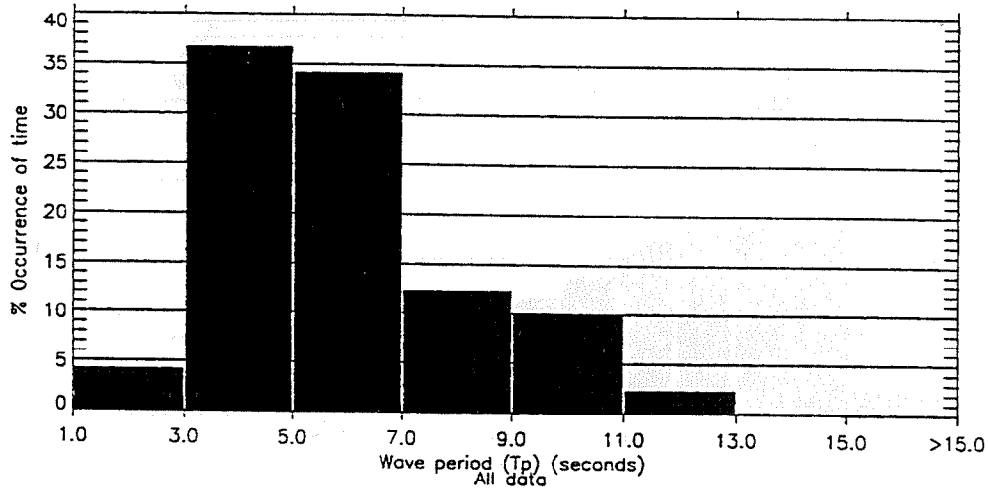
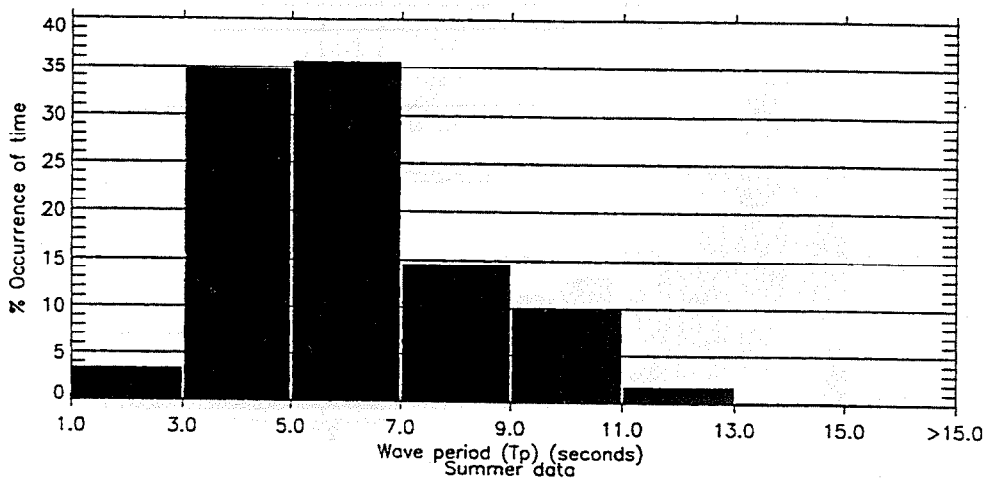
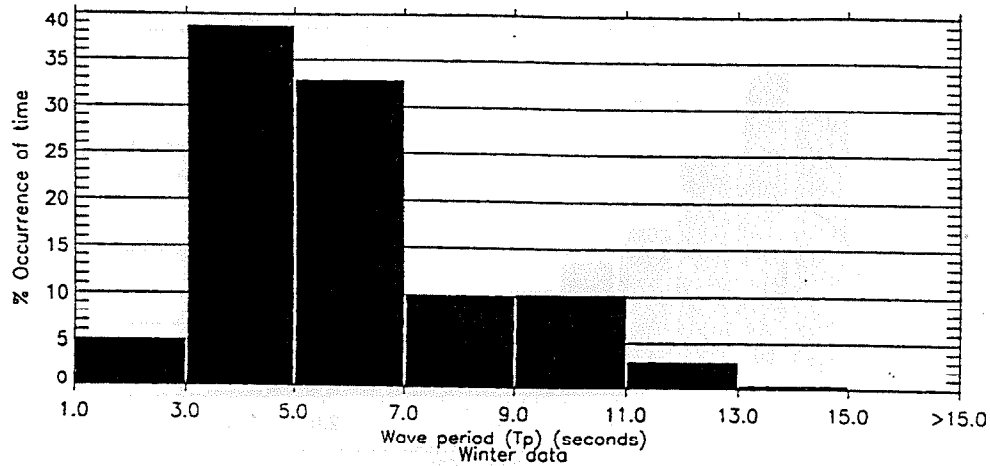
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**Figure 3**





**Histogram percentage (of time)  
occurrence of wave periods (Tp)  
for all wave heights (Hsig)**

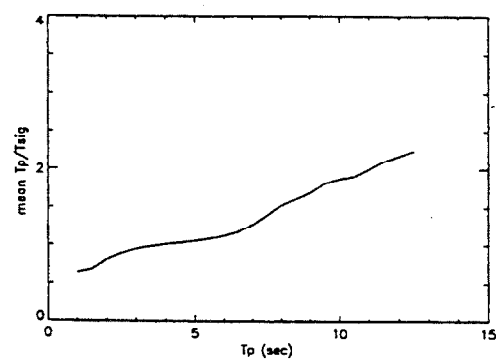
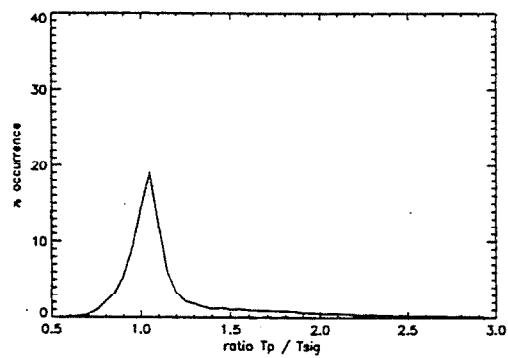
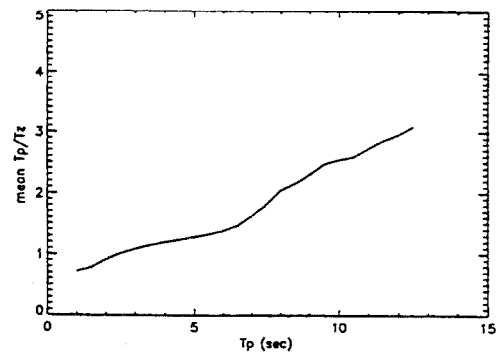
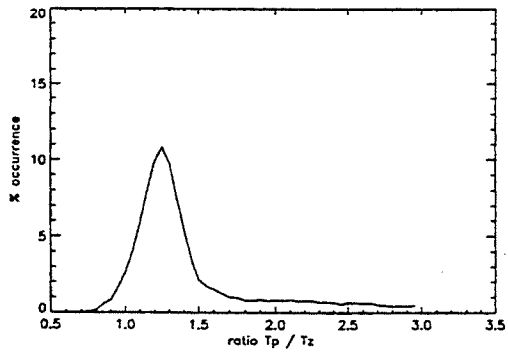
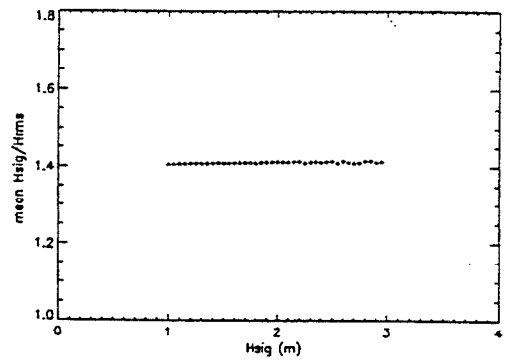
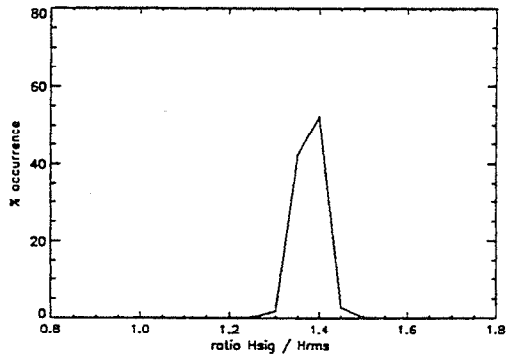
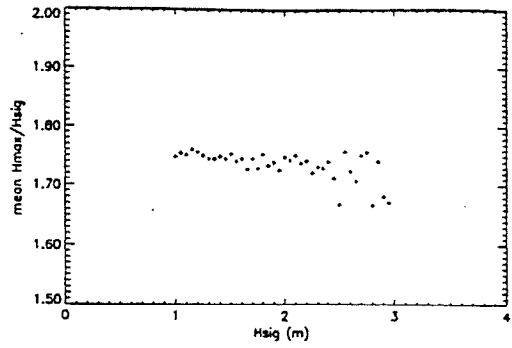
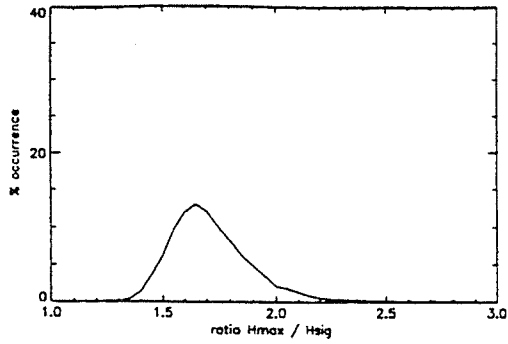


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**Figure 4**



**Wave parameter relationships**  
19 September 1975 to 31 October 1996



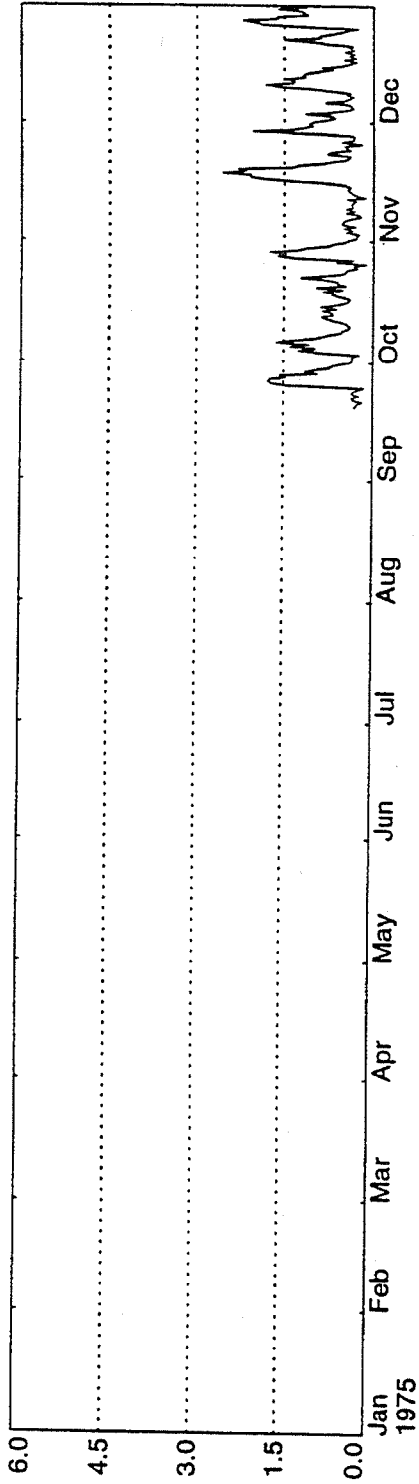
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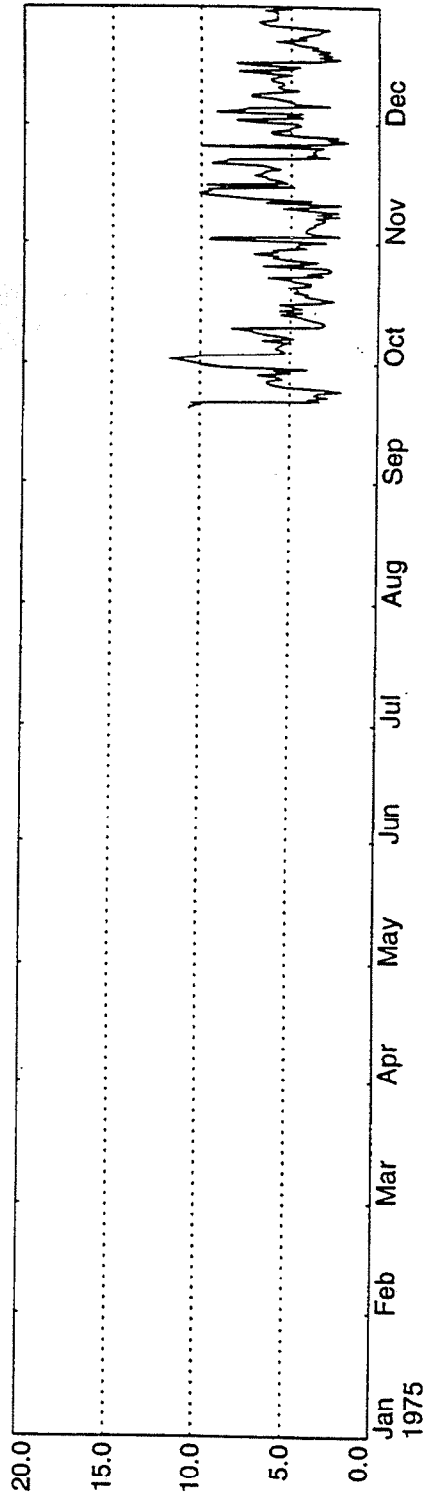
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**Figure 5**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
19 September 1975 to 31 December 1975



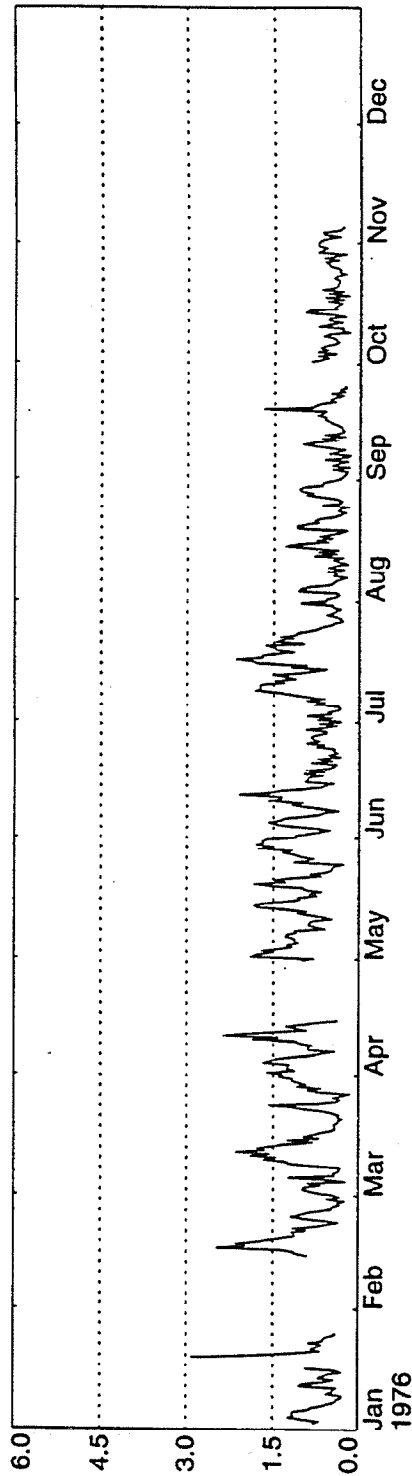
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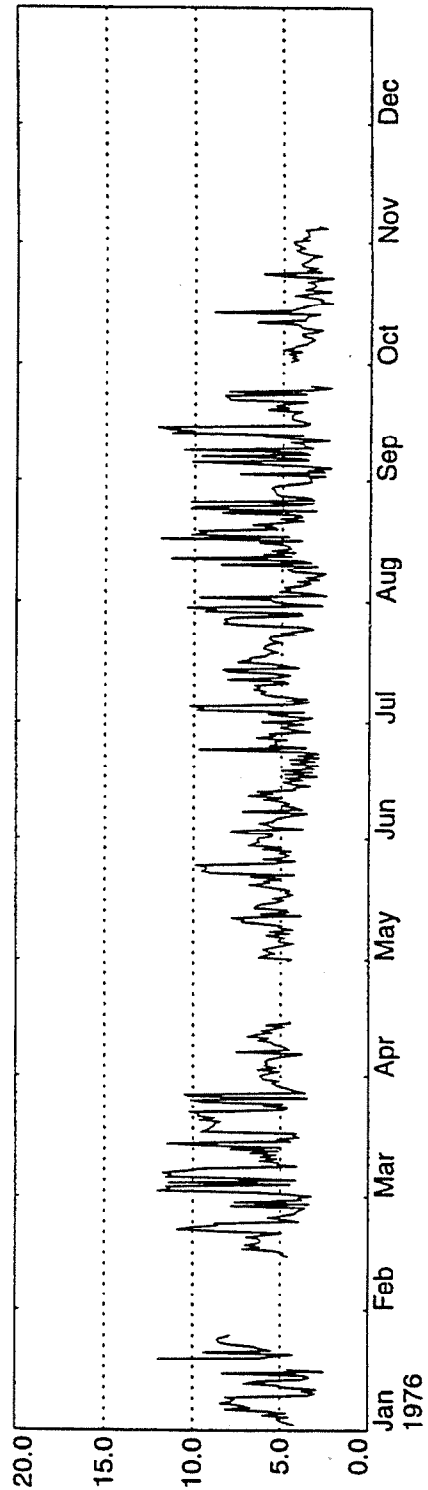
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**Figure 6.01**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1976 to 31 December 1976



