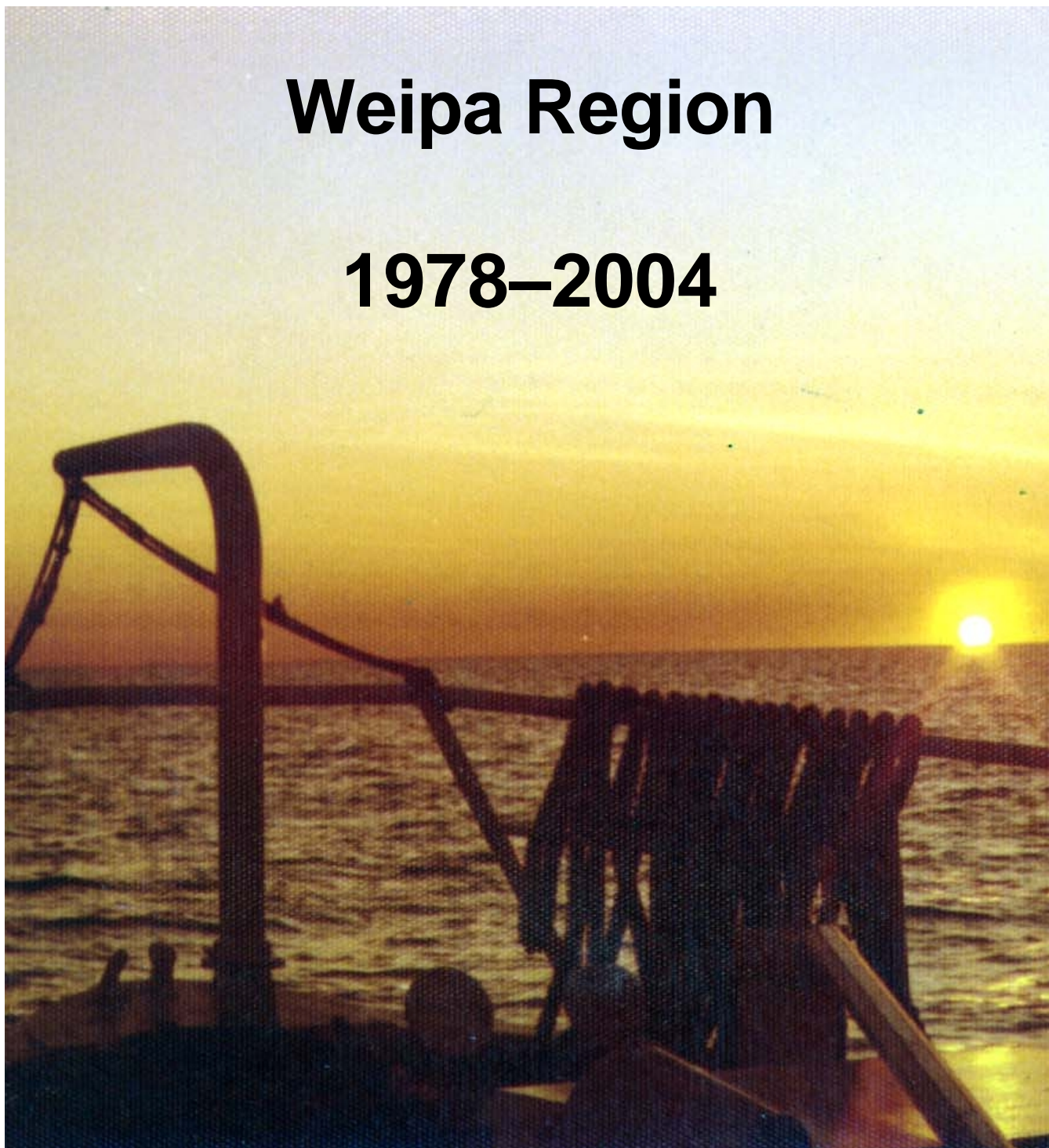


Wave data recording program

Weipa Region

1978–2004



Coastal Sciences data report No. W2004.5
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Abstract

This report provides summaries of primary analysis of wave data recorded in water depths of approximately 5.2m relative to lowest astronomical tide, 10km west of Evans Landing in Albatross Bay, west of Weipa. Data was recorded using a Datawell Waverider buoy, and covers the periods from 22 December, 1978 to 31 January, 2004. 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 Sciences 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 Weipa Region 1978–2004

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 Sciences 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 bow of a vessel proceeding into the Gulf of Carpentaria passing close to the location of the Weipa wave measuring buoy.

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1.0 Introduction

The Environmental Protection Agency's, Coastal Sciences 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 Weipa station. In addition, brief details of the recording equipment, the methods of handling raw data and the type of analyses employed are provided. The Weipa wave recording station was commissioned as a joint project site operated by the EPA in collaboration with the Ports Corporation of Queensland (PCQ).

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 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 in conjunction with (and jointly funded by) other agencies.

The 2004 site groups are as follows:

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 Queensland and New South Wales governments with support of Gold Coast City Council); ⁺ Gold Coast City Council; [#] Ports Corporation of Queensland; [♦] Port of Brisbane Corporation

2.0 Recording equipment configuration

The Coastal Sciences 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 Weipa site. 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.

When first installed on 21 December, 1978, the Weipa station comprised a Datawell 6000 series non-directional Waverider buoy and a recording station consisting of a Mark II Waverider receiver (WAREP) coupled to an ANMA analogue recorder. The WAREP controlled the timing of data recording, provided a paper chart of the water level recordings and relayed an analogue signal to the ANMA analogue recorder. On 3 December, 1981, the recording station was upgraded by replacing the ANMA analogue recorder with a DIMA digitiser/ recorder. Wave data were recorded by the DIMA unit in 20-minute bursts and digitised at 0.5 second intervals (2.0Hz). The data were recorded on digital cassettes and, along with the paper charts, transferred to the Brisbane office for processing.

On 9 October, 1993, the recording station was upgraded to a personal-computer (PC) based system utilising a Datawell Waverider receiver/digitiser (DIWAR). The changing water level was digitized at a rate of 0.39s 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 Sciences 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 vertical displacements of either 2m or 2.7m 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; and
- power output.

Waverider buoys are typically recovered after a deployment period of 1 year. When buoys are recovered from Weipa, laboratory calibration checks for accelerometer error and platform tilt were performed. The results of these checks were always within the manufacturer's specifications (unless a significant event such as a ship-strike had caused the buoy to be recovered early), so no adjustments to the recorded data were made.

4.0 Wave recording and analysis procedures

From 21 December, 1978 to 2 December, 1981, wave data were recorded twice daily, each record being of 20-minutes duration, with the timing of recordings set at 0300 hours and 1500 hours Australian Eastern Standard Time (AEST). Between 3 December, 1981 and 9 October, 1993, wave data were recorded four times per day at 0300, 0900, 1500 and 2100 hours (AEST). During storm events, the recording frequency may have been manually switched by an on-site operator to record eight times per day.

Between 10 October, 1993, and 31 January, 2004, the PC-based recording system generally recorded data at (nominally) hourly intervals. During periods when the recorded significant wave height (H_{sig}) value reached a storm threshold of 2 metres, the recording frequency was increased to (nominally) half hourly intervals.

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
H_{sig}	Significant wave height (time domain), the average of the highest third of the waves in the record
H_{max}	Highest individual wave in the record (time domain)
H_{rms}	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 recorded waves
T_z	Average period of all zero up-crossing waves in the record (time domain)
T_p	Wave period corresponding to the peak of the energy density spectrum (frequency domain)
T_c	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 Weipa 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 Sciences 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 3 and 4. 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 Waverider recording system that is utilised by the Coastal Sciences 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 22 December, 1978–31 January, 2004*, 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 22 December, 1978–31 January, 2004*, 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 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
Dunk Island	Report No. 2004.2	18 Dec 1998–14 Nov 2002
Tweed Region	Report No. 2004.6	13 Dec 1995–30 May 2004

9.0 Details of wave recorder installations

Weipa

Buoy locations:

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

Location 1

Co-ordinates: 141° 45.20' East, 12° 40.83' South

Water depth at buoy: 5.3m relative to Lowest Astronomical Tide

Periods: 21 December, 1978 –17 April, 1991

Location 2

Co-ordinates: 141° 45.02' East, 12° 40.05' South

Water depth at buoy: 5.3m relative to Lowest Astronomical Tide

Periods: 27 April, 1991 –11 February 1992

Location 3

Co-ordinates: 141° 45.03' East, 12° 40.42' South

Water depth at buoy: 5.3m relative to Lowest Astronomical Tide

Periods: 11 February, 1992– 2 August 1995

Location 4

Co-ordinates: 141° 45.10' East, 12° 40.60' South

Water depth at buoy: 5.3m relative to Lowest Astronomical Tide

Periods: 4 August, 1995 –10 September, 1998

Location 5

Co-ordinates: 141° 45.15' East, 12° 40.52' South

Water depth at buoy: 5.2m relative to Lowest Astronomical Tide

Periods: 10 September, 1998– 31 January, 2004

Note: – The above buoy locations were determined using radar ranges or GPS fixing procedures.

– All water depths are accurate to ± 1 m.

Location of recording stations:

Harbour Masters Office, Lorim Point

Co-ordinates: 141° 52.10' East, 12° 40.31' South

Period: 21 December, 1978–2 September, 1991

Harbour Masters boat shed, Evans Landing

Co-ordinates: 141° 50.82' East, 12° 39.96' South

Period: 8 September, 1991–31 January, 2004

Recording intervals:

Two twenty-minute records each day (at 0300 hours and 1500 hours) were recorded between 21 December 1978 and 2 December 1981.

Four twenty-minute records daily (at 0300 hours, 0900 hours, 1500 hours and 2100 hours) were recorded between 3 December 1981 and 2 January 1993.

Commencing on 10 October 1993, one hourly records, each of approximately twenty-six (26) minutes have been taken, giving 4096 water surface elevation measurements for that period, from which sea state parameters are calculated and recorded. (Refer section 4.0)

Normally during periods when the recorded Hsig value reaches the storm threshold of 2m, the recording frequency would be increased to half hourly intervals. However, the protected nature of the Weipa site 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 used in analysis:	116,286
Number of days in recording period:	9,171
Number of days used in analysis:	7,352.412
Number of days lost:	1,818.588

HAT at nearest port: Weipa, 3.38m

Gaps in data (greater than 2 days)

Dates of gap	Duration (days)
10/04/1979 15:00–26/04/1979 15:00	16.00
26/01/1980 15:00–31/01/1980 15:00	5.00
05/06/1980 03:00–22/06/1980 15:00	17.50
22/10/1980 15:00–11/11/1980 15:00	20.00
19/01/1981 03:00–22/01/1981 15:00	3.50
14/03/1981 03:00–19/03/1981 15:00	5.50
31/03/1981 03:00–02/04/1981 15:00	2.50
11/04/1981 03:00–16/04/1981 15:00	5.50
24/04/1981 15:00–30/04/1981 15:00	6.00
07/06/1981 03:00–11/06/1981 15:00	4.50
20/06/1981 03:00–25/06/1981 15:00	5.50
01/02/1982 03:00–04/02/1982 15:00	3.50
16/02/1982 21:00–22/02/1982 15:00	5.75
26/02/1982 21:00–03/03/1982 21:00	5.00
06/05/1982 09:00–11/05/1982 03:00	4.75
13/05/1982 09:00–18/05/1982 03:00	4.75
27/05/1982 09:00–17/06/1982 15:00	21.25
24/06/1982 09:00–01/07/1982 15:00	7.25
09/07/1982 09:00–15/07/1982 15:00	6.25
12/08/1982 09:00–16/08/1982 09:00	4.00
16/09/1982 09:00–23/09/1982 15:00	7.25
04/11/1982 09:00–11/11/1982 15:00	7.25
02/12/1982 03:00–09/12/1982 15:00	7.50
23/02/1983 03:00–28/02/1983 15:00	5.50
03/07/1983 03:00–18/07/1983 21:00	15.75
22/09/1983 09:00–29/09/1983 15:00	7.25
04/02/1984 15:00–09/02/1984 21:00	5.25
14/02/1984 09:00–16/02/1984 15:00	2.25
25/02/1984 15:00–01/03/1984 21:00	5.25
16/04/1984 21:00–19/04/1984 21:00	3.00
07/05/1984 21:00–10/05/1984 15:00	2.75
02/07/1984 09:00–05/07/1984 15:00	3.25
09/07/1984 21:00–13/07/1984 15:00	3.75
17/07/1984 21:00–26/07/1984 15:00	8.75
28/10/1984 21:00–08/11/1984 15:00	10.75
07/01/1985 21:00–10/01/1985 15:00	2.75
14/01/1985 21:00–17/01/1985 21:00	3.00
04/02/1985 21:00–25/02/1985 15:00	20.75
05/03/1985 03:00–07/03/1985 15:00	2.50
09/04/1985 03:00–11/04/1985 09:00	2.25
25/04/1985 15:00–02/05/1985 15:00	7.00
09/05/1985 03:00–13/05/1985 09:00	4.25
24/06/1985 21:00–27/06/1985 15:00	2.75
11/11/1985 21:00–19/11/1985 21:00	8.00
07/12/1985 09:00–09/12/1985 21:00	2.50
11/12/1985 21:00–26/12/1985 15:00	14.75
27/01/1986 21:00–30/01/1986 15:00	2.75
10/04/1986 09:00–18/06/1986 15:00	69.25
20/12/1986 15:00–09/01/1987 15:00	20.00
18/01/1987 15:00–20/01/1987 15:00	2.00
14/03/1987 21:00–10/04/1987 15:00	26.75
25/09/1987 03:00–08/10/1987 15:00	13.50
24/10/1987 09:00–30/10/1987 15:00	6.25
08/11/1987 09:00–11/11/1987 15:00	3.25
15/11/1987 09:00–08/12/1987 15:00	23.25
02/02/1988 21:00–05/02/1988 15:00	2.75
14/02/1988 15:00–18/04/1988 15:00	64.00
22/04/1988 09:00–06/05/1988 09:00	14.00
23/05/1988 15:00–27/05/1988 15:00	4.00
22/06/1988 09:00–24/06/1988 15:00	2.25
01/07/1988 09:00–12/07/1988 15:00	11.25
27/07/1988 15:00–01/08/1988 15:00	5.00
05/08/1988 21:00–10/08/1988 15:00	4.75
19/08/1988 15:00–26/08/1988 21:00	7.25
04/09/1988 15:00–06/09/1988 15:00	2.00
15/09/1988 15:00–03/10/1988 14:59	18.00
22/12/1988 21:29–29/12/1988 15:04	6.73
23/01/1989 09:07–31/01/1989 15:10	8.25
06/02/1989 09:10–13/02/1989 15:12	7.25
20/02/1989 09:10–22/02/1989 15:13	2.25

Dates of gap	Duration (days)
15/05/1989 20:48–18/05/1989 02:58	2.26
19/05/1989 14:57–23/05/1989 14:56	4.00
03/06/1989 08:54–05/06/1989 14:54	2.25
05/06/1989 20:44–13/06/1989 14:52	7.76
26/08/1989 03:07–29/08/1989 15:08	3.50
07/09/1989 21:13–26/09/1989 15:15	18.75
01/10/1989 15:16–03/10/1989 15:17	2.00
03/11/1989 09:22–06/11/1989 09:22	3.00
11/11/1989 09:24–14/11/1989 09:24	3.00
26/12/1989 21:38–02/01/1990 09:34	6.50
02/01/1990 09:34–08/01/1990 09:35	6.00
09/01/1990 03:38–14/01/1990 09:36	5.25
15/01/1990 15:39–17/01/1990 21:10	2.23
27/03/1990 09:13–06/08/1990 15:06	132.25
10/08/1990 15:06–15/08/1990 09:05	4.75
17/08/1990 21:11–23/08/1990 15:09	5.75
31/08/1990 03:11–13/09/1990 21:16	13.75
18/09/1990 03:14–20/09/1990 15:14	2.50
02/10/1990 09:14–05/10/1990 15:16	3.25
16/10/1990 09:16–20/10/1990 09:10	4.00
20/10/1990 21:15–29/10/1990 15:13	8.75
08/11/1990 15:15–12/11/1990 15:16	4.00
19/11/1990 21:21–01/12/1990 15:19	11.75
01/12/1990 15:19–03/12/1990 15:19	2.00
23/12/1990 15:07–02/05/1991 21:14	130.25
25/05/1991 21:19–05/06/1991 21:20	11.00
09/06/1991 03:18–21/06/1991 09:18	12.25
25/06/1991 09:18–27/06/1991 09:19	2.00
05/07/1991 09:01–12/07/1991 15:05	7.25
24/07/1991 03:08–26/07/1991 15:08	2.50
01/08/1991 09:07–09/08/1991 15:11	8.25
20/08/1991 21:16–31/08/1991 15:15	10.75
02/09/1991 09:13–08/09/1991 15:07	6.25
08/09/1991 15:07–10/09/1991 20:57	2.24
15/09/1991 03:07–21/09/1991 09:07	6.25
21/09/1991 15:06–24/09/1991 20:55	3.24
24/09/1991 20:55–27/09/1991 20:53	3.00
08/10/1991 14:57–21/10/1991 14:51	13.00
23/10/1991 14:50–09/11/1991 14:43	17.00
06/12/1991 02:33–13/12/1991 14:31	7.50
20/12/1991 08:31–27/12/1991 14:28	7.25
27/12/1991 14:28–03/01/1992 14:27	7.00
31/01/1992 02:27–11/02/1992 11:15	11.37
13/03/1992 08:55–20/03/1992 14:53	7.25
24/04/1992 02:49–01/05/1992 20:42	7.75
08/05/1992 02:51–15/05/1992 08:58	7.25
26/06/1992 14:58–03/07/1992 10:06	6.80
03/07/1992 22:14–27/07/1992 11:50	23.57
27/07/1992 11:50–05/08/1992 20:54	9.38
21/08/1992 09:02–28/08/1992 15:01	7.25
13/11/1992 20:50–23/12/1992 20:53	40.00
02/01/1993 09:03–20/04/1993 12:11	108.13
03/05/1993 21:02–07/05/1993 15:13	3.76
09/07/1993 09:33–16/07/1993 09:35	7.00
18/07/1993 09:36–23/07/1993 15:37	5.25
30/07/1993 15:39–05/08/1993 09:41	5.75
05/08/1993 09:41–13/08/1993 09:43	8.00
20/08/1993 09:45–27/08/1993 15:46	7.25
17/09/1993 03:50–08/10/1993 15:56	21.50
22/12/1993 23:00–01/01/1994 00:01	9.04
30/06/1994 05:00–26/07/1994 10:00	26.21
14/09/1995 05:30–06/10/1995 10:30	22.21
24/08/1996 12:00–18/09/1996 08:00	24.83
17/09/1997 22:00–23/09/1997 09:00	5.46
30/09/1997 23:00–04/10/1997 05:00	3.25
10/10/1997 13:00–13/10/1997 18:00	3.21
18/01/1998 10:00–22/01/1998 12:30	4.10
07/03/2000 01:00–13/03/2000 15:00	6.58
21/05/2000 17:00–27/05/2000 15:00	5.92
20/04/2001 08:00–27/04/2001 11:30	7.15

Table 1
Weipa wave climate summary of data capture December 1978–January 2004.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly
1978												31.85	31.85
1979	100.00	100.00	100.00	46.67	100.00	100.00	100.00	100.00	100.00	100.00	93.33	100.00	95.00
1980	80.65	100.00	100.00	100.00	100.00	41.67	100.00	100.00	100.00	50.40	64.58	100.00	86.44
1981	85.48	100.00	79.44	56.25	100.00	66.67	100.00	100.00	100.00	100.00	100.00	96.77	90.38
1982	87.90	59.38	90.73	98.33	54.44	20.83	77.82	83.87	74.17	95.97	72.50	72.58	74.04
1983	98.39	72.32	98.39	100.00	100.00	100.00	49.19	98.39	75.83	94.35	100.00	98.39	90.44
1984	98.39	59.05	91.94	88.33	91.13	90.83	49.19	100.00	98.33	87.50	74.58	98.39	85.64
1985	79.84	25.89	88.71	72.92	81.05	87.50	92.74	100.00	98.33	100.00	73.33	44.35	78.72
1986	91.13	94.64	100.00	31.25	–	41.25	100.00	100.00	98.33	100.00	100.00	63.31	76.66
1987	65.73	98.21	42.34	67.92	96.77	100.00	95.16	100.00	75.42	50.40	37.08	65.73	74.56
1988	96.77	37.50	–	12.50	61.69	82.50	49.60	59.27	42.08	91.53	95.01	78.28	58.89
1989	73.38	62.47	91.92	71.36	76.95	66.65	98.39	83.88	37.50	90.33	78.34	79.51	75.89
1990	64.91	98.20	79.47	–	–	–	–	31.45	32.04	26.24	20.88	41.98	32.93
1991	–	–	–	–	46.77	23.74	37.12	25.46	3.73	5.98	63.01	20.50	18.86
1992	79.02	60.88	76.62	75.39	73.81	85.41	1.63	60.90	92.05	71.32	41.25	26.23	62.04
1993	4.44	–	–	34.97	84.65	96.64	54.52	62.41	53.87	70.21	82.57	54.30	49.88
1994	90.05	97.92	99.19	95.69	88.44	85.00	16.40	96.64	88.75	89.65	84.86	78.23	84.24
1995	89.52	94.04	72.85	79.44	92.20	91.11	94.09	92.47	33.89	71.84	80.35	93.02	82.07
1996	94.89	90.23	76.34	80.83	94.62	79.31	85.89	61.96	34.58	88.71	85.15	82.73	79.60
1997	87.23	90.55	86.29	80.07	78.36	90.90	94.29	88.98	54.87	31.72	81.94	81.45	78.89
1998	84.61	72.48	74.32	77.57	89.52	89.58	94.62	97.31	86.74	82.66	80.00	88.17	84.80
1999	97.18	97.32	61.28	74.72	88.98	90.42	93.15	84.68	75.98	84.14	73.55	88.78	84.18
2000	88.84	88.65	55.25	64.44	61.83	82.22	78.09	84.14	76.54	81.86	79.45	96.44	78.15
2001	80.11	97.02	69.82	65.83	87.23	91.25	79.50	80.71	80.77	79.63	87.22	95.83	82.91
2002	90.45	99.55	83.06	81.11	88.84	96.04	90.19	94.42	82.71	89.99	91.67	85.48	89.46
2003	97.72	90.92	85.21	69.31	81.99	88.96	92.13	86.09	83.41	90.46	89.79	91.80	87.32
2004	76.81												76.81

Table 2
Tropical cyclones impacting on Weipa wave site 22 December, 1978–31 January, 2004

Cyclone name	Start date	End date	Impacting Weipa site
PETER	29/12/1978	2/01/1979	Yes
GRETA	8/01/1979	12/01/1979	Yes
ROSA	24/02/1979	26/02/1979	Yes
STAN ¹	5/04/1979	15/04/1979	Yes
PAUL	4/01/1980	8/01/1980	Yes
UNNAMED	20/12/1981	20/12/1981	No
EDDIE	9/02/1981	12/02/1981	Yes
FREDA	25/02/1981	6/03/1981	Yes
DOMINIC	4/04/1982	7/04/1982	Yes
REBECCA ¹	21/02/1985	21/02/1985	Yes
KATHY	17/03/1984	23/03/1984	Yes
JIM	6/03/1984	8/03/1984	Yes
SANDY	20/03/1985	24/03/1985	Yes
VERNON	22/01/1986	24/01/1986	Yes
IRMA	19/01/1987	20/01/1987	Yes
JASON	6/02/1987	12/02/1987	Yes
MEENA	4/05/1989	8/05/1989	Yes
FELICITY	13/12/1989	19/12/1989	Yes
GREG	2/03/1990	4/03/1990	Yes
IVOR ¹	15/03/1990	21/03/1990	Yes
KELVIN	24/02/1991	5/03/1991	Yes
MARK	5/01/1992	10/01/1992	Yes
NINA	23/12/1992	2/01/1993	Yes
SADIE	29/01/1994	30/01/1994	Yes
WARREN	4/03/1995	5/03/1995	Yes
BARRY	3/01/1996	6/01/1996	Yes
DENNIS	15/02/1996	17/02/1996	Yes
ETHEL	8/03/1996	12/03/1996	Yes
PHIL	25/12/1996	2/01/1997	Yes
SID	25/12/1997	28/12/1997	Yes
LES	23/01/1998	24/01/1998	Yes
MAY	25/02/1998	25/02/1998	Yes
STEVE	26/02/2000	29/02/2000	Yes
WYLVA	15/02/2001	16/02/2001	Yes
ABIGAIL	23/02/2001	26/02/2001	Yes
BERNIE	2/01/2002	4/01/2002	Yes
CRAIG	9/03/2003	12/03/2003	Yes

Cyclone tracks are shown in figure 8.

¹ Wave information not available for these tropical cyclones.

