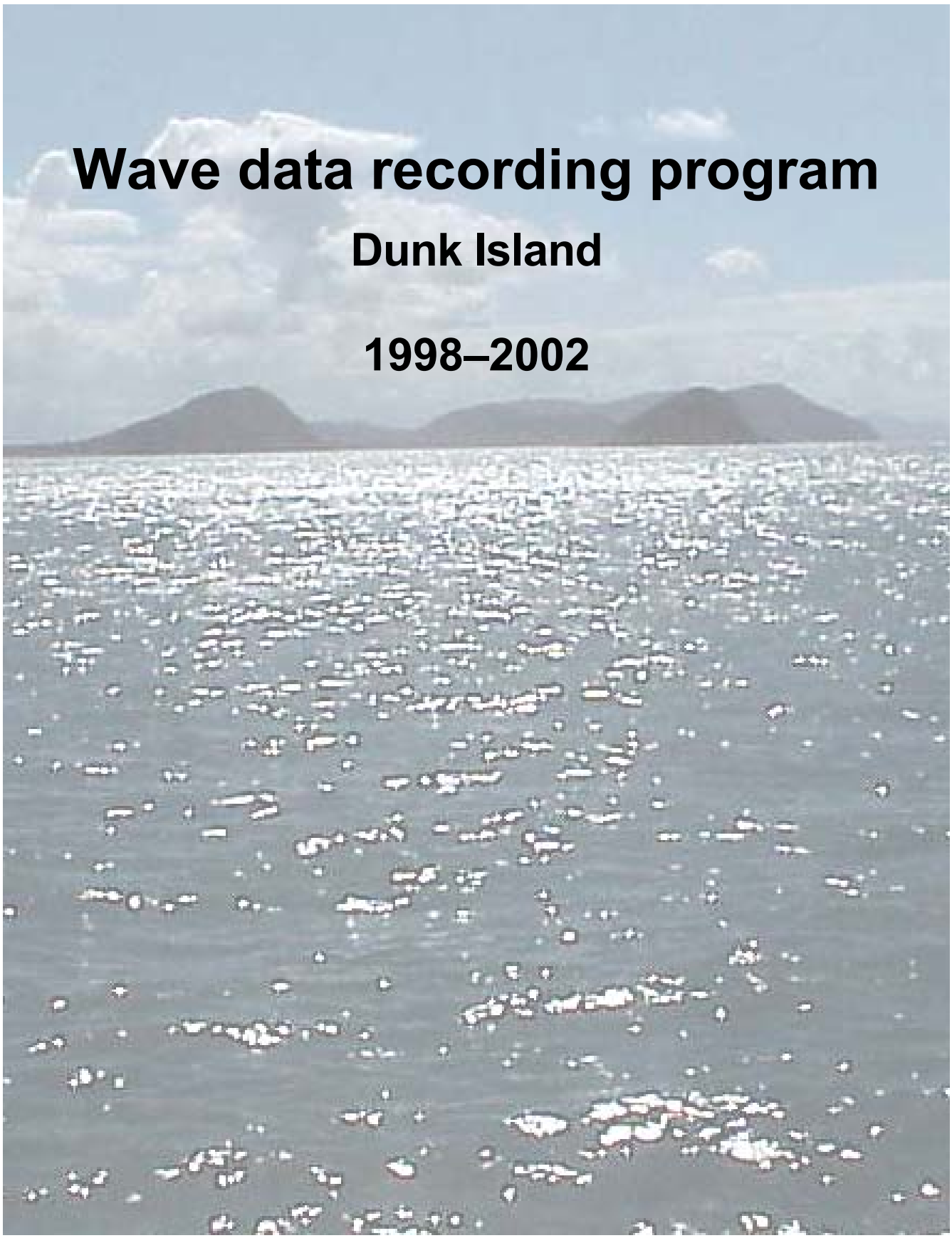
Wave data recording program

Dunk Island

1998–2002



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Abstract

This report provides summaries of primary analysis of wave data recorded in water depths of approximately 20m relative to lowest astronomical tide, 12.7km north of Dunk Island and 8km northeast of Clump Point in north Queensland. Data was recorded using a Datawell Waverider buoy, and covers the periods from 18 December 1998 to 12 November 2002. 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 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:

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Wave data recording program
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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. The Environmental Protection Agency accepts no responsibility for the use of this information in any way.

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Cover photo: View from the Dunk Island Waverider buoy location, looking north towards the Barnard Islands and the Queensland coastline (see figure 1).

Contents

Tables

Figures

Appendices

1.0 Introduction

The Coastal Services Unit, as part of its long-term data collection program, has maintained a network of wave recording stations along Queensland's coast since 1968. This report summarises the primary analysis of wave data collected at the Dunk Island station. In addition, brief details of the recording equipment, the methods of handling raw data and the type of analyses employed are provided. The Dunk Island wave recording station was commissioned as a project to study cyclonic wave conditions by the Environmental Protection Agency (EPA).

As an overview of the EPA's coverage of data recording along the Queensland coastline, the wave recording stations have been grouped into three categories and are shown below:

Permanent sites: These sites form part of long-term data collection activities along the Queensland coast that collect wave statistics used for coastal management purposes. The stations are fully funded and operated by the EPA

Project sites: These sites are of limited duration, associated with some specific coastal activity, and 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 Environmental Protection Agency 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 in conjunction with (and jointly funded by) other agencies.

The 2003 site groups are as follows:

Active wave recording stations–2003

Permanent	Project		Joint project	Joint project partners
Brisbane	Woorim		Tweed Heads	TRESBP♣
Mackay	Moreton Bay		Gold Coast Seaway	GCCC+
Townsville	Mooloolaba		Hay Point	PCQ #
Cairns			Weipa	PCQ #
Emu Park			Caloundra	PoBC♦

♣ Tweed River Entrance Sand Bypassing Project (joint project of Qld and NSW governments with support of GCCC)
+ Gold Coast City Council
# Ports Corporation of Queensland
♦ Port of Brisbane Corporation

2.0 Recording equipment configuration

The Coastal Services Unit's wave recording program utilises either of two systems to measure wave data: the Waverider buoy system or a wave pole. For the period covered by this summary report the Waverider system was utilised to measure the sea surface fluctuations at the Dunk Island site.

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. This data is twice integrated to give displacement. The instantaneous water level and directional data (if present) are transmitted to the shore recording station as a frequency-modulated high frequency radio signal. Both directional and non-directional buoys are in operation but only a non-directional buoy was used at Dunk Island.

The Dunk Island station was first installed on 18 December, 1998, and consisted of a shore station and Waverider buoy. The shore station used a personal computer (PC) system linked to the Datawell DIWAR Waverider receiver/digitiser. The changing water level was digitised at a rate of 0.39sec intervals (2.56Hz) and recorded in bursts of 4096 data points (approximately 26min of data). Each record was stored on the hard disk of the PC. Proprietary software running on the PC controlled the timing of the data recordings and

processed the data in 'near real time' to provide a set of standard sea-state parameters and spectra. Recorded data and analysis results were then accessed remotely via the public telephone network and downloaded daily to a central computer system in Brisbane for further checking, processing and archiving.

Further information on the operation of the Waverider buoy and the recording systems may be obtained from the sources listed in section 7.0 of this report.

3.0 Laboratory calibration checks

Waverider buoys used by the Coastal Services Unit are calibrated before deployment and also after recovery. Calibration is performed at the EPA's Deagon site using a buoy calibrator to simulate sinusoidal waves with amplitudes of either 1m or 1·4m depending on whether a 0·7m or 0·9m diameter buoy is being tested. The wheel is electrically controlled and the frequency may be varied from 0.016–0.25Hz. It is usual to check three frequencies during a calibration. The following characteristics of the buoy are also checked during the calibration procedure:

- phase and amplitude response;
- accelerometer platform stability;
- platform tilt;
- battery capacity;
- power output.

When the buoy was recovered from Dunk Island, laboratory calibration checks for accelerometer error and platform tilt were performed on the buoy. The results of these checks were within the manufacturer's specifications and so no adjustments to the recorded data were made.

4.0 Wave recording and analysis procedures

Between 18 December, 1998, and 14 November, 2002, wave data was recorded 24 times daily, each of 26min duration, with the timing of recordings set at hourly intervals (Australian Eastern Standard Time).

Recorded non-directional wave data is analysed in the time domain by the zero up-crossing method (see figure 9) and in the frequency domain by spectral analysis. Spectral analysis by the PC-based system uses Fast Fourier Transform techniques to give 128 spectral estimates in bands of 0.01Hz.

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

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

These parameters form the basis for the summary plots and tables attached to 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 data points being corrected by an interpolation procedure, otherwise the entire series is rejected. (Details of data losses for the Dunk Island wave recording station are included in section 9.0, *Details of wave recorder installations)*.

The wave climate data presented in this report is based on statistical analysis of the parameters obtained from the recorded wave data. Programs developed by the Coastal Services Unit provide statistical information on percentage of time occurrence and exceedance for wave heights and periods. The results of these analyses are presented in tables 4 to 9 and figures 4 and 5. In addition, similar analysis is carried out on the relationships between the various wave parameters and these are presented in figure 5.

The various sources of data loss can cause occasional gaps in the data record. Gaps may be relatively short, caused by rejection of individual data records, or much longer if caused by malfunction of the Waverider buoy or the recording equipment.

In the calculation of wave climate statistics, each record is assigned a total duration equal to half the recording interval on either side of that record. The duration on the side of records adjacent to gaps in the data is limited to a maximum value dependent on the nominal recording interval of that record. With the nominal recording interval set at one hour, the maximum allowable total duration of a record is three hours. Each duration 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 deepwater waves. Before any use is made of this data it is necessary to note the exact location of the buoy and the water depth in which the buoy was moored. This data is shown in section 9.0 – Details of the wave recorder installations. The non-directional Waverider recording system that is utilised by the Coastal Services Unit 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.

Table 2, *Queensland cyclones for 20 January, 1999 – 5 March, 2000*, lists the names and dates of cyclones that occurred along the eastern seaboard of Queensland during the recording period of this report.

Table 3, *Major meteorological events for 11 February, 1999 – 12 April, 2000*, provides a summary of meteorological events that occurred during the recording period of this report where the recorded Hsig value reached or exceeded one metre during the event. The wave parameters Hsig, Hmax, and Tp are listed for each event together with other relevant information.

Note that in figure 4, *Histogram percentage (of time) occurrence of wave periods (Tp) for all wave heights (Hsig)*, the bar columns begin at one second. This is because wave periods (Tp) for the Dunk Island site were rarely below two seconds and because the Waverider system will not measure a wave period if it is outside the range of 1.6 to 20sec.

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 Waverider — series 6000*.
Datawell, *Manual of the Digital Waverider Receiver type DIWAR*.
Lawson and Treloar Pty Ltd (1991), *Real Time Wave Analysis Package*.
Bureau of Meteorology, *Monthly Weather Reviews: Queensland*.

