# Wave data recording program
# Kirra
# 1988 - 1994

Queensland
Department of
Environment and
Heritage

Conservation data report No.W15.1

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# Wave data recording program Kirra 1988-1994


## Abstract

This report provides summaries of primary analyses of wave data recorded in water depths of 16 metres and greater offshore from the Miles Street groyne and Kirra Point in southern Queensland. Data was recorded using a Datawell Waverider buoy, and covers the period 25 August 1988 to 30 June 1994. The data was 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, Division of Conservation, Queensland Department of Environment and Heritage on behalf of the Beach Protection Authority.





August 1994

Beach Protection Authority, c/ Queensland Department of Environment and Heritage, PO Box 155, BRISBANE ALBERT STREET QLD 4002.




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) 19 Nov. 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
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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
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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 (Report No.W14.1) 20 Feb. 1987 to 30 June 1994

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## 1.0 Introduction

As part of its long-term data collection program, the Beach Protection Authority has been recording wave characteristics along Queensland's coastline since 1968. The Kirra wave recording station has been funded jointly by the Queensland Government and the Gold Coast City Council as part of a series of beach nourishment projects in the southern Gold Coast area. This report summarises the primary analyses of wave data collected at the Kirra station. In addition, brief details of the recording equipment, the method of handling raw data and the type of analyses used are provided.

## 2.0 Recording equipment

All the Beach Protection Authority's wave recording stations use the Waverider system manufactured by Datawell b.v. of the Netherlands. In this system, a waverider buoy is used to determine the sea surface fluctuations at an offshore location. Vertical acceleration of the buoy is measured by an accelerometer mounted on a stabilised platform in the buoy and twice integrated to give displacement. The instantaneous water level data are then transmitted to the shore station as a frequency modulated high frequency radio signal.

In the original configuration of the Kirra station, first installed on 25 August 1988, the shore station consisted of a WAREP Waverider receiver and a DIMA digitiser/recorder. The WAREP receiver controlled the timing of data recording and provided a paper chart of the water level signal. 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, along with the paper charts, transferred to Brisbane office for processing.

On 1 January 1991, the wave recording system was upgraded to a personal computer-based system utilising the Datawell DIWAR Waverider receiver/digitiser. The water level data, digitised at 0.39 second intervals (2.56Hz), are recorded in bursts of 4096 points (approximately 27 minutes) and recorded on the hard disk of the PC. 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 which may be accessed remotely via the public switched telephone network. Recorded data and analysis results are downloaded daily to a central computer system in Brisbane for checking and archiving.

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

## 3.0 Wave recording and analysis procedures

Over the period 25 August 1988 to 31 December 1990, wave data have generally been recorded four times a day at 0300, 0900, 1500 and 2100 hours (Australian Eastern Standard Time). During storm events the recording frequency might have been manually switched by the operator to record eight times a day. Since 1 January 1991, the PC-based recording system has recorded data at (nominally) hourly intervals.

Recorded 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 autocorrelation method providing 50 lags at a spacing of 0.2 Hz. The PC-based analysis uses Fast Fourier Transform techniques to give 128 spectral estimates in bands of 0.01 Hz. 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 the waves in the record |
| Hmax | highest individual wave in the record |
| Hrms | 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 | average period of all zero upcrossing waves in the record (time domain) |
| Tpeak | wave period corresponding to the peak of the energy density spectrum |
| Tc | average period of all the waves in the record based on successive crests |

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

## 4.0 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 the WAREP/DIMA and the PC-based systems include some data rejection checks. In the case of the WAREP/DIMA data, the length of the record can be shortened to exclude corrupt data points. In the PC-based analysis, a small number of spurious data points can be corrected by an interpolation procedure. Otherwise the entire series is rejected.

Details of data losses for the Kirra wave recording station are included in Appendix 1.

## 5.0 Wave climate

The wave climate presented in this report is based on statistical analyses of the parameters obtained from the recorded wave data. Programs developed by the 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, 2 and 3 and figs.2, 3 and 4. In addition, similar analyses are carried out on the relationships between the various wave parameters and these are presented in fig.5.

## 6.0 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, the exact location of the buoy and the water depth in which the buoy was moored should be noted. This information is given in Appendix 1. The data presented does not include any information on wave directions. The Waverider recording system is designed to record only vertical movements of the water surface. Other means must be used to correlate wave directions and wave records.

When major meteorological events such as cyclones occurred during the recording period, these have been noted. They are summarised with the maximum wave heights recorded and other comments in Appendix 2.

For 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.

## 7.0 References

Datawell, *Operation and service manual for the Waverider - series 6000*
Datawell, *Manual of Waverider receiver type WAREP - mark II*
Datawell, *Manual of the digital Waverider receiver type DIWAR*
Datawell, *Manual of the digital magnetic tape recorder type DIMA - mark II*
Lawson and Treloar Pty Ltd (1991), *Real time wave analysis package*
Bureau of Meteorology, *Monthly weather review*

## Appendices

### Appendix 1 Details of Gold Coast wave recorder installations

Details of wave recorder installation
Location: 153°31.7' East, 28°09.5' South; 0.82nm off Kirra Point (see fig.1)
Period: 25 August 1988 to 28 July 1991
Water depth at buoy: 16 metres relative to low water datum

Note: This location was calculated using radar ranging and compass bearings to prominent landmarks.

Location: 153°31.76' East, 28°09.43' South; 1.5km offshore Kirra Point (see fig.1)
Period: 28 July 1991 to present
Water depty at buoy: 16 metres relative to low water datum

Note: This location was measured using GPS fixing procedures.

All water depths are accurate to ±1m.

#### Location of recording station

Air Sea Rescue Facility, Point Danger

#### Recording

Normal recording interval: Four 20-minute records daily at 0300 hours, 0900 hours, 1500 hours and 2100 hours between 25 August 1988 and 31 December 1990.

From 1 January 1991, one-hourly samples approximately 26 minutes long have been taken giving 4096 water surface elevation figures for that period from which sea state parameters are calculated and recorded.

Number of records analysed: 30 677
Number of days in recording period 25 August 1988 to 30 June 1994: 2135
Number of days of data lost due to equipment failure and signal corruption (see 4.0 above): 293
Percentage of recordings available for analysis: 86.3%

## Appendix 2 Major meteorological events

| Meteorological event | Central pressure (HPa) | Date | Estimated position of cyclone relative to buoy (km) | Maximum Hsig recorded (metres) | Maximum Hmax recorded (metres) | Tp (secs) |
|---|---|---|---|---|---|---|
| Cyclone Aivu | 955 | 05-04-89 | 800 NNE | 2.49 | 4.59 | 10.02 |
| Low pressure system off south-east Queensland and high pressure system off southern central NSW | 1000 and 1028 | 25-04-89 | | 2.50 | 4.39 | 11.75 |
| Low pressure system off south-east Queensland | 1004 | 29-05-89 | | 2.63 | 4.76 | 10.22 |
| Low pressure system off south-east Queensland | 1004 | 19-08-89 | | 2.69 | 4.46 | 10.16 |
| High pressure system over Tasman Sea | 1024 | 07-09-89 | | 4.09 | 5.81 | 9.43 |
| Cyclone Nancy | 975 | 01-02-90 | 375 NE | 2.01 | 3.18 | 10.81 |
| Cyclone Betsy | 978 | 13-01-92 | 740 NE | 2.61 | 4.16 | 13.16 |
| Cyclone Daman | 998 | 18-02-92 | 410 E | 2.71 | 3.85 | 17.12 |
| Cyclone Fran | 980 | 16-03-92 | | ** | ** | ** |
| Cyclone Roger | 992 | 17-03-93 | 450 NE | 4.85 | 7.73 | 13.35 |
| Cyclone Rewa | 992 | 21-01-94 | 320 ENE | 2.38 | 4.26 | 10.38 |

** Data not available due to buoy failure.

The highest significant wave height (Hsig) recorded was 4.85 metres on 17 March 1993 due to the passage of Cyclone Roger off the south Queensland coast.

The highest maximum wave height (Hmax) recorded was 7.73 metres on 17 March 1993 due to the passage of Cyclone Roger off the south Queensland coast.

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

Events are reported only where recorded data available and Hsig exceeds 2.0 metres.