Table 3
Major meteorological events 22 December, 1978–31 January, 2004

Meteorological Event (All Gulf of Carpentaria cyclones and other storm events)	Central Pressure (lowest) (hpa)	Date	Estimated position of cyclone relative to buoy (km)	Peak Hsig recorded (Note 1) (m)	Peak Hmax recorded (Note 2) (m)	Tp (Note 3) (s)
Tropical cyclone Peter.	980	31/12/1978	150 S	3.09	4.05	10.67
Tropical cyclone Greta.	985	10/01/1979	150 SSW	2.97	4.46	11.62
		21/01/1979		1.78	2.66	8.21
		25/01/1979		2.39	3.36	9.13
		5/02/1979		1.59	2.92	8.28
Tropical cyclone Rosa.	965	21/02/1979	460 SW	1.42	2.55	7.05
Tropical cyclone Stan.	995	13/04/1979	60 N	**	**	**
Tropical cyclone Paul.	996 (983)	6/01/1980	500 S	2.05	3.27	8.13
		6/02/1980		1.91	2.71	8.72
		16/02/1980		1.95	2.74	8.24
		9/01/1981		1.85	2.96	8.14
		13/01/1981		1.56	2.63	8.06
Low in southern Gulf of Carpentaria.	998	15/01/1981		2.39	3.84	9.46
Tropical cyclone Eddie.	984 (981)	11/02/1981	790 SW	1.63	3.12	8.22
Tropical cyclone Freda.	996 (962)	26/02/1981	350 SE	2.12	3.09	8.21
Strong wind field from tropical cyclone Abigail.		27/01/1982		2.22	3.11	8.10
		30/01/1982		1.92	2.88	8.61
Tropical cyclone Dominic.	950	7/04/1982	150 SSW	2.91	3.69	10.67
		12/01/1983		1.51	2.63	7.52
Tropical cyclone Kathy.	984 (920)	20/03/1984	192 WSW	1.25	1.96	4.78
Tropical cyclone Rebecca.	994	21/02/1985	24 SW	**	**	**
		21/03/1985		1.69	2.55	8.43
Tropical cyclone Sandy.	953	23/03/1985	330 WSW	2.72	4.03	10.08
		20/01/1986		1.61	2.47	8.62
Tropical cyclone Vernon.	1000 (990)	22/01/1986	434 S	2.27	4.95	8.11
Tropical cyclone Irma.	984 (978)	20/01/1987	880 WSW	1.36	2.58	7.93
		8/02/1987		1.97	3.19	8.55
		11/02/1987		1.82	2.89	9.91
Tropical cyclone Jason.	973 (970)	13/02/1987	540 SSW	2.05	3.75	9.46
		31/01/1988		1.68	2.69	9.41
		12/02/1988		2.00	2.76	8.67
		13/12/1988		1.83	2.78	7.40
		30/12/1988		1.68	2.94	7.54
		4/01/1989		1.53	2.34	6.77
Low in southeastern Gulf of Carpentaria.	1000	3/02/1989		2.15	3.58	9.17
Tropical cyclone Felicity.	975	15/12/1989	400 SSW	1.42	2.66	7.58
Tropical cyclone Greg.	990	8/03/1990	192 W	1.71	2.62	8.04
Tropical cyclone Ivor.	984 (965)	21/03/1990	175 S	2.73	3.87	8.76
Tropical cyclone Kelvin.	999 (980)	23/02/1991	113 N	**	**	**
Tropical cyclone Mark.	980	10/01/1992	110 SW	4.68	6.16	10.22
Low in southeastern Gulf of Carpentaria.	1000	27/02/1992		2.29	3.59	9.92
Tropical cyclone Nina.	970 (960)	24/12/1992	150 SSW	2.58	3.95	8.87
Tropical cyclone Sadie.	990 (985)	31/01/1994	186 WSW	1.17 (1.29)	2.16 (2.66)	7.53
Low in Gulf of Carpentaria and over Broome.	1000/992	20/02/1994		2.01	3.06(3.30)	9.05
Series of lows across northeastern Australia.	1004	28/02/1994		2.05 (2.11)	3.31(3.65)	8.75
Low in southern Gulf of Carpentaria.	1004	12/02/1995		1.89 (2.03)	3.02(3.66)	8.30
Tropical cyclone Warren	985 (960)	5/03/1995	325 SW	2.83(2.87)	4.10(5.10)	9.64
Low in southern Gulf of Carpentaria	1004	9/03/1995		2.16	3.74	9.20
Tropical cyclone Barry in southeast Gulf of Carpentaria.	955 (950)	6/01/1996	359 SSW	1.83 (1.97)	2.99 (3.51)	8.03
Tropical cyclone Dennis.	1000 (990)	12/02/1996	62 N	1.02(1.11)	1.72(1.94)	7.62
Low in western Gulf of Carpentaria.	1000	1/03/1996		1.61(1.66)	2.61(3.32)	8.72
Tropical cyclone Ethel.	1000 (980)	9/03/1996	200 SW	3.64 (3.76)	6.96	10.99

Notes: 1 & 2. The Hsig and Hmax values are the Peaks 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 4.68m, recorded on 10/01/1992 during passage of tropical cyclone Mark.
Highest maximum wave height (Hmax) recorded was 5.76m, recorded on 9/03/1996 during passage of tropical cyclone Ethel.

Table 3 - continued
Major meteorological events 31 December, 1978–15 January, 2004

Meteorological Event (All Gulf of Carpentaria cyclones and other storm events)	Central Pressure (lowest) (hpa)	Date	Estimated position of cyclone relative to buoy (km)	Peak Hsig recorded (Note 1) (m)	Peak Hmax recorded (Note 2) (m)	Tp (Note 3) (s)
Tropical cyclone Phil.	996 (975)	26/12/1996	No info.	1.59(1.63)	2.90(3.00)	8.48
Low in western Gulf of Carpentaria.	1000	23/02/1997		2.57(2.85)	4.18(4.64)	9.01
Ex -tropical cyclone Ita moving into southern Gulf.		25/02/1997		2.20	3.50	8.66
Low inland from Broome.	1000	2/03/1997		1.70	2.72	8.56
Trough associated with low over north-western Australia and tropical cyclone Justin in Coral Sea.	1004/976	8/03/1997	480 SW	2.99(3.35)	4.31(4.84)	10.07
Tropical cyclone Sid.	985	28/12/1997	403 SW	2.54(2.78)	4.26(4.75)	10.00
Ex-tropical cyclone Sid.	1004	4/01/1998		2.14	3.38	8.96
Ex-tropical cyclone Sid.	1004	6/01/1998		1.66	2.54	7.96
Ridge along Queensland east coast.		9/01/1998		2.10(2.31)	3.82(4.90)	7.99
Low over southern Gulf of Carpentaria.	1004	22/01/1998		2.64 (2.83)	4.23(5.14)	9.63
Tropical cyclone Les.	994 (980)	25/01/1998	264 SW	1.60	2.68	8.97
Tropical cyclone May.	990	27/02/1998	516 SW	1.76(1.84)	2.95(3.12)	8.80
Tropical cyclone May.	1004(990)	5/03/1998		1.49(1.65)	2.34(2.96)	7.86
Trough extending from southern Gulf of Carpentaria.		9/01/1999		1.83(1.92)	3.10(3.74)	7.71
Trough across central Australia.		15/01/1999		1.62(1.76)	2.80(3.30)	7.08
Ex-tropical cyclone Rona on east coast.		12/02/1999		2.12 (2.21)	3.42(4.23)	8.45
Tropical cyclone Steve.	985 (975)	2/03/2000	580 SW	1.12	1.97(2.10)	8.27
Tropical cyclone Winsome.	992	11/02/2001	600 WSW	1.75(1.94)	2.92(3.53)	10.48
Tropical cyclone Wylia.	990	15/02/2001	473 SW	2.54 (2.67)	4.21	8.82
Tropical cyclone Abigail.	1000 (970)	26/02/2001	450 SSW	2.28 (2.46)	3.67(4.62)	8.70
Monsoon trough across northern Australia.		17/12/2001		1.60(1.75)	2.62(3.01)	6.61
Tropical cyclone Bernie.	985	03/01/2002	400 SW	2.10 (2.29)	3.26(3.83)	8.65
Monsoon trough across northern Australia.		09/02/2002		1.55(1.71)	2.67(2.98)	7.81
Monsoon trough across northern Australia.		11/02/2002		1.84(2.04)	3.21(3.96)	8.09
Monsoon trough across northern Australia.		20/02/2002		1.74(1.90)	2.69(3.17)	8.71
Monsoon trough across northern Australia.		17/01/2003		1.57(1.65)	2.71(3.09)	9.04
Monsoon trough across northern Australia,						
Tropical cyclone Graham on WA coast.		28/02/2003		2.13 (2.37)	3.50 (4.59)	8.35
Tropical cyclone Craig.	982	12/03/2003		2.89 (3.12)	4.16 (4.84)	11.15
Ex-tropical cyclone Debbie over Northern Territory and active monsoon flow through Arafura Sea into Gulf of Carpentaria.		22/12/2003		1.31(3.38)	1.98(2.36)	10.32
Monsoon trough across northern Australia.		15/01/2004		1.56(1.66)	2.50(2.77)	8.06

** No wave information available

Notes: 1 & 2. The Hsig and Hmax values are the Peaks 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 4.68m, recorded on 10/01/1992 during passage of tropical cyclone Mark.

Highest maximum wave height (Hmax) recorded was 5.76m, recorded on 9/03/1996 during passage of tropical cyclone Ethel.

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 4
Wave statistics
Wave period (Tp)/ wave height (Hsig) occurrences
All data, all directions, measured in days

* = 0.00

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

Significant wave height (Hsig) (m)	Peak Energy Wave Period (Tp) (s)								Totals
	0-2.99	3-4.99	5-6.99	7-8.99	9-10.99	11-12.99	13-14.99	>14.99	
0.00 - 0.19	1053.67	342.16	203.52	20.02	3.12	6.42	9.89	2.20	1641.01
0.20 - 0.39	2512.21	737.70	602.84	57.35	4.52	0.42	*	*	3915.04
0.40 - 0.59	262.98	297.38	369.88	92.20	1.83	0.04	*	*	1024.32
0.60 - 0.79	6.82	52.88	173.30	79.89	3.29	*	*	*	316.18
0.80 - 0.99	1.50	9.15	59.44	94.04	3.21	*	*	*	167.34
1.00 - 1.19	1.00	1.12	24.33	69.83	4.81	0.02	*	*	101.11
1.20 - 1.39	1.00	0.26	6.04	56.25	5.06	*	*	*	68.61
1.40 - 1.59	*	0.33	3.56	36.68	4.67	0.06	*	*	45.31
1.60 - 1.79	*	0.04	0.25	24.27	4.36	0.06	*	*	28.98
1.80 - 1.99	*	*	0.04	12.27	3.78	*	*	*	16.10
2.00 - 2.19	*	*	*	7.16	3.88	*	*	*	11.04
2.20 - 2.39	*	*	*	2.98	4.41	0.06	*	*	7.45
2.40 - 2.59	*	*	*	1.61	1.32	0.25	*	*	3.18
2.60 - 2.79	*	*	*	0.40	2.81	*	*	*	3.20
2.80 - 2.99	*	*	*	0.25	1.43	0.27	*	*	1.95
3.00 - 3.19	*	*	*	*	0.47	*	0.08	*	0.55
3.20 - 3.39	*	*	*	*	0.05	*	*	*	0.05
3.40 - 3.59	*	*	*	*	0.09	*	*	*	0.09
3.60 - 3.79	*	*	*	*	0.05	0.33	*	*	0.38
3.80 - 3.99	*	*	*	*	*	*	*	*	*
4.00 - 4.19	*	*	*	*	*	*	*	*	*
4.20 - 4.39	*	*	*	*	*	0.25	*	*	0.25
4.40 - 4.59	*	*	*	*	*	*	*	*	*
4.60 - 4.79	*	*	*	*	0.25	*	*	*	0.25
4.80 - 4.99	*	*	*	*	*	*	*	*	*
Totals	3839.18	1441.02	1443.22	555.20	53.43	8.19	9.97	2.20	7352.41

Table 5
Wave statistics
Wave period (Tp)/ wave height (Hsig) occurrences
Summer data, all directions, measured in days

* = 0.00

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

Significant wave height (Hsig) (m)	Peak Energy Wave Period (Tp) (s)								Totals
	0-2.99	3-4.99	5-6.99	7-8.99	9-10.99	11-12.99	13-14.99	>14.99	
0.00 - 0.19	569.39	163.38	158.74	18.90	2.62	5.38	5.14	0.90	924.44
0.20 - 0.39	892.42	288.41	280.41	45.14	3.52	0.42	*	*	1510.33
0.40 - 0.59	80.36	132.66	215.79	83.22	1.83	0.04	*	*	513.91
0.60 - 0.79	3.90	19.37	141.54	79.45	3.04	*	*	*	247.30
0.80 - 0.99	1.25	4.36	55.71	93.04	3.21	*	*	*	157.56
1.00 - 1.19	1.00	0.53	22.75	69.83	4.81	0.02	*	*	98.94
1.20 - 1.39	0.75	0.26	6.04	56.25	5.06	*	*	*	68.37
1.40 - 1.59	*	0.33	3.56	36.68	4.67	0.06	*	*	45.31
1.60 - 1.79	*	0.04	0.25	24.27	4.36	0.06	*	*	28.98
1.80 - 1.99	*	*	0.04	12.27	3.78	*	*	*	16.10
2.00 - 2.19	*	*	*	7.16	3.88	*	*	*	11.04
2.20 - 2.39	*	*	*	2.98	4.41	0.06	*	*	7.45
2.40 - 2.59	*	*	*	1.61	1.32	0.25	*	*	3.18
2.60 - 2.79	*	*	*	0.40	2.81	*	*	*	3.20
2.80 - 2.99	*	*	*	0.25	1.43	0.27	*	*	1.95
3.00 - 3.19	*	*	*	*	0.47	*	0.08	*	0.55
3.20 - 3.39	*	*	*	*	0.05	*	*	*	0.05
3.40 - 3.59	*	*	*	*	0.09	*	*	*	0.09
3.60 - 3.79	*	*	*	*	0.05	0.33	*	*	0.38
3.80 - 3.99	*	*	*	*	*	*	*	*	*
4.00 - 4.19	*	*	*	*	*	*	*	*	*
4.20 - 4.39	*	*	*	*	*	0.25	*	*	0.25
4.40 - 4.59	*	*	*	*	*	*	*	*	*
4.60 - 4.79	*	*	*	*	0.25	*	*	*	0.25
4.80 - 4.99	*	*	*	*	*	*	*	*	*
Totals	1549.08	609.34	884.83	531.46	51.68	7.15	5.22	0.90	3639.65

Table 6
Wave statistics
Wave period (Tp)/ wave height (Hsig) occurrences
Winter data, all directions, measured in days

* = 0.00

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

Significant wave height (Hsig) (m)	Peak Energy Wave Period (Tp) (s)								Totals
	0-2.99	3-4.99	5-6.99	7-8.99	9-10.99	11-12.99	13-14.99	>14.99	
0.00 - 0.19	484.28	178.79	44.78	1.12	0.50	1.04	4.76	1.30	716.57
0.20 - 0.39	1619.79	449.29	322.43	12.21	1.00	*	*	*	2404.71
0.40 - 0.59	182.62	164.73	154.09	8.98	*	*	*	*	510.41
0.60 - 0.79	2.91	33.51	31.77	0.44	0.25	*	*	*	68.88
0.80 - 0.99	0.25	4.79	3.73	1.00	*	*	*	*	9.77
1.00 - 1.19	*	0.58	1.58	*	*	*	*	*	2.17
1.20 - 1.39	0.25	*	*	*	*	*	*	*	0.25
1.40 - 1.59	*	*	*	*	*	*	*	*	*
1.60 - 1.79	*	*	*	*	*	*	*	*	*
1.80 - 1.99	*	*	*	*	*	*	*	*	*
2.00 - 2.19	*	*	*	*	*	*	*	*	*
2.20 - 2.39	*	*	*	*	*	*	*	*	*
2.40 - 2.59	*	*	*	*	*	*	*	*	*
2.60 - 2.79	*	*	*	*	*	*	*	*	*
2.80 - 2.99	*	*	*	*	*	*	*	*	*
3.00 - 3.19	*	*	*	*	*	*	*	*	*
3.20 - 3.39	*	*	*	*	*	*	*	*	*
3.40 - 3.59	*	*	*	*	*	*	*	*	*
3.60 - 3.79	*	*	*	*	*	*	*	*	*
3.80 - 3.99	*	*	*	*	*	*	*	*	*
4.00 - 4.19	*	*	*	*	*	*	*	*	*
4.20 - 4.39	*	*	*	*	*	*	*	*	*
4.40 - 4.59	*	*	*	*	*	*	*	*	*
4.60 - 4.79	*	*	*	*	*	*	*	*	*
4.80 - 4.99	*	*	*	*	*	*	*	*	*
Totals	2290.10	831.68	558.38	23.74	1.75	1.04	4.76	1.30	3712.76

Table 7
Wave statistics
Wave period (Tp)/ wave height (Hsig) occurrences
All data, all directions, measured as percentage occurrence of the recording period

* = 0.00

(Table values are percentage occurrences for the recording period, rounded to the second decimal point)

Significant wave height (Hsig) (m)	Peak energy wave period (Tp) (s)								Totals
	0-2.99	3-4.99	5-6.99	7-8.99	9-10.99	11-12.99	13-14.99	>14.99	
0.00 - 0.19	14.33	4.65	2.77	0.27	0.04	0.09	0.13	0.03	22.32
0.20 - 0.39	34.17	10.03	8.20	0.78	0.06	0.01	*	*	53.25
0.40 - 0.59	3.58	4.04	5.03	1.25	0.02	*	*	*	13.93
0.60 - 0.79	0.09	0.72	2.36	1.09	0.04	*	*	*	4.30
0.80 - 0.99	0.02	0.12	0.81	1.28	0.04	*	*	*	2.28
1.00 - 1.19	0.01	0.02	0.33	0.95	0.07	*	*	*	1.38
1.20 - 1.39	0.01	*	0.08	0.77	0.07	*	*	*	0.93
1.40 - 1.59	*	*	0.05	0.50	0.06	*	*	*	0.62
1.60 - 1.79	*	*	*	0.33	0.06	*	*	*	0.39
1.80 - 1.99	*	*	*	0.17	0.05	*	*	*	0.22
2.00 - 2.19	*	*	*	0.10	0.05	*	*	*	0.15
2.20 - 2.39	*	*	*	0.04	0.06	*	*	*	0.10
2.40 - 2.59	*	*	*	0.02	0.02	*	*	*	0.04
2.60 - 2.79	*	*	*	0.01	0.04	*	*	*	0.04
2.80 - 2.99	*	*	*	*	0.02	*	*	*	0.03
3.00 - 3.19	*	*	*	*	0.01	*	*	*	0.01
3.20 - 3.39	*	*	*	*	*	*	*	*	*
3.40 - 3.59	*	*	*	*	*	*	*	*	*
3.60 - 3.79	*	*	*	*	*	*	*	*	0.01
3.80 - 3.99	*	*	*	*	*	*	*	*	*
4.00 - 4.19	*	*	*	*	*	*	*	*	*
4.20 - 4.39	*	*	*	*	*	*	*	*	*
4.40 - 4.59	*	*	*	*	*	*	*	*	*
4.60 - 4.79	*	*	*	*	*	*	*	*	*
4.80 - 4.99	*	*	*	*	*	*	*	*	*
Totals	52.22	19.60	19.63	7.55	0.73	0.11	0.14	0.03	100.0

Table 8
Wave statistics
Wave period (Tp)/ wave height (Hsig) occurrences
Summer data, all directions, measured as percentage occurrence of the recording period

* = 0.00

(Table values are percentage occurrences for the recording period, rounded to the second decimal point)

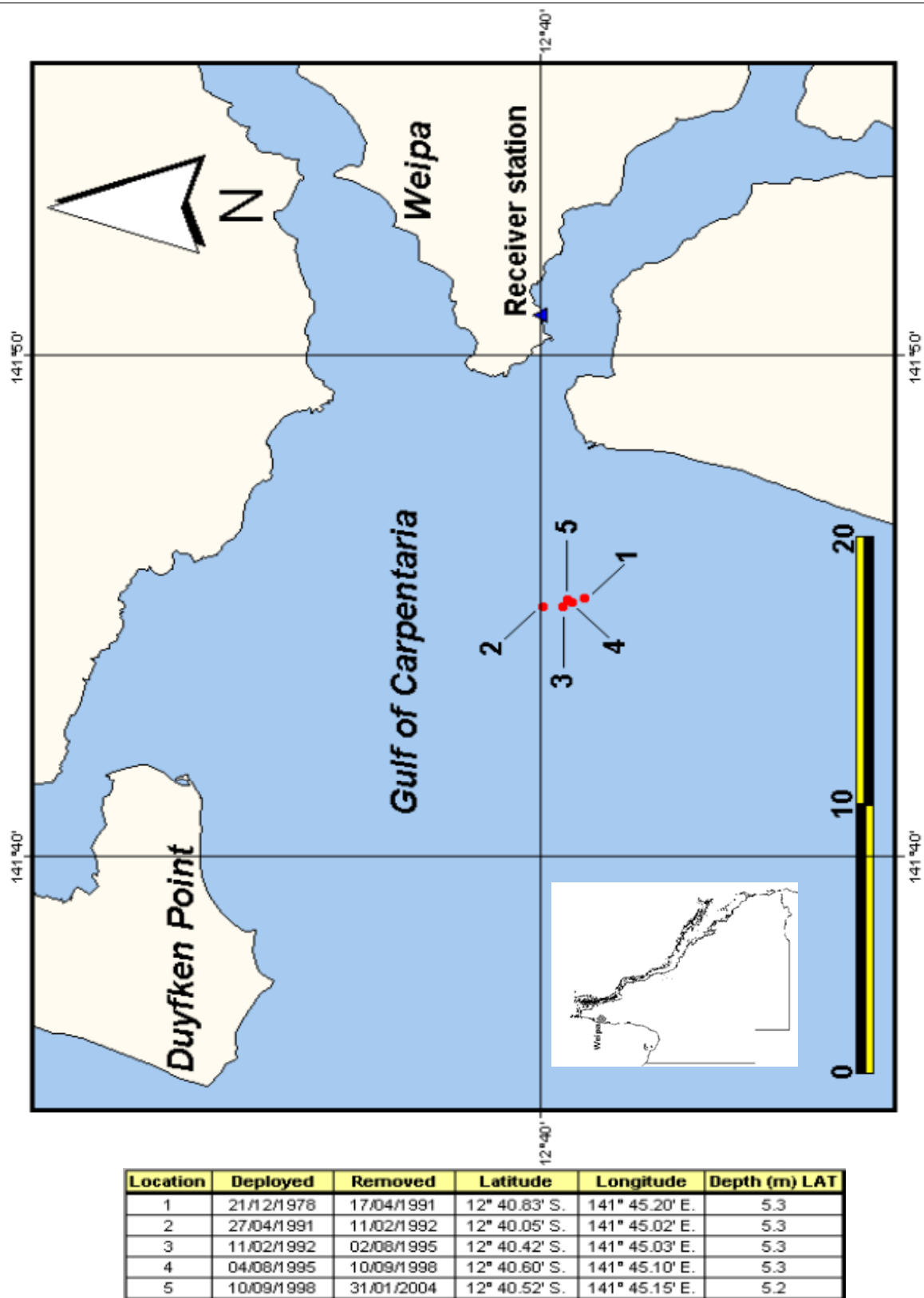
Significant wave height (Hsig) (m)	Peak energy wave period (Tp) (s)								Totals
	0-2.99	3-4.99	5-6.99	7-8.99	9-10.99	11-12.99	13-14.99	>14.99	
0.00 - 0.19	15.64	4.49	4.36	0.52	0.07	0.15	0.14	0.02	25.40
0.20 - 0.39	24.52	7.92	7.70	1.24	0.10	0.01	*	*	41.50
0.40 - 0.59	2.21	3.64	5.93	2.29	0.05	*	*	*	14.12
0.60 - 0.79	0.11	0.53	3.89	2.18	0.08	*	*	*	6.79
0.80 - 0.99	0.03	0.12	1.53	2.56	0.09	*	*	*	4.33
1.00 - 1.19	0.03	0.01	0.63	1.92	0.13	*	*	*	2.72
1.20 - 1.39	0.02	0.01	0.17	1.55	0.14	*	*	*	1.88
1.40 - 1.59	*	0.01	0.10	1.01	0.13	*	*	*	1.24
1.60 - 1.79	*	*	0.01	0.67	0.12	*	*	*	0.80
1.80 - 1.99	*	*	*	0.34	0.10	*	*	*	0.44
2.00 - 2.19	*	*	*	0.20	0.11	*	*	*	0.30
2.20 - 2.39	*	*	*	0.08	0.12	*	*	*	0.20
2.40 - 2.59	*	*	*	0.04	0.04	0.01	*	*	0.09
2.60 - 2.79	*	*	*	0.01	0.08	*	*	*	0.09
2.80 - 2.99	*	*	*	0.01	0.04	0.01	*	*	0.05
3.00 - 3.19	*	*	*	*	0.01	*	*	*	0.02
3.20 - 3.39	*	*	*	*	*	*	*	*	*
3.40 - 3.59	*	*	*	*	*	*	*	*	*
3.60 - 3.79	*	*	*	*	*	0.01	*	*	0.01
3.80 - 3.99	*	*	*	*	*	*	*	*	*
4.00 - 4.19	*	*	*	*	*	*	*	*	*
4.20 - 4.39	*	*	*	*	*	0.01	*	*	0.01
4.40 - 4.59	*	*	*	*	*	*	*	*	*
4.60 - 4.79	*	*	*	*	0.01	*	*	*	0.01
4.80 - 4.99	*	*	*	*	*	*	*	*	*
Totals	42.56	16.74	24.31	14.60	1.42	0.20	0.14	0.02	100.0

Table 9
Wave statistics
Wave period (Tp)/ wave height (Hsig) occurrences
Winter data, all directions, measured as percentage occurrence of the recording period