8.0 Other reports in this *Wave data recording program* series

Cairns Region	Report No. W01.1	2 May 1975 – 3 Sept 1978
Cairns Region	Report No. W01.2	2 May 1975 – 11 Jun 1985
Cairns Region	Report No. W01.3	2 May 1975 – 30 Apr 1997
Mackay Region	Report No. W02.1	17 Sept 1975 – 5 Nov 1976
Mackay Region	Report No. W02.2	17 Sept 1975 – 23 Aug 1985
Mackay Region	Report No. W02.3	17 Sept 1975 – 30 Oct 1996
Townsville Region	Report No. W03.1	16 July 1975 – 23 Feb 1979
Townsville Region	Report No. W03.2	19 Nov 1975 – 29 Dec 1987
Townsville Region	Report No. W03.3	19 Nov 1975 – 30 Apr 1997
Sunshine Coast Region	Report No. W04.1	5 Apr 1974 – 5 Jul 1977
Burnett Heads Region	Report No. W05.1	5 May 1976 – 5 Mar 1982
Burnett Heads Region	Report No. W05.2	5 May 1976 – 13 Oct 1988
Abbot Point Region	Report No. W06.1	6 May 1977 – 9 Aug 1979
Abbot Point Region	Report No. W06.2	6 May 1977 – 31 Oct 1996
Weipa Region	Report No. W07.1	21 Dec 1978 – 7 Apr 1983
Weipa Region	Report No. W07.2	21 Dec 1978 – 30 Apr 1997
Gladstone Region	Report No. W08.1	19 Dec 1979 – 16 May 1983
Brisbane Region	Report No. W09.1	30 Oct 1976 – 30 Jun 1983
Brisbane Region	Report No. W09.2	30 Oct 1976 – 30 Jun 1994
Brisbane Region	Report No. W09.3	30 Oct 1976 – 28 Feb 1997
Bowen Region	Report No. W10.1	14 Sept 1978 – 15 Nov 1984
Moreton Island Region	Report No. W11.1	15 Jun 1983 – 12 Apr 1985
Bramston Beach Region	Report No. W12.1	16 Dec 1981 – 28 Oct 1985
Hay Point Region	Report No. W13.1	22 Mar 1977 – 25 May 1987
Hay Point Region	Report No. W13.2	22 Mar 1977 – 31 Oct 1996
Gold Coast Region	Report No. W14.1	20 Feb 1987 – 30 Jun 1994
Gold Coast Region	Report No. W14.2	20 Feb 1987 – 28 Feb 1997
Kirra	Report No. W15.1	25 Aug 1988 – 30 Jun 1994
Kirra	Report No. W15.2	25 Aug 1988 – 28 Feb 1997
Repulse Bay	Report No. W16.1	2 Jun 1994 – 22 Oct 1995
Hayman Island	Report No. W17.1	26 Oct 1995 – 14 Oct 1996
Tweed Region	Report No. W18.1	15 Jan 1995 – 28 Feb 1997
Lucinda Region	Report No. W19.1	28 Feb 1995 – 16 May 1996
Annual summary for season 2000–01	Report No. 2004.3	1 Nov 2000 – 31 Oct 2001
Annual summary for season 2001–02	Report No. 2004.4	1 Nov 2001 – 31 Oct 2002
Annual summary for season 2002–03	Report No. 2004.1	1 Nov 2002 – 31 Oct 2003

9.0 Details of wave recorder installations

Dunk Island

Buoy locations:

See figure 1 for the representative location of the Waverider buoy for the period of this report.

Location 1

Co-ordinates:	146° 11.06' East, 17° 52.21' South
Water depth at buoy:	20.0m relative to Lowest Astronomical Tide
Periods:	17 December, 1998 – 1 July, 1999

Location 2

Co-ordinates:	146° 11.08' East, 17° 52.15' South
Water depth at buoy:	19.3m relative to Lowest Astronomical Tide
Periods:	1 July, 1999 –18 September, 2000

Location 3

Co-ordinates:	146° 11.13' East, 17° 49.09' South
Water depth at buoy:	20.0m relative to Lowest Astronomical Tide
Periods:	14 November, 2000 – 12 November, 2002

Note: – The above buoy location was measured using GPS fixing procedures.
– All water depths are accurate to ±1m.

Location of recording stations:

Queensland Parks and Wildlife Service Ranger Residence, Ninny Rise Mission Beach
Co-ordinates: 146^{o} 05.94' East, 17^{o} 49.77' South
Period: 17 December, 1998 – 12 November, 2002

Recording intervals:

Hourly records, each of approximately 26min were taken, giving 4096 water surface elevation measurements per record, from which sea state parameters were calculated and recorded.

Normally during periods when the recorded Hsig value reaches the storm threshold of 2m, the recording frequency would be increased to 30min intervals. However, the protected nature of the Dunk Island site, due to the Great Barrier Reef and surrounding islands near the buoy deployment area, meant that the buoy seldom received storm threshold wave heights, even in the presence of tropical cyclone events.

Data collection and analysis:

Number of records collected:	40,005
Number of records used in analysis:	40,005
Number of days in recording period:	1425.978
Number of days used in analysis:	1077.73
Number of days lost:	348.252

Table 1
Dunk Island wave climate summary of data capture December 1998 – November 2002.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	—	—	—	—	—	—	—	—	—	—	—	97.97*
1999	99.33	99.30	30.49	0.00	0.00	0.00	0.00	45.30	99.59	99.87	99.44	98.93
2000	99.60	98.27	20.94	0.00	62.67	100.0	99.73	99.19	56.81	0.00	30.56	74.13
2001	99.73	99.19	56.81	0.00	30.56	74.13	100.0	97.18	99.86	35.28	84.93	98.39
2002	98.79	98.52	97.52	94.45	83.15	96.04	94.49	96.98	54.72	72.24	37.01*	—

* **part month**

Table 2
Queensland cyclones 20 January, 1999–5 March, 2002

Cyclone name	Start date	End date	Affecting Dunk Island site
Olinda	20/01/1999	21/01/1999	No
Pete	21/01/1999	23/01/1999	No
Rona	09/02/1999	12/02/1999	Yes
Frank	16/02/1999	18/02/1999	No
Steve	25/02/2000	11/03/2000	Yes
Tessi	31/03/2000	03/04/2000	Site not operating
Vaughan	28/03/2000	07/04/2000	Site not operating
Wylva	14/02/2001	16/02/2001	No
Abigail	23/02/2001	26/02/2001	Yes
Bernie	30/12/2001	06/01/2002	No
Claudia	10/02/2002	12/02/2002	Yes
Des	03/03/2002	05/03/2002	Yes

Cyclone tracks are shown in figure 8.

Table 3
Major meteorological events 11 February, 1999–12 April, 2002

Meteorological event	Central pressure (hPa)	Date	Estimated position of event relative to buoy (km)	Maximum Hsig recorded (m) (Note 1)	Maximum Hmax recorded (m) (Note 2)	Tp (s) (Note 3)
Tropical cyclone Rona.	996	11/02/1999	140 NE	**2.91 (3.06)**	**5.12**	7.08
High in the Tasman Sea.	1032	27/11/1999		1.51 (1.64)	2.66 (2.99)	5.83
High over South Australian Basin into Tasman Sea.	1028	24/12/1999		2.11 (2.24)	3.75	6.14
High in the Tasman Sea.	1024	03/02/2000		1.71	2.85	5.46
High in the Tasman Sea.	1024	05/02/2000		1.73 (1.88)	3.13 (3.33)	5.81
High in the Tasman Sea.	1028	08/02/2000		1.84 (2.01)	3.24 (3.56)	5.71
Tropical cyclone Steve	985	27/02/2000	180 SSE	2.04	3.50	5.78
Tropical cyclone Tessie (Buoy not installed, potentially significant event).	**	1–3/4/2000	**	**	**	**
Tropical cyclone Vaughan (Buoy not installed, potentially significant event).	**	4–6/4/2000	**	**	**	**
High over southern coast of Australia.	1032	18/05/2000		1.98	3.28	5.99
High across NSW and Great Aust. Bight.	1028	08/06/2000		1.54	2.56	5.47
High over Victoria.	1040	13/06/2000		1.96	3.46	6.16
High in Tasman Sea and monsoon trough in Torres Strait.	1024	05/12/2000		1.76 (1.82)	2.91 (3.23)	5.69
High in Tasman Sea, extending ridge along east coast. Also low in Coral Sea on active monsoon trough.	1026/1004	04/01/2001		1.67	3.09	5.73
High in Tasman Sea and monsoon trough in Coral Sea.	1022	08/02/2001		1.81 (1.94)	3.31	5.81
High in Tasman Sea, extending ridge along east coast. Also low in Coral Sea on active monsoon trough.	1021/996	10/02/2001		1.52	2.74	5.52
High over Tasmania and low in Coral Sea on active monsoon trough.	1024/996	17/02/2001		1.94 (2.16)	3.58	6.14
Tropical cyclone Abigail	992	24/02/2001	150 ENE	1.81 (1.92)	3.22	6.01
High in Tasman Sea combined with low off New Caledonia.	1028/1006	30/03/2001		2.05 (2.15)	3.45	6.22
High over Victoria and formation of Tropical cyclone Sose in New Hebrides area.	1024/1003	05/04/2001	2250 E	1.54	2.77	5.40
High over New South Wales combined with low off New Zealand.	1030/992	13/04/2001		1.75	3.29	5.88
High on New South Wales coast and high off New Zealand producing onshore air flow.	1032/1033	04/06/2001		1.54	2.89	5.51
High in Great Australian Bight extending firm ridge over New South Wales and southern Queensland coasts. Low off New Caledonia.	1030/1002	14/03/2002		1.45 (1.65)	2.62	5.76
High in Tasman Sea with a firm ridge along the Queensland coast.	1030	23/03/2002		1.51	2.56	6.24
High moving slowly east across Tasman Sea and tropical low in northern Coral Sea.	1030/1006	02/04/2002		1.53 (1.65)	2.86 (3.16)	5.35
Complex high pressure system over New Zealand and monsoon trough over top end.	1035	12/04/2002		1.51	2.58	5.22

Notes: **1 & 2.** The Hsig and Hmax values are the maximums recorded for each event and are not necessarily coincident in time.

1 & 3. The Tp and Hsig values are coincident as a single event for the date shown.

Highest significant wave height (Hsig) recorded was 2.91m (3.06m), recorded on 11/02/1999 during passage of TC Rona.

Highest maximum wave height (Hmax) recorded was 5.12m, recorded on 11/02/1999 during passage of TC Rona.

