Department of Science, Information Technology and Innovation

Beach Surveys and Data Assessment, Mackay Region

COPE Report – Sarina Beach

Coastal Impacts Unit

2015

Queensland Government

Prepared by

GHD Pty Ltd (Reference 4128646) on behalf of:
Coastal Impacts Unit
Science Delivery Division
Department of Science, Information Technology and Innovation
PO Box 5078
Brisbane QLD 4001

Acknowledgements

This report has been prepared by the Department of Science, Information Technology and Innovation. Acknowledgement is made of all of the identified volunteers that contributed their time and effort in collecting the COPE data.

Front Cover Photo: Sarina Beach January 1988 looking North Source: BPA file

April 2015

Contents

List of tables

List of figures

1 Introduction

1.1 Preamble

The Coastal Observation Program Engineering (COPE) data collection system was designed to collect data at selected sites along the Queensland coast to assist in the understanding of coastal processes and the way these processes affect the coast line. COPE was managed for the Beach Protection Authority (BPA) (now disbanded) by the Department of Harbours and Marine up until 1989 and then by the Coastal Management Branch in what is now the Department of Environment and Heritage Protection (DEHP). COPE data was progressively analysed and reports at selected sites were compiled up to mid-1996[1] when the program was abandoned. After that date very little further analysis was carried out, however all data was archived for possible future use. Custodianship of this data rests with the Coastal Impacts Unit of the Department of Science, Information Technology, and Innovation (DSITI).

For this report, raw data was provided by DSITI for Sarina Beach – COPE Station Number 18010. This data had not been pre-processed to identify errors in the recordings and/or errors from the transfer of the data from the recording sheets to the computer data file.

In February 2015, the Coastal Impacts Unit of DSITI commissioned GHD to compile a report on the COPE data from the Sarina Beach site, located north of Sarina Beach Road and south of Cooper Avenue. The report is modelled on the Bilinga site report compiled in February 2014 by GHD for the Department of Science, Information Technology, Innovation and Arts (DSITIA).

DSITI provided the following data:

1. Recorded raw data in the form of a text file – this was data compiled directly from the recording sheets;
2. Sieve data from the analysis of the sand samples collected by the observers at the site;
3. Beach profile data collected by the observers at the site and subsequent data collected by staff from DSITI at Deagon; and
4. Photographs and other relevant information about the Sarina Beach COPE Station extracted from the BPA files.

GHD, through its Principal Coastal Engineer, Paul O’Keeffe, a former engineer to the BPA, was able to source other background information on the COPE program and make assessments of the data analysis based on first-hand experience with the COPE program.

In addition, the BPA Beach Conservation newsletters were reviewed for any articles on the COPE program relating to the Sarina Beach site. However, no articles that provided additional information on the Sarina Beach COPE station were identified.

Reference documents and technical papers that have been used to assist in the preparation of this report are listed in Section 4.

[1] This date concurs with the recollection of Paul O’Keeffe (GHD) and Sel Sultmann (DEHP), Coastal Engineer and Dune Conservationist respectively for the BPA at the time that the COPE program was finalised.

1.2 The Program

The BPA required basic data on the behaviour of Queensland's beaches in order to provide evidence-based coastal management advice to Local Authorities. The COPE project aimed to collect information on wind, waves and beach behaviour in areas where extensive investigations were not practical and where otherwise little or no data existed.

The project was based on the recruitment of volunteer observers who were prepared to record a series of basic parameters daily for at least a three year period. The COPE project was operational from late in 1971 to about mid-1996[2].

1.3 Site Selection

In selecting a site for a COPE station, consideration was given to:

1. The general shoreline configuration and the possibility of extrapolation of data to other adjacent beaches;
2. The distribution of stations along Queensland's coastline; and
3. The need to correlate the COPE data with planned or existing data collection programs.

1.4 Instruments

The COPE observers were supplied with a basic kit of recording instruments including:

1. 30 m tape measure;
2. Wind meter;
3. Stop watch;
4. 2.0 m measuring sticks;
5. Recording forms;
6. Fluorescent dye (Rhodamine or Flourescene);
7. 1.5 m support stick (as suggested by Appendix A – Instructions for filling out COPE recording form);
8. Hand held level (as suggested by Appendix A – Instructions for filling out COPE recording form); and
9. Plastic bags and envelopes for sand samples, mailing envelopes for the return of recording sheets, clipboard, pencils and erasers.

A graduated reference pole was usually installed on the beach to serve as the base point for all measurements in plan and the control for vertical levelling.

1.5 Observers

The majority of COPE observers were volunteers. Some stations were also operated by Government and Local Authority employees who carried out the observations as part of their official duties.