***Table 1.*** *Wave statistics — Wave period/water height occurrences — All data, all directions.*

| Significant wave height (metres) | Peak energy wave period (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 - 0.25 | * | * | 0.17 | 0.73 | 3.81 | 2.04 | 1.92 | 0.35 | 9.02 |
| 0.26 - 0.50 | 2.35 | 15.69 | 38.81 | 57.97 | 123.80 | 92.19 | 30.43 | 9.56 | 370.80 |
| 0.51 - 0.75 | 2.24 | 55.50 | 107.71 | 137.28 | 155.09 | 88.75 | 28.96 | 12.08 | 587.62 |
| 0.76 - 1.00 | 1.61 | 40.99 | 86.19 | 157.49 | 84.16 | 41.48 | 11.25 | 2.50 | 425.66 |
| 1.01 - 1.25 | 0.25 | 13.26 | 43.86 | 101.05 | 55.90 | 15.40 | 4.84 | 0.58 | 235.14 |
| 1.26 - 1.50 | * | 2.31 | 19.48 | 43.10 | 35.58 | 11.02 | 1.11 | 0.34 | 112.93 |
| 1.51 - 1.75 | * | 0.04 | 5.85 | 17.88 | 26.53 | 7.50 | 0.74 | 0.12 | 58.67 |
| 1.76 - 2.00 | * | * | 1.30 | 7.11 | 10.31 | 5.65 | 1.12 | 0.08 | 25.58 |
| 2.01 - 2.25 | * | * | 0.31 | 2.59 | 8.13 | 5.51 | 0.52 | * | 17.07 |
| 2.26 - 2.50 | * | * | * | 1.01 | 6.00 | 2.46 | 0.04 | 0.08 | 9.60 |
| 2.51 - 2.75 | * | * | 0.25 | 0.33 | 2.93 | 1.21 | 0.08 | 0.04 | 4.85 |
| 2.76 - 3.00 | * | * | * | 0.13 | 1.95 | 0.62 | 0.33 | * | 3.03 |
| 3.01 - 3.25 | * | * | * | 0.17 | 1.08 | 0.63 | 0.42 | * | 2.30 |
| 3.26 - 3.50 | * | * | * | 0.04 | 0.24 | 0.24 | 0.04 | * | 0.56 |
| 3.51 - 3.75 | * | * | * | * | * | 0.13 | * | * | 0.13 |
| 3.76 - 4.00 | * | * | * | * | 0.25 | 0.17 | 0.08 | * | 0.50 |
| 4.01 - 4.25 | * | * | * | * | * | 0.17 | 0.08 | * | 0.25 |
| 4.26 - 4.50 | * | * | * | * | * | 0.08 | 0.08 | * | 0.17 |
| 4.51 - 4.75 | * | * | * | * | * | 0.30 | 0.04 | * | 0.34 |
| 4.76 - 5.00 | * | * | * | * | * | * | 0.04 | * | 0.04 |
| 5.01 - 5.25 | * | * | * | * | * | 0.25 | * | * | 0.25 |
| 5.26 - 5.50 | * | * | * | * | * | * | * | * | 0.00 |
| 5.51 - 5.75 | * | * | * | * | * | * | * | * | 0.00 |
| 5.76 - 6.00 | * | * | * | * | * | * | * | * | 0.00 |
| 6.01 - 6.25 | * | * | * | * | * | * | * | * | 0.00 |
| 6.26 - 6.50 | * | * | * | * | * | * | * | * | 0.00 |
| Totals | 6.45 | 127.79 | 303.94 | 526.89 | 515.76 | 275.81 | 82.13 | 25.74 | 1864.50 |

Values in days have been rounded to two decimal places.

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

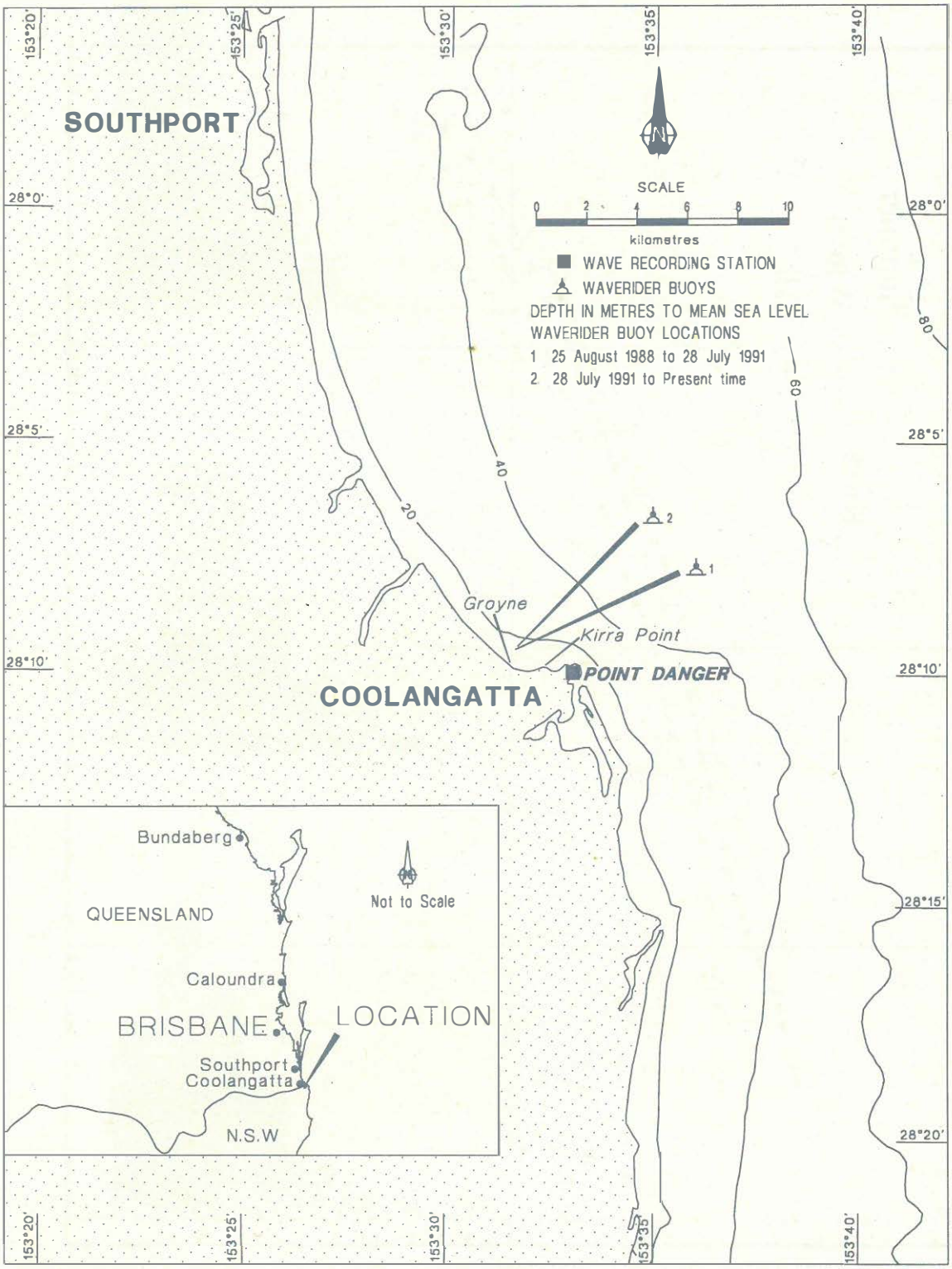
| Significant wave height (metres) | Peak energy wave period (seconds) | | | | | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|
| | 0 - 2.99 | 3 - 4.99 | 5 - 6.99 | 7 - 8.99 | 9 - 10.99 | 11 - 12.99 | 13 - 14.99 | > 14.99 | |
| 0.00 - 0.25 | * | * | * | 0.29 | 0.42 | * | 0.25 | * | 0.96 |
| 0.26 - 0.50 | 0.17 | 5.74 | 18.49 | 23.55 | 32.26 | 13.26 | 3.62 | 1.08 | 98.17 |
| 0.51 - 0.75 | 0.39 | 28.66 | 65.95 | 86.26 | 81.07 | 26.64 | 10.06 | 2.06 | 301.09 |
| 0.76 - 1.00 | * | 21.62 | 52.95 | 117.37 | 60.77 | 21.69 | 6.44 | 0.81 | 282.64 |
| 1.01 - 1.25 | * | 8.03 | 22.06 | 72.39 | 41.30 | 10.66 | 2.86 | * | 157.32 |
| 1.26 - 1.50 | * | 1.08 | 8.89 | 30.88 | 27.71 | 6.96 | 0.48 | * | 76.01 |
| 1.51 - 1.75 | * | * | 1.76 | 12.48 | 21.11 | 5.75 | 0.27 | 0.04 | 41.41 |
| 1.76 - 2.00 | * | * | 0.91 | 4.92 | 7.22 | 4.78 | 1.12 | 0.08 | 19.03 |
| 2.01 - 2.25 | * | * | 0.25 | 1.37 | 5.81 | 3.68 | 0.52 | * | 11.64 |
| 2.26 - 2.50 | * | * | * | 0.70 | 4.95 | 2.42 | 0.04 | 0.08 | 8.19 |
| 2.51 - 2.75 | * | * | 0.25 | 0.33 | 2.43 | 0.46 | 0.08 | 0.04 | 3.59 |
| 2.76 - 3.00 | * | * | * | 0.13 | 1.47 | 0.13 | 0.08 | * | 1.81 |
| 3.01 - 3.25 | * | * | * | 0.17 | 0.82 | 0.63 | 0.04 | * | 1.66 |
| 3.26 - 3.50 | * | * | * | 0.04 | 0.24 | 0.24 | 0.04 | * | 0.56 |
| 3.51 - 3.75 | * | * | * | * | * | 0.13 | * | * | 0.13 |
| 3.76 - 4.00 | * | * | * | * | 0.25 | 0.17 | 0.08 | * | 0.50 |
| 4.01 - 4.25 | * | * | * | * | * | 0.17 | 0.08 | * | 0.25 |
| 4.26 - 4.50 | * | * | * | * | * | 0.08 | 0.08 | * | 0.17 |
| 4.51 - 4.75 | * | * | * | * | * | 0.30 | 0.04 | * | 0.34 |
| 4.76 - 5.00 | * | * | * | * | * | * | 0.04 | * | 0.04 |
| 5.01 - 5.25 | * | * | * | * | * | 0.25 | * | * | 0.25 |
| 5.26 - 5.50 | * | * | * | * | * | * | * | * | 0.00 |
| 5.51 - 5.75 | * | * | * | * | * | * | * | * | 0.00 |
| 5.76 - 6.00 | * | * | * | * | * | * | * | * | 0.00 |
| 6.01 - 6.25 | * | * | * | * | * | * | * | * | 0.00 |
| 6.26 - 6.50 | * | * | * | * | * | * | * | * | 0.00 |
| Totals | 0.55 | 65.14 | 172.51 | 350.89 | 287.83 | 98.39 | 26.24 | 4.21 | 1005.77 |

Values in days have been rounded to two decimal places.

