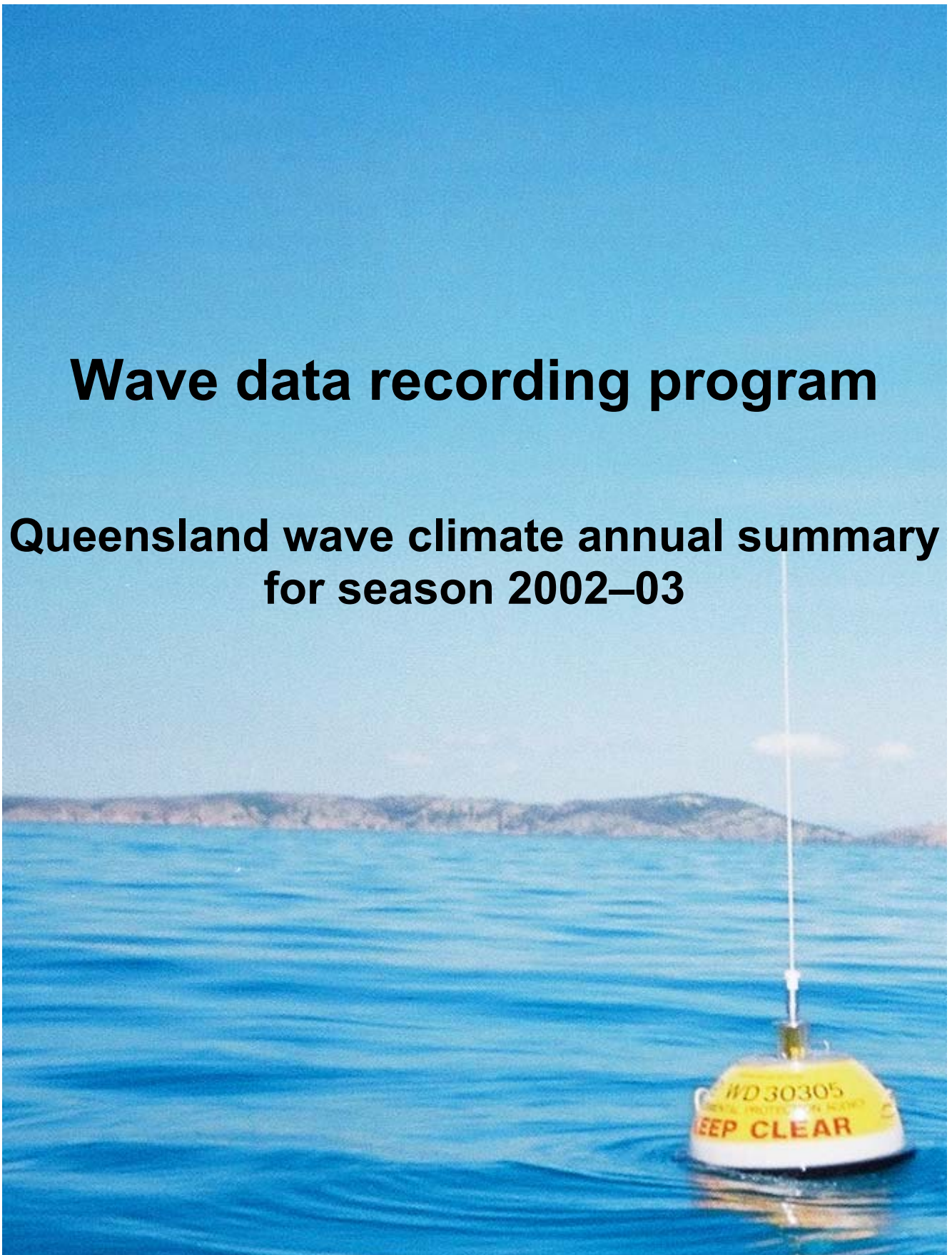


# Wave data recording program

## Queensland wave climate annual summary for season 2002–03



Coastal Services data report No.2004.1  
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## Foreword

This summary of wave climate in Queensland is one of the series of technical wave reports to be prepared annually by the Environmental Protection Agency's (EPA) Coastal Services Unit.

Annual wave reports supplement the reporting ability of the EPA's Coastal Services Unit by providing timely information on wave climates in Queensland. More comprehensive regional wave data reports provide the more thorough, long-time presentation of regional conditions.

Using the information presented annually, regional reports should be updated every five years.

Annual reports cover the year from 1 November through to 31 October of the following calendar year. The start of the year therefore coincides with the commencement of the annual cyclone season, which extends from 1 November through to 30 April. This period is also classed as *summer* in both this annual report and the regional technical reports. The remainder of the year (1 May to 31 October) is classed as *winter* in these reports.

Annual reports present wave information in a similar format to the existing regional reports, however they also include plots of monthly average significant wave heights and a directional wave rose (where possible).

Cover photo: Shows the Datawell directional Waverider buoy moored off Cape Ferguson, near Townsville.

## **Abstract**

This report summarises the primary analyses of wave data recorded using Datawell non-directional and directional Waverider buoys positioned at selected locations along the Queensland coast for the 2002–03 seasonal year.

The data recorded covers the period from 1 November, 2002, to 31 October, 2003, which embraces all of the seasonal variations for one year, and includes the 2002–03 cyclone season.

The data is divided into seasonal groupings for analysis and no estimations of wave directions have been provided, unless calculated by a directional buoy.

This report has been prepared by the EPA's Coastal Services Unit, Environmental Sciences Division. The EPA acknowledges the following team members who contributed their time and effort to the preparation of this report:

John Mohaupt; Vince Cunningham; Gary Hart; Jeff Shortell; Daniel Conwell; Colin Newport; Darren Hanis; Martin Hansen and Jim Waldron.

## **Disclaimer**

While reasonable care and attention have been exercised in the collection, processing and compilation of the wave data included in this report, the Coastal Services Unit does not guarantee the accuracy and reliability of this information in any way. Neither the Queensland Government nor the EPA accepts liability for any decisions or actions taken on the basis of this report.

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## 1.0 Introduction

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

The network of wave recording stations has been grouped into three categories:

- Long-term sites: These sites form part of long-term data collection activities along the Queensland coast that gather wave statistics used for coastal management purposes. The stations are fully funded and operated by the EPA.
- EPA project sites: These sites are of limited duration, associated with some specific coastal activity, which are used to assess wave conditions for coastal investigation projects and/or to help monitor works such as beach nourishment. The stations are fully-funded and operated by the EPA, as specific projects.
- Joint project sites: The life of these sites will vary in duration, and they are associated with specific projects, to assess wave conditions or to monitor works. These stations are operated by the EPA in conjunction with (and jointly-funded by) other agencies.

The 2002–03 site groups are as follows:

**Table 1**  
Wave recording stations  
for season 2002–03

Long term	EPA project	Joint project	Joint project partners
Brisbane	Moreton Bay	Tweed Heads	TRESBP*
Mackay	Mooloolaba	Gold Coast	GCCC <sup>+</sup>
Townsville		Hay Point	PCQ <sup>#</sup>
Cairns		Weipa	PCQ <sup>#</sup>
Emu Park			

\* Tweed River Entrance Sand Bypassing Project (joint project of Queensland and New South Wales Governments with support from Gold Coast City Council)

<sup>+</sup> Gold Coast City Council

<sup>#</sup> Ports Corporation of Queensland

This report is from a series of reports intended to make wave information more readily available by summarising the primary analysis of wave data collected at the buoy locations along the Queensland coastline and presenting wave climate information for the period 1 November, 2002 to 31 October, 2003.

For all stations, the wave data collected for the current year is statistically compared to the long-term average conditions at the site. Brief details of the recording equipment, the methods of handling raw data and the type of analyses employed are provided within this report.

## 2.0 Recording equipment configuration

For the duration of this summary report the EPA's Coastal Services Unit's wave recording program utilised the Waverider system, manufactured by Datawell of the Netherlands to measure the sea surface fluctuations at an

offshore location. Both non-directional and directional Waverider buoys were in operation during the period of this report.

Both the directional and non-directional Waverider buoys measure vertical acceleration by means of an accelerometer that is 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 displacement.

The directional buoy also measures horizontal accelerations using two fixed accelerometers and an onboard fluxgate compass to give the directional displacement in two horizontal axes. By use of a transformation matrix, these measured accelerations in the north–south and east–west directions are calculated.

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

Non-directional Waverider receiver stations comprise of a computer-based system utilising the Datawell DIWAR Waverider receiver/digitiser. The water level data, digitised at 0.39sec intervals (2.56Hz), is recorded in bursts of 4096 points (approximately 26min) and recorded on the computer's hard disk.

Directional Waverider receiver stations also comprise a PC-based system utilising the Datawell DIWAR Waverider receiver/digitiser. The water level data, digitised at 0.78sec intervals (1.28Hz), is recorded in bursts of 2048 points (approximately 26min) 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 and spectra that may be accessed remotely via the public 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 can be obtained from the sources listed in section 7.0 of this report.

### **3.0 Laboratory calibration checks**

Waverider buoys used by the EPA are calibrated before deployment and also after recovery. Normally, a buoy is calibrated once every 12 months. Calibration is performed at the EPA's Deagon site using a buoy calibrator to simulate sinusoidal waves with amplitudes of either 2m or 2.8m depending on whether a 0.7m or 0.9m diameter buoy is being tested. The calibrator is electrically controlled and the frequency may be adjusted 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.



There are no adjustments to the recorded wave data, based on the laboratory calibration results. Monthly averages are calculated based on available data and no wave data records are rejected based on low capture rates. Research [Bacon and Carter (1991), Allan and Komar (2001)] has suggested rejecting entire records where less than a certain threshold has been recorded. All Queensland wave-recording sites generally have high-percentage capture rates for the seasonal year (table 4) and thus minimal bias is introduced into calculations.

## 4.0 Wave recording and analysis procedures

The PC-based, wave-recording system generally records data at (nominally) hourly intervals. During periods when the recorded significant wave height ( $H_{sig}$ ) value reaches the predetermined storm threshold of the site, the recording frequency is increased to (nominally) thirty-minute intervals.

Recorded non-directional wave data is analysed in the time domain by the zero up-crossing method and in the frequency domain by spectral analysis using Fast Fourier Transform (FFT) 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 sub-sets and each sub-set is analysed using FFT techniques. The output from this processing is then transmitted to the shore station, along with the raw data, where it undergoes further analysis using FFT techniques to produce 128 spectral estimates in bands of 0.005Hz.

The zero up-crossing analysis is equivalent in both systems.

Wave parameters resulting from the time and frequency domain analysis included the following:

$S(f)$	energy density spectrum
$H_{sig}$	significant wave height (time domain), the average of the highest third of the waves in the record
$H_{max}$	the highest individual wave in the record (time domain)
$H_{rms}$	the root mean square of the wave heights in the record (time domain)
$T_{sig}$	significant wave period (time domain), the average period of the highest third of waves in the record
$T_z$	the average period of all zero up-crossing waves in the record (time domain)
$T_p$	the wave period corresponding to the peak of the energy density spectrum (frequency domain)
$T_c$	the average period of all the waves in the record based on successive crests (time domain)

These parameters form the basis for the summary plots and tables included in this report.

## 5.0 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 recorded data by the PC-based systems includes some data rejection checks which may result in a small number of spurious and rejected data points being replaced using an interpolation procedure, otherwise the entire series is rejected.

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 durations on the side of those records adjacent to gaps in the data are limited to a maximum value dependent on the nominal-recording interval of those records.

With the nominal-recording interval set at one hour, the maximum allowable total duration of a record is equal to three hours. Any durations on either side of a record greater than 90min (half the maximum allowable total duration) is set to the maximum allowable of exactly 90min, and a gap in the data is reported.

## 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. Details are presented in the location history plans (figures 1.1 to 12.1) for each site shown later in this report. The non-directional Waverider recording system utilised by the EPA 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.

Data capture rates for each wave site over the seasonal year are presented in table 4.

A summary of major meteorological events, where the recorded Hsig value reached the storm threshold wave height for a site, for the 2002–03 seasonal year is shown in table 5. Wave parameters Hsig, Hmax, Tp, and other relevant information are listed for each event. Only storm and cyclone events that contributed to the Hsig reaching the storm threshold value at any of the wave sites are listed in the table.

Table 6 lists the details of the only two cyclones that occurred along the Queensland coastline during the 2002–03 season (figure 13).


Figure A presents a large-scale view of the locations of wave recording stations in operation around the Queensland coastline for the 2002–03 seasonal year (Detailed station location maps are presented for all sites in figures 1.1 through to 12.1).

Details of wave recorder installations for each site are shown on the first page of each site section, and include information on buoy location, recording station location, recording intervals and data collection.

The wave-climate data presented in this report is based on statistical analyses of the parameters obtained from the recorded-wave data. Programs developed by the EPA provide statistical information on percentage of time occurrence and exceedance for wave heights and periods. The results of these analyses are presented in figures §.2, §.3 and §.4 for each site, where § represents the site number. In each of these three figures for each site, the term *All data* refers to the entire available dataset collected for that site (table 2). To determine how much emphasis should be placed on this data, recording histories are shown in table 2 below. In addition, similar statistical analysis provides monthly averages of wave heights for the seasonal year and all data.

**Table 2**  
Wave recording history

Site	Start date	End date	Restart	End date	Total years
Cairns	4/05/1975	31/10/2003			28.51
Mackay	19/09/1975	31/10/2003			28.13
Townsville	20/11/1975	31/10/2003			27.96
Brisbane	31/10/1976	31/10/2003			27.02
Weipa	22/12/1978	31/10/2003			24.87
Hay Point	24/03/1977	25/05/1987	3/03/1993	31/10/2003	20.84
Gold Coast	21/02/1987	31/10/2003			16.70
Tweed Heads	13/01/1995	31/10/2003			8.80
Emu Park	24/07/1996	31/10/2003			7.27
Mooloolaba	20/04/2000	31/10/2003			3.53
Moreton Bay	19/10/2000	31/10/2003			3.03

 denotes a directional site for 2002–03

Daily wave recordings for the seasonal year are shown for all sites, however directional sites show average water temperature and peak direction (Dir\_p) recordings as well.

Directional wave roses for the 2002–03 seasonal year are presented for the sites shown in table 3 below. Wave roses summarise wave occurrence at a directional site by indicating their size, direction and frequency. Each branch of a wave rose represents waves coming from that direction with branches divided into three Hsig segments of varying range. The length of each branch represents the total percentage of waves from that direction with the length of each segment within a branch representing the percentage of waves, in that size range, arriving from that direction for all wave periods. Calm wave conditions have been defined as below 0.5m and are represented as a percentage inside the centre circle. Periods of deployment as a directional site will vary from site to site as indicated in table 3 (Note that a 0.2 percent cut off has been applied to the data as the wave roses are only intended as a visual guide to the wave climate at a site).

**Table 3**  
Directional wave recording history  
for current directional sites

Site	Start date	End date	Total years
Tweed Heads	13/01/1995	31/10/2003	8.80
Brisbane	20/01/1997	31/10/2003	6.78
Emu Park	24/07/1996	31/10/2003	7.27
Mackay	13/02/2002	31/10/2003	1.67
Townsville	12/10/2001	31/10/2003	2.05

This report covers the seasonal year from 1 November, 2002 to 31 October, 2003 where, for the purposes of analysis, summer has been taken as the period from 1 November to 30 April of the following year and winter covers the period 1 May to 31 October in any one year.

## 7.0 References

Permanent International Association of Navigation Congresses (1986), *List of Sea State Parameters*

Datawell, *Operation and Service Manual for the Non-directional Waverider* (2001)

Datawell, *Manual of the Digital Waverider Receiver Type DIWAR* (1992)

Datawell, *Operations and Service Manual for Directional Waverider* (2002)

Lawson and Treloar Pty Ltd (2002), *Real Time Wave Analysis Package*

Queensland Transport, *The Official Tide Tables & Boating Safety Guide 2002*

Australian Hydrographic Service, *Australian National Tide Tables 2002*

Bureau of Meteorology, *Monthly Weather Reviews*

## 8.0 Other wave data reports in this series

Cairns Region	(Report No. W01.1)	2 May 1975 to 3 Sept 1978
Cairns Region	(Report No. W01.2)	2 May 1975 to 11 Jun 1985
Cairns Region	(Report No. W01.3)	2 May 1975 to 30 Apr 1997
Mackay Region	(Report No. W02.1)	17 Sept 1975 to 5 Nov 1976
Mackay Region	(Report No. W02.2)	17 Sept 1975 to 23 Aug 1985
Mackay Region	(Report No. W02.3)	17 Sept 1975 to 30 Oct 1996
Townsville Region	(Report No. W03.1)	16 July 1975 to 23 Feb 1979
Townsville Region	(Report No. W03.2)	19 Nov 1975 to 29 Dec 1987
Townsville Region	(Report No. W03.3)	19 Nov 1975 to 30 Apr 1997
Sunshine Coast Region	(Report No. W04.1)	5 Apr 1974 to 5 Jul 1977
Burnett Heads Region	(Report No. W05.1)	5 May 1976 to 5 Mar 1982
Burnett Heads Region	(Report No. W05.2)	5 May 1976 to 13 Oct 1988
Abbot Point Region	(Report No. W06.1)	6 May 1977 to 9 Aug 1979
Abbot Point Region	(Report No. W06.2)	6 May 1977 to 31 Oct 1996
Weipa Region	(Report No. W07.1)	21 Dec 1978 to 7 Apr 1983
Weipa Region	(Report No. W07.2)	21 Dec 1978 to 30 Apr 1997
Gladstone Region	(Report No. W08.1)	19 Dec 1979 to 16 May 1983
Brisbane Region	(Report No. W09.1)	30 Oct 1976 to 30 Jun 1983
Brisbane Region	(Report No. W09.2)	30 Oct 1976 to 30 Jun 1994
Brisbane Region	(Report No. W09.3)	30 Oct 1976 to 28 Feb 1997
Bowen Region	(Report No. W10.1)	14 Sept 1978 to 15 Nov 1984
Moreton Island Region	(Report No. W11.1)	15 Jun 1983 to 12 Apr 1985
Bramston Beach Region	(Report No. W12.1)	16 Dec 1981 to 28 Oct 1985
Hay Point Region	(Report No. W13.1)	22 Mar 1977 to 25 May 1987
Hay Point Region	(Report No. W13.2)	22 Mar 1977 to 31 Oct 1996
Gold Coast Region	(Report No. W14.1)	20 Feb 1987 to 30 Jun 1994
Gold Coast Region	(Report No. W14.2)	20 Feb 1987 to 28 Feb 1997
Kirra	(Report No. W15.1)	25 Aug 1988 to 30 Jun 1994
Kirra	(Report No. W15.2)	25 Aug 1988 to 28 Feb 1997
Repulse Bay	(Report No. W16.1)	2 Jun 1994 to 22 Oct 1995
Hayman Island	(Report No. W17.1)	26 Oct 1995 to 14 Oct 1996
Tweed Region	(Report No. W18.1)	15 Jan 1995 to 28 Feb 1997
Lucinda	(Report No. W19.1)	2 Mar 1995 to 13 May 1996


**Table 4**  
Wave recording program—summary of data capture (%)  
for season 2002–03

Station	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Average
Tweed Heads	99.93	<b>100.0</b>	99.87	99.95	99.93	99.93	99.94	98.68	99.60	<b>100.0</b>	98.89	98.32	<b>99.59</b>
Gold Coast	<b>100.0</b>	99.93	99.97	80.80	92.07	99.93	<b>100.0</b>	98.61	99.87	<b>100.0</b>	99.17	99.19	<b>97.46</b>
Brisbane	89.24	84.27	99.80	<b>100.0</b>	99.94	99.52	91.46	62.29	99.93	99.93	52.71	74.19	<b>87.77</b>
Moreton Bay	93.54	95.77	97.03	95.24	92.27	88.34	<b>100.0</b>	94.86	92.81	93.54	95.21	90.79	<b>94.12</b>
Mooloolaba	99.40	99.46	<b>100.0</b>	<b>100.0</b>	99.87	99.73	91.94	99.92	99.13	99.79	96.71	98.75	<b>98.73</b>
Emu Park	98.86	96.77	96.60	97.98	99.10	98.92	99.06	98.96	98.79	96.53	98.86	99.80	<b>98.35</b>
Hay Point	95.83	99.66	99.23	<b>100.0</b>	99.80	99.93	<b>100.0</b>	99.92	99.93	99.93	98.52	98.75	<b>99.29</b>
Mackay Offshore	42.14	82.12	82.92	83.20	81.46	84.95	83.87	94.64	85.01	81.11	75.60	90.97	<b>80.67</b>
Townsville	70.77	80.38	75.63	69.35	55.56	90.08	90.32	45.09	34.21	43.96	36.36	95.21	<b>65.58</b>
Cairns	98.45	99.67	97.64	96.16	96.60	<b>100.0</b>	<b>100.0</b>	99.48	99.86	<b>100.0</b>	99.73	<b>100.0</b>	<b>98.97</b>
Weipa	90.66	94.16	84.31	90.86	91.94	86.35	97.04	91.74	86.49	71.67	83.27	89.79	<b>88.19</b>

**Denotes directional site in 2002–03**

**Table 5 - Significant meteorological events**


Tweed Heads					
Storm threshold value: 2.0 metres					
Date	Time	Hs	Hmax	Tp	Event
28/10/2002	0230	2.0	3.3	8.9	A trough lying across the coast near Yeppoon moving north, with a firm coastal ridge to the south. A small low east of Double Island Point moving east. Southeast winds 25–40knots.
29/12/2002	1930	2.0	3.4	8.8	A 1030hPa high over the Tasman Sea directing strong southeast winds along the southern and central Qld coast.
01/01/2003	2230	2.3 (2.5)	3.9 (4.8)	11.4	Trough extending over Qld and a 1006hPa low over northern NSW.
09/01/2003	1830	2.1	3.8	10.7	A trough over Fraser Island waters. A high in the Great Australian Bight and a low in the northwest Tasman sea producing a firm ridge over southern Qld waters.
02/02/2003	0930	3.0	4.9	11.3	A 1028hPa high moving into Tasman Sea. Ex TC Beni about 650kms northeast of Sandy Cape moving northwest. Southeast winds 30–40knots.
24/02/2003	1530	2.7 (2.9)	4.7 (4.8)	9.7	A strong ridge along south coast combined with a trough over the southern Coral Sea strengthening winds along the south coast. Southeast winds 25–33knots and very heavy rain.
13/03/2003	1330	2.0	3.4	9.6	Tropical cyclone Erica, 920hPa, located just north of New Caledonia. 1026hPa high in Tasman Sea. Winds 25–30knots.
17/04/2003	0100	2.2	3.9	12.0	A firm ridge extends along the south coast from a large high in the Great Australian Bight. South to southeast winds 25–33knots.
19/04/2003	2000	2.0	3.5	12.3	A large high almost stationary near Tasmania extends a slowly strengthening ridge along the Qld coast. South to southeast winds 25–30knots.
26/04/2003	0900	2.6	4.3	9.3	A large high located over the southern Tasman Sea and a trough located off the coast. South to southeast winds 25–30knots.
04/05/2003	2100	2.7 (2.9)	4.6	11.5	A large high 1040hPa located in Great Australian Bight extending a ridge through southern Qld. Southeast winds 25–30knots.
15/05/2003	2100	3.2 (3.4)	5.5	10.2	Weak low off the Gold Coast, moving south and deepening. Southeast to northeast winds 25–30knots.
28/05/2003	2130	2.5	4.3	9.9	A large 1034hPa high near Tasmania moving very slowly eastwards. Southeast winds 25–30knots.
27/06/2003	0130	3.2 (3.6)	5.3	11.8	A deep low 990hPa, off the far northern NSW coast moving steadily southwards. Gusty southwest winds 25–30knots.
03/07/2003	1700	2.1 (2.3)	3.6 (3.8)	11.2	Complex high over South Australia
17/07/2003	2330	2.2 (2.5)	3.7 (3.9)	11.9	A 1034hPa high moving slowly east from the Great Australian Bight reinforcing a strong ridge along the Qld east coast.
24/07/2003	1030	2.1	3.6	8.1	A firm ridge along the north tropical coast linked to a large high over the southwest Tasman Sea.
24/08/2003	0530	2.2	3.8	7.1	A vigorous trough over the Qld interior moving eastwards off the southern coast.
04/09/2003	1300	2.7 (3.0)	4.4 (4.6)	15.4	A large high over southeast Australia moving eastwards and weakening. This high extends a firm ridge into southeast Qld.
28/09/2003	0700	2.2	3.6 (4.3)	11.3	A firm ridge along the coast south of Fraser Island extending along the entire east coast.

 Denotes peak event

**Notes:** Barometric pressure measured in hectopascals (hPa). The Hsig values and the Hmax values are the maximum values recorded for each event and are not necessarily coincident in time. The Tp values and the Hsig values are coincident as a single event on the date shown. Due to possible statistical errors arising from finite length records used in calculating wave climate, the above storm peak Hsig and Hmax values are derived from the time series smoothed by a simple three hourly moving average following the recommendation of Forristall G.Z., Heideman J.C., Leggett I.M., Roskam B. and Vanderschuren L. (1996), “Effect of Sampling Variability on Hindcast and Measured Wave Heights”, J. Waterway, Port, Coastal and Ocean Engineering, Vol 122, No. 5, September/October 1996. Thus the un-smoothed data shown in brackets may be of a slightly larger value.

**Table 5 (continued)**  
Significant meteorological events


<b>Gold Coast</b>					
<b>Storm threshold value: 2.0 metres</b>					
Date	Time	Hs	Hmax	Tp	Event
27/10/2002	2330	2.0	3.6 (4.1)	8.0	A trough lying across the coast near Double Island Point with a firm ridge to the south. Southeast winds 25–30knots.
02/02/2003	1200	2.7	4.6	11.2	A 1028hPa high moving into Tasman Sea. Ex TC Beni about 650kms northeast of Sandy Cape moving northwest. Southeast winds 30–40knots.
24/02/2003	1730	2.9 (3.2)	<b>5.2</b> (6.0)	9.3	A strong ridge along south coast combined with a trough over southern Coral Sea strengthening winds along the south coast. Southeast winds 25–33knots and very heavy rain.
27/02/2003	1300	2.0	3.5 (3.8)	8.4	A large high east of New Zealand directing a belt of strong winds onto southern Qld coast. Southeast to east winds 25–30knots.
16/04/2003	2300	2.1	3.7 (4.0)	12.3	A firm ridge developing along south coast from a large high in the Great Australian Bight. South to southeast winds 25–33knots.
26/04/2003	0130	2.6	4.4	8.3	A large high located over the southern Tasman Sea and a trough located off the coast. South to southeast winds 25–30knots.
07/05/2003	1500	2.6 (2.8)	4.4 (6.0)	11.7	A 1033hPa high over southeast NSW extending a strong ridge along the Qld east coast. Southeast winds 25–30knots.
15/05/2003	2030	3.0 (3.1)	<b>5.2</b> (5.9)	10.3	Weak low off the Gold Coast, moving south and deepening. Southeast to northeast winds 25–30knots.
28/05/2003	1500	2.6 (2.8)	4.4 (4.6)	10.4	A large 1034hPa high near Tasmania moving very slowly eastwards. Southeast winds 25–30knots.
27/06/2003	0600	<b>3.2</b> (3.4)	5.1 (5.4)	12.2	A deep low 990hPa, off the far northern NSW coast moving steadily southwards. Gusty southwest winds 25–30knots.
17/07/2003	2130	2.0	3.3 (3.6)	11.6	A 1034hPa high moving slowly east from the Great Australian Bight, reinforcing a strong ridge along the Qld east coast.
04/09/2003	1200	2.2 (2.5)	4.0	14.7	A large high over southeast Australia moving eastwards and weakening, extending a firm ridge into southeast Qld.
<b>Brisbane</b>					
<b>Storm threshold value: 4.0 metres</b>					
Date	Time	Hs	Hmax	Tp	Event
16/11/2002	2200	4.1	6.6 (6.8)	10.0	A 1030hPa high over the western Tasman Sea extending a firm ridge onto the southern coast. An upper low located over southeast Qld. Southeast winds 25–30knots.
02/02/2003	1500	<b>4.6</b> (4.8)	<b>7.5</b>	10.1	Ex TC Beni about 650kms northeast of Sandy Cape moving northwest. Southeast gales along coast. Seas very rough.
04/05/2003	2230	4.3 (4.8)	7.1 (7.6)	11.3	A large high 1040hPa located in the Great Australian Bight extending a ridge through southern Qld. Southeast winds 25–30knots.
27/06/2003	0600	4.0 (4.4)	6.8 (8.0)	11.4	A deep low 990hPa off the far northern NSW coast moving steadily southwards. Gusty southwest winds 25–30knots.
<b>Moreton Bay</b>					
<b>Storm threshold value: 1.0 metres</b>					
Date	Time	Hs	Hmax	Tp	Event
28/10/2002	0001	<b>1.3</b> (1.6)	<b>2.3</b> (2.9)	4.3	A trough lying across the coast near Yeppoon moving north, with a firm coastal ridge to the south. A small low east of Double Island Point moving east. Southeast winds 25–40knots.
10/01/2003	1830	1.0	1.9	4.2	A low over the far northern Tasman Sea and a high near Tasmania producing a strong pressure gradient over southern Qld waters. South to southeast winds 25–30knots.
02/02/2003	1430	1.1	1.9 (2.1)	4.1	A 1028hPa high moving into Tasman Sea. Ex TC Beni about 650 kms northeast of Sandy Cape moving northwest. Southeast winds 30–40knots.
16/04/2003	2030	1.0	1.9	4.2	A firm ridge developing along south coast from a large high in the Great Australian Bight. South to southeast winds 25–33knots.
28/10/2003	2200	1.0	1.8 (2.0)	4.0	A deep low will moving across southern NSW, with an associated trough moving across inland Qld.

 Denotes peak event



**Table 5 (continued)**  
Significant meteorological events

<b>Mooloolaba</b>					
<b>Storm threshold value: 2.0 metres</b>					
Date	Time	Hs	Hmax	Tp	Event
28/10/2002	0200	2.6 (3.0)	4.8 (5.5)	7.6	A trough lying across the coast near Yeppoon moving north, with a firm coastal ridge to the south. A small low east of Double Island Point moving east. Southeast winds 25–40knots.
17/11/2002	0430	2.1	3.6 (4.0)	6.9	A firm ridge extending along the east coast from a high over the Tasman Sea. Southeast winds 25–30knots.
05/01/2003	2200	2.0	3.3 (3.9)	7.8	A 1026hPa high centred near Bass Strait moving east and building a strong ridge along the eastern seaboard. Southeast winds averaging 25–30knots.
04/02/2003	1700	2.8 (3.0)	4.8	8.4	A 998hPa low, ex TC Beni was centred about 390 kms east to northeast of Mackay. Southeast to east winds 25–33knots.
26/02/2003	0600	2.7 (3.2)	4.6 (5.0)	10.3	A large high east of New Zealand combined with a weak trough across southern Coral Sea directing a belt of strong winds onto southern Qld coast. Southeast to east winds 25–30knots.
17/04/2003	0500	2.4 (2.6)	4.0 (4.4)	12.6	A firm ridge extending along the south coast from a large high in Great Australian Bight. South to southeast winds 25–33knots.
26/04/2003	1400	<b>3.0</b> (3.2)	<b>5.0</b>	9.6	A large high located over the southern Tasman Sea and trough off the coast. South to southeast winds 25–30knots.
04/05/2003	1700	2.1	3.8	6.7	A large high 1040hPa located in Great Australian Bight extending a ridge through southern Qld. Southeast winds 25–30knots.
07/05/2003	2230	2.3 (2.5)	4.0 (4.4)	9.2	A 1033hPa high over southeast NSW extending a strong ridge along the Qld east coast. Southeast winds 25–30knots.
15/05/2003	0400	2.3 (2.6)	4.0 (4.4)	8.5	Weak low off the Gold Coast, moving south and deepening. Southeast to northeast winds 25–30knots.
29/05/2003	0130	2.4 (2.6)	4.0	10.1	A large 1034hPa high over Victoria moving slowly eastwards extending a firm ridge to Qld coast. Southeast winds 25–33knots.
26/06/2003	0430	2.2	3.7	8.7	A deepening low about 400kms east of the Gold Coast moving steadily southward. Southwest to south winds 25–30knots.
17/07/2003	2030	2.4 (2.6)	3.9	11.7	A 1034hPa high moving slowly east from the Great Australian Bight, reinforcing a strong ridge along the Qld east coast.
16/08/2003	1030	2.4 (2.6)	4.0	7.8	A 1028hPa high over southern NSW moving eastwards and a weakening trough near Gladstone.
<b>Emu Park</b>					
<b>Storm threshold value: 2.0 metres</b>					
Date	Time	Hs	Hmax	Tp	Event
28/10/2002	2100	2.3	4.0	7.3	A trough lying across the coast near Yeppoon moving north, with a firm coastal ridge to the south. A small low east of Double Island Point moving east. Southeast winds 25–40knots.
06/01/2003	1930	2.1	3.7	6.8	A 1026hPa high moving slowly east from Bass Strait extends a strong ridge along the Qld coast. Southeast winds averaging 25–30knots.
24/01/2003	2130	2.2 (2.4)	3.6 (3.9)	6.5	A slow moving 1024hPa high centred over western Tasman Sea extending firm ridge along east Qld coast. Southeast winds 25–30knots.
02/02/2003	1900	2.2	3.7	6.5	A 1028hPa high moving into Tasman Sea. Ex TC Beni about 650kms northeast of Sandy Cape moving northwest. Southeast winds 30–40knots.
06/02/2003	0530	2.1	3.6	6.6	High in Tasman Sea.
03/03/2003	2030	<b>2.5</b> (2.7)	<b>4.2</b>	7.1	Tropical low about 100kms northeast of Whitsunday Is. Firm ridge along coast south of the low. South to southeast winds 25–33knots.
05/05/2003	0030	2.1	3.7	7.4	A large high 1039hPa located in Bass Strait combined with a weak low north of New Zealand to produce a pressure gradient through southern Qld waters. Southeast winds 25–30knots.
29/05/2003	1830	2.0	3.4	6.6	A large 1034hPa high over Victoria moving very slowly eastwards extending a firm ridge to Qld coast. Southeast winds 25–33knots.
19/07/2003	2100	2.1 (2.3)	3.7	6.6	A large 1035hPa high over Victoria moving slowly east, extending a strengthening ridge along Qld east coast.

 Denotes peak event



**Table 5 (continued)**  
Significant meteorological events

<b>Hay Point</b>					
<b>Storm threshold value: 1.5 metres</b>					
Date	Time	Hs	Hmax	Tp	Event
28/10/2002	2300	1.6	2.9	5.8	A trough lying across the coast near Yeppoon moving north, with a firm coastal ridge to the south. A small low, east of Double Island Point moving east. Southeast winds 25–40knots.
17/11/2002	2030	1.7	2.8	5.8	A firm ridge extending along the east coast from a high over the Tasman Sea. Southeast winds 25–30knots.
06/01/2003	2200	1.8	3.0	5.9	A 1026hPa high moving slowly east from Bass St, extending a strong ridge along the Qld coast. Southeast winds averaging 25–30knots.
25/01/2003	1230	1.8	3.3	6.1	A slow moving 1023hPa high in western Tasman Sea has a firm ridge along the east Qld coast. Southeast winds 25–30knots.
05/02/2003	1130	1.9	3.3	6.5	Ex TC Beni, 1006hPa was centred north of St Lawrence and moving South-southwest. Southeast to northeast winds 25–30knots.
03/03/2003	0830	<b>2.0</b> (2.2)	<b>3.4</b> (3.5)	6.8	Tropical low about 100kms northeast of Whitsunday Is. Firm ridge along coast south of the low. South to southeast winds 25–33knots.
18/04/2003	1000	1.7	2.9	6.0	A firm ridge extends along the central and south coasts from a large high near Tasmania. South to southeast winds 25–30knots.
05/05/2003	1000	1.9	3.5	5.9	A large high 1039hPa located in Bass Strait combined with a weak low north of New Zealand producing a pressure gradient through southern Qld waters. Southeast winds 25–30knots.
30/05/2003	2030	1.7	2.9	5.7	A large 1034hPa high over Victoria moving very slowly eastwards extending a firm ridge to Qld coast. Southeast winds 25–30knots.
14/07/2003	2330	1.5	2.6	5.7	A high over NSW moving east strengthening the east coast ridge.
<b>Mackay</b>					
<b>Storm threshold value: 2.0 metres</b>					
Date	Time	Hs	Hmax	Tp	Event
29/10/2002	0130	2.2	3.8	7.2	A 1021hPa high located near Brisbane.
18/11/2002	0230	2.2	3.7	6.7	A firm ridge extending along the east coast from a high over the Tasman Sea. Southeast winds 25–30knots.
06/01/2003	2200	2.3	3.9	7.1	A 1026hPa high moving slowly east from Bass Strait extending a strong ridge along the Qld coast. Southeast winds averaging 25–30knots.
25/01/2003	0330	2.6 (2.8)	4.4	7.5	A slow moving 1023hPa high in western Tasman Sea with firm ridge along the east Qld coast. Southeast winds 25–30knots.
03/02/2003	0200	2.7 (2.9)	4.8	8.0	A 1029hPa high east of Tasmania with a firm ridge along south Qld coast. Ex TC Beni about 650kms east of Mackay moving northwest. Southeast winds 30–40knots.
03/03/2003	0900	<b>3.3</b>	<b>6.4</b>	8.2	Tropical low about 100kms northeast of Whitsunday Is. Firm ridge along coast south of the low. South to southeast winds 25–33knots.
06/03/2003	2230	2.0	3.4	7.0	Weak tropical cyclone ERICA located 900kms east of Cardwell moving slowly north. Southeast winds 25–30knots.
18/04/2003	0930	2.5 (2.8)	4.2 (4.5)	7.8	A firm ridge extending along the central and south coasts from a large high near Tasmania. South to southeast winds 25–30knots.
05/05/2003	0430	3.0 (3.2)	5.4 (5.8)	8.1	A large high 1039hPa located in Bass Strait combined with a weak low north of New Zealand to produce a pressure gradient through southern Qld waters. Southeast winds 25–30knots.
29/05/2003	1930	2.9	5.3	7.8	A large 1034hPa high over Victoria moving very slowly eastwards extending a firm ridge to the Qld coast. Southeast winds 25–33knots.
09/06/2003	0530	2.2	3.5	6.7	A large high of about 1031hPa moving east across NSW extending a strong ridge along the Qld east coast. South to southeast winds 25–30knots.
25/06/2003	0930	2.3	3.7	7.4	A low developing east of Townsville intensifying rapidly and moving in a southeast direction. Southeast winds 25–30knots.
15/07/2003	0200	2.4	5.5	6.7	A firm ridge from a large high extends along the east Qld coast directing fresh to strong airflow across these waters.
18/07/2003	0100	2.0	3.4	7.3	A large 1035hPa high moving slowly east towards Bass Strait, extending a strong ridge along the Qld east coast.
20/07/2003	0400	2.2	3.5	6.9	Large 1035hPa high over eastern Bass Strait moving eastwards.
03/09/2003	0900	2.0	3.6	5.8	A large high over southeast Australia moving eastwards and Weakening, extending a firm ridge into southeast Qld.

**Table 5 (continued)**  
Significant meteorological events

<b>Townsville</b>					
<b>Storm threshold value: 1.5 metres</b>					
Date	Time	Hs	Hmax	Tp	Event
18/11/2002	2000	1.6	2.9 (3.9)	6.0	A firm ridge extending along the east coast from a high over the Tasman Sea. Southeast winds 25–30knots.
07/01/2003	1130	1.7	2.8	6.2	A 1025hPa high moving slowly east from Bass Strait extending a strong ridge along the Qld coast. Southeast winds averaging 25–30 knots.
25/01/2003	1930	<b>1.8</b>	<b>3.4</b>	6.5	A slow moving 1023hPa high in western Tasman Sea has firm ridge along the east Qld coast. Southeast winds 25–30knots.
29/05/2003	2130	1.5 (1.6)	2.8	6.4	A large 1034hPa high over Victoria moving very slowly eastwards extending a firm ridge to Qld coast. Southeast winds 25–33knots.
07/07/2003	2000	1.6 (1.8)	2.7 (3.0)	6.5	A firm ridge extending along much of the east Qld coast from a large 1030hPa high now moving east into the Tasman Sea.
14/07/2003	2230	1.7 (2.0)	3.2 (3.4)	6.9	A high over NSW moving east strengthening the east coast ridge.
<b>Cairns</b>					
<b>Storm threshold value: 1.0 metres</b>					
Date	Time	Hs	Hmax	Tp	Event
08/11/2002	1330	1.1	1.8	4.4	A 1026hPa high located in the Tasman Sea
24/02/2003	2130	1.0	1.9	4.5	Large high over the Tasman Sea with a tight pressure gradient over most waters. 1004hPa low and monsoon trough in Coral Sea.
14/03/2003	0730	1.1	2.0	4.2	Monsoon trough across the coast near Cairns with a weak 1002hPa low embedded just offshore. Southeast winds 25–30knots.
20/04/2003	1030	1.1 (1.3)	1.9 (2.4)	4.6	A large high almost stationary near Tasmania extending a slowly strengthening ridge along Qld coast. South to southeast winds 25–30knots.
03/05/2003	1030	1.1	2.0	4.9	A large high located in the Great Australian Bight. Southeast winds 25–30knots.
06/05/2003	0130	<b>1.4</b>	<b>2.2</b>	4.9	Firm ridge along the tropical coast from a large high 1038hPa over eastern Victoria. Southeast winds 25–30knots.
07/07/2003	0930	1.2	2.1 (2.3)	4.5	A firm ridge extending along much of the east Qld coast from a large 1030hPa high moving east into the Tasman Sea.
15/07/2003	0400	1.1	1.9	4.6	A firm ridge extends along the Qld east coast from a large high centred over the Tasman Sea.
05/09/2003	0600	1.0	1.8	4.5	The ridge along the tropical coast.
<b>Weipa</b>					
<b>Storm threshold value: 1.0 metres</b>					
Date	Time	Hs	Hmax	Tp	Event
09/01/2003	0100	1.0	1.7	9.34	A slow moving 997hPa monsoon low over the Top End producing 25–30knot northeast to northwest winds over the Gulf.
11/01/2003	1630	1.3 (1.4)	2.1 (2.6)	8.4	A slow moving tropical low below 1000hPa located over land in southern Gulf. Northeast to northwest winds 25–30knots.
17/01/2003	0900	1.6 (1.7)	2.6	9.0	A monsoon low with central pressure about 1000hPa located near southern Gulf coast. Wind gusts to 90km/h in exposed areas.
22/02/2003	1230	1.1	1.8	8.4	Firm ridging along Qld coast combined with monsoon trough across northern Australia.
28/02/2003	0900	2.1 (2.4)	3.4 (3.9)	8.4	Monsoon low centred over southern Gulf. Northwest to west winds 25–30knots.
12/03/2003	1530	<b>2.9</b> (3.1)	<b>4.3</b> (4.5)	11.2	Tropical cyclone Craig, 985hPa, located in eastern Gulf. Winds 25–30knots.

**Notes:** The Hsig values and the Hmax values are the maximum values recorded for each event and are not necessarily coincident in time. The Tp values and the Hsig values are coincident as a single event on the date shown.

Due to possible statistical errors arising from finite length records used in calculating wave climate, the above storm peak Hsig and Hmax values are derived from the time series smoothed by a simple three hour moving average following the recommendation of Forristall G.Z., Heideman J.C., Leggett I.M., Roskam B. and Vanderschuren L. (1996), "Effect of Sampling Variability on Hindcast and Measured Wave Heights", J. Waterway, Port, Coastal and Ocean Engineering, Vol 122, No. 5, September/October 1996. Thus the unsmoothed data shown in brackets may be of a slightly larger value.