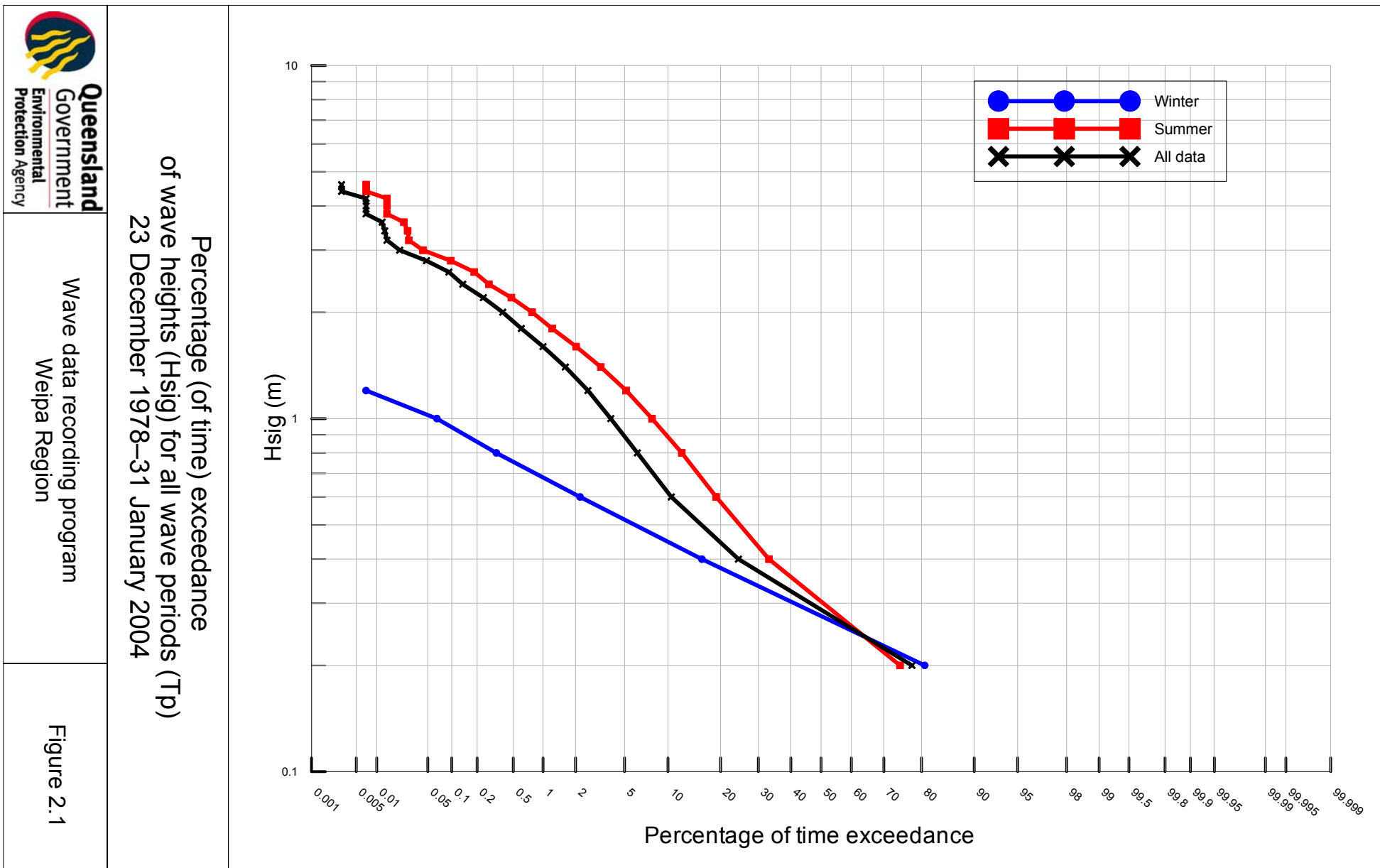
* = 0.00

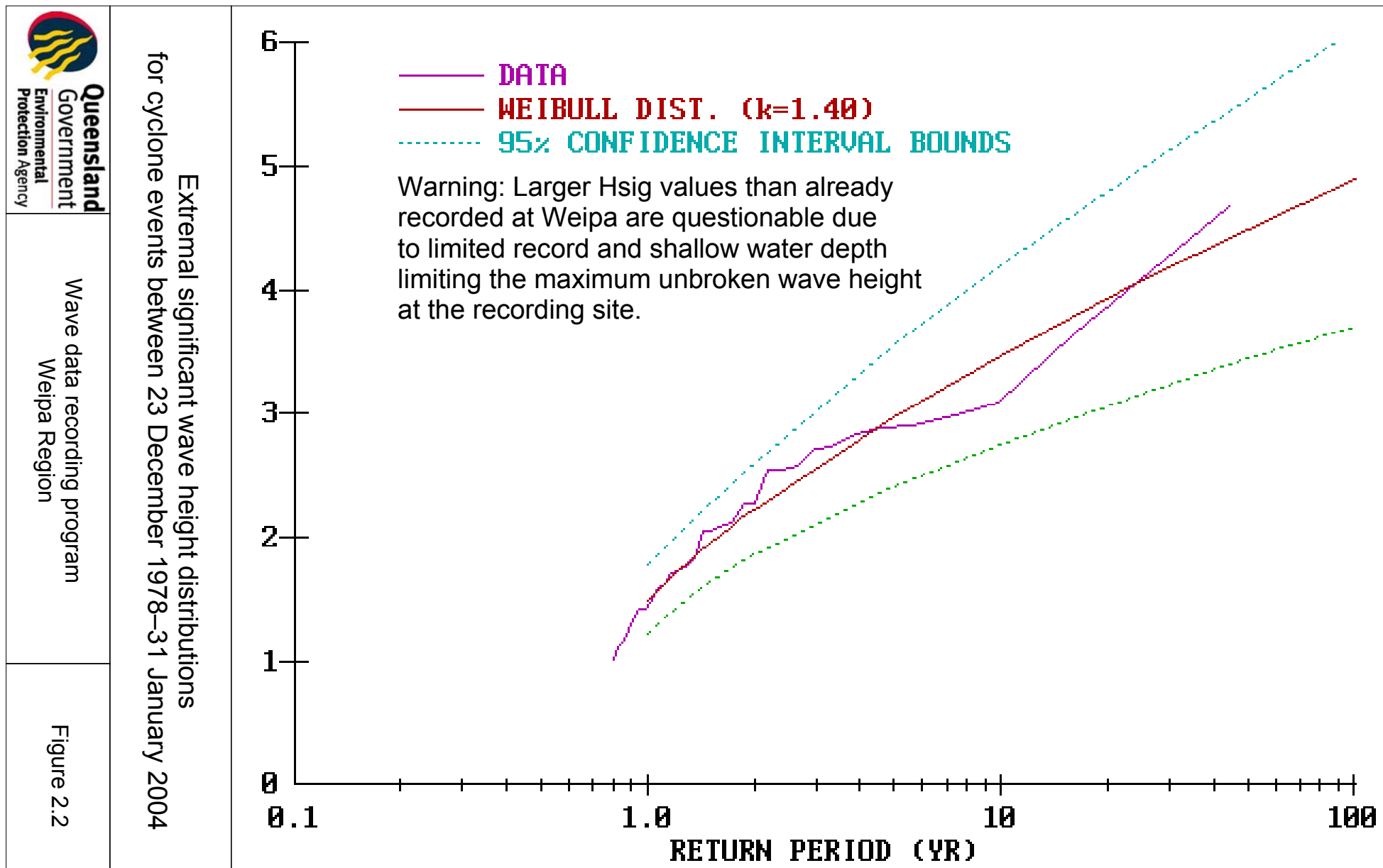
(Table values are percentage occurrences for the recording period, rounded to the second decimal point)

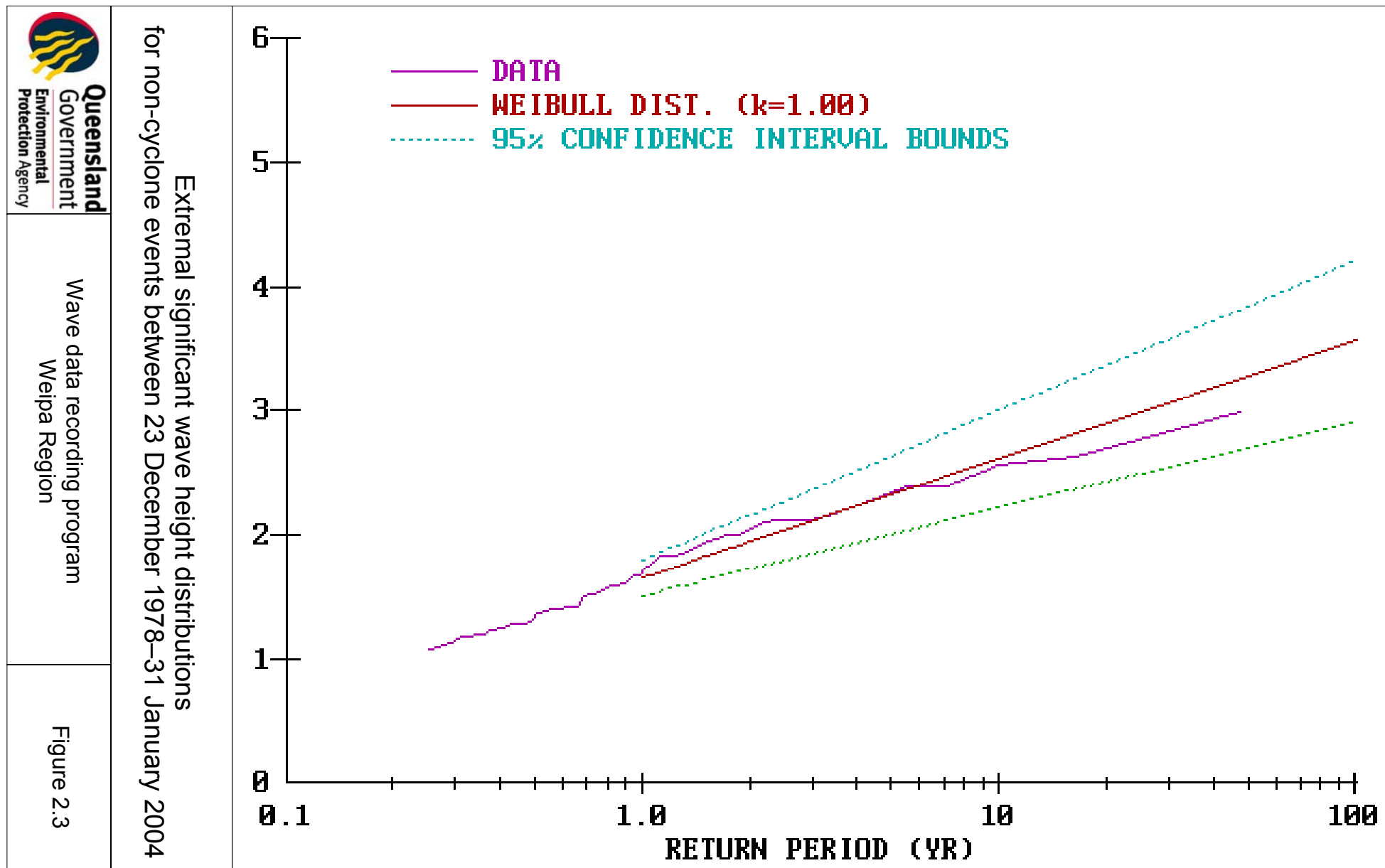
Significant wave height (Hsig) (m)	Peak energy wave period (Tp) (s)								Totals
	0-2.99	3-4.99	5-6.99	7-8.99	9-10.99	11-12.99	13-14.99	>14.99	
0.00 - 0.19	13.04	4.82	1.21	0.03	0.01	0.03	0.13	0.04	19.30
0.20 - 0.39	43.63	12.10	8.68	0.33	0.03	*	*	*	64.77
0.40 - 0.59	4.92	4.44	4.15	0.24	*	*	*	*	13.75
0.60 - 0.79	0.08	0.90	0.86	0.01	0.01	*	*	*	1.86
0.80 - 0.99	0.01	0.13	0.10	0.03	*	*	*	*	0.26
1.00 - 1.19	*	0.02	0.04	*	*	*	*	*	0.06
1.20 - 1.39	0.01	*	*	*	*	*	*	*	0.01
1.40 - 1.59	*	*	*	*	*	*	*	*	*
1.60 - 1.79	*	*	*	*	*	*	*	*	*
1.80 - 1.99	*	*	*	*	*	*	*	*	*
2.00 - 2.19	*	*	*	*	*	*	*	*	*
2.20 - 2.39	*	*	*	*	*	*	*	*	*
2.40 - 2.59	*	*	*	*	*	*	*	*	*
2.60 - 2.79	*	*	*	*	*	*	*	*	*
2.80 - 2.99	*	*	*	*	*	*	*	*	*
3.00 - 3.19	*	*	*	*	*	*	*	*	*
3.20 - 3.39	*	*	*	*	*	*	*	*	*
3.40 - 3.59	*	*	*	*	*	*	*	*	*
3.60 - 3.79	*	*	*	*	*	*	*	*	*
3.80 - 3.99	*	*	*	*	*	*	*	*	*
4.00 - 4.19	*	*	*	*	*	*	*	*	*
4.20 - 4.39	*	*	*	*	*	*	*	*	*
4.40 - 4.59	*	*	*	*	*	*	*	*	*
4.60 - 4.79	*	*	*	*	*	*	*	*	*
4.80 - 4.99	*	*	*	*	*	*	*	*	*
Totals	61.68	22.40	15.04	0.64	0.05	0.03	0.13	0.04	100.0

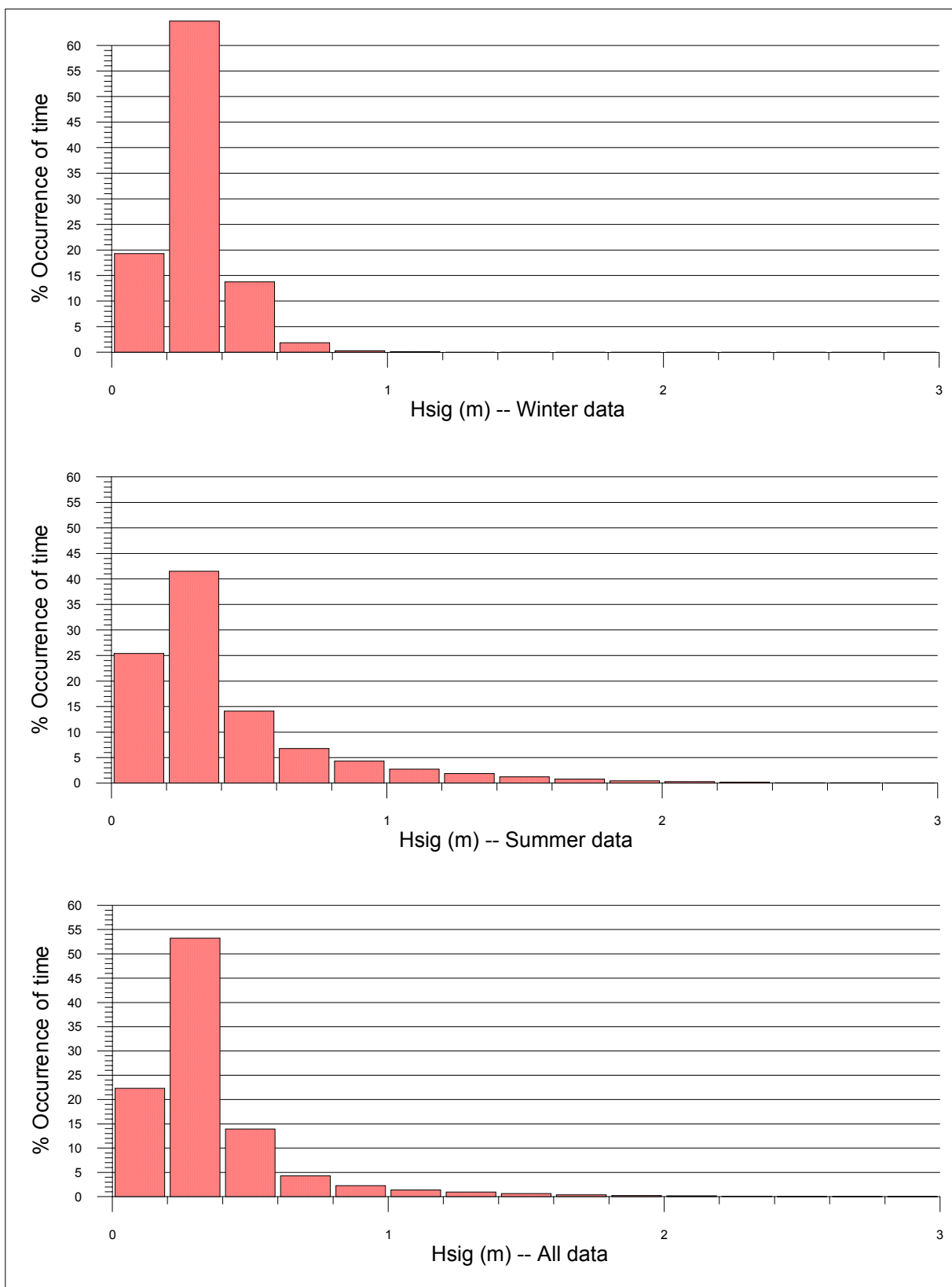


Weipa region—Locality plan

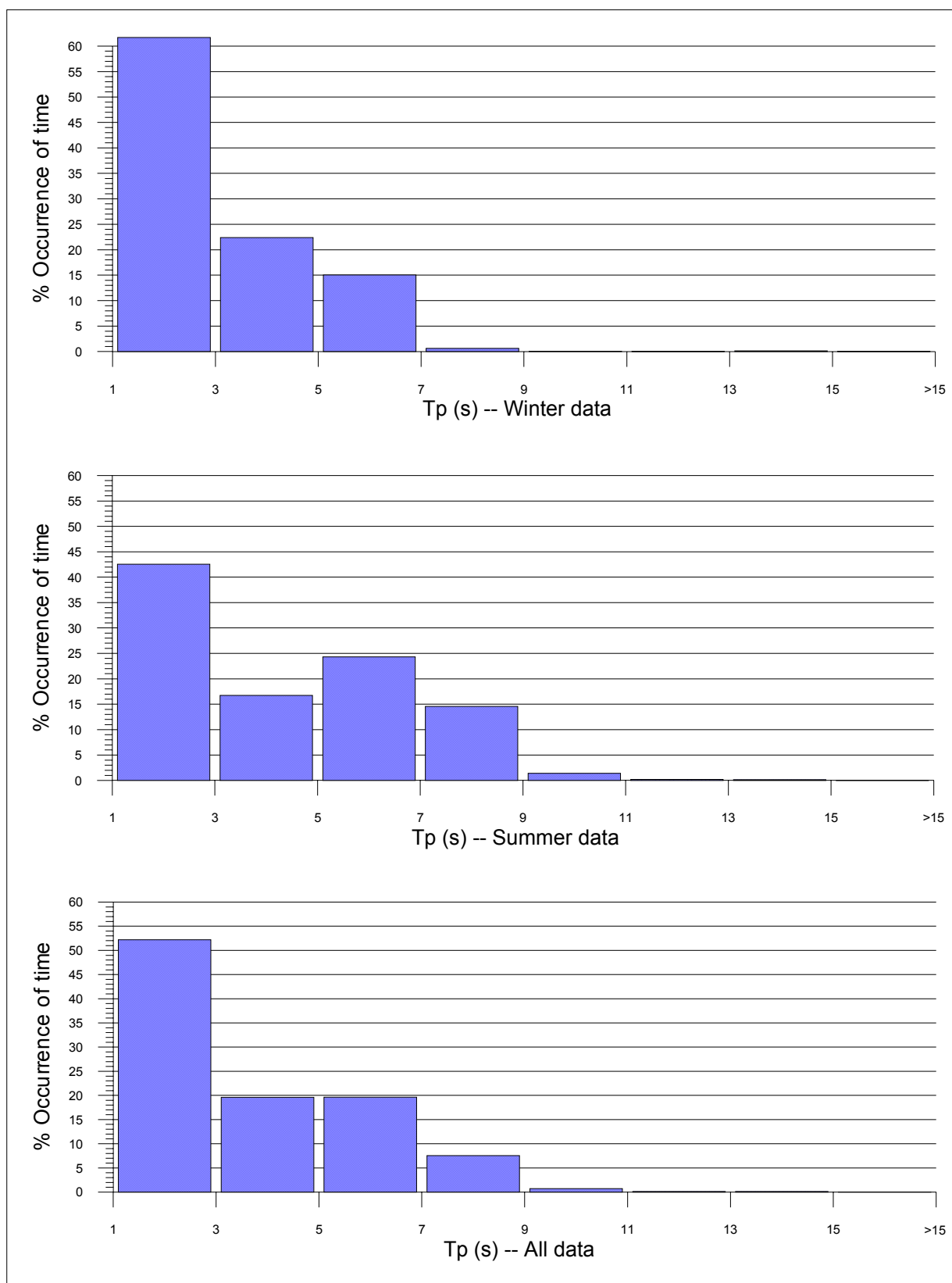




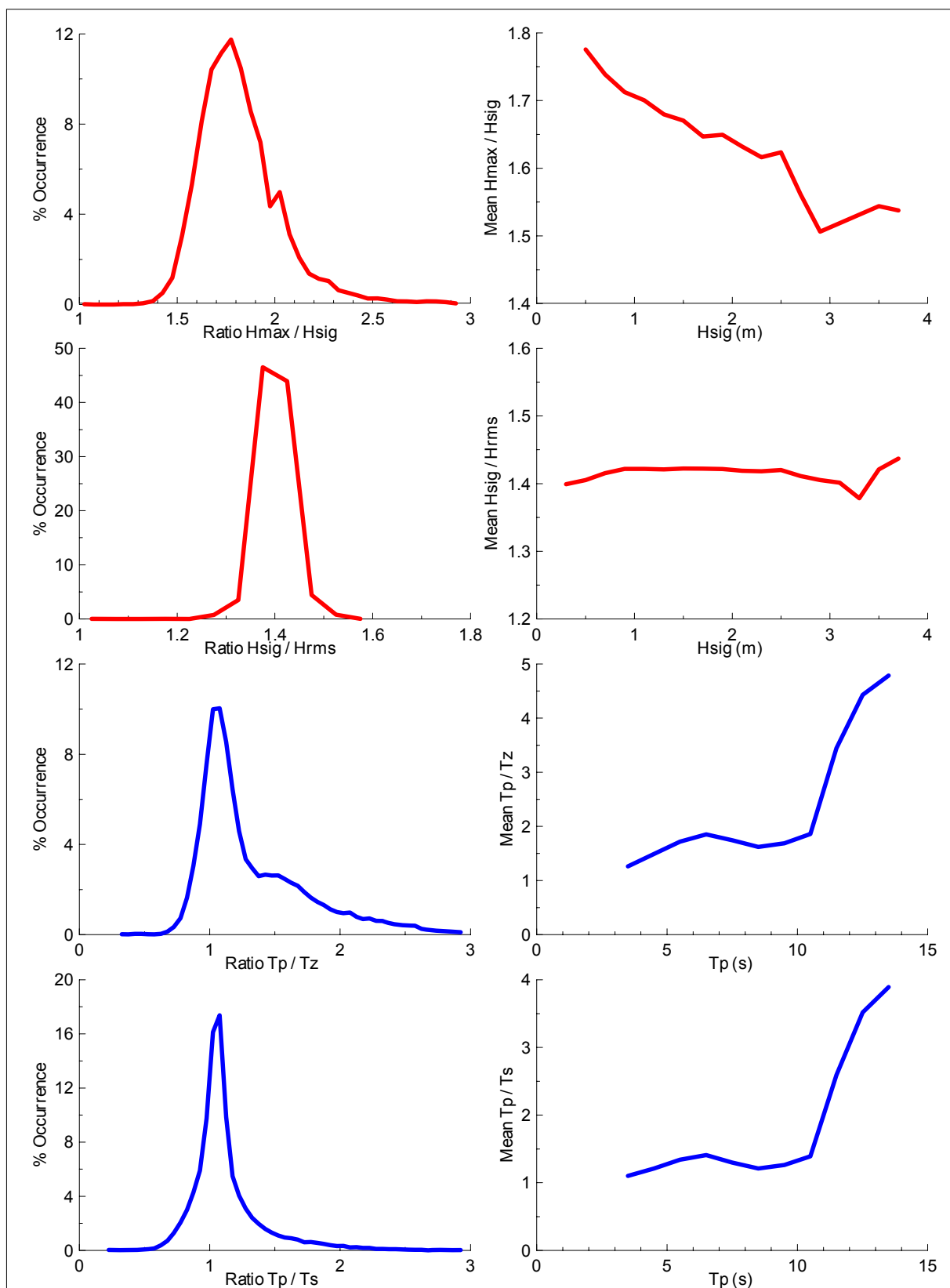




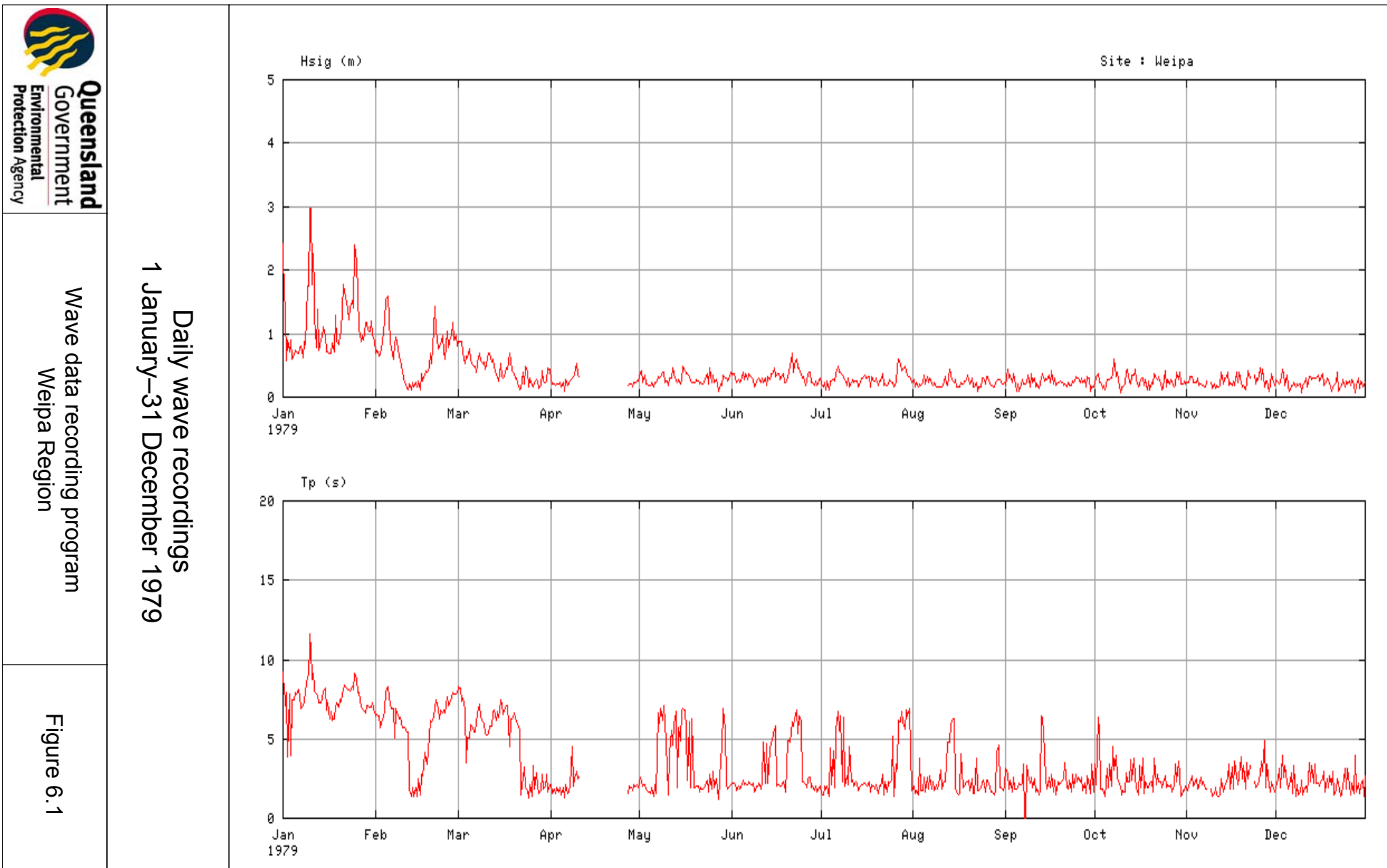
Histogram percentage (of time)
occurrence of wave heights (Hsig)
for all wave periods (Tp)