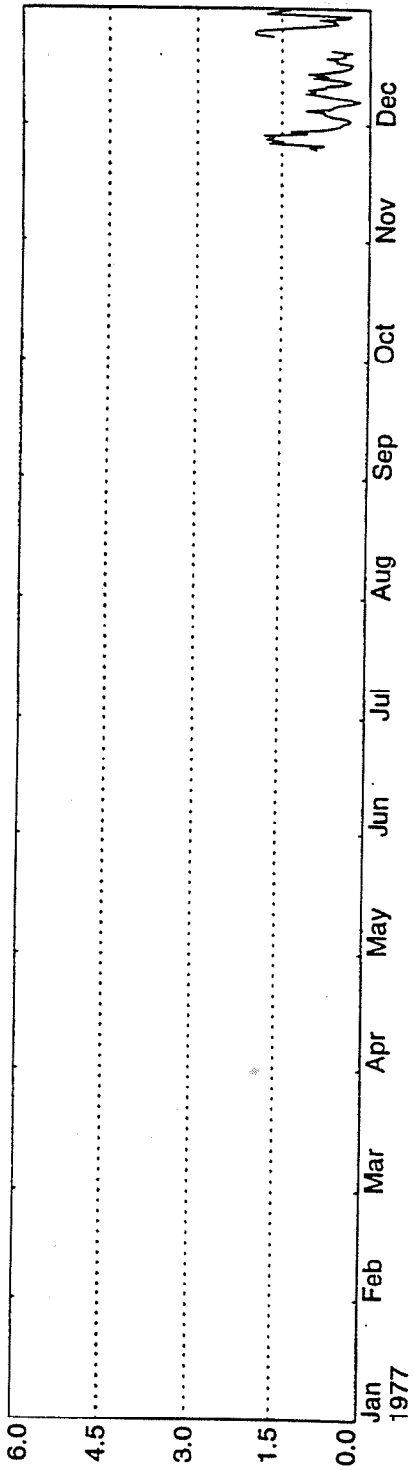
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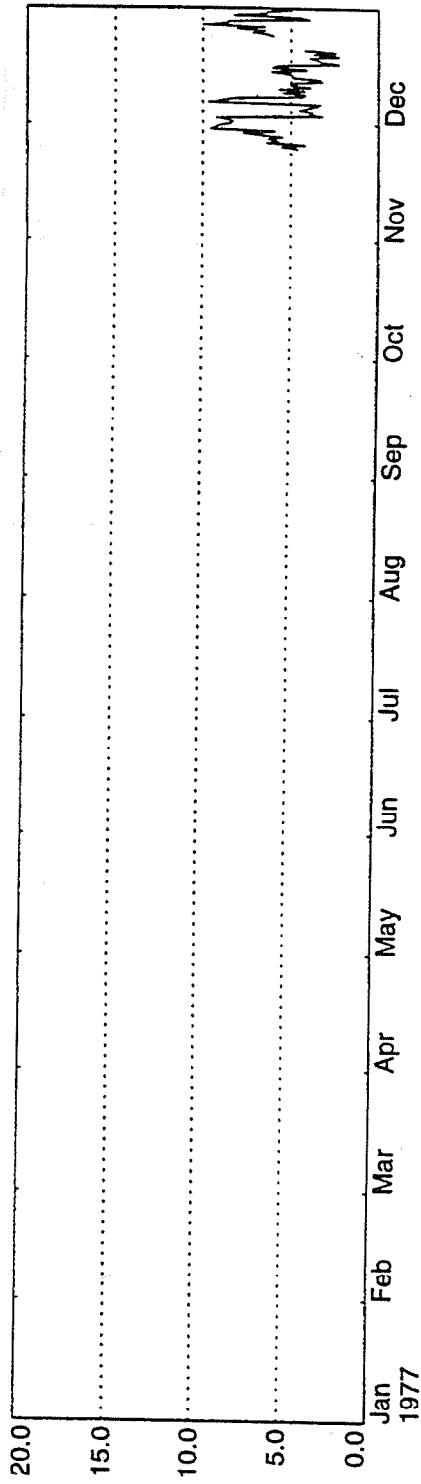
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**Figure 6.02**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1977 to 31 December 1977



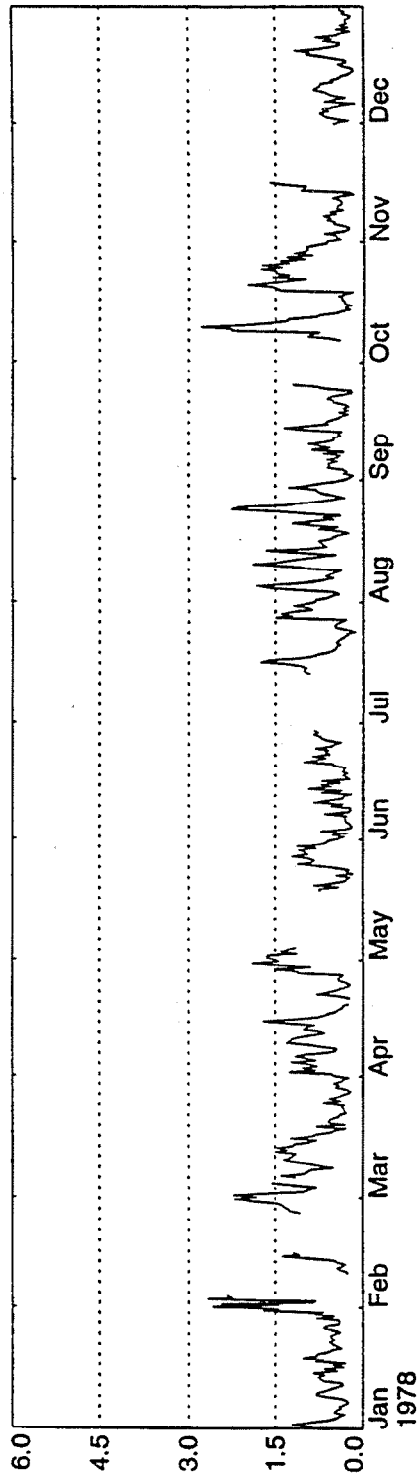
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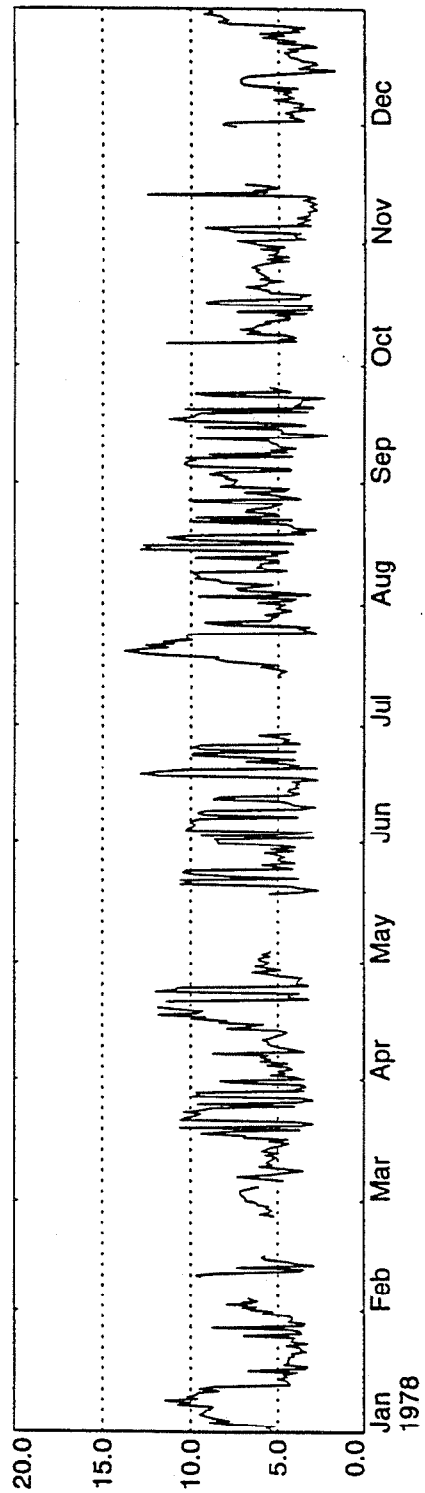
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**Figure 6.03**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1978 to 31 December 1978



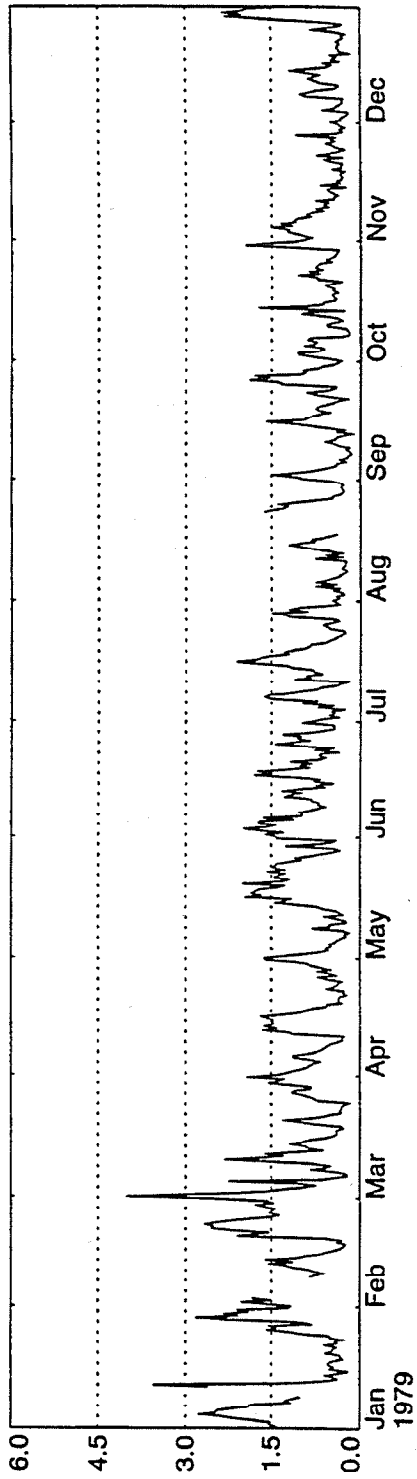
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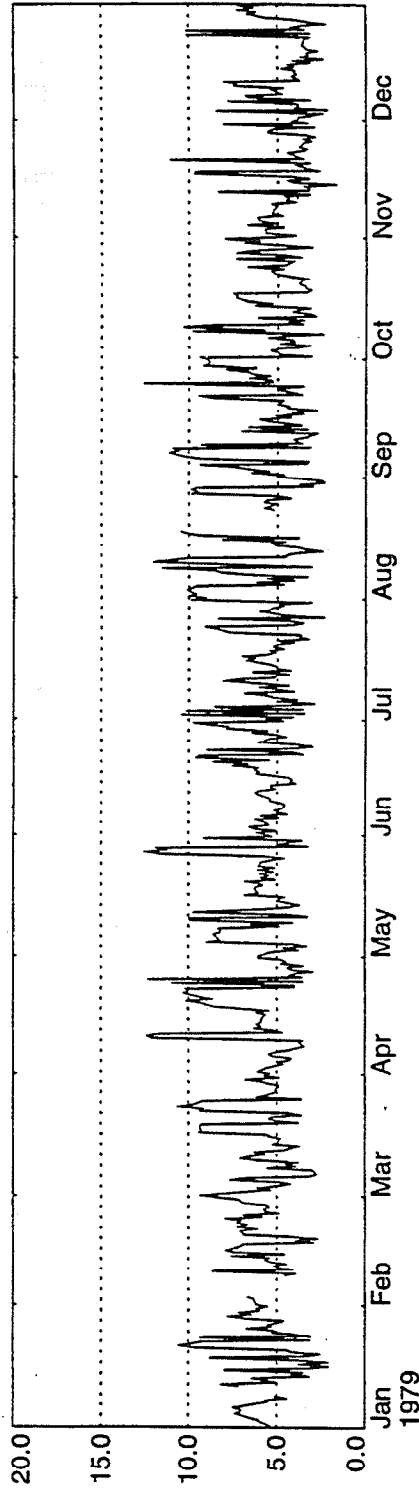
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**Figure 6.04**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1979 to 31 December 1979



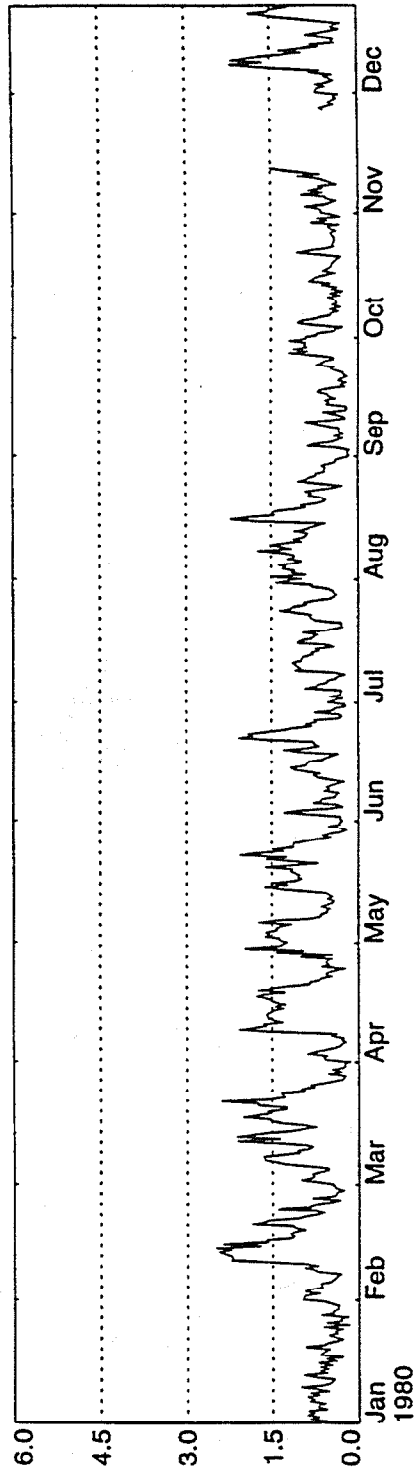
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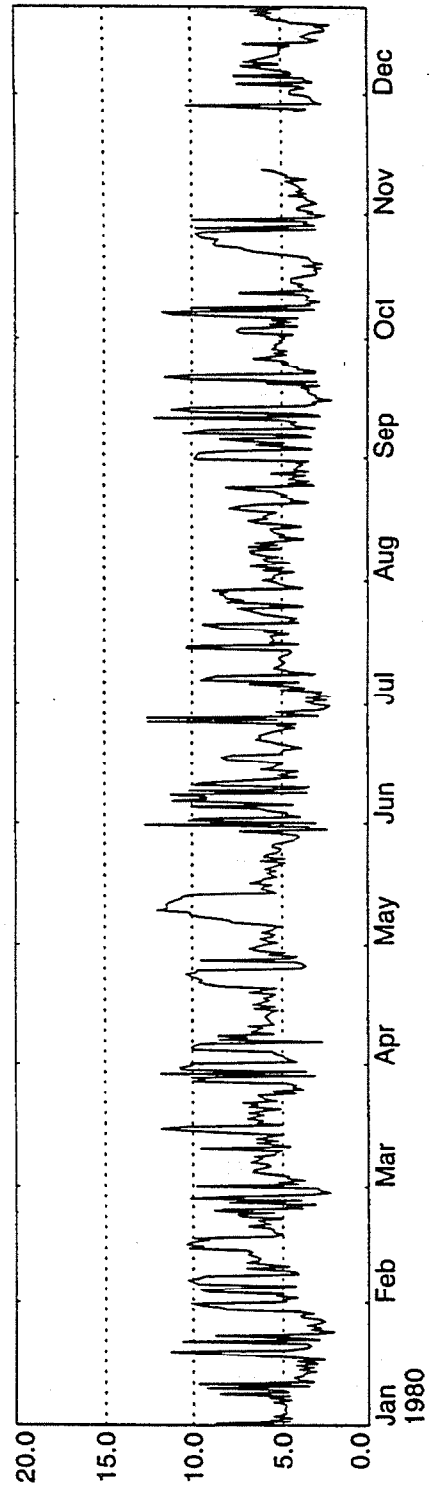
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Mackay Region