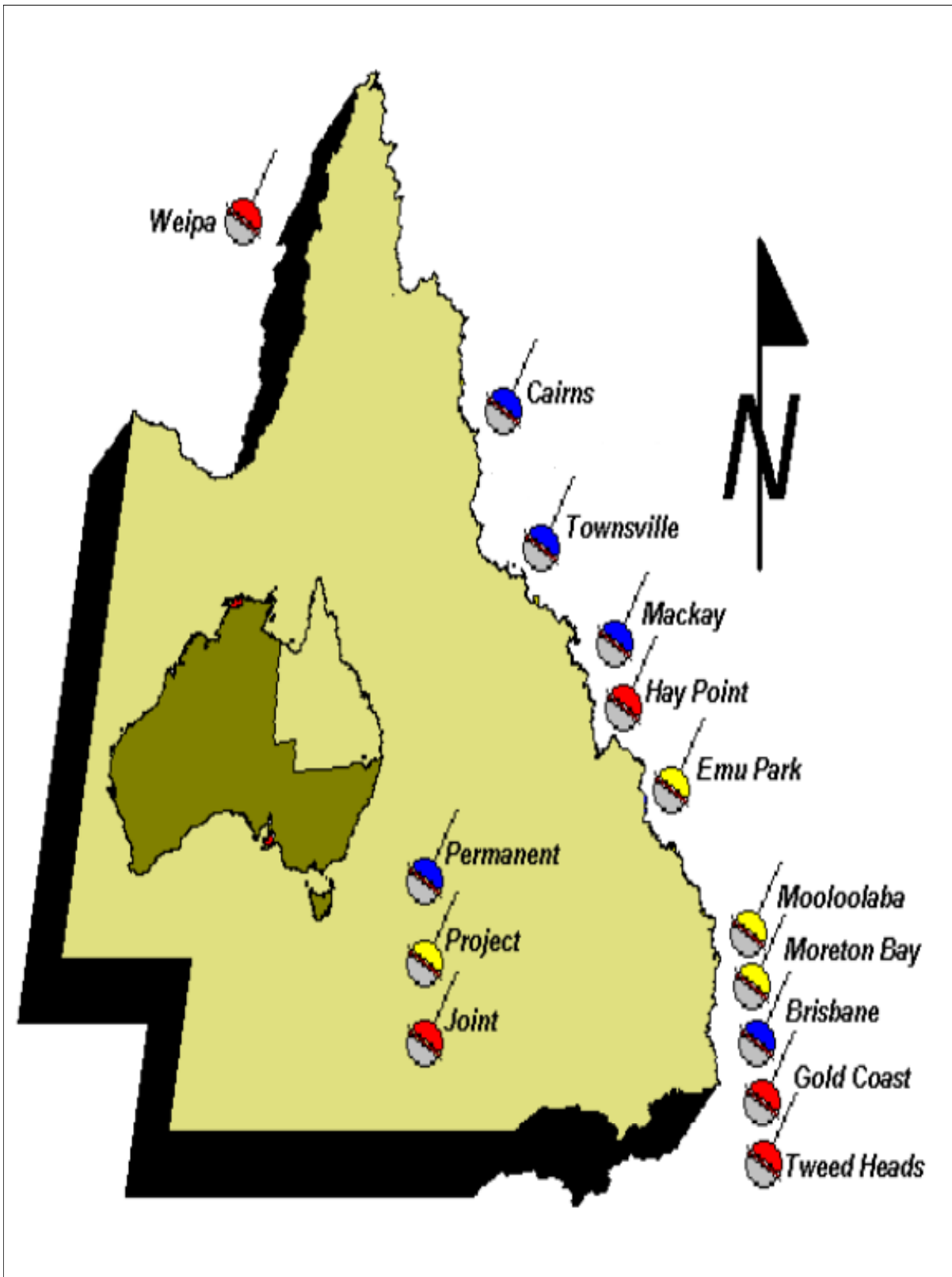
**Table 6 – Queensland cyclones for season 2002–03 (see figure 13)**

TC Erica						
Advice	Date	Time	Latitude	Longitude	Pressure	Category
1	01/03/2003	1200	-21.0000	147.5000	999	0
2		1800	-20.5000	149.0000	998	0
3	02/03/2003	0000	-20.3000	149.4000	1001	0
4		0600	-20.0000	149.8000	1000	0
5		1200	-20.0000	150.0000	1002	0
6		1800	-19.7000	149.7000	1001	1
7	03/03/2003	0000	-19.5000	149.5000	1003	0
8		0600	-19.7000	151.0000	1001	1
9		1200	-20.3000	151.5000	1000	1
10		1800	-20.3000	152.2000	998	1
11	04/03/2003	0000	-20.5000	153.0000	997	1
12		0600	-20.5000	154.0000	995	1
13		1200	-20.6000	154.4000	990	2
14		1800	-20.5000	154.6000	985	2
15	05/03/2003	0000	-20.1000	154.9000	985	2
16		0600	-19.4000	155.1000	985	2
17		1200	-18.7000	155.1000	988	2
18		1800	-18.0000	155.1000	990	1
19	06/03/2003	0000	-17.5000	154.5000	990	1
20		0600	-16.8000	154.0000	990	1
21		1200	-16.0000	154.0000	992	1
22		1800	-15.5000	153.9000	995	1
23	07/03/2003	0000	-15.1000	153.9000	998	0
24		0600	-14.5000	153.7000	998	0
25		1200	-13.8000	153.5000	998	0
26		1200	-13.8000	153.5000	998	0
27		1800	-12.8000	154.2000	997	1
28	08/03/2003	0000	-12.7000	154.0000	998	1
29		0600	-12.5000	154.4000	998	1
30		1200	-12.5000	154.6000	999	0
31		1800	-12.2000	154.8000	999	0
32	09/03/2003	0000	-12.2000	154.9000	999	0
33		0600	-12.4000	155.3000	999	0
34		1200	-12.3000	155.9000	1000	0
35		1800	-12.2000	156.8000	1000	0
36	10/03/2003	0000	-12.0000	157.5000	1000	0
37		0600	-12.1000	157.9000	995	1
38		1200	-12.3000	158.2000	993	1
39		1800	-12.7000	158.3000	990	2
40	11/03/2003	0000	-13.1000	158.4000	985	2
41		0600	-13.6000	158.8000	980	2
42		1200	-14.4000	159.4000	975	2
43		1800	-15.2000	159.8000	970	3
44	12/03/2003	0000	-16.4000	159.7000	965	3
45		0600	-16.9000	160.0000	960	3

**Table 6 (continued) – Queensland cyclones for season 2002–03 (see figure 13)**

TC Craig						
Advice	Date	Time	Latitude	Longitude	Pressure	Category
1	07/03/2003	1200	-13.0000	130.3000	1004	0
2		1800	-12.4000	130.0000	1001	0
3	08/03/2003	0000	-11.7000	129.5000	1000	0
4		0600	-11.4000	129.0000	998	0
5		1200	-11.2000	129.3000	998	0
6		1800	-11.2000	129.6000	996	0
7	09/03/2003	0000	-11.1000	129.1000	993	0
8		0600	-10.6000	129.0000	990	1
9		1200	-10.7000	129.7000	988	1
10		1800	-10.6000	130.3000	985	1
11	10/03/2003	0000	-11.0000	130.6000	985	1
12		0600	-11.2000	130.9000	982	2
13		1200	-11.4000	131.1000	982	2
14		1800	-11.4000	131.4000	982	2
15	11/03/2003	0000	-11.6000	132.2000	976	2
16		0600	-11.9000	133.1000	980	2
17		1200	-12.1000	134.4000	988	1
18		1800	-12.2000	136.1000	988	1
19	12/03/2003	0000	-13.0000	138.0000	985	1
20		0600	-14.5000	140.1000	982	2
21		1200	-15.2000	141.0000	996	1
22		1800	-15.2000	141.0000	997	0

The above information has been obtained from the Bureau of Meteorology (BOM) cyclone advices



**Wave recording sites—Locality plan**



Wave data recording program  
Annual summary for season 2002-03

Figure A

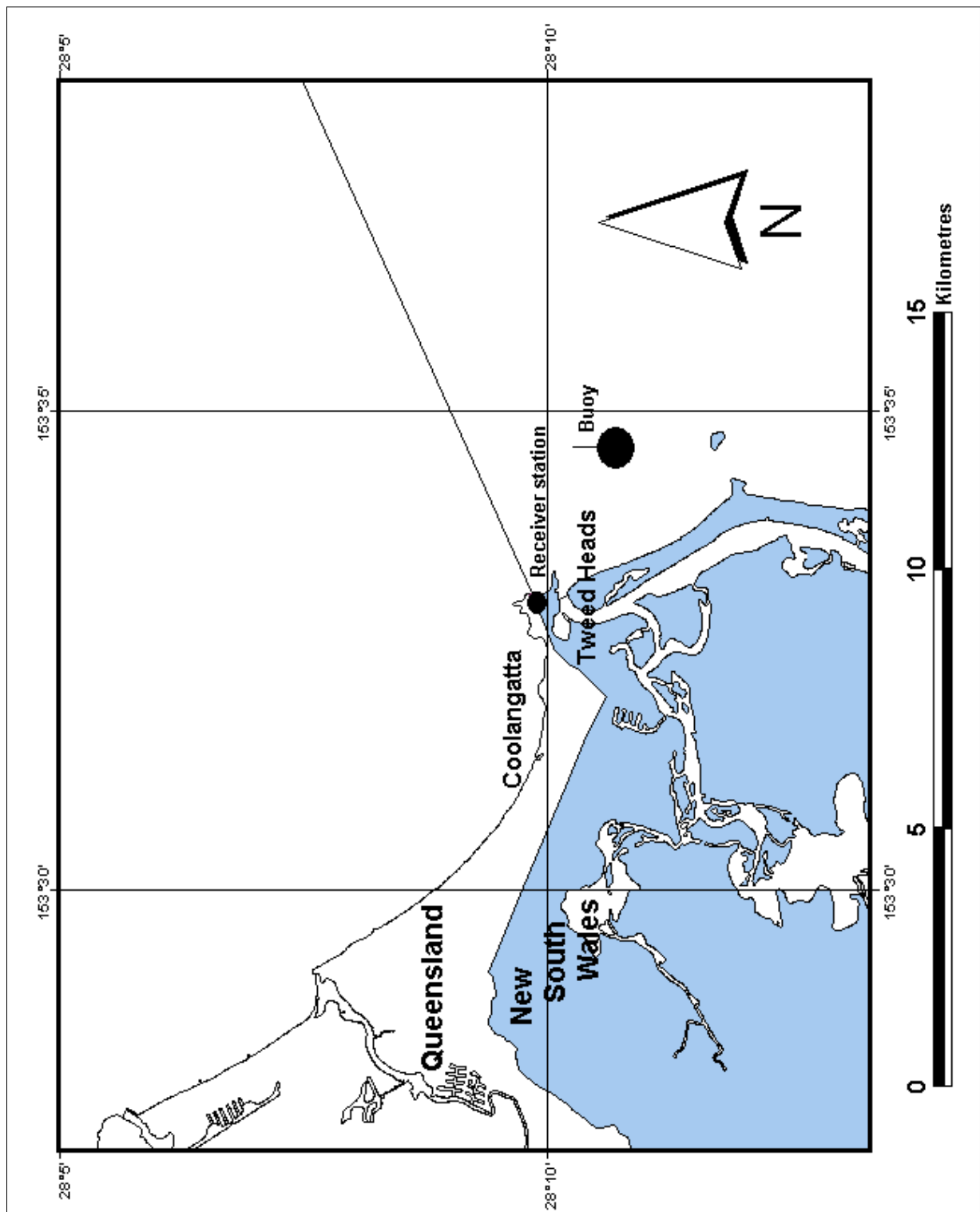
# Tweed

## Wave recording station

### Details of wave recorder station

Maximum Possible Analysis Days (Last record–First record)	=	365.000
Total Days Used in Analysis	=	364.484
Gaps in Data from Selected Dates (Days)	=	0.516
Gaps in Data from Analysed Records (Days)	=	0.516
Gaps in Data from Duration Analysis (Days)	=	0.516
Number of Records Used in Analysis	=	17439

HAT at nearest standard port: Tweed River breakwater, 1.89m



Latitude	Longitude	Depth (m)	LAT	Deployment date	Removal date
28° 10.745'	153° 34.597'	25.0		25/06/2002	18/09/2003
28° 11.700'	153° 34.638'	24.0		18/09/2003	

### Tweed region—Locality plan

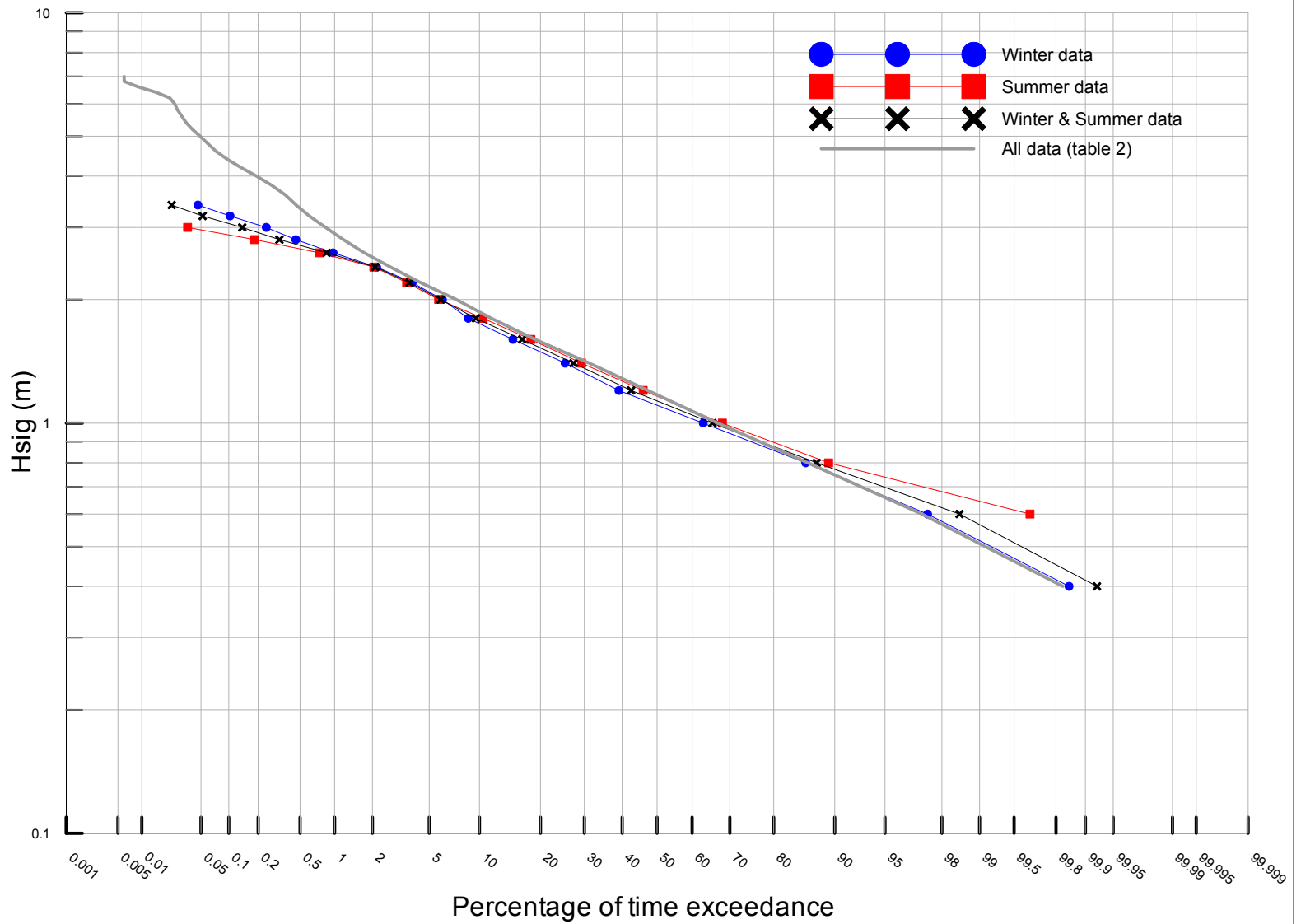


Wave data recording program  
Annual summary for season 2002-03

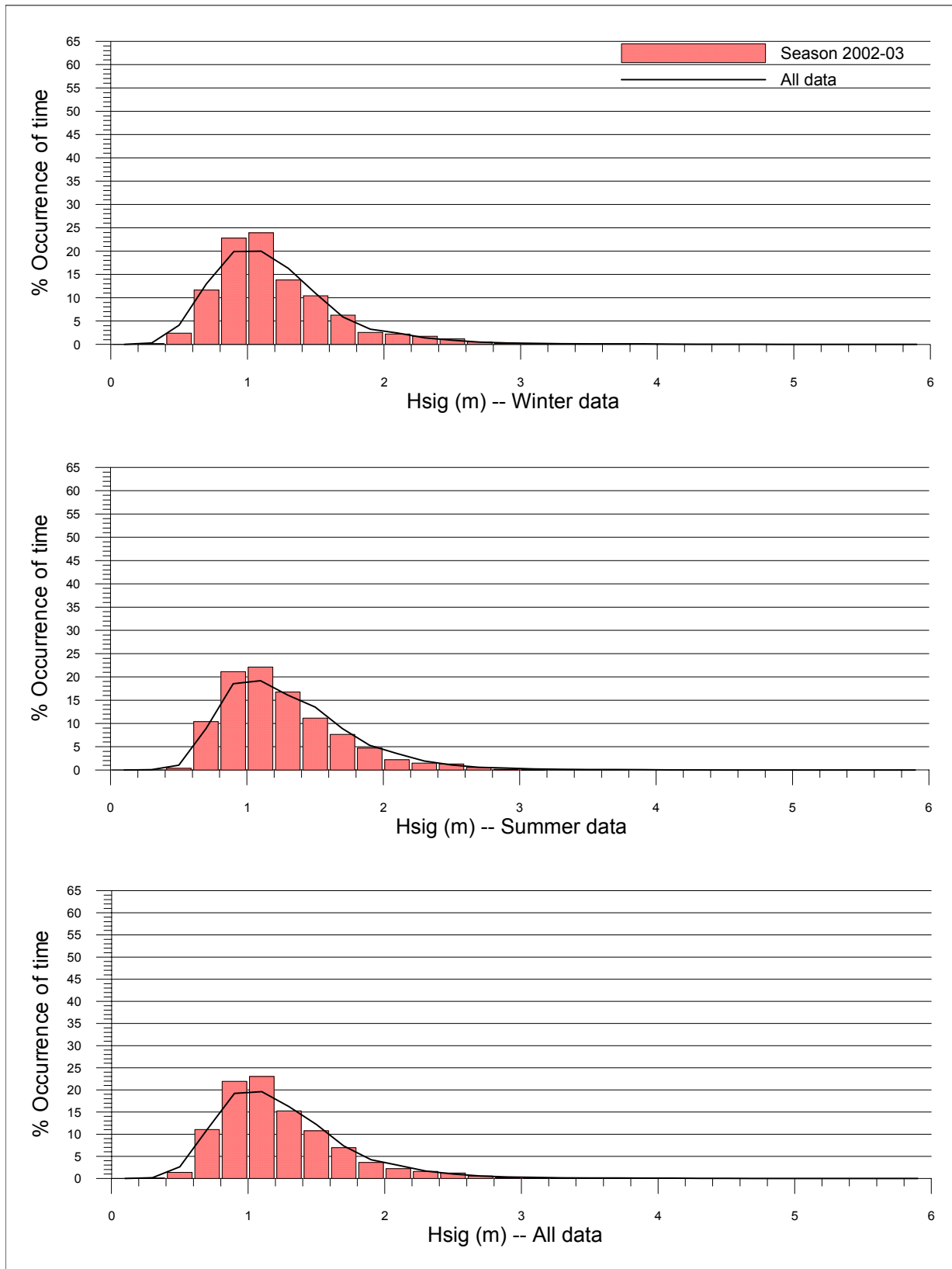
Figure 1.1



### Tweed Heads region—Percentage (of time) exceedance of wave heights (Hsig) for all wave periods (Tp)





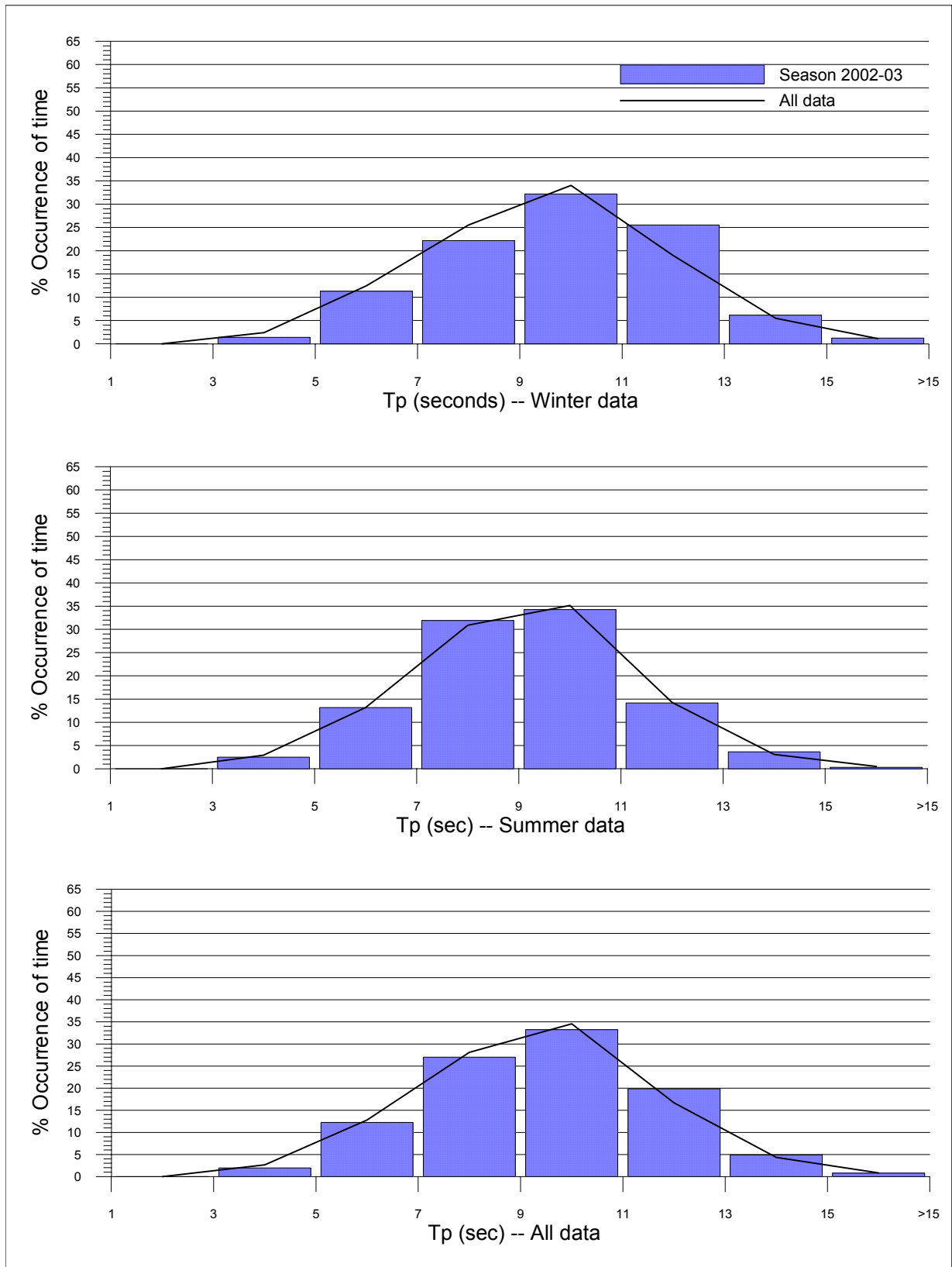


**Tweed Heads region—Histogram percentage (of time) occurrence of wave heights (Hsig) for all wave periods (Tp)**



Wave data recording program  
Annual summary for season 2002-03

Figure 1.3



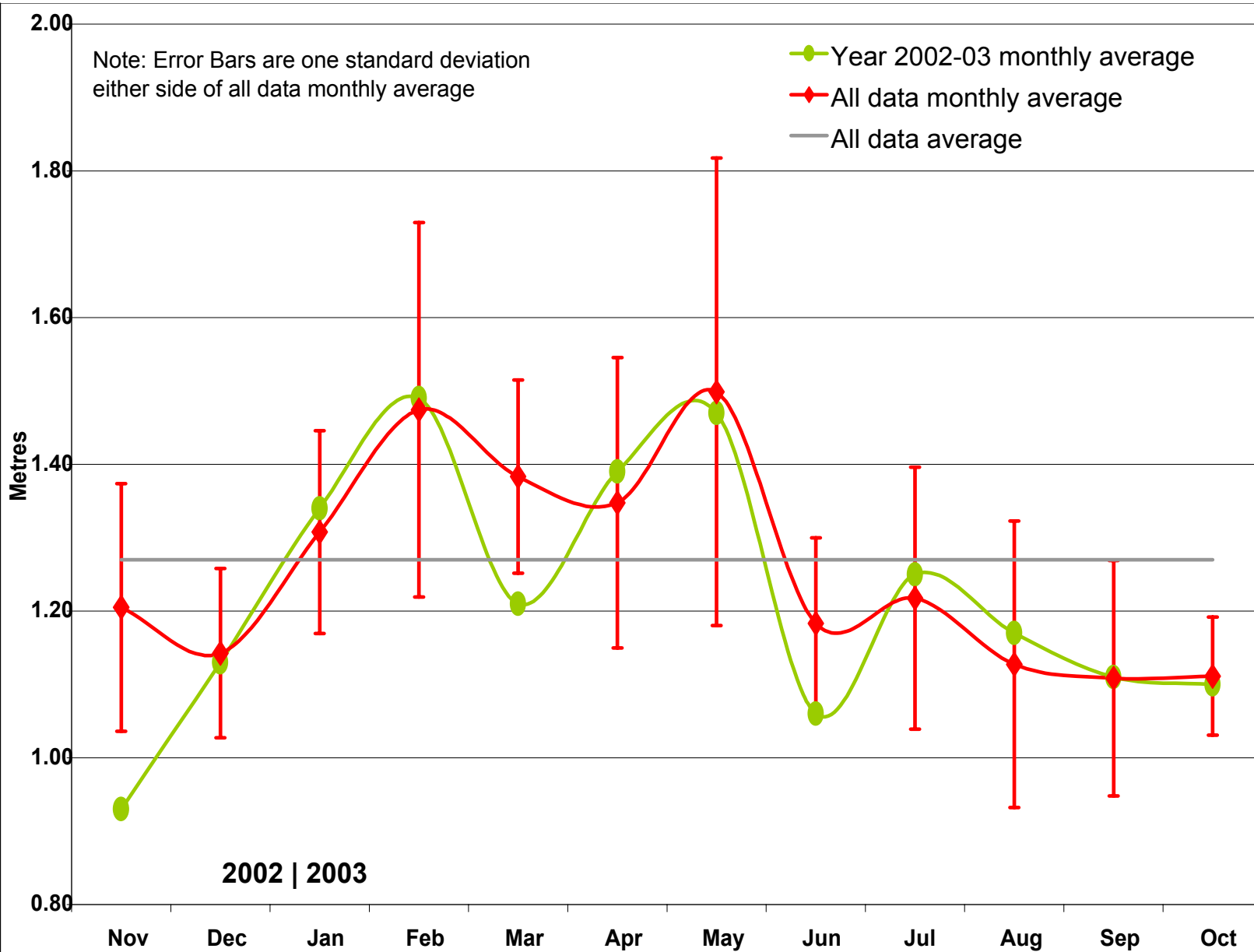
**Tweed Heads region—Histogram percentage (of time) occurrence of wave periods (Tp) for all wave heights (Hsig)**



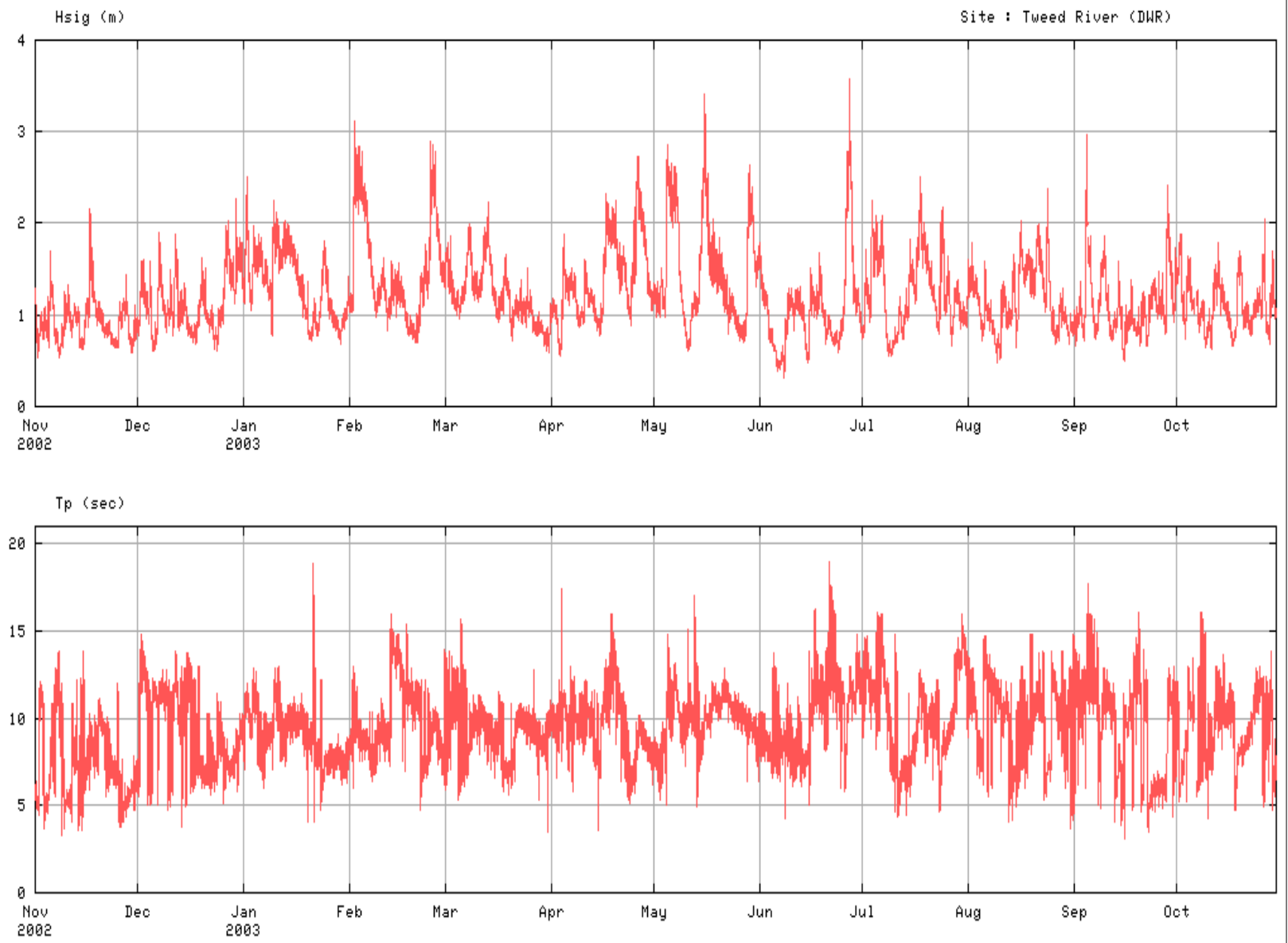
Wave data recording program  
Annual summary for season 2002-03

Figure 1.4

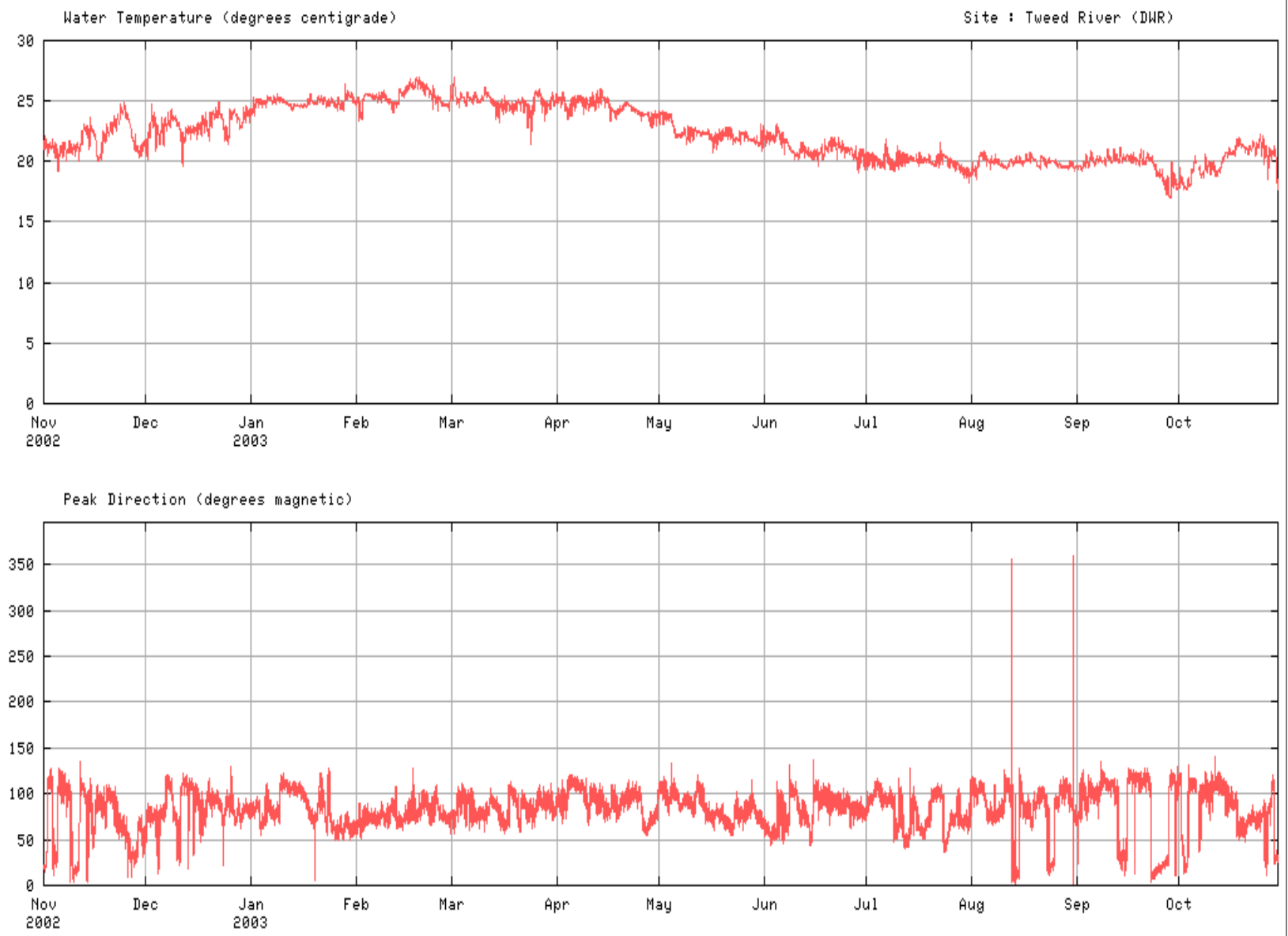
**Tweed Heads region—Plot of monthly averages for seasonal year and for all data, for wave height (Hsig)**

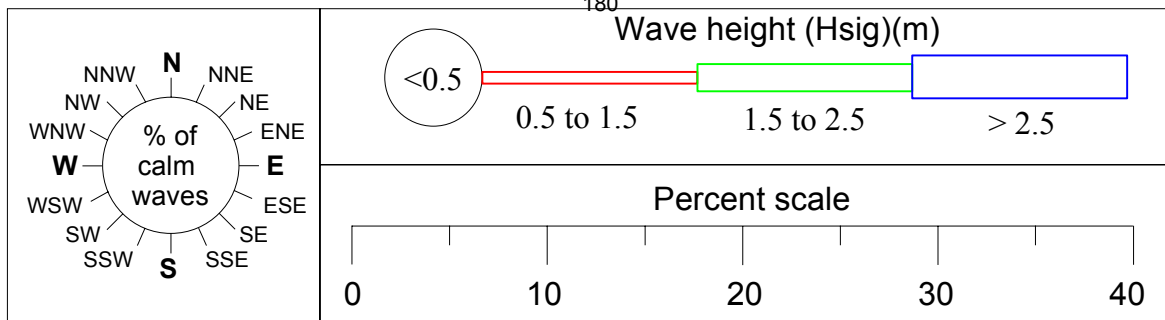
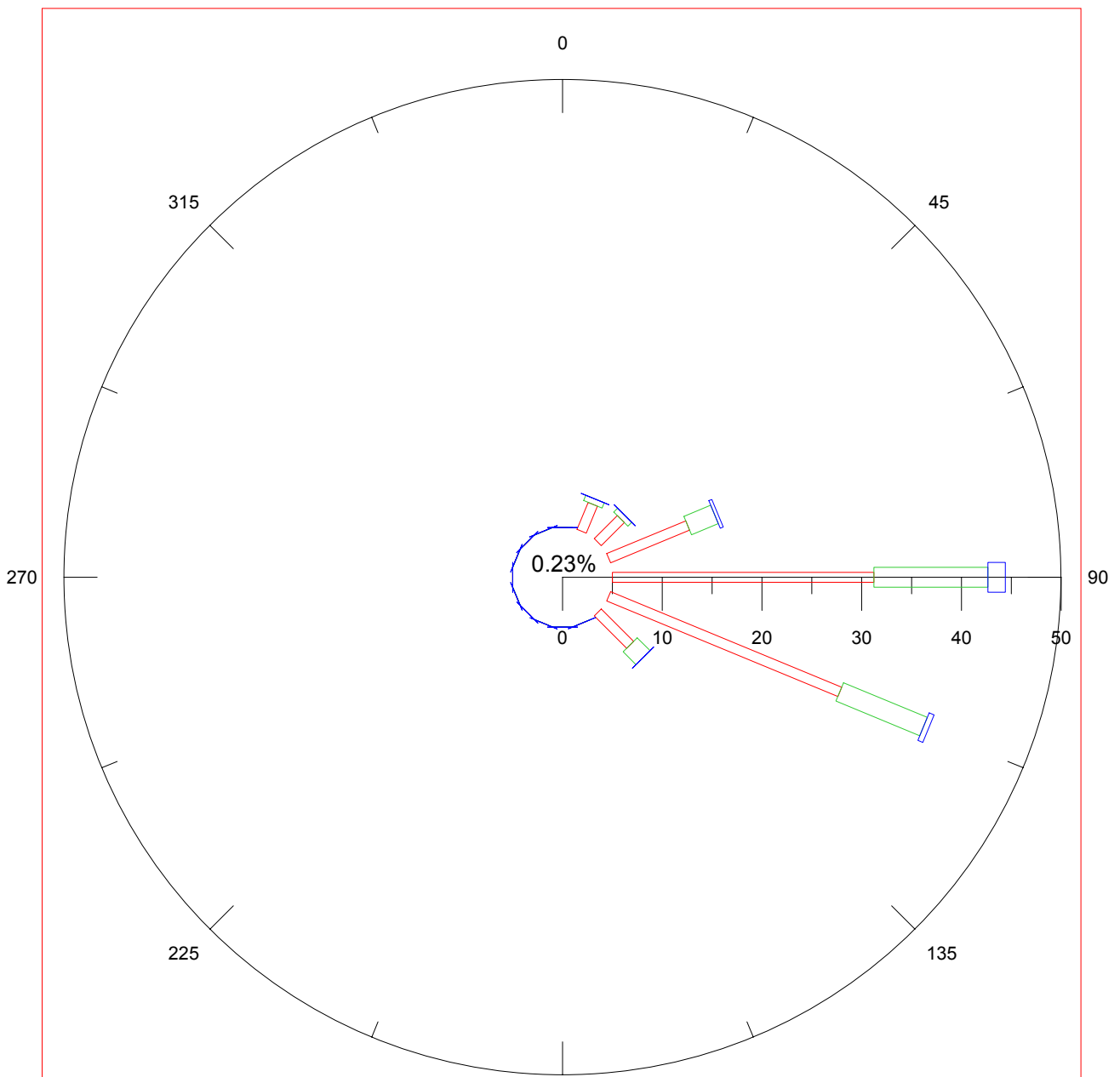


**Tweed Heads region—Daily wave recordings**



**Tweed Heads region—Water temperature  
and peak direction recordings**





**Tweed region—Directional wave rose**



Wave data recording program  
Annual summary for season 2002-03

Figure 1.8

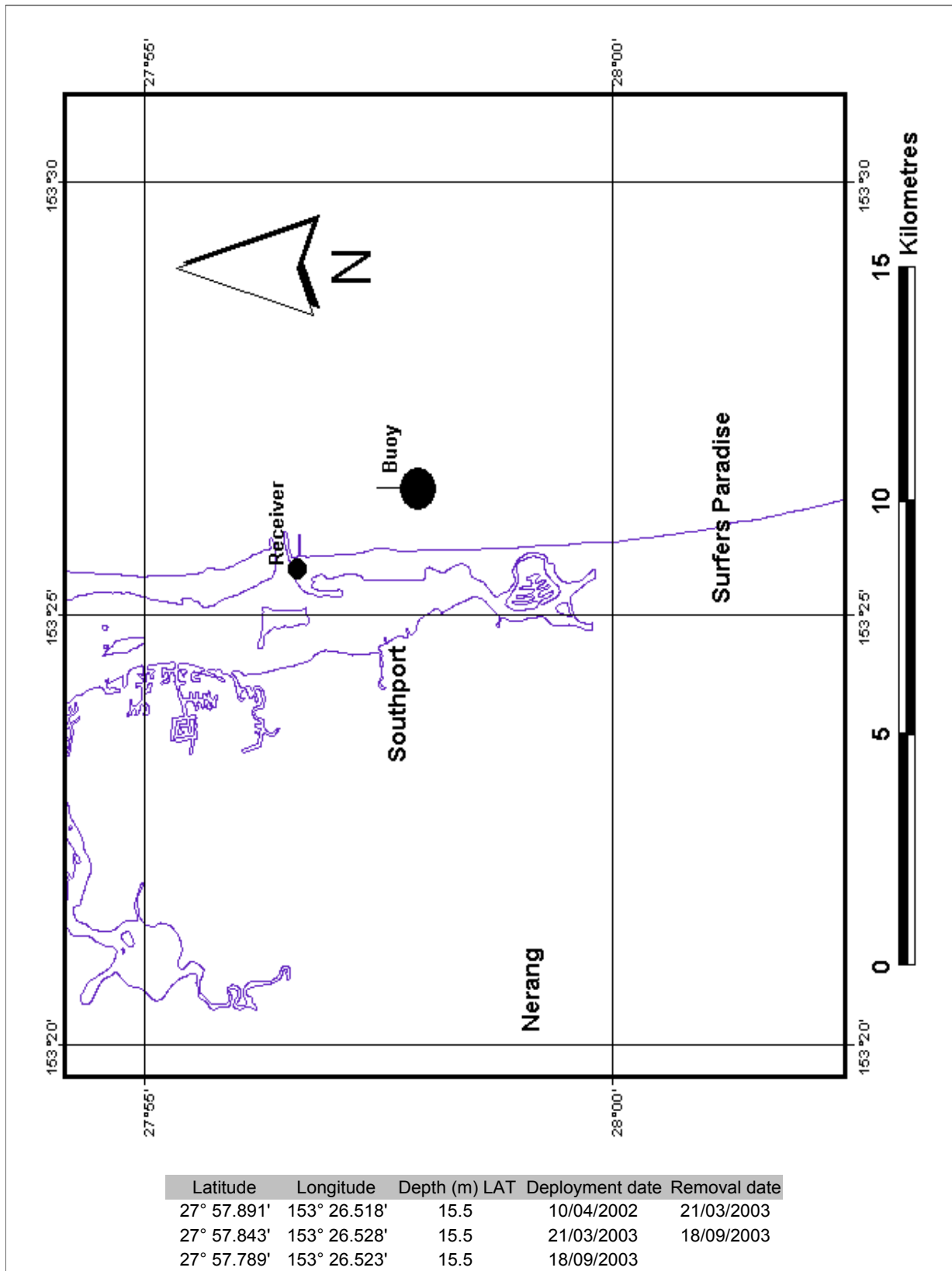
# Gold Coast

## Wave recording station

### Details of wave recorder installation

Maximum Possible Analysis Days (Last record–First record)	=	365.000
Total Days Used in Analysis	=	358.228
Gaps in Data from Selected Dates (Days)	=	6.772
Gaps in Data from Analysed Records (Days)	=	6.772
Gaps in Data from Duration Analysis (Days)	=	6.772
Number of Records Used in Analysis	=	17094