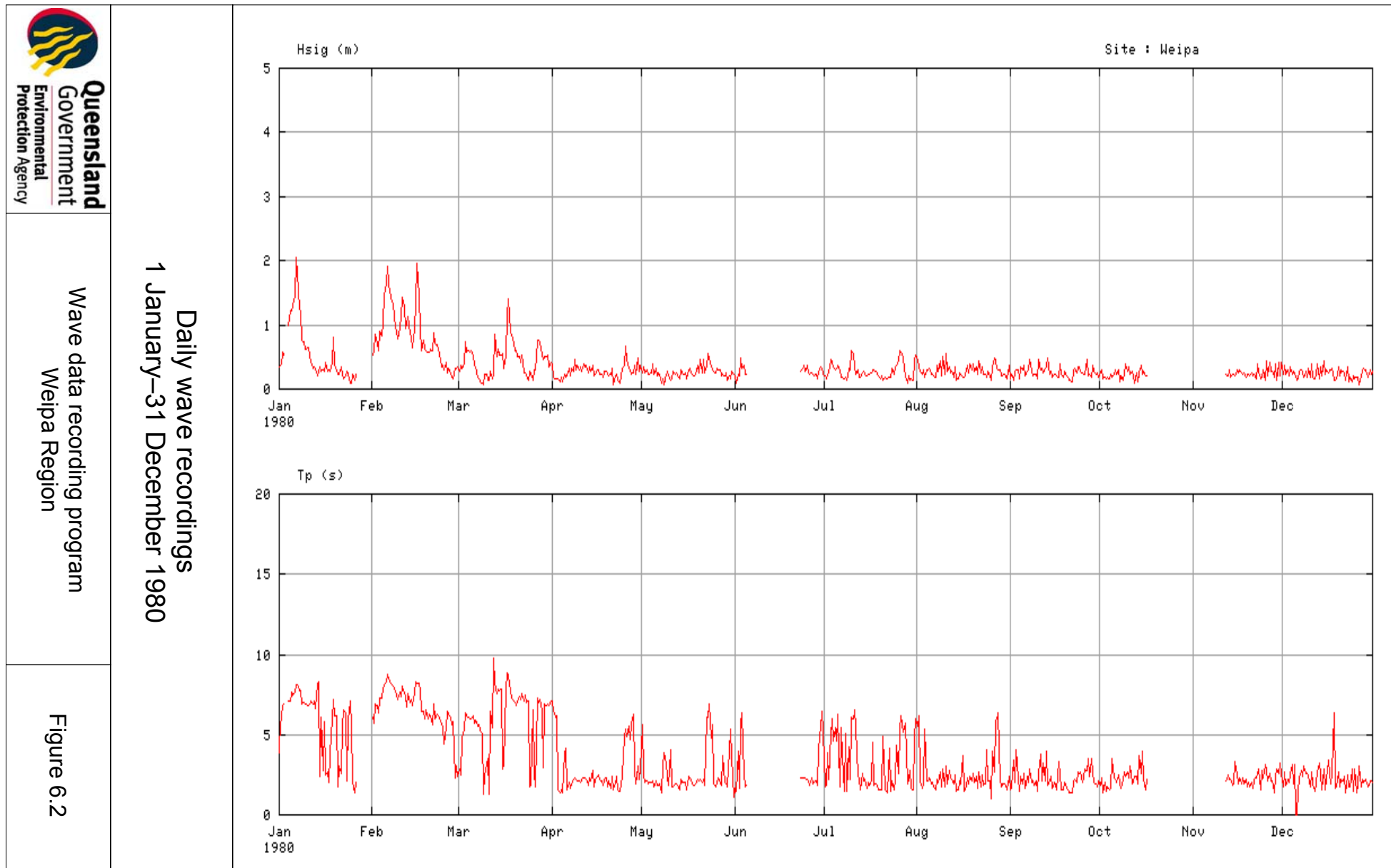


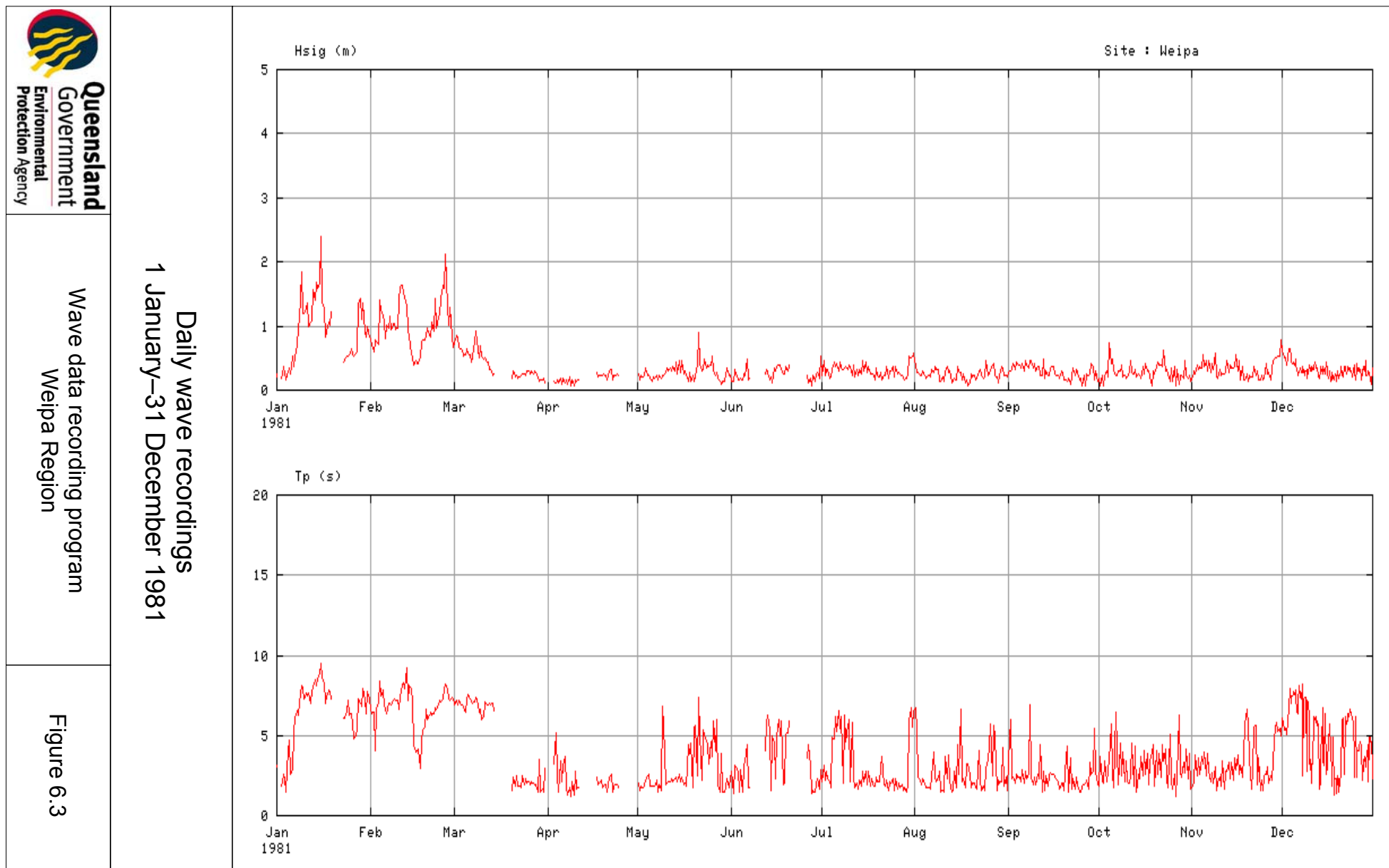
Histogram percentage (of time)
occurrence of wave periods (Tp)
for all wave heights (Hsig)

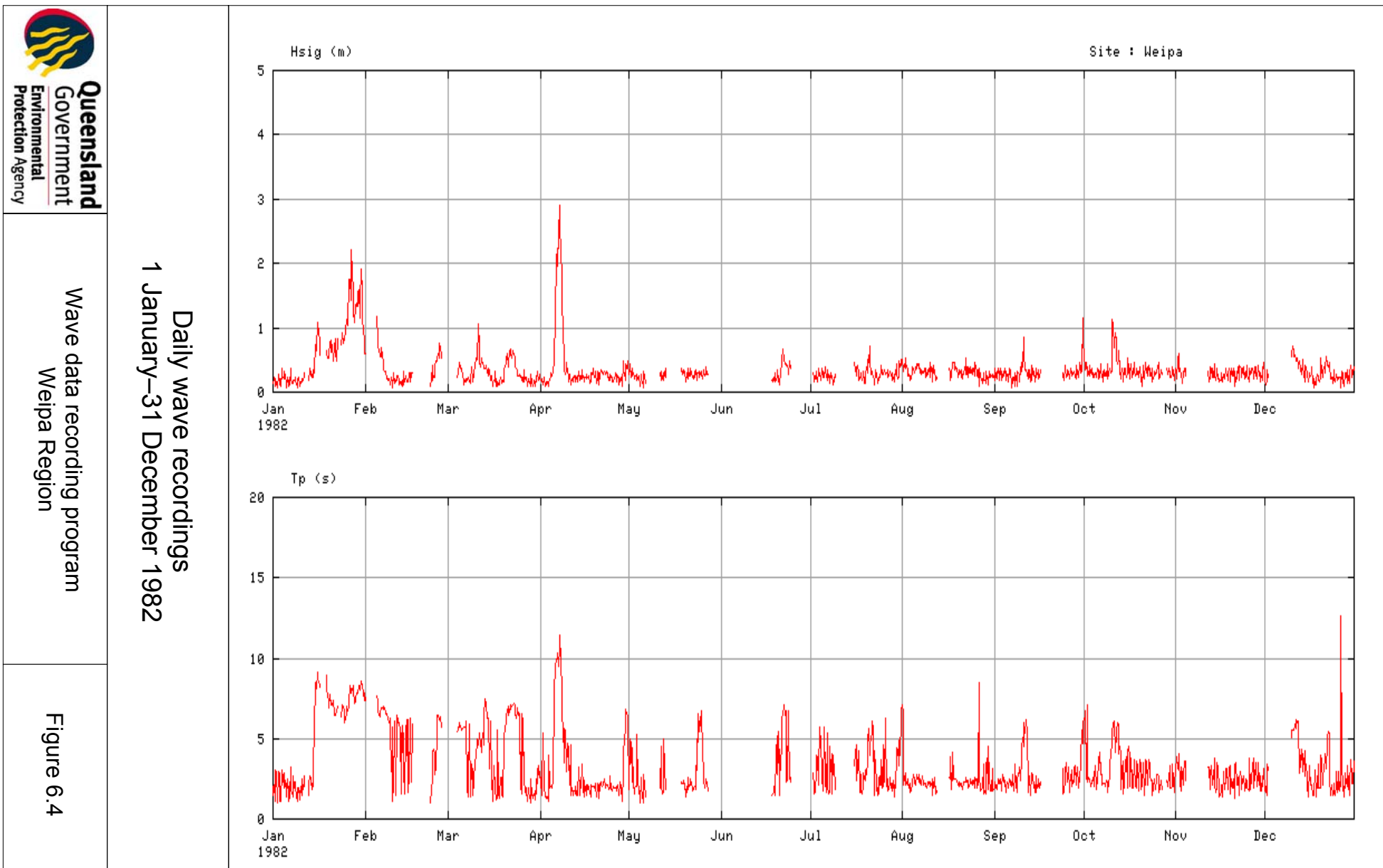


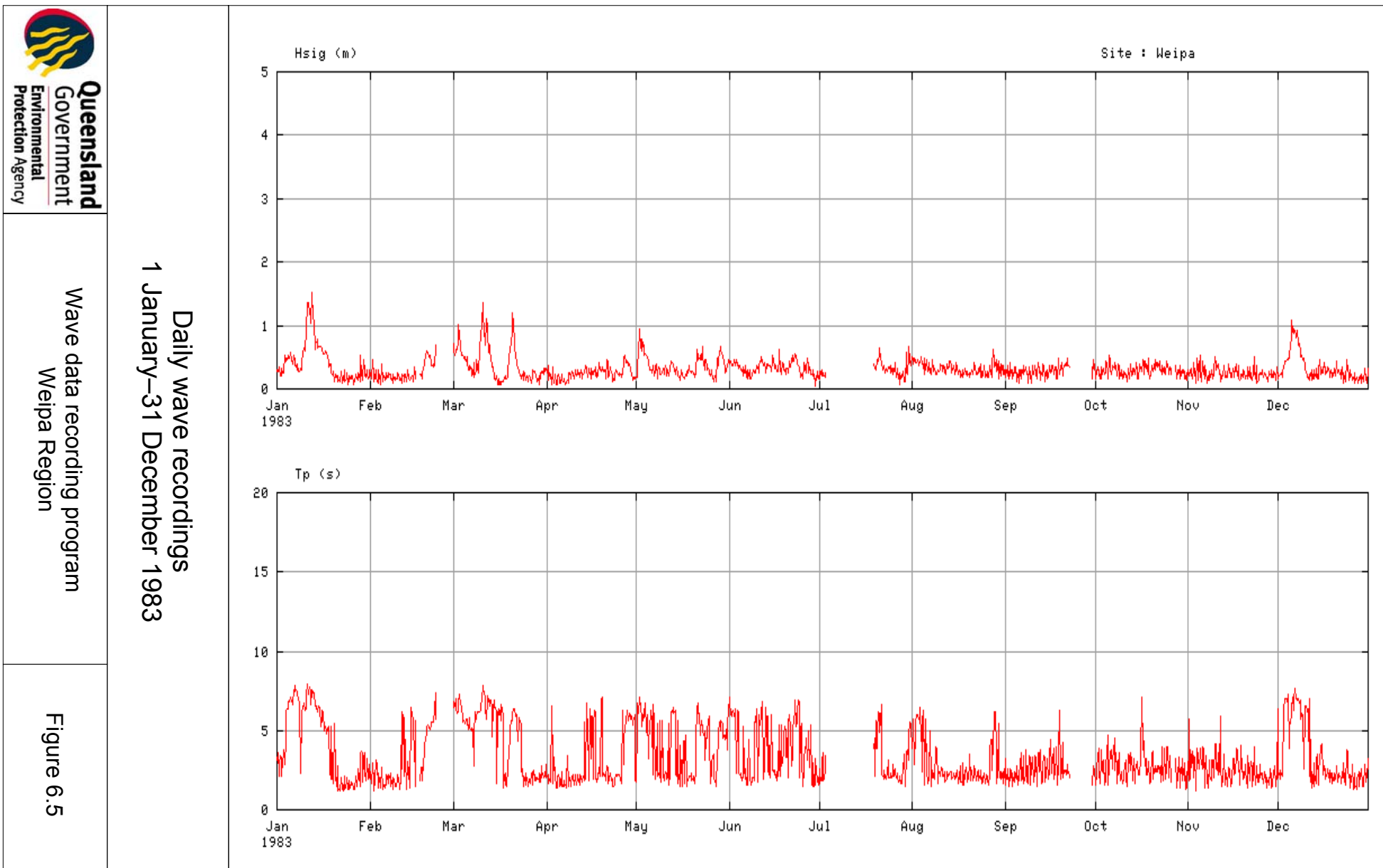
Wave parameter relationships
22 December 1978–31 January 2004