**Figure 6.05**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1980 to 31 December 1980



**Beach Protection  
Authority  
Queensland**

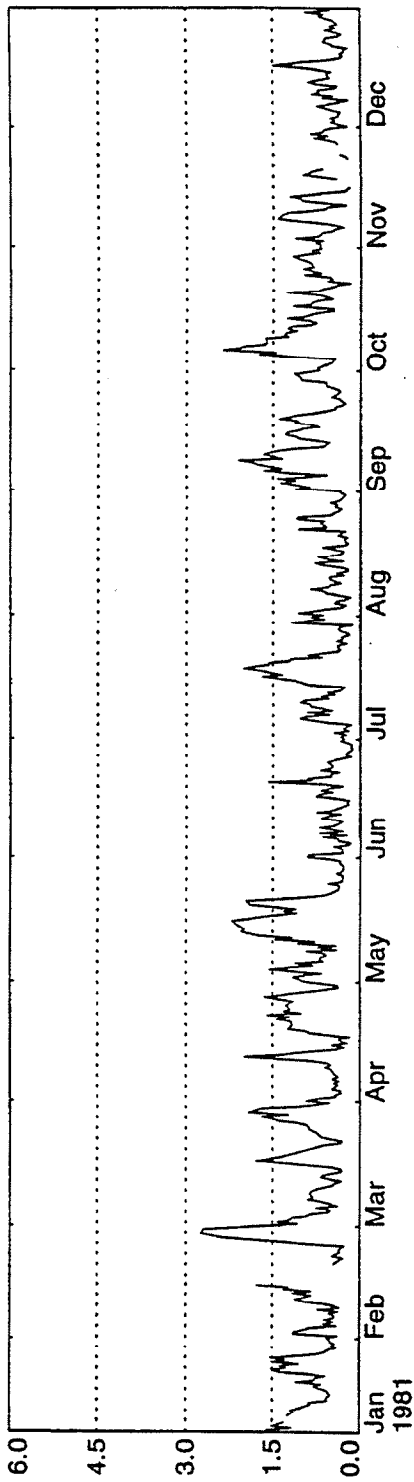
Department of Environment and Heritage

Wave data recording program  
Mackay Region

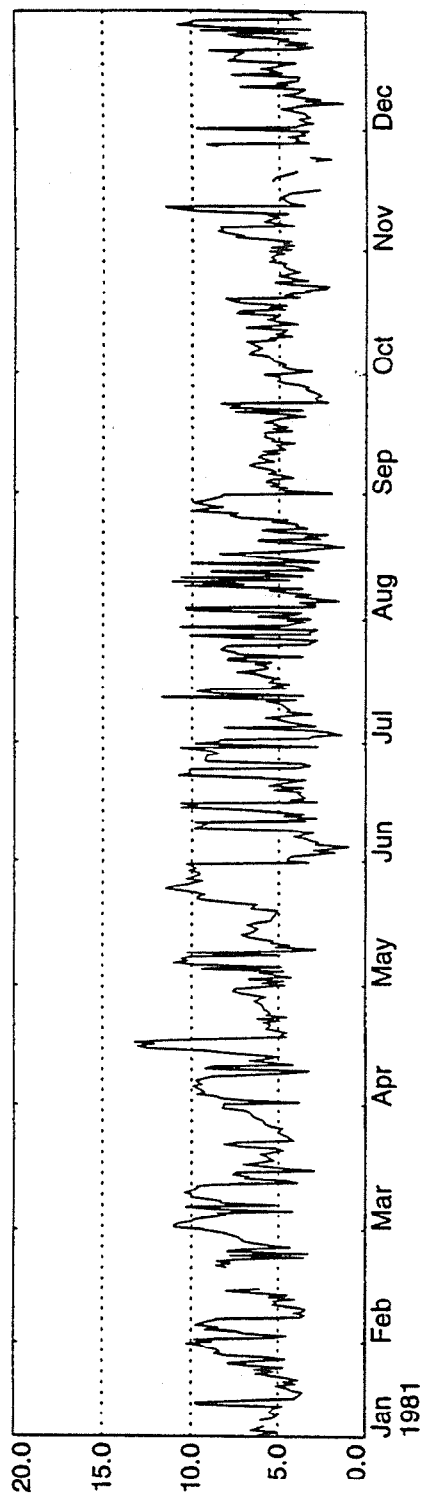
**Figure 6.06**



Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1981 to 31 December 1981



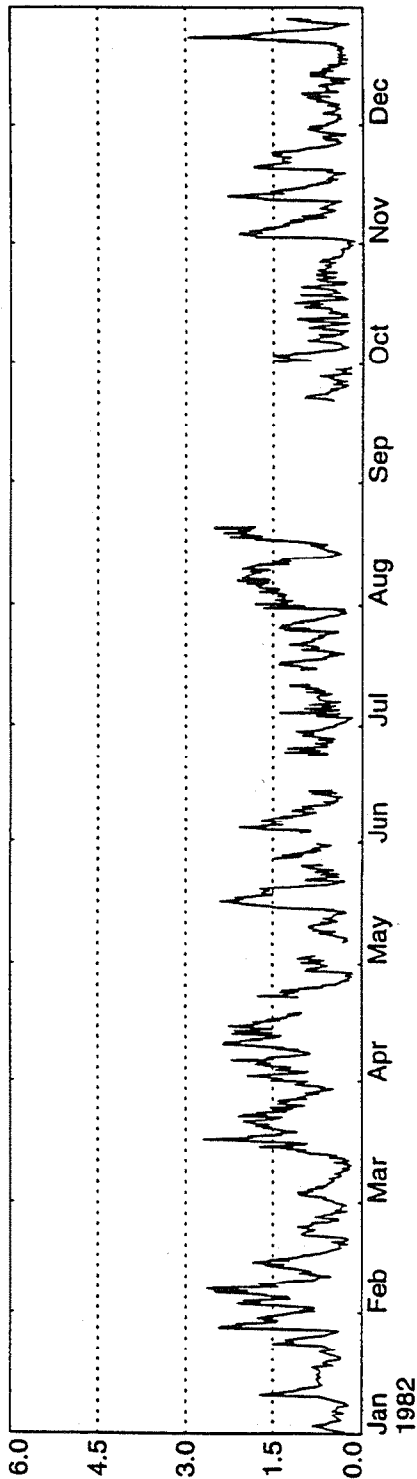
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Department of Environment and Heritage

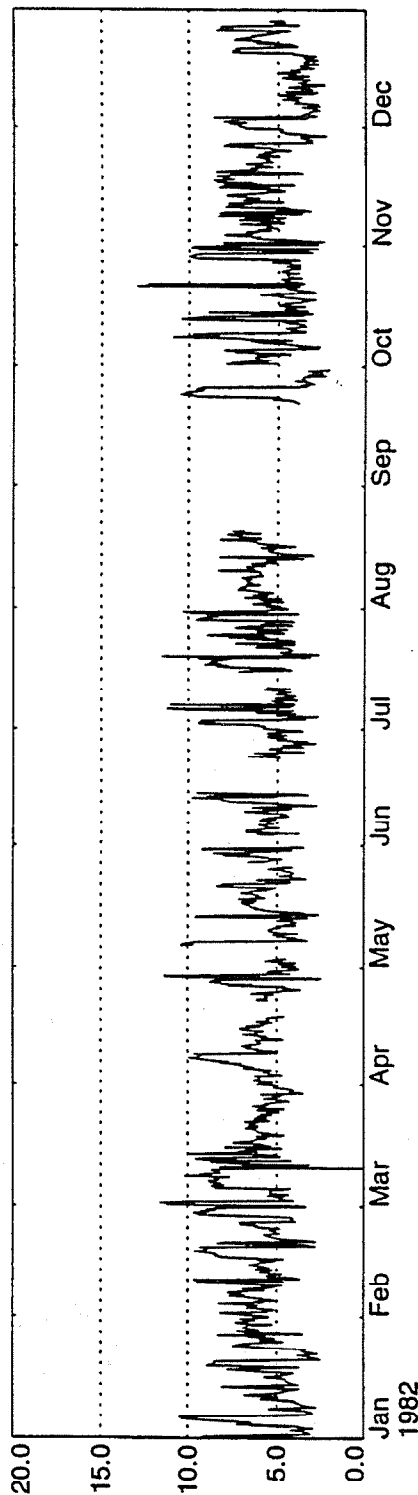
Wave data recording program  
Mackay Region

**Figure 6.07**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1982 to 31 December 1982



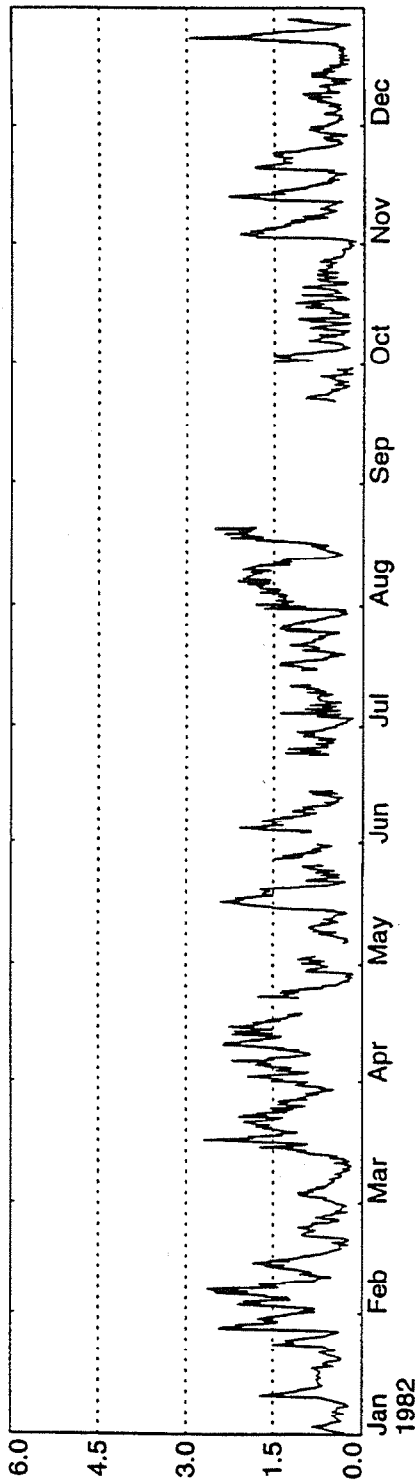
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Queensland**

Department of Environment and Heritage

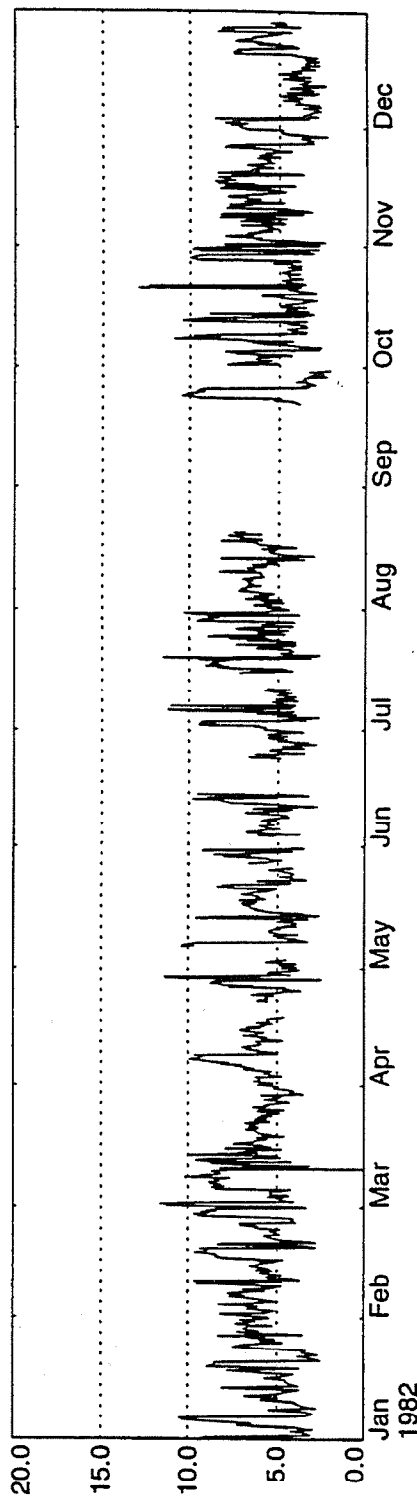
Wave data recording program  
Mackay Region

**Figure 6.08**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1982 to 31 December 1982



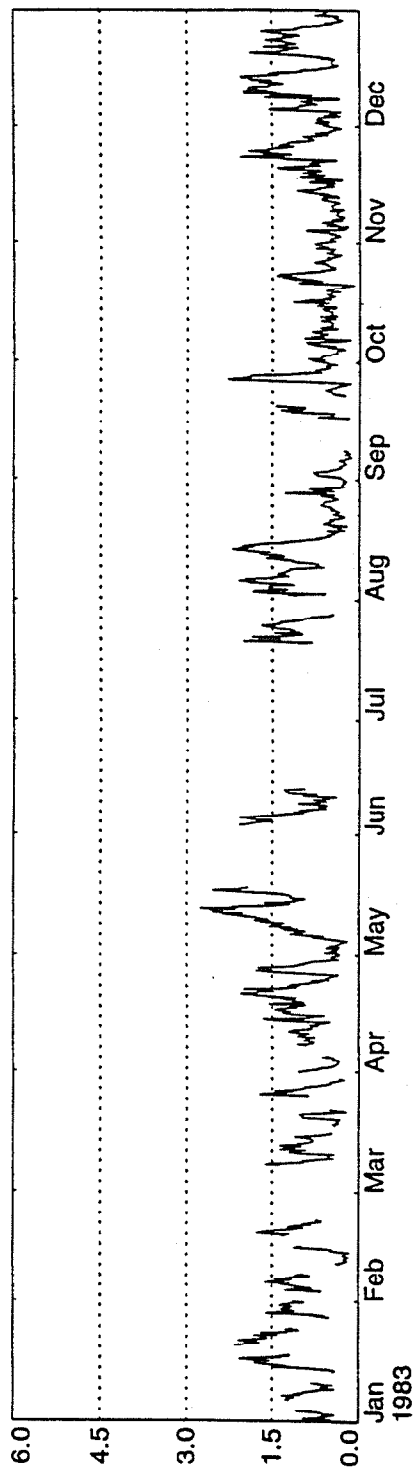
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Queensland**

Department of Environment and Heritage

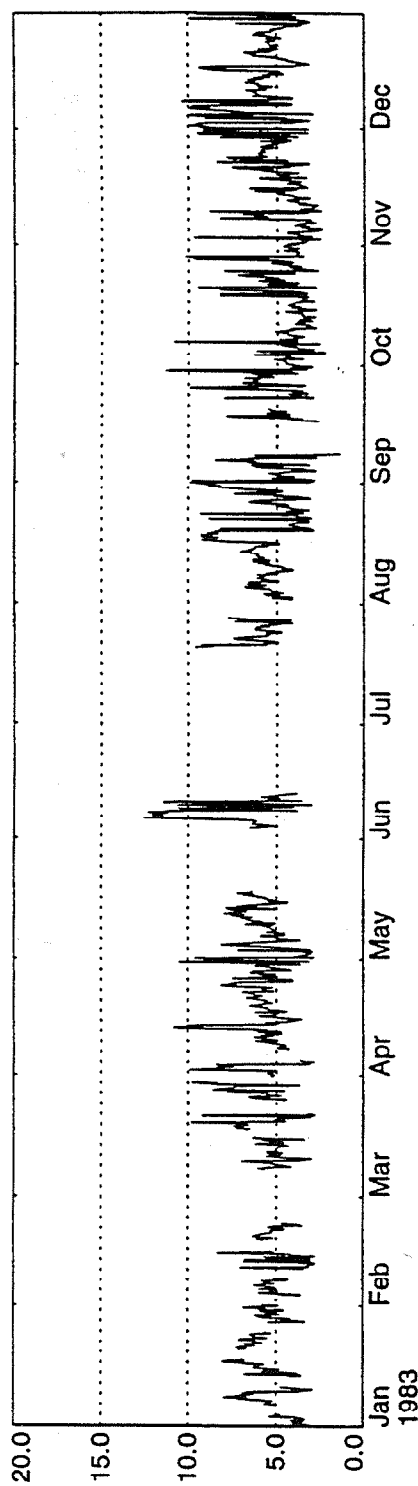
Wave data recording program  
Mackay Region