HAT at nearest standard port: Gold Coast seaway, 1.89m



**Gold Coast region—Locality plan**

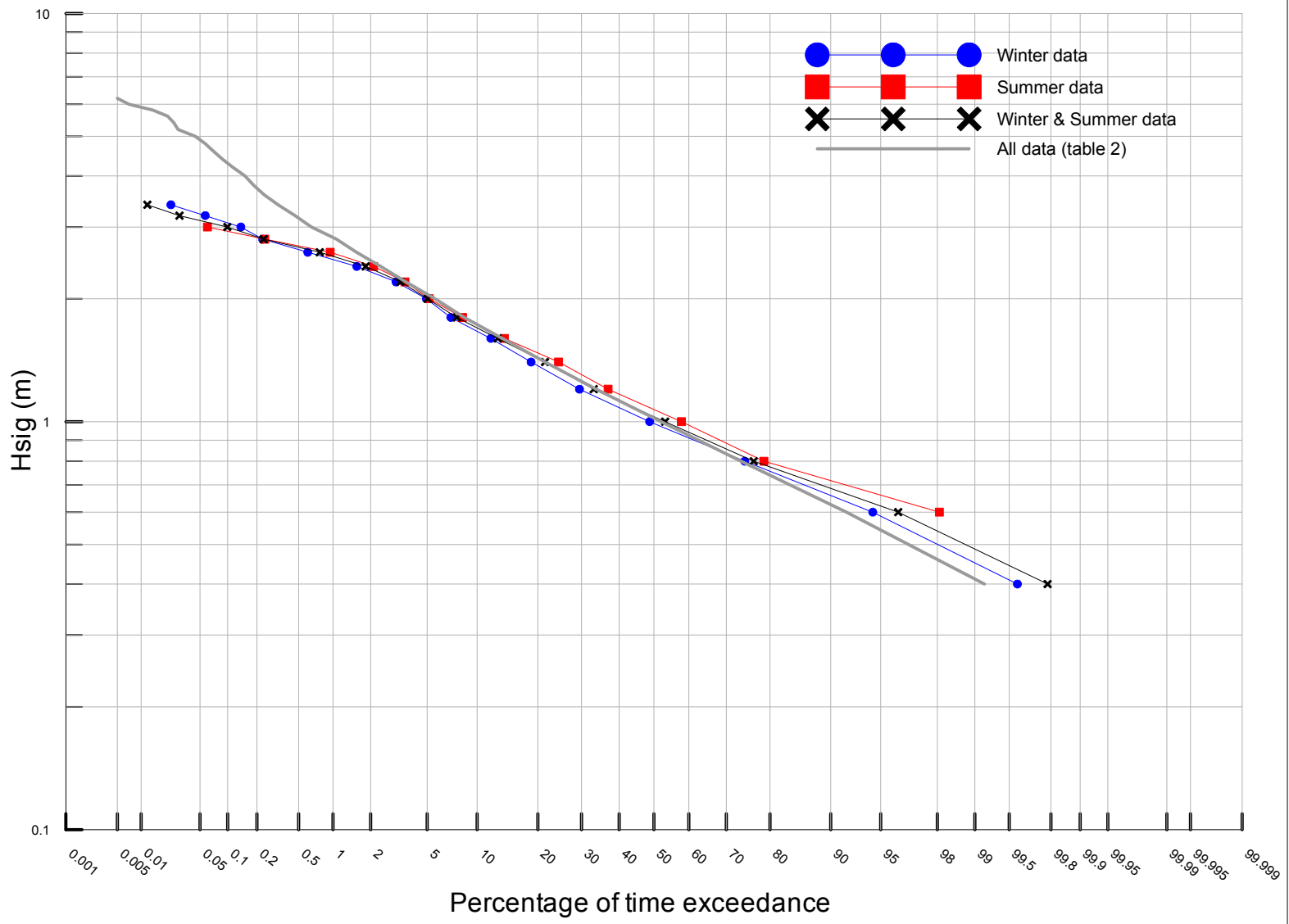


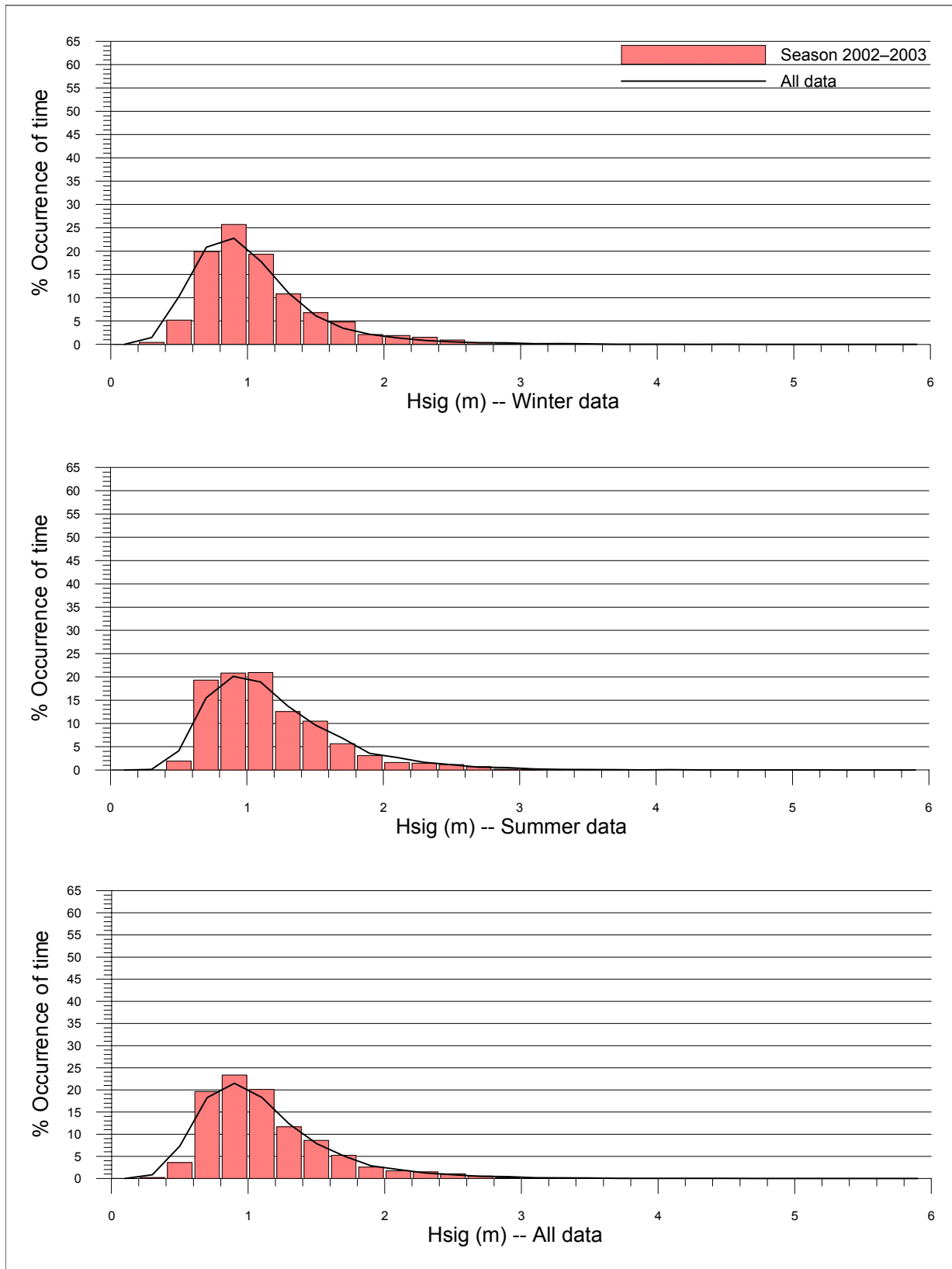
Wave data recording program  
Annual summary for season 2002-03

Figure 2.1



**Gold Coast region—Percentage (of time) exceedance of wave heights (Hsig) for all wave periods (Tp)**



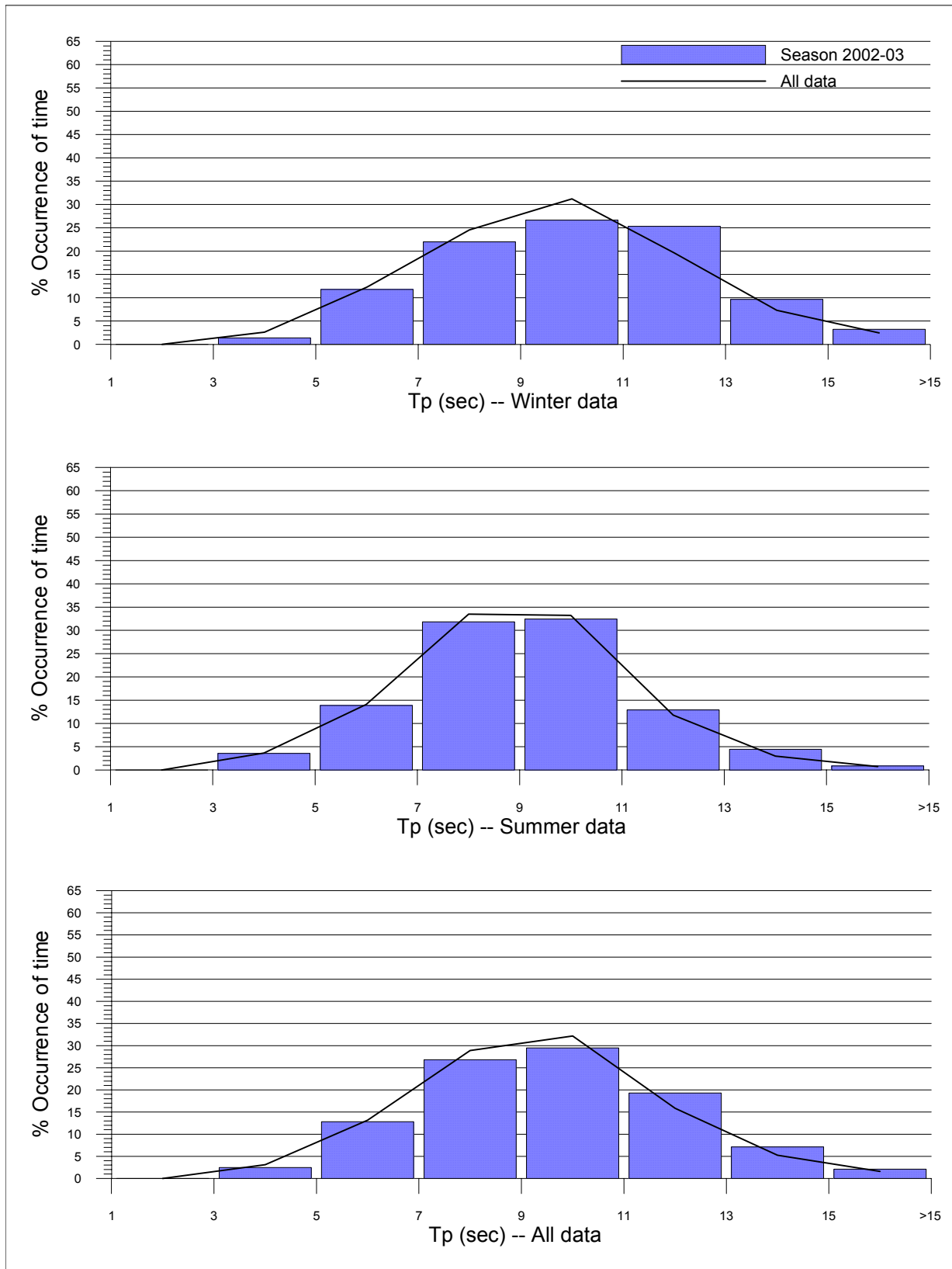


**Gold Coast region—Histogram percentage (of time) occurrence of wave heights (Hsig) for all wave periods (Tp)**



Wave data recording program  
Annual summary for season 2002-03

Figure 2.3



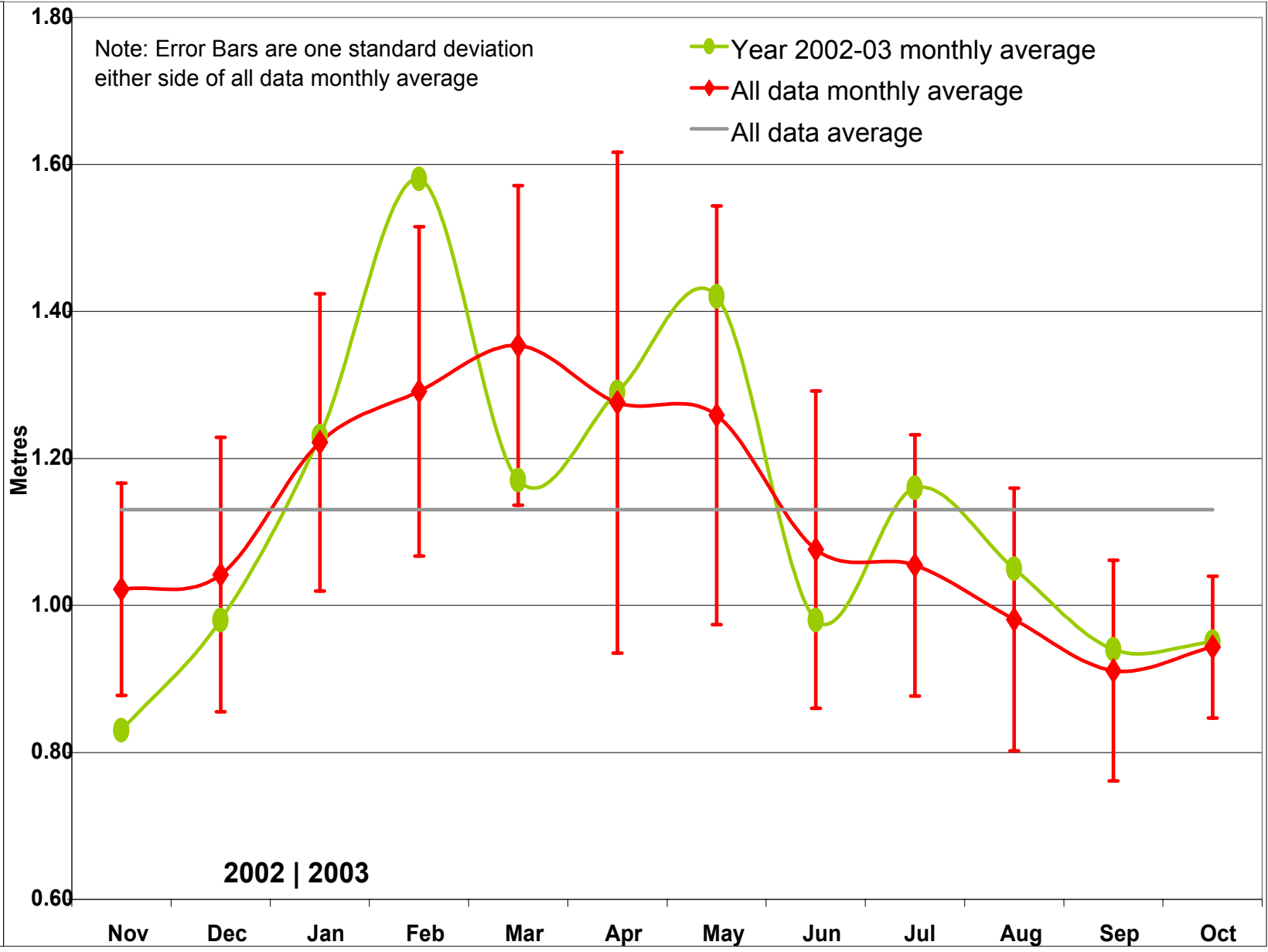
**Gold Coast region—Histogram percentage (of time) occurrence of wave periods (Tp) for all wave heights (Hsig)**



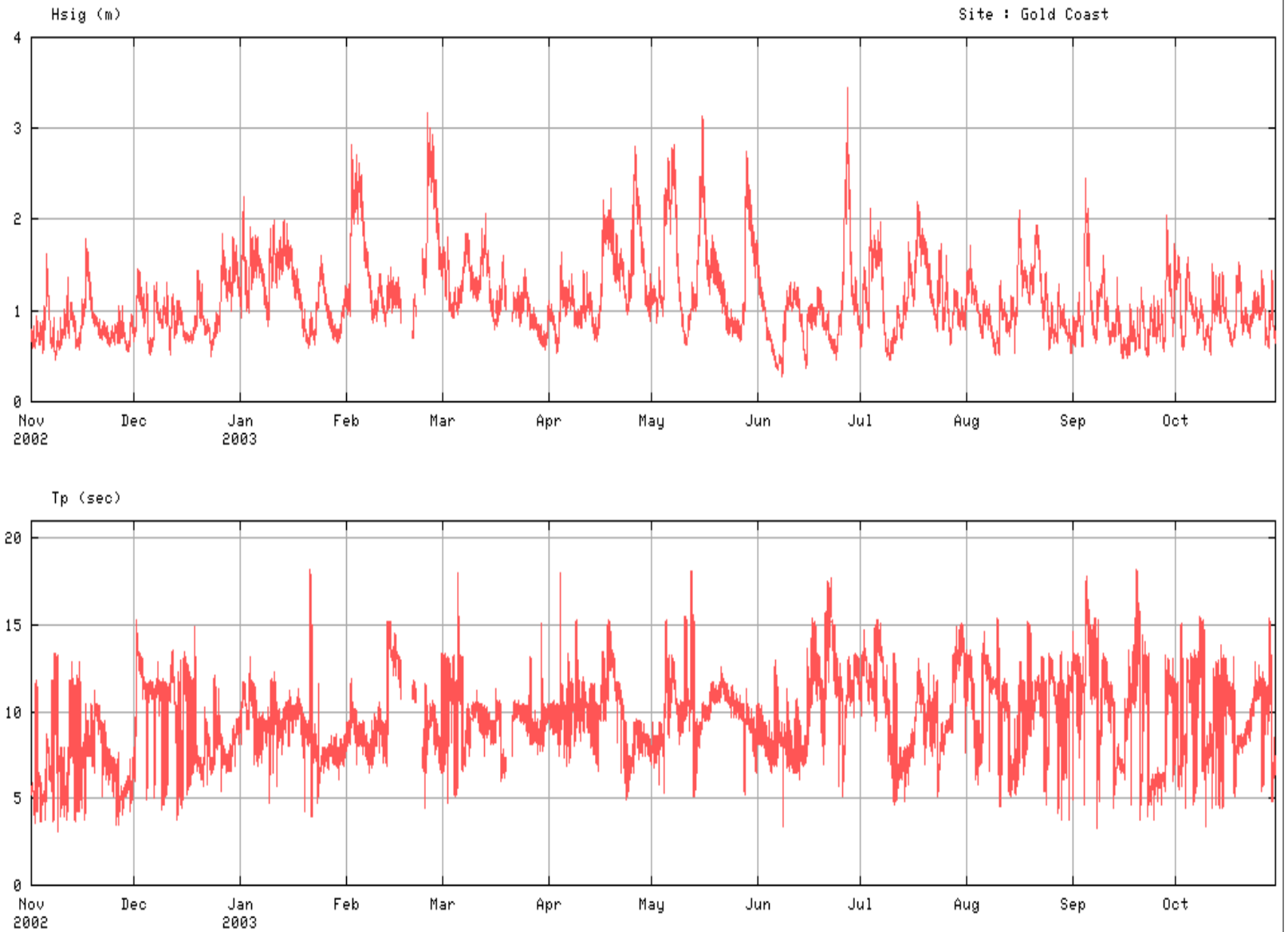
Wave data recording program  
Annual summary for season 2002-03

Figure 2.4

**Gold Coast region—Plot of monthly averages for seasonal year and for all data, for wave height (Hsig)**



**Gold Coast region—Daily wave recordings**



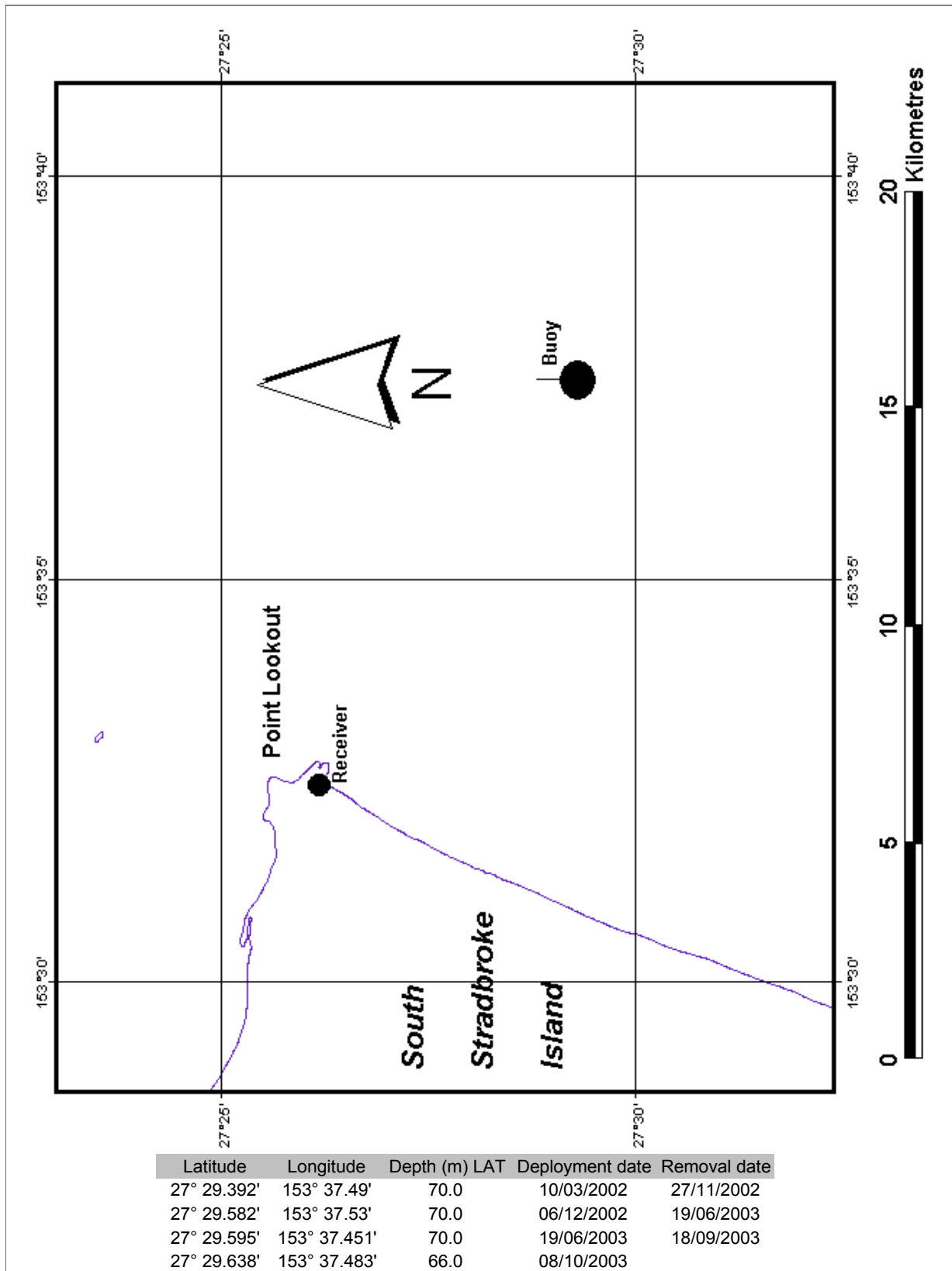
# Brisbane

## Wave recording station

### Details of wave recorder station

Maximum Possible Analysis Days (Last record–First record)	=	365.000
Total Days Used in Analysis	=	330.785
Gaps in Data from Selected Dates (Days)	=	34.215
Gaps in Data from Analysed Records (Days)	=	34.215
Gaps in Data from Duration Analysis (Days)	=	34.215
Number of Records Used in Analysis	=	15336

HAT at nearest standard port: Gold Coast seaway, 1.89m



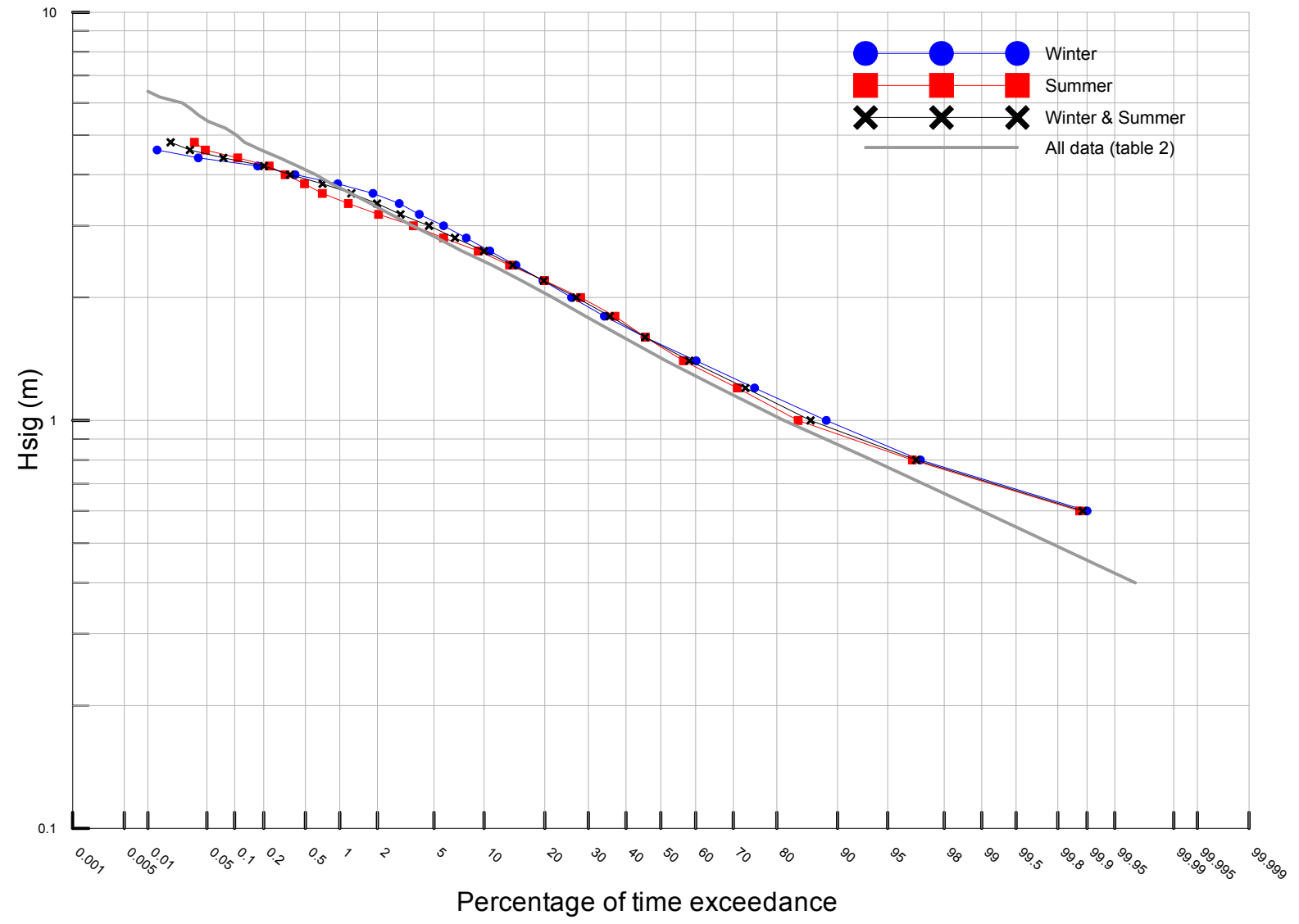
**Brisbane region—Locality plan**



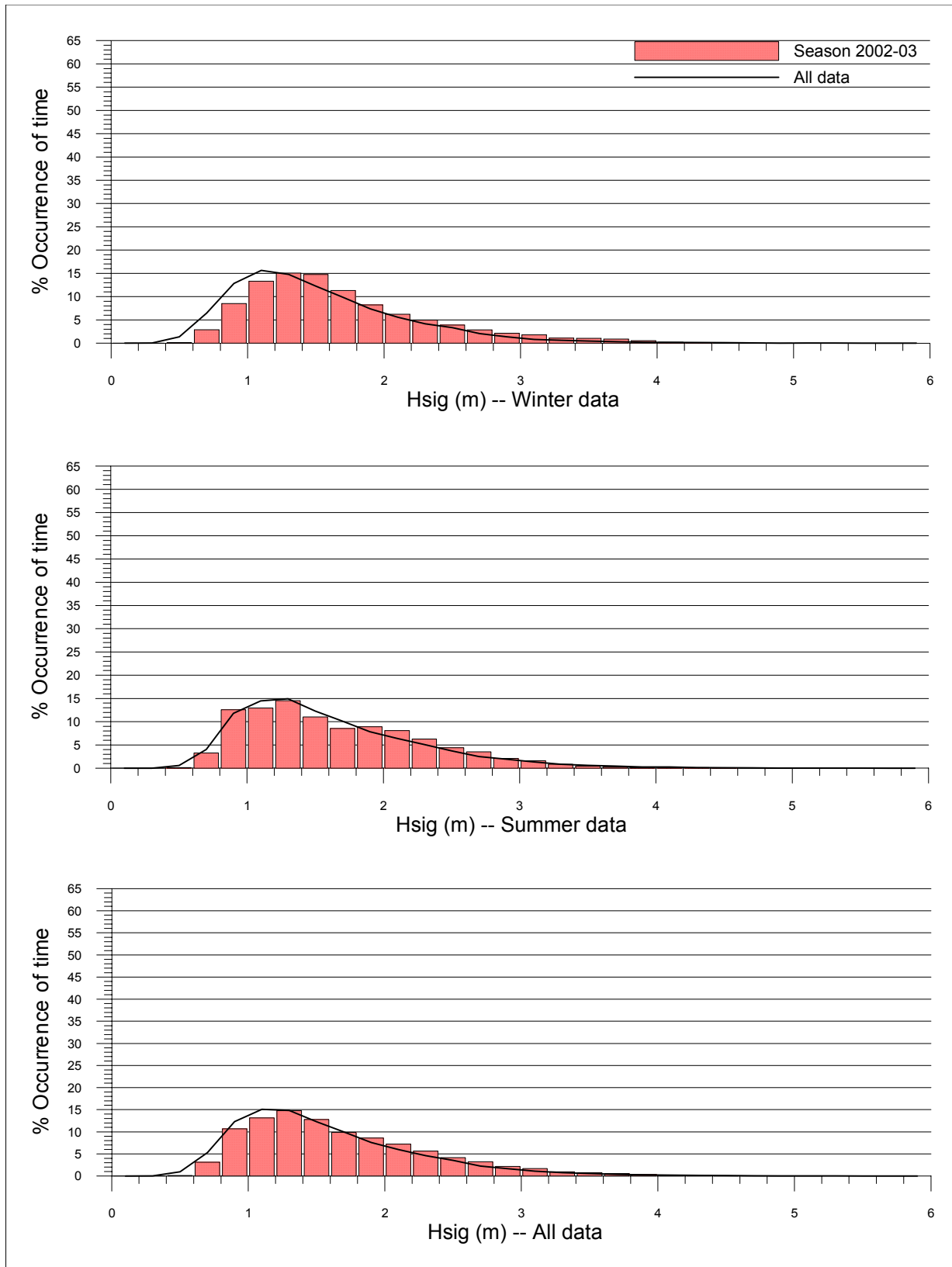
Wave data recording program  
Annual summary for season 2002-03

Figure 3.1

**Brisbane region—Percentage (of time) exceedance  
 of wave heights (Hsig) for all wave periods (Tp)**





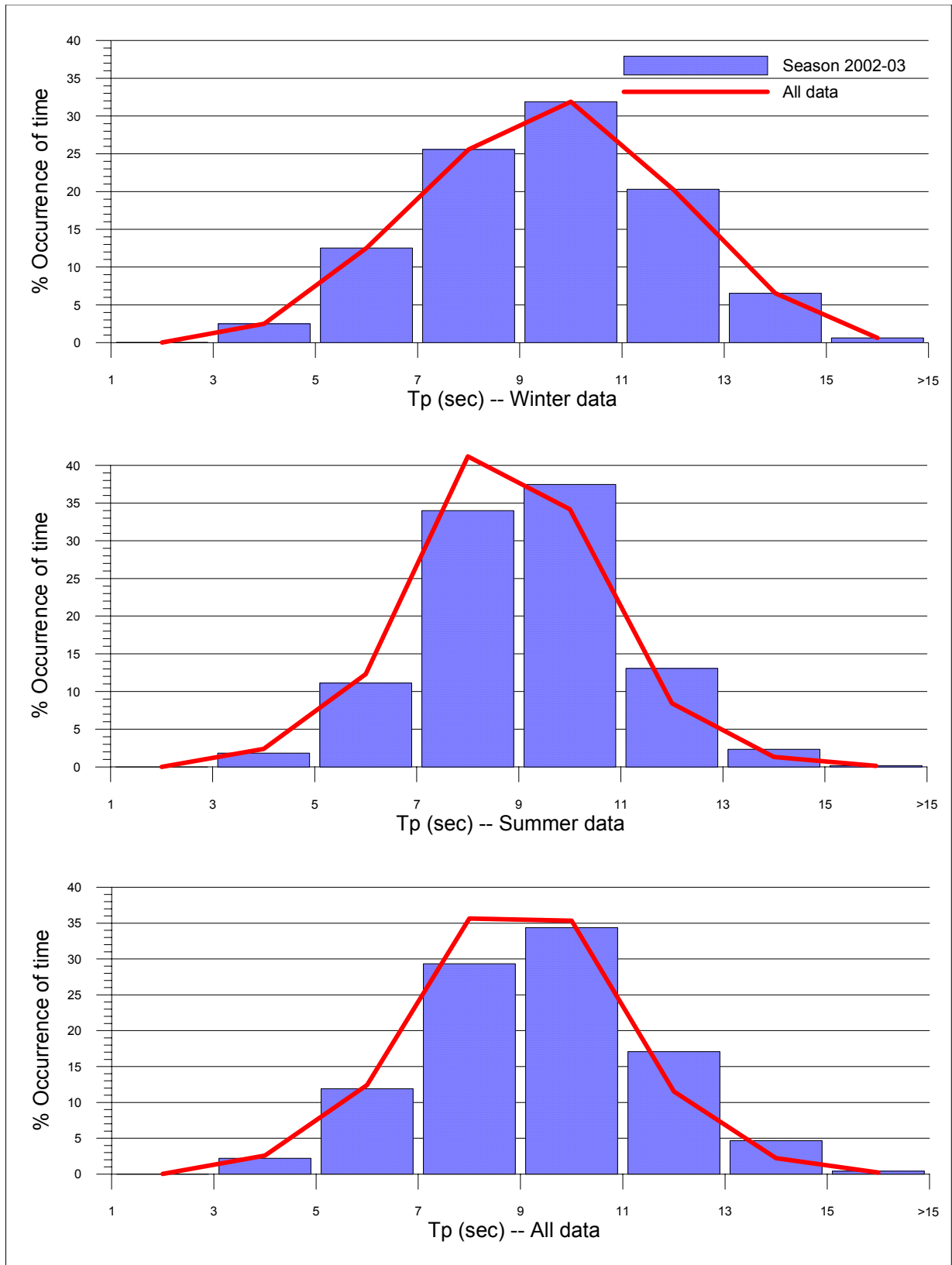


**Brisbane region—Histogram percentage (of time) occurrence of wave heights (Hsig) for all wave periods (Tp)**




Wave data recording program  
Annual summary for season 2002-03

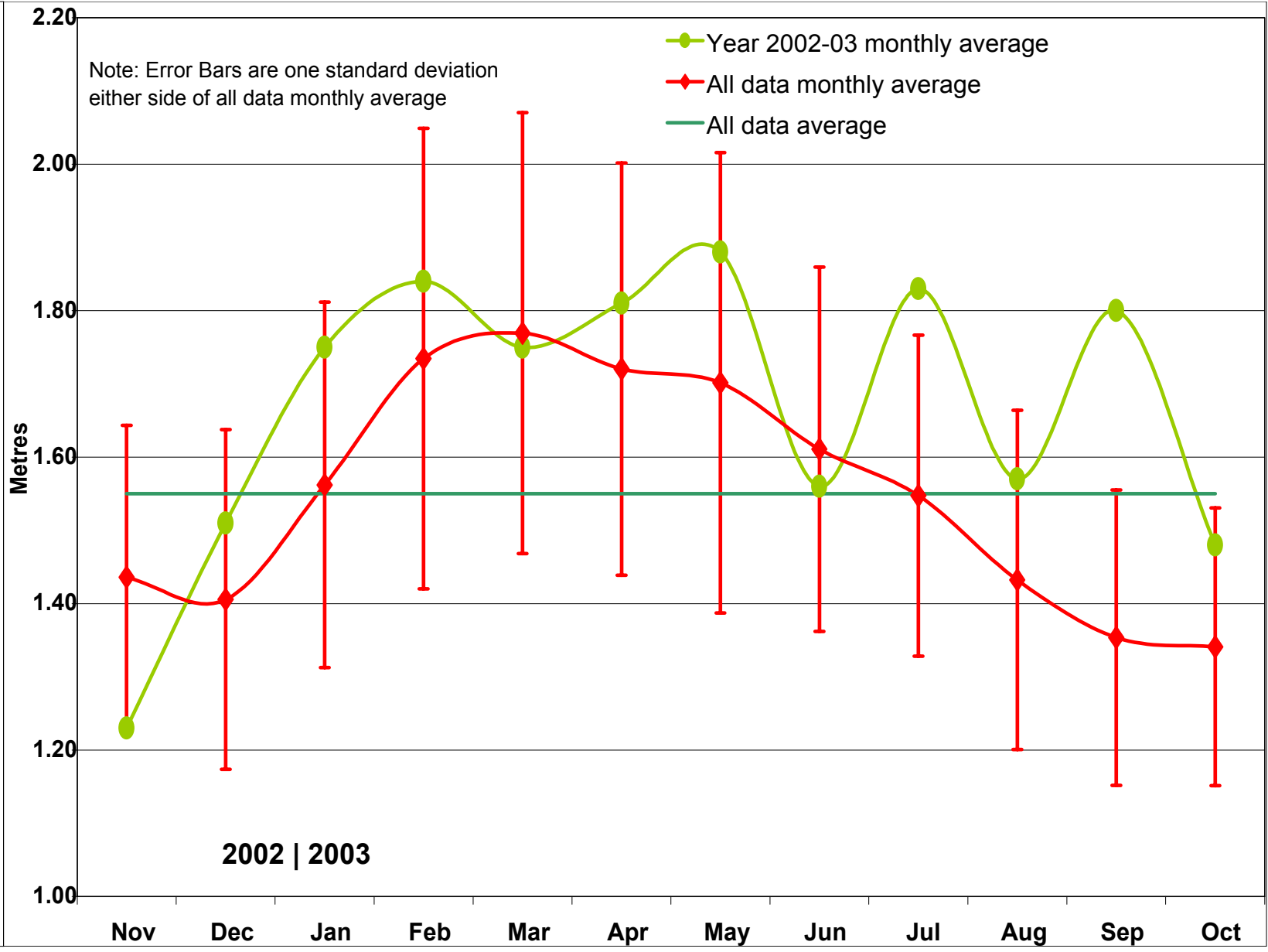
Figure 3.3



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

 <p><b>Queensland Government</b> Environmental Protection Agency</p>	<p>Wave data recording program Annual summary for season 2002-03</p>	<p>Figure 3.4</p>
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**Brisbane region—Plot of monthly averages for seasonal year and for all data, for wave height (Hsig)**



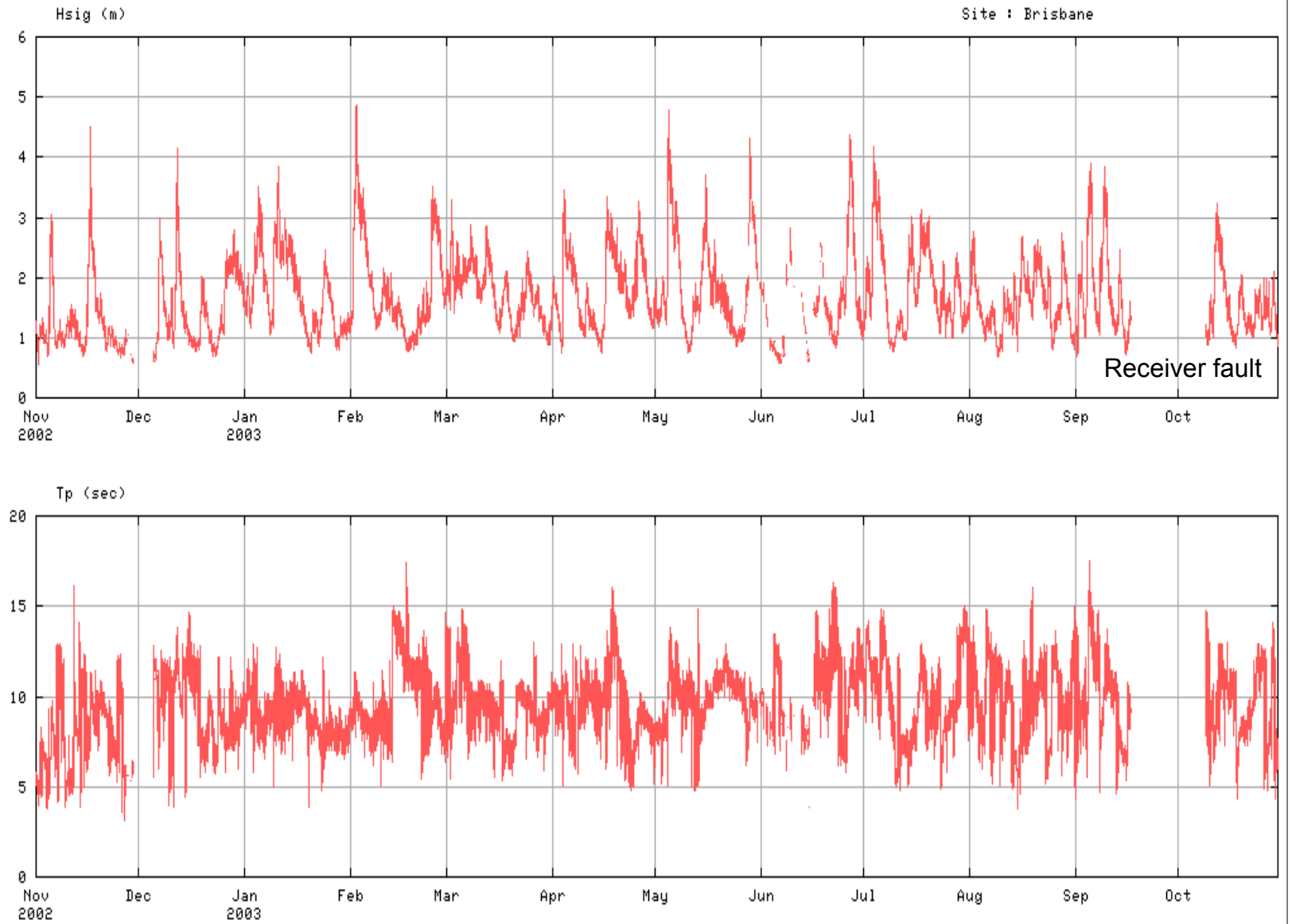


Queensland  
Government  
Environmental  
Protection Agency

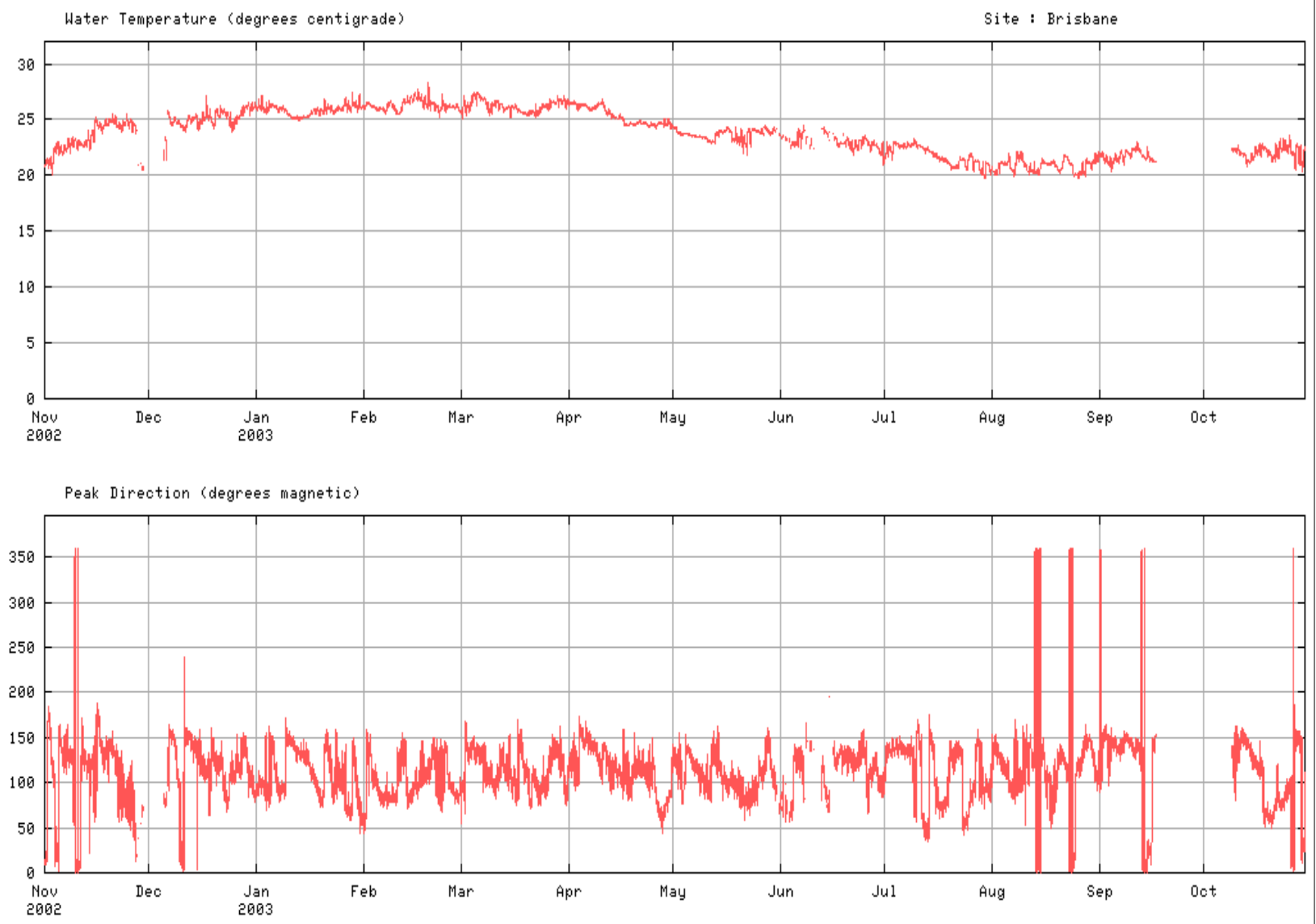
Wave data recording program  
Annual summary for season 2002-03