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

| Significant wave height (metres) | Peak energy wave period (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 - 0.25 | * | * | 0.17 | 0.44 | 3.39 | 2.04 | 1.66 | 0.35 | 8.06 |
| 0.26 - 0.50 | 2.18 | 9.94 | 20.32 | 34.42 | 91.54 | 78.94 | 26.81 | 8.48 | 272.63 |
| 0.51 - 0.75 | 1.85 | 26.84 | 41.77 | 51.02 | 74.02 | 62.11 | 18.90 | 10.02 | 286.53 |
| 0.76 - 1.00 | 1.61 | 19.37 | 32.24 | 40.12 | 23.39 | 19.79 | 4.81 | 1.68 | 143.02 |
| 1.01 - 1.25 | 0.25 | 5.22 | 21.80 | 28.66 | 14.60 | 4.74 | 1.98 | 0.58 | 77.82 |
| 1.26 - 1.50 | * | 1.23 | 10.58 | 12.22 | 7.87 | 4.06 | 0.63 | 0.34 | 36.92 |
| 1.51 - 1.75 | * | 0.04 | 4.09 | 5.40 | 5.42 | 1.75 | 0.47 | 0.08 | 17.26 |
| 1.76 - 2.00 | * | * | 0.40 | 2.18 | 3.09 | 0.87 | * | * | 6.54 |
| 2.01 - 2.25 | * | * | 0.06 | 1.22 | 2.33 | 1.83 | * | * | 5.43 |
| 2.26 - 2.50 | * | * | * | 0.31 | 1.05 | 0.04 | * | * | 1.41 |
| 2.51 - 2.75 | * | * | * | * | 0.50 | 0.75 | * | * | 1.25 |
| 2.76 - 3.00 | * | * | * | * | 0.48 | 0.50 | 0.25 | * | 1.23 |
| 3.01 - 3.25 | * | * | * | * | 0.26 | * | 0.37 | * | 0.63 |
| 3.26 - 3.50 | * | * | * | * | * | * | * | * | 0.00 |
| 3.51 - 3.75 | * | * | * | * | * | * | * | * | 0.00 |
| 3.76 - 4.00 | * | * | * | * | * | * | * | * | 0.00 |
| 4.01 - 4.25 | * | * | * | * | * | * | * | * | 0.00 |
| 4.26 - 4.50 | * | * | * | * | * | * | * | * | 0.00 |
| 4.51 - 4.75 | * | * | * | * | * | * | * | * | 0.00 |
| 4.76 - 5.00 | * | * | * | * | * | * | * | * | 0.00 |
| 5.01 - 5.25 | * | * | * | * | * | * | * | * | 0.00 |
| 5.26 - 5.50 | * | * | * | * | * | * | * | * | 0.00 |
| 5.51 - 5.75 | * | * | * | * | * | * | * | * | 0.00 |
| 5.76 - 6.00 | * | * | * | * | * | * | * | * | 0.00 |
| 6.01 - 6.25 | * | * | * | * | * | * | * | * | 0.00 |
| 6.26 - 6.50 | * | * | * | * | * | * | * | * | 0.00 |
| Totals | 5.89 | 62.65 | 131.42 | 176.00 | 227.94 | 177.42 | 55.88 | 21.53 | 858.74 |

Values in days have been rounded to two decimal places.

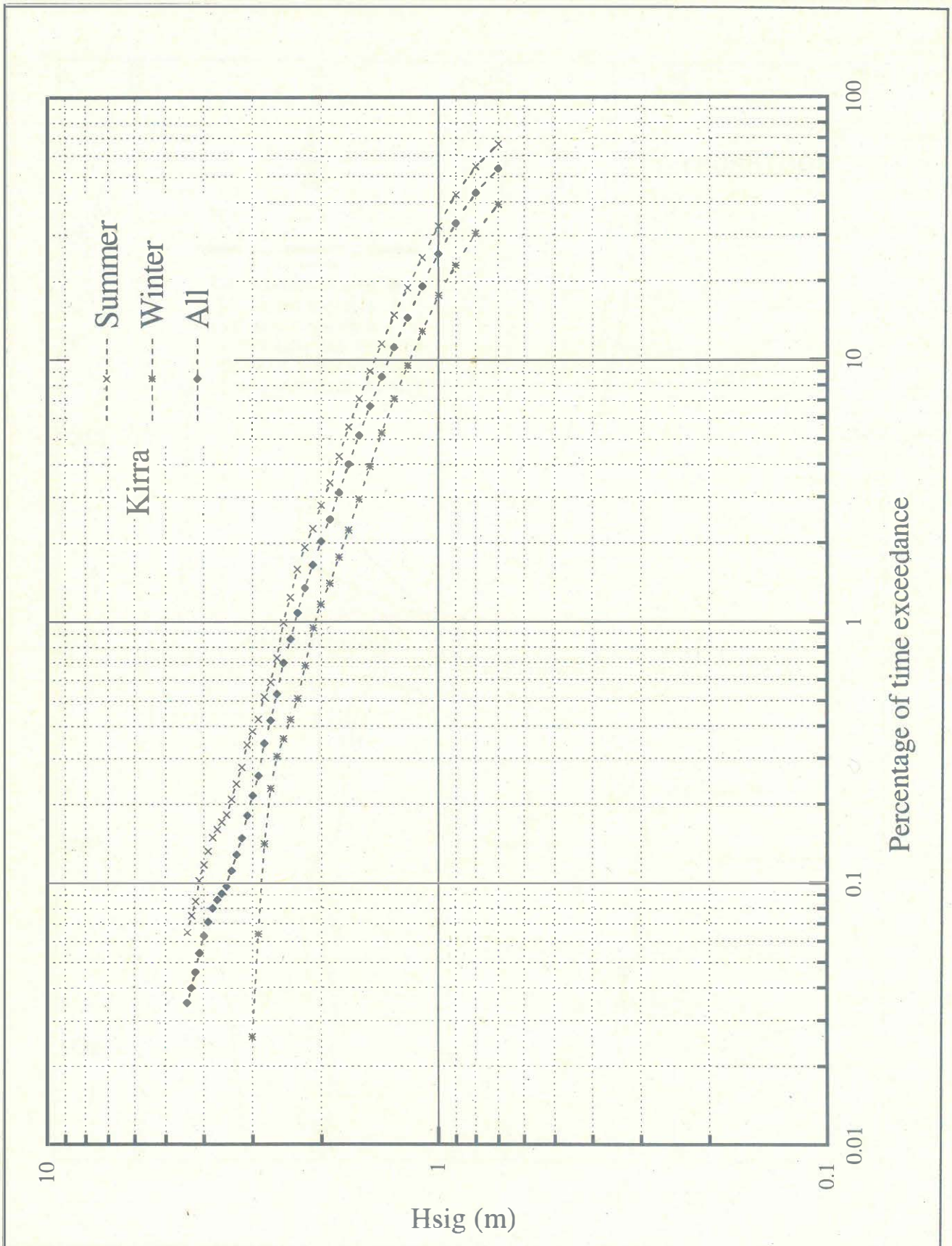



LOCALITY MAP

Beach Protection Authority Queensland
Queensland Department of Environment and Heritage