**Figure 6.08**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1983 to 31 December 1983



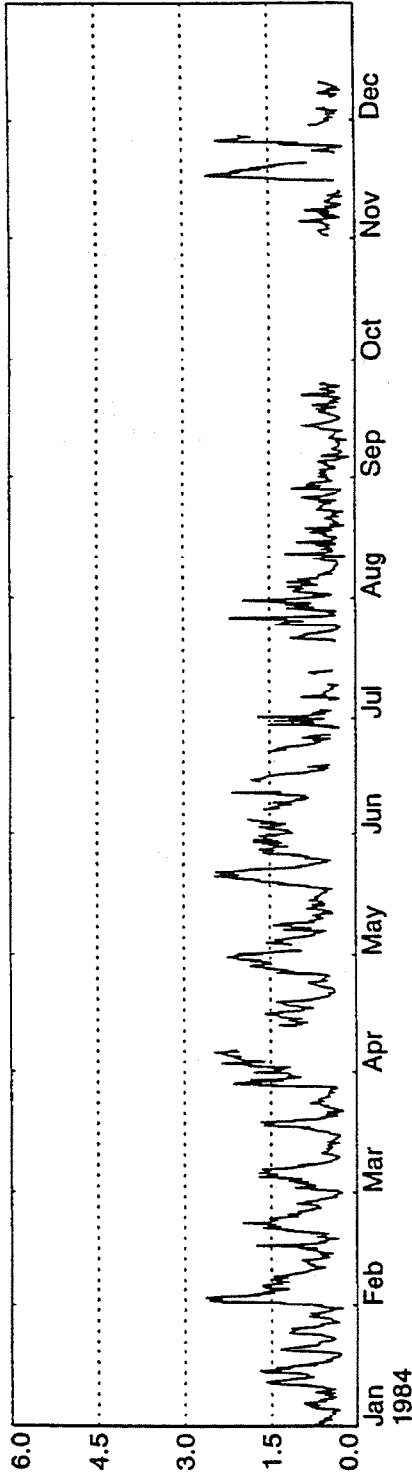
**Beach Protection  
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Queensland**

Department of Environment and Heritage

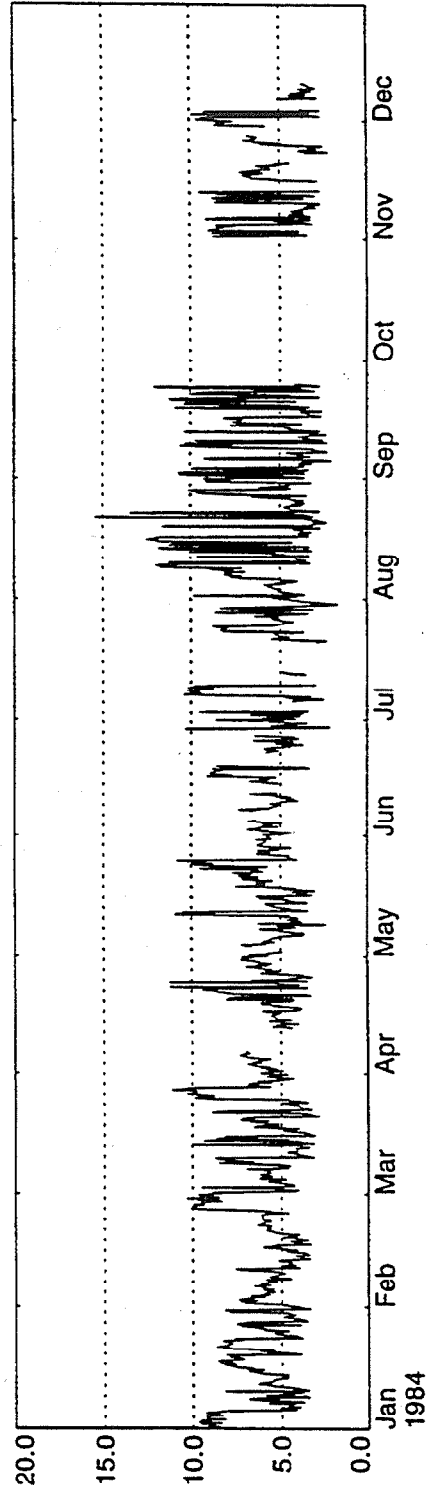
Wave data recording program  
Mackay Region

**Figure 6.09**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1984 to 31 December 1984



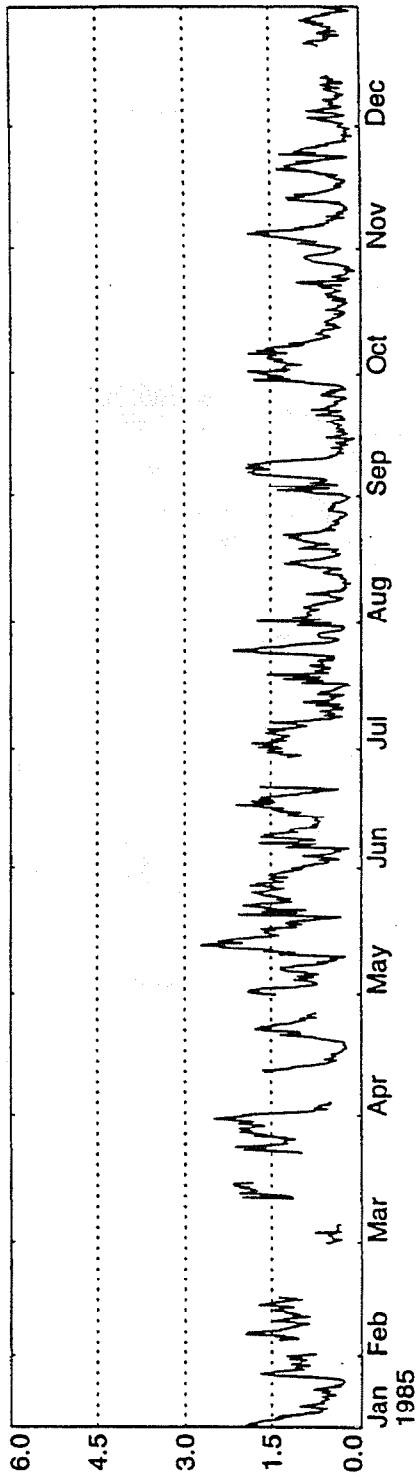
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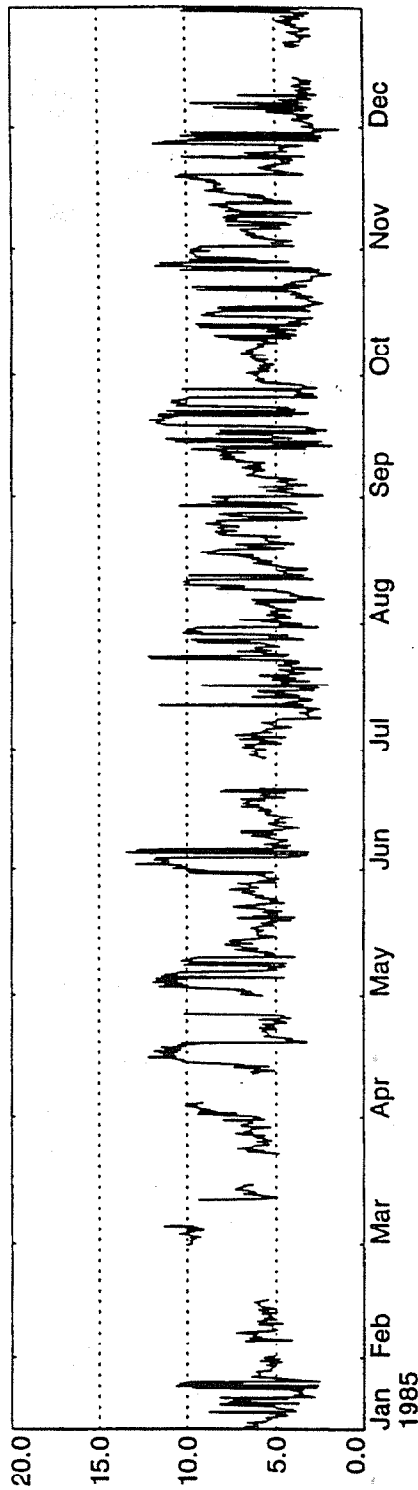
Wave data recording program  
Mackay Region

**Figure 6.10**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1985 to 31 December 1985



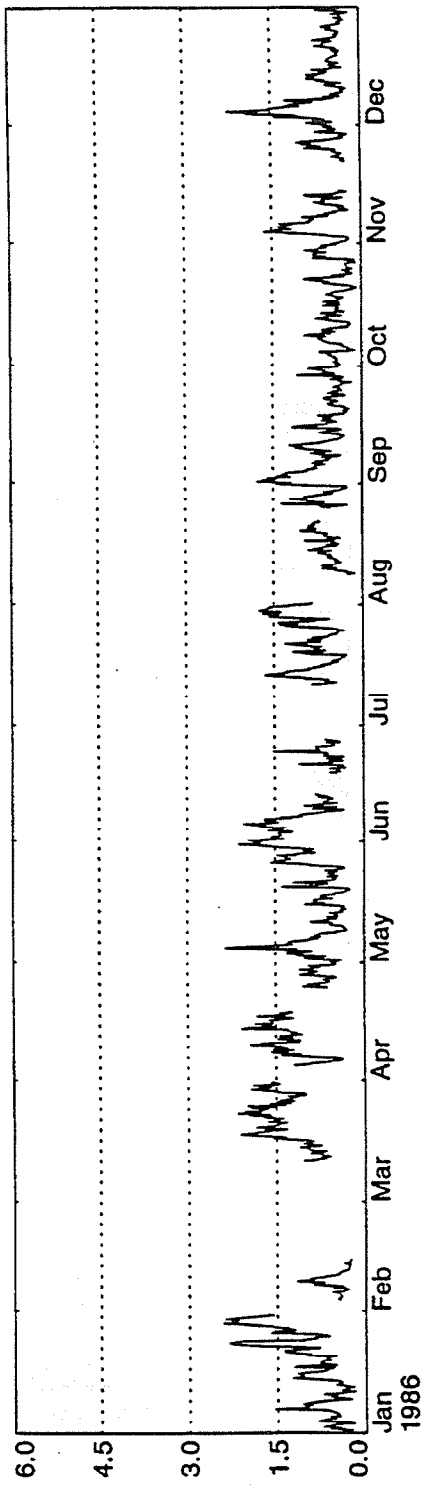
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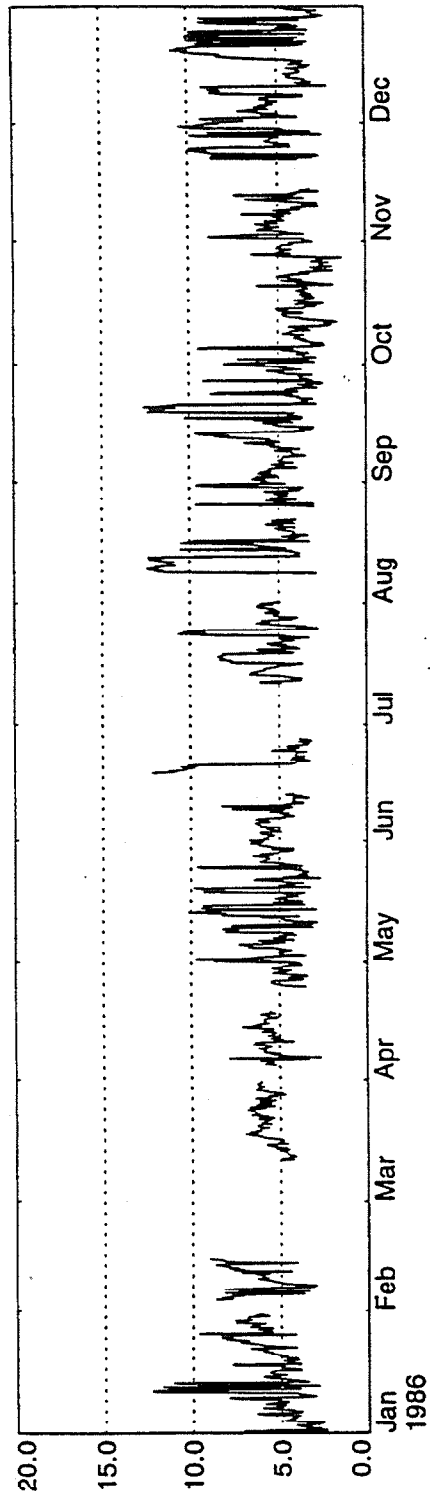
Wave data recording program  
Mackay Region

**Figure 6.11**

Mackay Hsig (m)



Mackay Tp (sec)



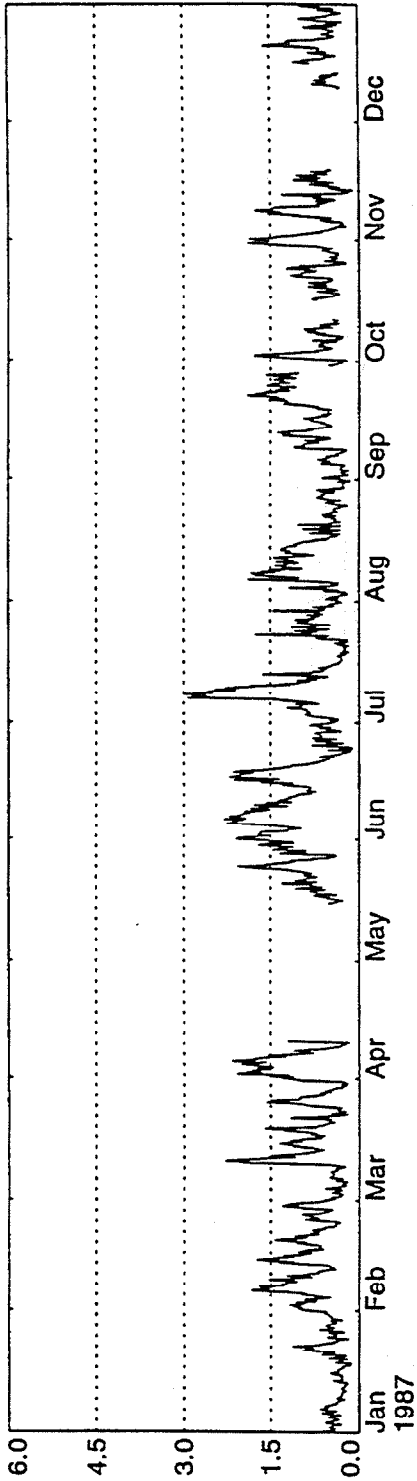
**Daily wave recordings**  
 1 January 1986 to 31 December 1986



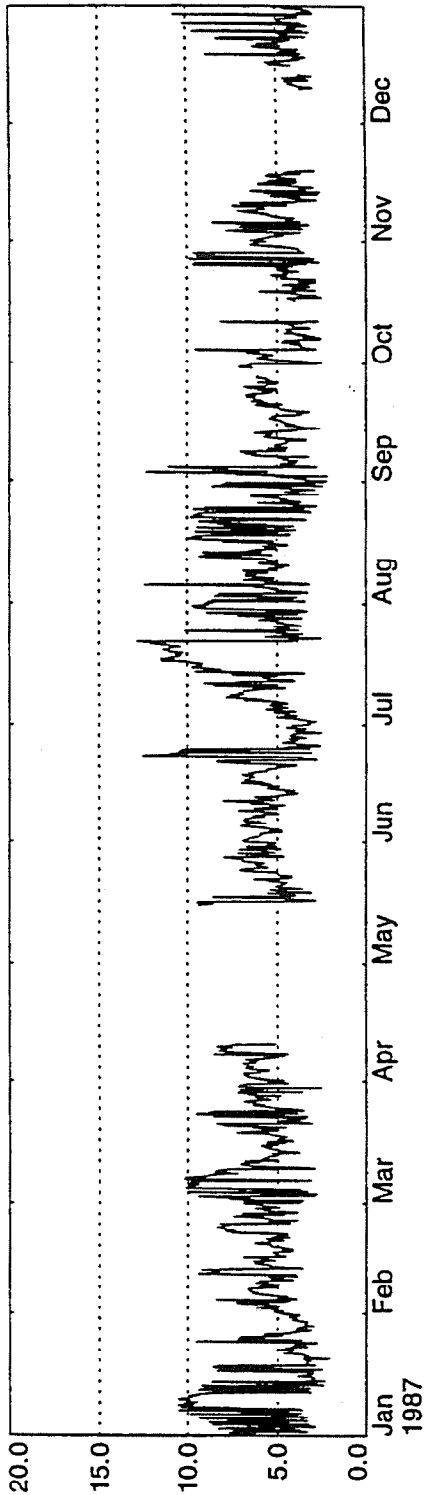
Wave data recording program  
 Mackay Region