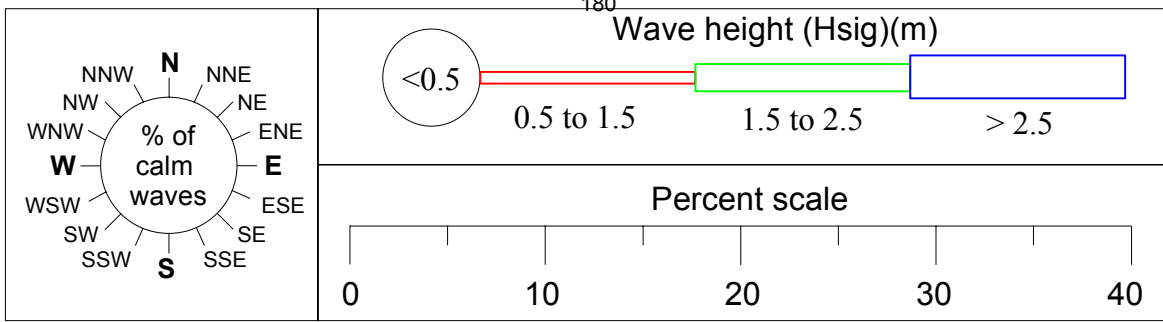
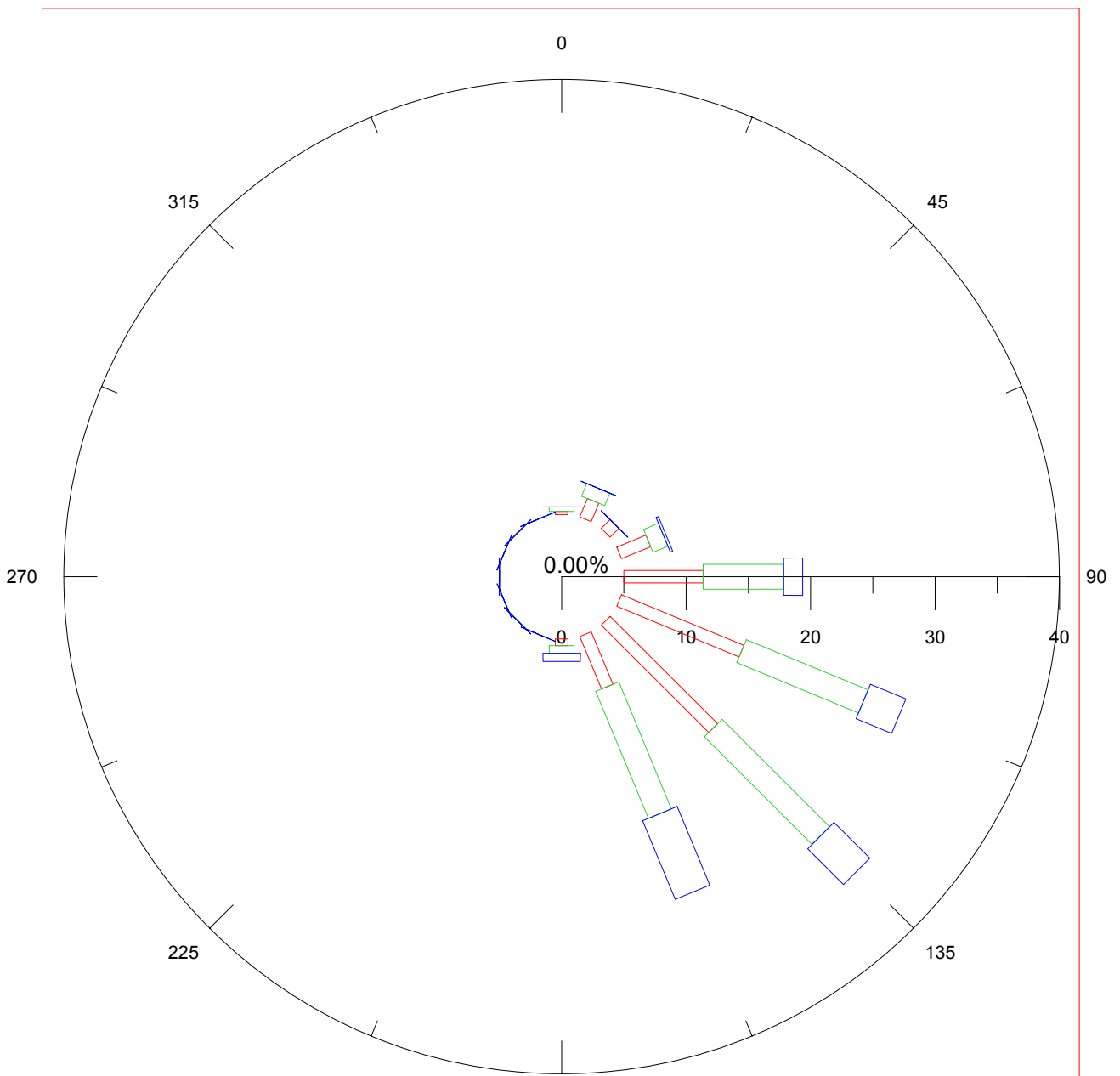
Figure 3.6

**Brisbane region—Daily wave recordings**



**Brisbane region—Water temperature  
and peak direction recordings**





**Brisbane region—Directional wave rose**

	<p>Wave data recording program Annual summary for season 2002-03</p>	<p>Figure 3.8</p>
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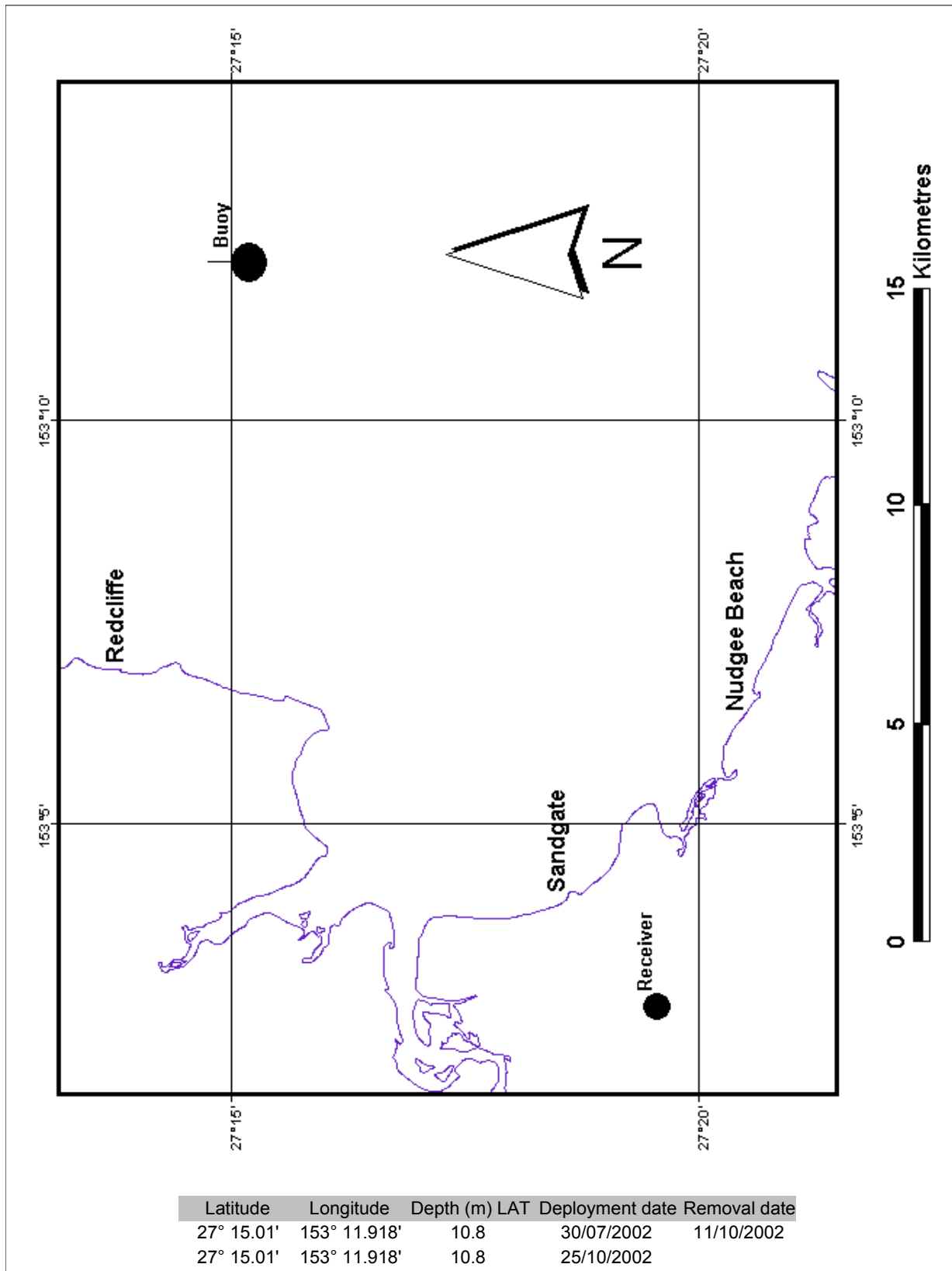
# Moreton Bay

## Wave recording station

### Details of wave recorder station

Maximum Possible Analysis Days (Last record–First record)	=	365.000
Total Days Used in Analysis	=	363.353
Gaps in Data from Selected Dates (Days)	=	1.647
Gaps in Data from Analysed Records (Days)	=	1.647
Gaps in Data from Duration Analysis (Days)	=	1.647
Number of Records Used in Analysis	=	16356

HAT at nearest standard port: Brisbane bar, 2.71m



**Moreton Bay region—Locality plan**



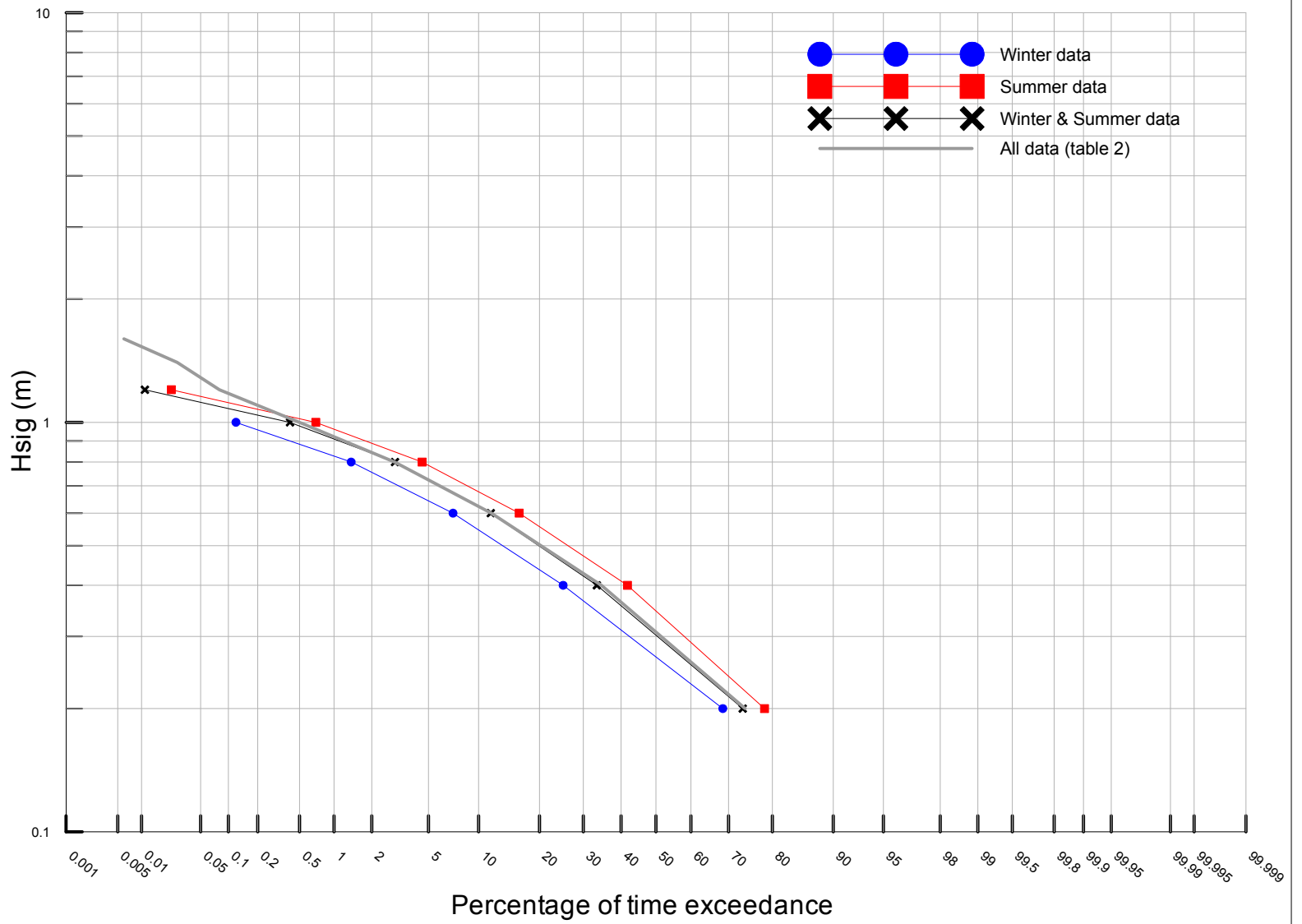
Wave data recording program  
Annual summary for season 2002-03

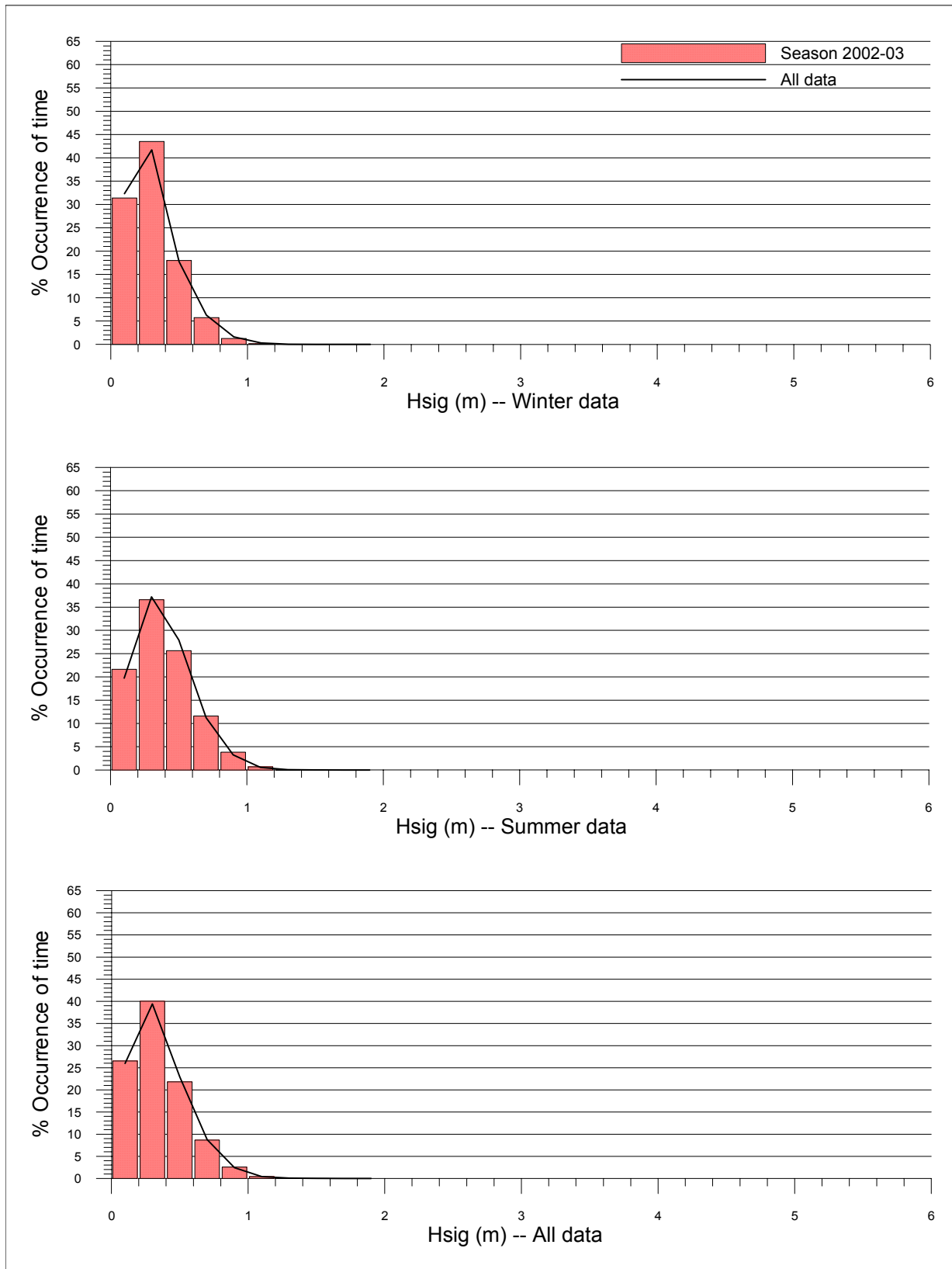
Figure 4.1





### Moreton Bay region—Percentage (of time) exceedance of wave heights (Hsig) for all wave periods (Tp)



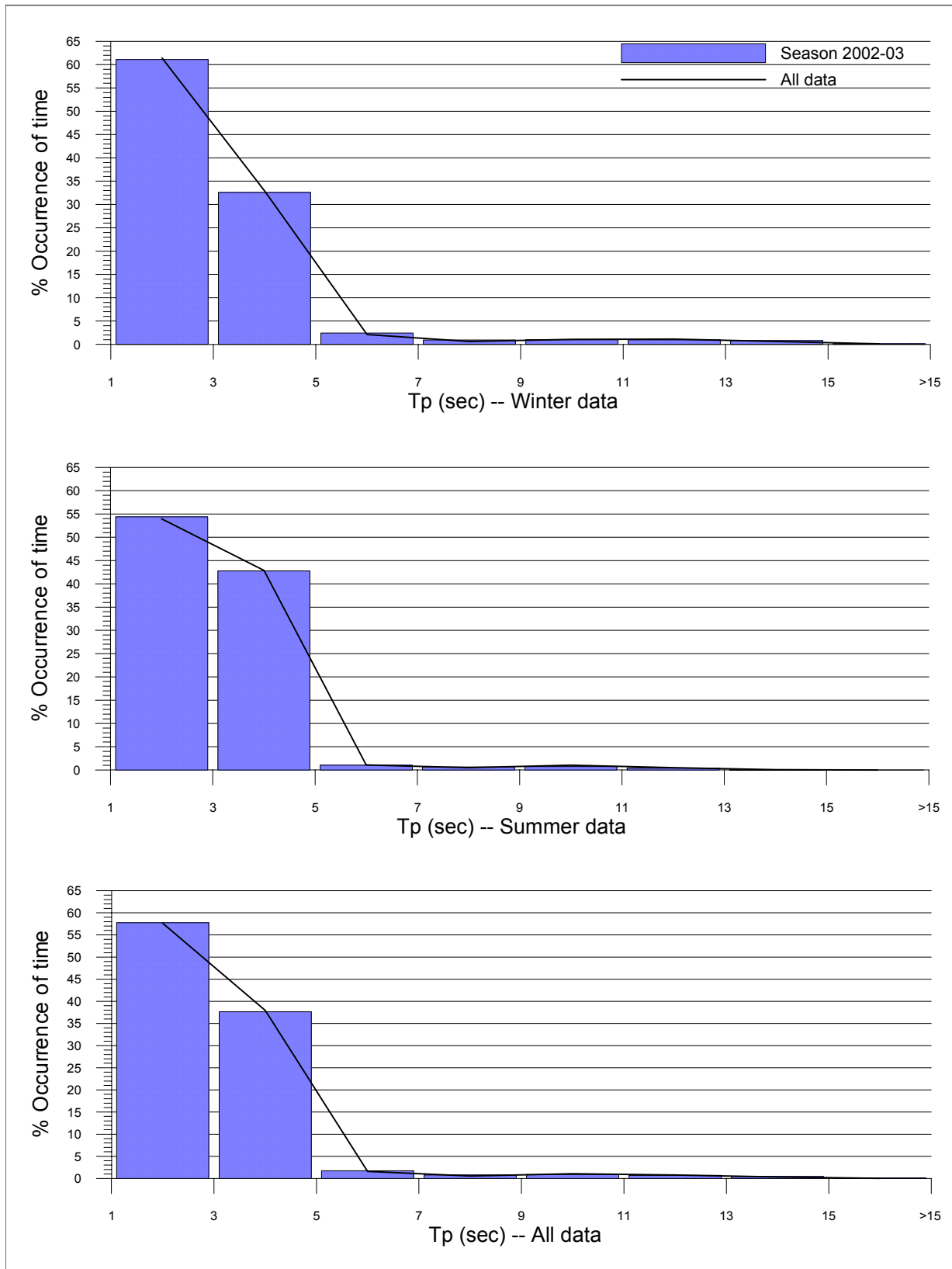


**Moreton Bay region—Histogram percentage (of time) occurrence of wave heights (Hsig) for all wave periods (Tp)**



Wave data recording program  
Annual summary for season 2002-03

Figure 4.3



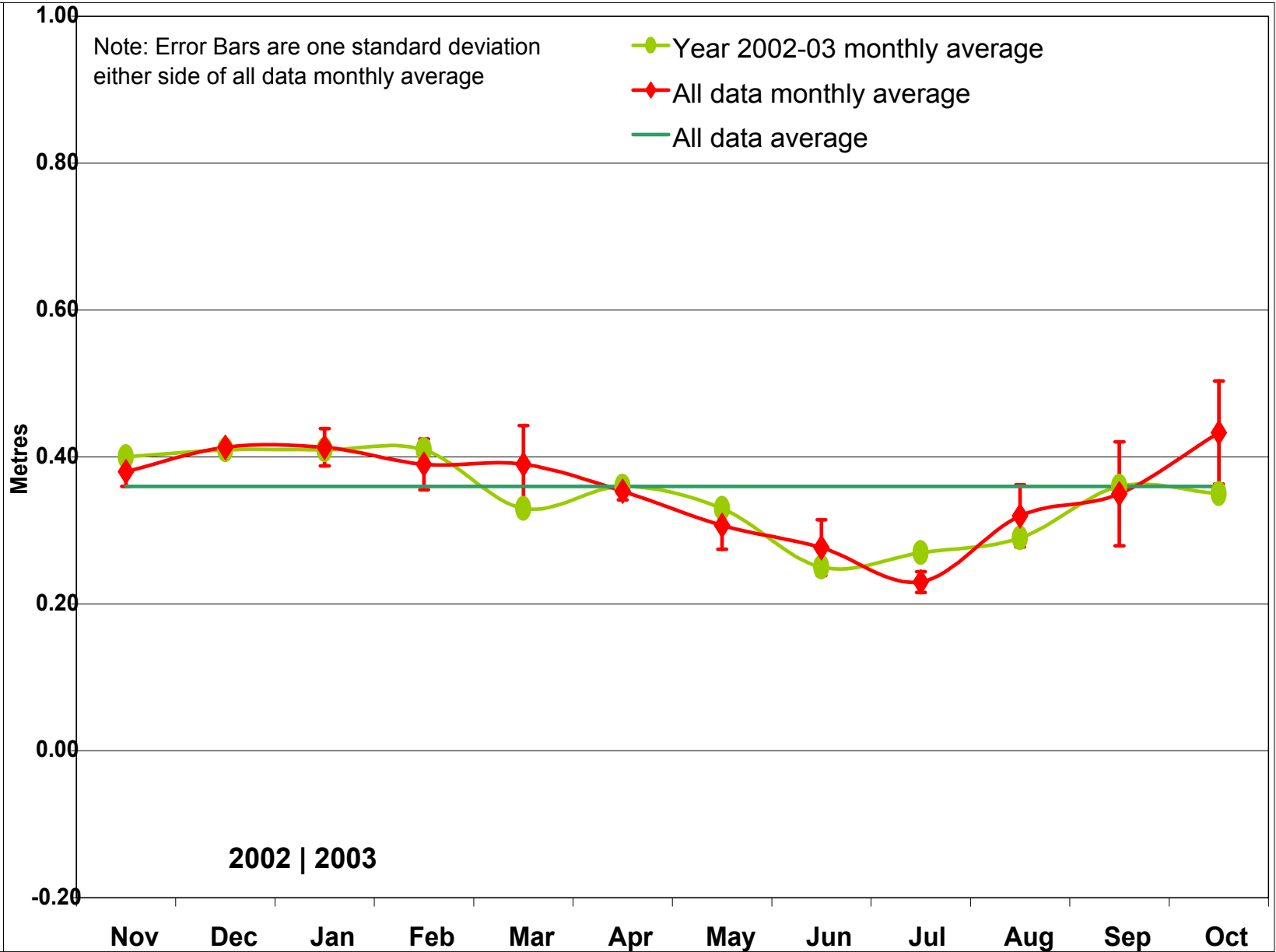
**Moreton Bay region—Histogram percentage (of time) occurrence of wave periods (Tp) for all wave heights (Hsig)**



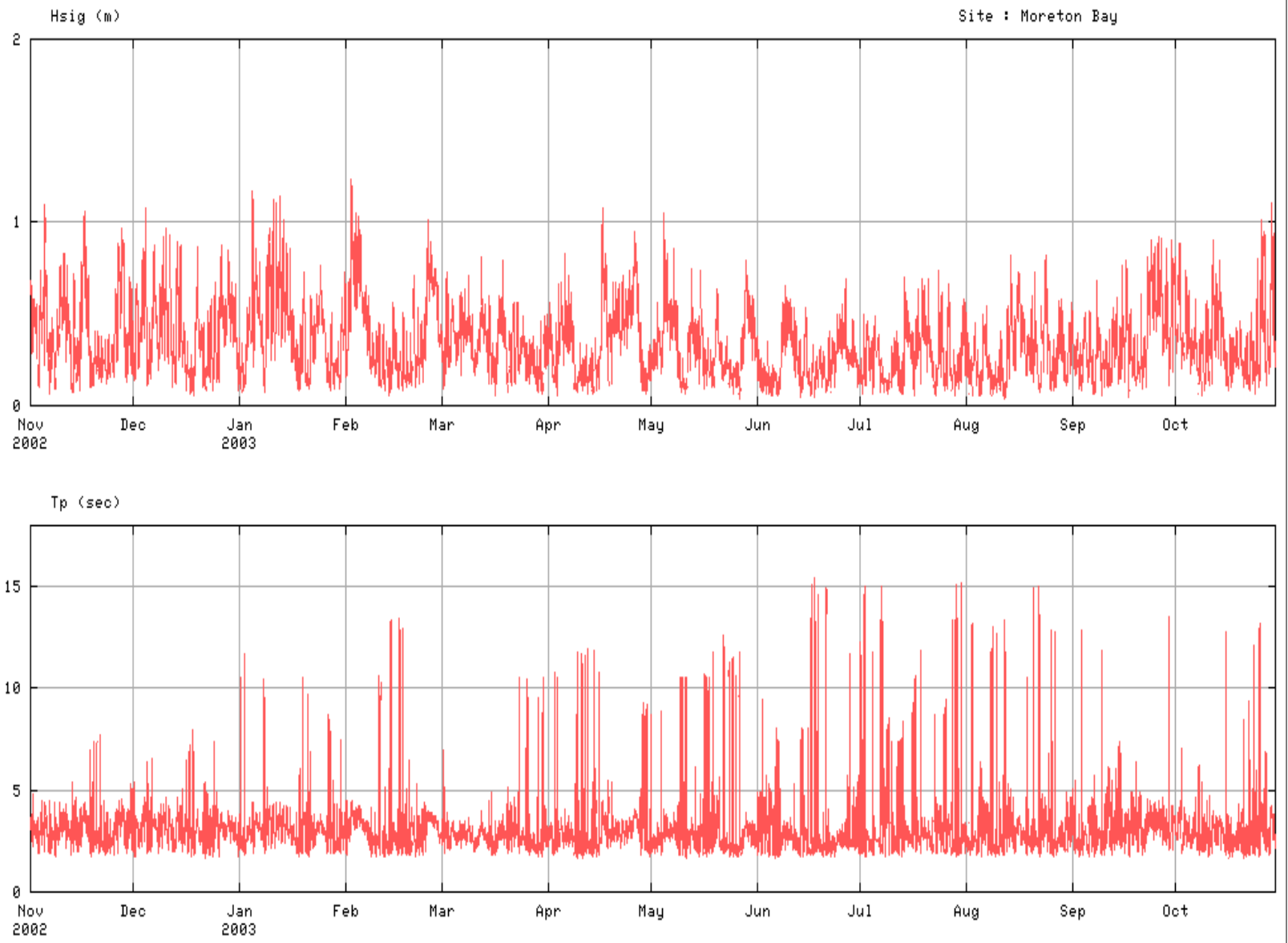
Wave data recording program  
Annual summary for season 2002-03

Figure 4.4

**Moreton Bay region—Plot of monthly averages for seasonal year and for all data, for wave height (Hsig)**



**Moreton Bay region—Daily wave recordings**



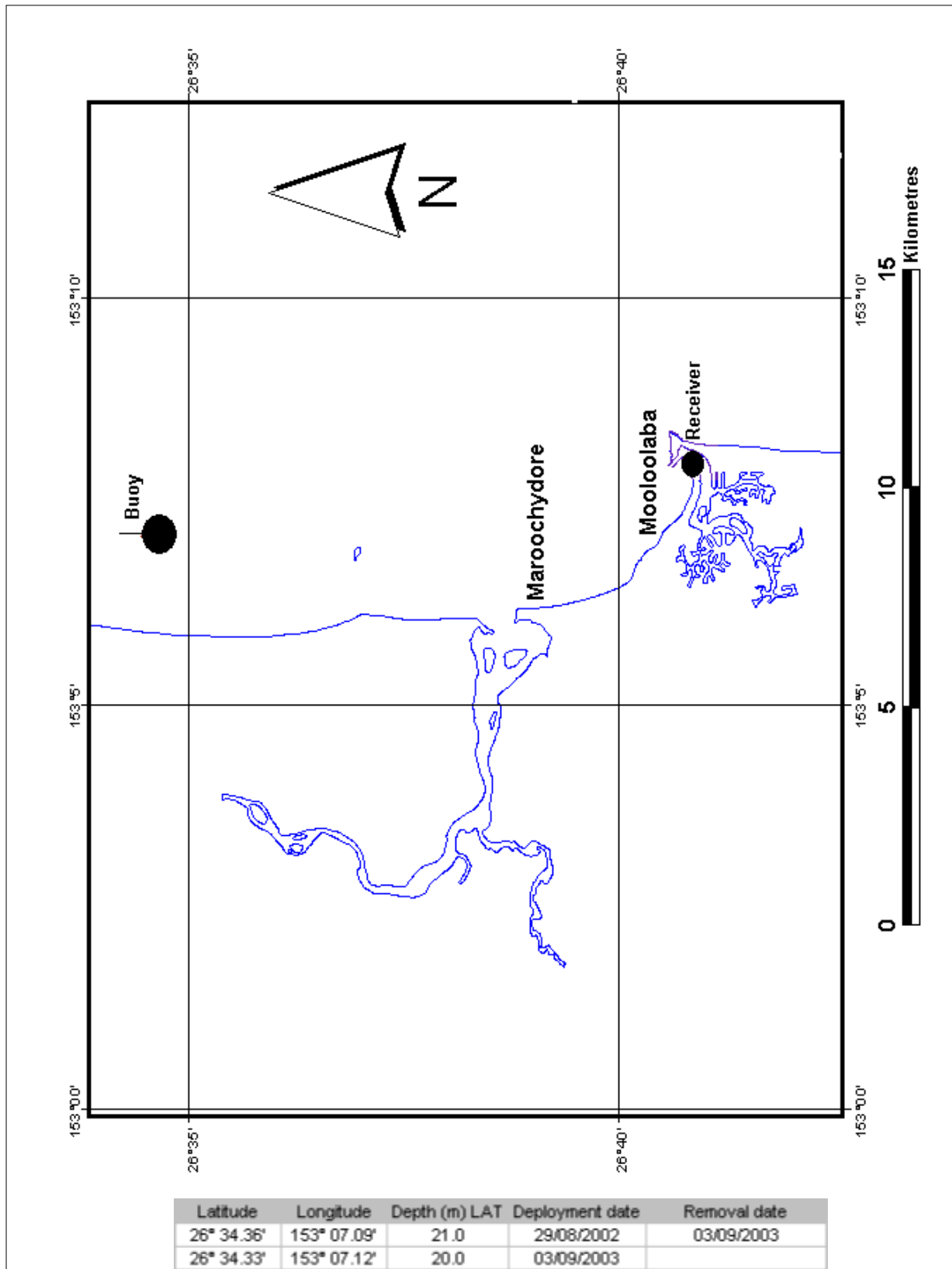
# Mooloolaba

## Wave recording station

### Details of wave recorder station

Maximum Possible Analysis Days (Last record–First record)	=	365.000
Total Days Used in Analysis	=	361.875
Gaps in Data from Selected Dates (Days)	=	3.125
Gaps in Data from Analysed Records (Days)	=	3.125
Gaps in Data from Duration Analysis (Days)	=	3.125
Number of Records Used in Analysis	=	17282

HAT at nearest standard port: Mooloolaba, 2.13m



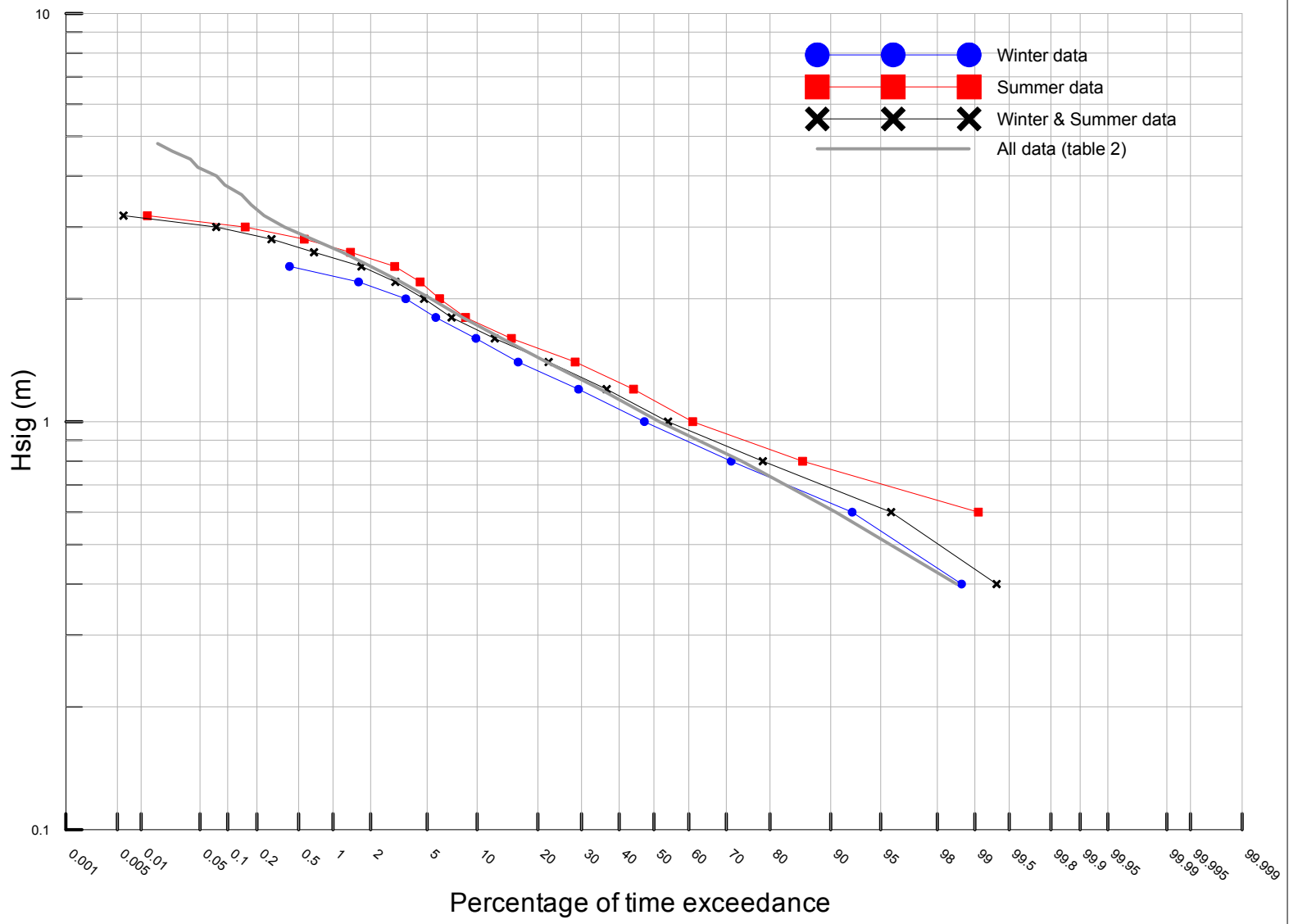
**Mooloolaba region—Locality plan**



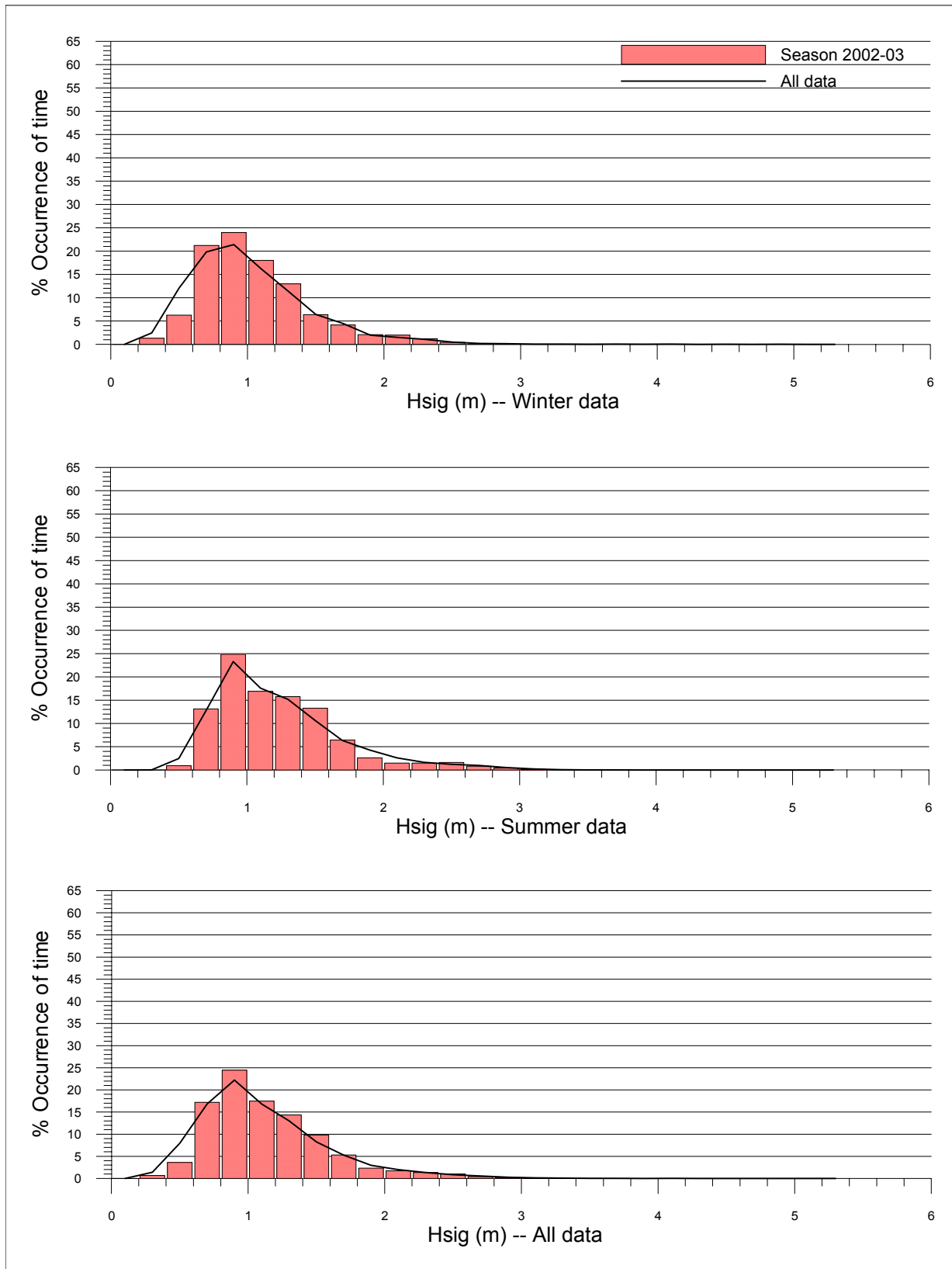
Wave data recording program  
Annual summary for season 2002-03

Figure 5.1

**Mooloolaba region—Percentage (of time) exceedance  
of wave heights (Hsig) for all wave periods (Tp)**





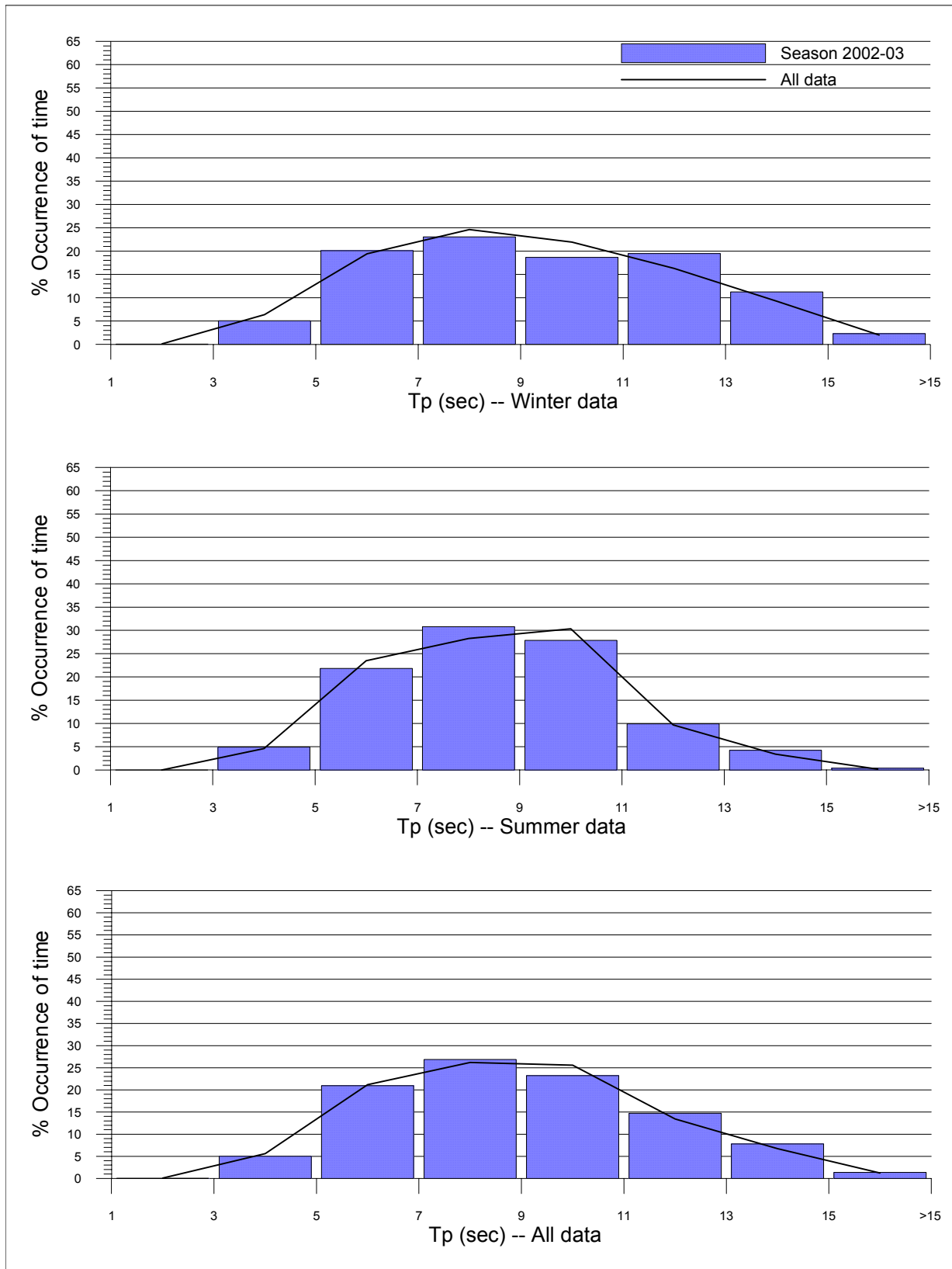


**Mooloolaba region—Histogram percentage (of time) occurrence of wave heights (Hsig) for all wave periods (Tp)**



Wave data recording program  
Annual summary for season 2002-03

Figure 5.3



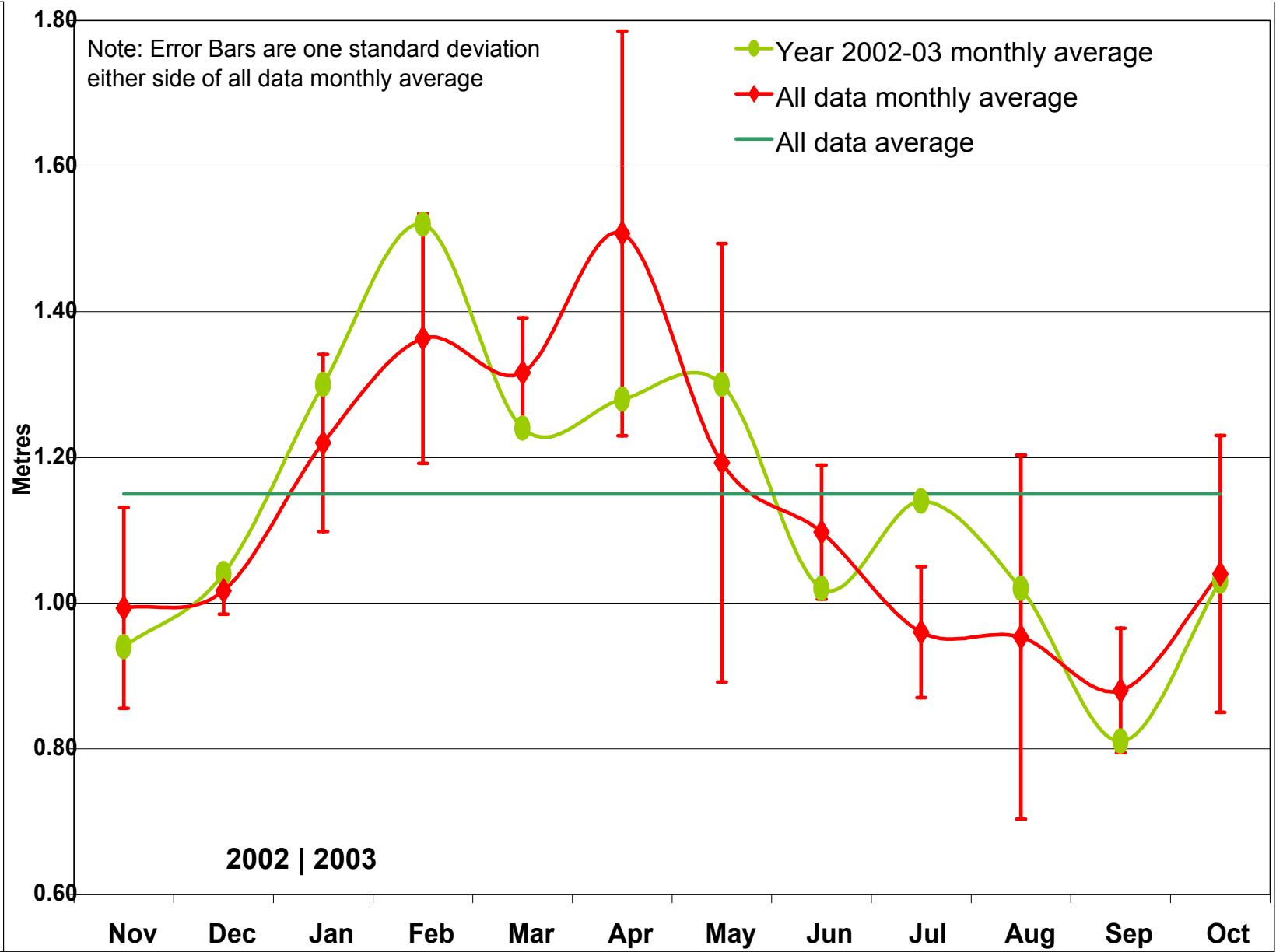
**Mooloolaba region—Histogram percentage (of time) occurrence of wave periods (Tp) for all wave heights (Hsig)**