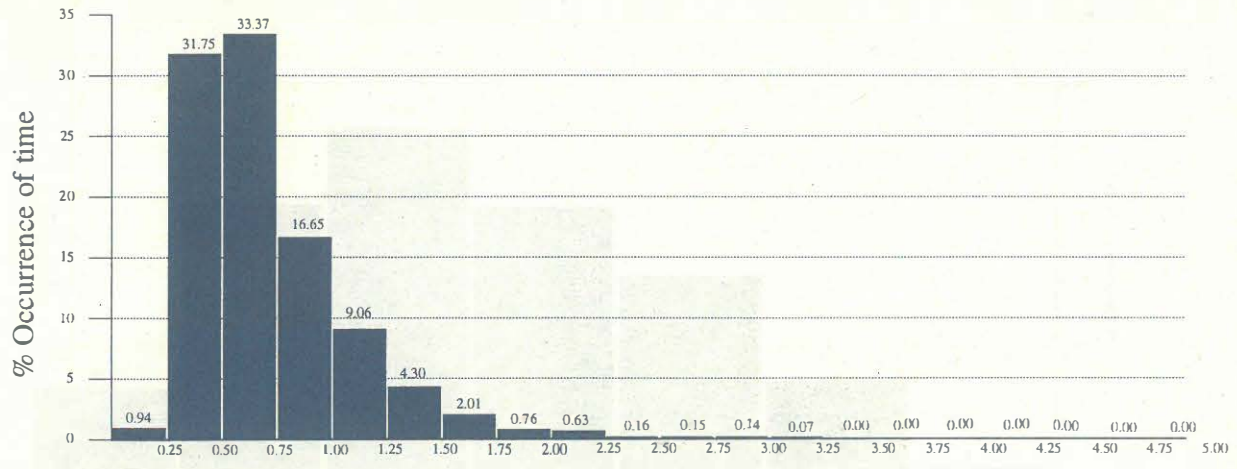
Wave Data Recording Program
KIRRA

**Figure 1**

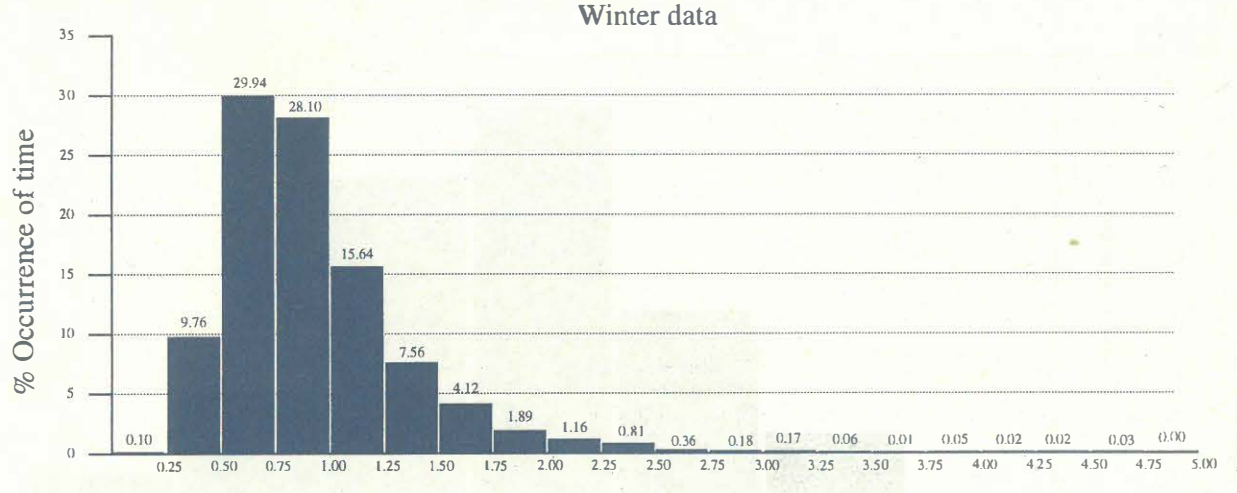



PERCENTAGE (of time) EXCEEDANCE
OF WAVE HEIGHTS (Hsig) FOR ALL WAVE PERIODS
25 August 1988 to 30 June 1994

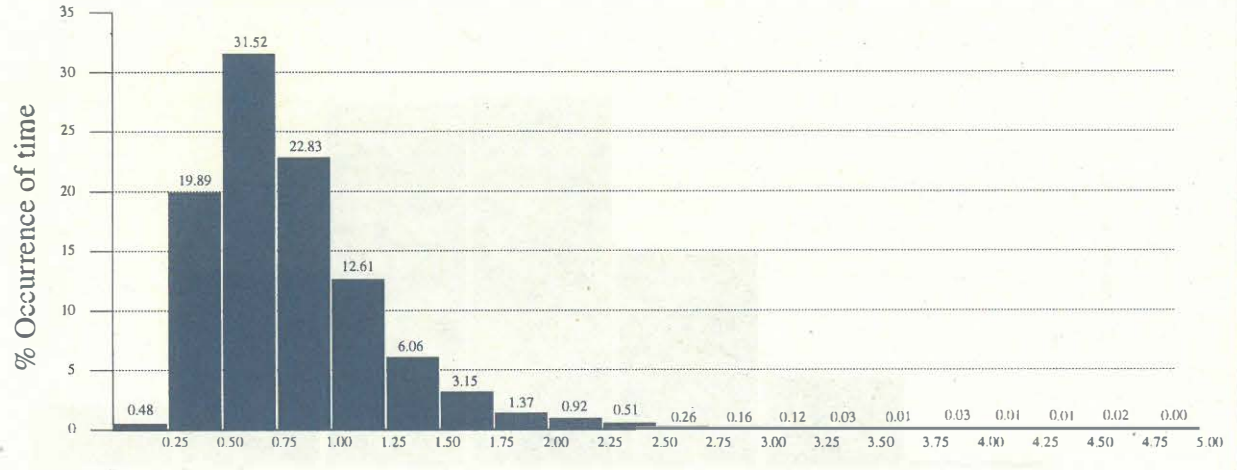
| | | |
|---|---|---|
| Beach Protection Authority Queensland<br>Queensland Department of Environment and Heritage | Wave Data Recording Program<br>KIRRA | **Figure 2** |




Winter data




Summer data



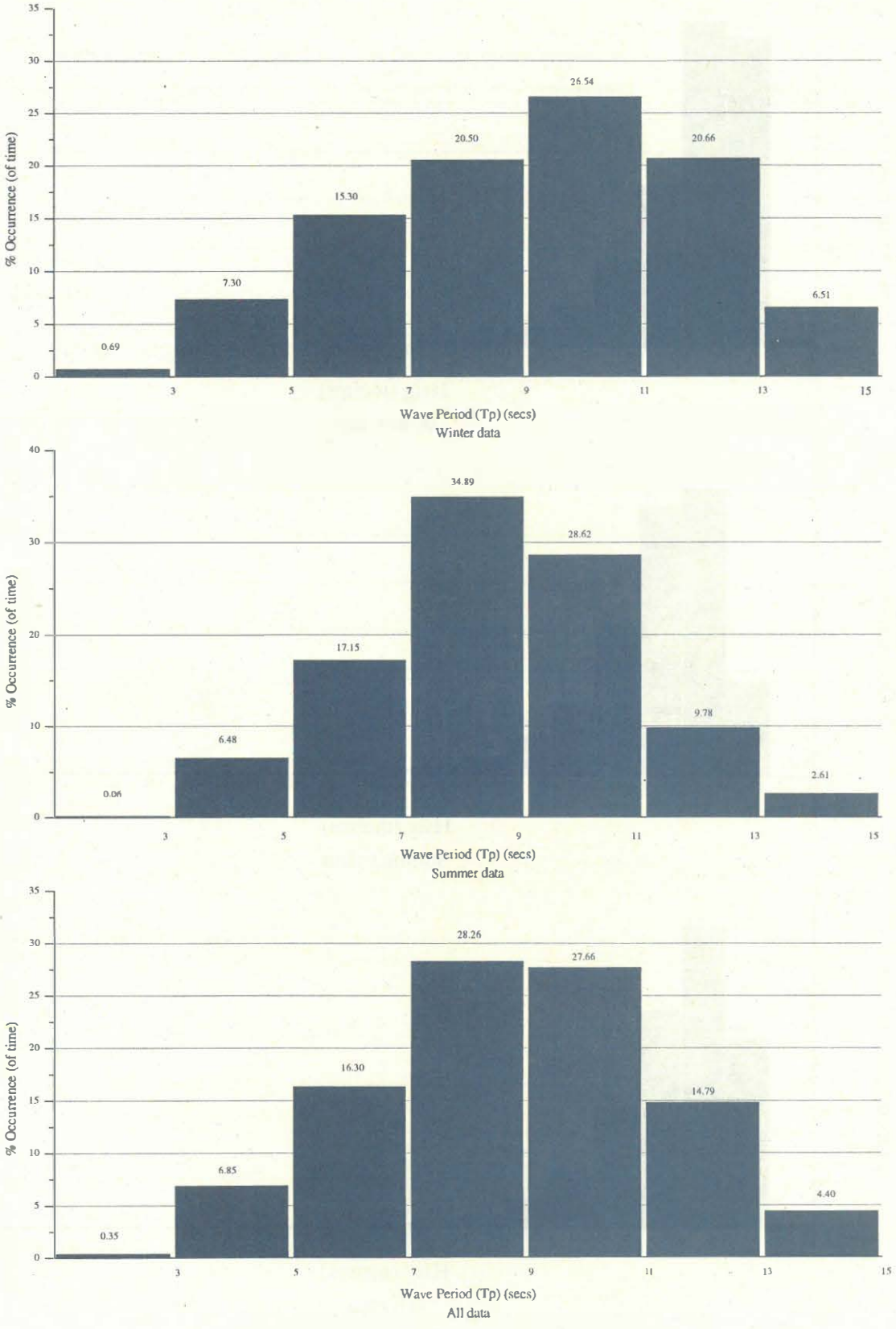

All data

HISTOGRAM PERCENTAGE (of time)
OCCURRENCE OF WAVE HEIGHTS (Hsig)
FOR ALL WAVE PERIODS (Tp)