**Figure 6.12**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1987 to 31 December 1987



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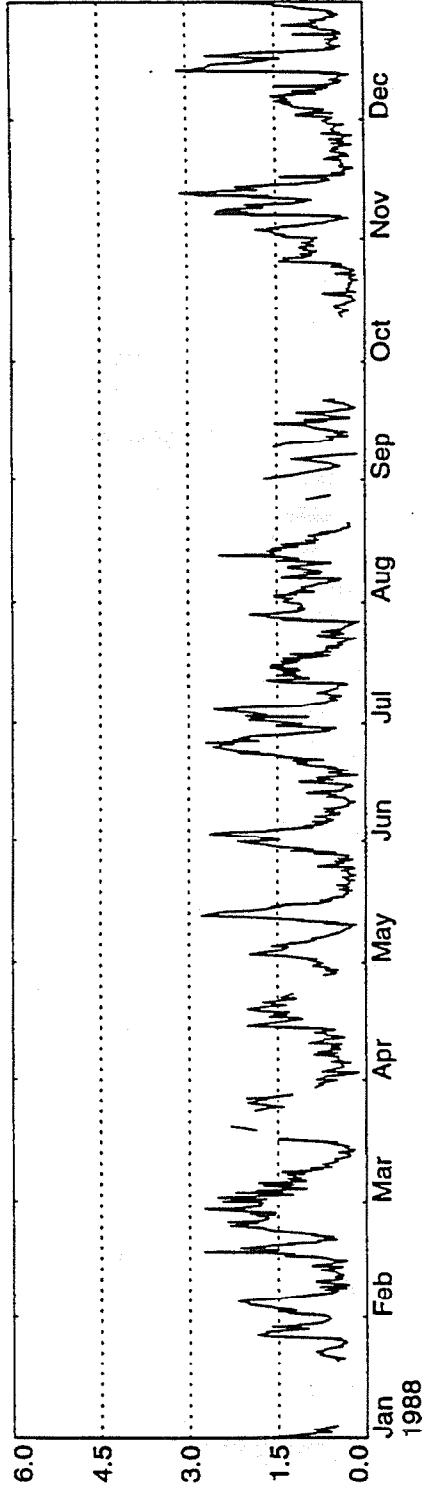
Department of Environment and Heritage

Wave data recording program  
Mackay Region

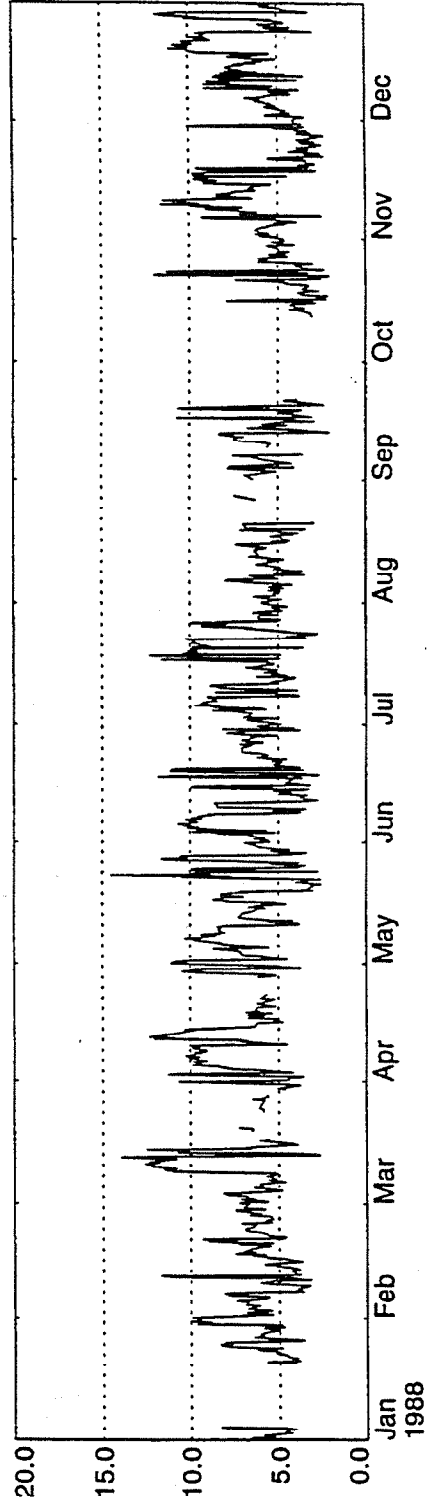
**Figure 6.13**



Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1988 to 31 December 1988



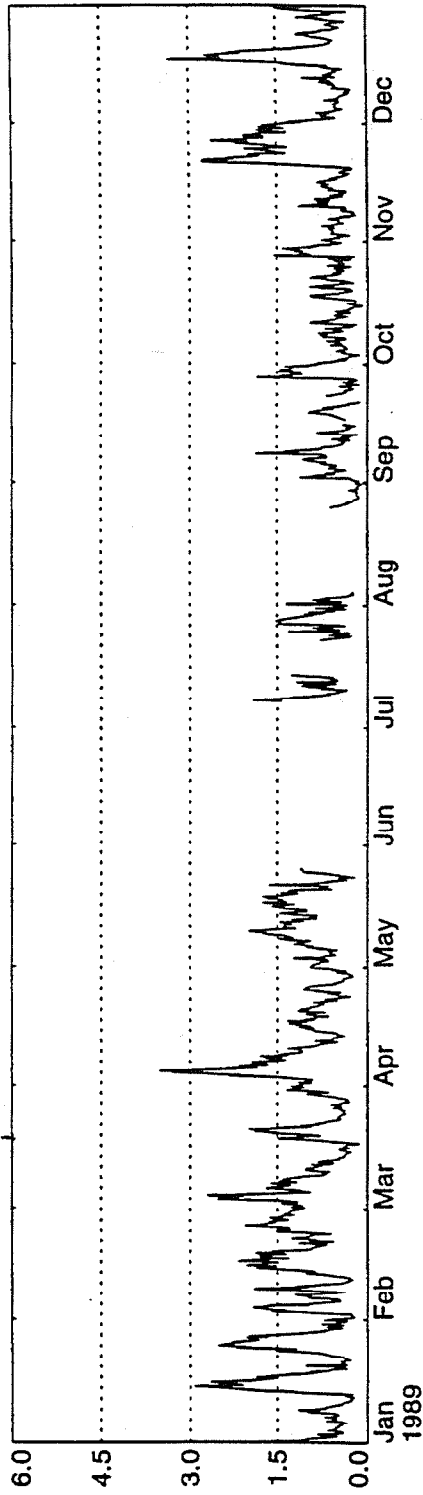
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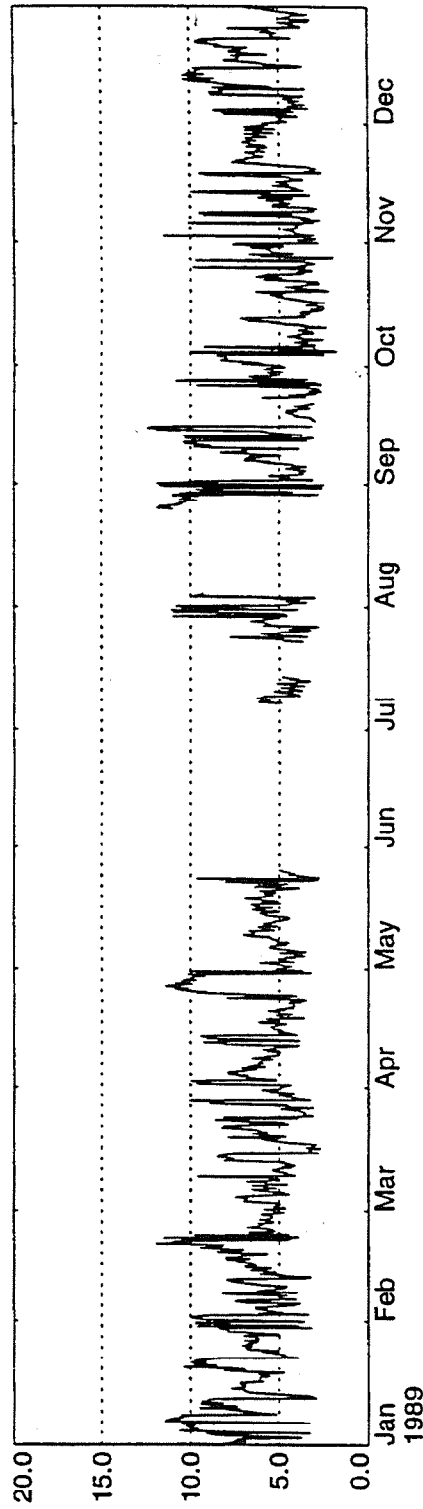
Wave data recording program  
Mackay Region

**Figure 6.14**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1989 to 31 December 1989



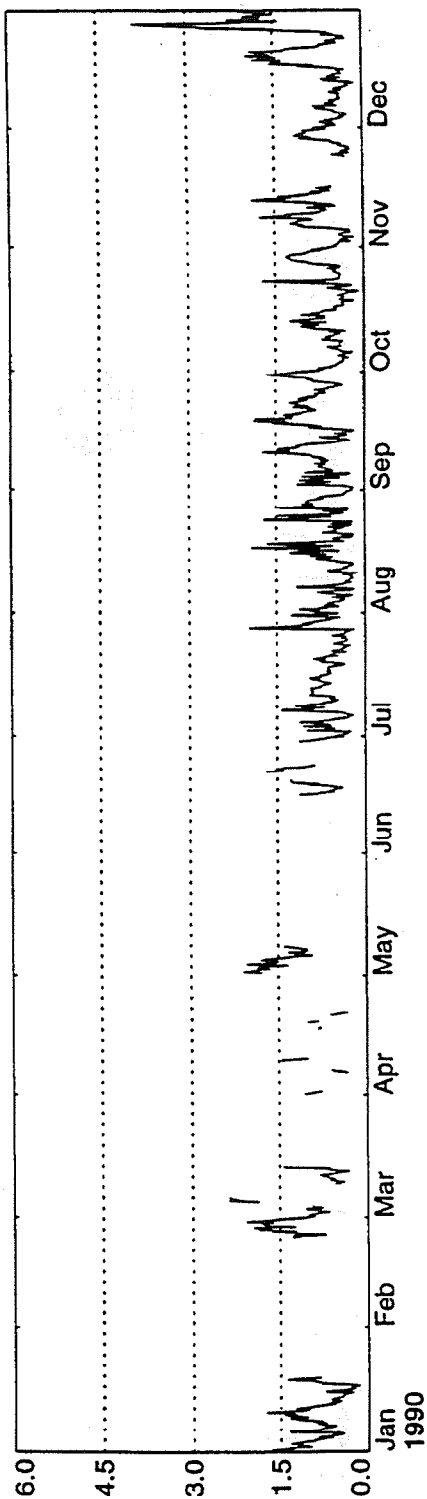
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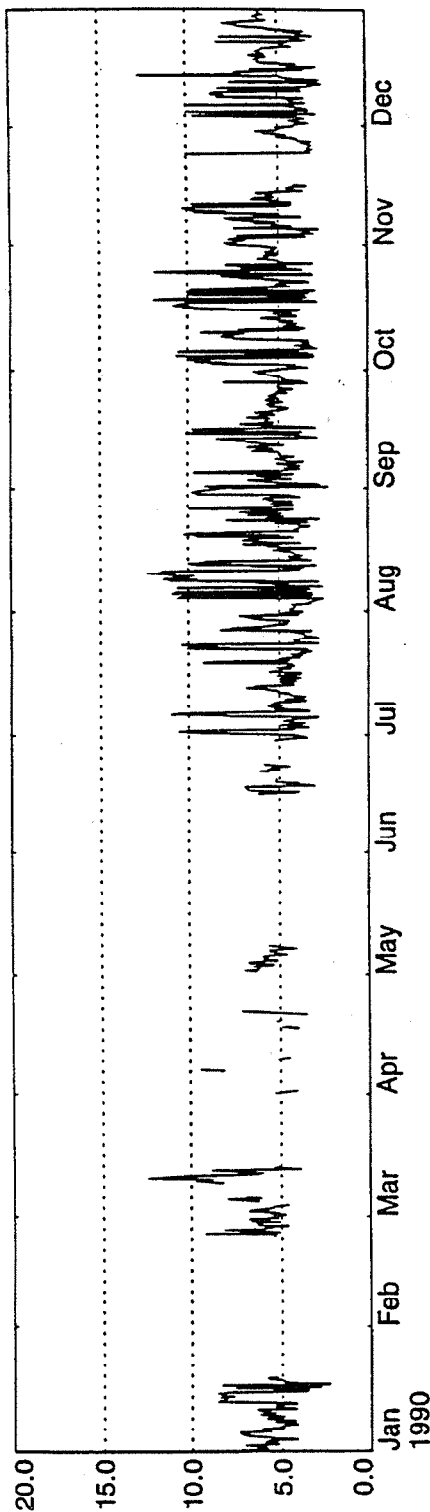
Wave data recording program  
Mackay Region

**Figure 6.15**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1990 to 31 December 1990



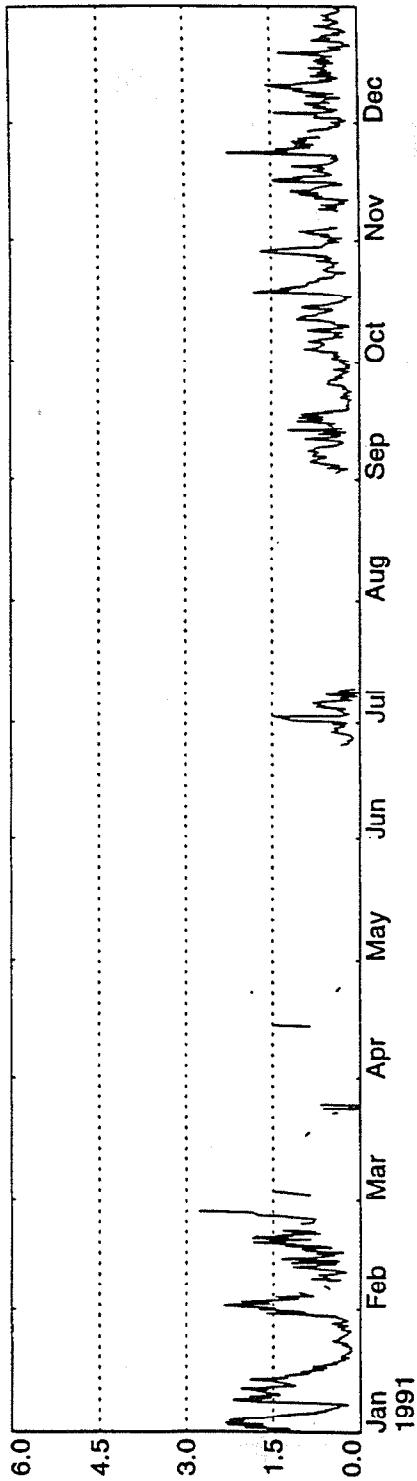
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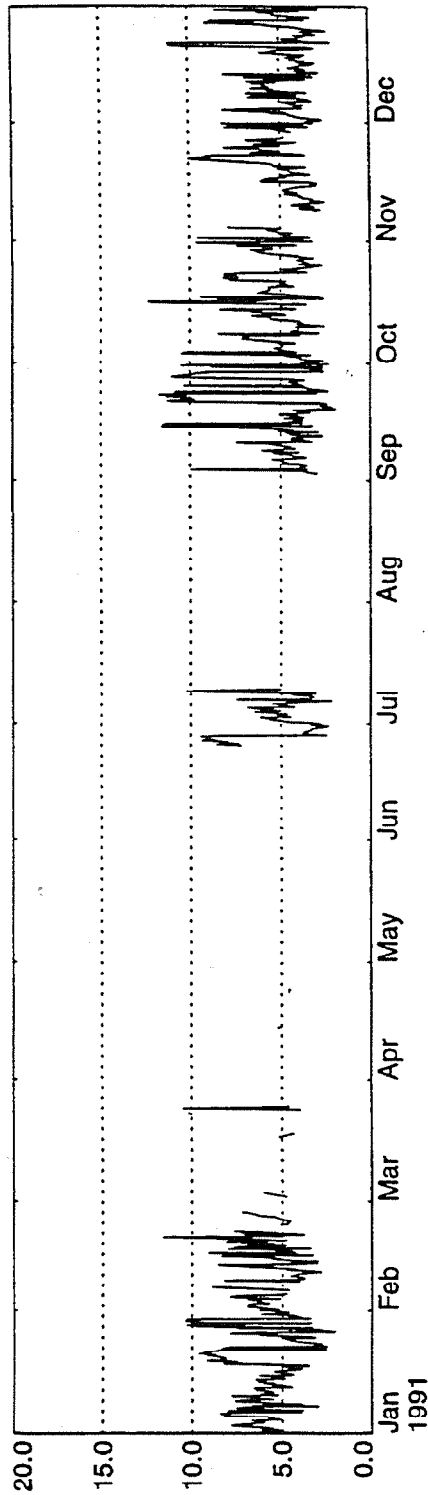
Wave data recording program  
Mackay Region