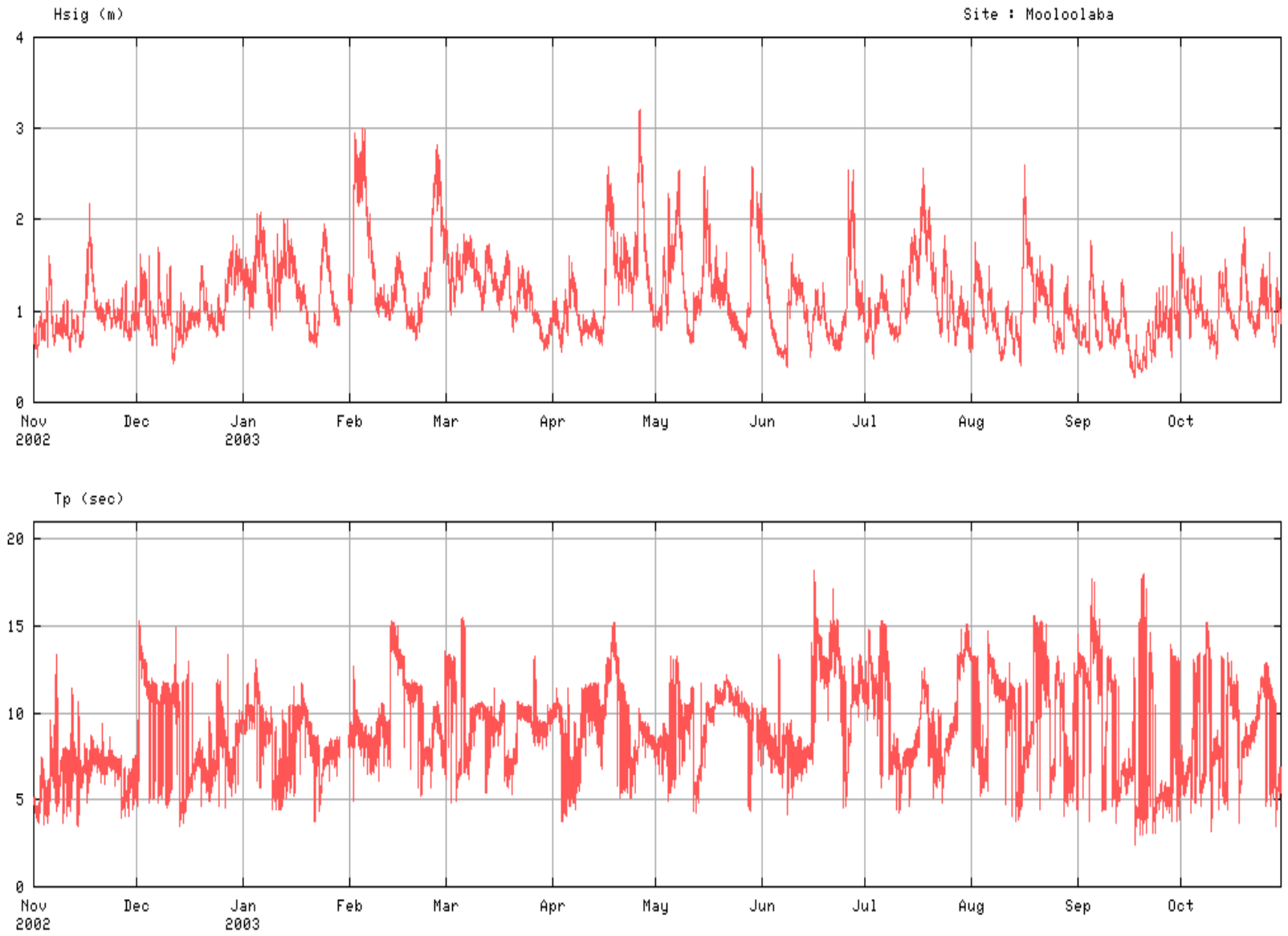
Wave data recording program  
Annual summary for season 2002-03

Figure 5.4

**Mooloolaba region**—Plot of monthly averages for seasonal year and for all data, for wave height (Hsig)



Mooloolaba region—Daily wave recordings



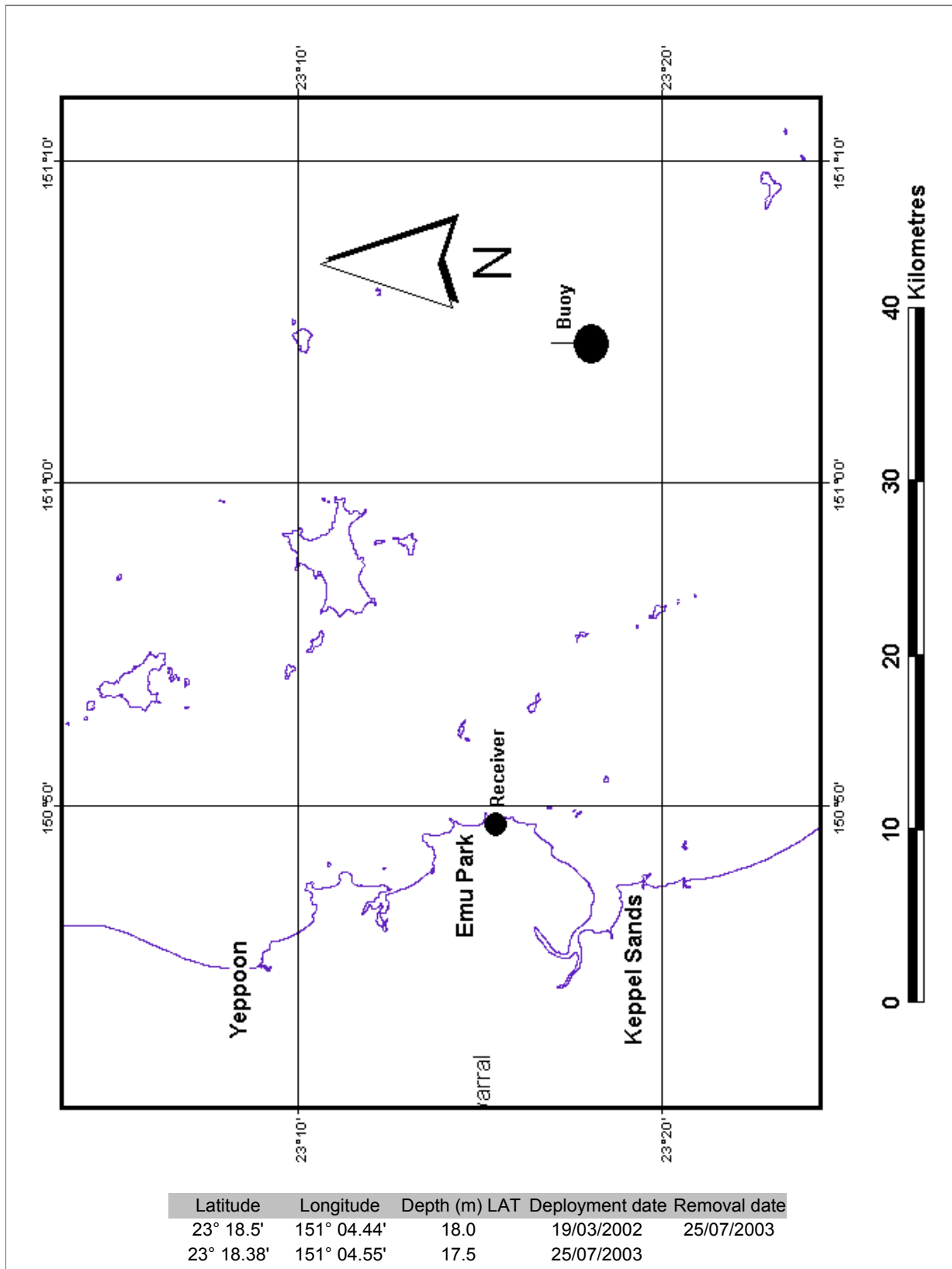
# Emu Park

## Wave recording station

### Details of wave recorder station

Maximum Possible Analysis Days (Last record–First record)	=	365.000
Total Days Used in Analysis	=	364.563
Gaps in Data from Selected Dates (Days)	=	0.437
Gaps in Data from Analysed Records (Days)	=	0.437
Gaps in Data from Duration Analysis (Days)	=	0.438
Number of Records Used in Analysis	=	17263

HAT at nearest standard port: Middle Island, 5.3m



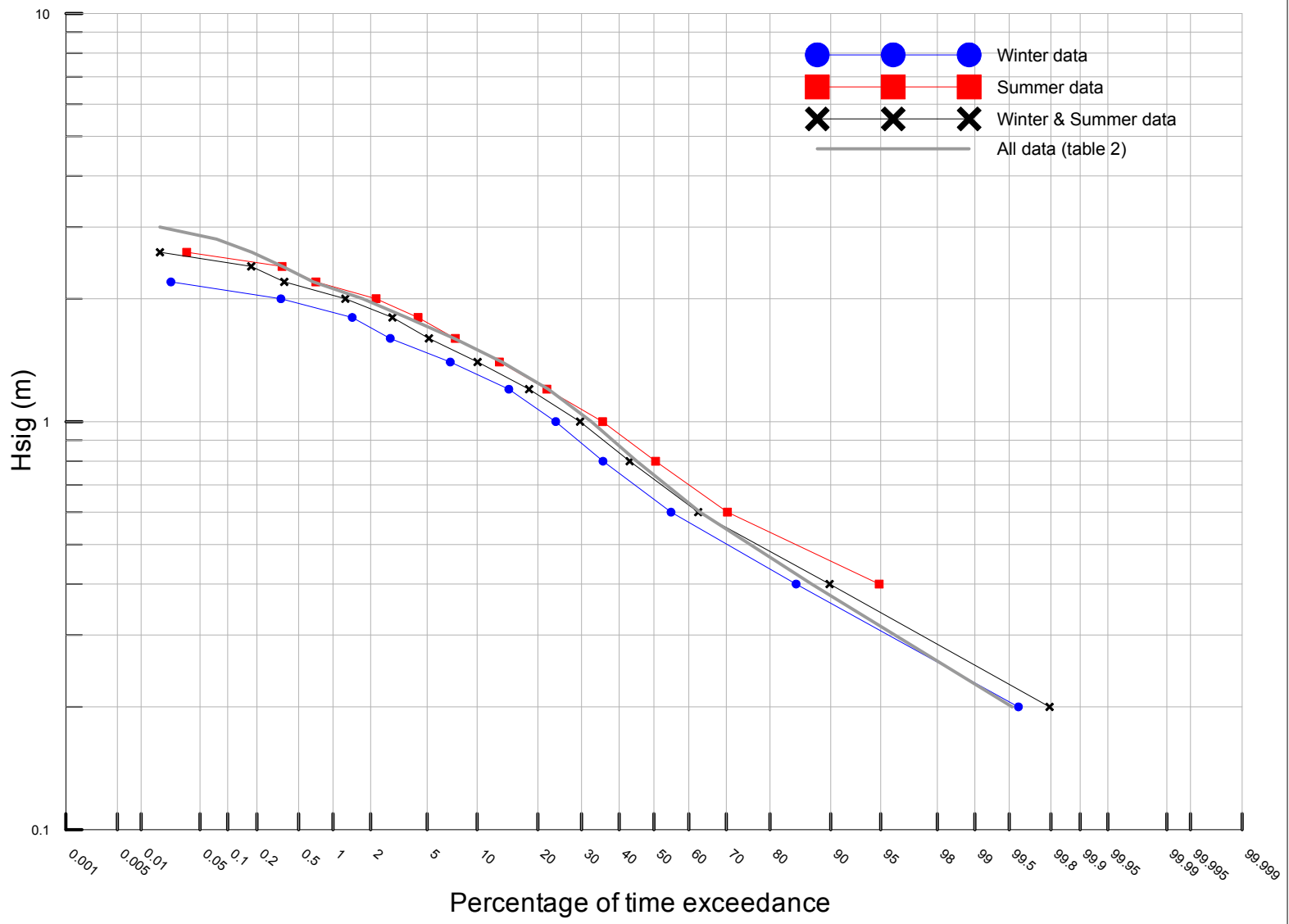
### Emu Park region—Locality plan

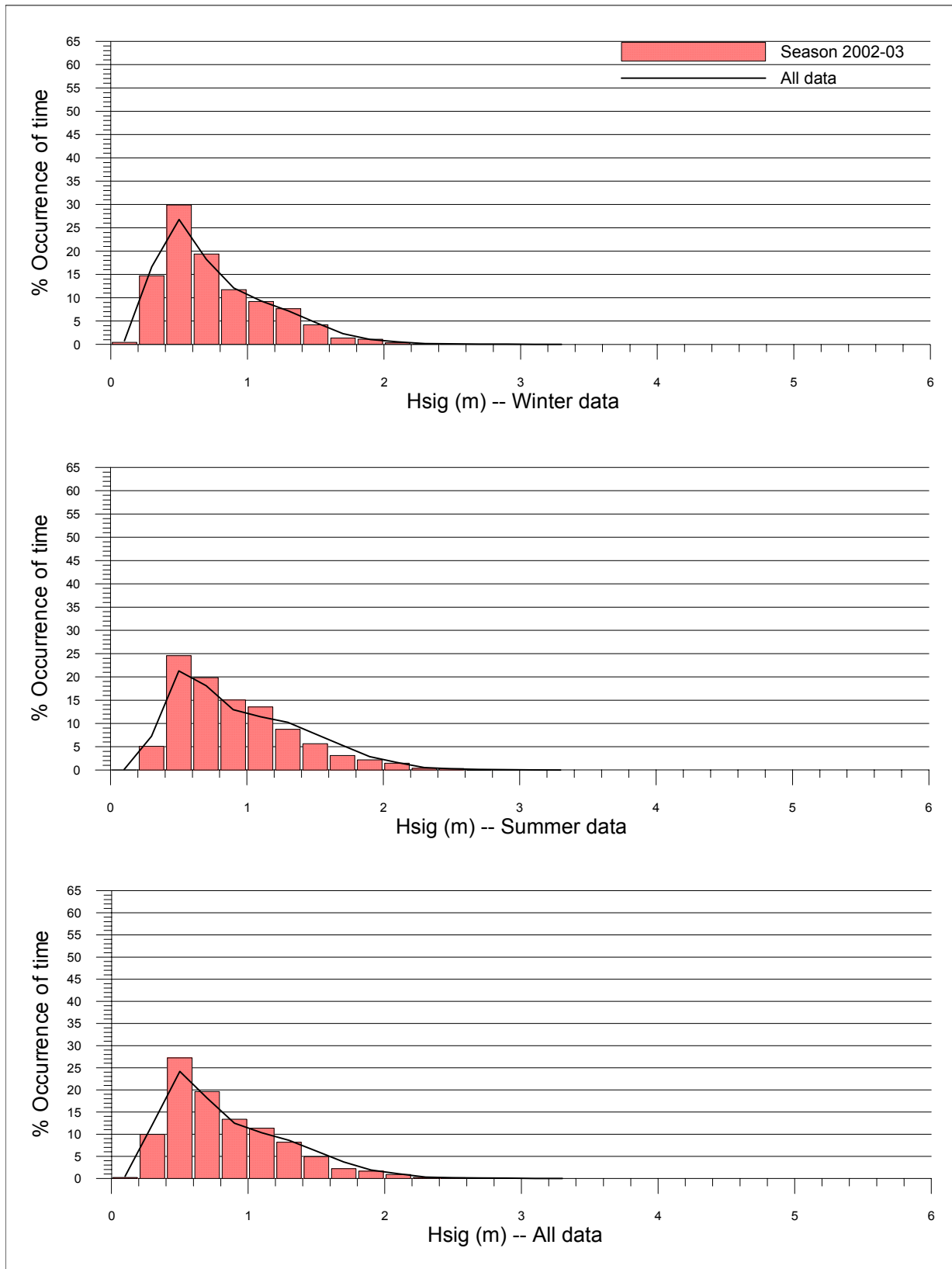


Wave data recording program  
Annual summary for season 2002-03

Figure 6.1

**Emu Park region—Percentage (of time) exceedance  
 of wave heights (Hsig) for all wave periods (Tp)**





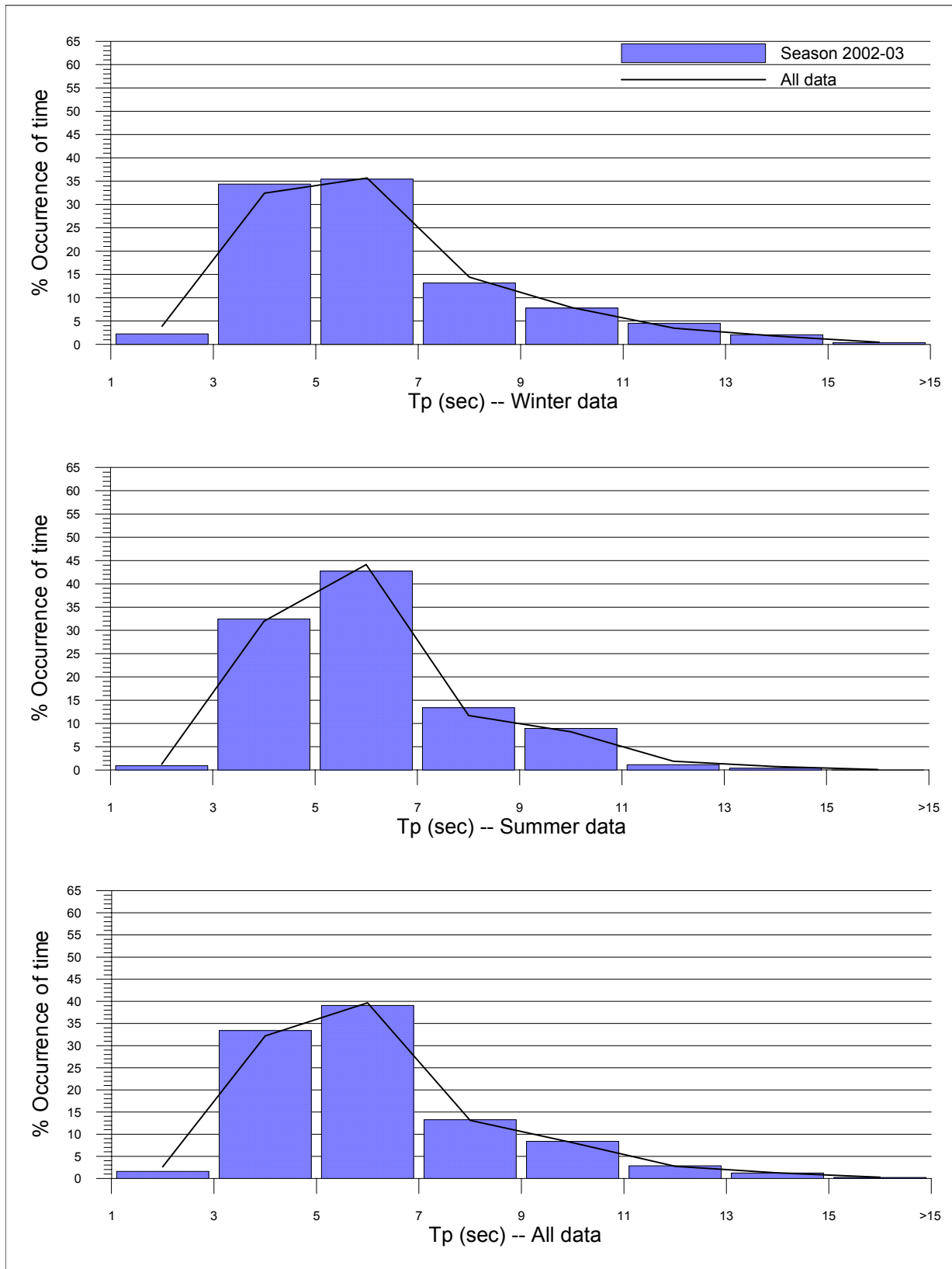
**Emu Park region—Histogram percentage (of time) occurrence of wave heights (Hsig) for all wave periods (Tp)**



Wave data recording program  
Annual summary for season 2002-03

Figure 6.3





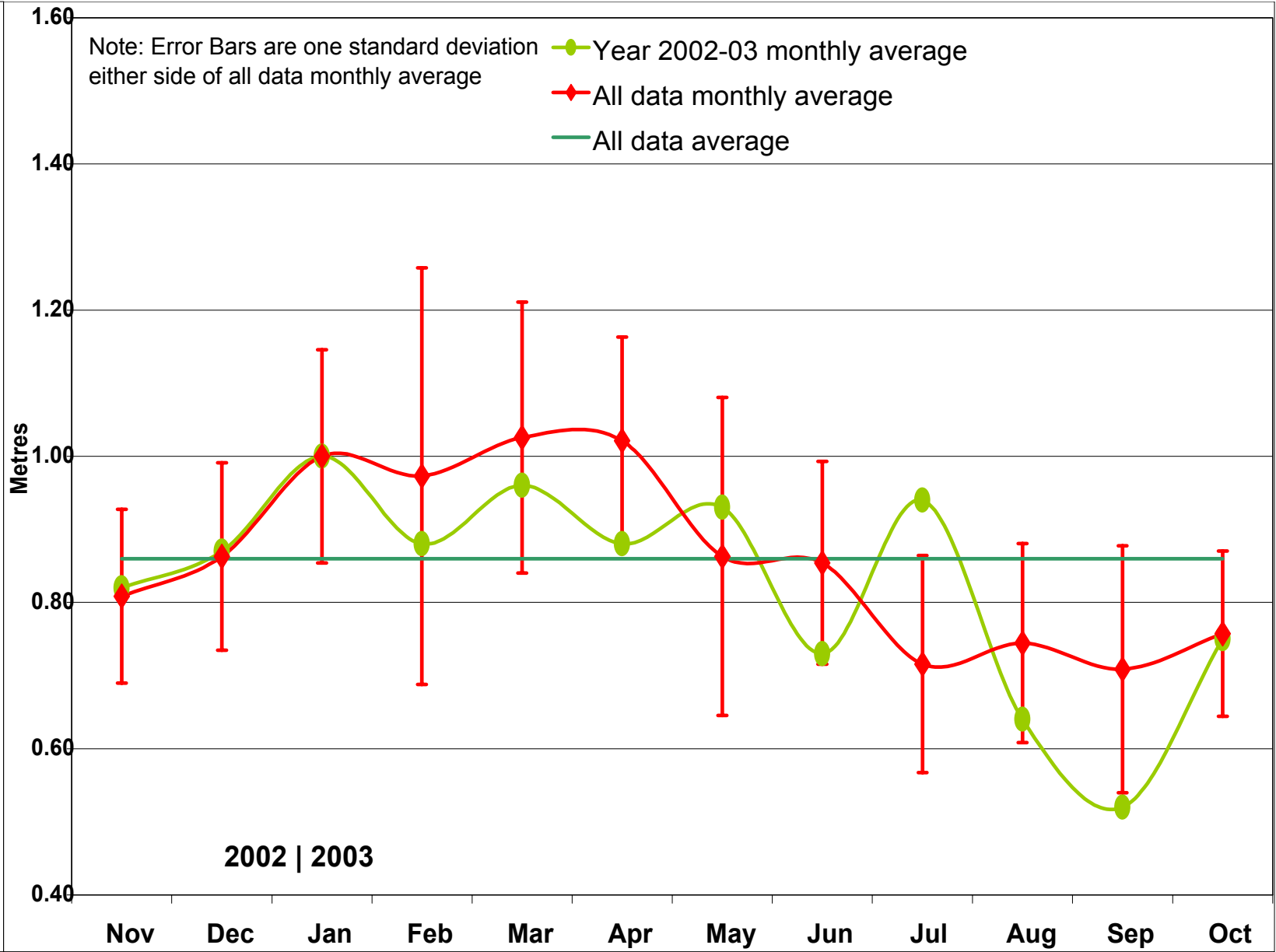
**Emu Park region—Histogram percentage (of time) occurrence of wave periods (Tp) for all wave heights (Hsig)**



Wave data recording program  
Annual summary for season 2002-03

Figure 6.4

**Emu Park region—Plot of monthly averages for seasonal year and for all data, for wave height (Hsig)**



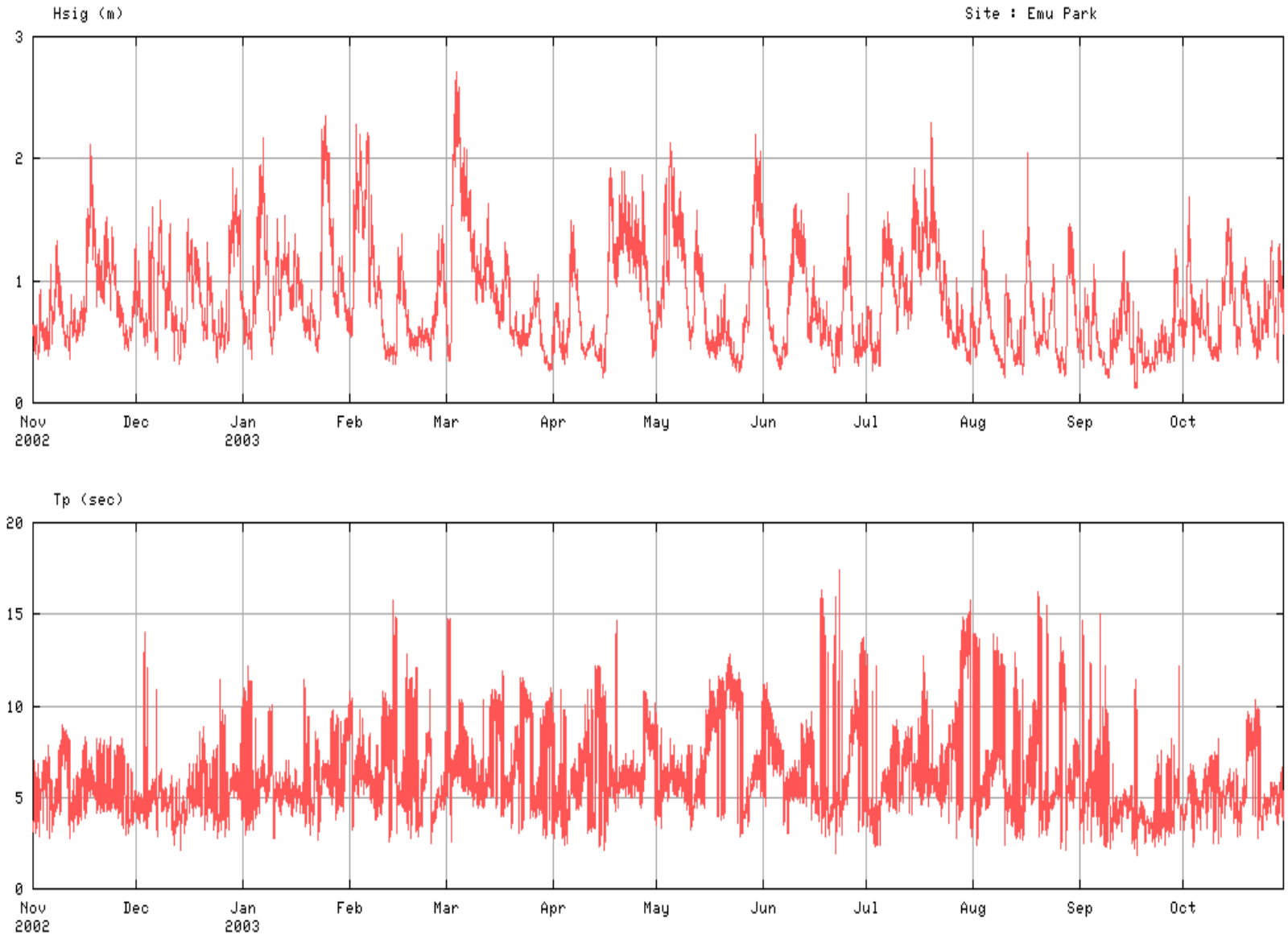


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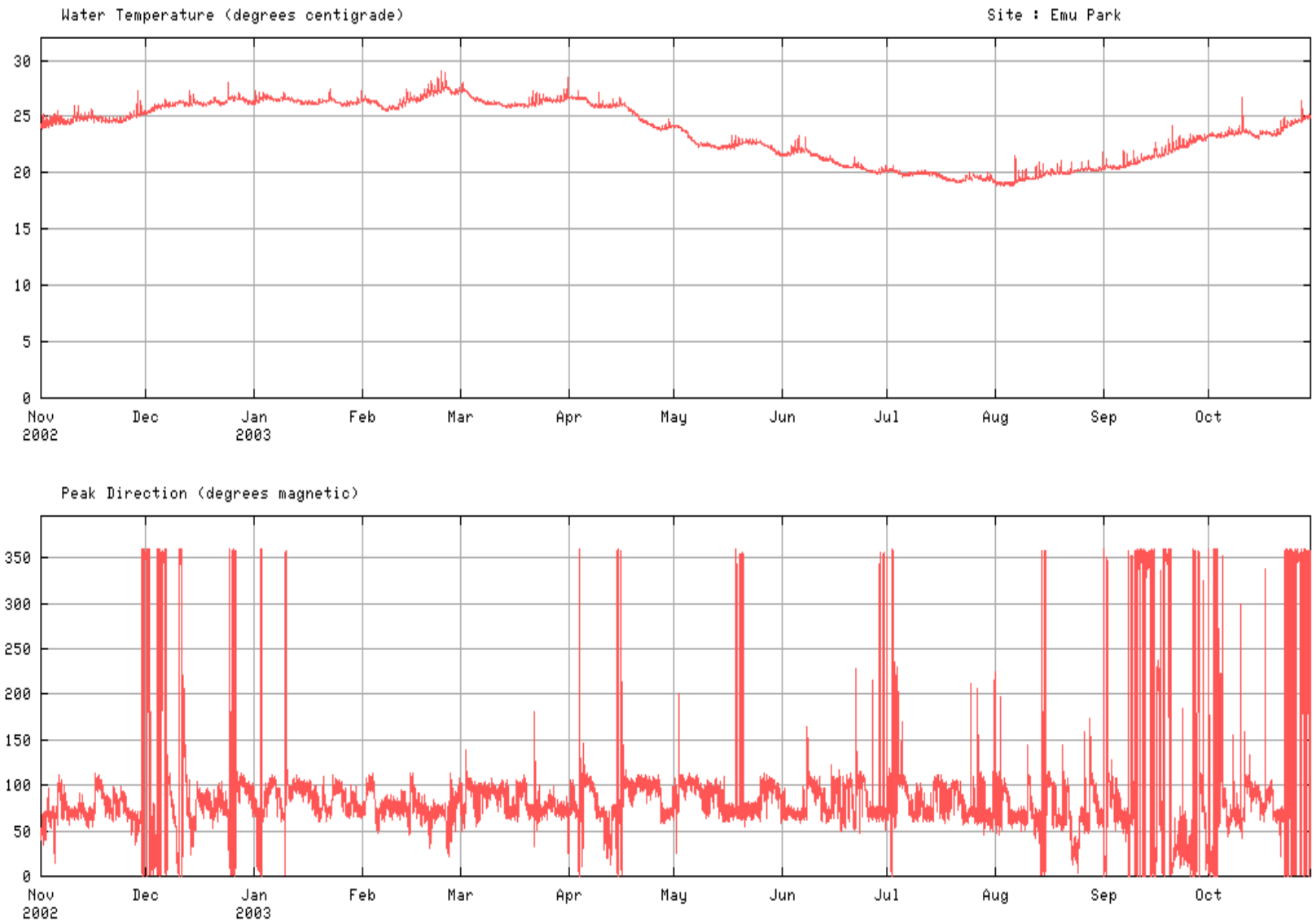
Wave data recording program  
Annual summary for season 2002-03

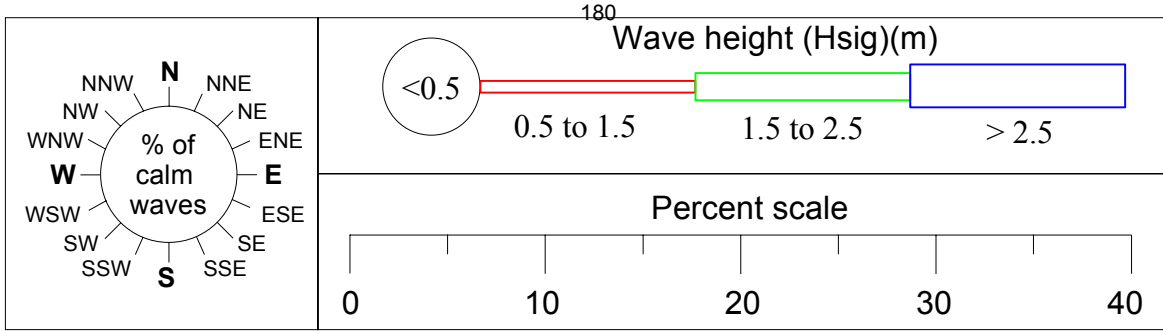
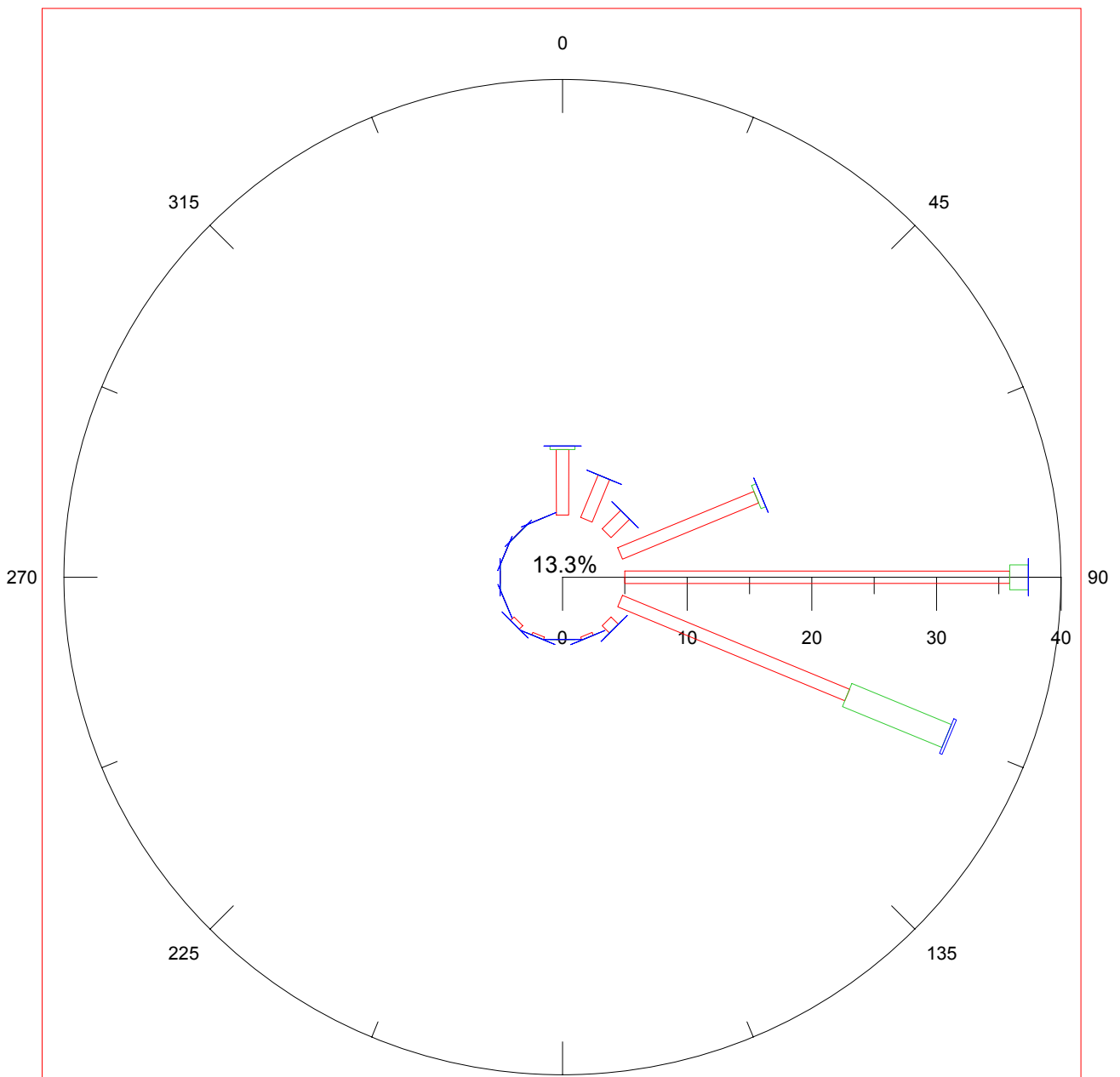
Figure 6.6

**Emu Park region—Daily wave recordings**



**Emu Park region—Water temperature  
and peak direction recordings**





**Emu Park region—Directional wave rose**



Wave data recording program  
Annual summary for season 2002-03

Figure 6.8

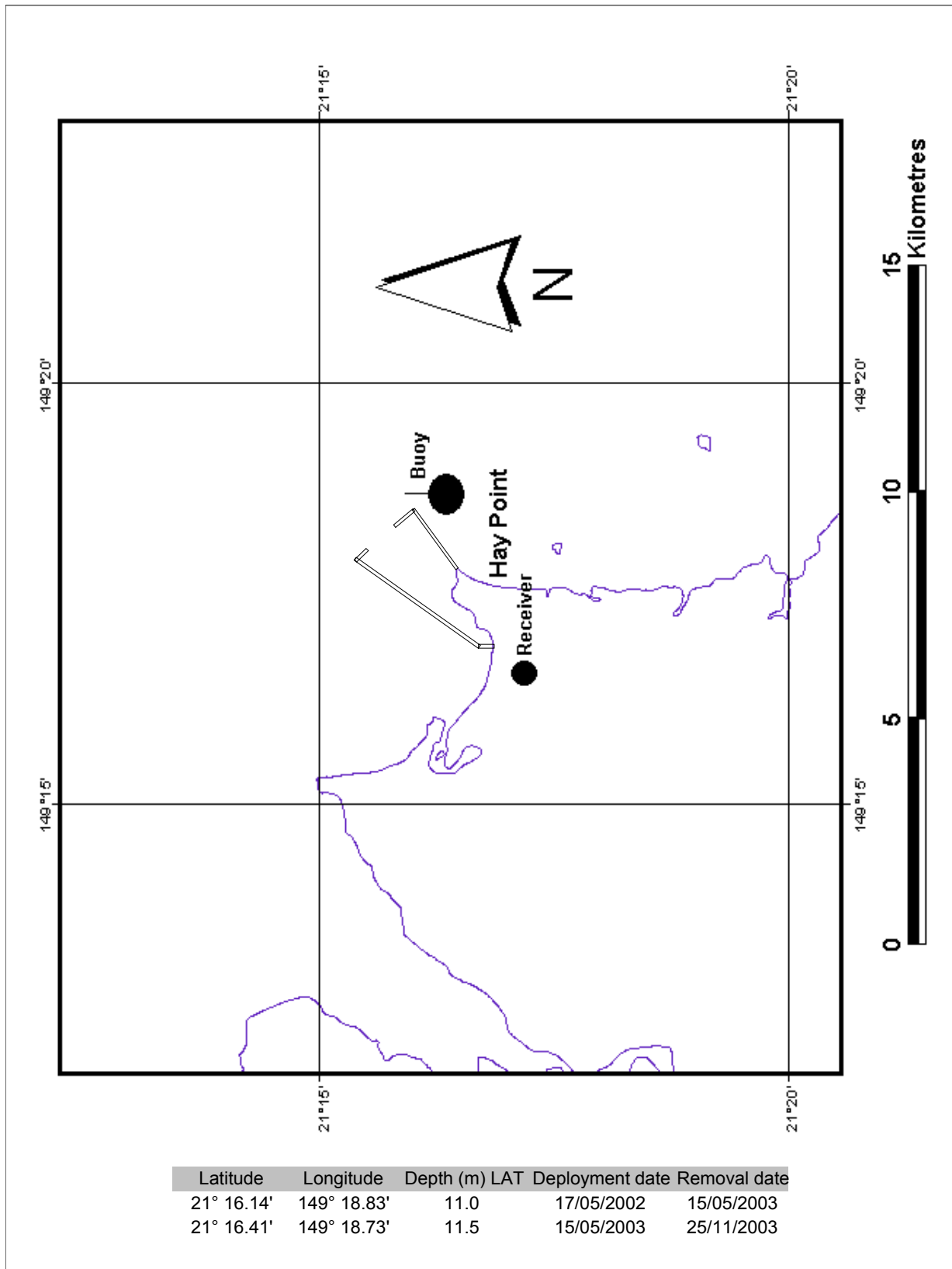
# Hay Point

## Wave recording station

### Details of wave recorder station

Maximum Possible Analysis Days (Last record–First record)	=	365.000
Total Days Used in Analysis	=	364.667
Gaps in Data from Selected Dates (Days)	=	0.333
Gaps in Data from Analysed Records (Days)	=	0.333
Gaps in Data from Duration Analysis (Days)	=	0.333
Number of Records Used in Analysis	=	17397