Beach Protection Authority Queensland
Queensland Department of Environment and Heritage

Wave Data Recording Program
KIRRA

**Figure 3**

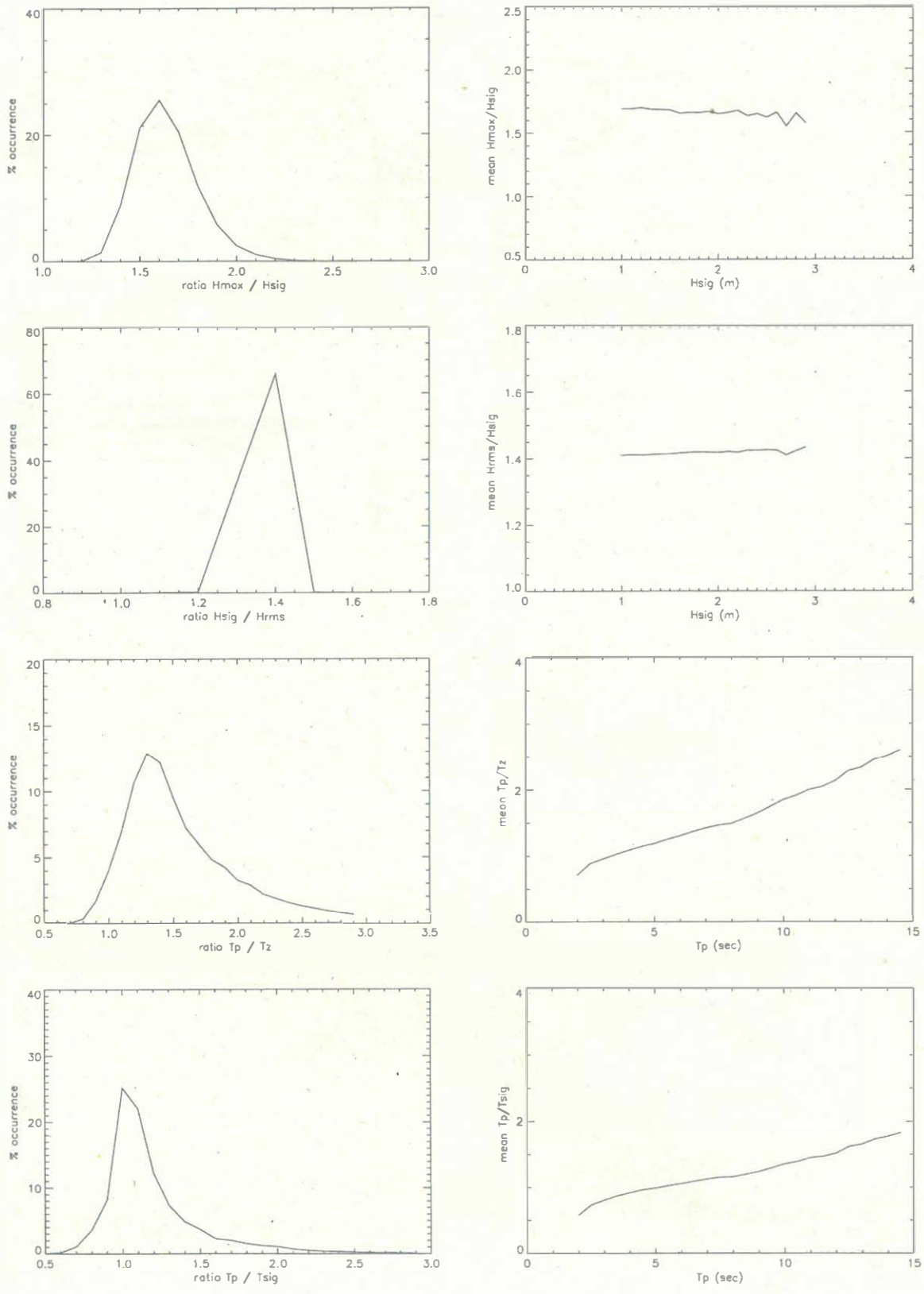



HISTOGRAM PERCENTAGE (of time)
OCCURRENCE OF WAVE PERIODS (Tp)
FOR ALL WAVE HEIGHTS (Hsig)

Beach Protection Authority Queensland
Queensland Department of Environment and Heritage

Wave Data Recording Program
KIRRA

**Figure 4**

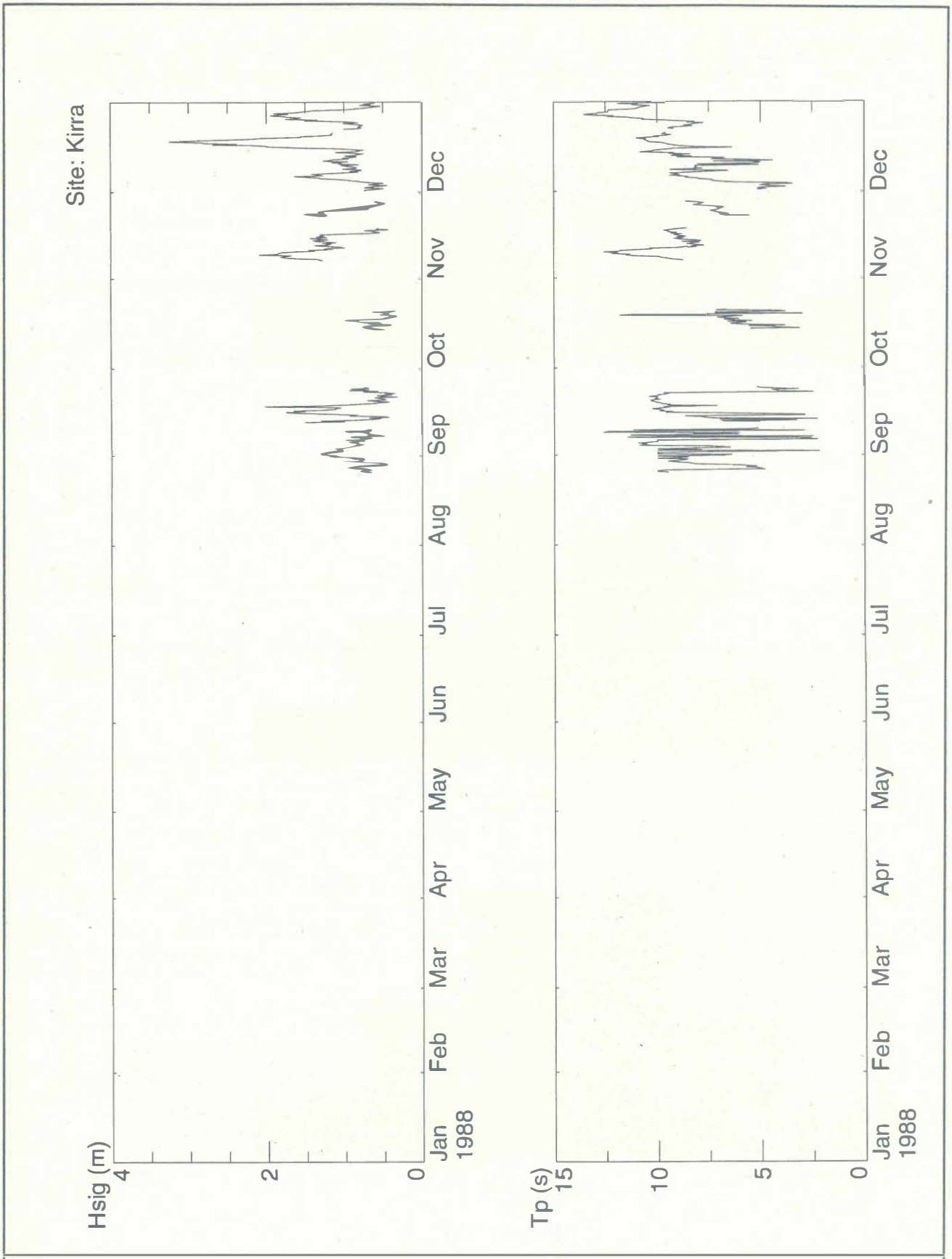



WAVE PARAMETER RELATIONSHIPS
25 August 1988 to 30 June 1994

Beach Protection Authority Queensland
Queensland Department of Environment and Heritage