**Figure 6.16**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1991 to 31 December 1991

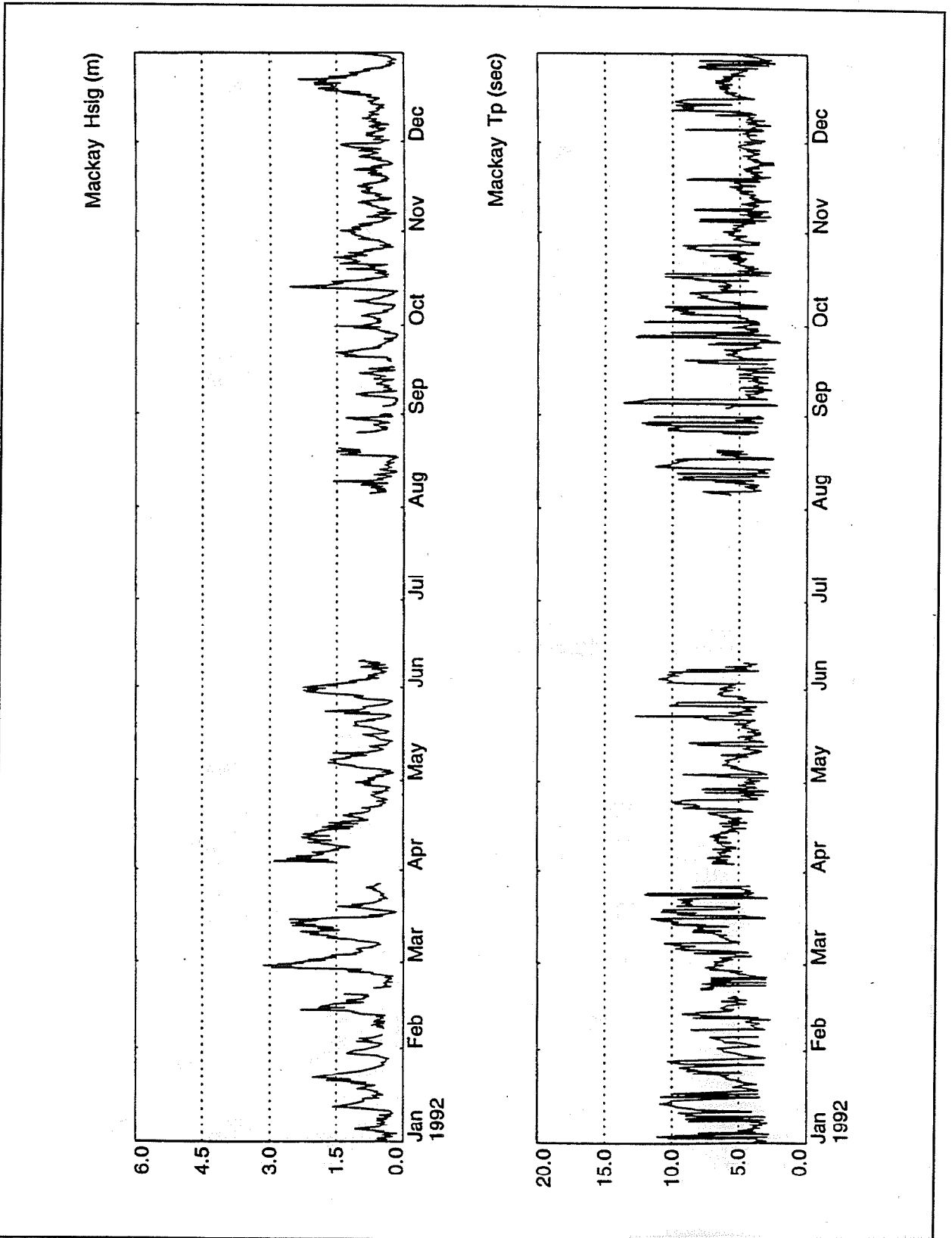


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Wave data recording program  
Mackay Region

**Figure 6.17**



**Daily wave recordings**  
 1 January 1992 to 31 December 1992



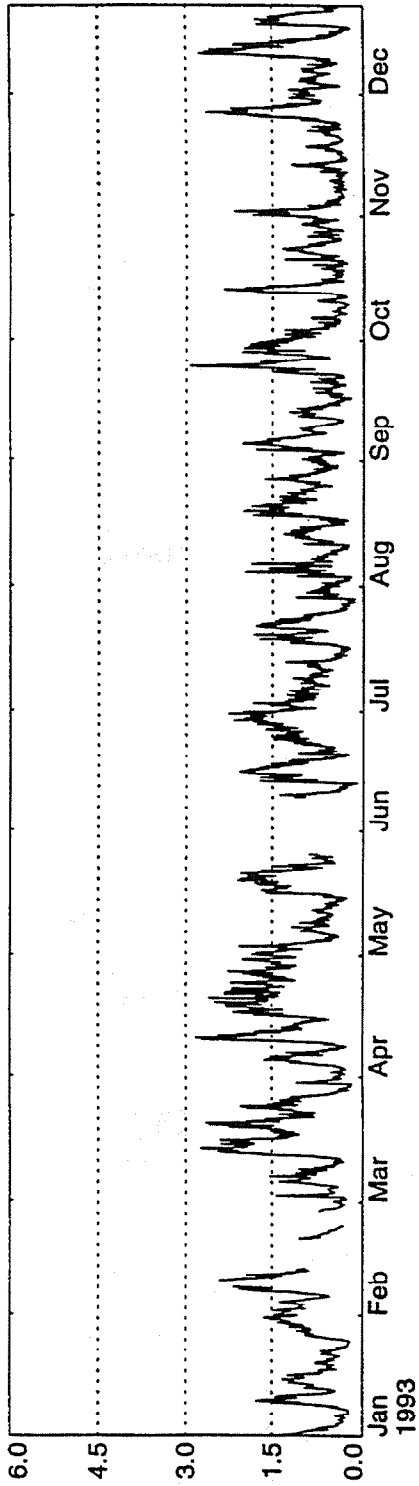
**Beach Protection  
 Authority  
 Queensland**

Department of Environment and Heritage

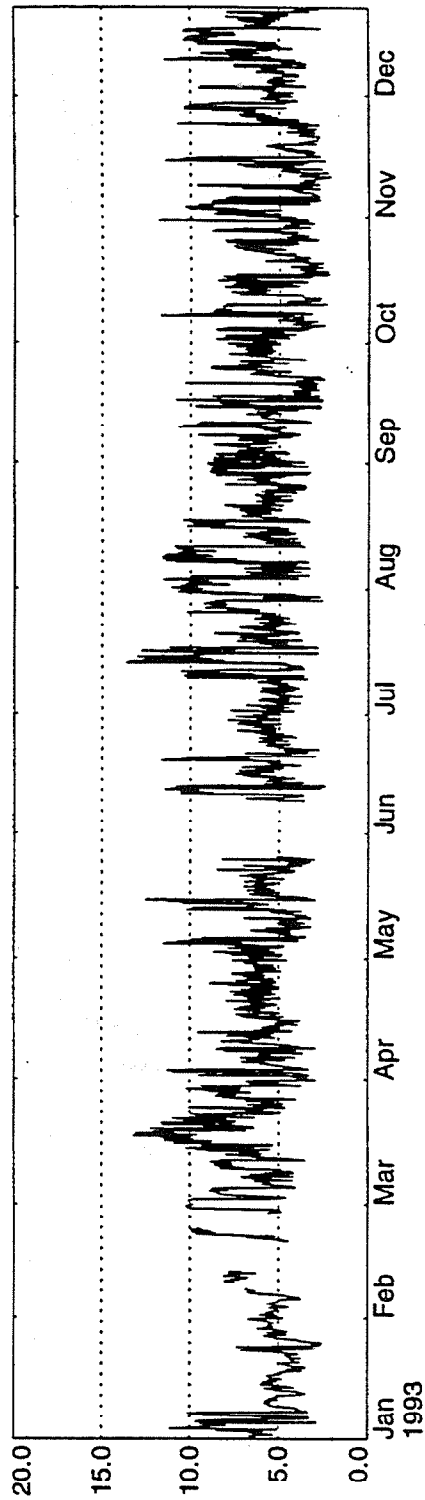
Wave data recording program  
 Mackay Region

**Figure 6.18**

Mackay Hs1g (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1993 to 31 December 1993



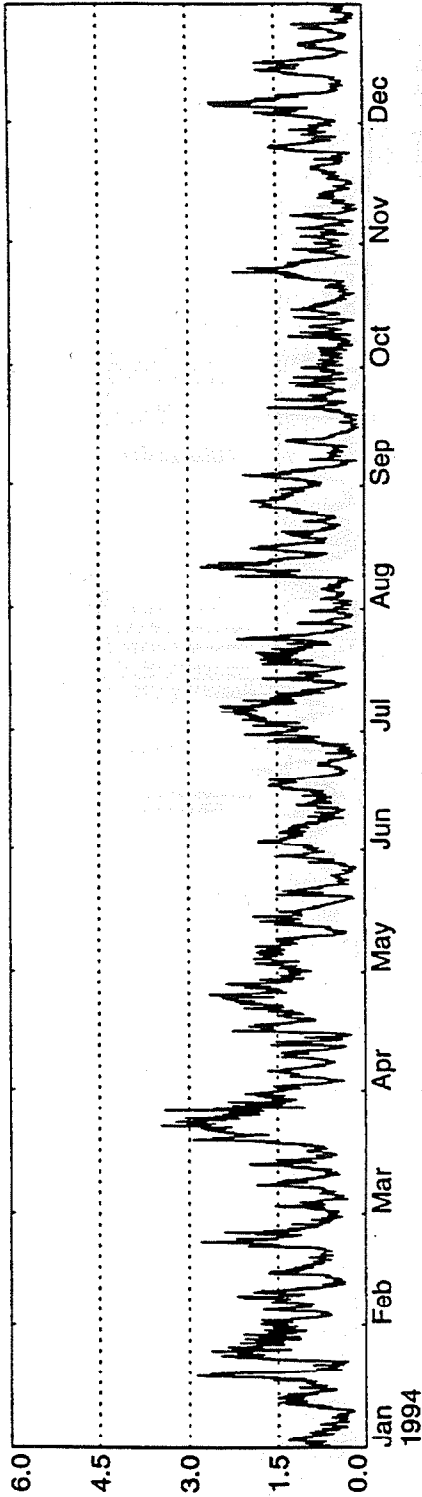
**Beach Protection  
Authority  
Queensland**

Department of Environment and Heritage

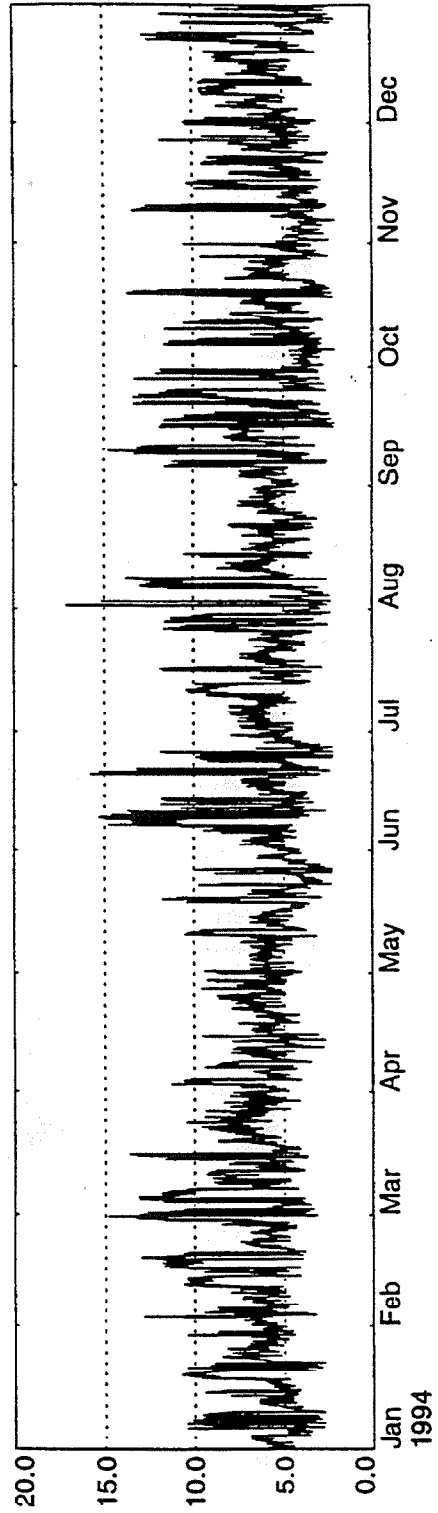
Wave data recording program  
Mackay Region

**Figure 6.19**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1994 to 31 December 1994



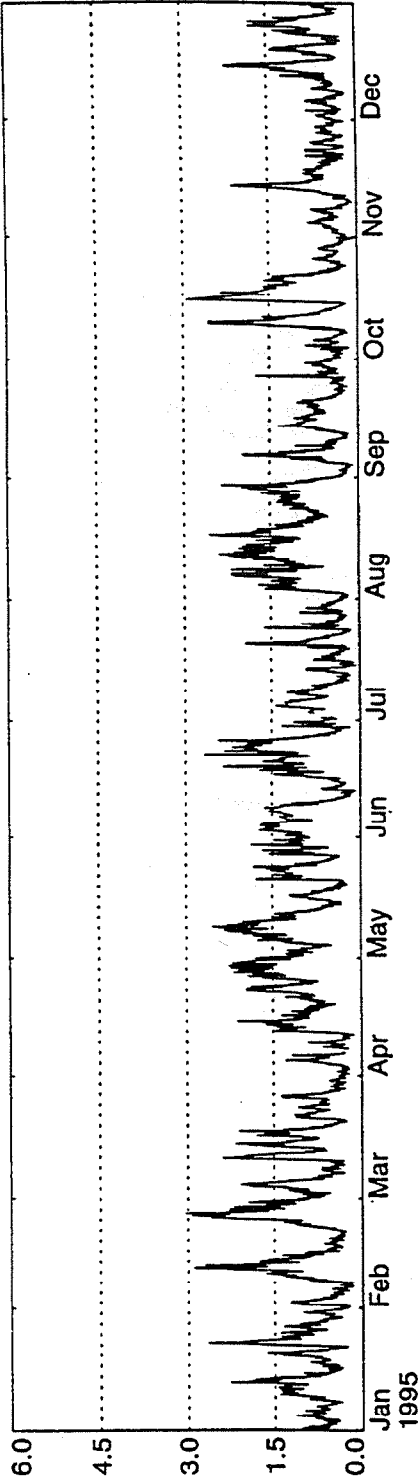
**Beach Protection  
Authority  
Queensland**

Department of Environment and Heritage

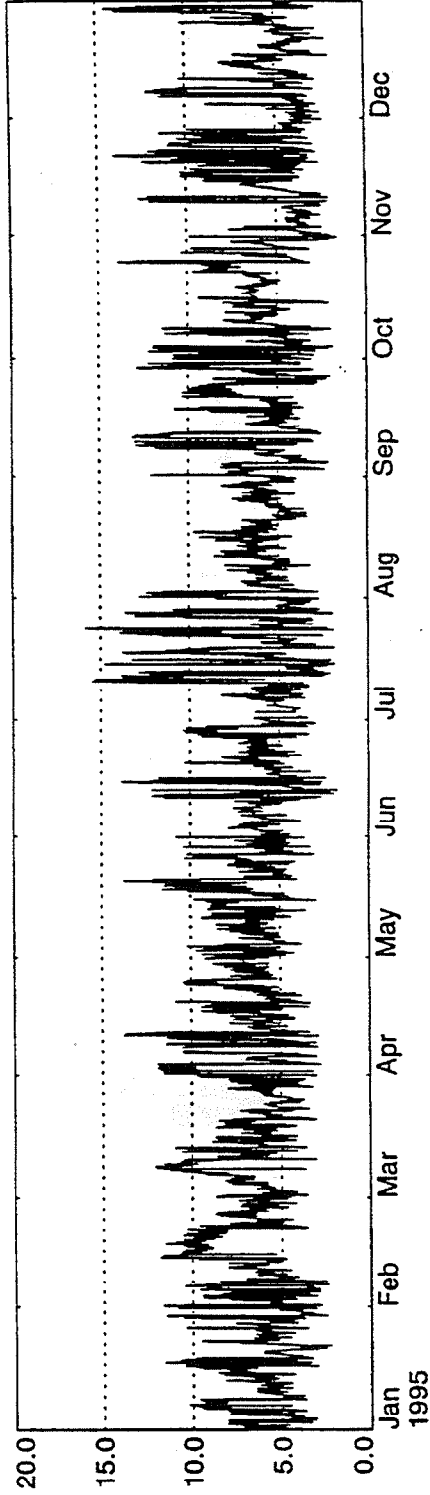
Wave data recording program  
Mackay Region