HAT at nearest standard port: Hay Point, 7.14m



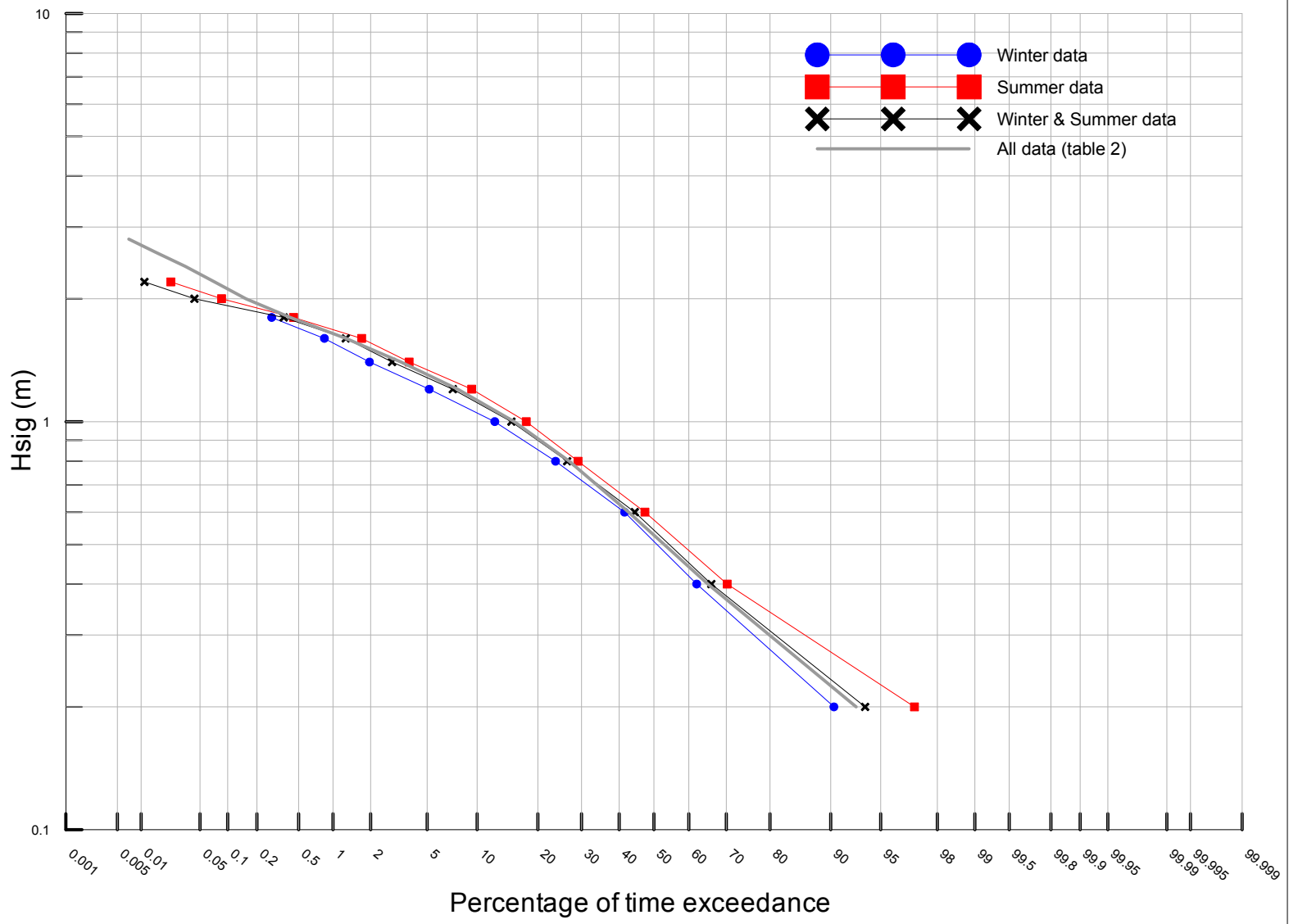
**Hay Point region—Locality plan**



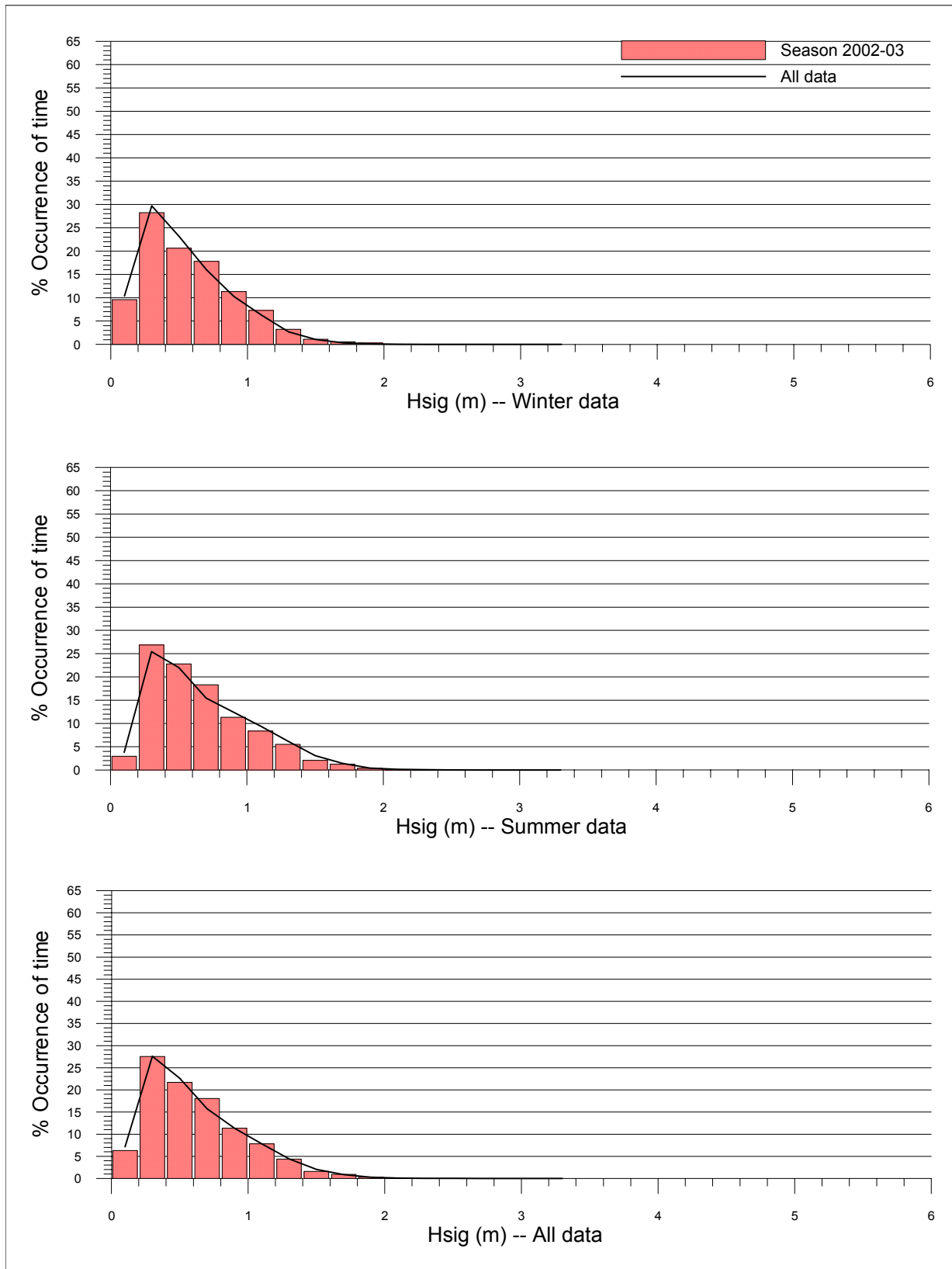
Wave data recording program  
Annual summary for season 2002-03

Figure 7.1

**Hay Point region—Percentage (of time) exceedance  
 of wave heights (Hsig) for all wave periods (Tp)**





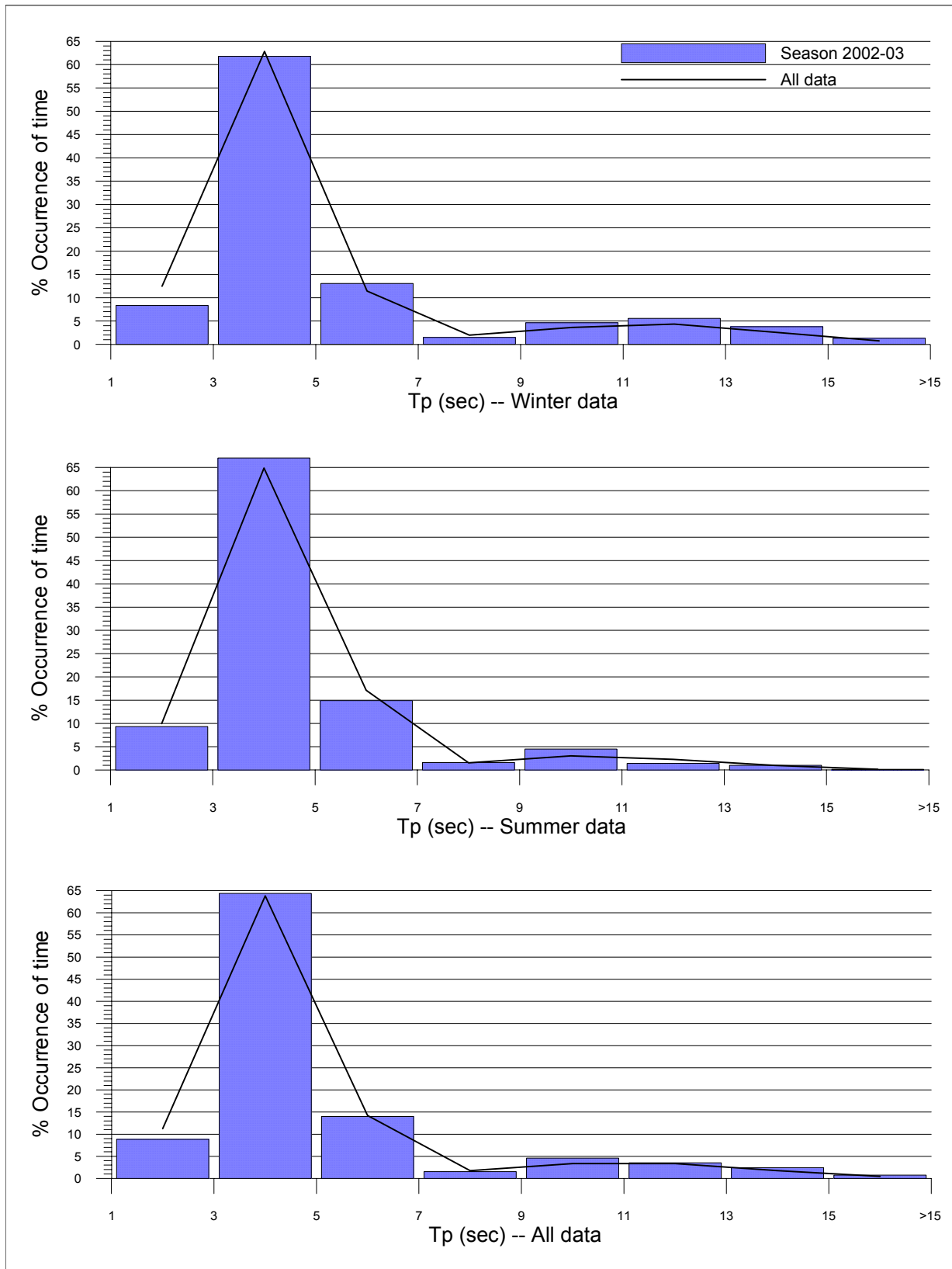


**Hay Point region—Histogram percentage (of time) occurrence of wave heights (Hsig) for all wave periods (Tp)**



Wave data recording program  
Annual summary for season 2002-03

Figure 7.3



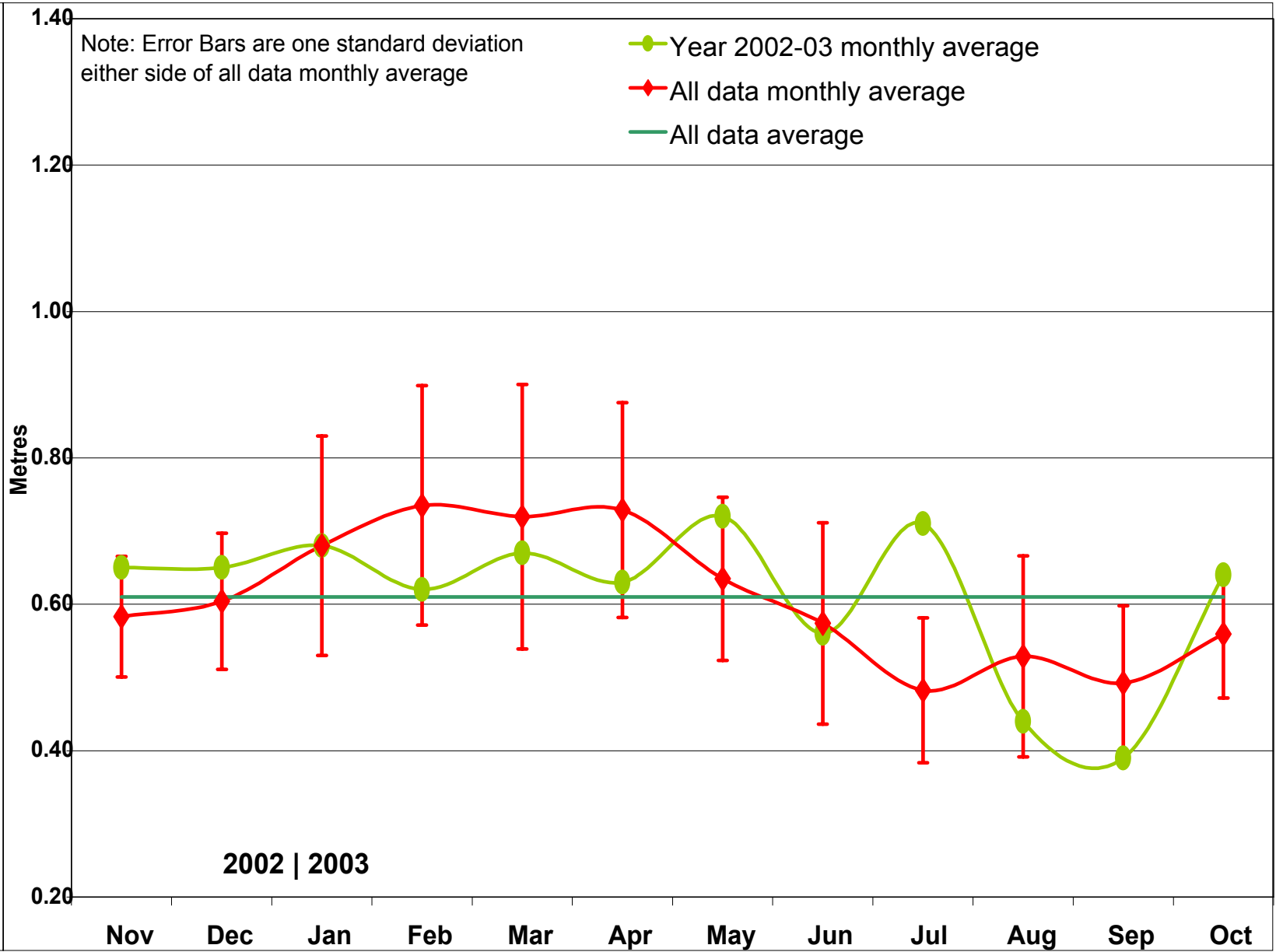
**Hay Point region—Histogram percentage (of time) occurrence of wave periods (Tp) for all wave heights (Hsig)**



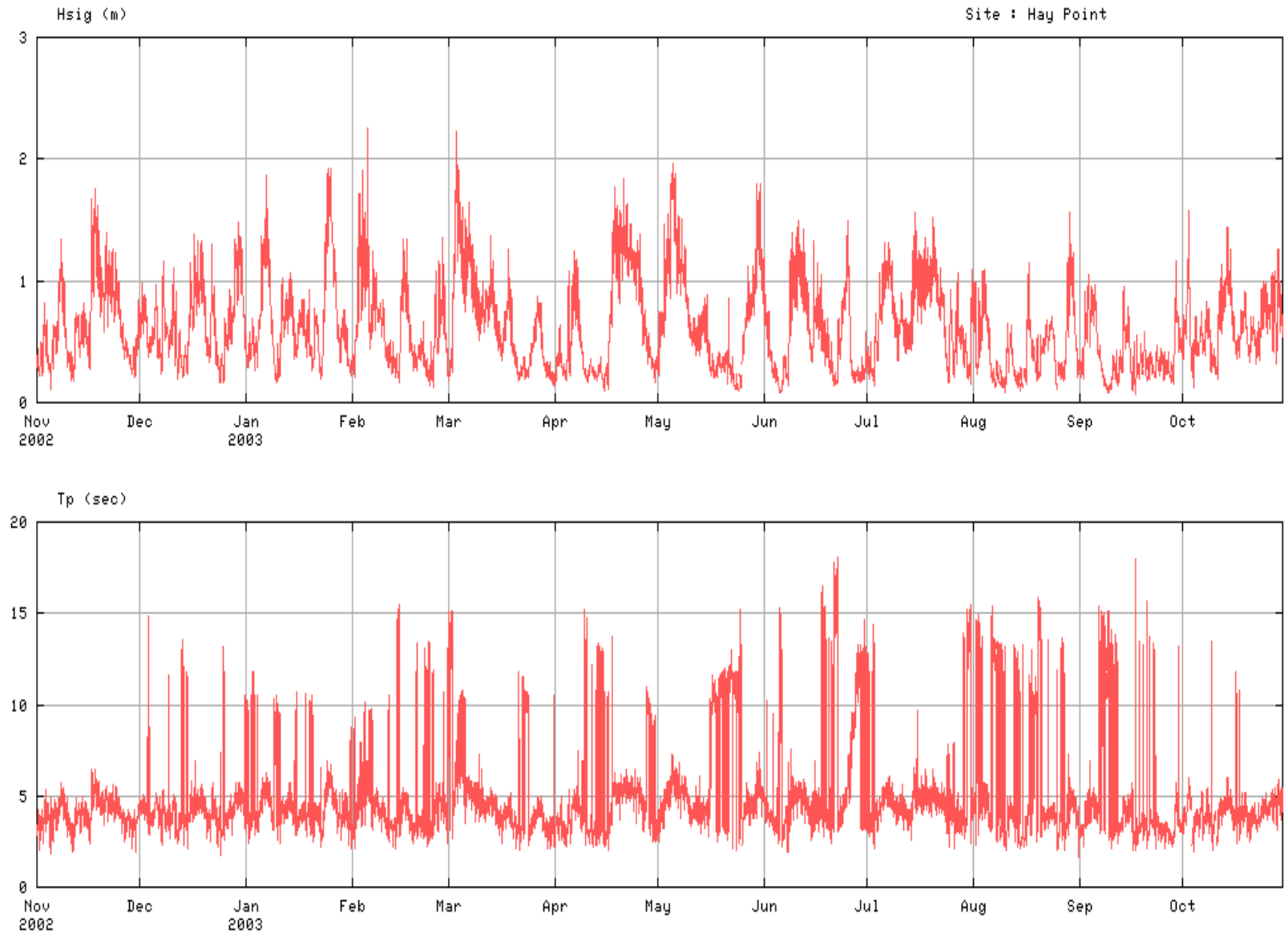
Wave data recording program  
Annual summary for season 2002-03

Figure 7.4

**Hay Point region—Plot of monthly averages for seasonal year and for all data, for wave height (Hsig)**



Hay Point region—Daily wave recordings



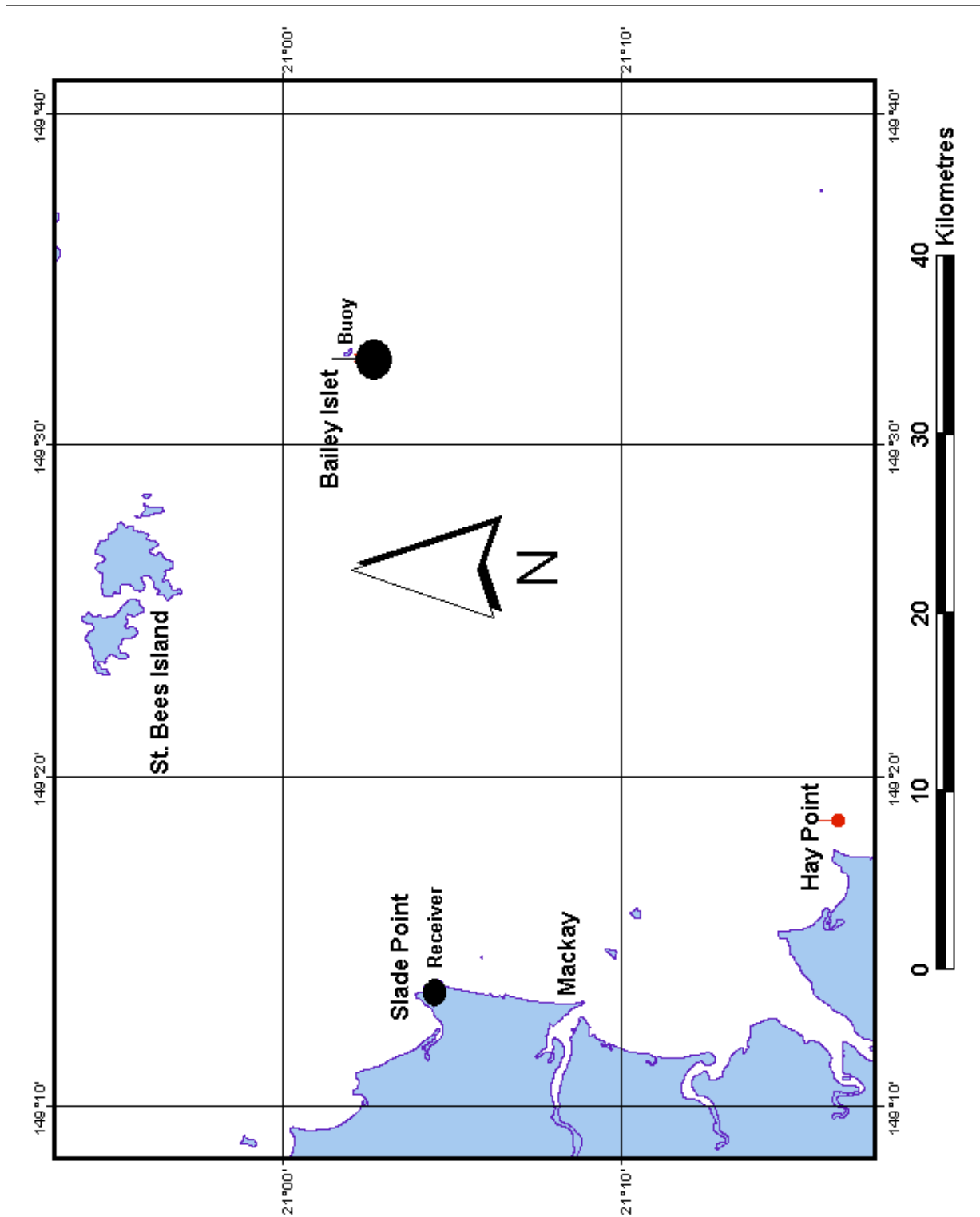
# Mackay

## Wave recording station

### Details of wave recorder station

Maximum Possible Analysis Days (Last record–First record)	=	365.000
Total Days Used in Analysis	=	357.875
Gaps in Data from Selected Dates (Days)	=	7.125
Gaps in Data from Analysed Records (Days)	=	7.125
Gaps in Data from Duration Analysis (Days)	=	7.125
Number of Records Used in Analysis	=	15178

HAT at nearest standard port: Saint Bees Island, 5.72m



Latitude	Longitude	Depth (m)	LAT	Deployment date	Removal date
21° 02.593'	149° 32.875'	31.0		16/07/2002	29/07/2003
21° 02.593'	149° 32.875'	25.0		29/07/2003	

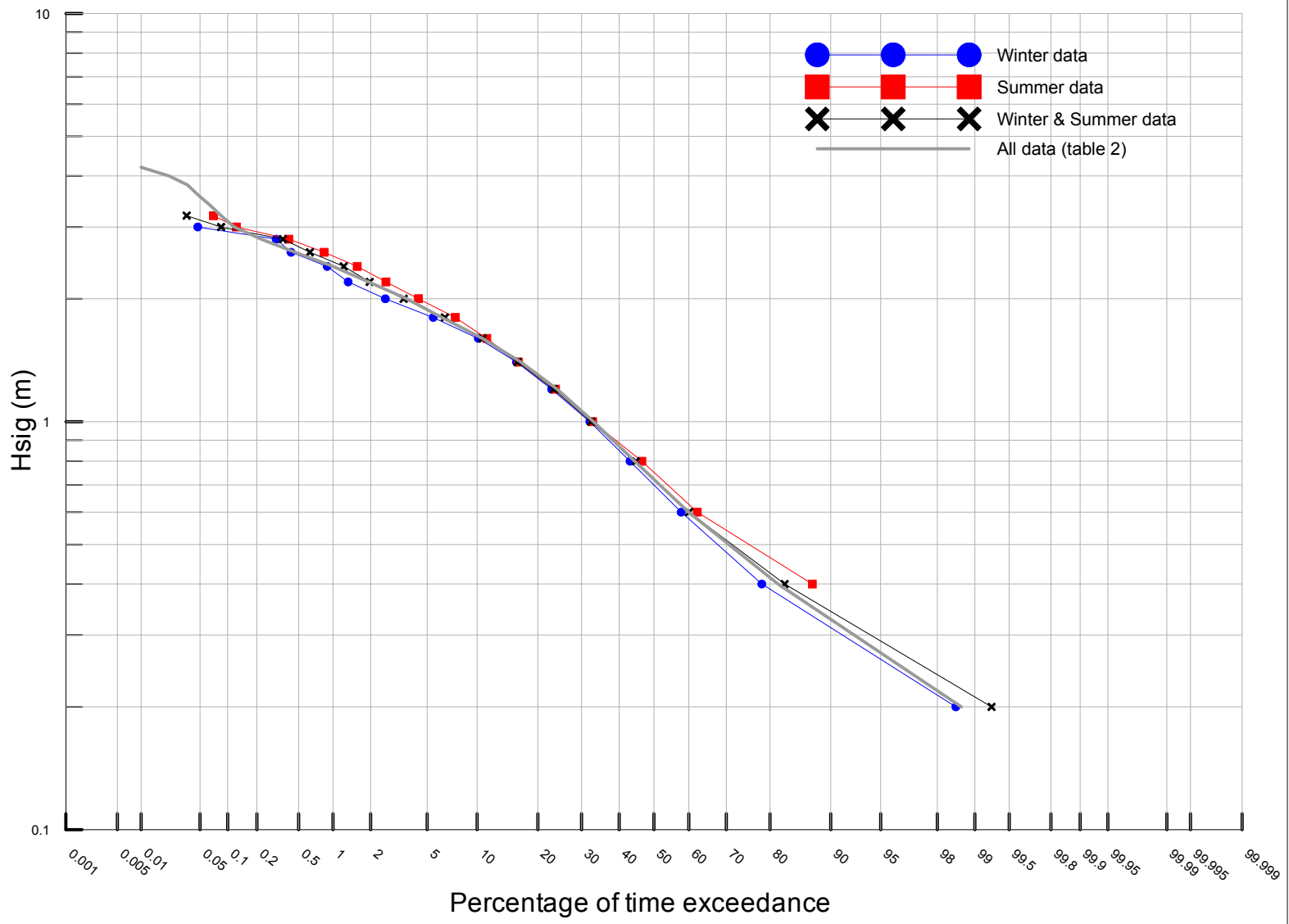
### Mackay region—Locality plan

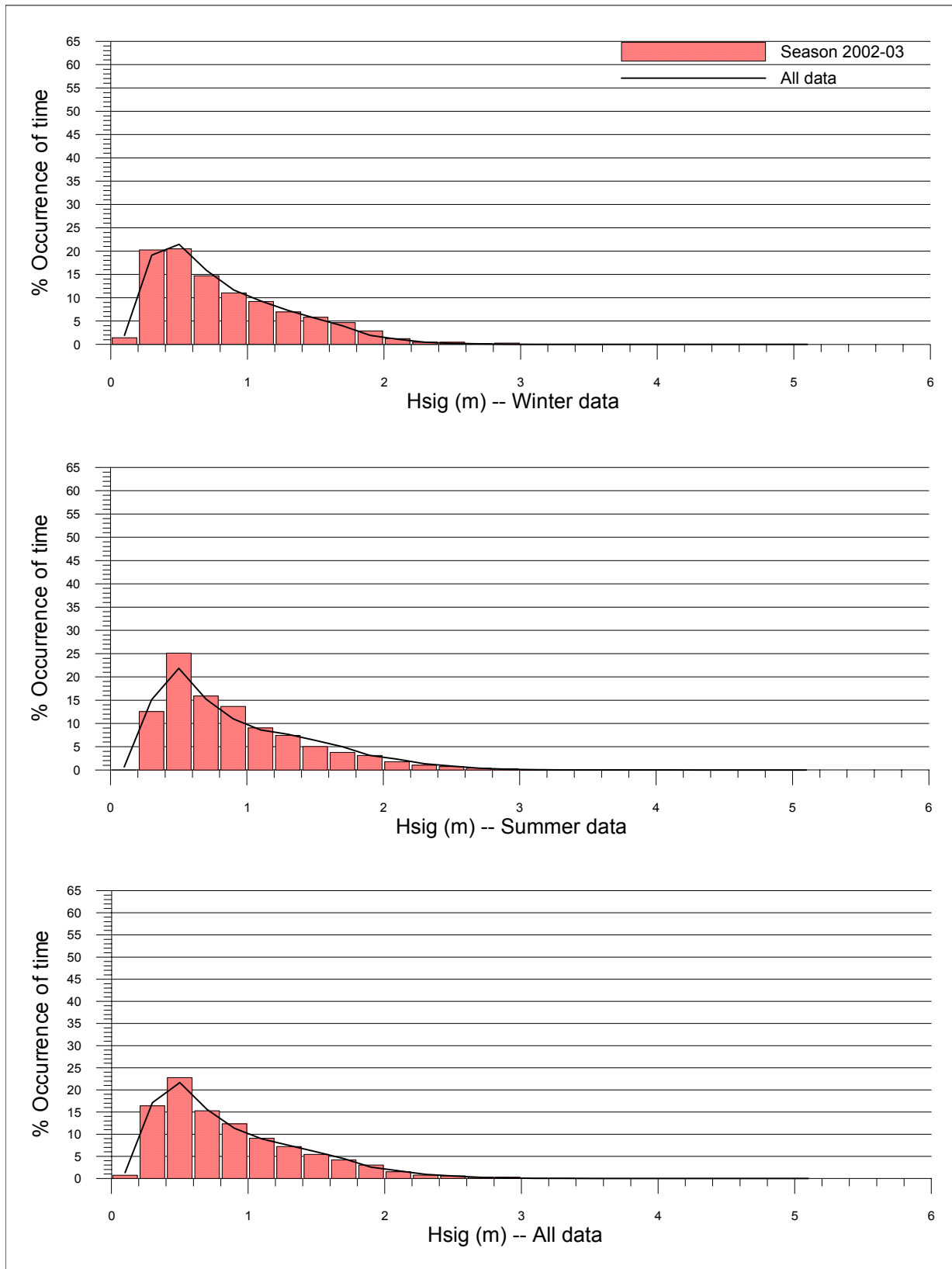


Wave data recording program  
Annual summary for season 2002-03

Figure 8.1

**Mackay region—Percentage (of time) exceedance  
 of wave heights (Hsig) for all wave periods (Tp)**





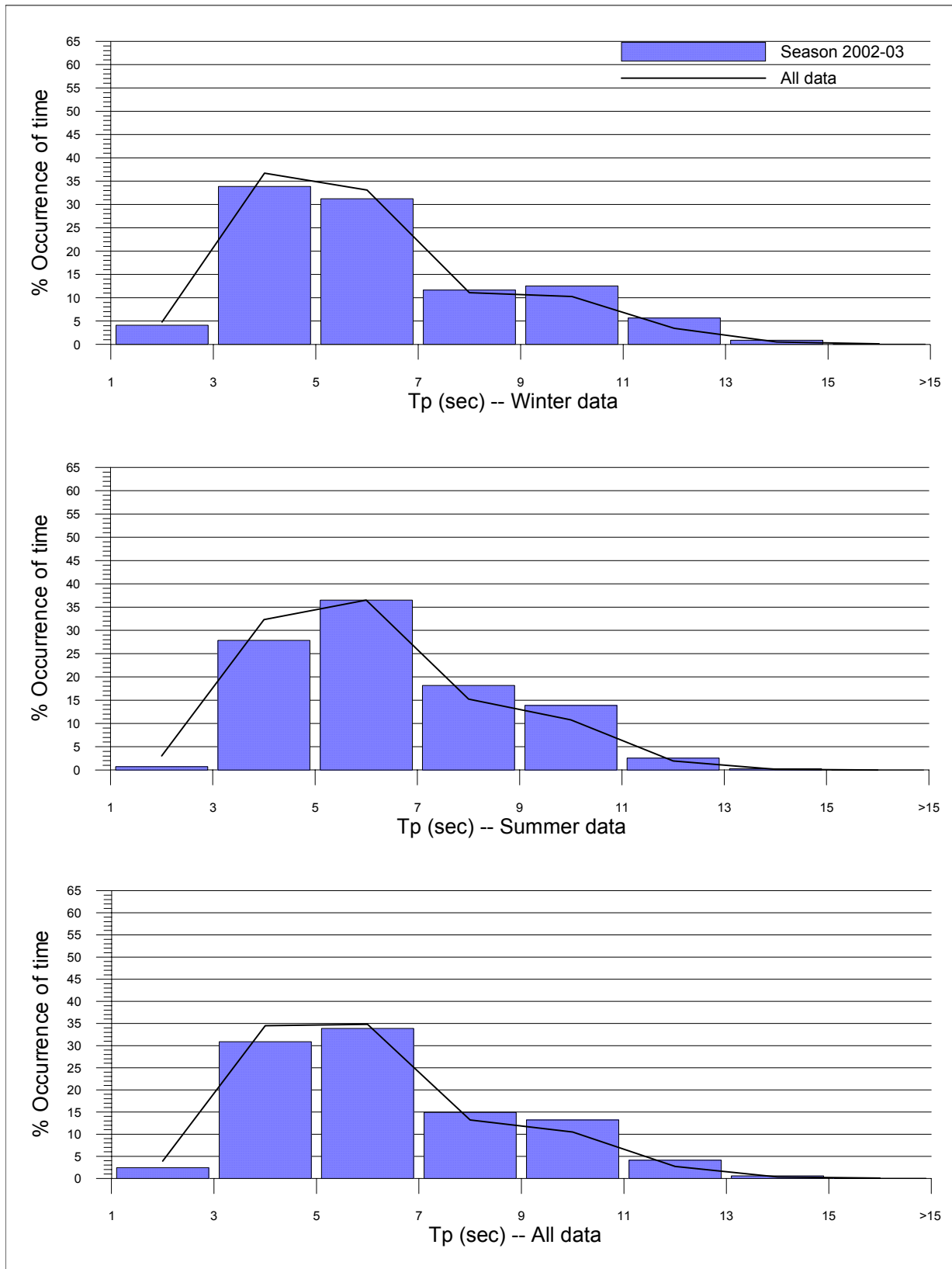
**Mackay region—Histogram percentage (of time) occurrence of wave heights (Hsig) for all wave periods (Tp)**



Wave data recording program  
Annual summary for season 2002-03

Figure 8.3





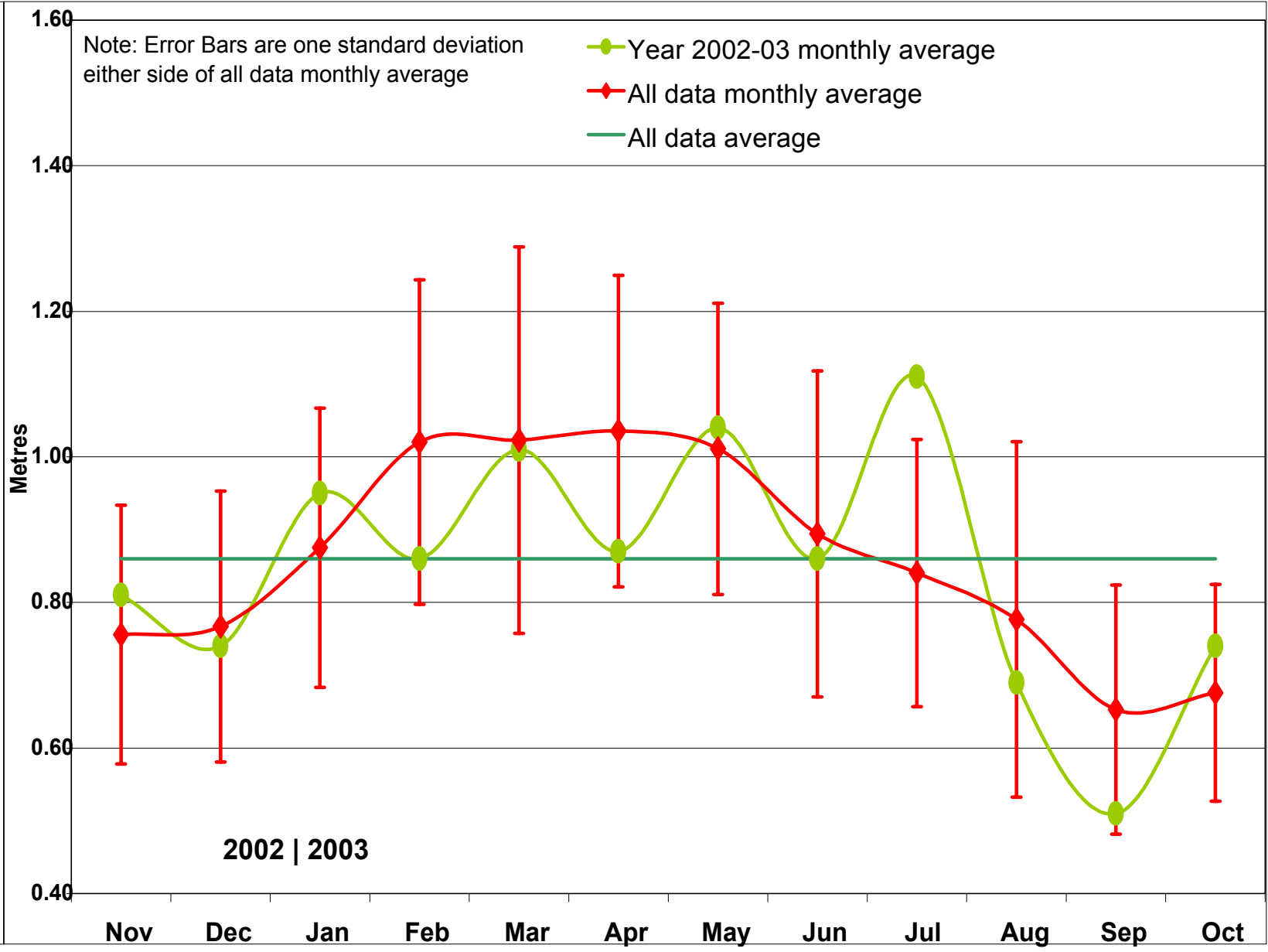
**Mackay region—Histogram percentage (of time) occurrence of wave periods (Tp) for all wave heights (Hsig)**



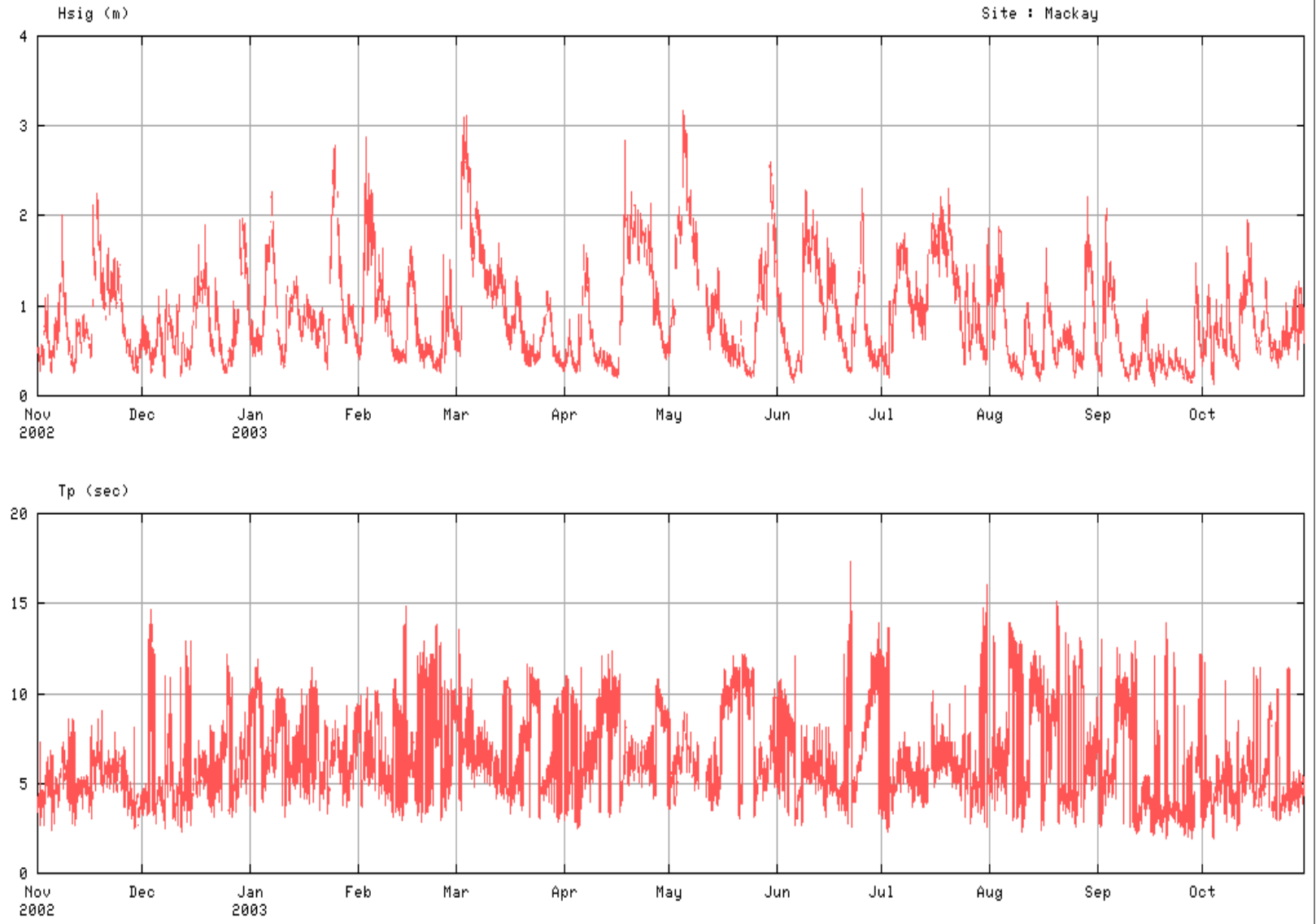
Wave data recording program  
Annual summary for season 2002-03

Figure 8.4

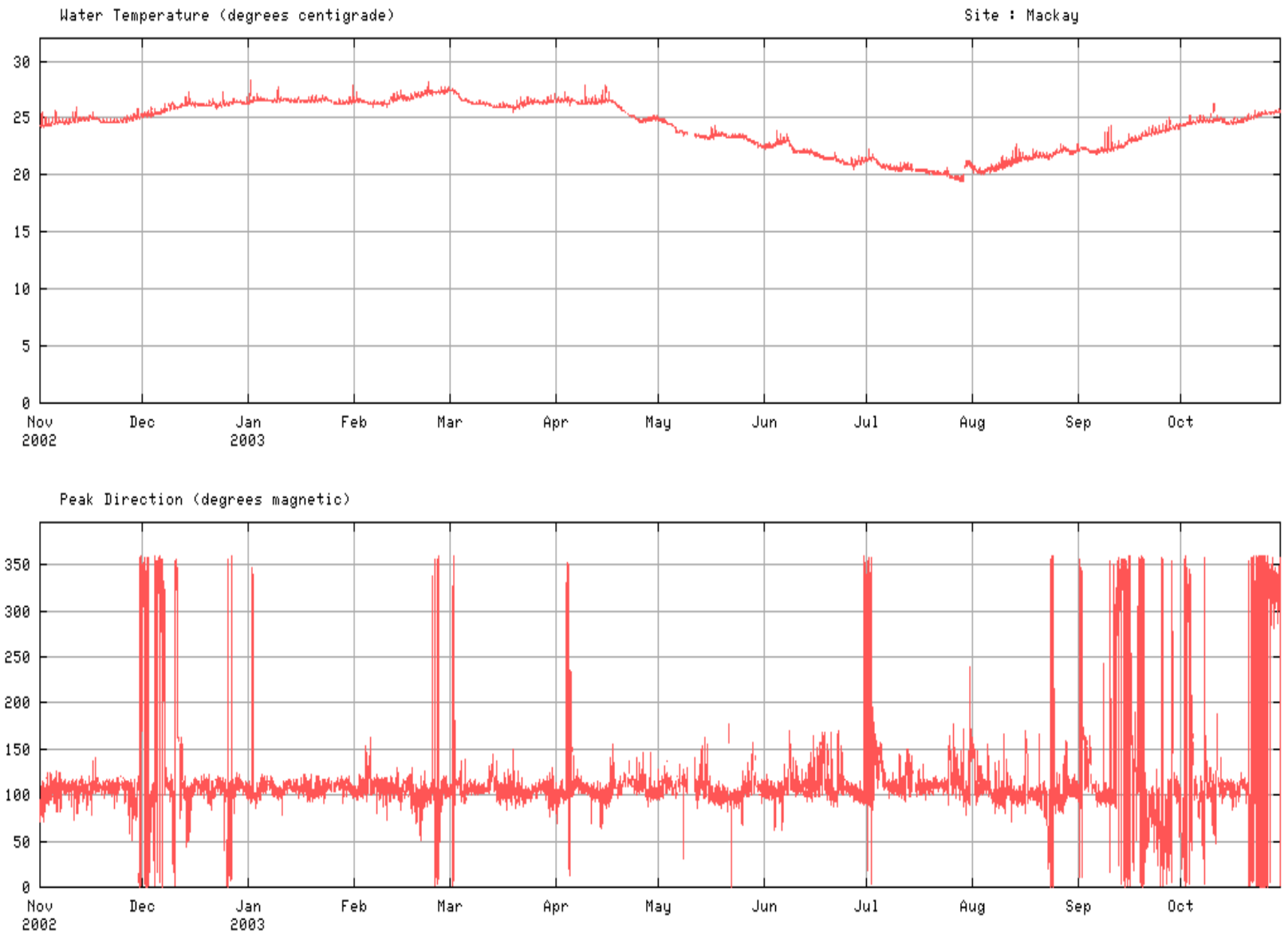
**Mackay region—Plot of monthly averages for seasonal year and for all data, for wave height (Hsig)**