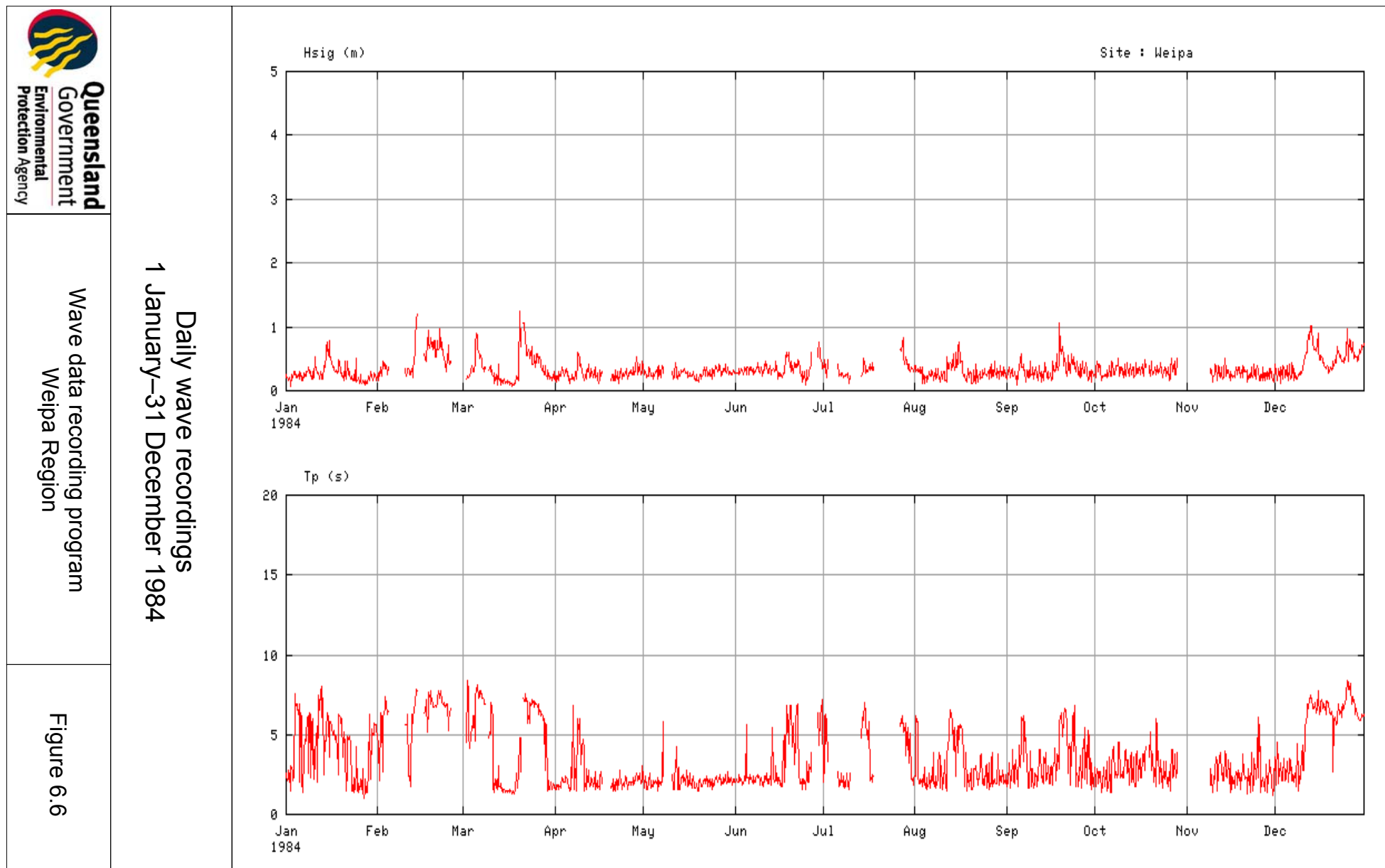


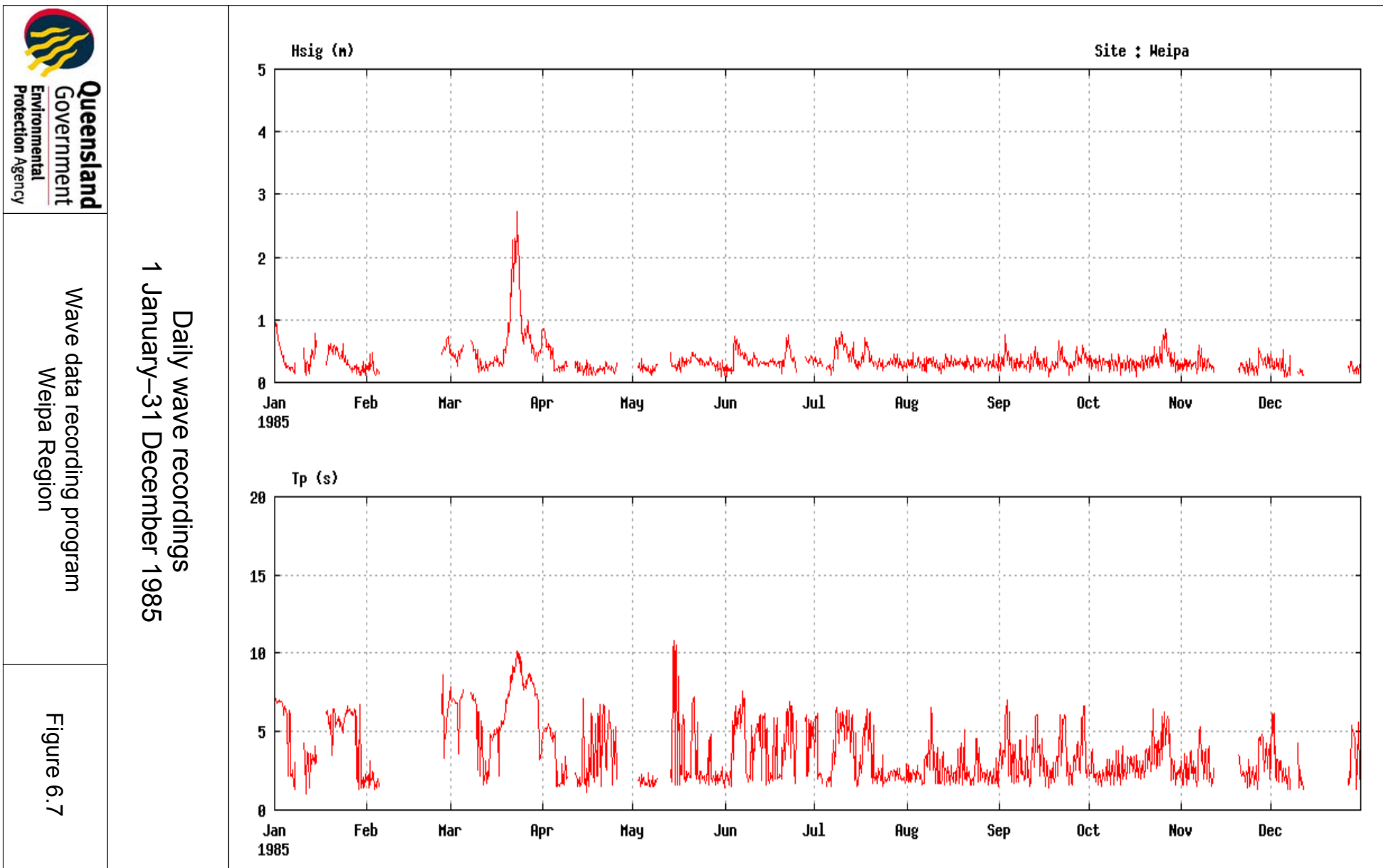


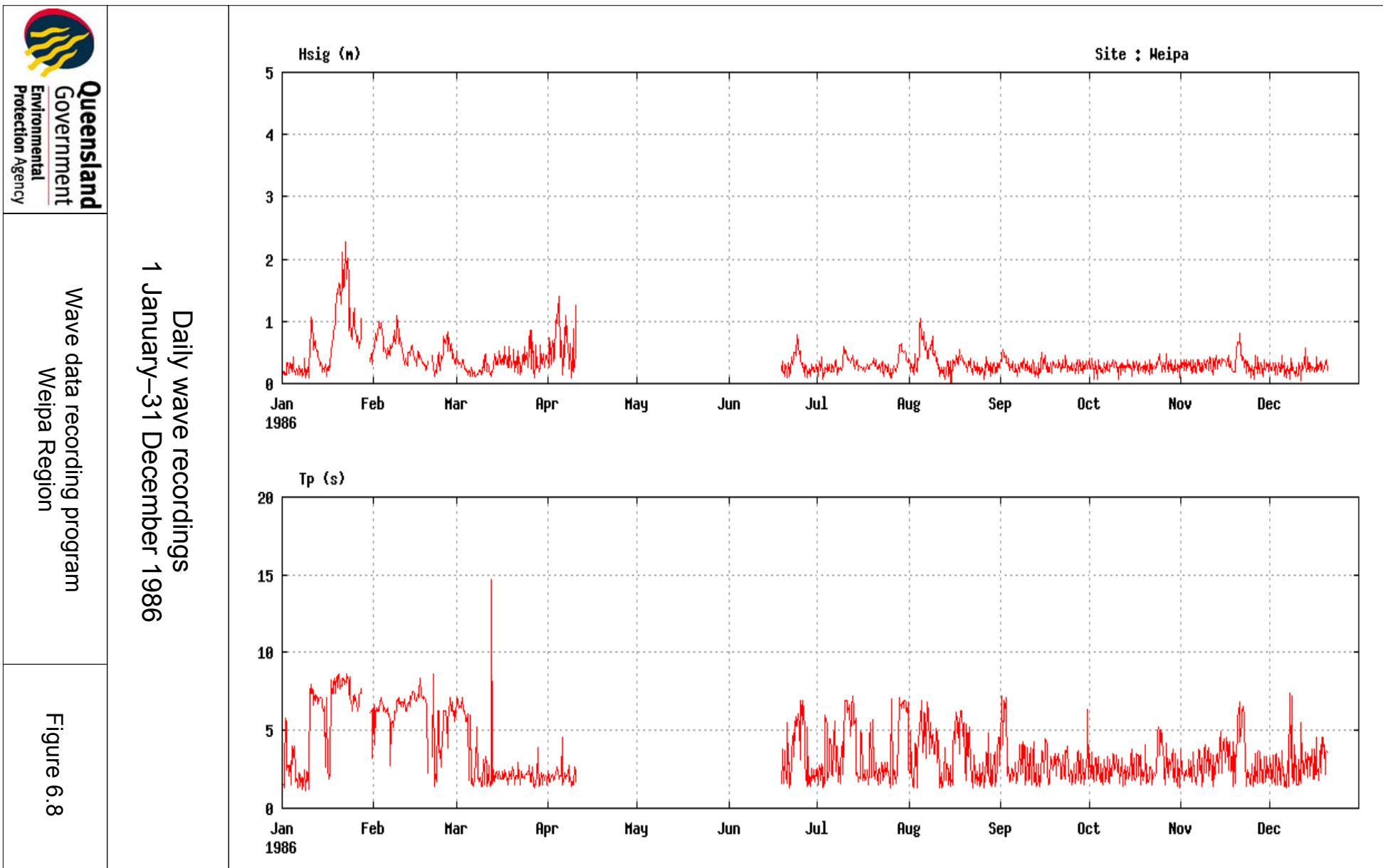


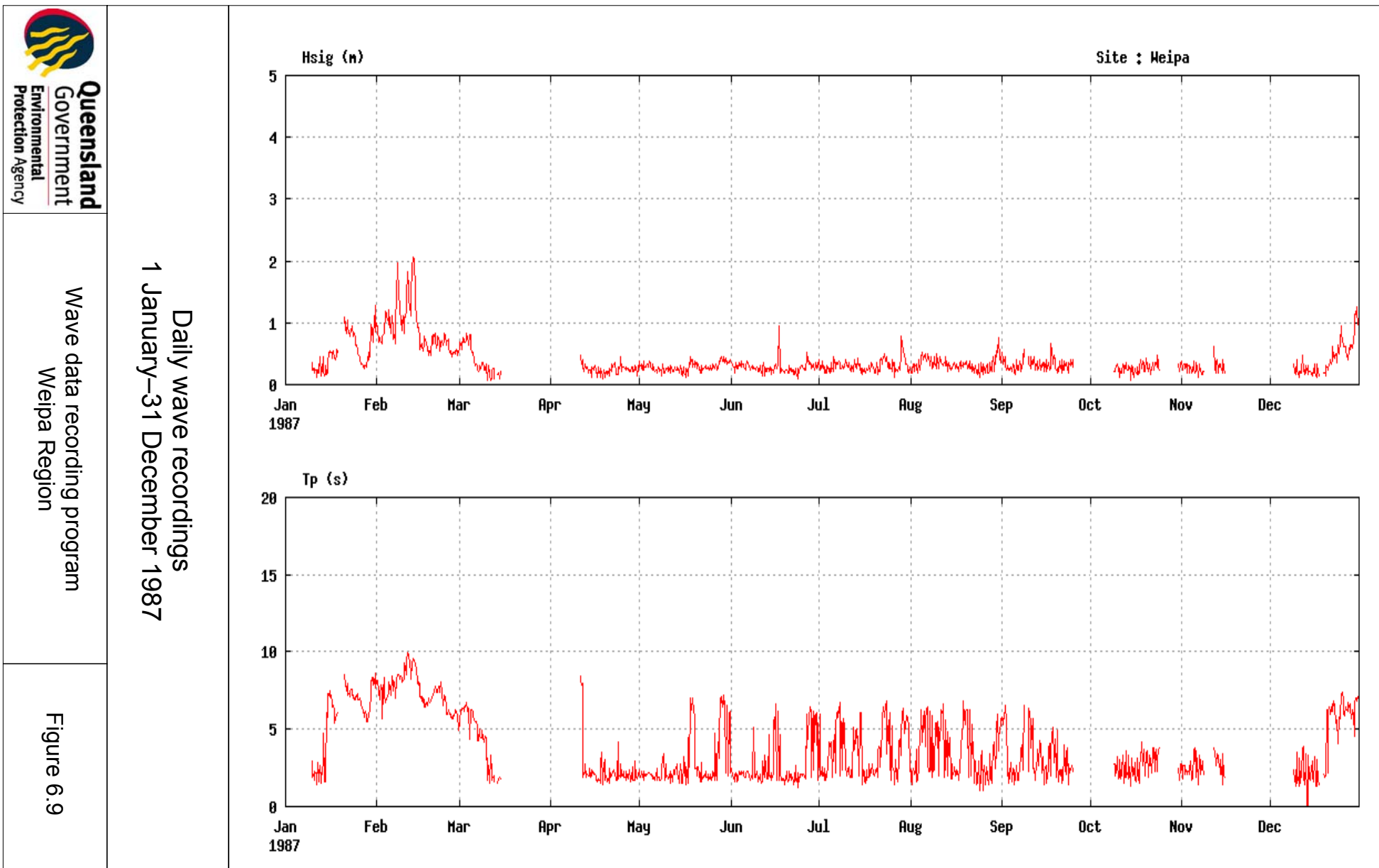


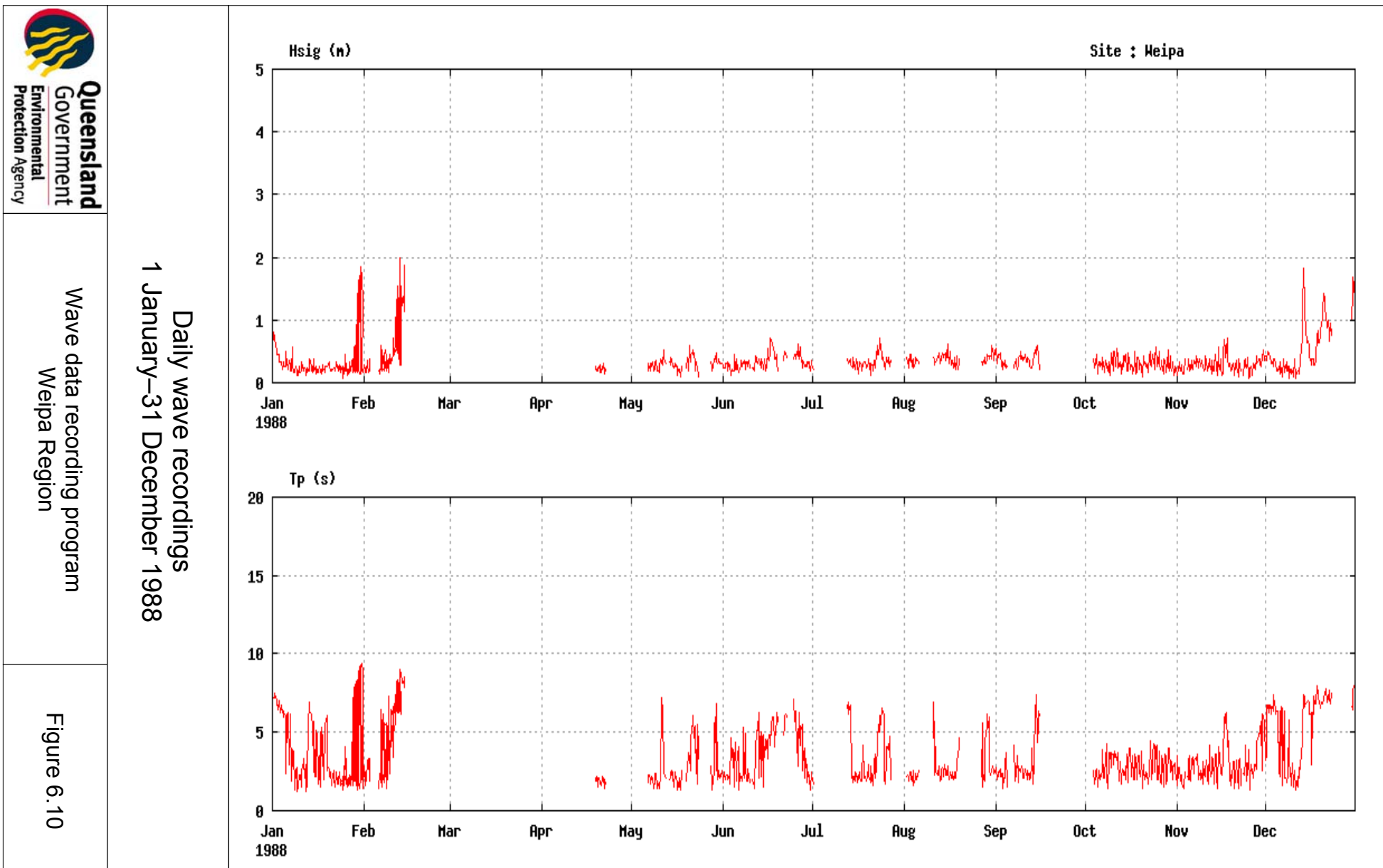


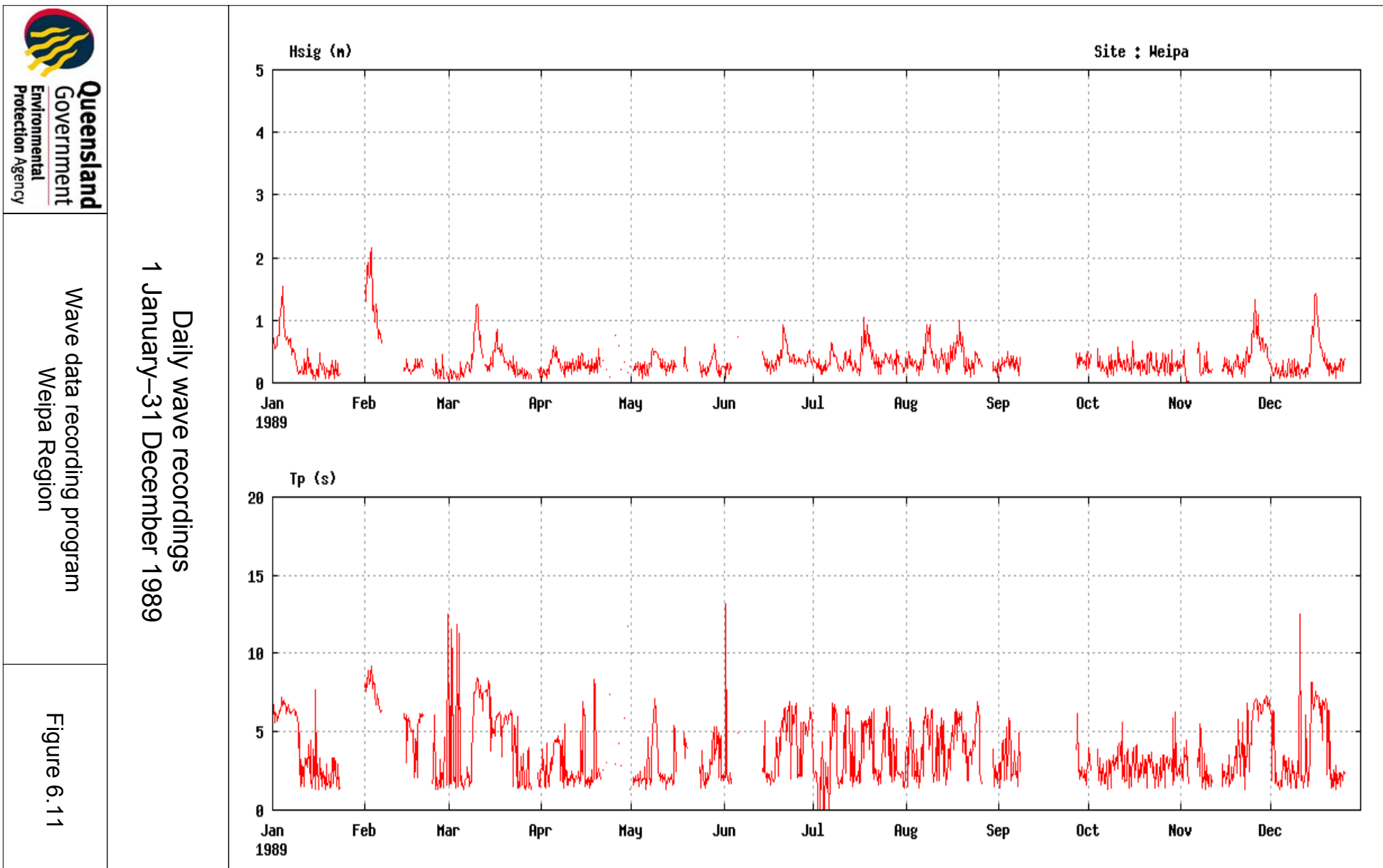


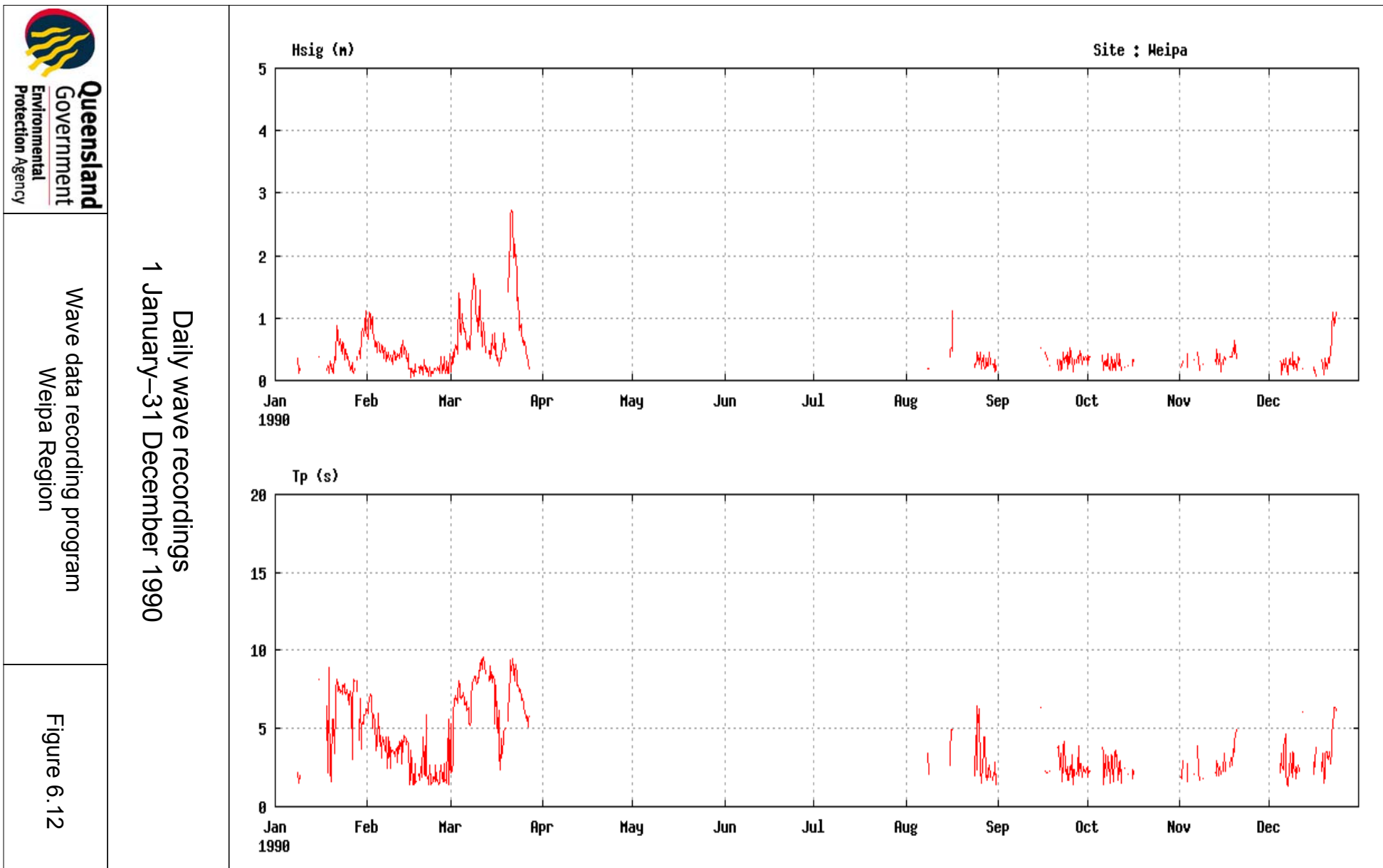


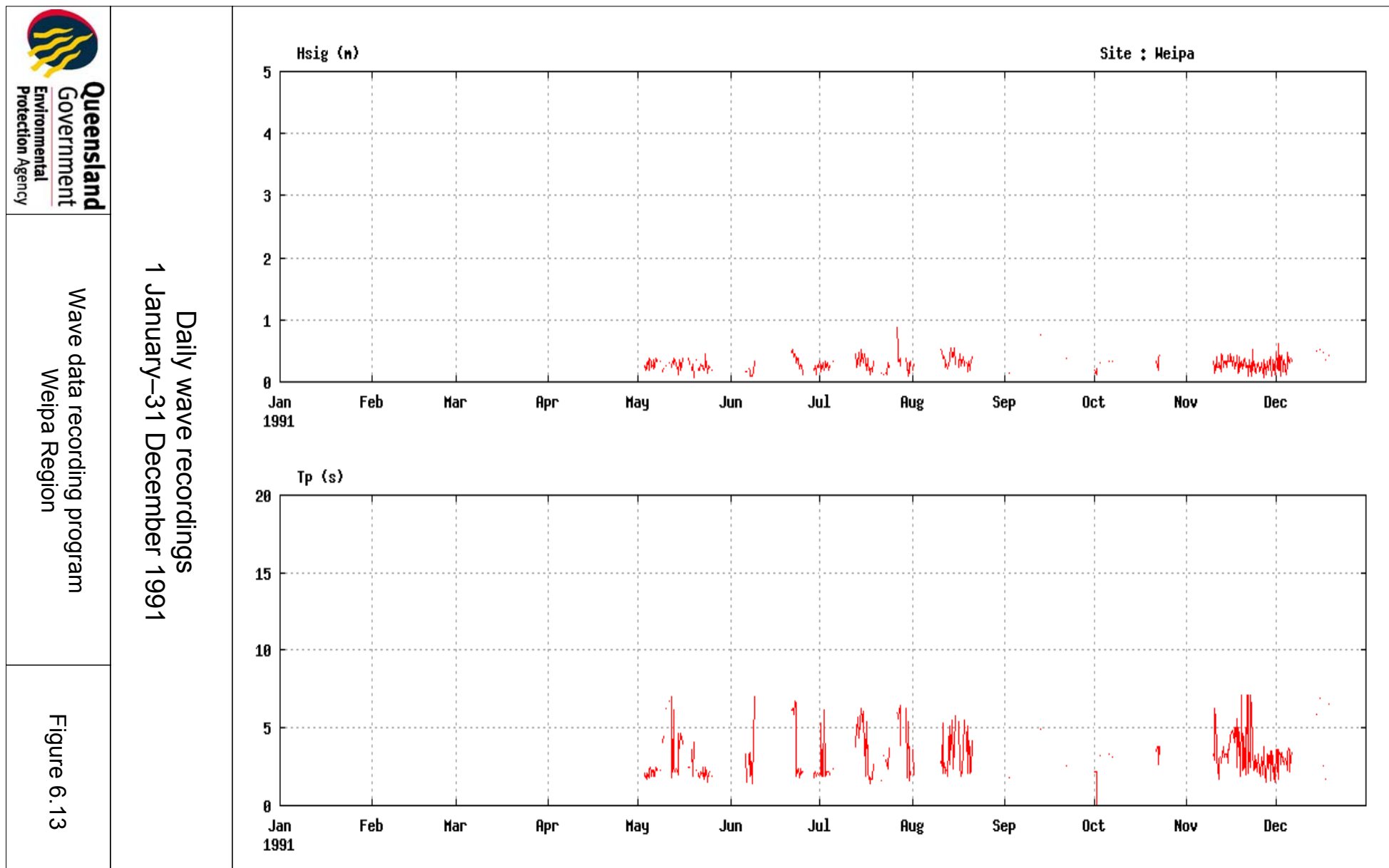


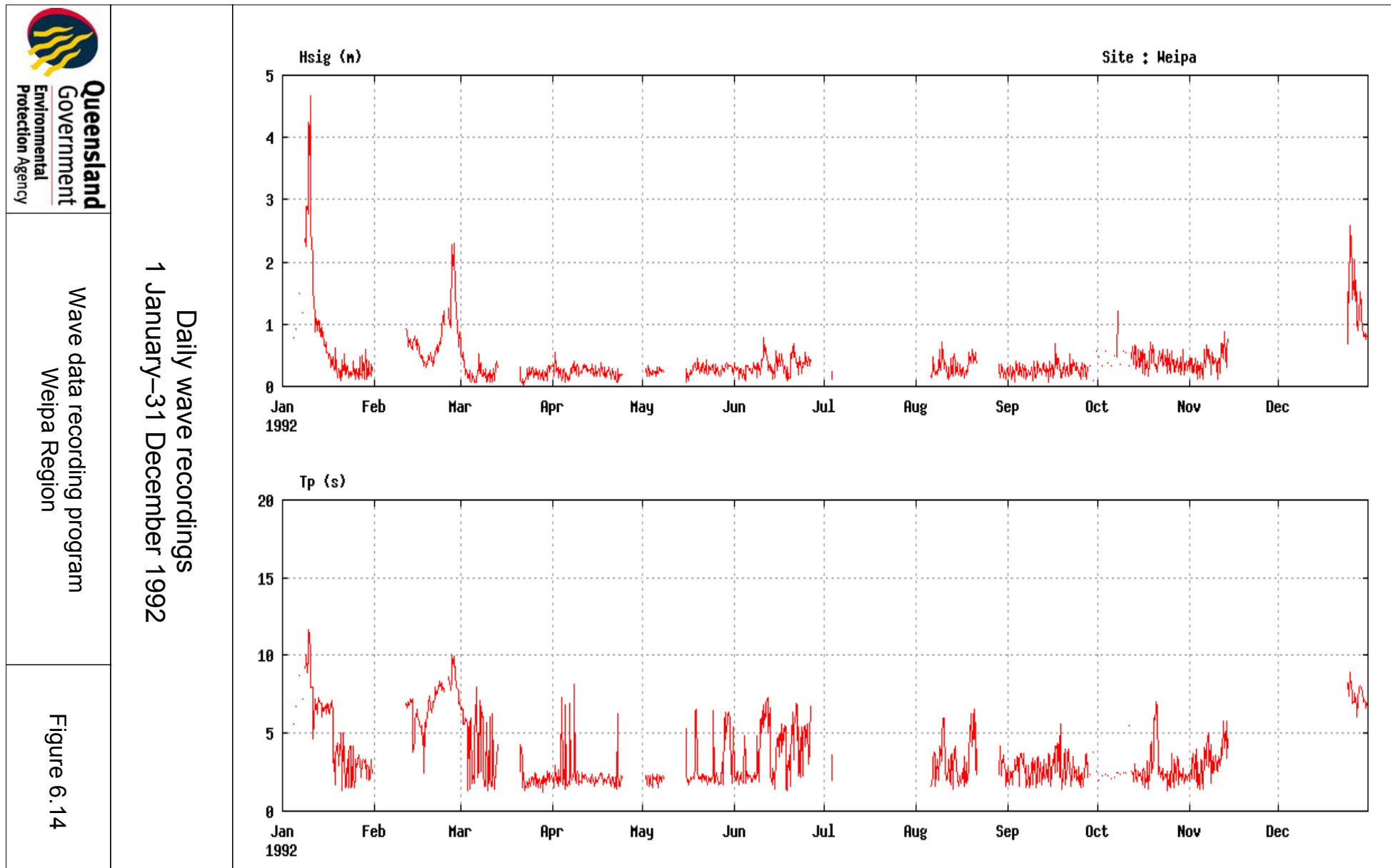


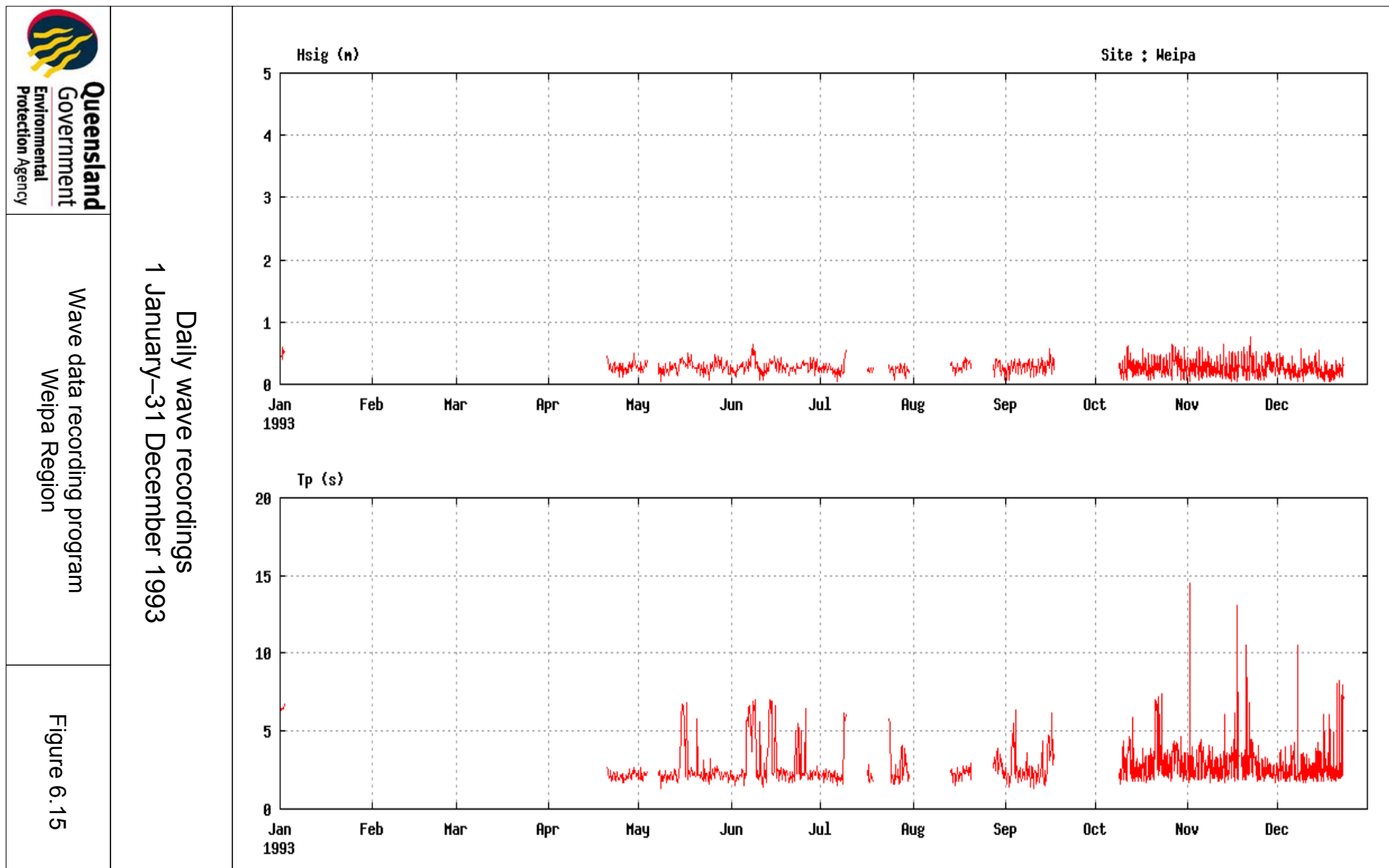