**Figure 6.20**

Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1995 to 31 December 1995



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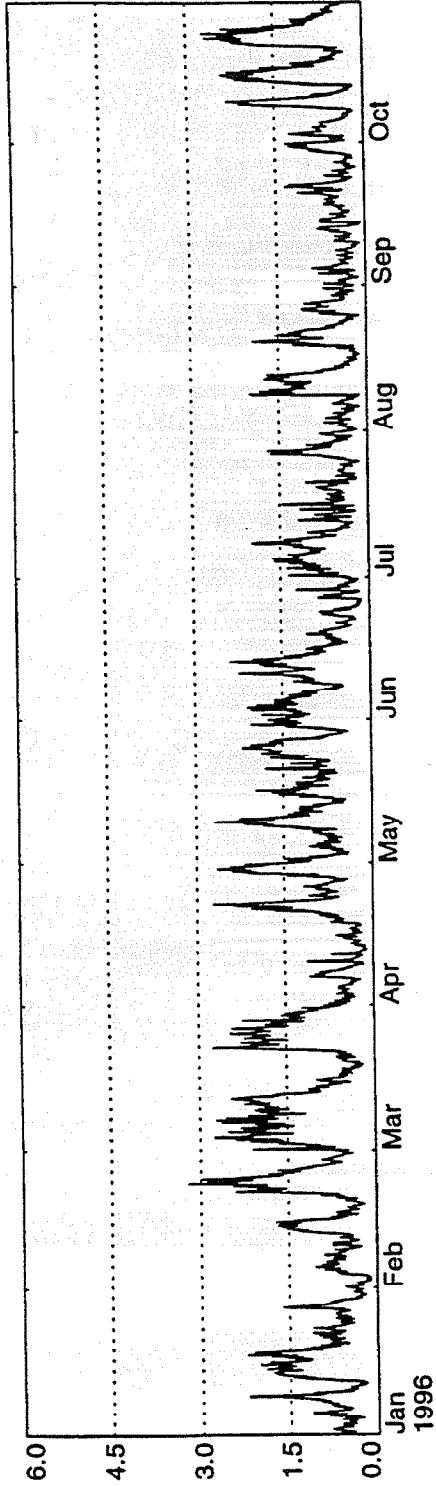
Department of Environment and Heritage

Wave data recording program  
Mackay Region

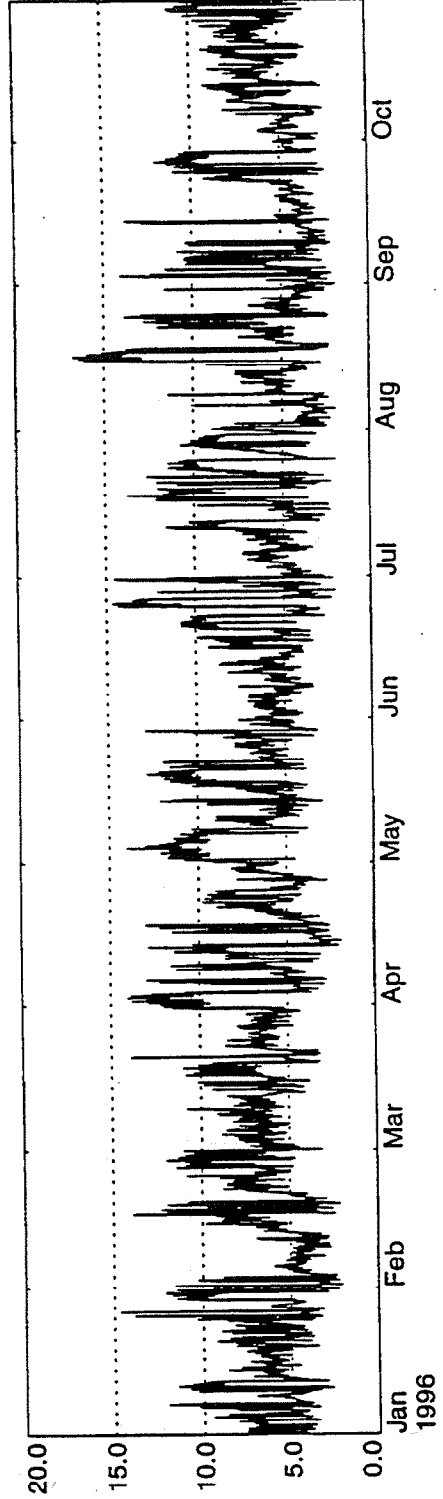
**Figure 6.21**



Mackay Hsig (m)



Mackay Tp (sec)



**Daily wave recordings**  
1 January 1996 to 31 December 1996

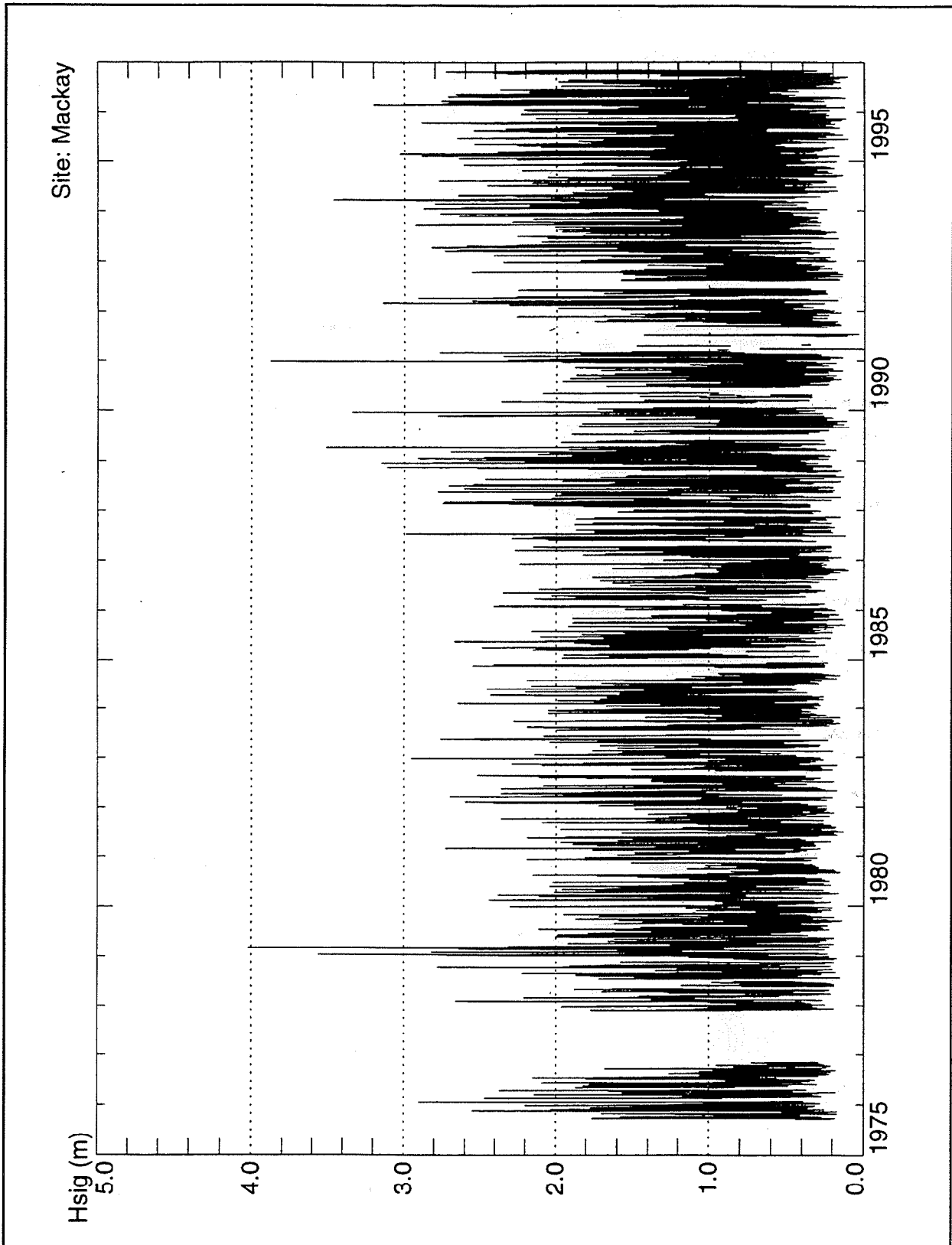


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Wave data recording program  
Mackay Region

**Figure 6.22**



Whole recording period wave heights (Hsig)

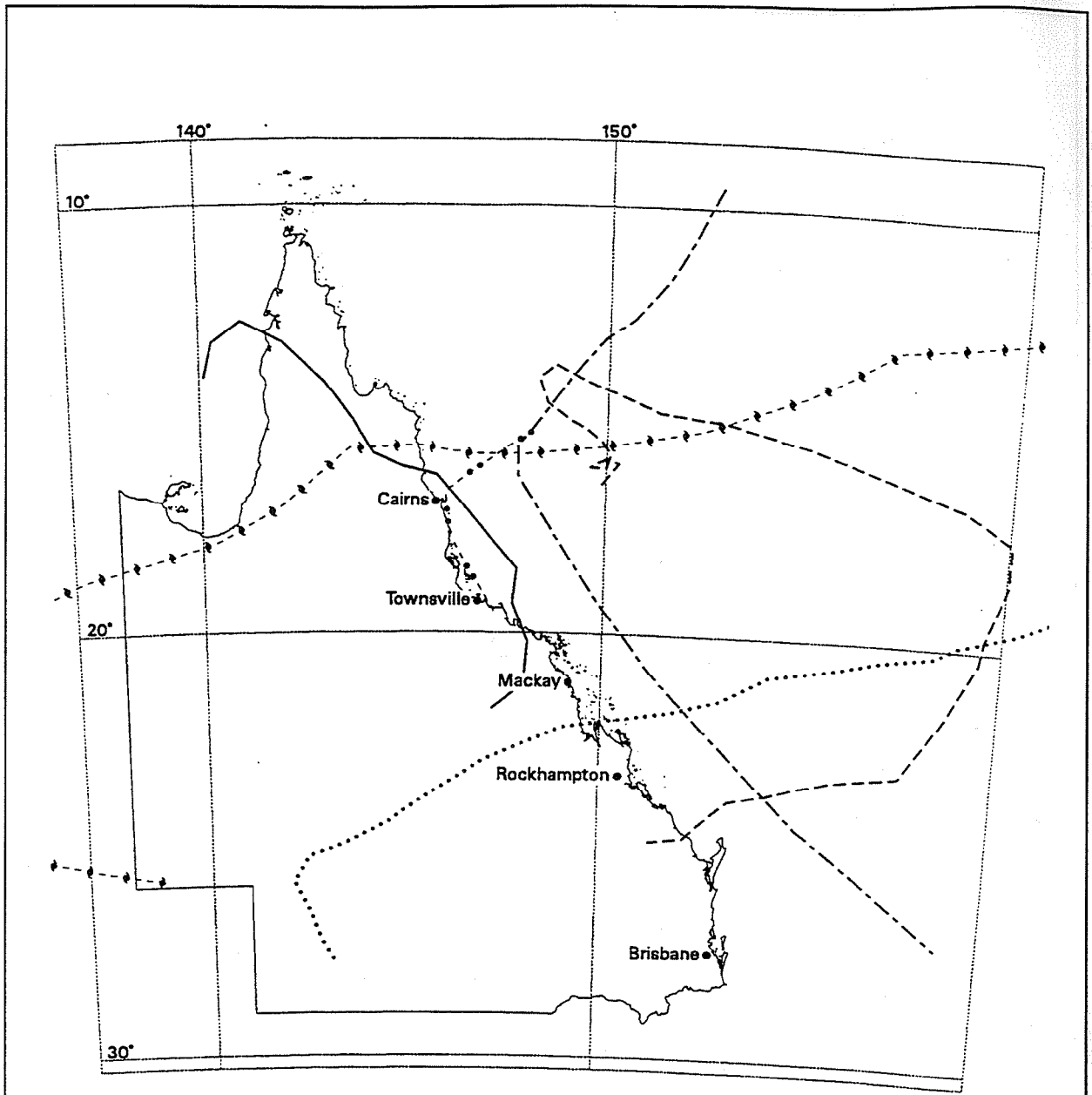


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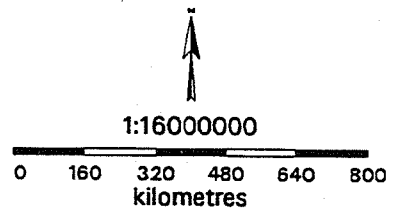
Wave data recording program  
Mackay Region

**Figure 7**



Key to cyclones

---◆---	Alan	-----	Beth
.....	David	- - - - -	Keith
—————	Otto	-----	Watorea



**Cyclone Tracks**  
1975-1977

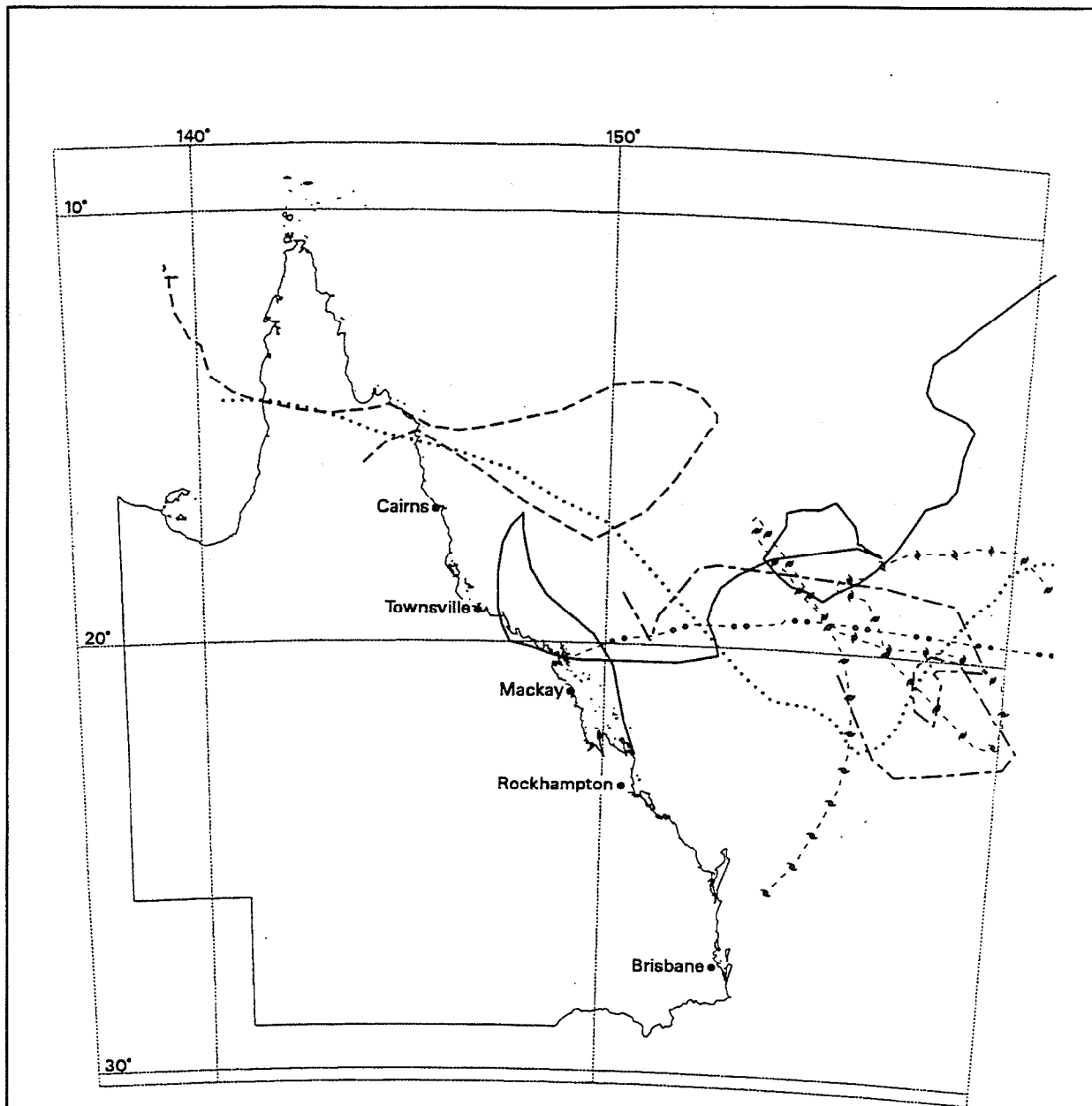


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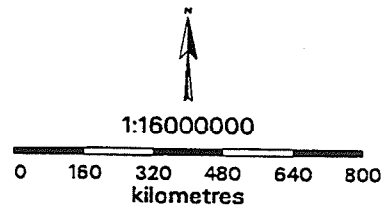
Department of Environment and Heritage

Wave data recording program  
Mackay Region

**Figure 8.01**



- Key to cyclones**
- |          |         |           |         |
|----------|---------|-----------|---------|
| ◆-◆-◆-◆- | Abigail | - - - - - | Dominic |
| .....    | Freda   | ·-·-·-·-  | Gordon  |
| —————    | Kerry   | - - - - - | Ruth    |