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 Hind cast and Measured Wave Heights", J. *Waterway, Port, Costal 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 4
Wave statistics
Wave period/wave height occurrences
All data, all directions

* = 0.00
(Table values are number of days for the recording period, rounded to the second decimal place)

Significant wave height (Hsig) (m)	**Peak Energy Wave Period (Tp) (s)**								
	0–2.99	3–4.99	5–6.99	7–8.99	9–10.99	11–12.99	13–14.99	>14.99	Totals
0.00 –0.19	86.45	60.17	46.15	22.97	5.81	0.92	0.42	*	222.89
0.20 –0.39	108.67	150.69	49.70	18.92	1.02	0.08	0.04	*	329.12
0.40 –0.59	8.20	131.38	26.21	2.48	0.21	*	*	*	168.47
0.60 –0.79	0.15	108.45	19.39	0.04	0.04	*	*	*	128.07
0.80 –0.99	0.24	79.41	15.76	0.25	*	*	*	*	95.66
1.00 –1.19	*	42.61	23.32	0.13	*	*	*	*	66.06
1.20 –1.39	*	13.02	27.36	0.04	*	*	*	*	40.42
1.40 –1.59	*	1.42	15.08	*	*	*	*	*	16.50
1.60 –1.79	*	0.06	5.60	0.04	*	*	*	*	5.71
1.80 –1.99	*	*	2.17	*	*	*	*	*	2.17
2.00 –2.19	*	*	1.38	*	*	*	*	*	1.38
2.20 –2.39	*	*	0.44	0.04	*	*	*	*	0.48
2.40 –2.59	*	*	0.19	0.04	*	*	*	*	0.23
2.60 –2.79	*	*	0.25	0.06	*	*	*	*	0.31
2.80 –2.99	*	*	0.10	0.13	*	*	*	*	0.23
3.00 –3.19	*	*	0.04	*	*	*	*	*	0.04
3.20 –3.39	*	*	*	*	*	*	*	*	0.00
Totals	203.70	587.21	233.13	45.13	7.08	1.00	0.46	0.00	1077.73

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

* = 0.00
(Table values are number of days for the recording period, rounded to the second decimal place)

Significant wave height (Hsig) (m)	**Peak Energy Wave Period (Tp) (s)**								
	0–2.99	3–4.99	5–6.99	7–8.99	9–10.99	11–12.99	13–14.99	>14.99	Totals
0.00 –0.19	34.23	26.54	24.20	9.75	3.08	0.81	0.31	*	98.93
0.20 –0.39	62.83	69.04	25.31	7.45	0.31	0.08	0.04	*	165.07
0.40 –0.59	5.65	69.73	14.80	0.90	*	*	*	*	91.07
0.60 –0.79	0.15	54.89	8.59	*	0.04	*	*	*	63.67
0.80 –0.99	0.24	36.90	6.78	0.25	*	*	*	*	44.17
1.00 –1.19	*	22.66	11.68	0.08	*	*	*	*	34.42
1.20 –1.39	*	8.79	15.30	0.04	*	*	*	*	24.13
1.40 –1.59	*	1.13	10.08	*	*	*	*	*	11.21
1.60 –1.79	*	0.06	4.37	0.04	*	*	*	*	4.48
1.80 –1.99	*	*	1.65	*	*	*	*	*	1.65
2.00 –2.19	*	*	1.23	*	*	*	*	*	1.23
2.20 –2.39	*	*	0.44	0.04	*	*	*	*	0.48
2.40 –2.59	*	*	0.19	0.04	*	*	*	*	0.23
2.60 –2.79	*	*	0.25	0.06	*	*	*	*	0.31
2.80 –2.99	*	*	0.10	0.13	*	*	*	*	0.23
3.00 –3.19	*	*	0.04	*	*	*	*	*	0.04
3.20 –3.39	*	*	*	*	*	*	*	*	0.00
Totals	103.10	289.73	125.03	18.78	3.44	0.90	0.35	0.00	541.33

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

* = 0.00
(Table values are number of days for the recording period, rounded to the second decimal place)

Significant wave height (Hsig) (m)	Peak Energy Wave Period (Tp) (s)								
	0–2.99	3–4.99	5–6.99	7–8.99	9–10.99	11–12.99	13–14.99	>14.99	Totals
0.00 –0.19	52.22	33.63	21.95	13.22	2.73	0.10	0.10	*	123.96
0.20 –0.39	45.84	81.65	24.38	11.47	0.71	*	*	*	164.05
0.40 –0.59	2.55	61.65	11.41	1.58	0.21	*	*	*	77.40
0.60 –0.79	*	53.56	10.79	0.04	*	*	*	*	64.40
0.80 –0.99	*	42.51	8.98	*	*	*	*	*	51.49
1.00 –1.19	*	19.96	11.63	0.04	*	*	*	*	31.63
1.20 –1.39	*	4.23	12.06	*	*	*	*	*	16.29
1.40 –1.59	*	0.29	5.00	*	*	*	*	*	5.29
1.60 –1.79	*	*	1.23	*	*	*	*	*	1.23
1.80 –1.99	*	*	0.52	*	*	*	*	*	0.52
2.00 –2.19	*	*	0.15	*	*	*	*	*	0.15
2.20 –2.39	*	*	*	*	*	*	*	*	0.00
2.40 –2.59	*	*	*	*	*	*	*	*	0.00
2.60 –2.79	*	*	*	*	*	*	*	*	0.00
2.80 –2.99	*	*	*	*	*	*	*	*	0.00
3.00 –3.19	*	*	*	*	*	*	*	*	0.00
3.20 –3.39	*	*	*	*	*	*	*	*	0.00
Totals	100.61	297.48	108.10	26.35	3.65	0.10	0.10	0.00	536.40

Table 7
Wave statistics
Wave period/wave height occurrences
All data, all directions

* = 0.00
(Table values are percentage occurrences for the recording period, rounded to the second decimal place)

Significant wave height (Hsig) (m)	Peak energy wave period (Tp) (s)								
	0–2.99	3–4.99	5–6.99	7–8.99	9–10.99	11–12.99	13–14.99	>14.99	Totals
0.00 –0.19	8.02	5.58	4.28	2.13	0.54	0.09	0.04	*	20.68
0.20 –0.39	10.08	13.98	4.61	1.76	0.09	0.01	*	*	30.54
0.40 –0.59	0.76	12.19	2.43	0.23	0.02	*	*	*	15.63
0.60 –0.79	0.01	10.06	1.80	*	*	*	*	*	11.88
0.80 –0.99	0.02	7.37	1.46	0.02	*	*	*	*	8.88
1.00 –1.19	*	3.95	2.16	0.01	*	*	*	*	6.13
1.20 –1.39	*	1.21	2.54	*	*	*	*	*	3.75
1.40 –1.59	*	0.13	1.40	*	*	*	*	*	1.53
1.60 –1.79	*	0.01	0.52	*	*	*	*	*	0.53
1.80 –1.99	*	*	0.20	*	*	*	*	*	0.20
2.00 –2.19	*	*	0.13	*	*	*	*	*	0.13
2.20 –2.39	*	*	0.04	*	*	*	*	*	0.04
2.40 –2.59	*	*	0.02	*	*	*	*	*	0.02
2.60 –2.79	*	*	0.02	0.01	*	*	*	*	0.03
2.80 –2.99	*	*	0.01	0.01	*	*	*	*	0.02
3.00 –3.19	*	*	*	*	*	*	*	*	0.00
3.20 –3.39	*	*	*	*	*	*	*	*	0.00
Totals	18.90	54.49	21.63	4.19	0.66	0.09	0.04	0.00	100.00

Table 8
Wave Statistics
Wave period/wave height occurrences
Summer data, all directions

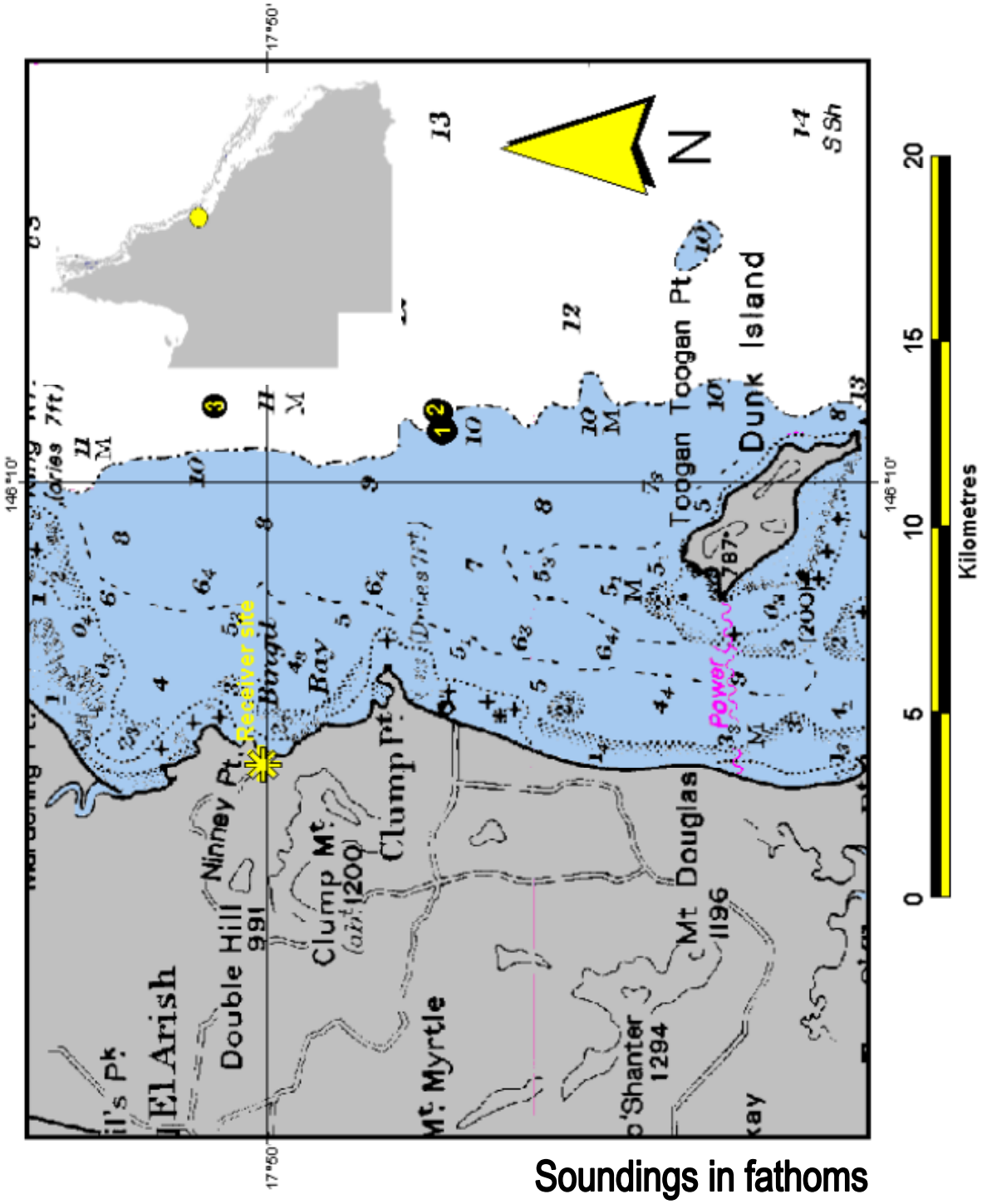
* = 0.00
(Table values are percentage occurrences for the recording period, rounded to the second decimal place)

Significant wave height (Hsig) (m)	Peak energy wave period (Tp) (s)								
	0–2.99	3–4.99	5–6.99	7–8.99	9–10.99	11–12.99	13–14.99	>14.99	Totals
0.00 –0.19	6.32	4.90	4.47	1.80	0.57	0.15	0.06	*	18.28
0.20 –0.39	11.61	12.75	4.68	1.38	0.06	0.02	0.01	*	30.49
0.40 –0.59	1.04	12.88	2.73	0.17	*	*	*	*	16.82
0.60 –0.79	0.03	10.14	1.59	*	0.01	*	*	*	11.76
0.80 –0.99	0.04	6.82	1.25	0.05	*	*	*	*	8.16
1.00 –1.19	*	4.19	2.16	0.02	*	*	*	*	6.36
1.20 –1.39	*	1.62	2.83	0.01	*	*	*	*	4.46
1.40 –1.59	*	0.21	1.86	*	*	*	*	*	2.07
1.60 –1.79	*	0.01	0.81	0.01	*	*	*	*	0.83
1.80 –1.99	*	*	0.30	*	*	*	*	*	0.30
2.00 –2.19	*	*	0.23	*	*	*	*	*	0.23
2.20 –2.39	*	*	0.08	0.01	*	*	*	*	0.09
2.40 –2.59	*	*	0.03	0.01	*	*	*	*	0.04
2.60 –2.79	*	*	0.05	0.01	*	*	*	*	0.06
2.80 –2.99	*	*	0.02	0.02	*	*	*	*	0.04
3.00 –3.19	*	*	0.01	*	*	*	*	*	0.01
3.20 –3.39	*	*	*	*	*	*	*	*	0.00
Totals	19.05	53.52	23.10	3.47	0.64	0.17	0.07	0.00	100.00