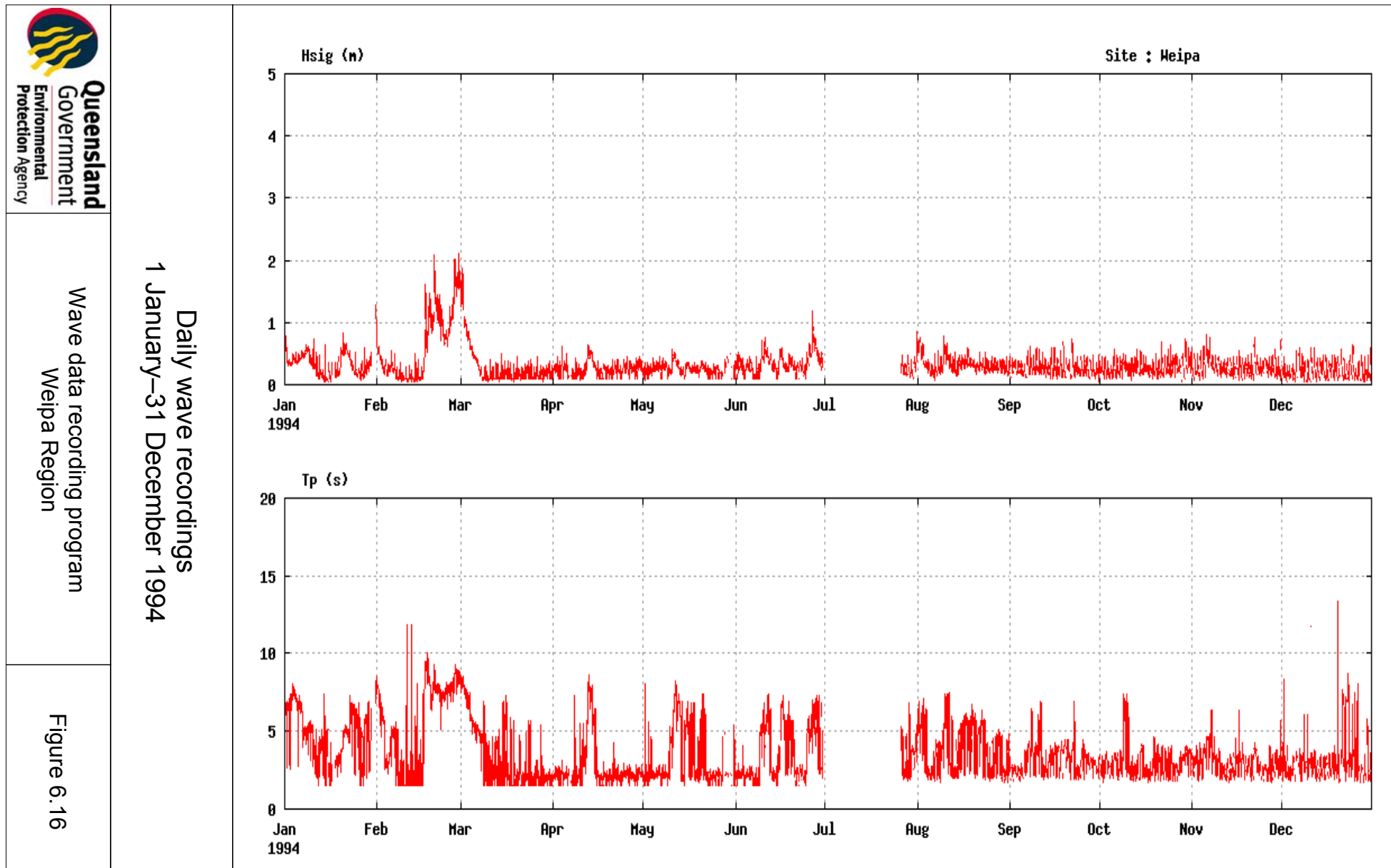


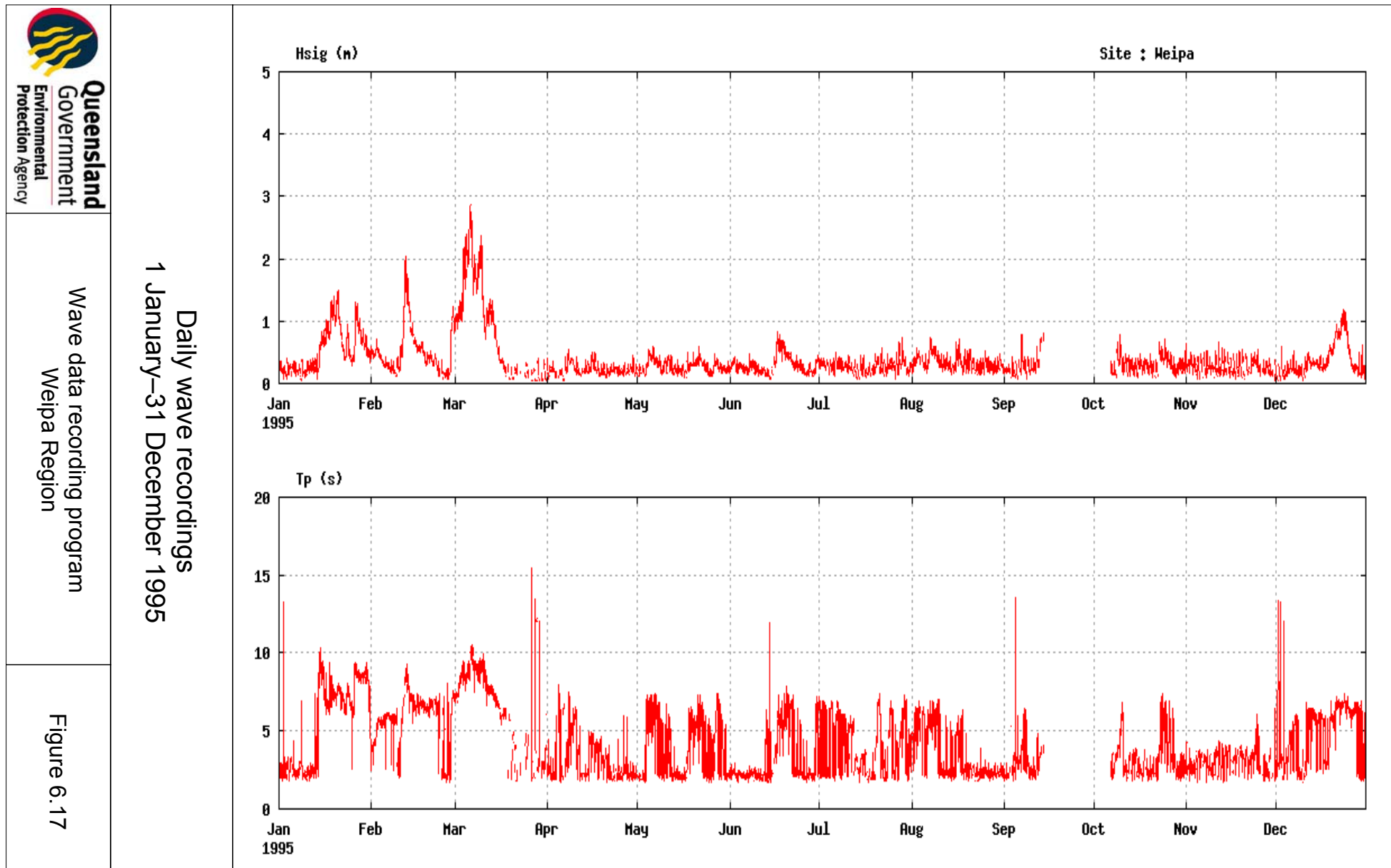


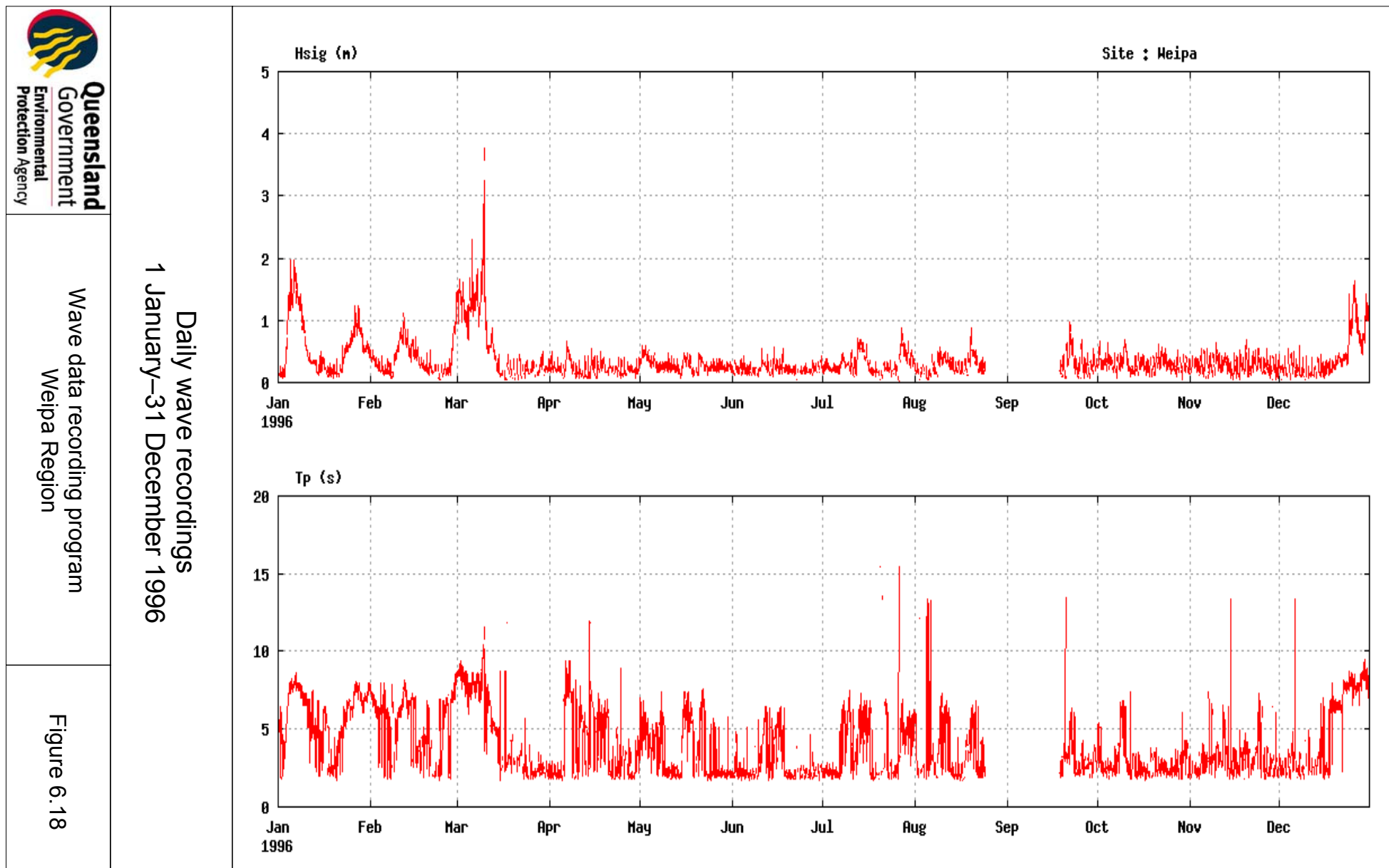




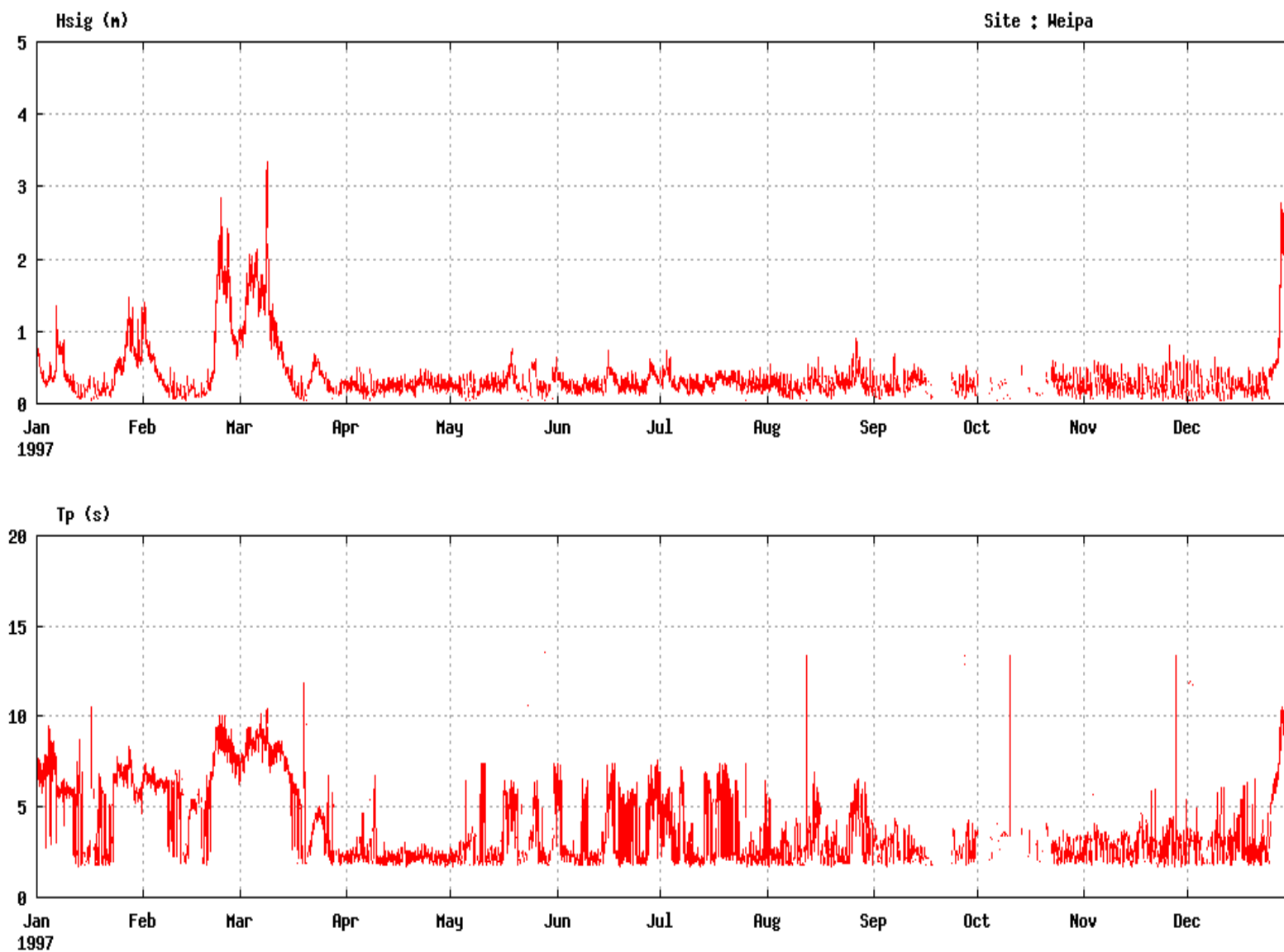


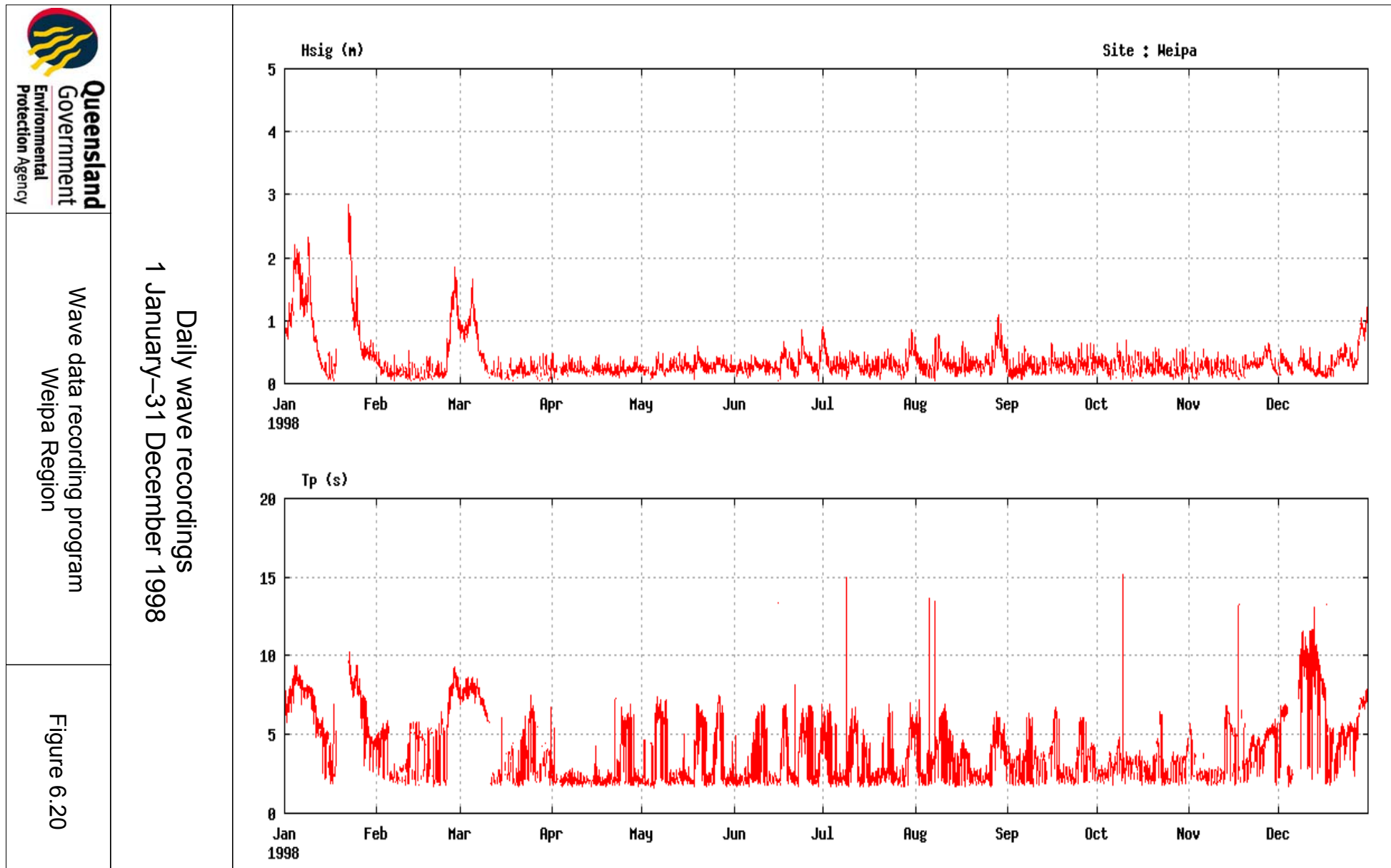


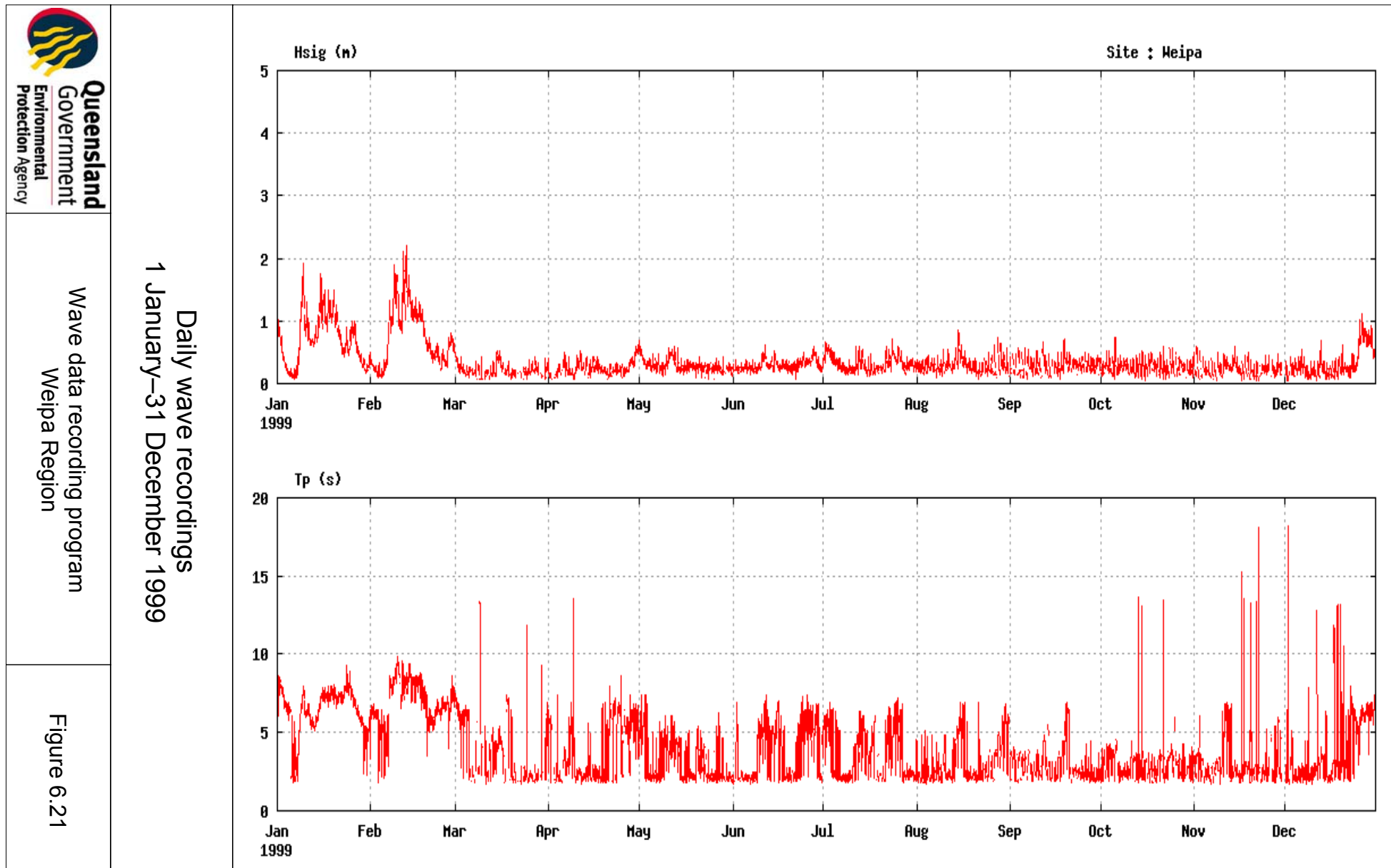


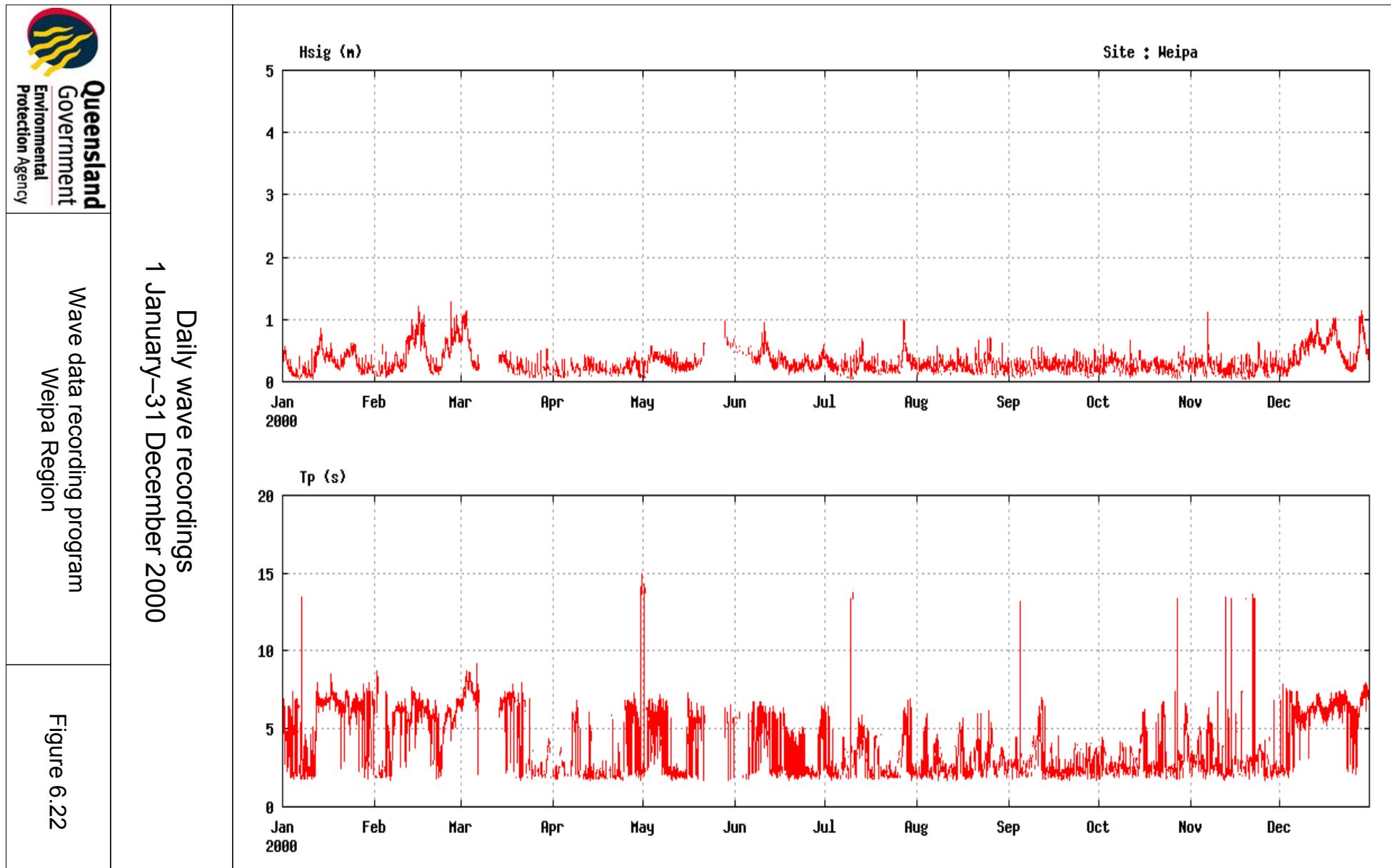


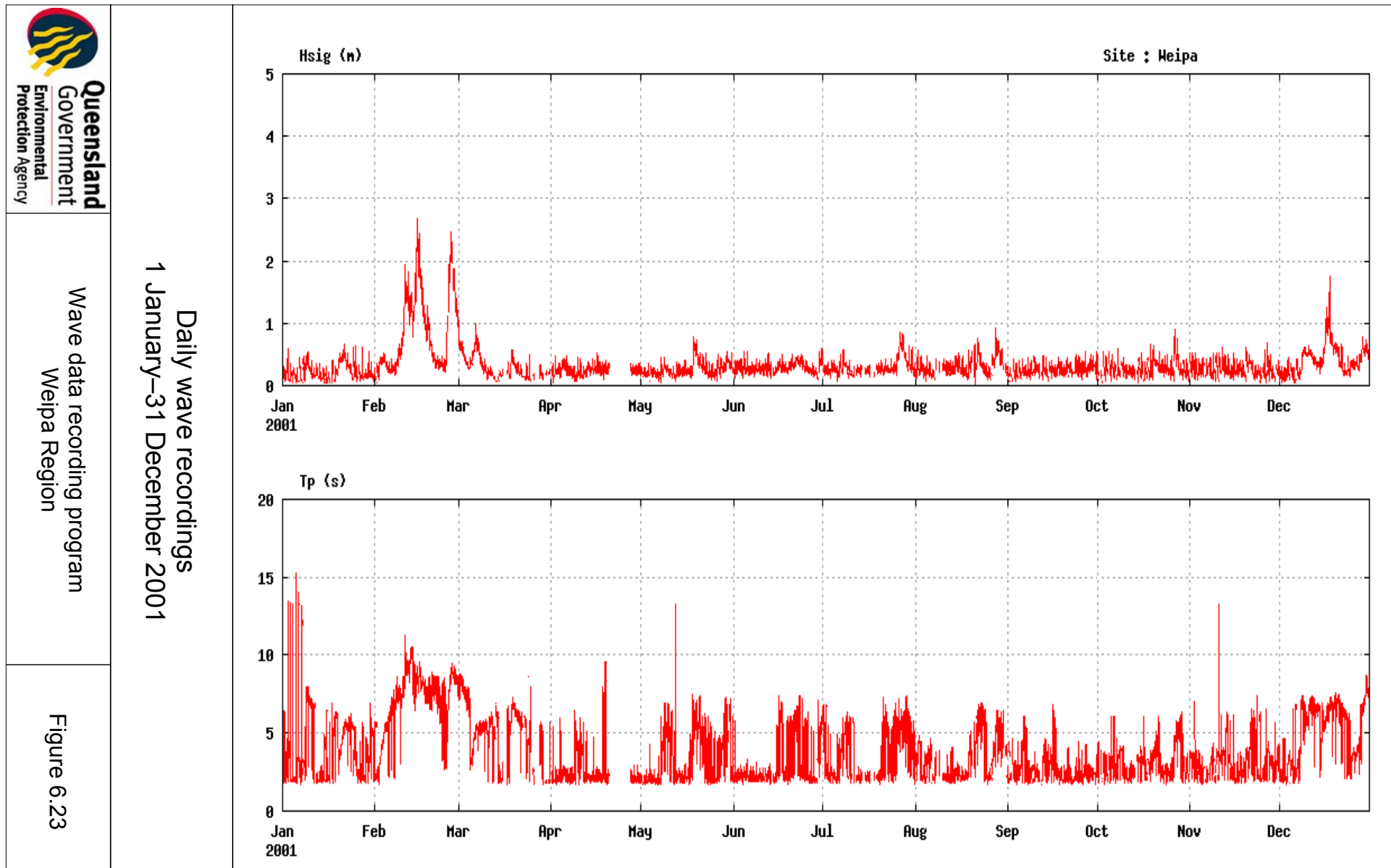
Daily wave recordings
 1 January–31 December 1997