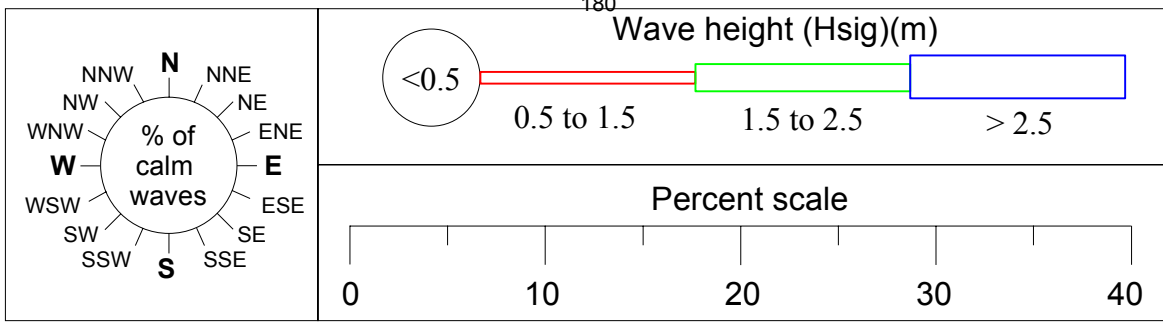
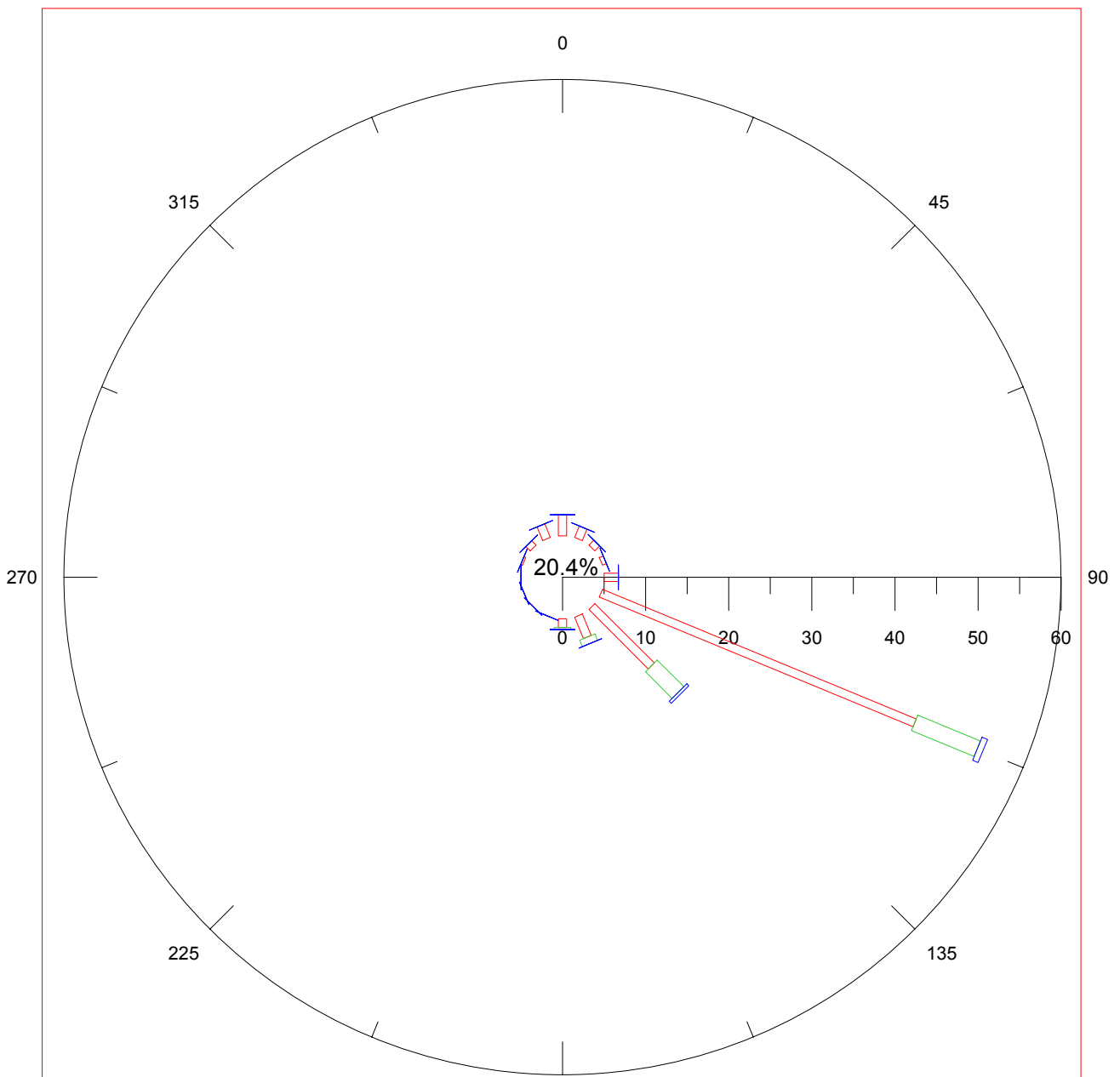


**Mackay region—Daily wave recordings**



**Mackay region—Water temperature  
and peak direction recordings**





**Mackay region—Directional wave rose**



Wave data recording program  
Annual summary for season 2002-03

Figure 8.8

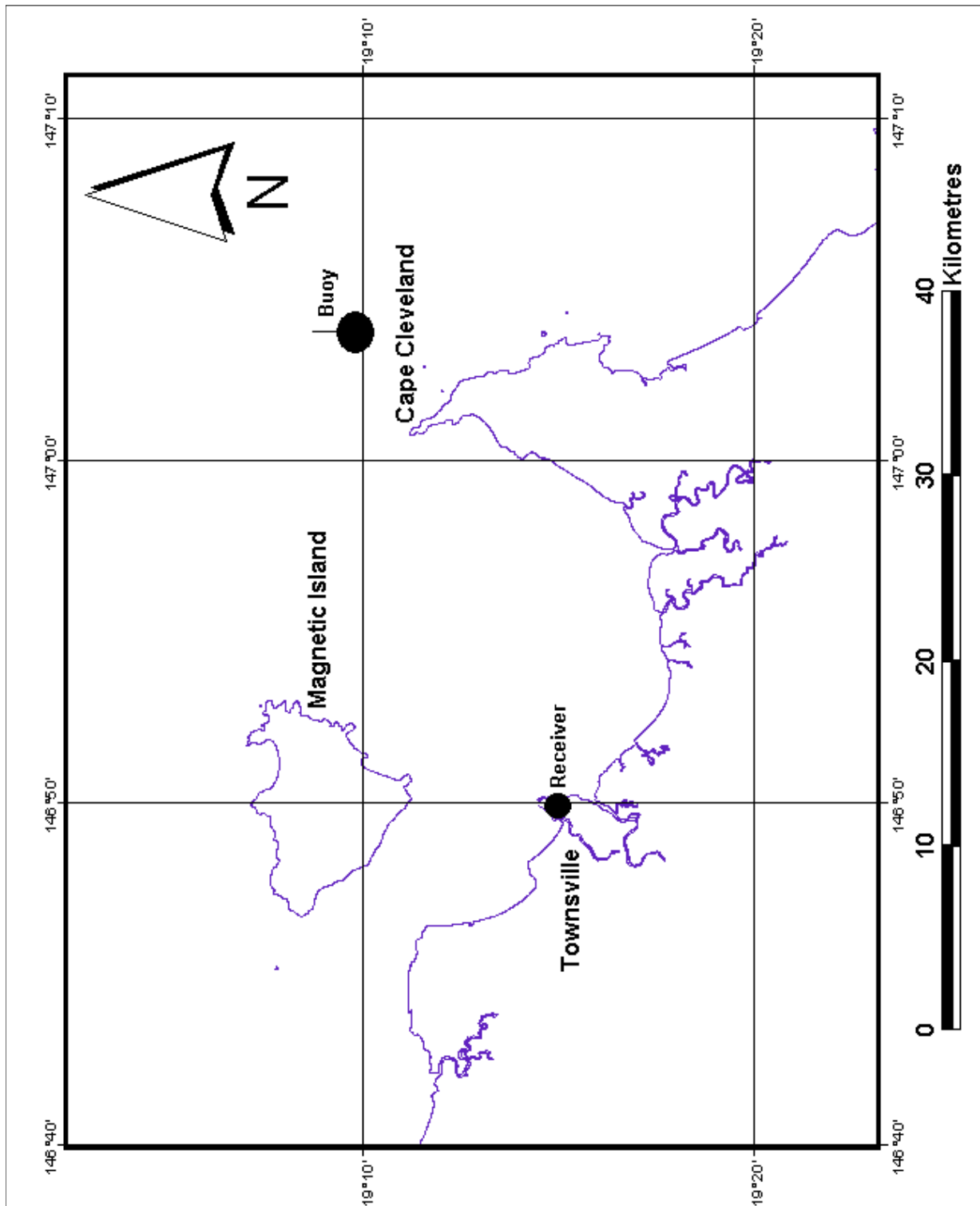
# Townsville

## Wave recording station

### Details of wave recorder station

Maximum Possible Analysis Days (Last record–First record)	=	365.000
Total Days Used in Analysis	=	259.179
Gaps in Data from Selected Dates (Days)	=	105.821
Gaps in Data from Analysed Records (Days)	=	105.821
Gaps in Data from Duration Analysis (Days)	=	105.821
Number of Records Used in Analysis	=	10907

HAT at nearest standard port: Cape Ferguson, 3.73m



Latitude	Longitude	Depth (m)	LAT	Deployment date	Failure date	Removal date
19° 09.37'	147° 03.803'	16.3		15/10/2002	10/04/2003	Retrieved at later date
19° 09.487'	147° 03.793'	15.5		20/05/2003	01/08/2003	Retrieved at later date
19° 09.485'	147° 03.787'	15.5		11/09/2003		

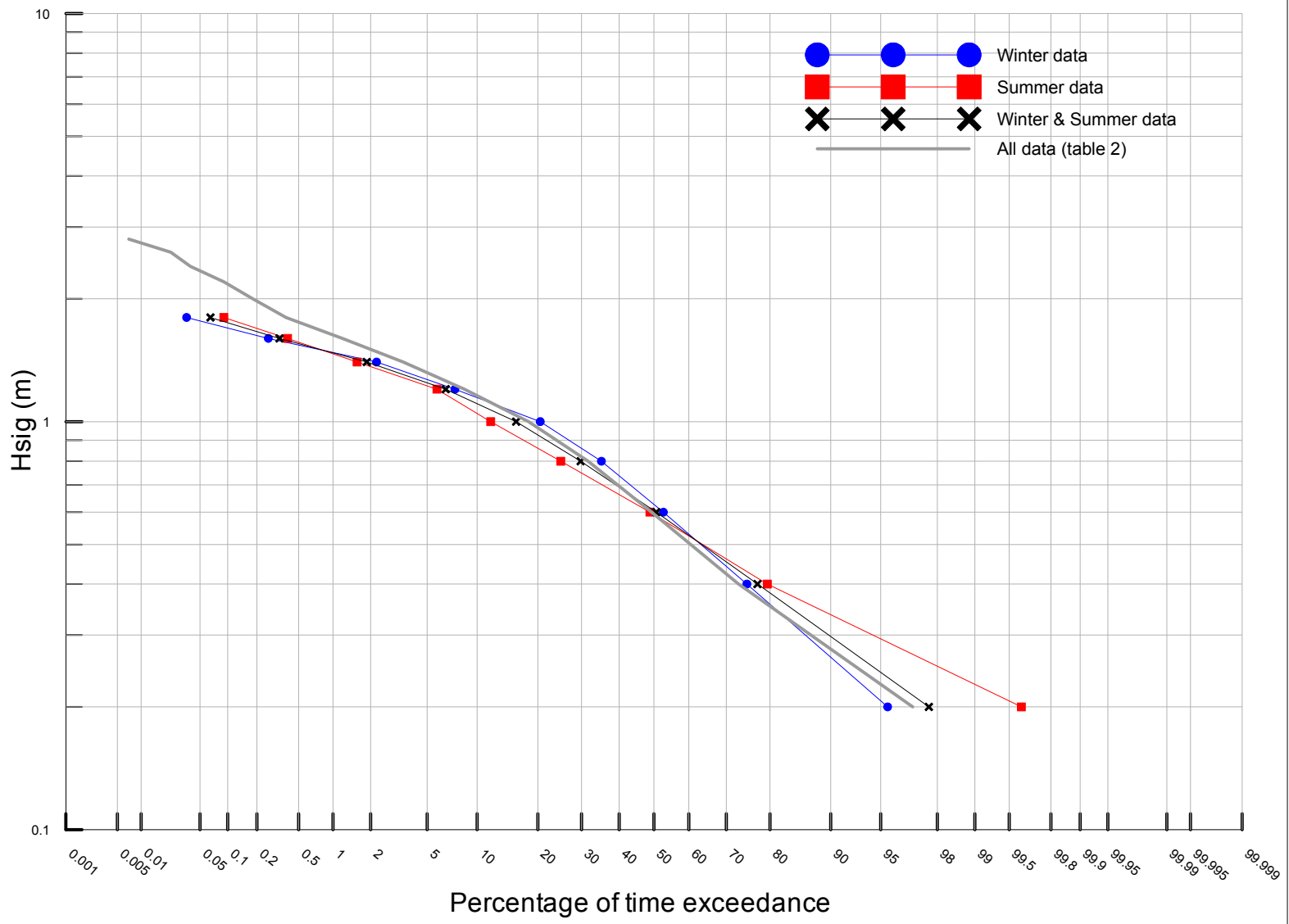
### Townsville region—Locality plan



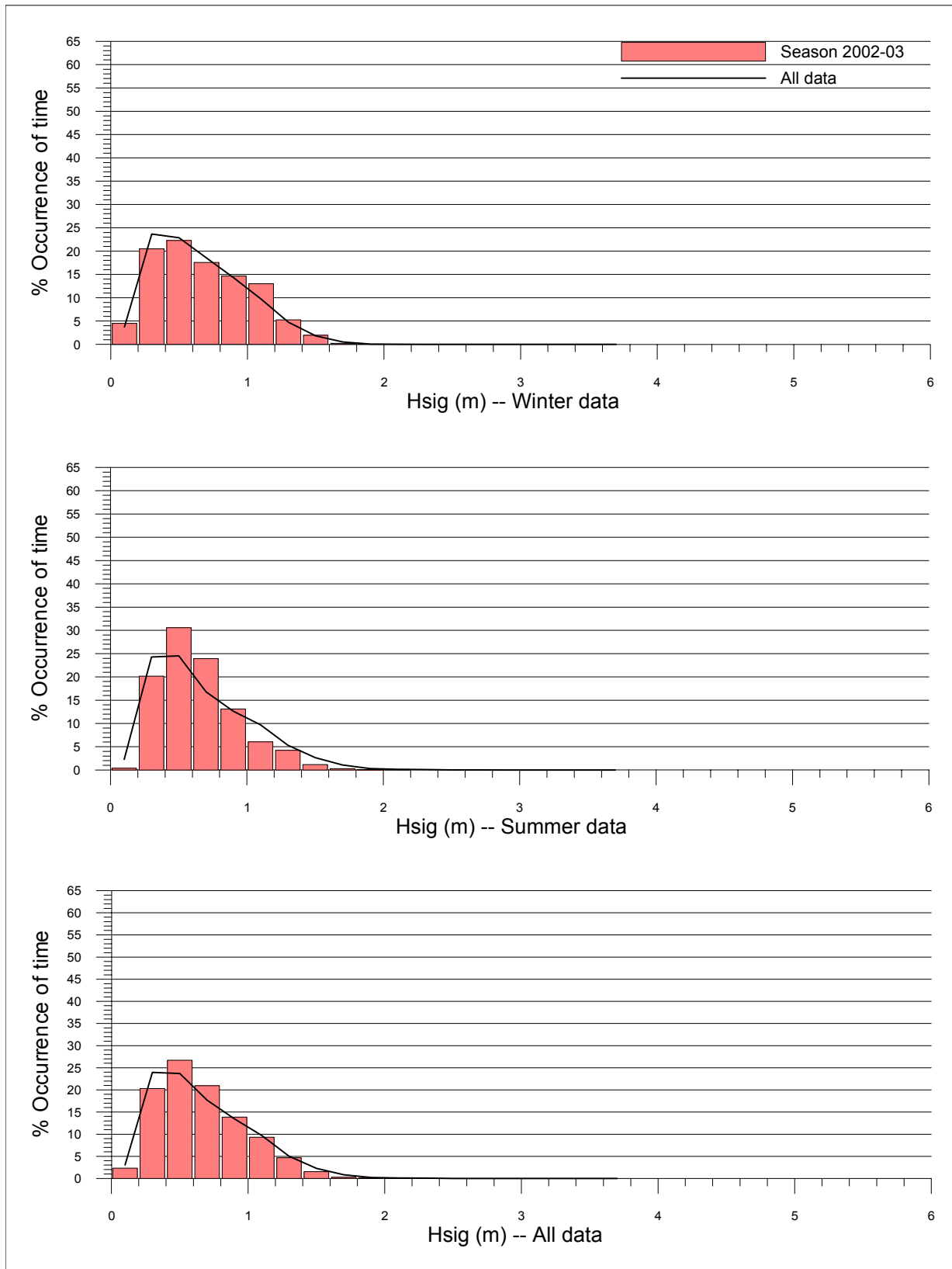
Wave data recording program  
Annual summary for season 2002-03

Figure 9.1

**Townsville region—Percentage (of time) exceedance of wave heights (Hsig) for all wave periods (Tp)**





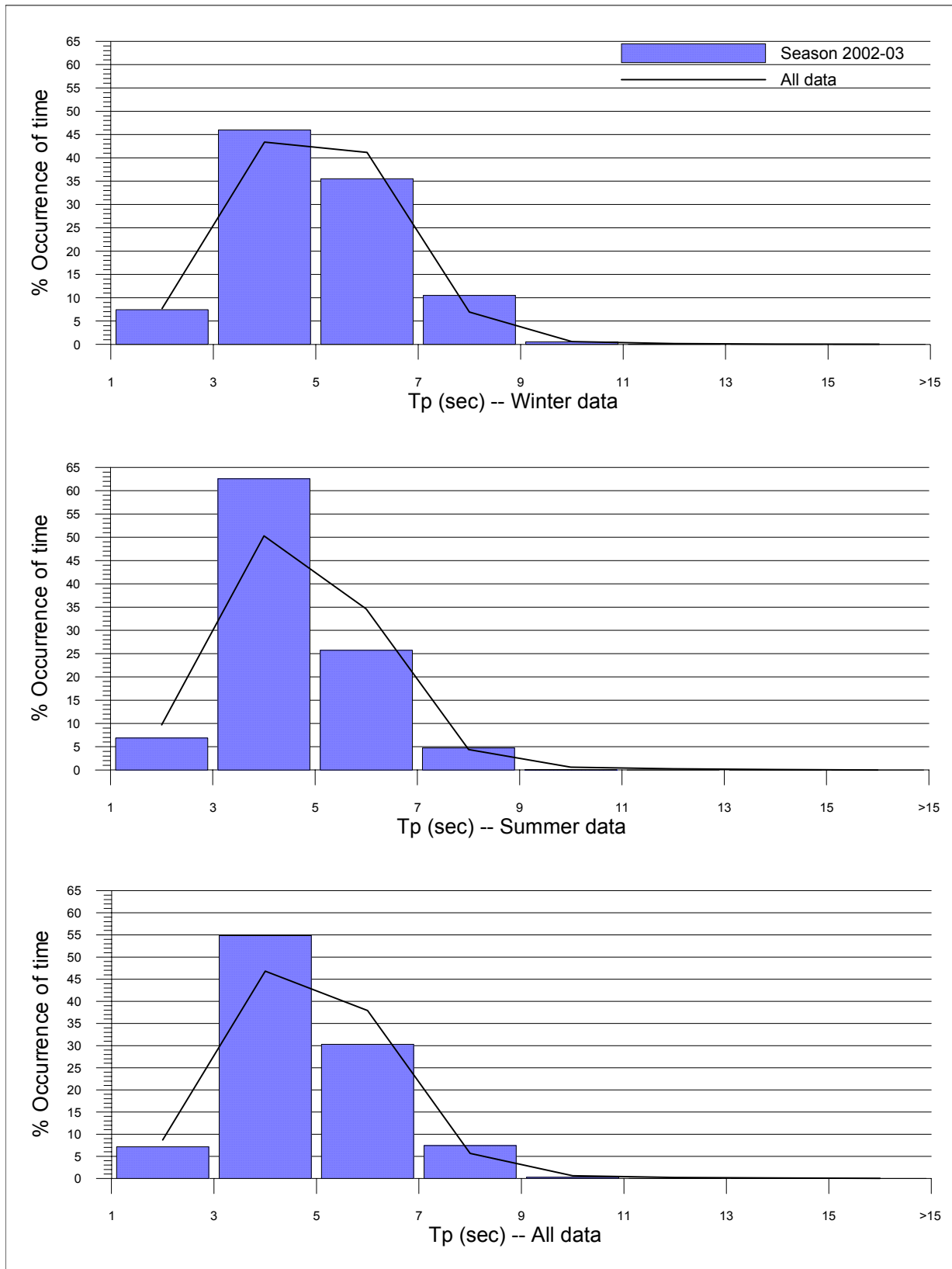


**Townsville region—Histogram percentage (of time) occurrence of wave heights (Hsig) for all wave periods (Tp)**




Wave data recording program  
Annual summary for season 2002-03

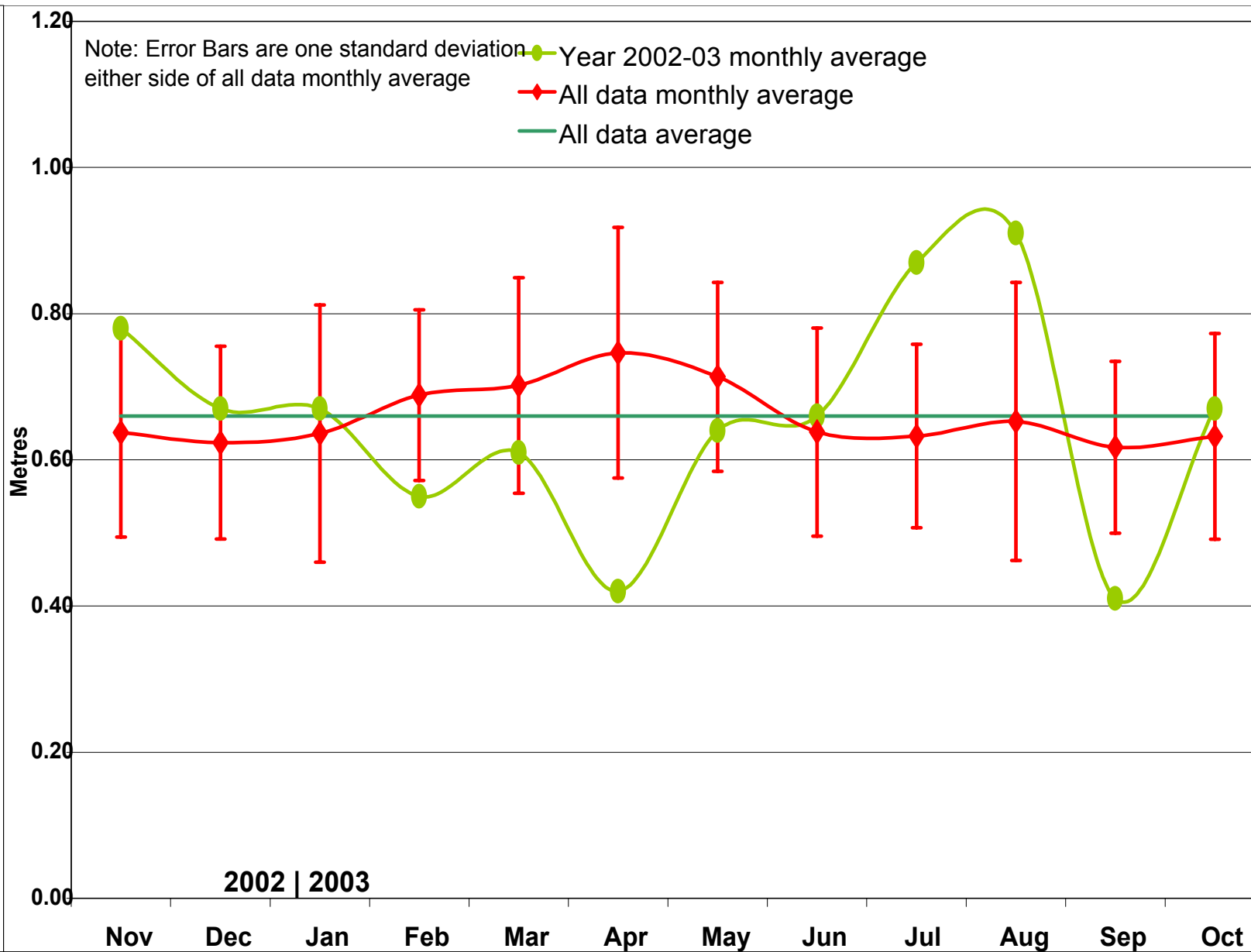
Figure 9.3



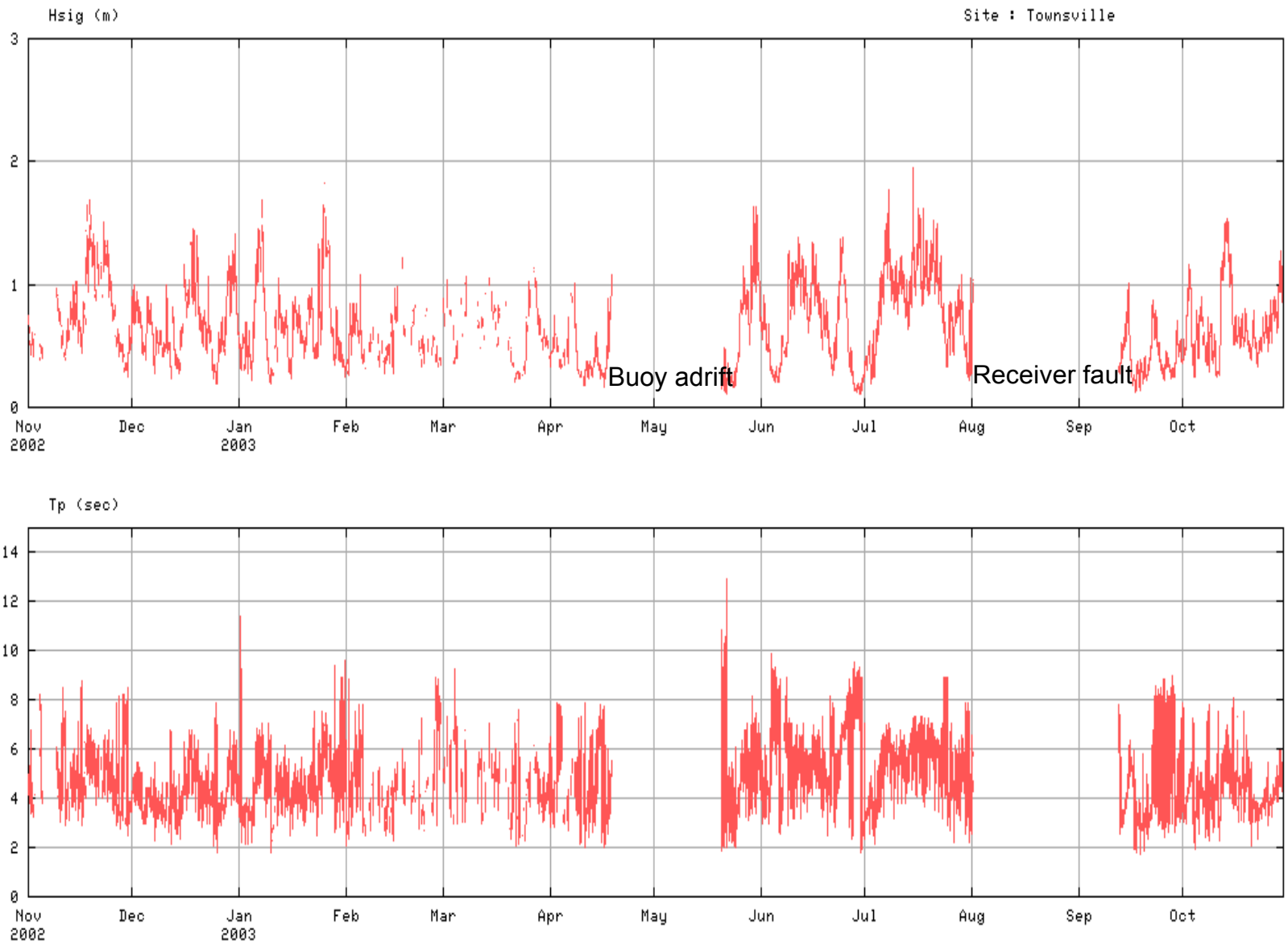
**Townsville region—Histogram percentage (of time) occurrence of wave periods (Tp) for all wave heights (Hsig)**

 <p><b>Queensland Government</b> Environmental Protection Agency</p>	<p>Wave data recording program Annual summary for season 2002-03</p>	<p>Figure 9.4</p>
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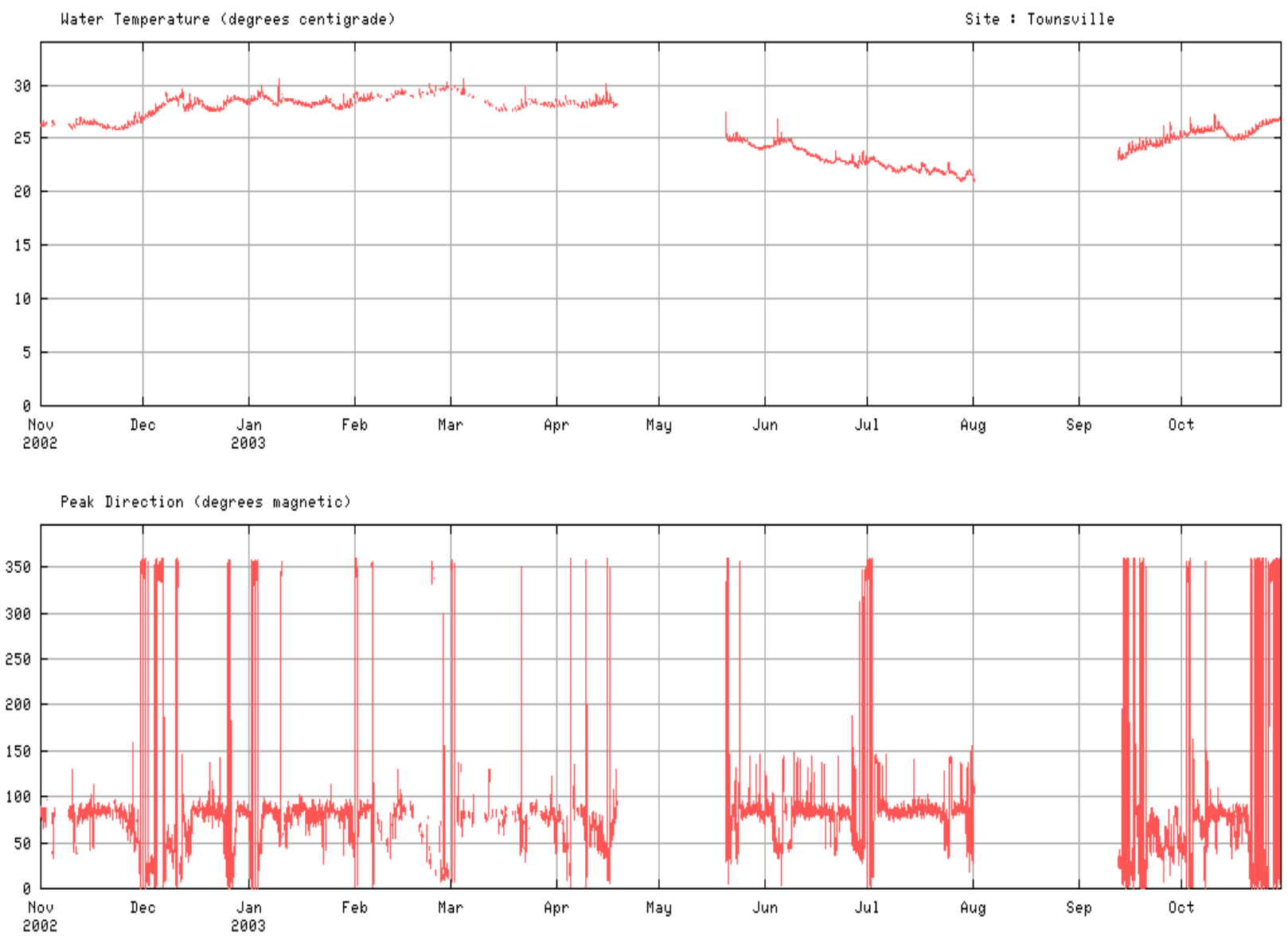
**Townsville region—Plot of monthly averages for seasonal year and for all data, for wave height (Hsig)**

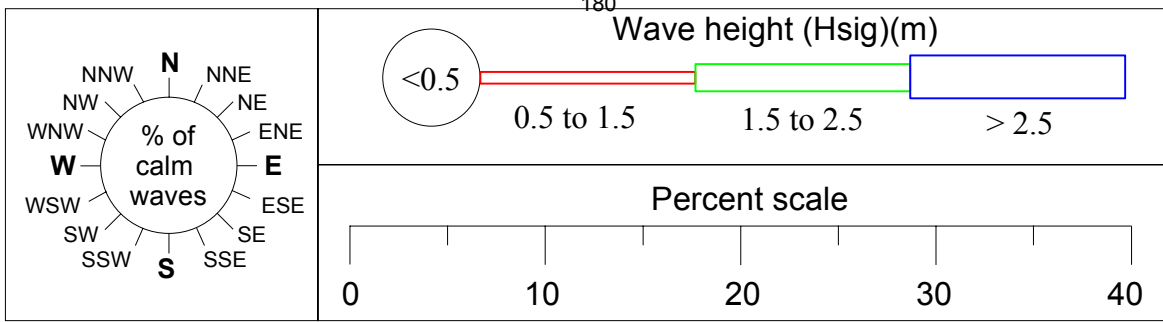
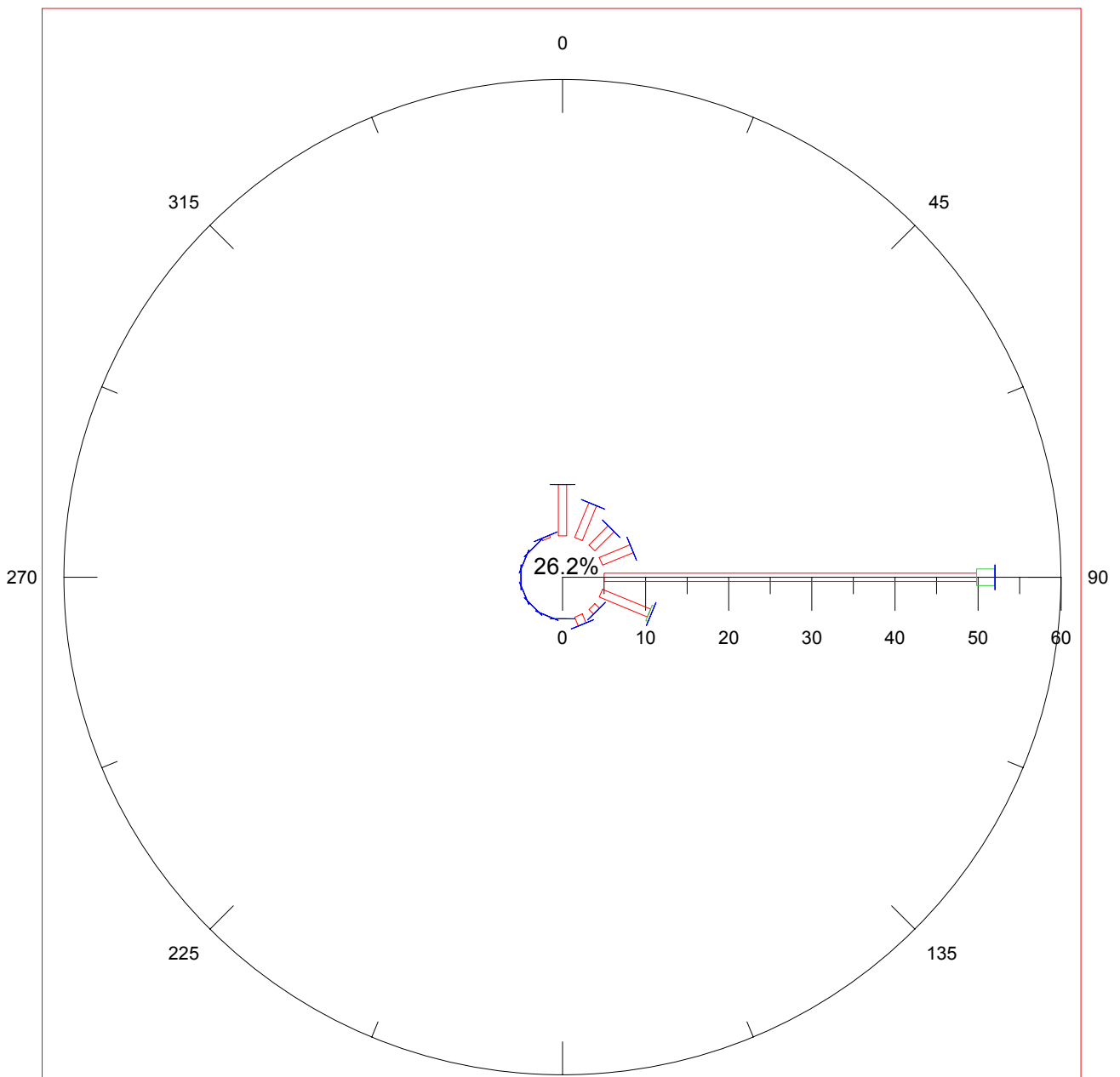


Townsville region—Daily wave recordings




**Townsville region—Water temperature  
and peak direction recordings**





**Townsville region—Directional wave rose**

 <p><b>Queensland Government</b> Environmental Protection Agency</p>	<p>Wave data recording program Annual summary for season 2002-03</p>	<p>Figure 9.8</p>
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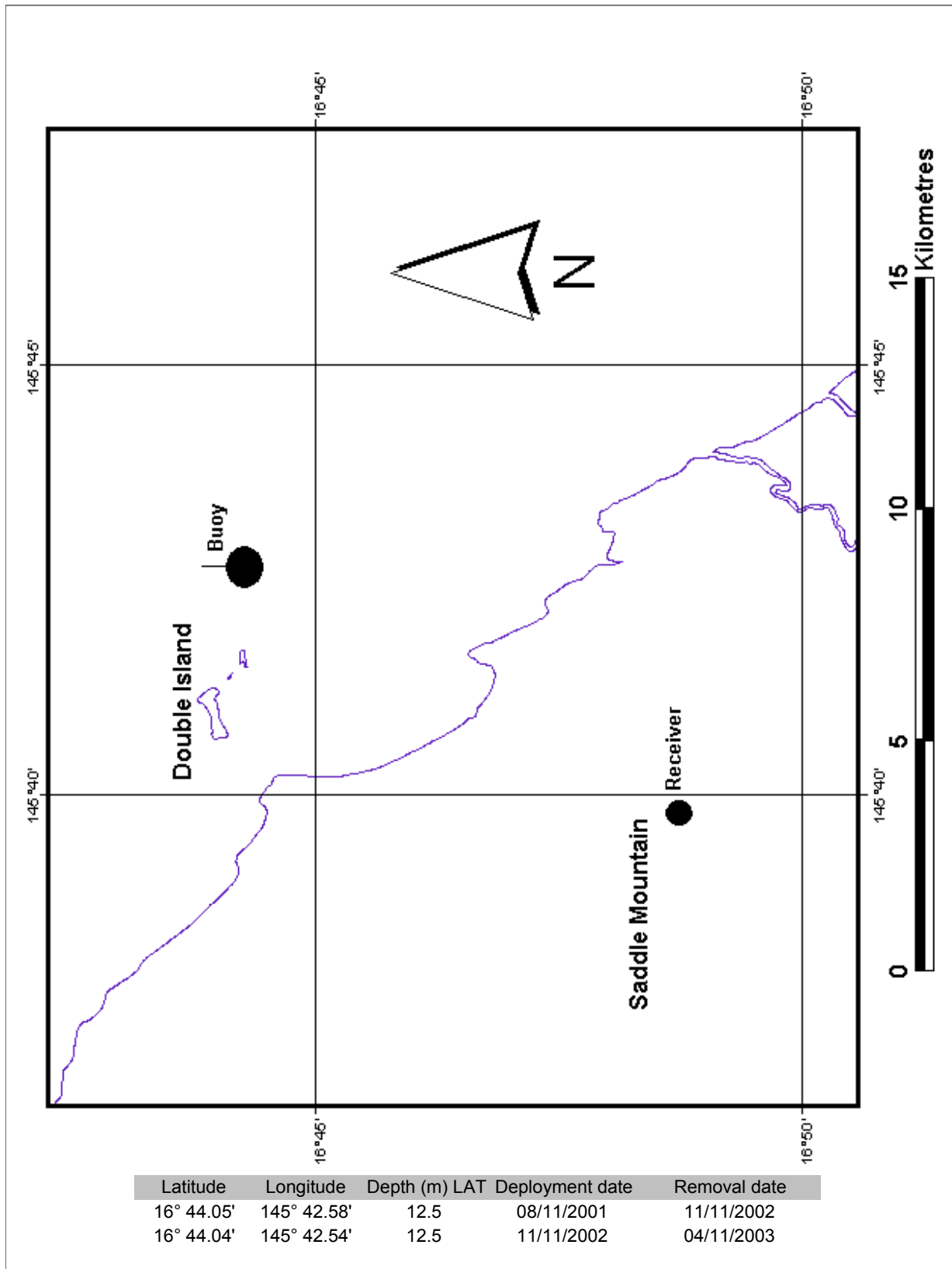
# Cairns

## Wave recording station

### Details of wave recorder station

Maximum Possible Analysis Days (Last record–First record)	=	365.000
Total Days Used in Analysis	=	362.604
Gaps in Data from Selected Dates (Days)	=	2.396
Gaps in Data from Analysed Records (Days)	=	0.042
Gaps in Data from Duration Analysis (Days)	=	2.396
Number of Records Used in Analysis	=	17342

HAT at nearest standard port: Palm Cove, 3.1m



**Cairns region—Locality plan**

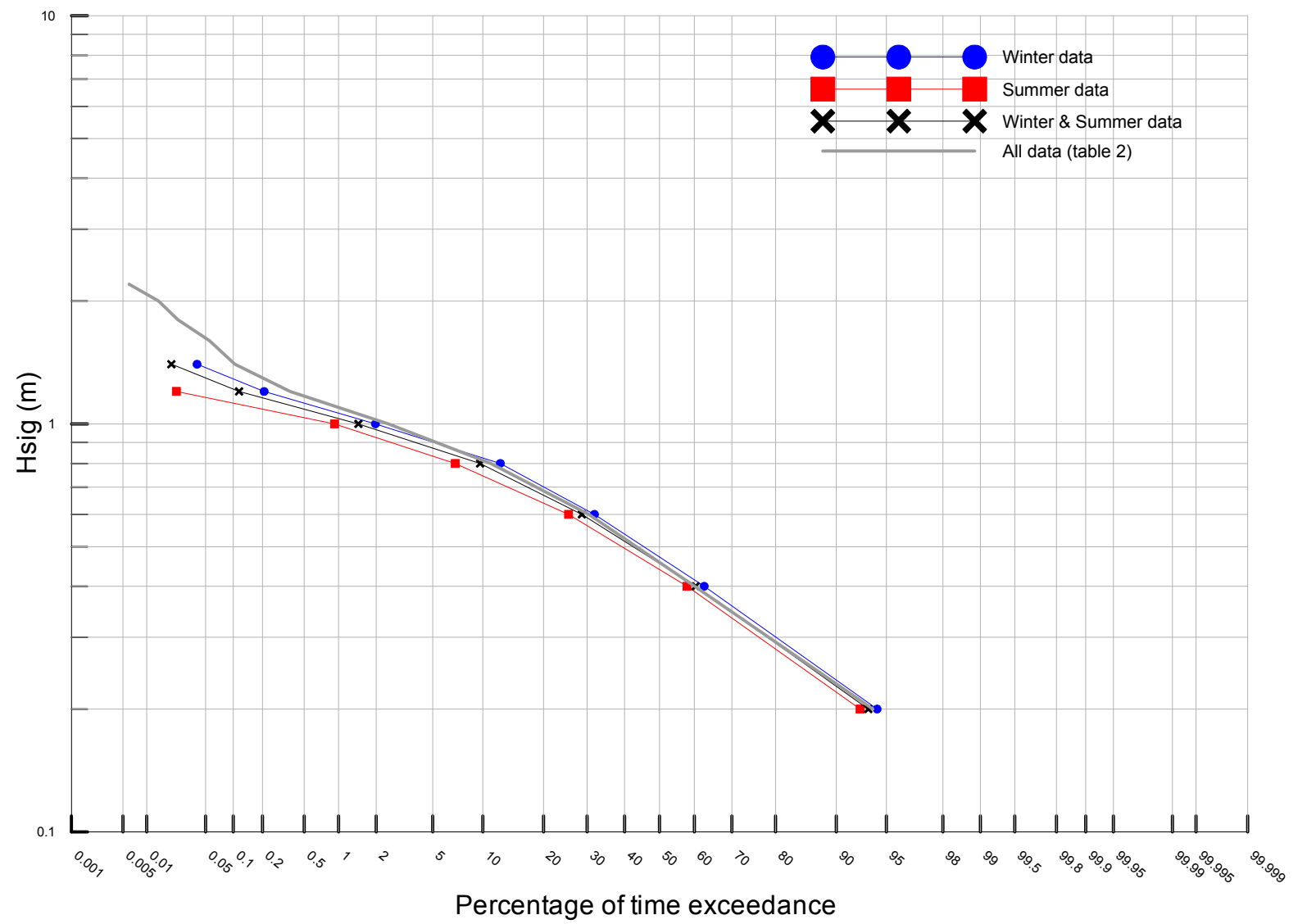


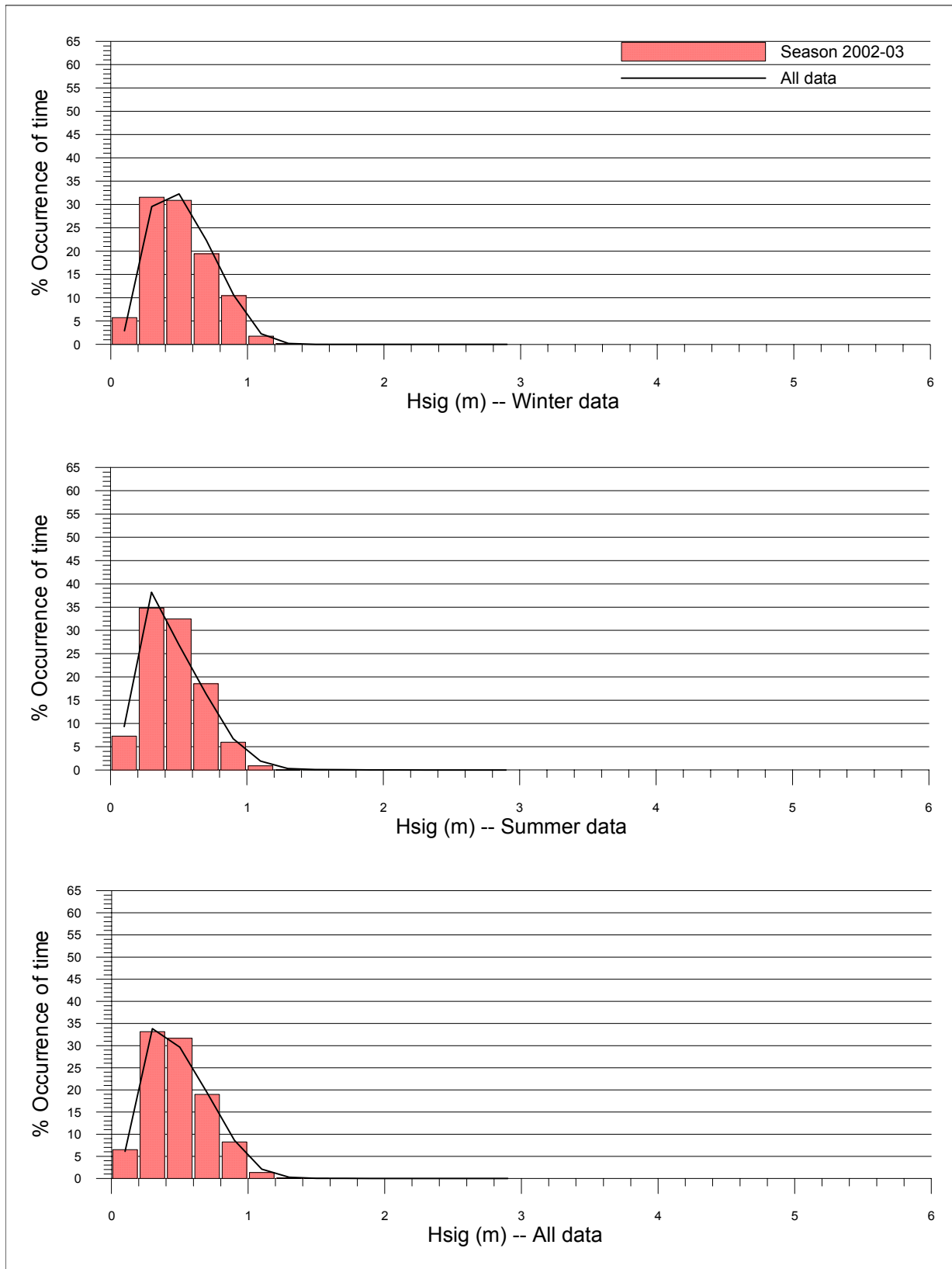
Wave data recording program  
Annual summary for season 2002-03