Wave Data Recording Program
KIRRA

**Figure 5**

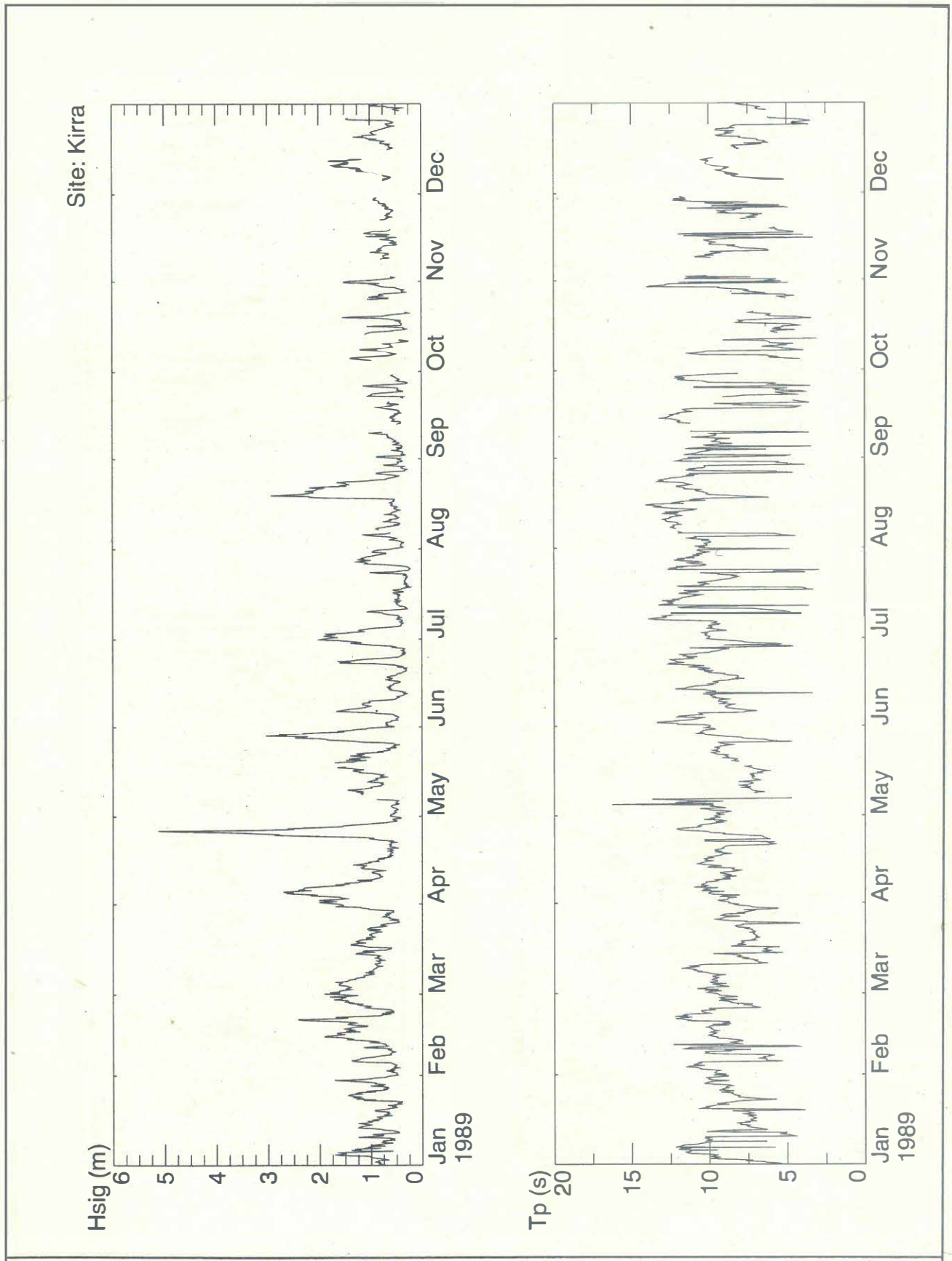



DAILY WAVE RECORDINGS
25 August 1988 to 30 June 1994

Beach Protection Authority Queensland
Queensland Department of Environment and Heritage

Wave Data Recording Program
KIRRA

**Figure 6.1**




DAILY WAVE RECORDINGS
25 August 1988 to 30 June 1994

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Queensland Department of Environment and Heritage

Wave Data Recording Program
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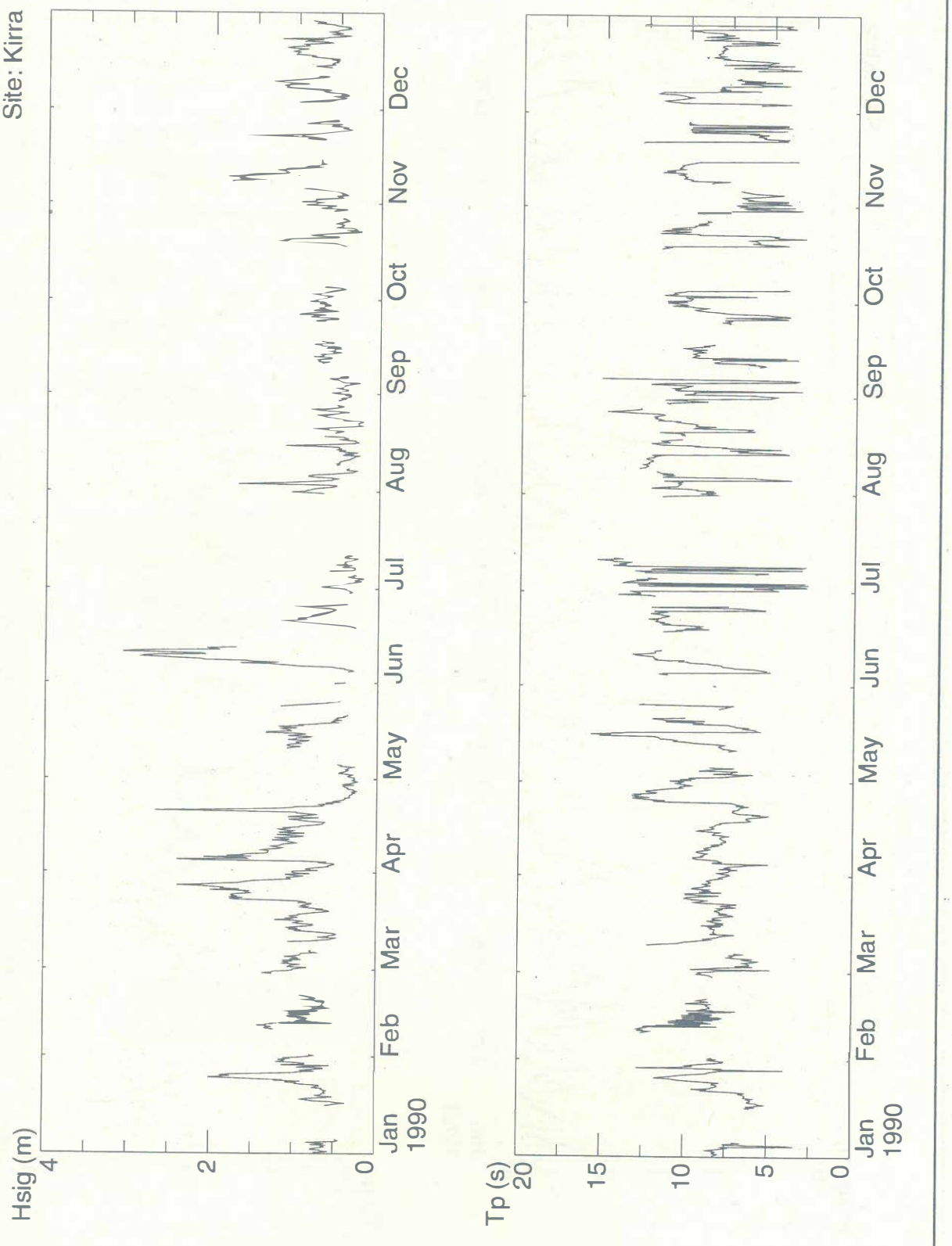
**Figure 6.2**




DAILY WAVE RECORDINGS
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**Figure 6.3**