Table 9
Wave statistics
Wave period/wave height occurrences
Winter data, all directions

* = 0.00
(Table values are percentage occurrences for the recording period, rounded to the second decimal place)

Significant wave height (Hsig) (m)	Peak energy wave period (Tp) (s)								
	0–2.99	3–4.99	5–6.99	7–8.99	9–10.99	11–12.99	13–14.99	>14.99	Totals
0.00 –0.19	9.73	6.27	4.09	2.46	0.51	0.02	0.02	*	23.11
0.20 –0.39	8.55	15.22	4.55	2.14	0.13	*	*	*	30.58
0.40 –0.59	0.48	11.49	2.13	0.30	0.04	*	*	*	14.43
0.60 –0.79	*	9.99	2.01	0.01	*	*	*	*	12.01
0.80 –0.99	*	7.93	1.67	*	*	*	*	*	9.60
1.00 –1.19	*	3.72	2.17	0.01	*	*	*	*	5.90
1.20 –1.39	*	0.79	2.25	*	*	*	*	*	3.04
1.40 –1.59	*	0.05	0.93	*	*	*	*	*	0.99
1.60 –1.79	*	*	0.23	*	*	*	*	*	0.23
1.80 –1.99	*	*	0.10	*	*	*	*	*	0.10
2.00 –2.19	*	*	0.03	*	*	*	*	*	0.03
2.20 –2.39	*	*	*	*	*	*	*	*	0.00
2.40 –2.59	*	*	*	*	*	*	*	*	0.00
2.60 –2.79	*	*	*	*	*	*	*	*	0.00
2.80 –2.99	*	*	*	*	*	*	*	*	0.00
3.00 –3.19	*	*	*	*	*	*	*	*	0.00
3.20 –3.39	*	*	*	*	*	*	*	*	0.00
Totals	18.76	55.46	20.15	4.91	0.68	0.02	0.02	0.00	100.00



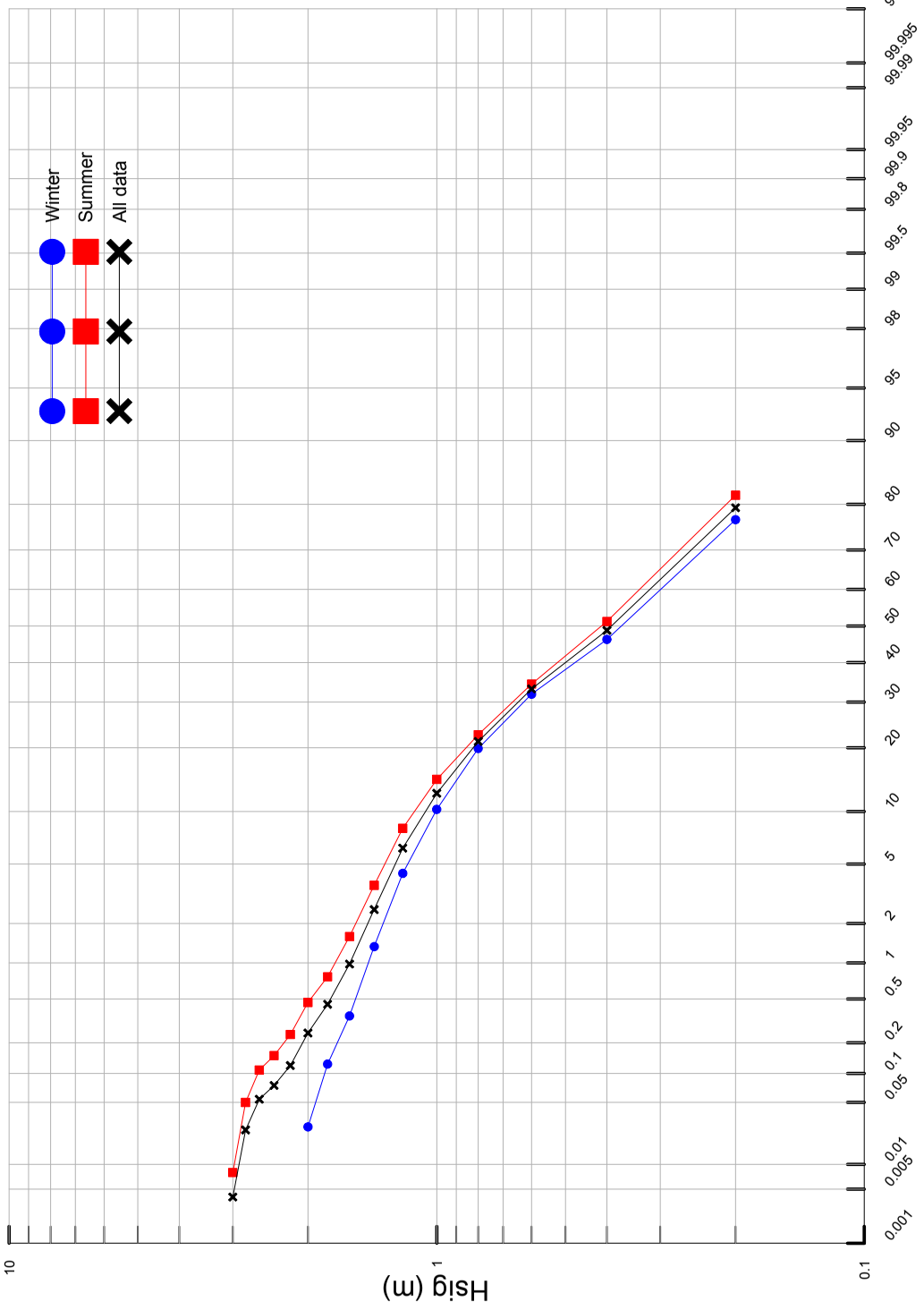
Location	Latitude	Longitude	Depth (m) LAT	Deployment date	Removal date
1	17° 52.21'	146° 11.06'	20.0	17-Dec-1998	(buoy lost)
2	17° 52.15'	146° 11.08'	19.3	1-Jul-1999	18-Sep-2000
3	17° 49.09'	146° 11.13'	20.0	14-Nov-2000	12-Nov-2002

Locality plan

Queensland Government Environmental Protection Agency

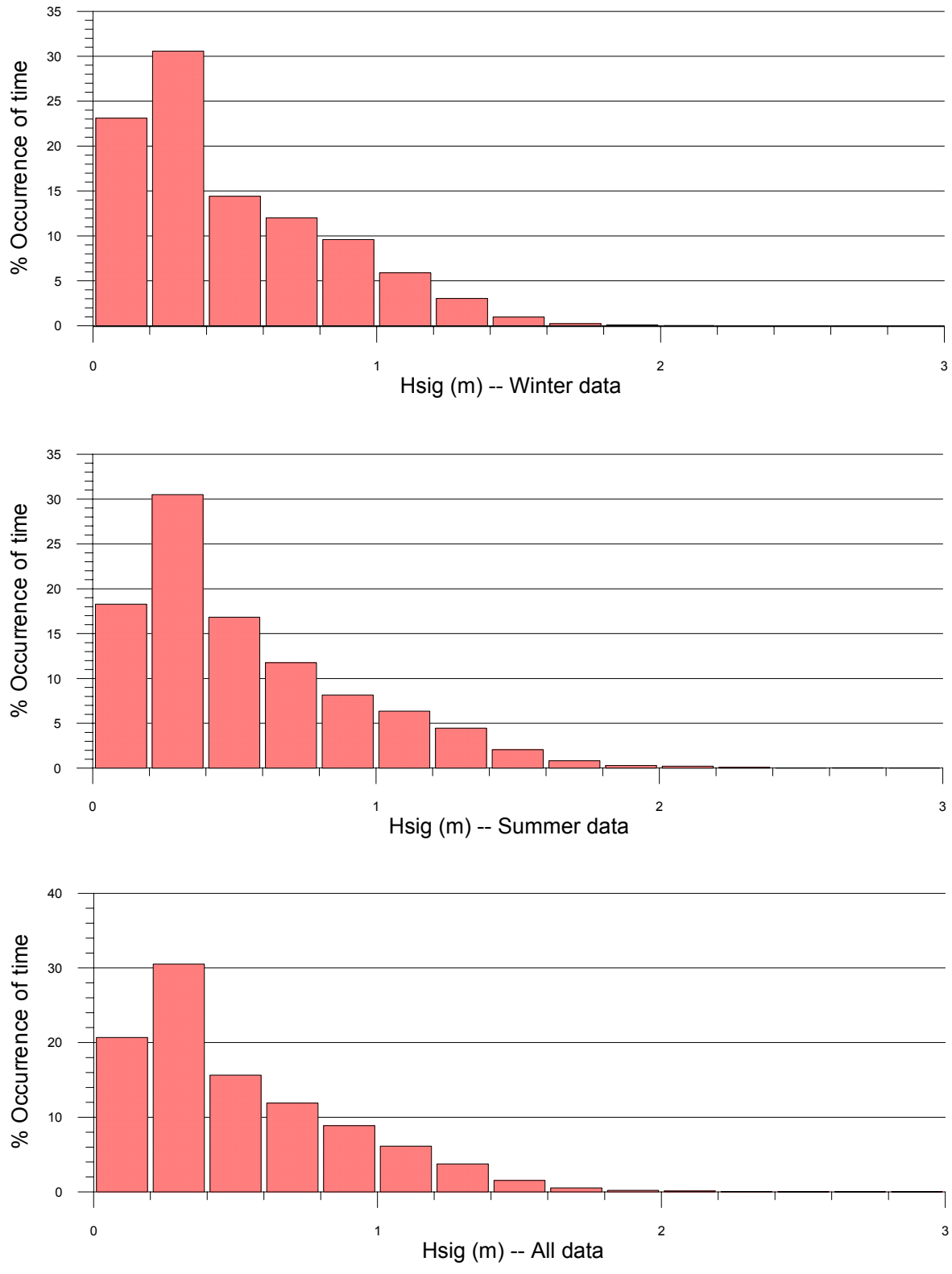
Wave data recording program
Dunk Island

Figure 1



Percentage (of time) exceedance
of wave heights (Hsig) for all wave periods (Tp)
18 December 1998 to 12 November 2002

Queensland Government Environmental Protection Agency	Wave data recording program Dunk Island	Figure 2