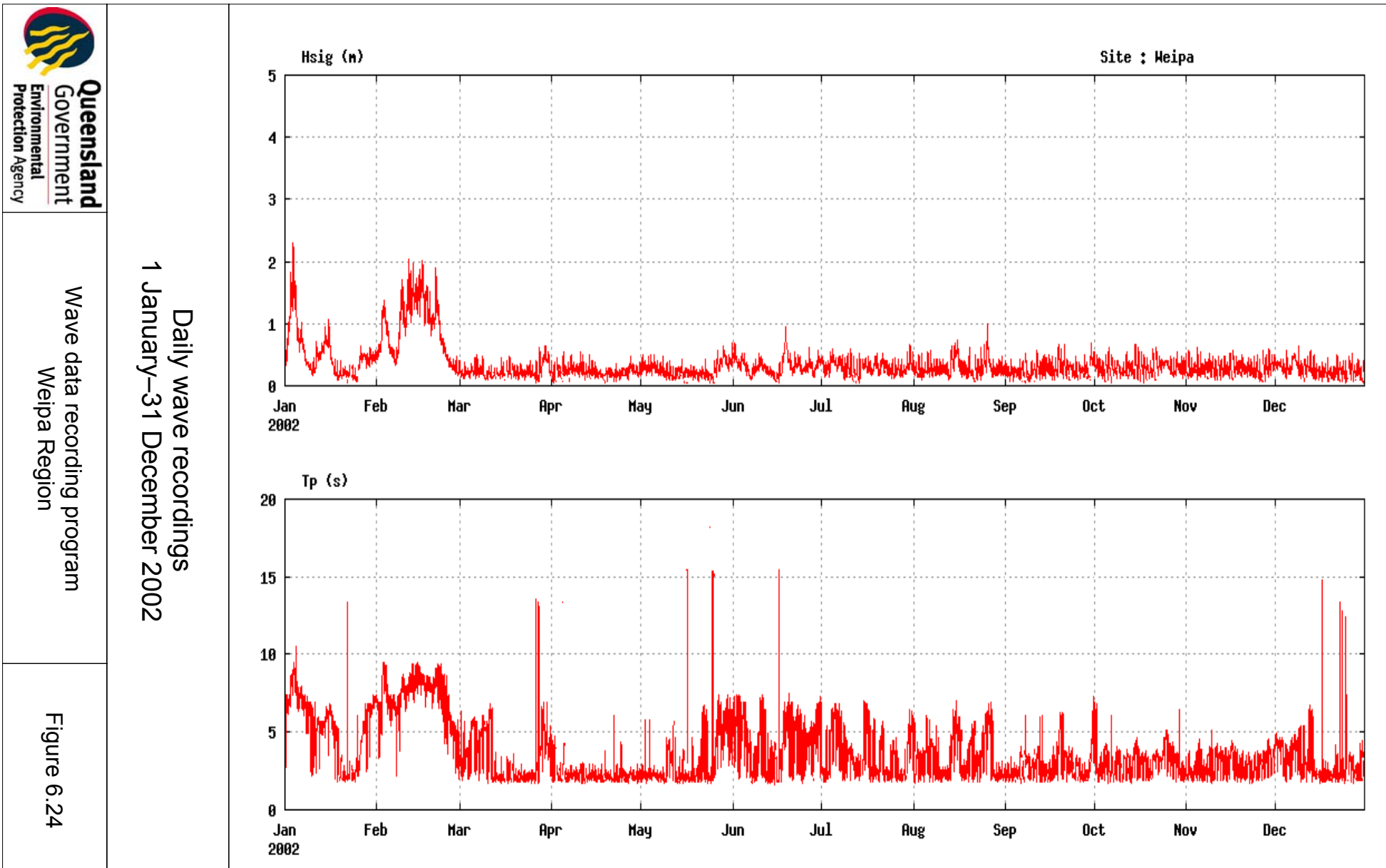


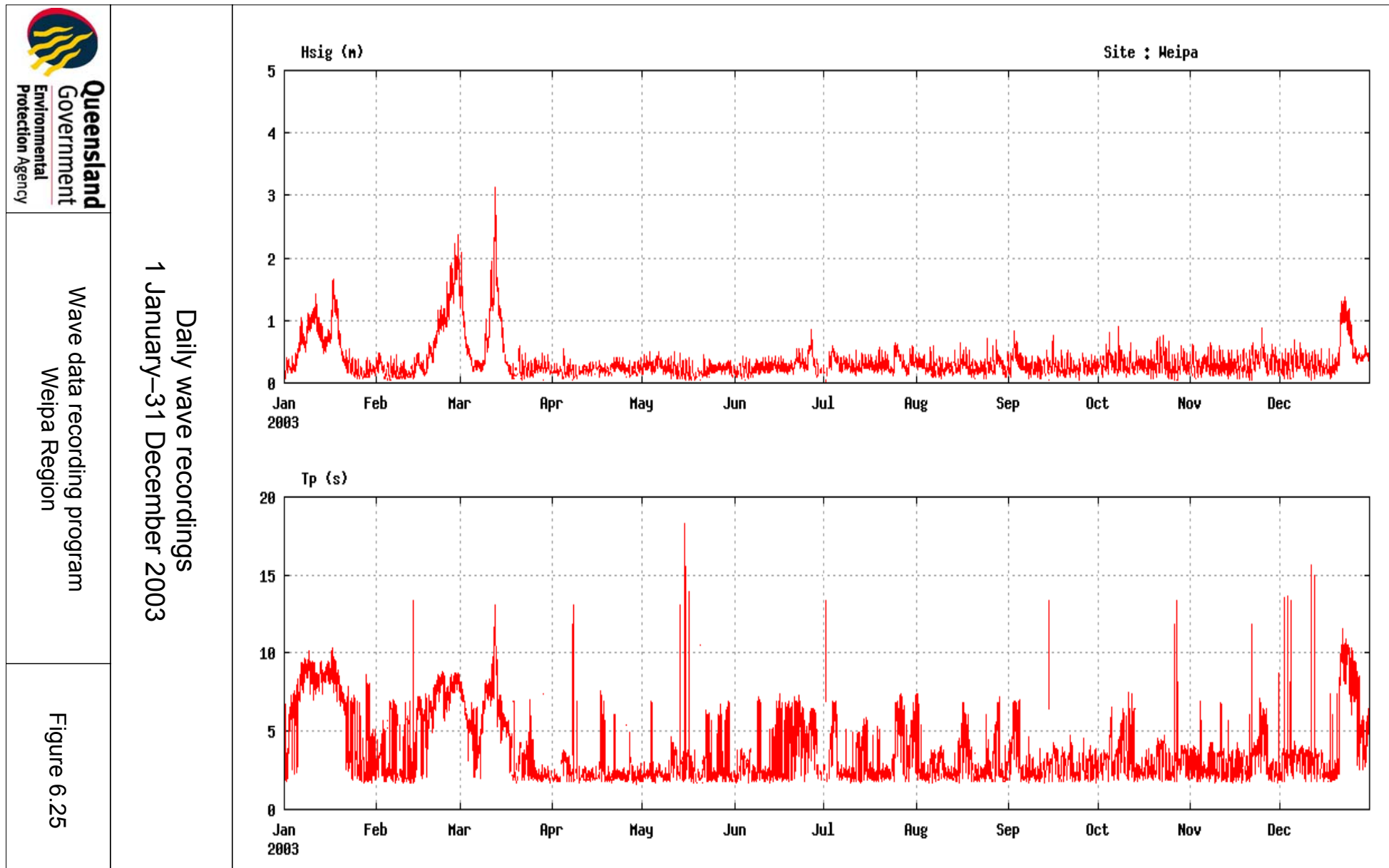


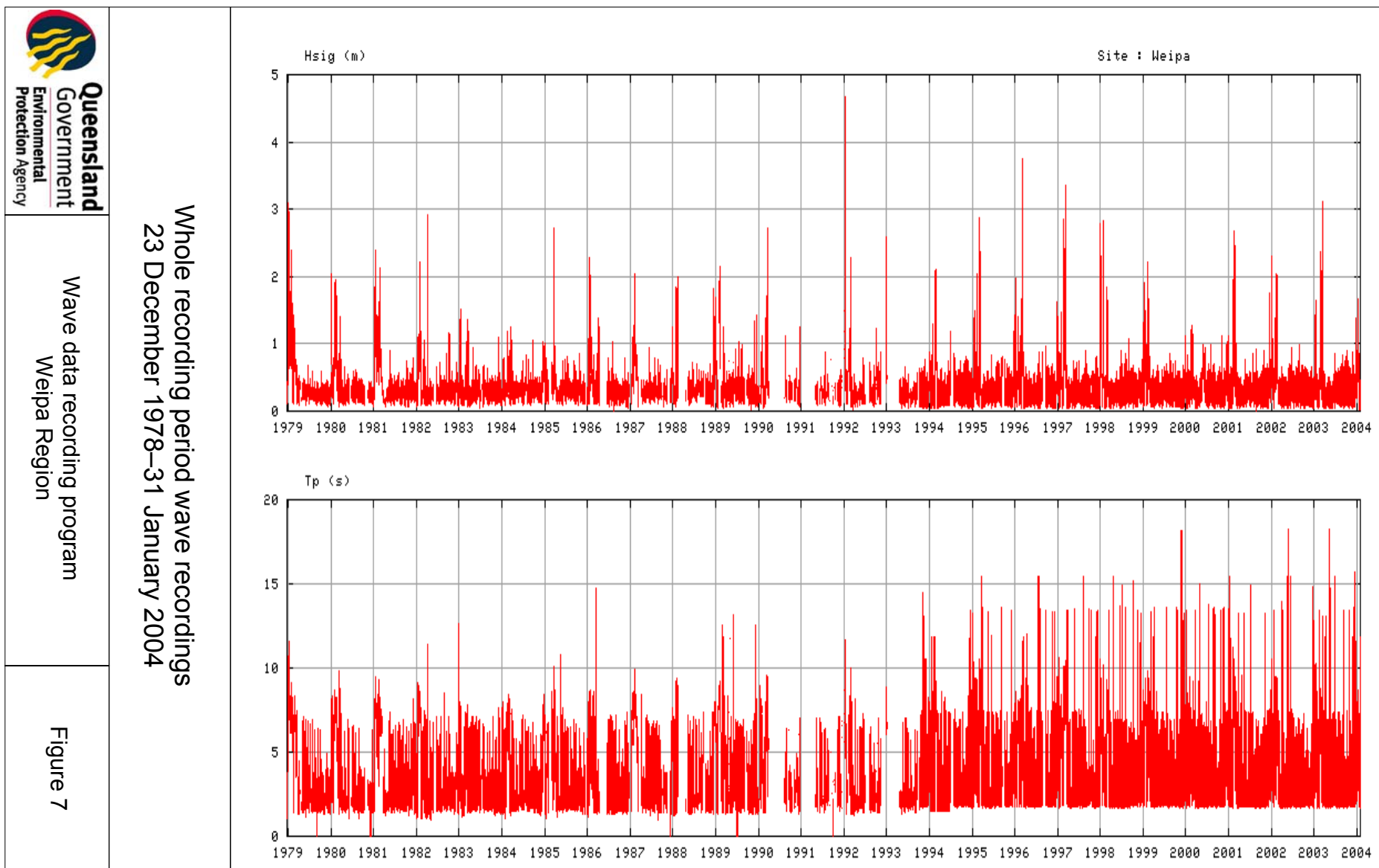


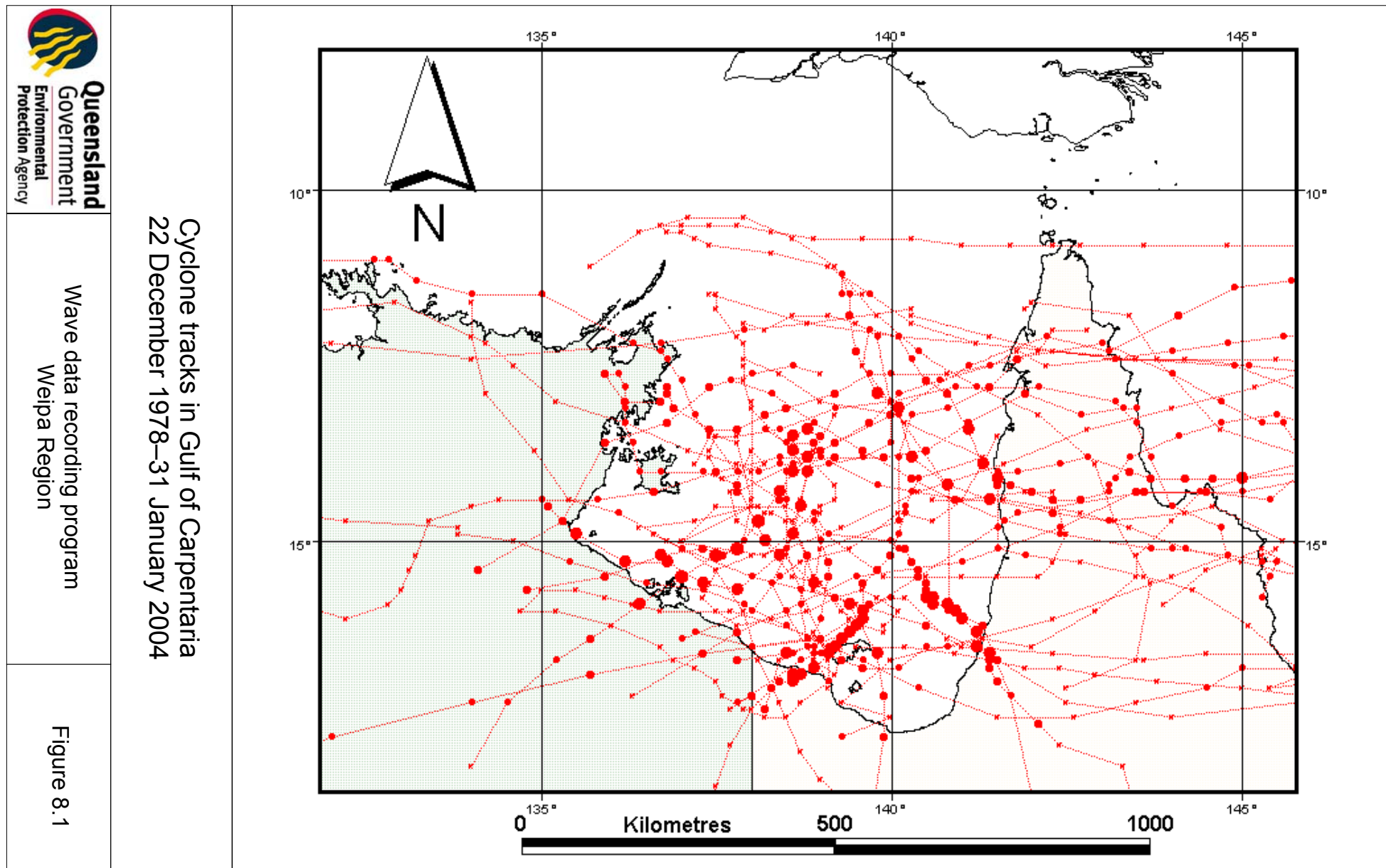


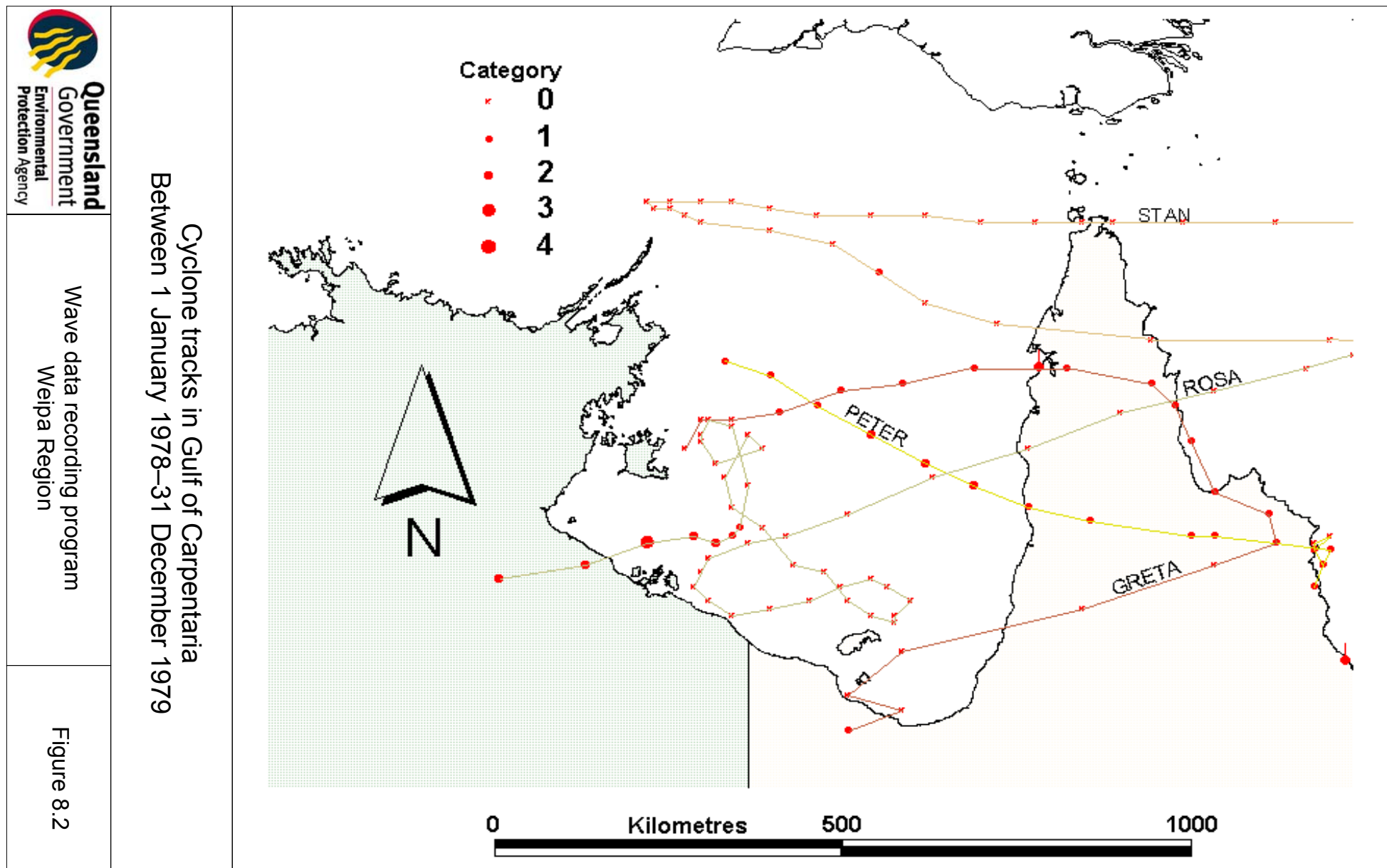


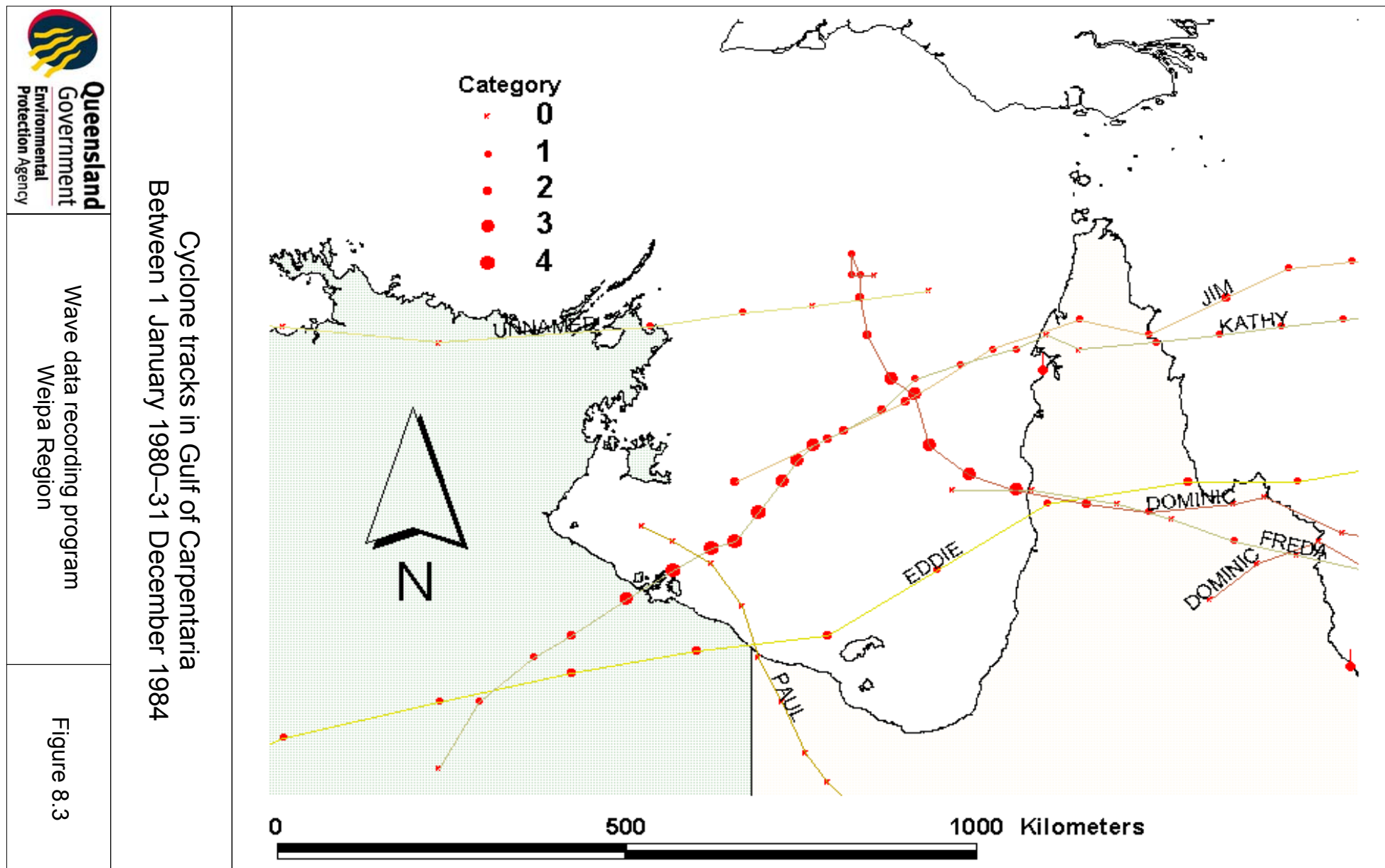


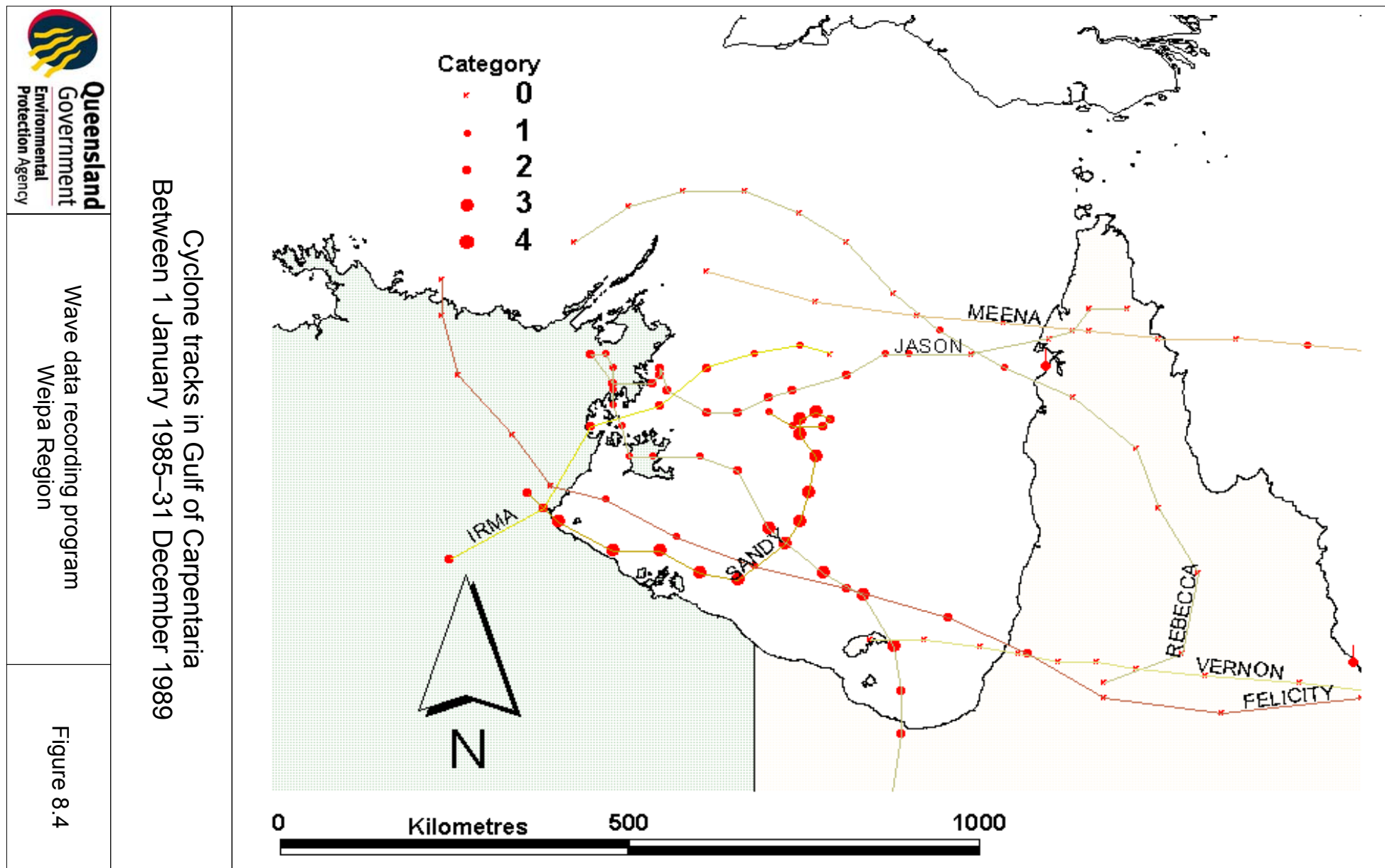


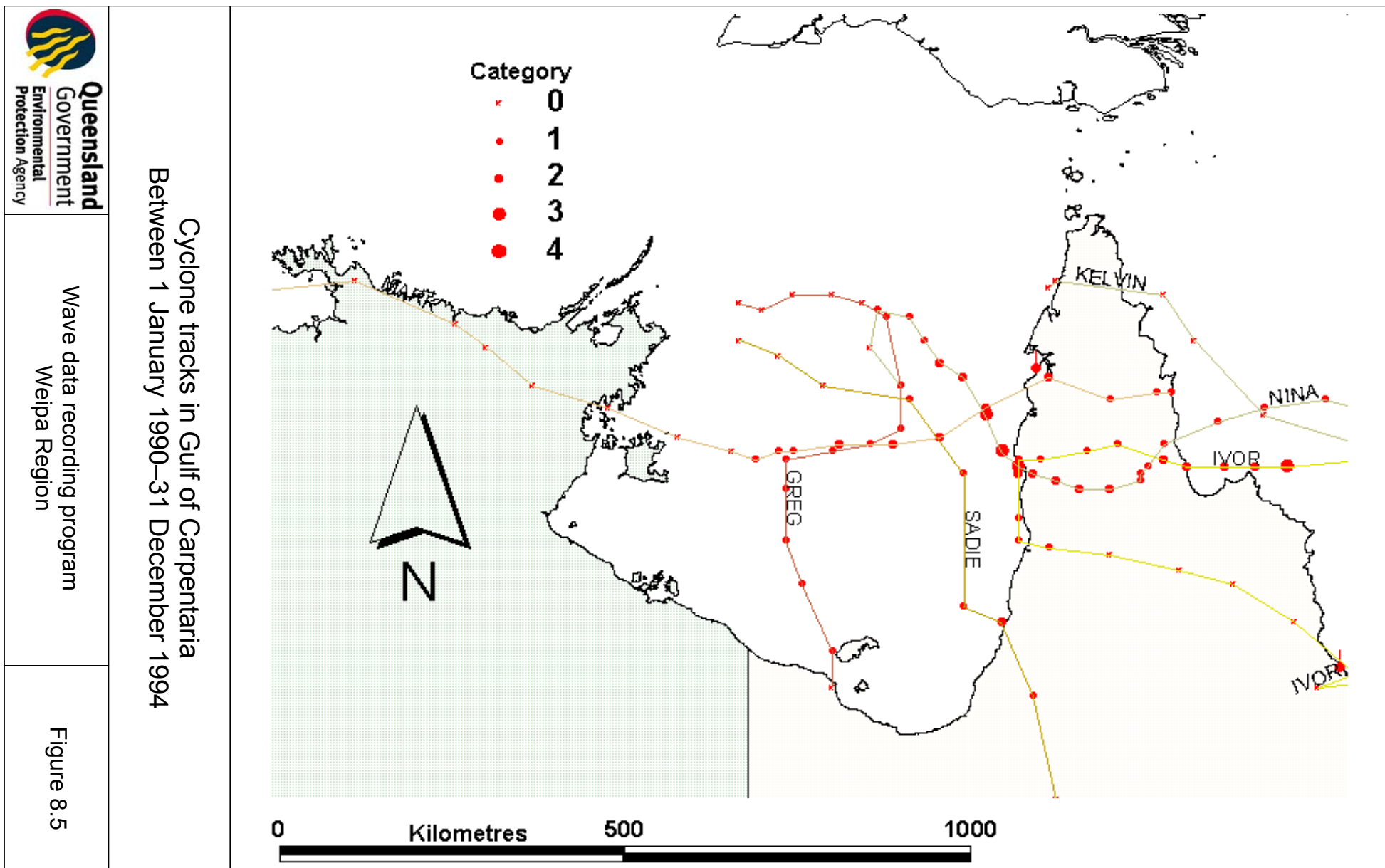


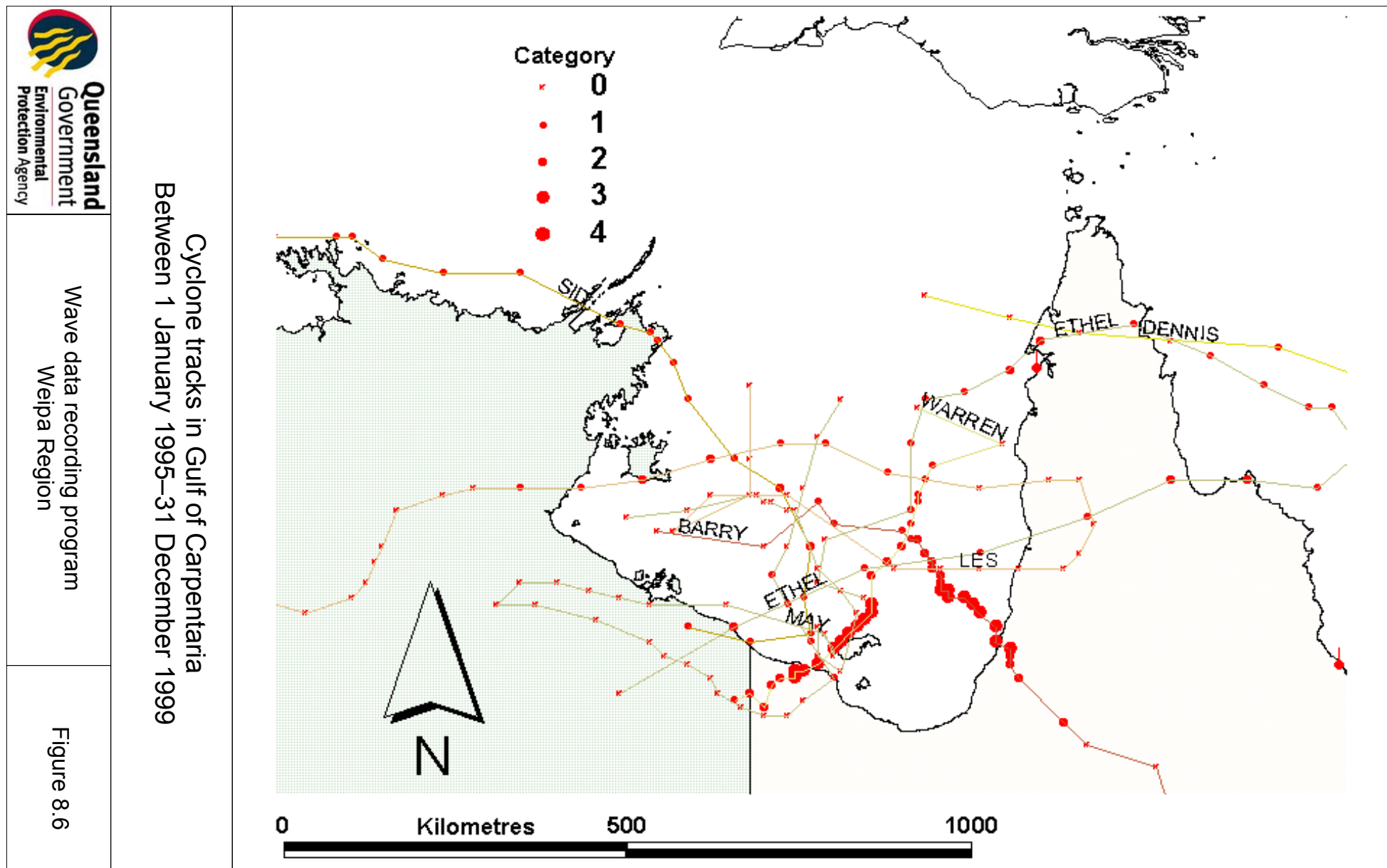