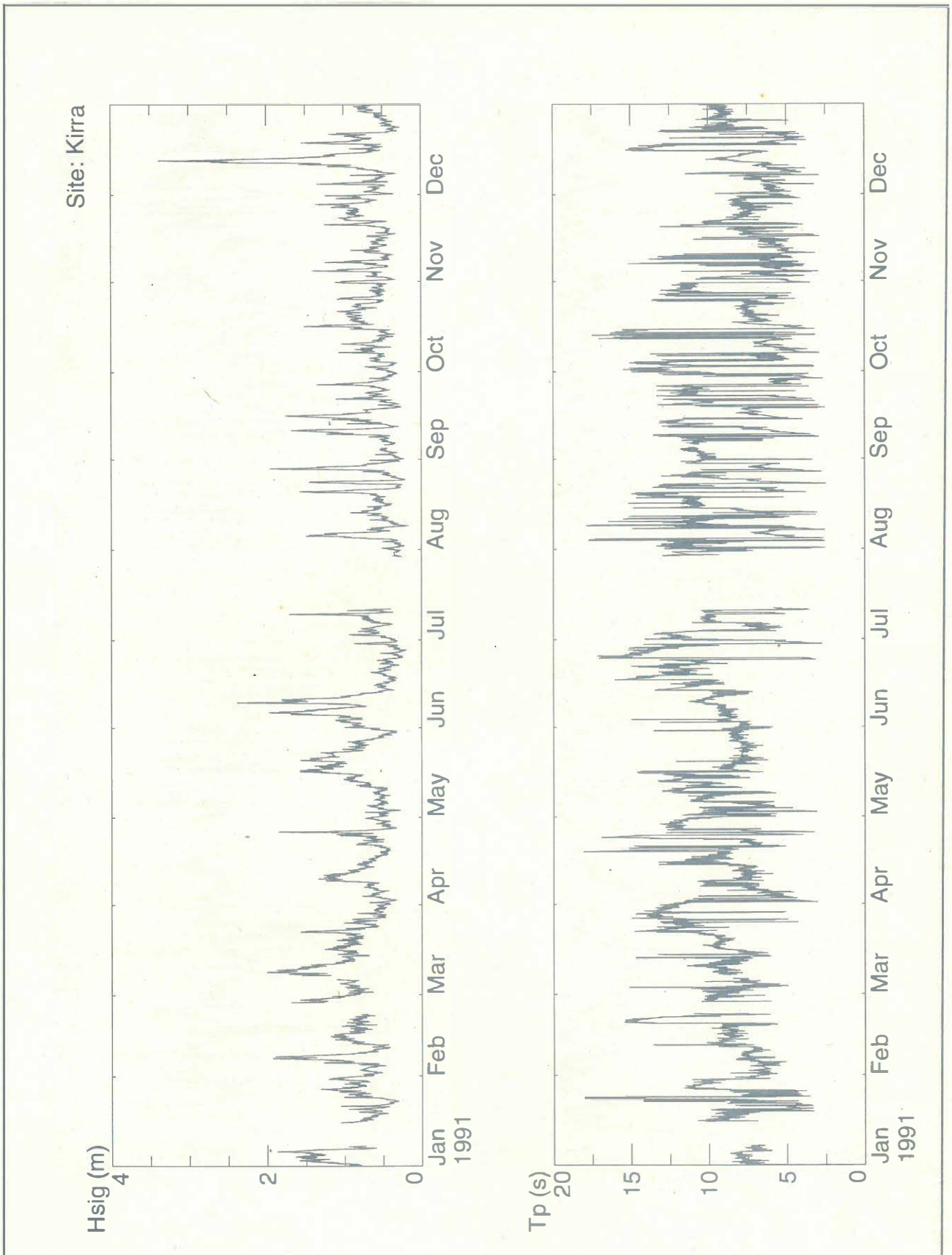


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**Figure 6.4**

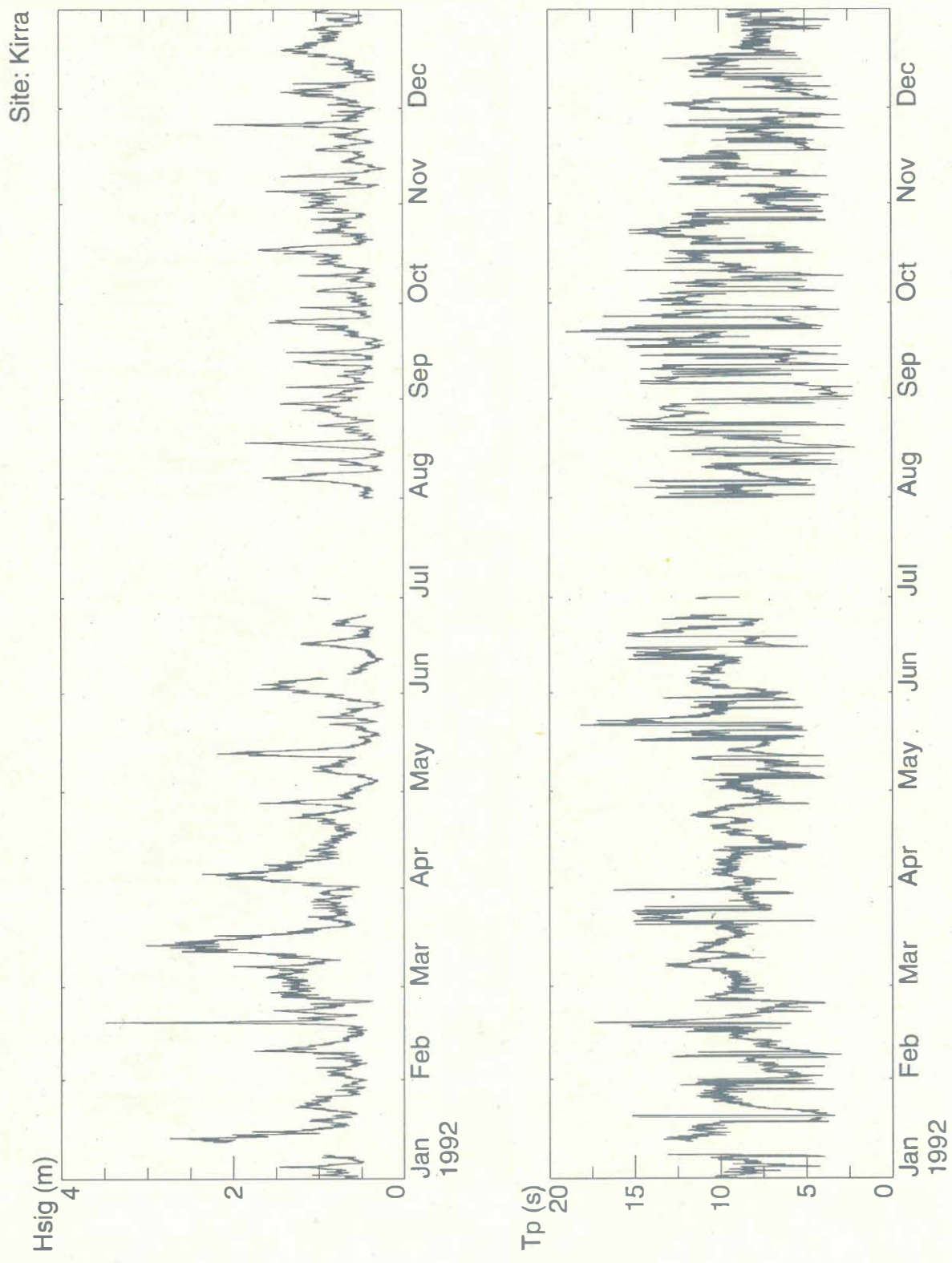


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**Figure 6.5**

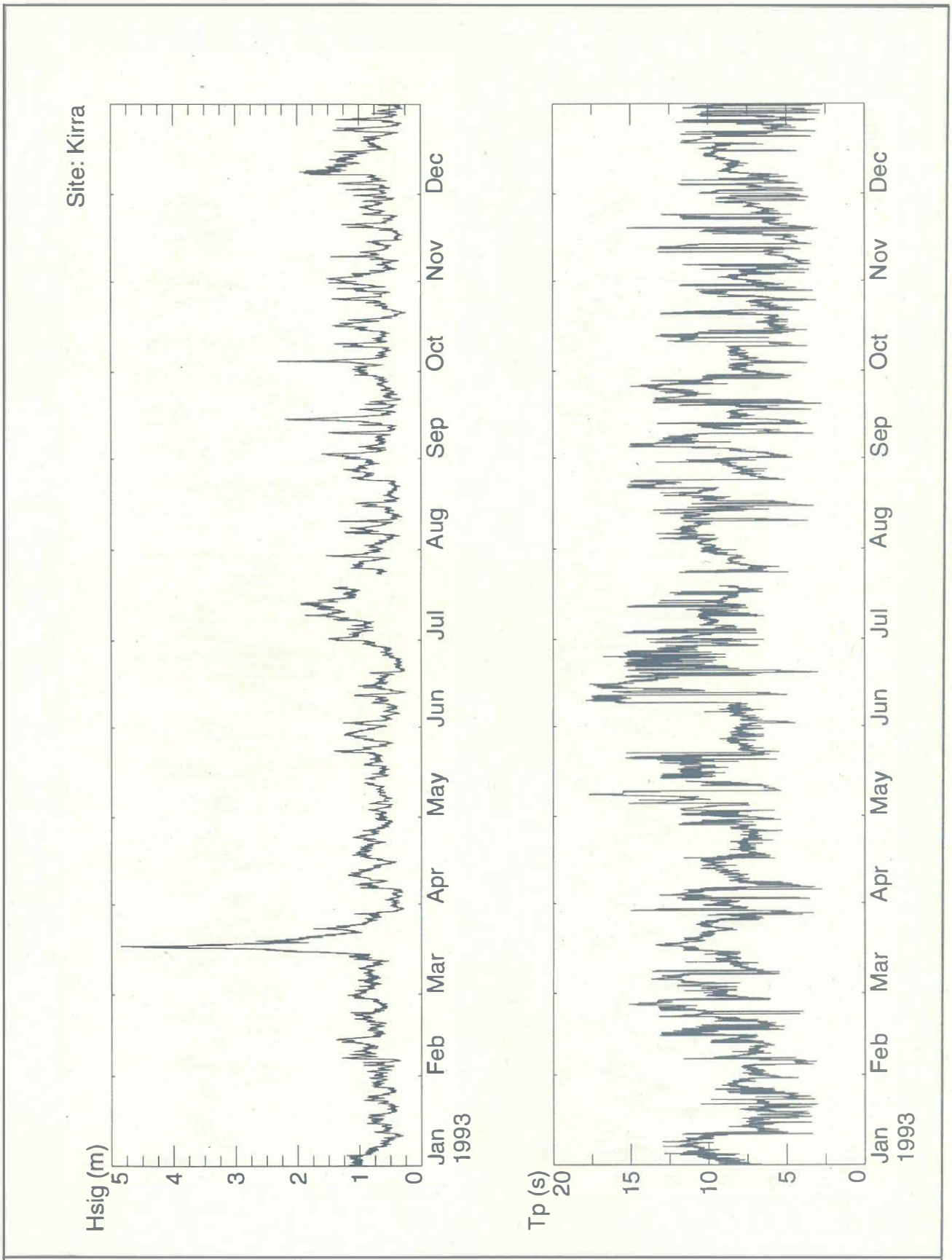