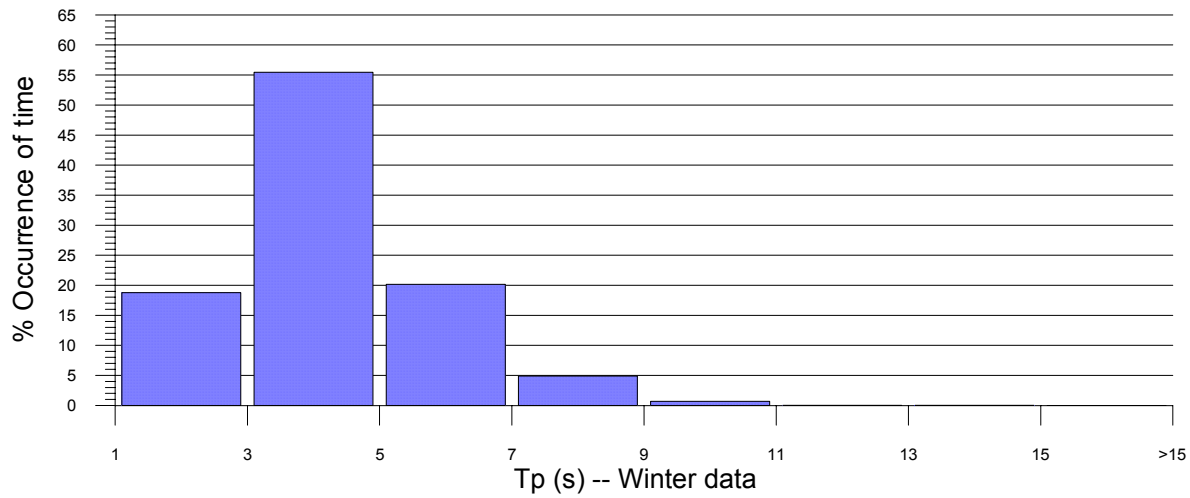


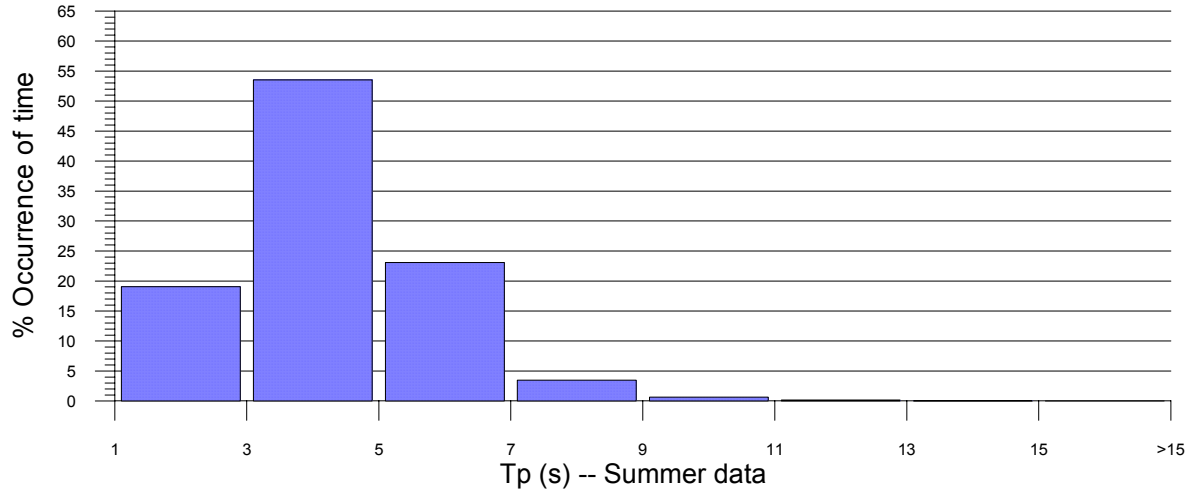
Histogram percentage (of time) occurrence of wave heights (Hsig) for all wave periods (Tp)

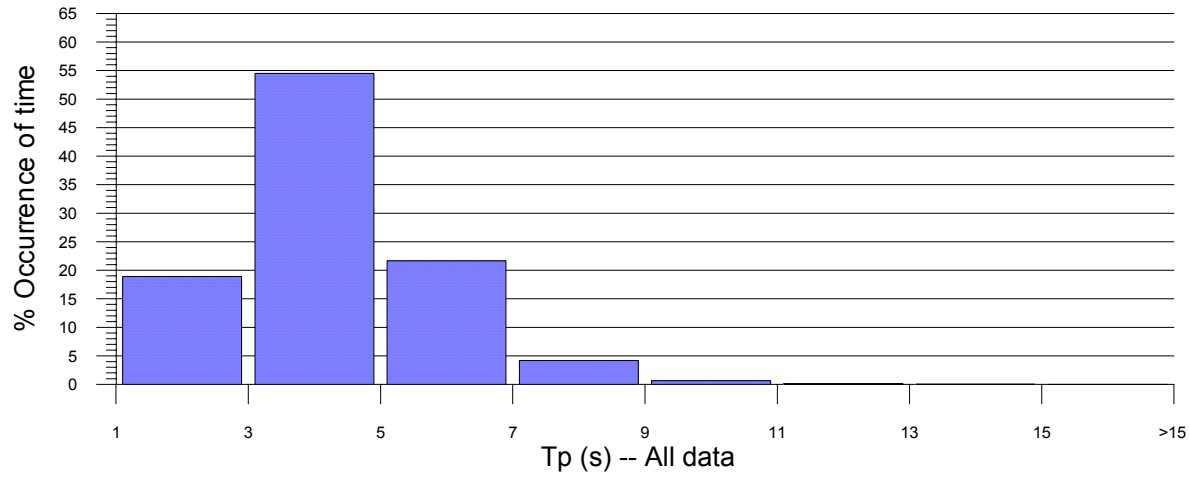
Queensland Government Environmental Protection Agency

Wave data recording program
Dunk Island

Figure 3

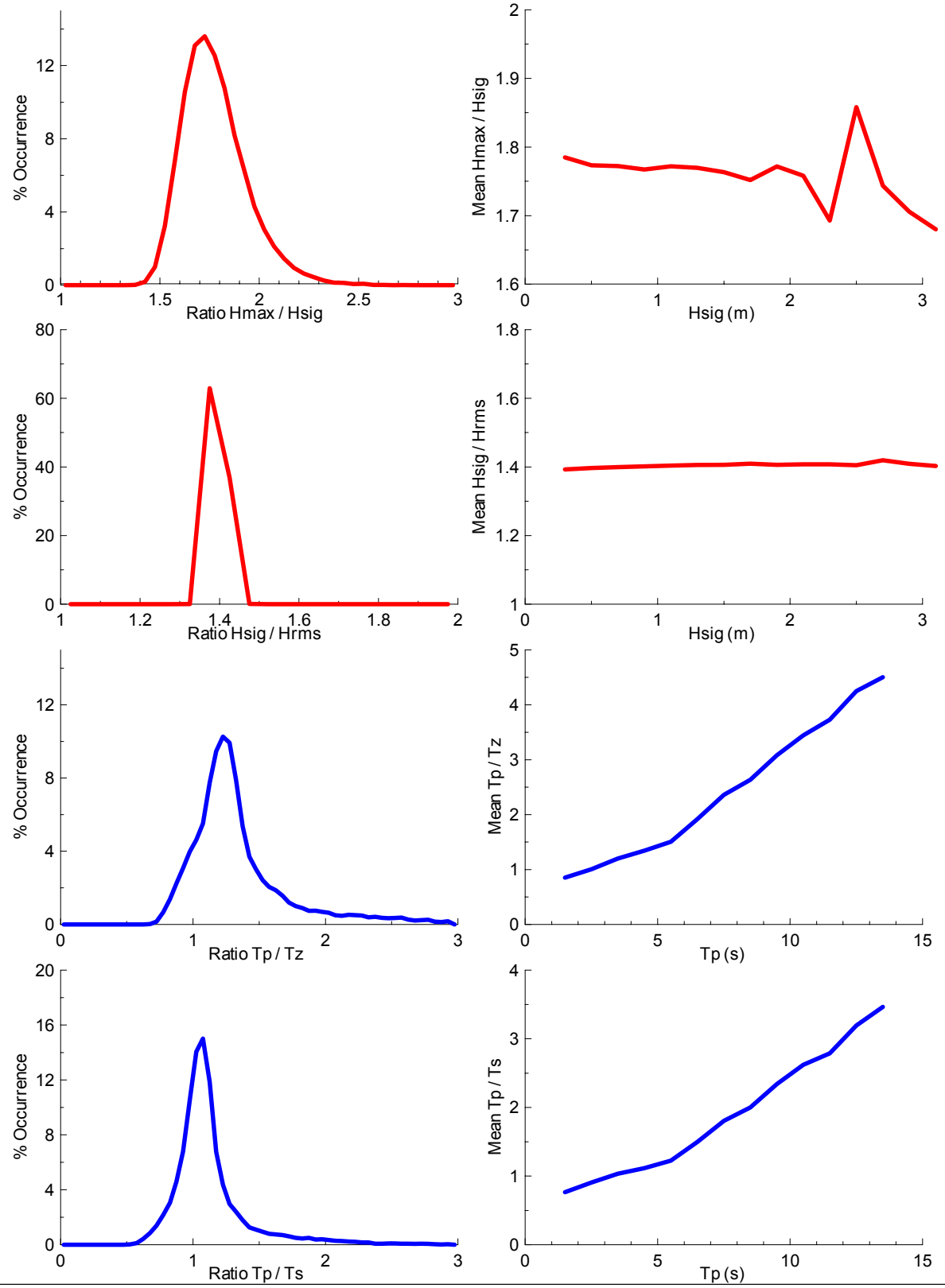






Histogram percentage (of time) occurrence of wave periods (Tp) for all wave heights (Hsig)

Queensland Government Environmental Protection Agency	Wave data recording program Dunk Island	Figure 4



Wave parameter relationships
18 December 1998–12 November 2002

Queensland Government Environmental Protection Agency	Wave data recording program Dunk Island	Figure 5