Figure 10.1



**Cairns region—Percentage (of time) exceedance  
 of wave heights (Hsig) for all wave periods (Tp)**



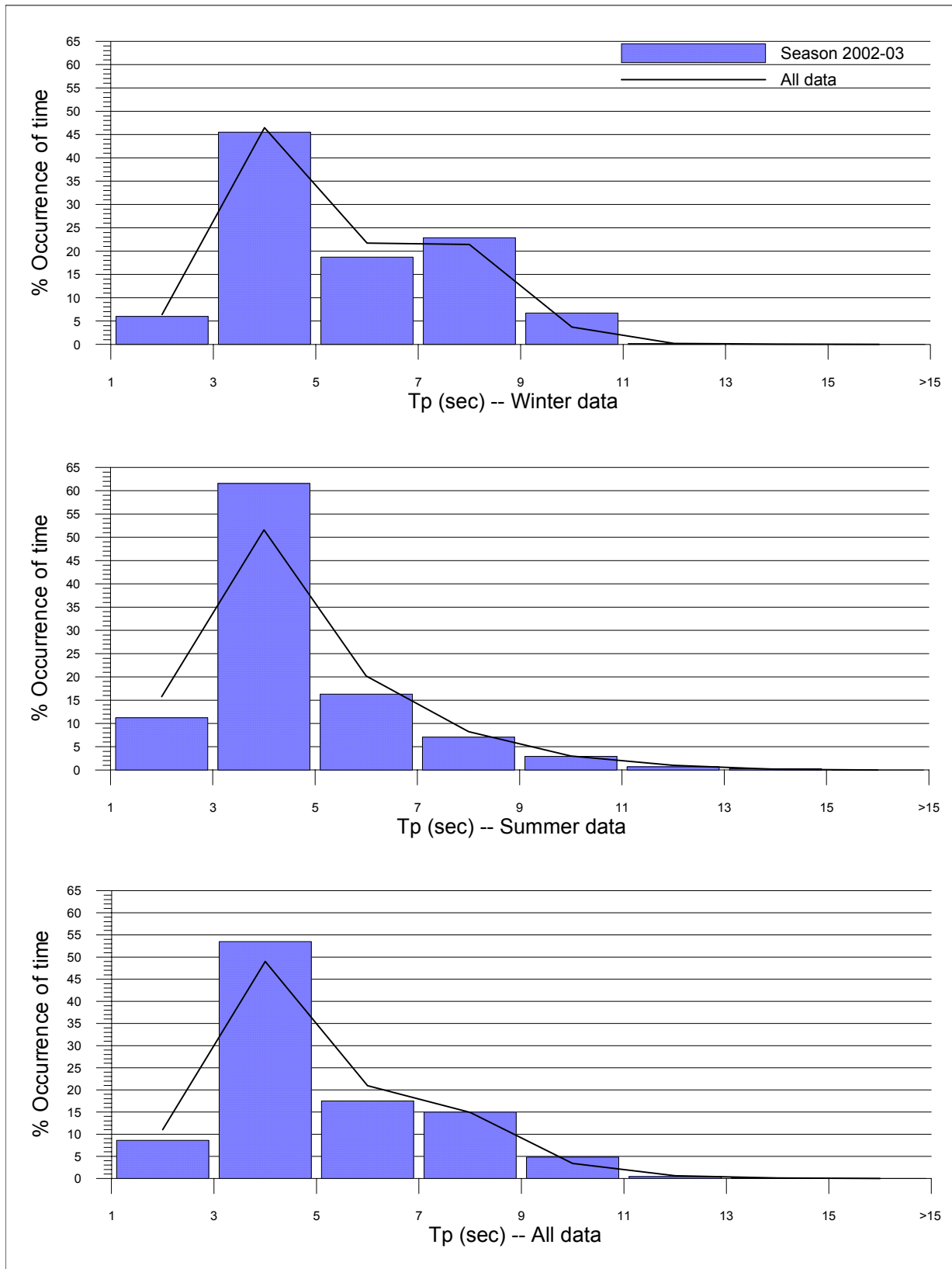


**Cairns region—Histogram percentage (of time) occurrence of wave heights (Hsig) for all wave periods (Tp)**



Wave data recording program  
Annual summary for season 2002-03

Figure 10.3



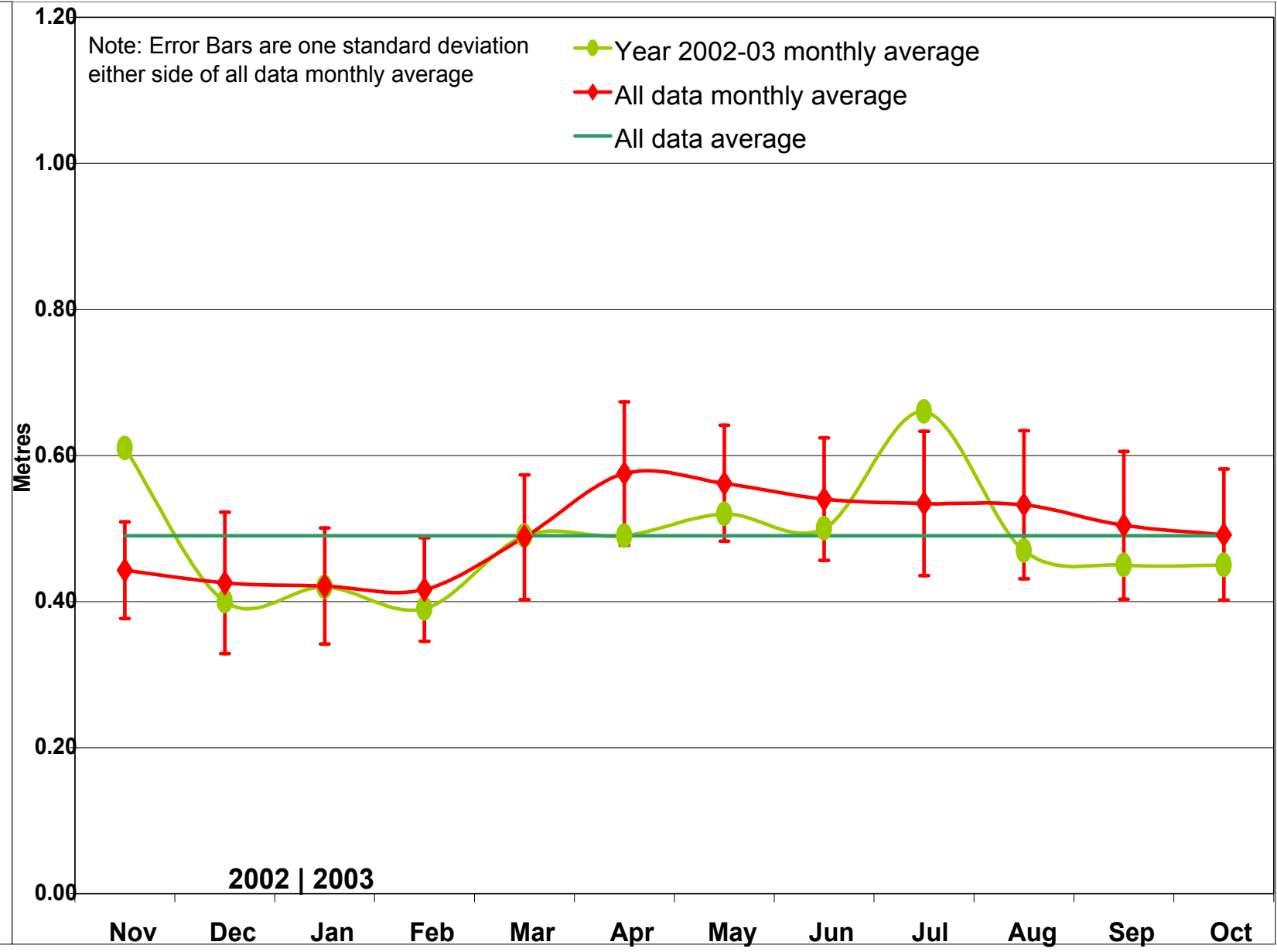
**Cairns region—Histogram percentage (of time) occurrence of wave periods (Tp) for all wave heights (Hsig)**



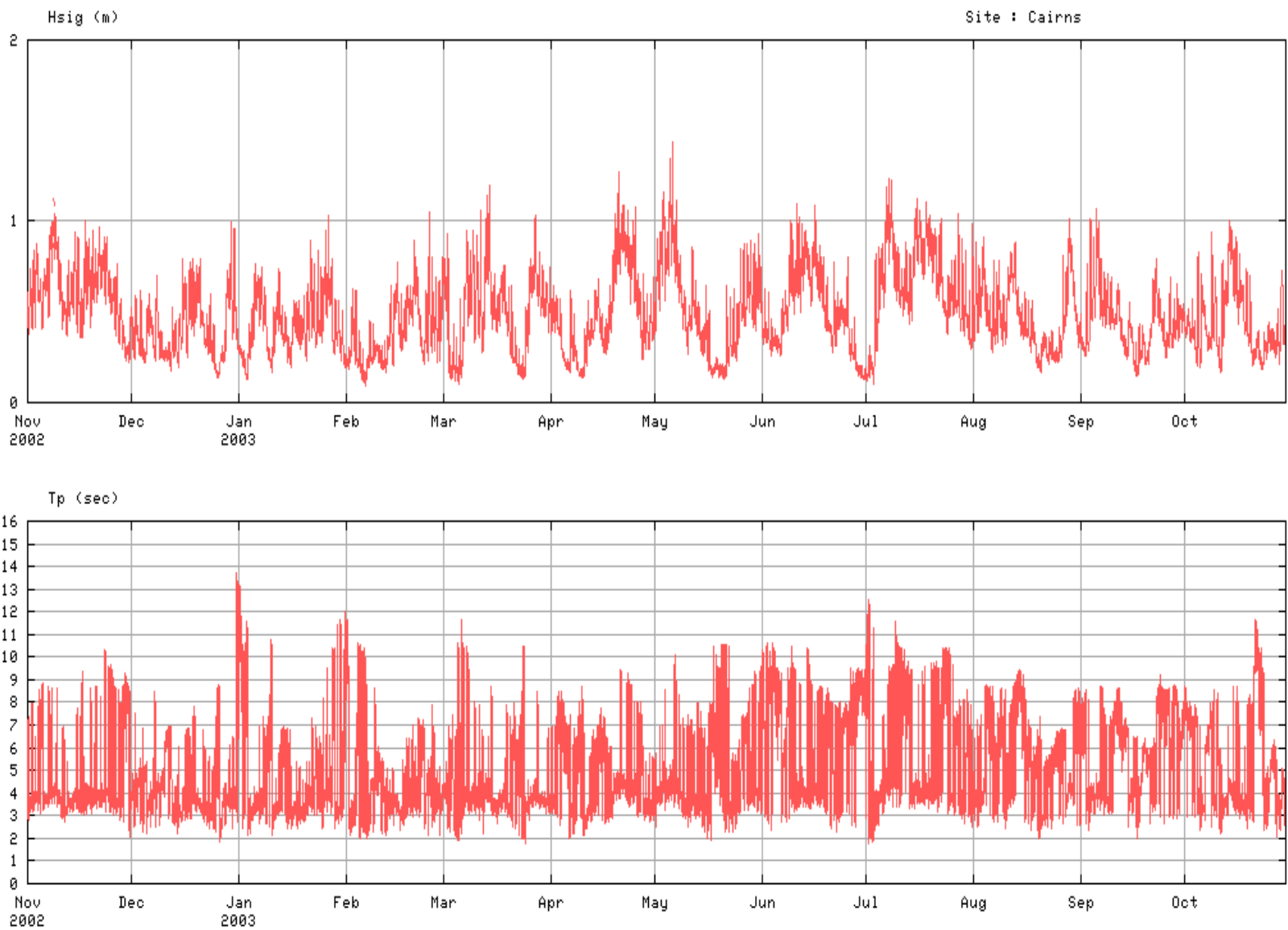
Wave data recording program  
Annual summary for season 2002-03

Figure 10.4

**Cairns region—Plot of monthly averages for seasonal year and for all data, for wave height (Hsig)**



Cairns region—Daily wave recordings



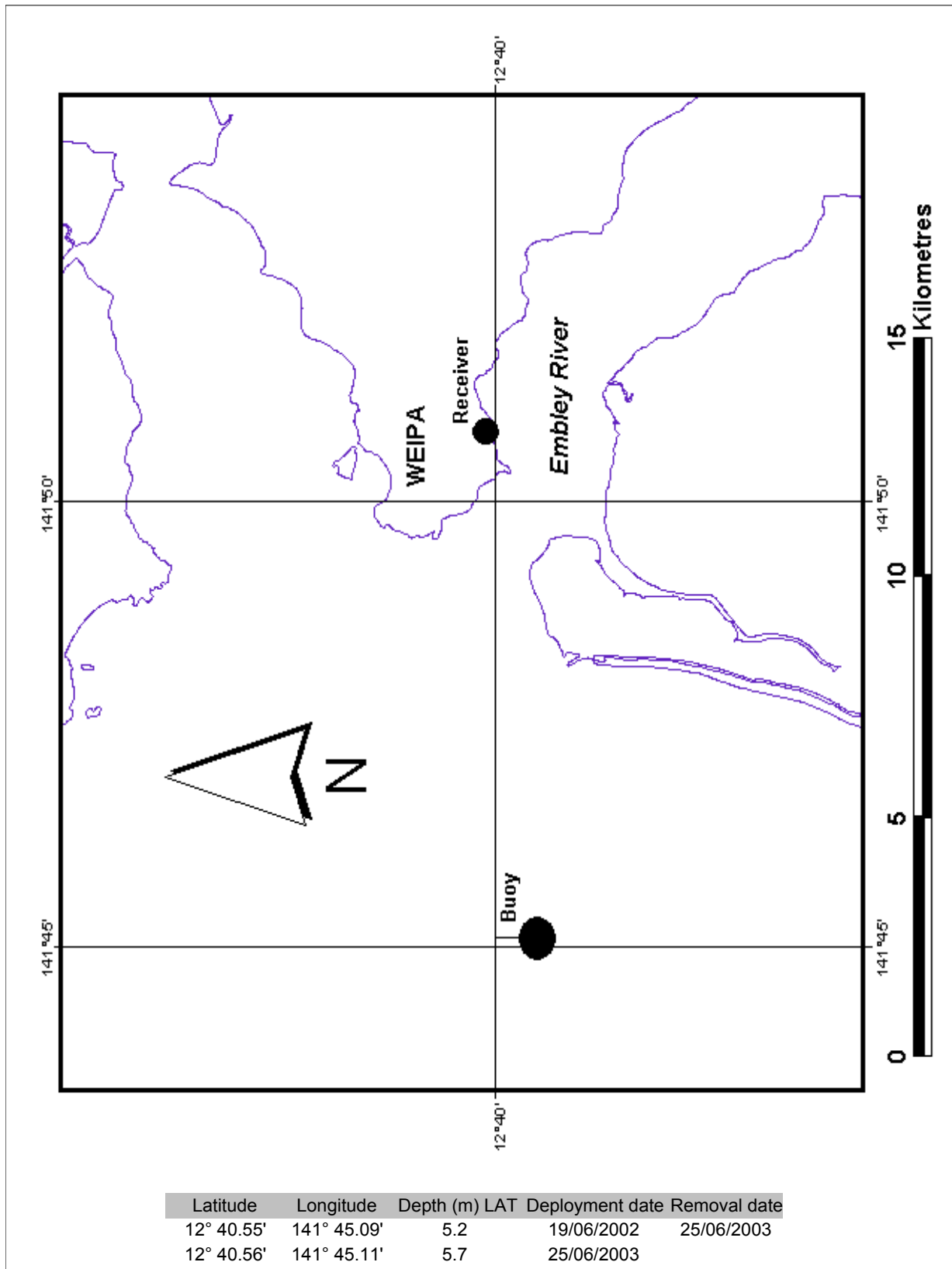
# Weipa

## Wave recording station

### Details of wave recorder station

Maximum Possible Analysis Days (Last record–First record)	=	365.000
Total Days Used in Analysis	=	350.856
Gaps in Data from Selected Dates (Days)	=	14.144
Gaps in Data from Analysed Records (Days)	=	14.144
Gaps in Data from Duration Analysis (Days)	=	14.144
Number of Records Used in Analysis	=	15369

HAT at nearest standard port: Weipa, 3.38m



### Weipa region—Locality plan

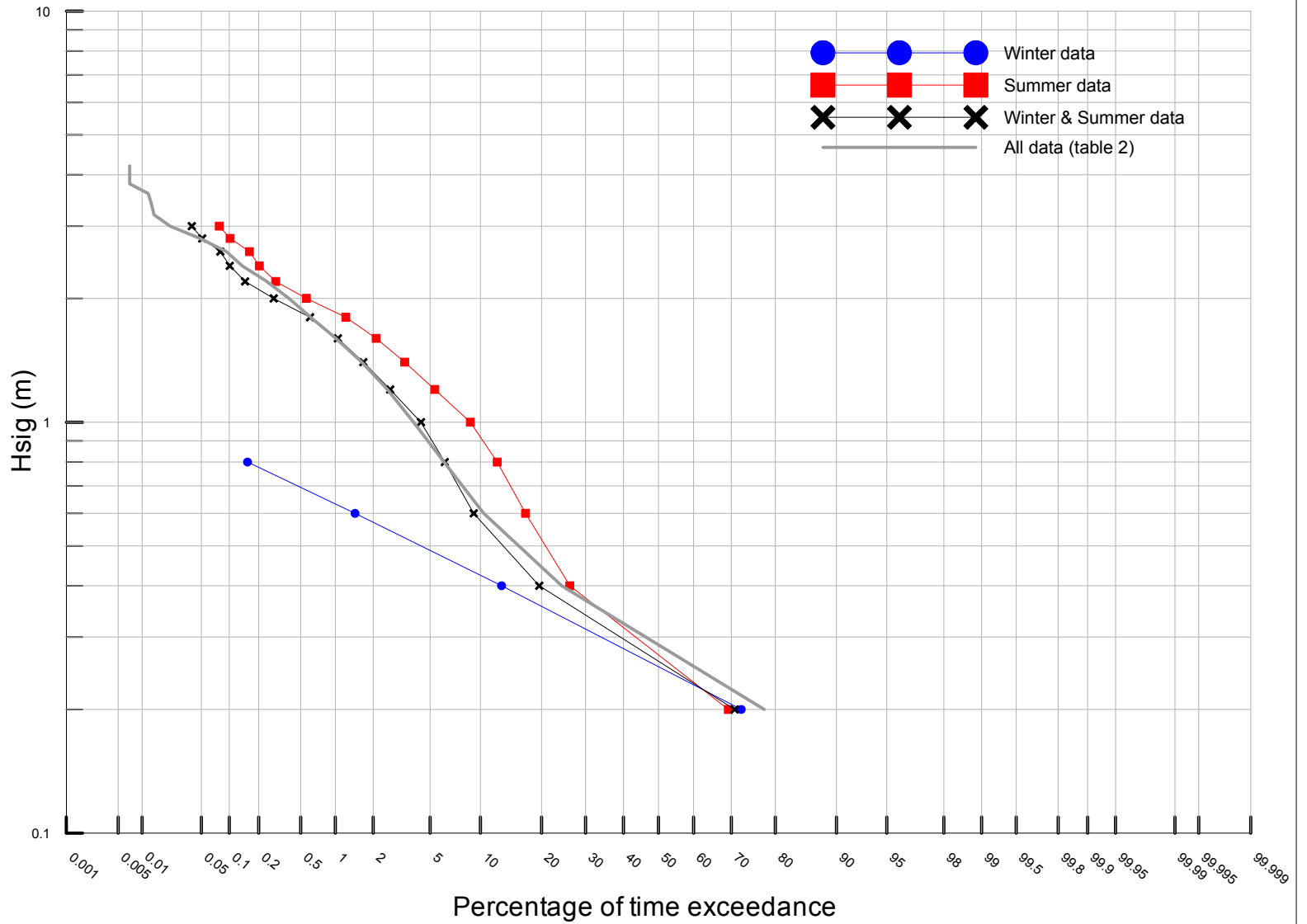


Wave data recording program  
Annual summary for season 2002-03

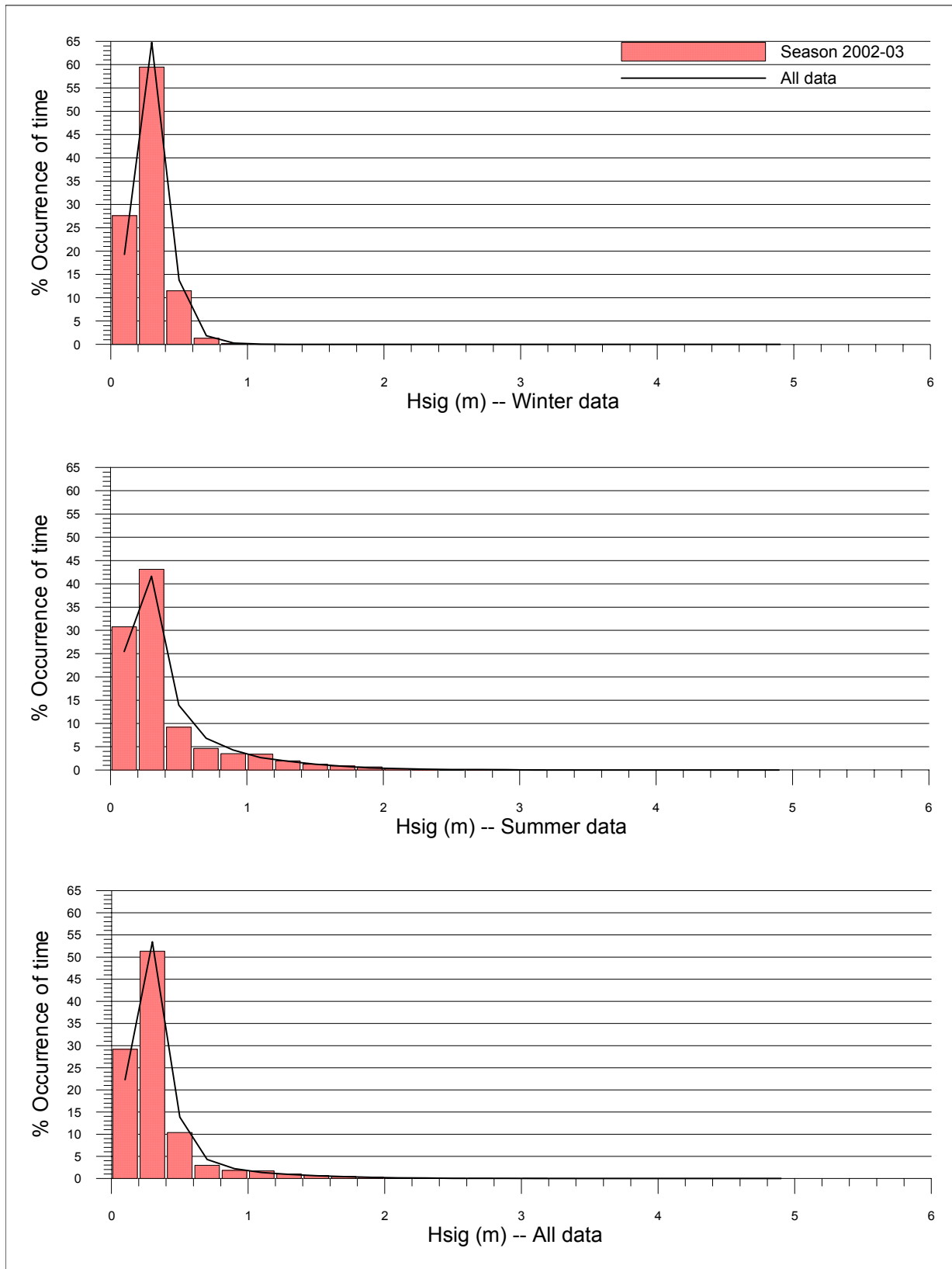
Figure 11.1



### Weipa region—Percentage (of time) exceedance of wave heights (Hsig) for all wave periods (Tp)





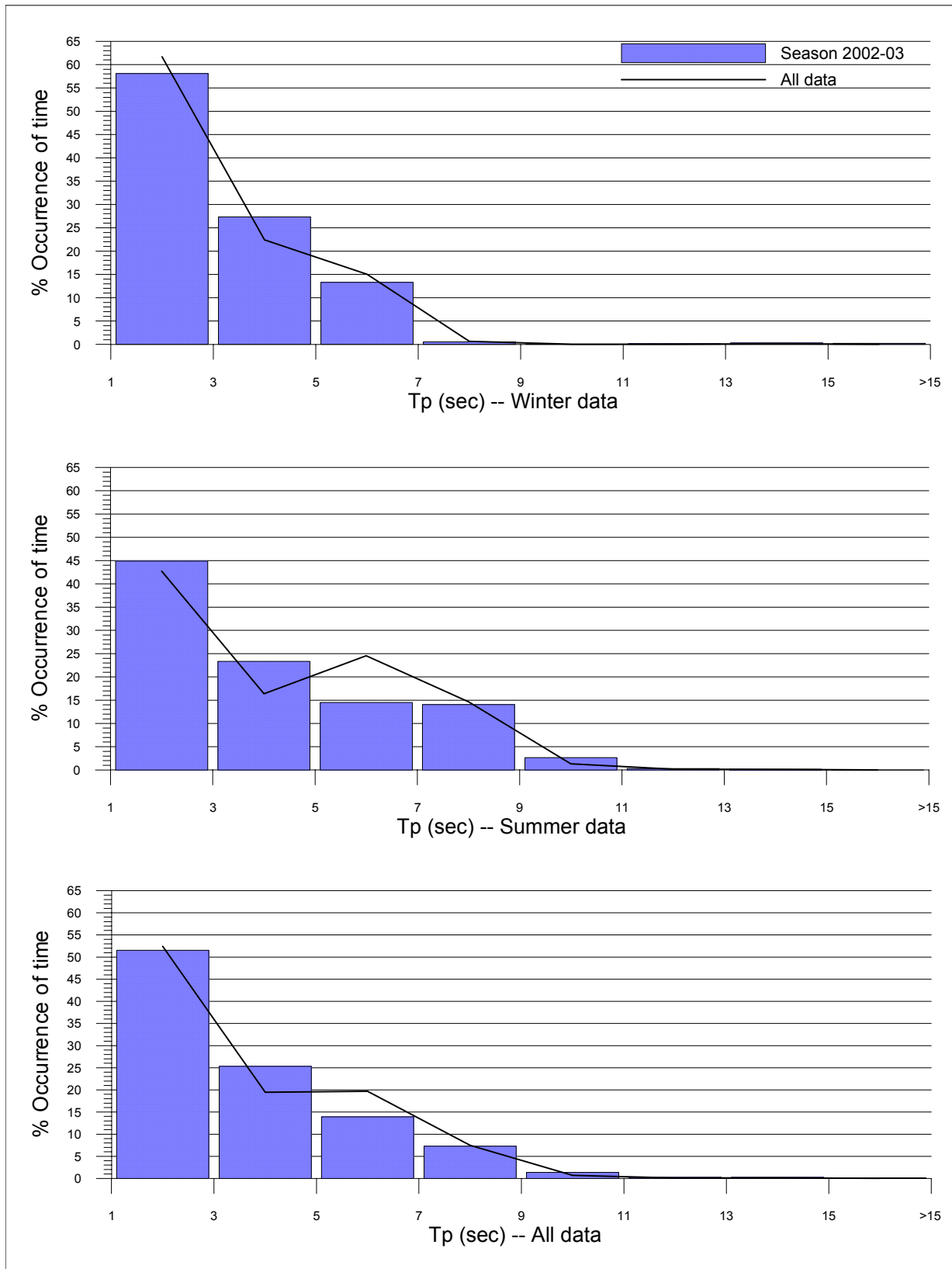


**Weipa region—Histogram percentage (of time) occurrence of wave heights (Hsig) for all wave periods (Tp)**



Wave data recording program  
Annual summary for season 2002-03

Figure 11.3



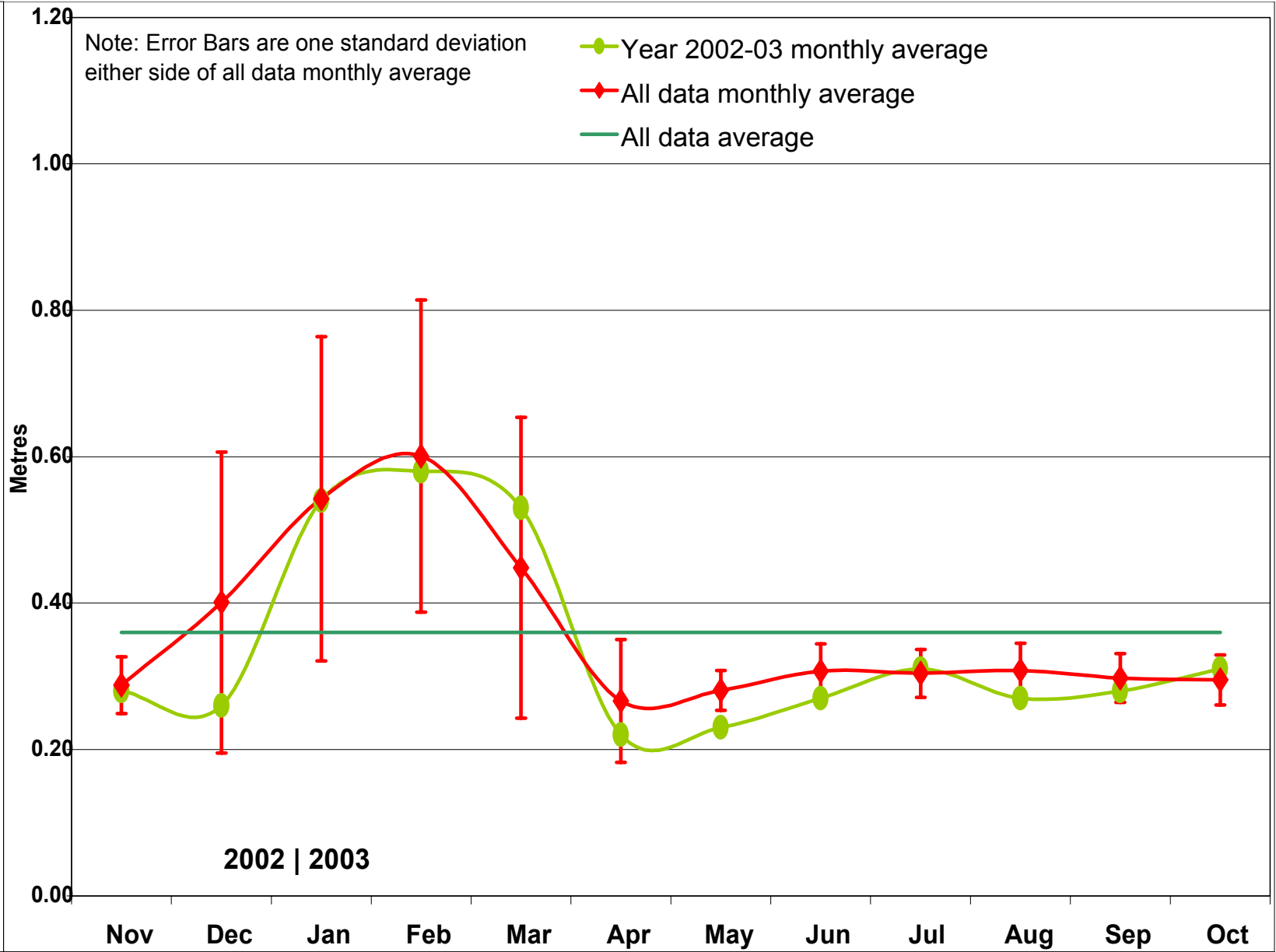
**Weipa region—Histogram percentage (of time) occurrence of wave periods (Tp) for all wave heights (Hsig)**



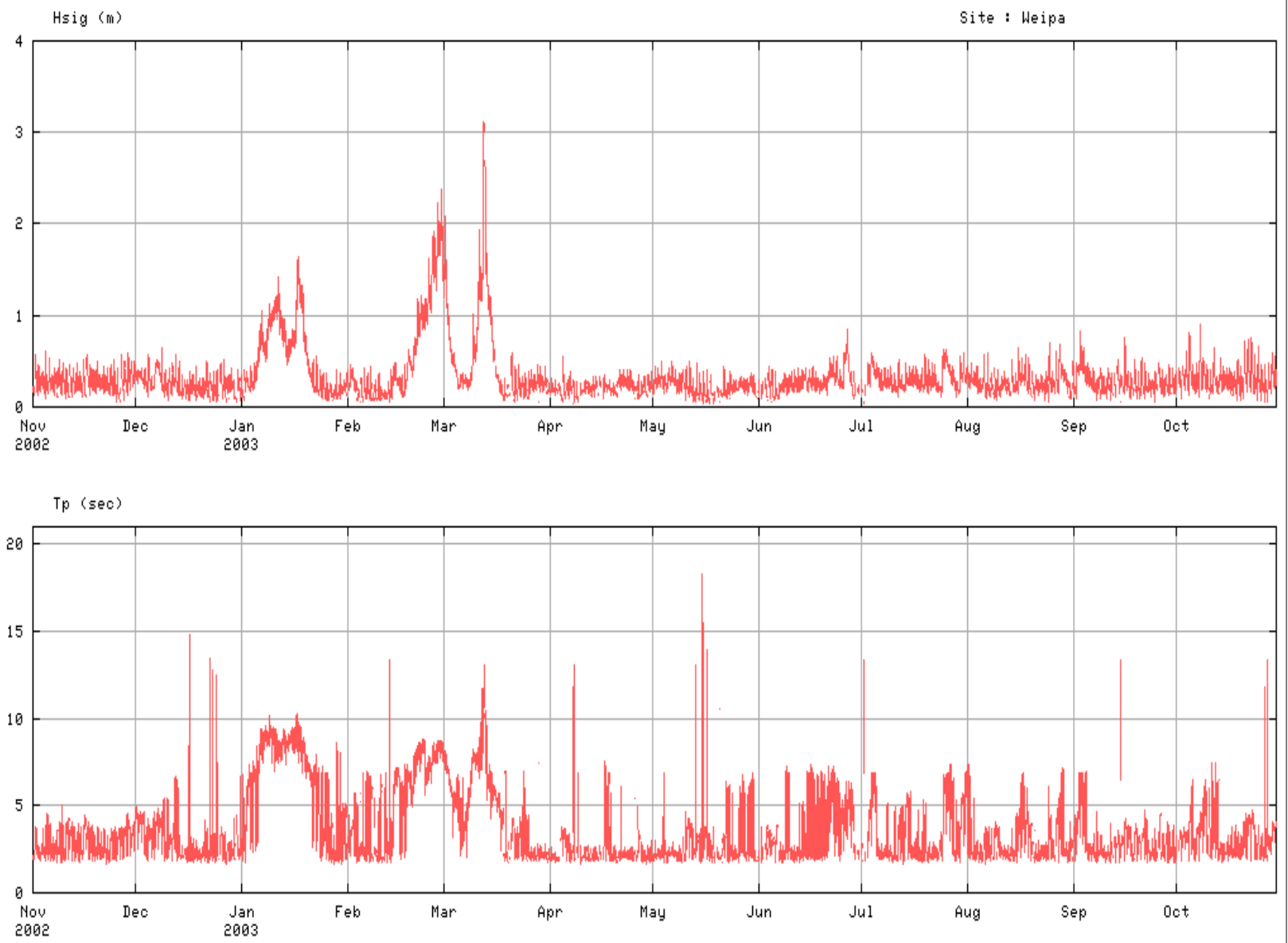
Wave data recording program  
Annual summary for season 2002-03

Figure 11.4

**Weipa region—Plot of monthly averages for seasonal year and for all data, for wave height (Hsig)**



**Weipa region—Daily wave recordings**



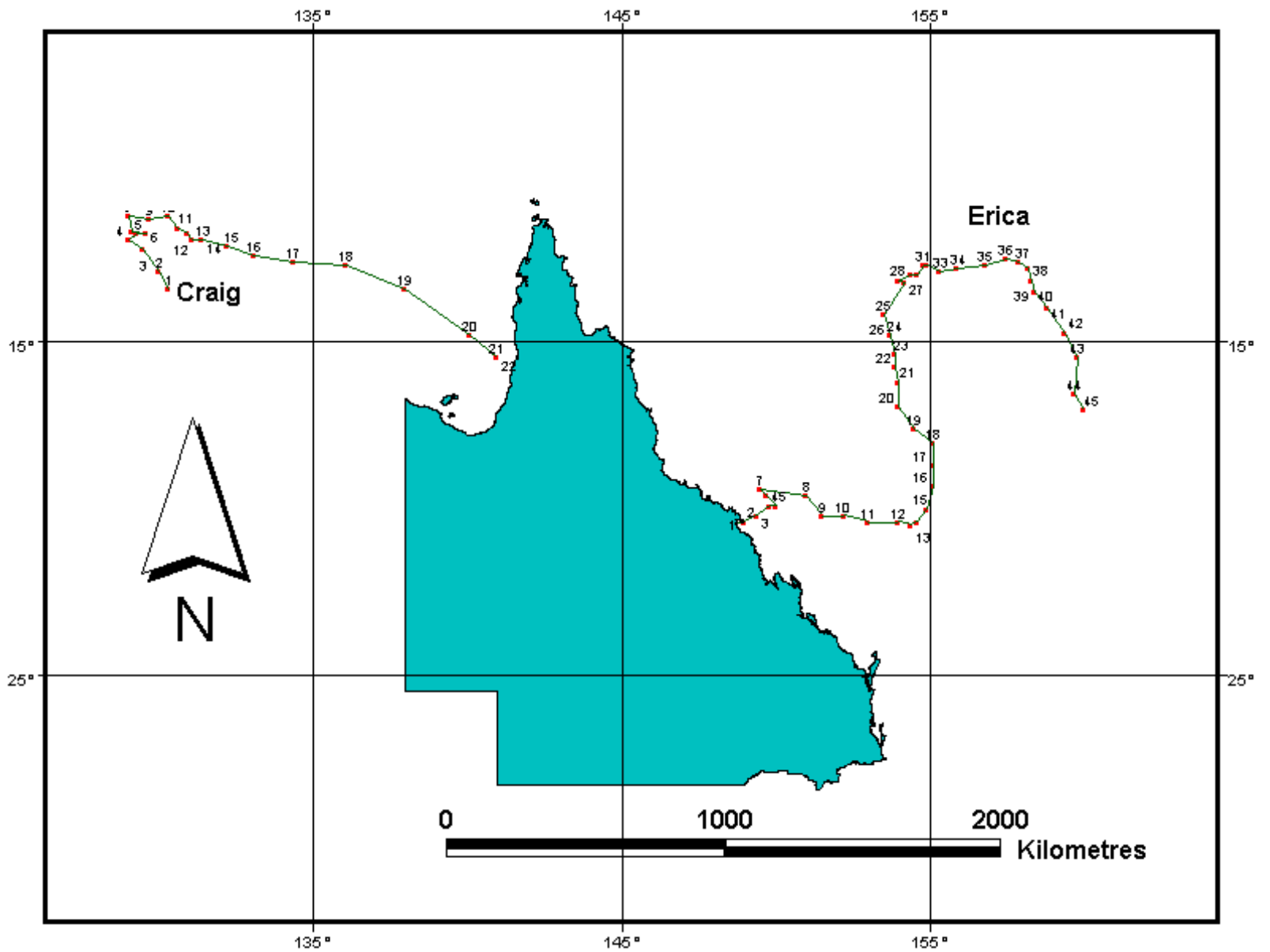


Queensland  
Government  
Environmental  
Protection Agency

Wave data recording program  
Annual summary for season 2002-03

Figure 12

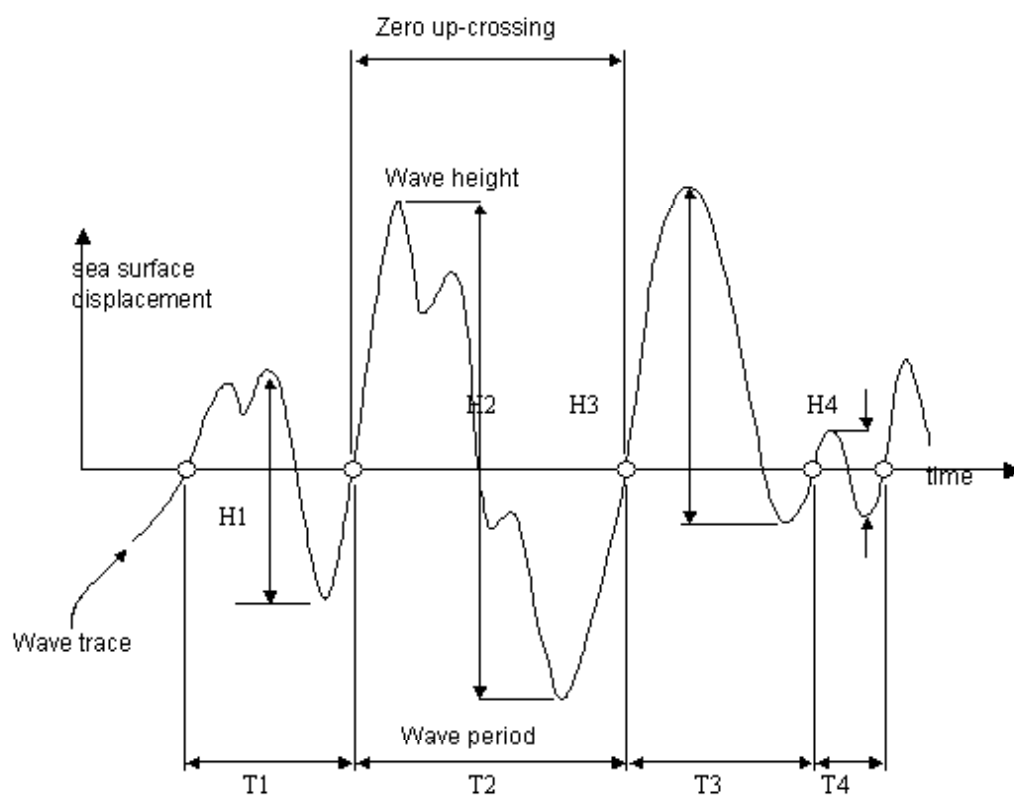
Cyclone tracks—Cyclone season 2002-03



## Zero crossing analysis

A direct, repeatable and widely accepted method to extract representative statistics from wave traces recorded by a Waverider buoy is the zero crossing method. For the zero upcrossing method, the method employed by the Agency, a wave is defined as the portion of the record between two successive zero upcrossings. The waves are ranked, with their corresponding periods, and statistical wave parameters computed.

An explanation of wave parameters is presented in the Glossary of terms.



## Zero up-crossing analysis

# Appendix A

## Glossary of terms

Wave parameter	Description
$H_s$	Significant wave height defined as average of highest $\frac{1}{3}$ of zero up-crossing wave heights
$TH_{sig}$	The average period of the highest $\frac{1}{3}$ of zero up-crossing wave heights
$H_{rms}$	Root mean square wave height from the time domain
$H_{max}$	The maximum zero up-crossing wave height in a record
$T_c$	The crest period
$T_z$	The zero crossing period from the time domain
$H_{10}$	Average of the highest 10percent of all waves in a record
$TH_{10}$	The period of the H10 waves
$TH_{max}$	Period of maximum height, zero up-crossing
$Tz_{max}$	The maximum zero crossing in a record
$H_{m0}$	Estimate of the significant wave height from frequency domain $4\sqrt{m_0}$
$T_{02}$	Average period from spectral moments zero and two, defined by $\sqrt{m_0 / m_2}$
$T_p$	Period at the peak spectral energy
$Dir_p$	Direction the Peak Period waves are coming from (in ° magnetic)