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**Figure 6.6**

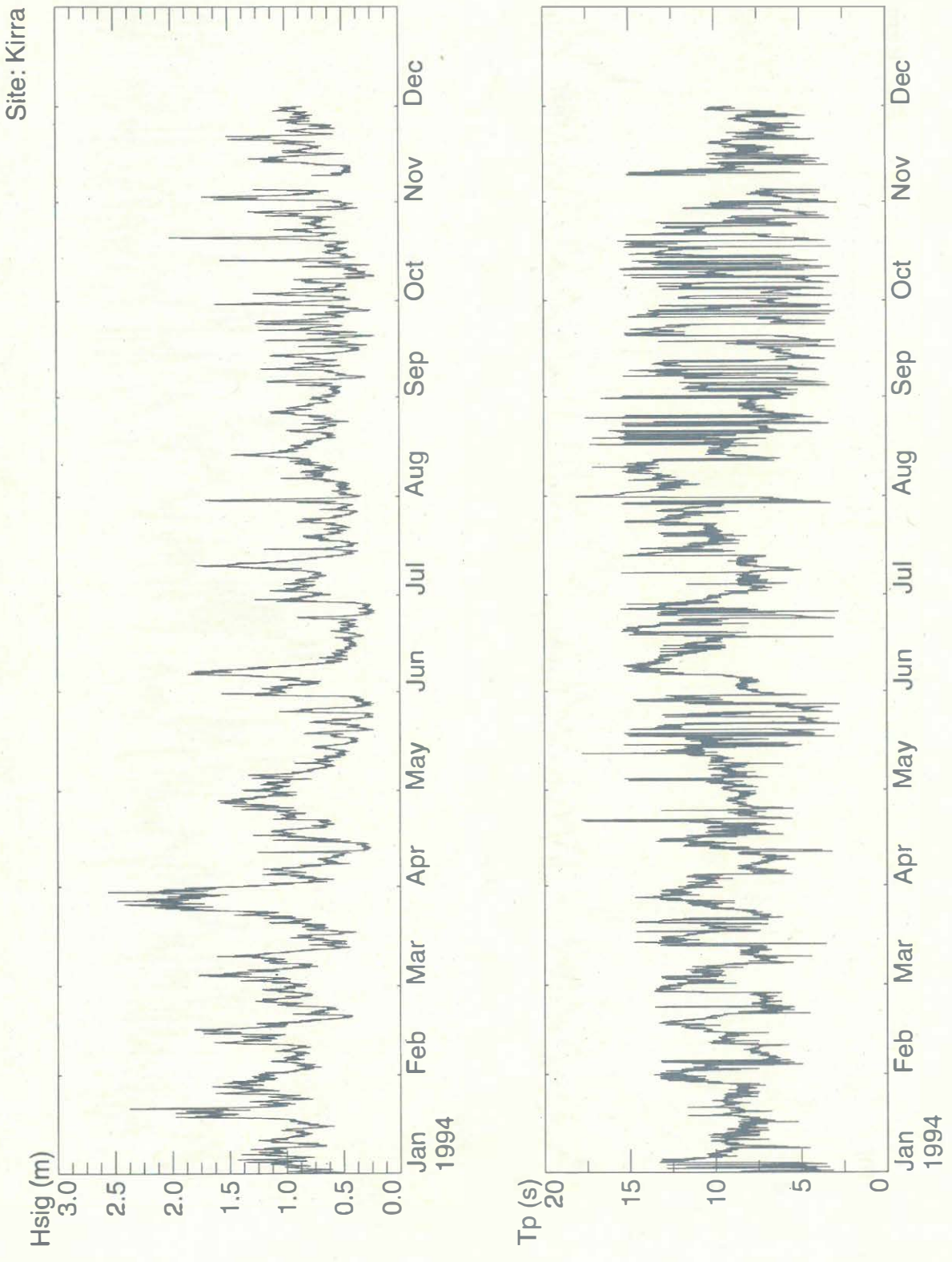


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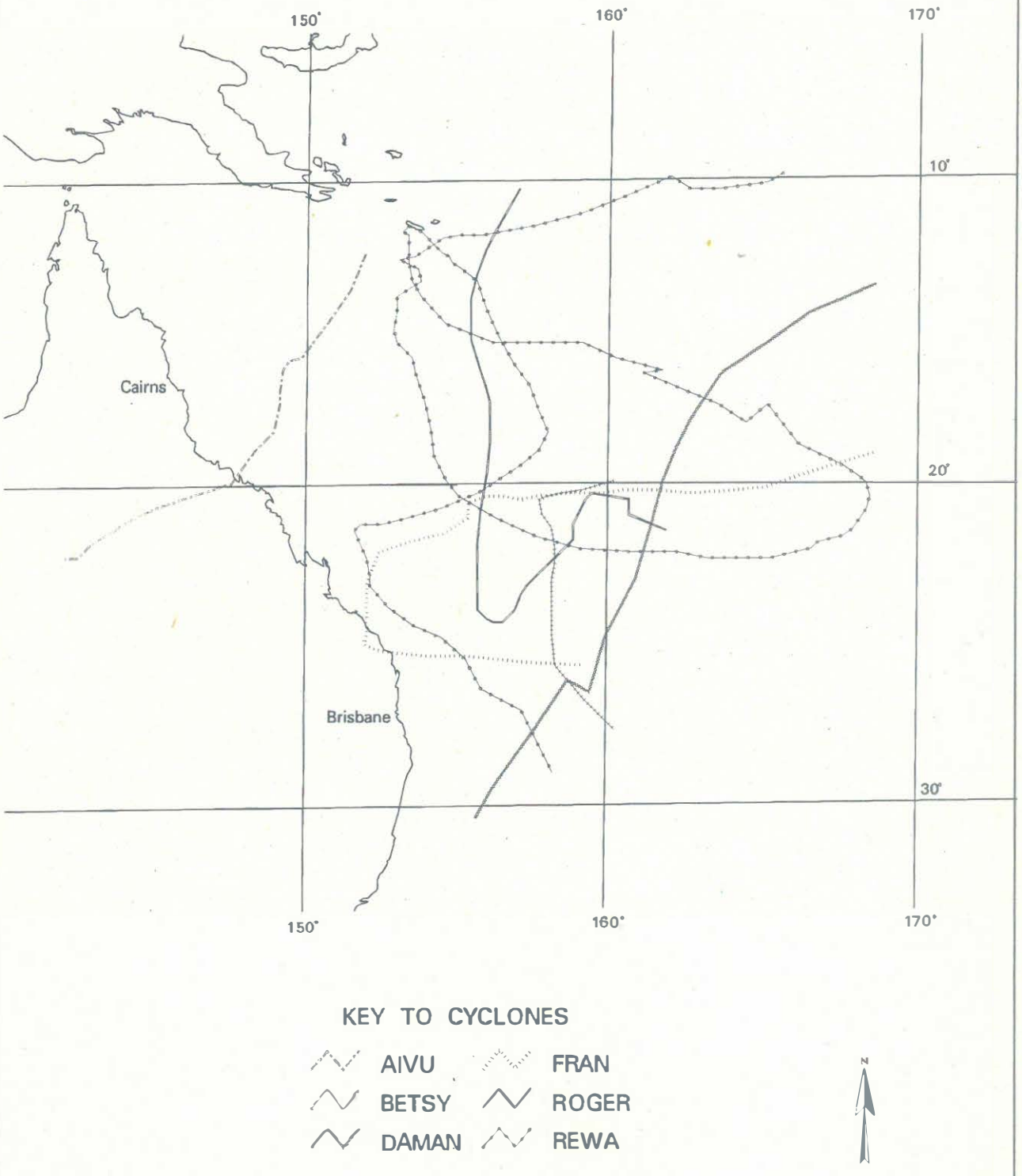
**Figure 6.7**




Cyclone Tracks

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**Figure 7**