Wave data recording program
Dunk Island

Daily wave recordings
1 January–31 December 1998

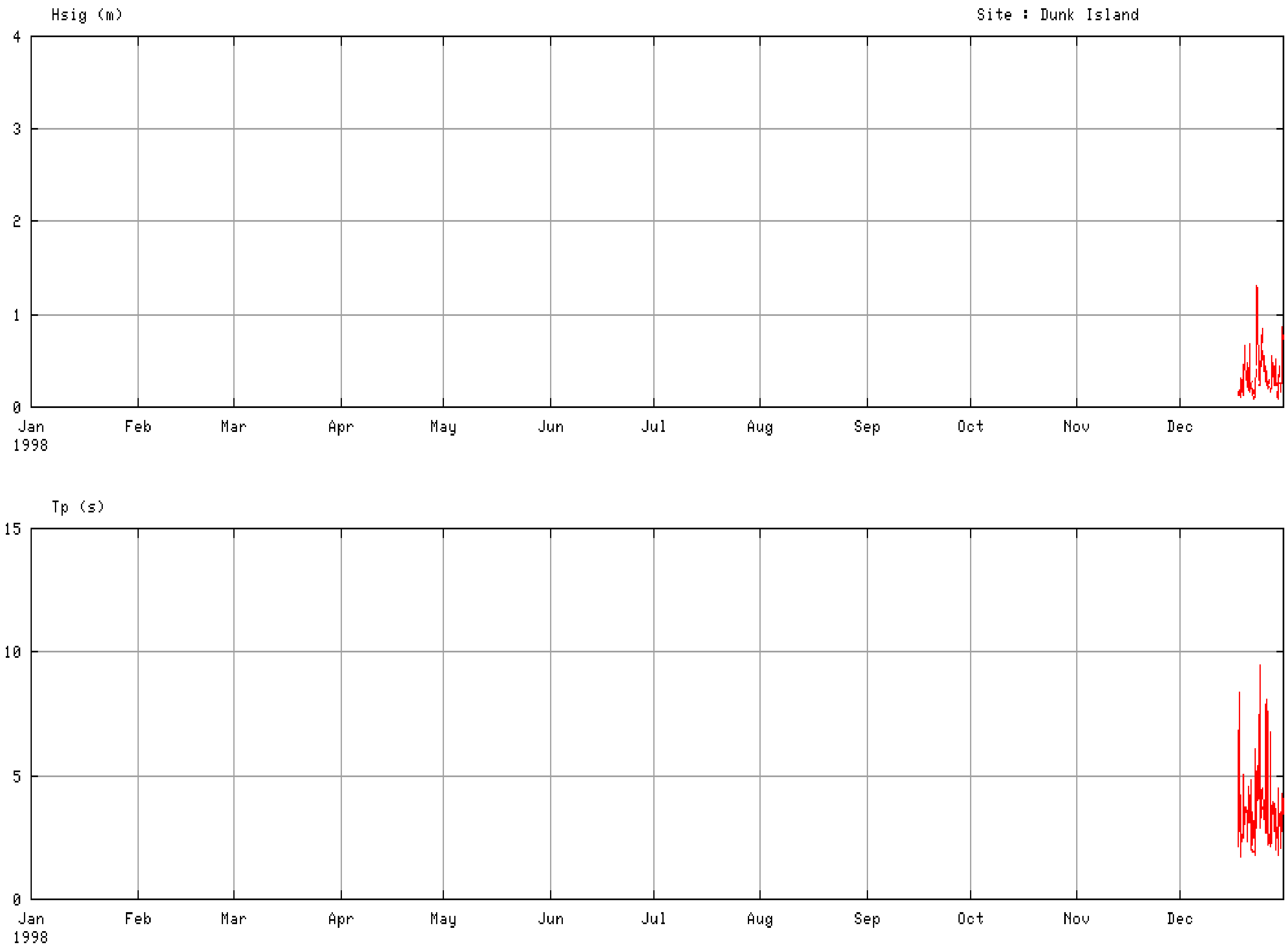


Figure 6.00

Queensland Government Environmental Protection Agency

Wave data recording program
Dunk Island

Daily wave recordings
1 January–31 December 1999

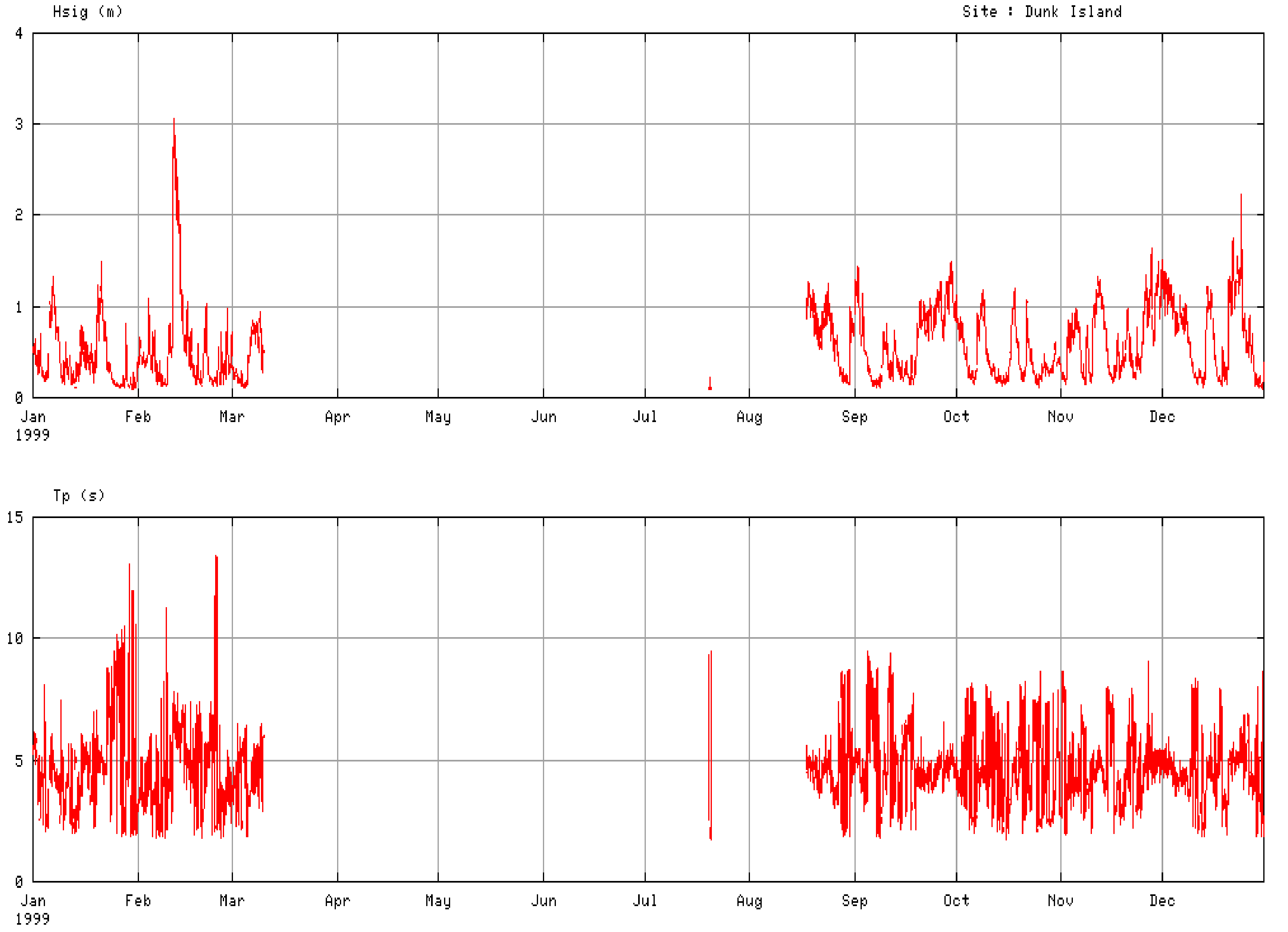


Figure 6.01

Queensland Government
Environmental Protection Agency

Wave data recording program
Dunk Island

Daily wave recordings
1 January–31 December 2000

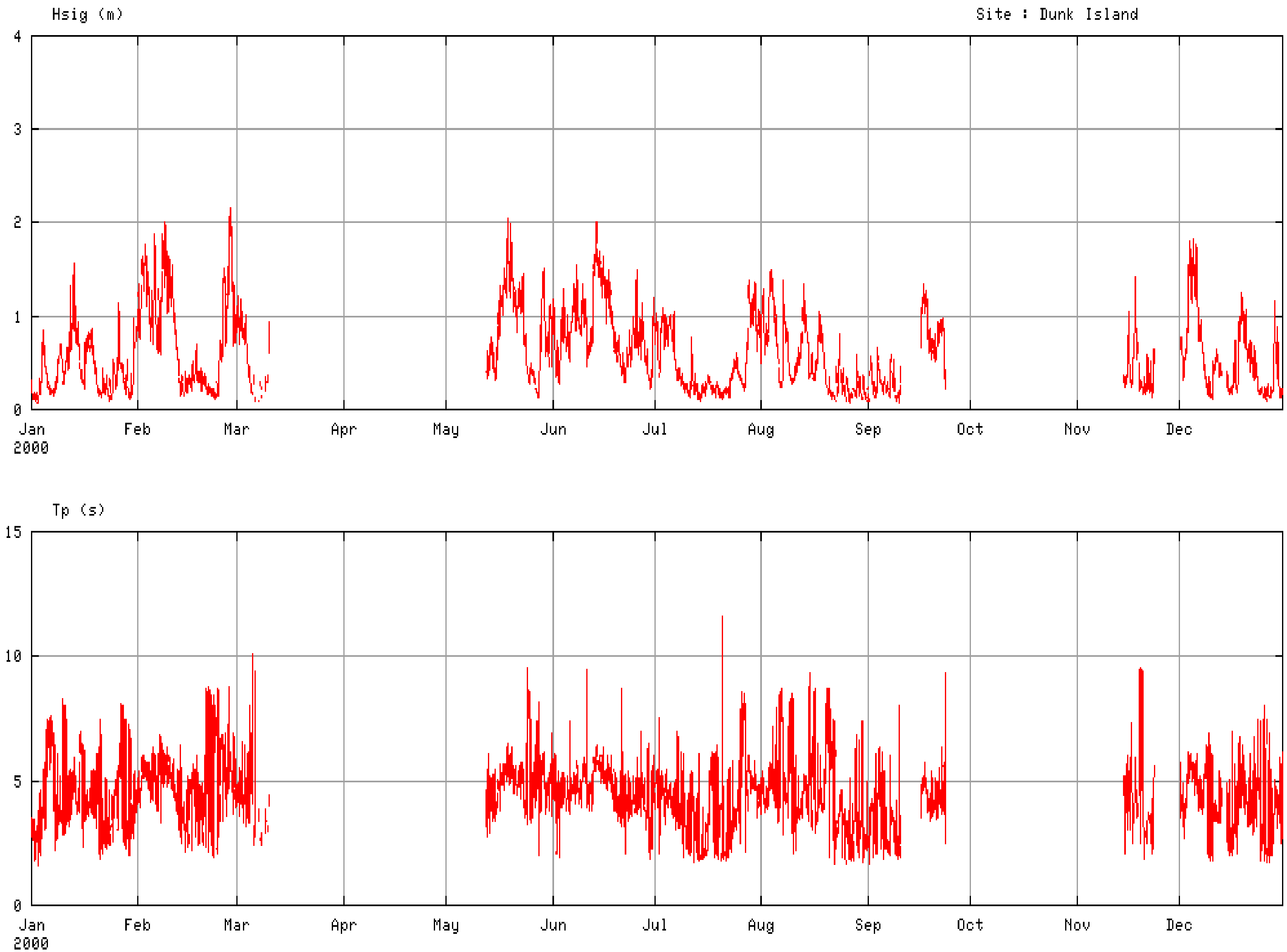


Figure 6.02

Queensland Government
Environmental Protection Agency

Wave data recording program
Dunk Island

Daily wave recordings
1 January–31 December 2001

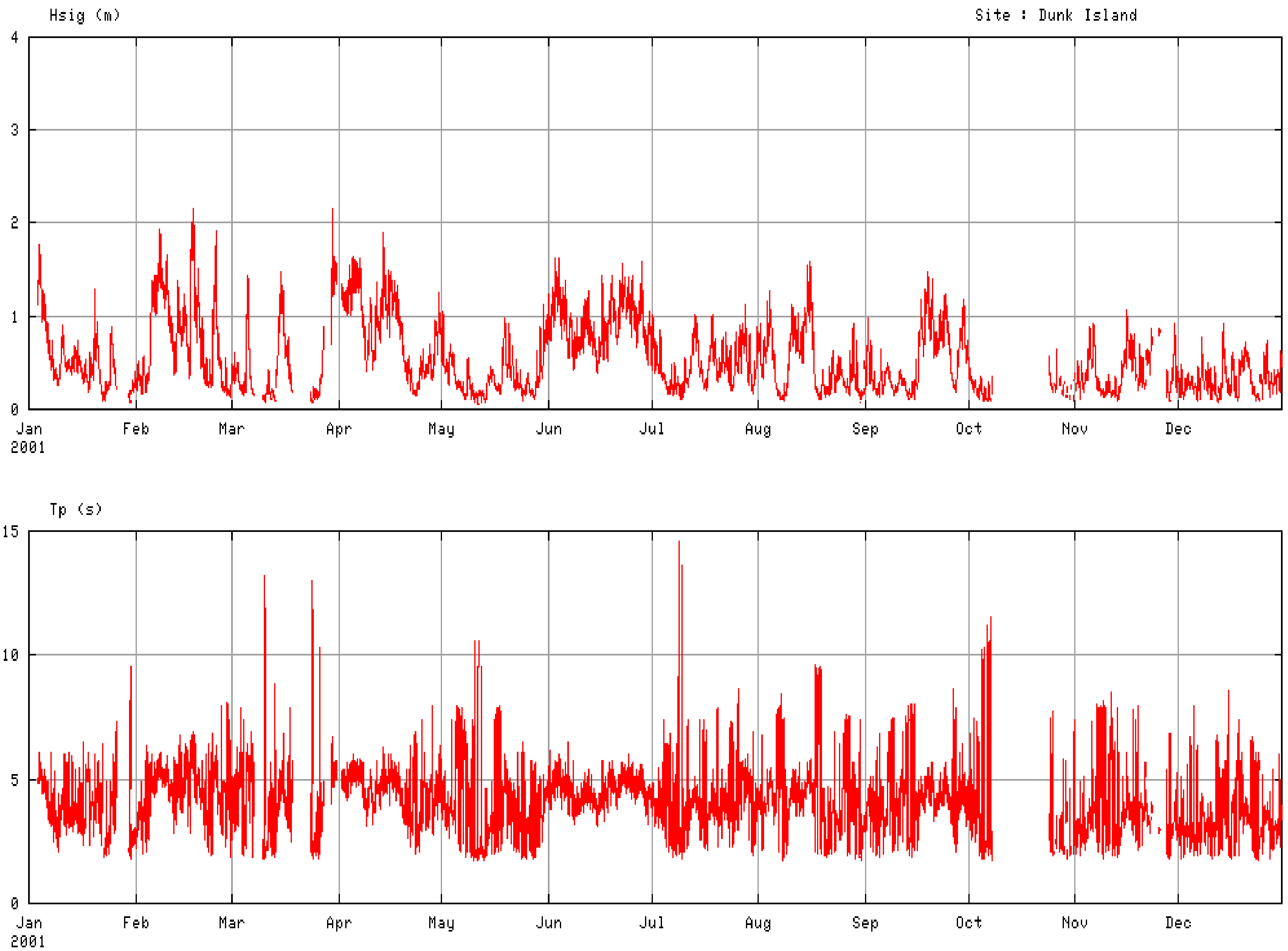


Figure 6.03

Queensland Government
Environmental Protection Agency

Wave data recording program