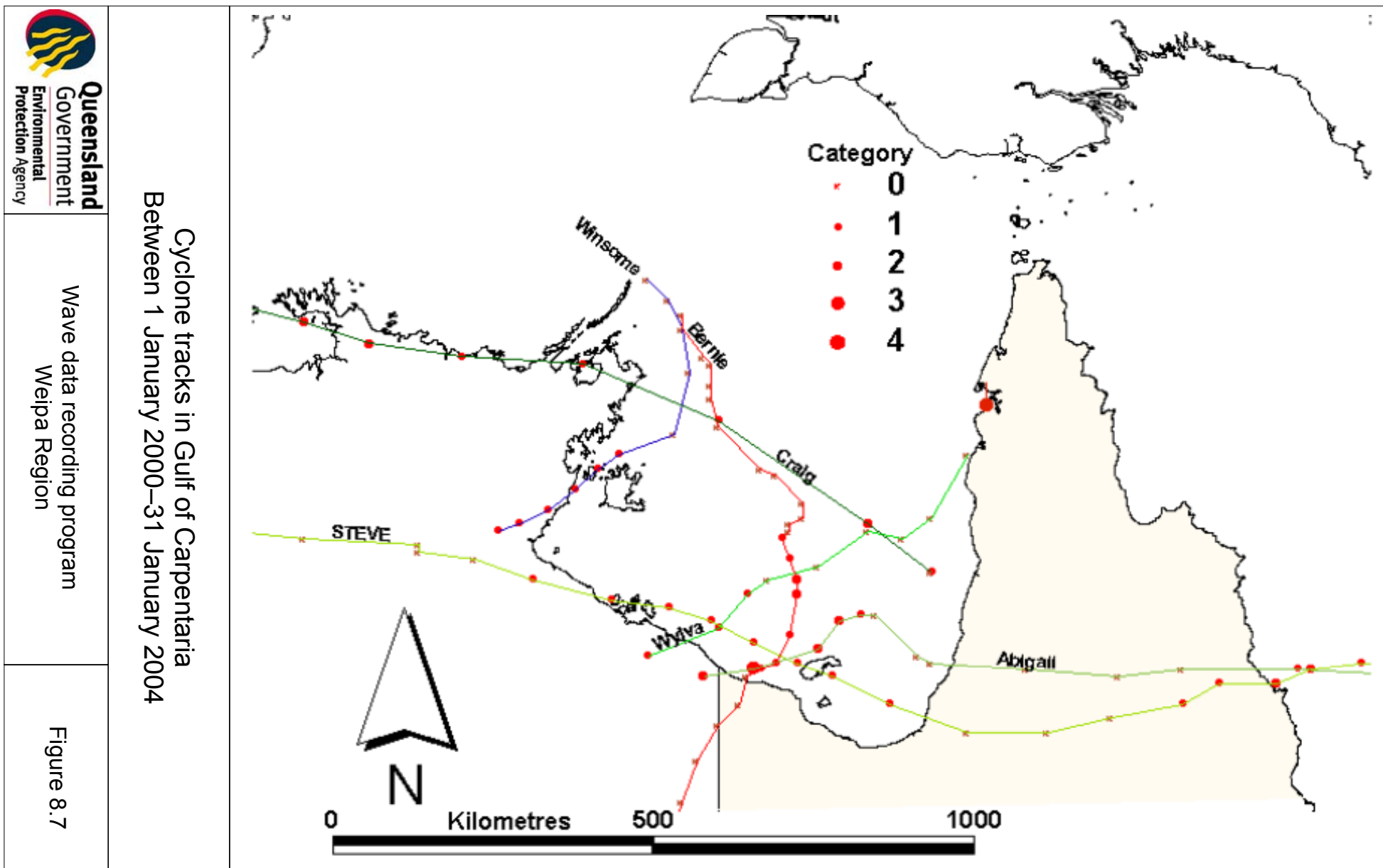








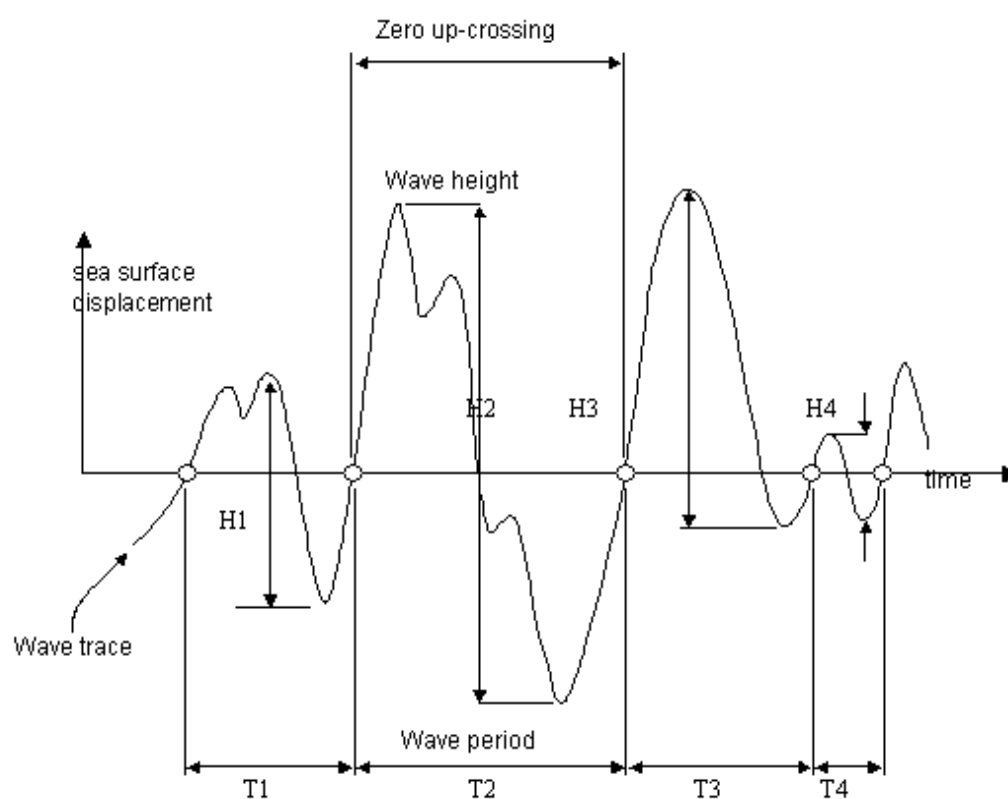




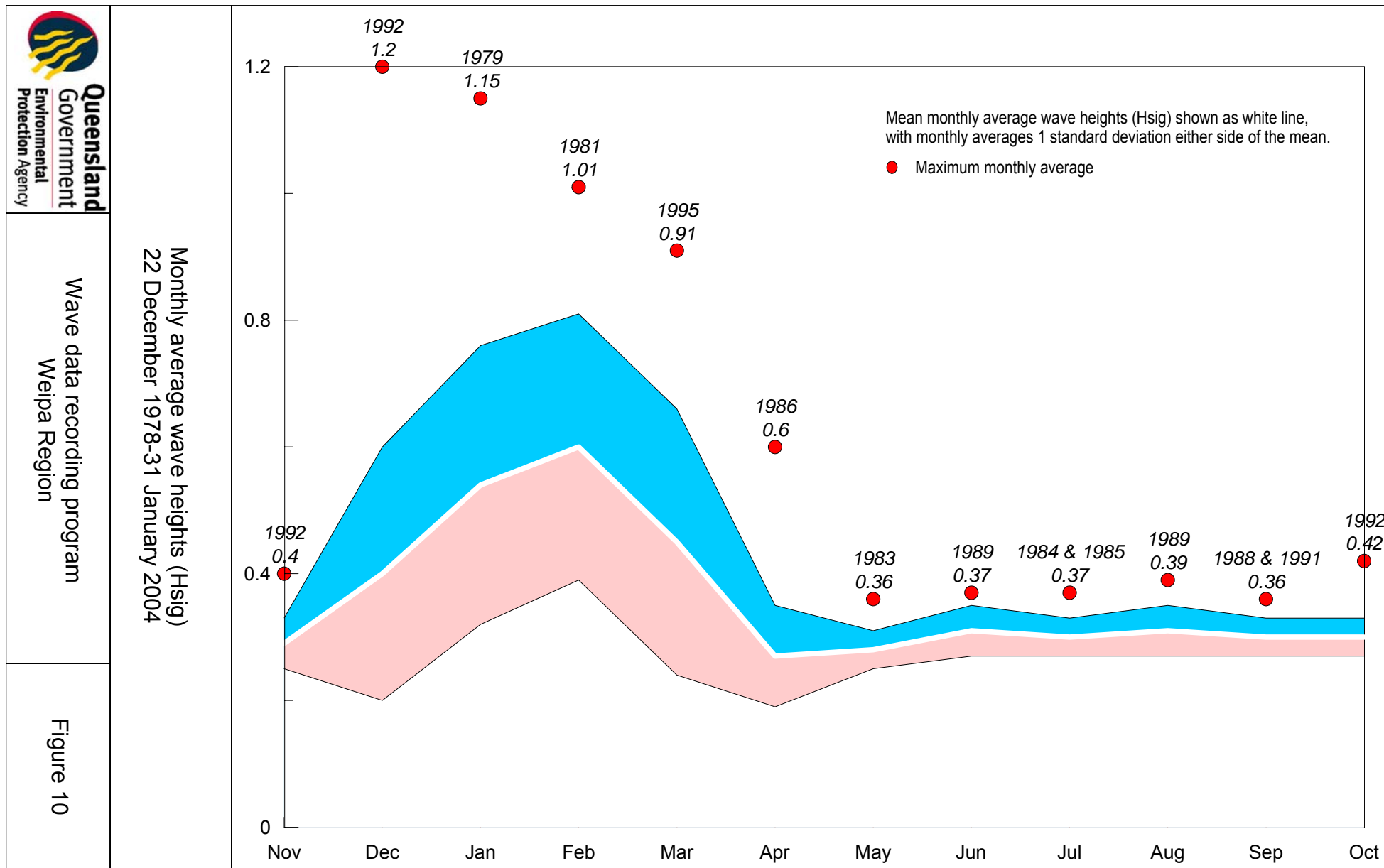
Zero crossing analysis

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



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
H_{10}	Average of the highest 10 percent of all waves in a record
TH_{10}	The period of the H_{10} 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