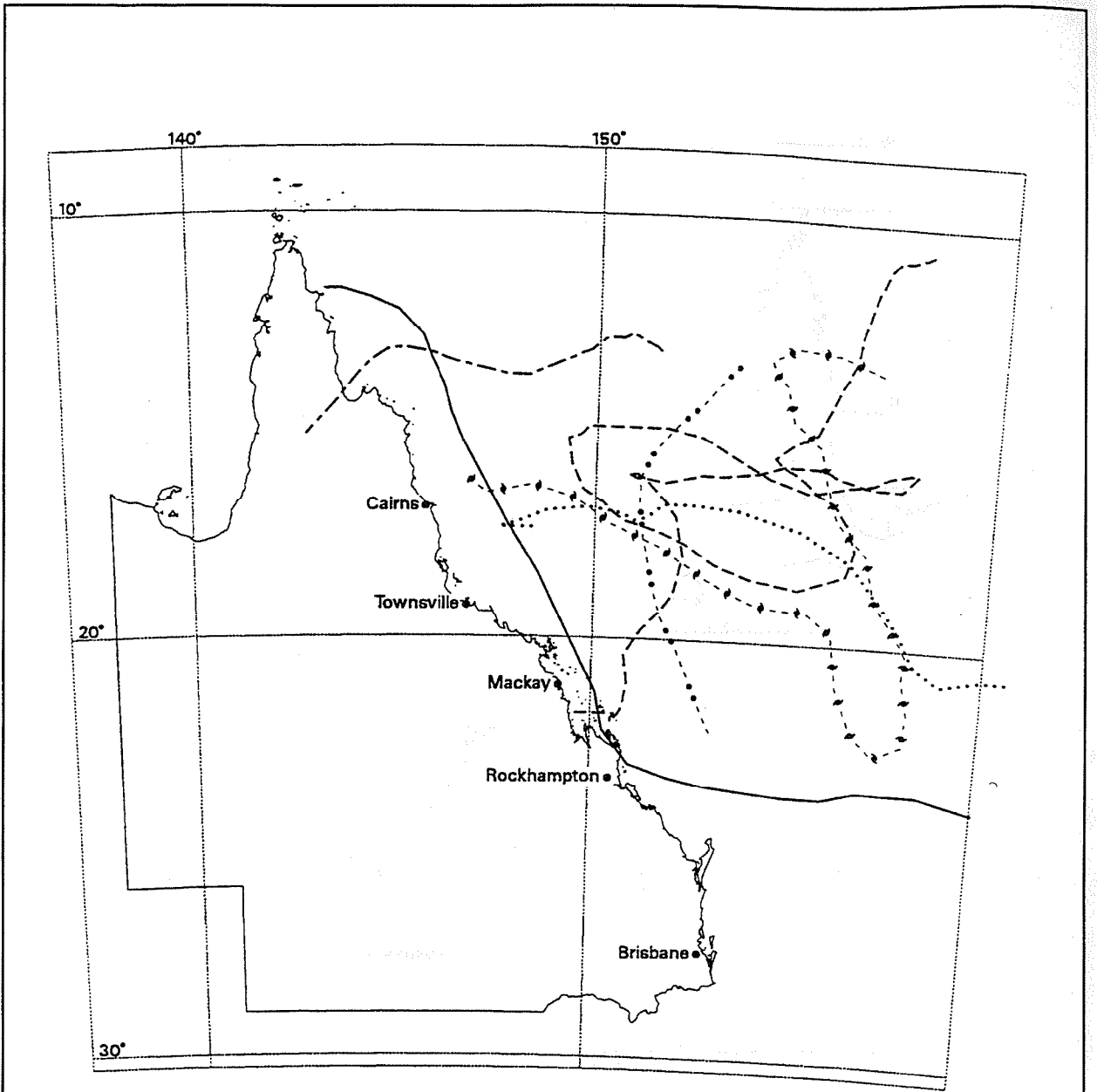


**Cyclone Tracks  
1978-1982**

 **Beach Protection  
Authority  
Queensland**  
Department of Environment and Heritage

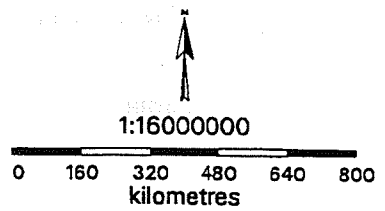
Wave data recording program  
Mackay Region

**Figure 8.02**



Key to cyclones

---◆---	Des	-----	Elinor
.....	Ingrid	- - - - -	Lance
—————	Pierre		Tanya



**Cyclone Tracks  
1983-1985**

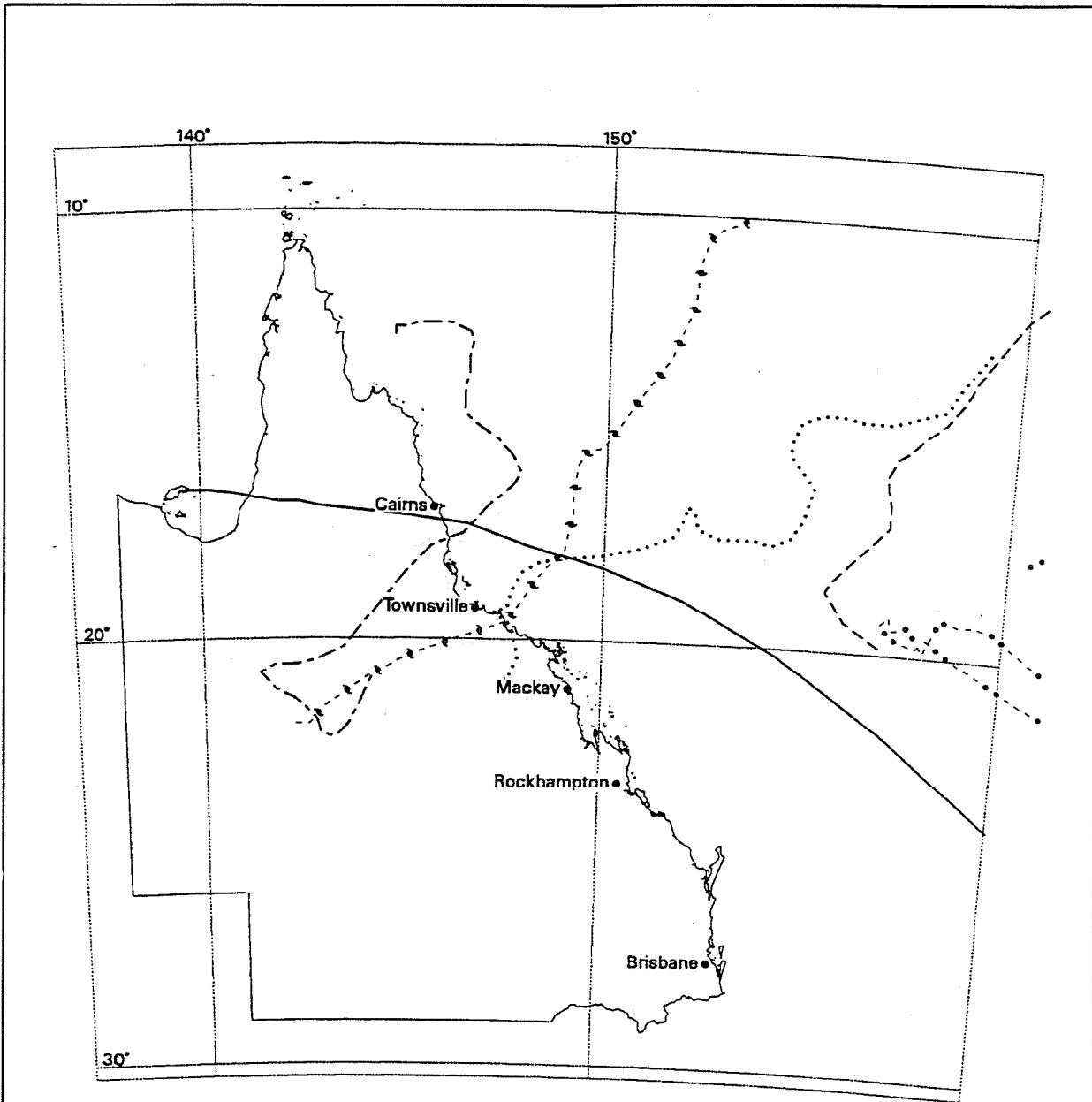


**Beach Protection  
Authority  
Queensland**

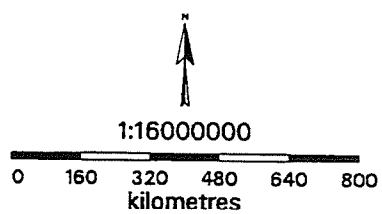
Department of Environment and Heritage

Wave data recording program  
Mackay Region

**Figure 8.03**



- Key to cyclones**
- |              |         |             |          |
|--------------|---------|-------------|----------|
| --->--->---> | Aivu    | -----       | Blanch   |
| .....        | Charlie | - . - . - . | Harry    |
| —————        | Vernon  | -----       | Winifred |



**Cyclone Tracks  
1986-1989**

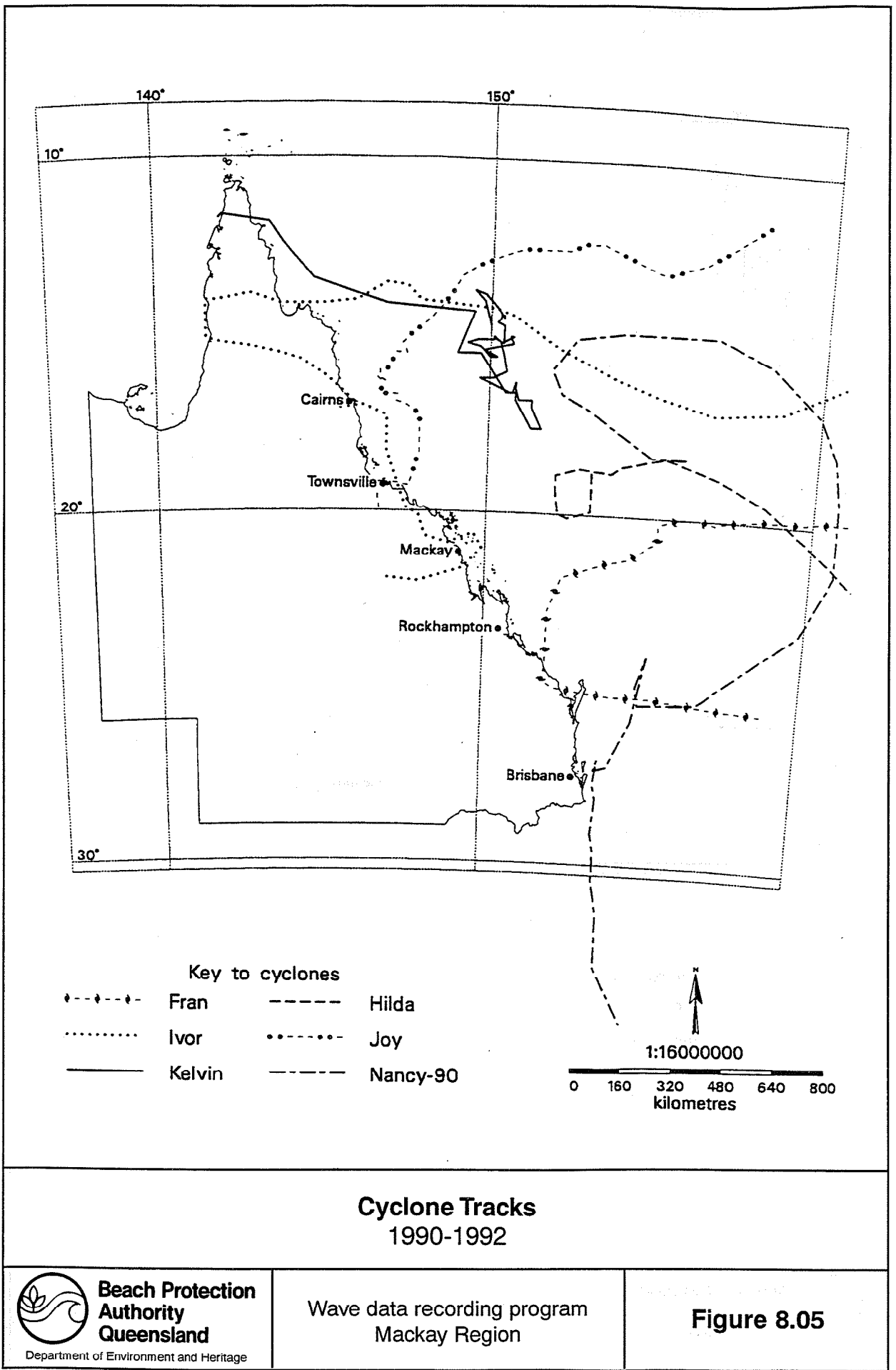


**Beach Protection  
Authority  
Queensland**

Department of Environment and Heritage

Wave data recording program  
Mackay Region

**Figure 8.04**

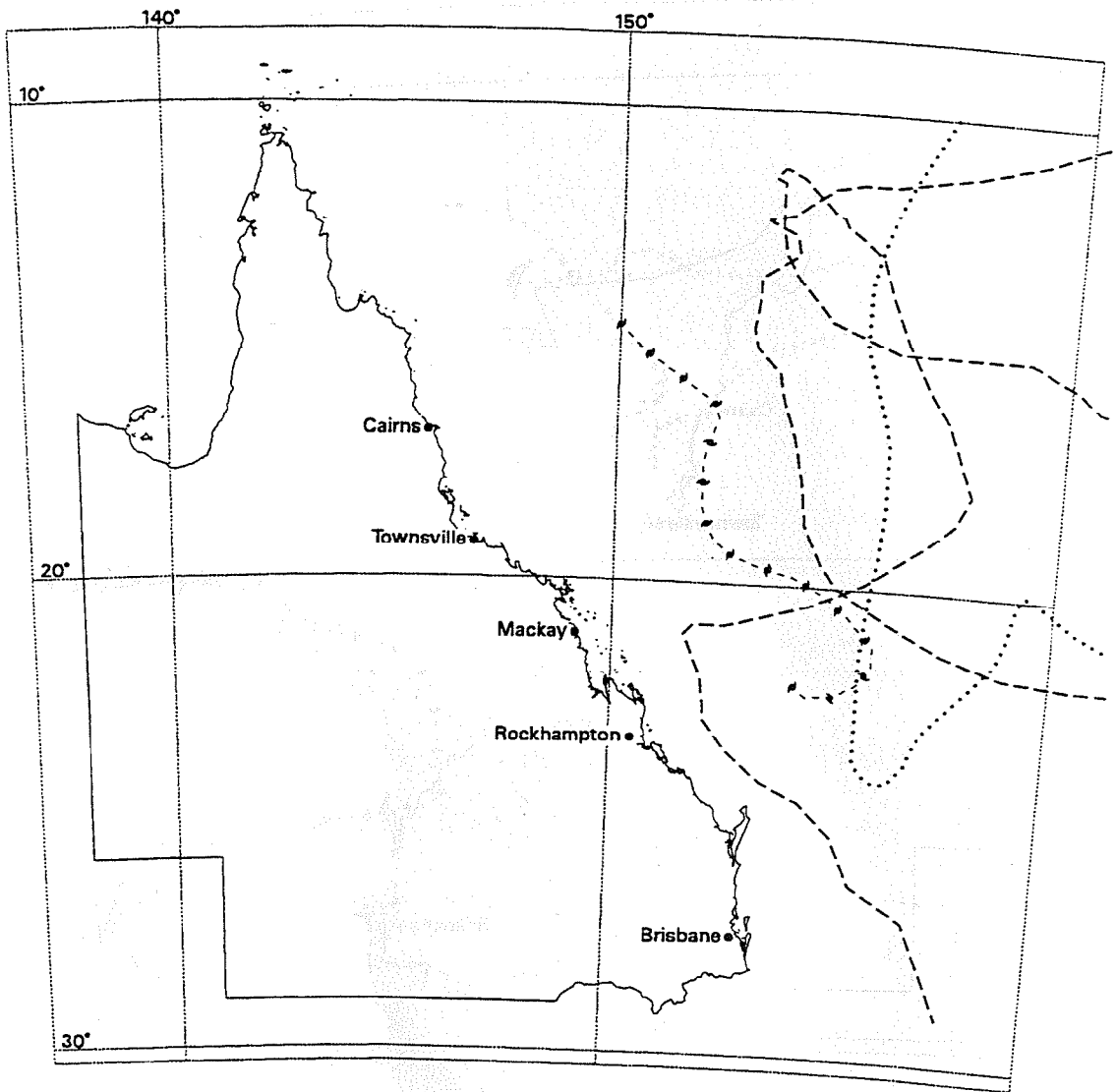


**Cyclone Tracks**  
1990-1992

  
**Beach Protection Authority Queensland**  
Department of Environment and Heritage

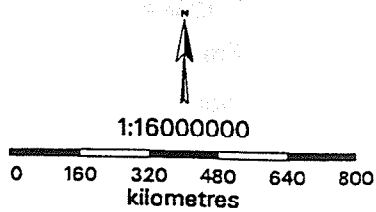
Wave data recording program  
Mackay Region

**Figure 8.05**



**Key to cyclones**

--->--->--->	Oliver	-----	Rewa
.....	Roger		



**Cyclone Tracks  
1993-1996**



**Beach Protection  
Authority  
Queensland**

Department of Environment and Heritage

Wave data recording program  
Mackay Region

**Figure 8.06**