Dunk Island

Daily wave recordings
1 January–31 December 2002

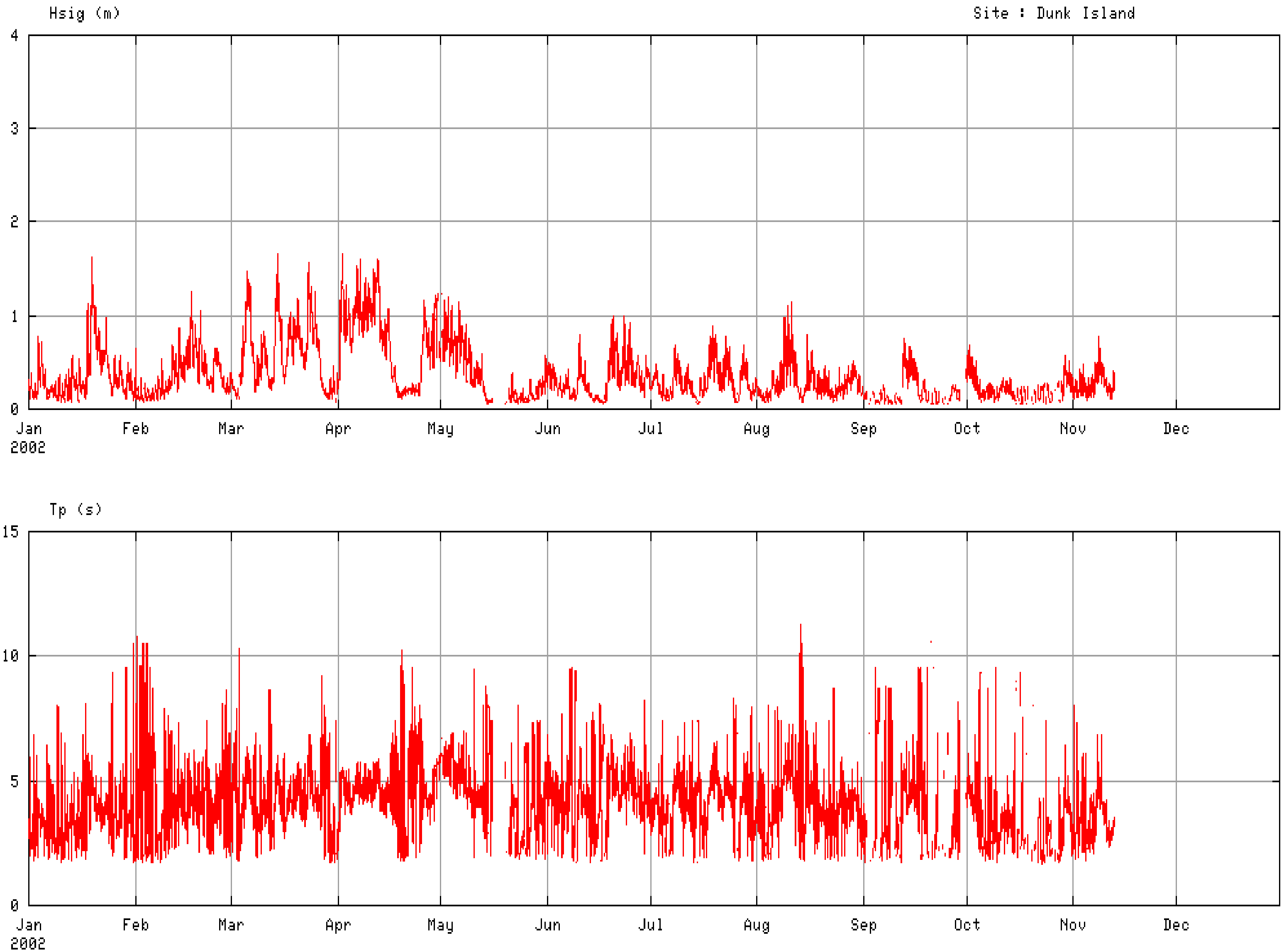


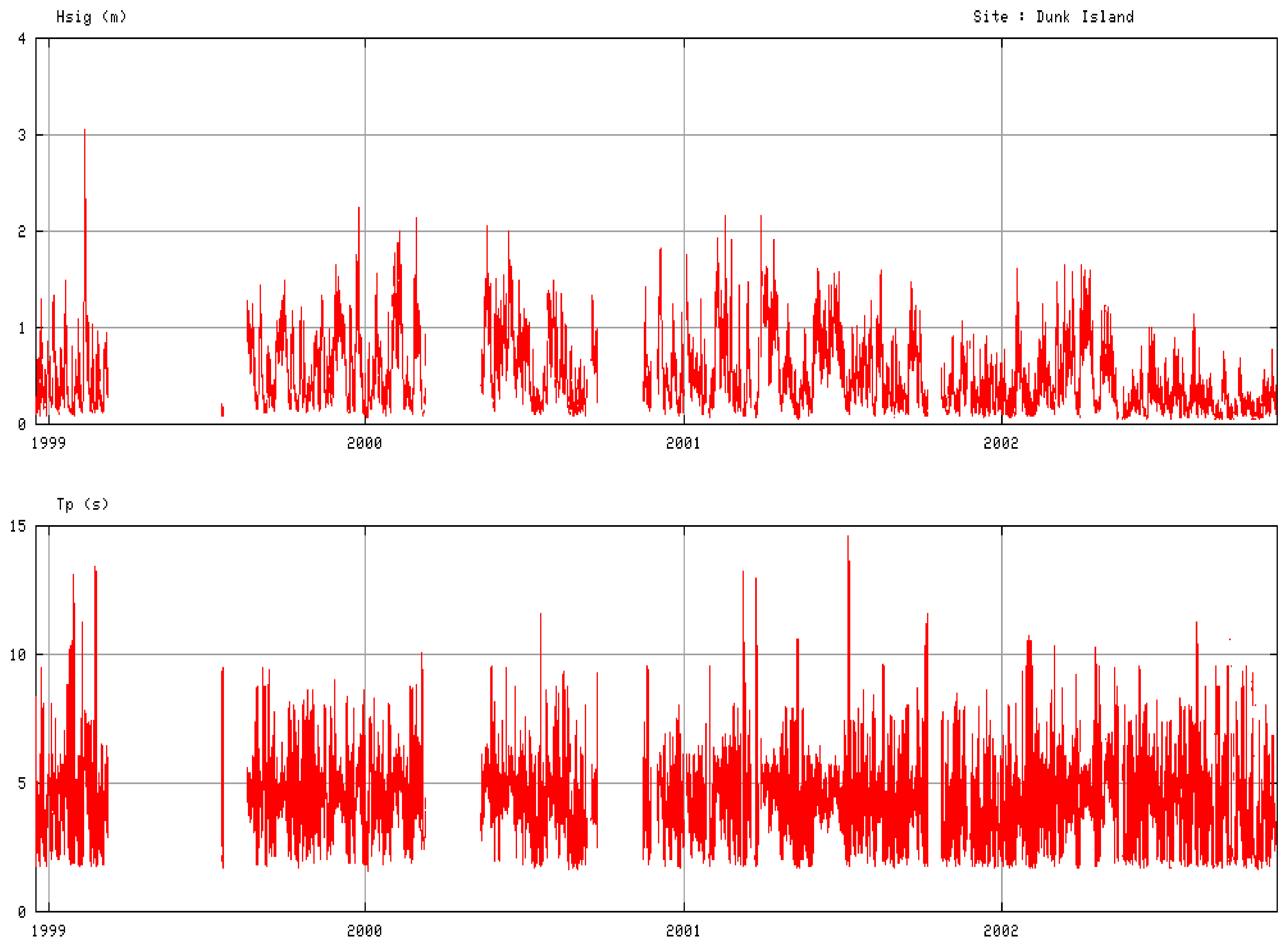
Figure 6.04

Queensland Government
Environmental Protection Agency

Whole recording period wave recordings
18 December 1998–12 November 2002

Wave data recording program
Dunk Island

Figure 7

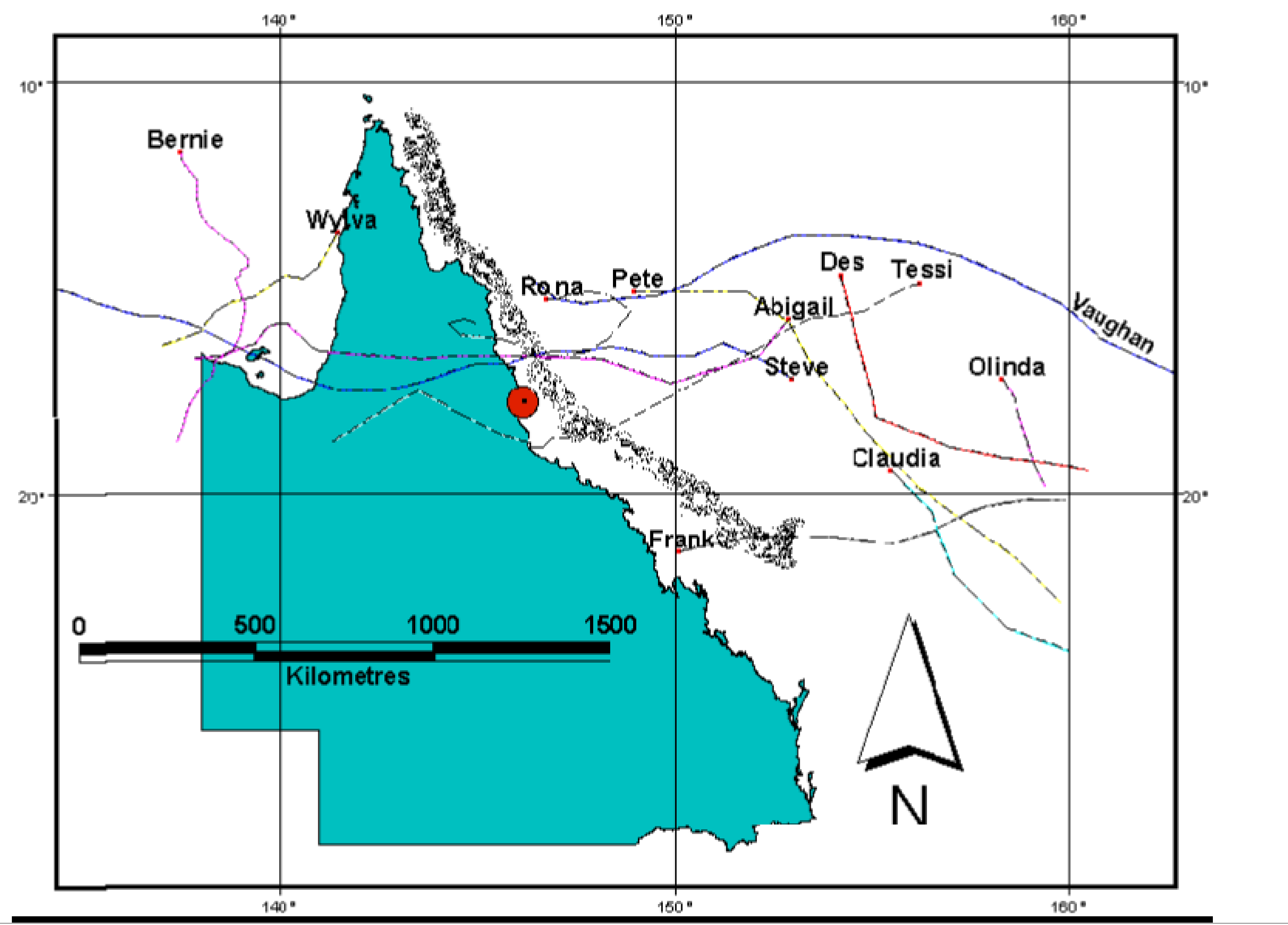


Queensland Government
Environmental Protection Agency

Cyclone tracks
18 December 1998–12 November 2002

Wave data recording program
Dunk Island

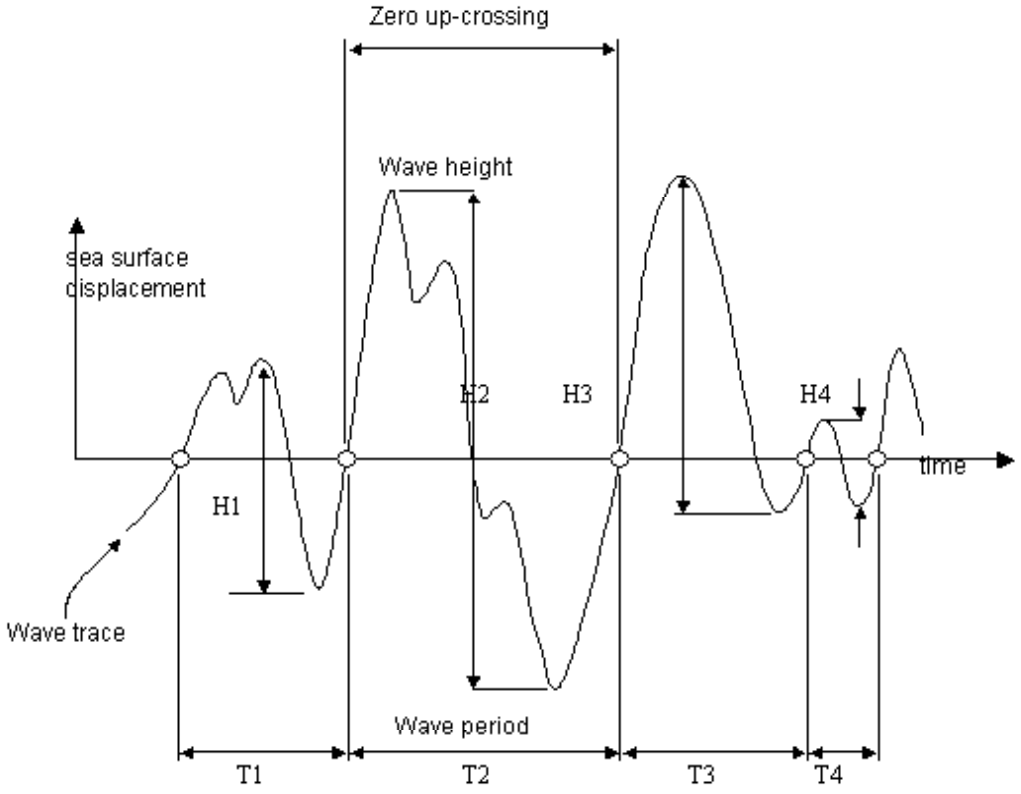
Figure 8



Zero crossing analysis

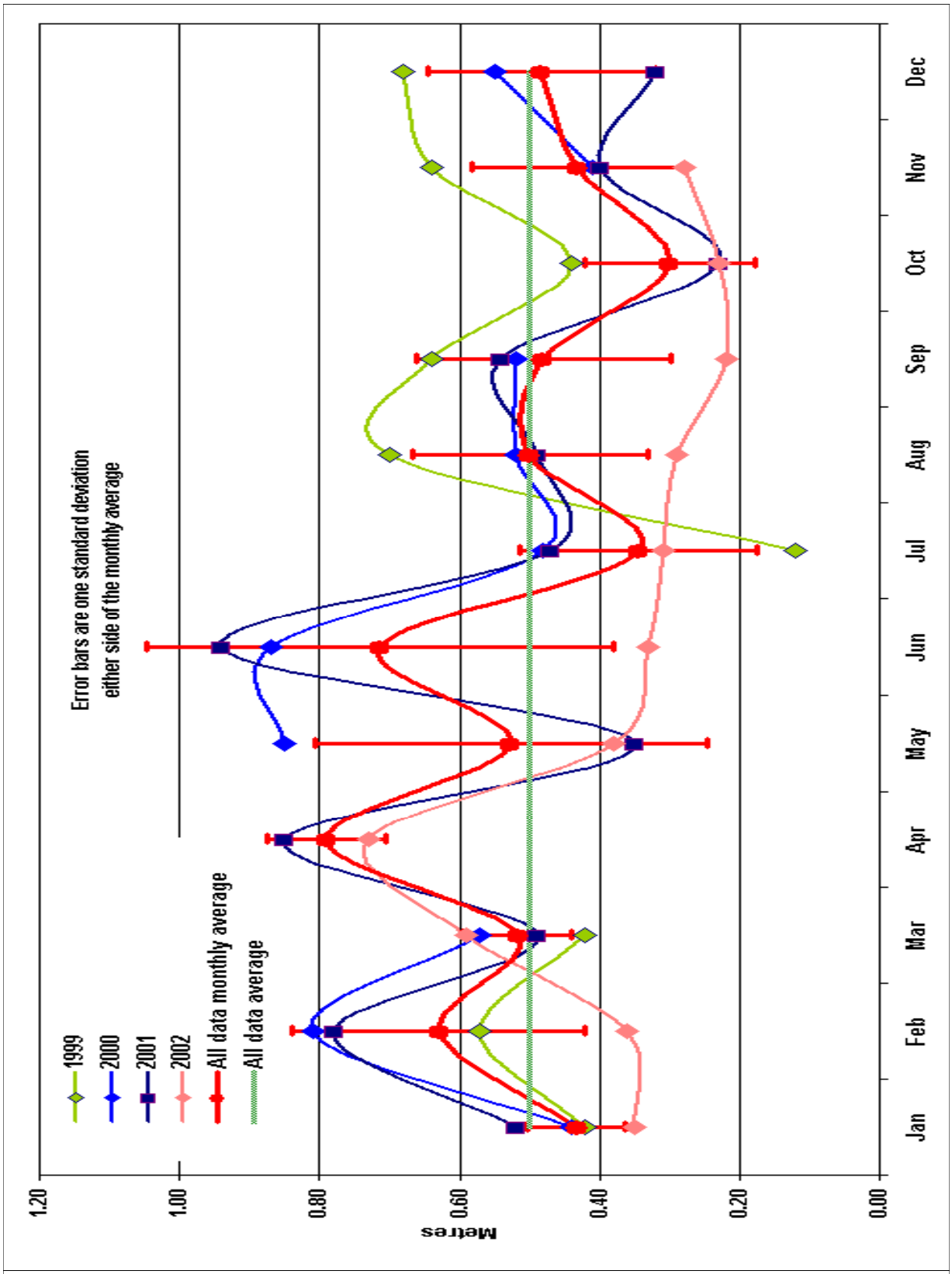
A direct, repeatable and widely accepted method to extract representative statistics from wave traces recorded by a Waverider buoy is the zero crossing method. For the zero upcrossing method, the method employed by the Agency, a wave is defined as the portion of the record between two successive zero 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

Queensland Government Environmental Protection Agency	Wave data recording program Dunk Island	Figure 9



Monthly average wave heights (Hsig)

Queensland Government Environmental Protection Agency	Wave data recording program Dunk Island	Figure 10

Appendix A

Glossary of terms

Wave parameter	Description
H_{sig}	Significant wave height defined as average of highest $\frac{1}{3}$ of zero up-crossing wave heights
T_s	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
H10	Average of the highest 10 per cent of all waves in a record
TH10	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 0 and 2, defined by $\sqrt{m_0 / m_2}$
T_p	Period at the peak spectral energy