[2] Refer previous footnote

1.6 Accuracy

Individual observers differed in their subjective assessment of the various parameters recorded as part of the COPE program. Wave parameters such as height, and angle of approach together with surf zone width and the location of vegetation line all required visual assessment. The accuracy of recorded details varied from observer to observer and possibly from recording to recording. Although the BPA was confident that all observers made their observations to the best of their ability and accepted these observations without adjustment, the existence of random and non-random errors in the recorded data was to be expected.

Problems associated with the use of data containing these errors are minimised in a number of ways as follows:

1. Regular visits were made to the COPE stations by the BPA's COPE Field Officer to provide a check on any bias introduced into the recordings by incorrect observation procedures.
2. It was determined that, with a large number of observations taken on a regular basis, a reasonable assessment can be made of the average values of the observed parameters provided the observation errors are random. A minimum recording period of three years was adopted for the analysis and publication of the data, in order to minimise the effects of random errors.
3. Five day moving averages are applied to observations of the various beach width and foreshore slope parameters to filter out random errors.
4. Pre-processing of the raw data was undertaken to remove obvious errors from either recording errors and/or errors from the transfer of the data from the recording sheets to the computer data file. For this report, these errors and how they were corrected have been documented in the Data Presentation section.

For these reasons, the BPA concluded that published COPE data can be used with confidence provided the above inherent limitations are recognised.

1.7 Presentation of Data

The purpose of this report is to present COPE data for Sarina Beach for the thirteen years' worth of data recorded between 1981 and 1993, and the continued profile data supplied by DSITI from April 1981 to May 1996 in a useful statistical form.

The thirteen year period can be considered to be representative of the long term average meteorological condition and the statistics presented on wind, wave and beach movements can be regarded as typical of the ambient conditions. However, this recording period is too short to be representative in terms of the average occurrence of extreme events such as cyclones and floods, and this should be taken into account when consideration is given to the influence of such events on trends of long term beach behaviour.

2 Station Particulars

2.1 Location

Sarina Beach is located approximately 30 kilometres south of Mackay on the Eastern Queensland coastline. The beach is approximately two kilometres long extending between rocky outcrops at the northern and southern ends of the beach. The location of the Sarina Beach COPE station is south/east of Poole Street as shown on Figure 6 and Figure 7.

2.2 Observers

From information available, the main observer for the Sarina Beach site was Mr Gordon Green. He took daily measurements from November 1984 until his retirement from the program in 1991. Several other observers participated in the program and their involvement is summarised in Table 1. Additionally, observer Mr Phil Cosgrove was assisted by his son Peter in taking the monthly profile recordings and sand samples.

Figure 1 COPE observers at Sarina Beach taking measurements at the COPE reference pole in August 1976.

Table 1 Summary of Sarina beach observers

Year	Observer	Year	Observer
1976	O. Jenkins	1987	P. Cosgrove & G. Green
1977	O. Jenkins	1988	G. Green
1978	O. Jenkins	1989	G. Green
1979	O. Jenkins	1990	G. Green
1980	O. Jenkins & B. Smith	1991	G. Green
1981	B. Smith & K. Neill	1992	P. Cosgrove & G. Green
1982	K. Neill	1993	Phil Cosgrove & Peter Cosgrove
1983	K. Neill	1994	Phil Cosgrove & Peter Cosgrove
1984	P. Cosgrove & G. Green	1995	Phil Cosgrove & Peter Cosgrove
1985	G. Green	1996	Phil Cosgrove & Peter Cosgrove
1986	G. Green		

2.3 Reports from Beach Conservation

Beach Conservation was the title of the newsletter of the Beach Protection Authority of Queensland and was published quarterly between September 1970 and June 1990. Various aspects of the COPE program were frequently featured in the newsletter including two main articles on the operation of the program in April 1977 (Issue No 27) and June 1990 (Issue No 69). However, no articles that provided additional information on the Sarina Beach COPE station were identified.

2.4 Site History

Listed below is information compiled from the BPA files for this site, including details of the installation and maintenance of the COPE pole. A photograph of the installed COPE pole is shown in Figure 2.

1. August 1976 – Observations commenced (but no recordings were received until April 1981) and COPE pole installed,
2. 6 June 1977 – Pole levelled and calibrated, RL top of flange recorded as 2.85 m,
3. 18 April 1978 – Top section replaced,
4. 5 April 1981 – Recordings commenced,
5. December 1981 – Beach building up, vegetation line near to the pole,

6. 10 December 1982 – Pole repainted,
7. 1988 – Pole repainted,
8. 31 March 1993 – Daily observations ceased, monthly profiles and sand samples continued,
9. 1996 – All observations ceased.

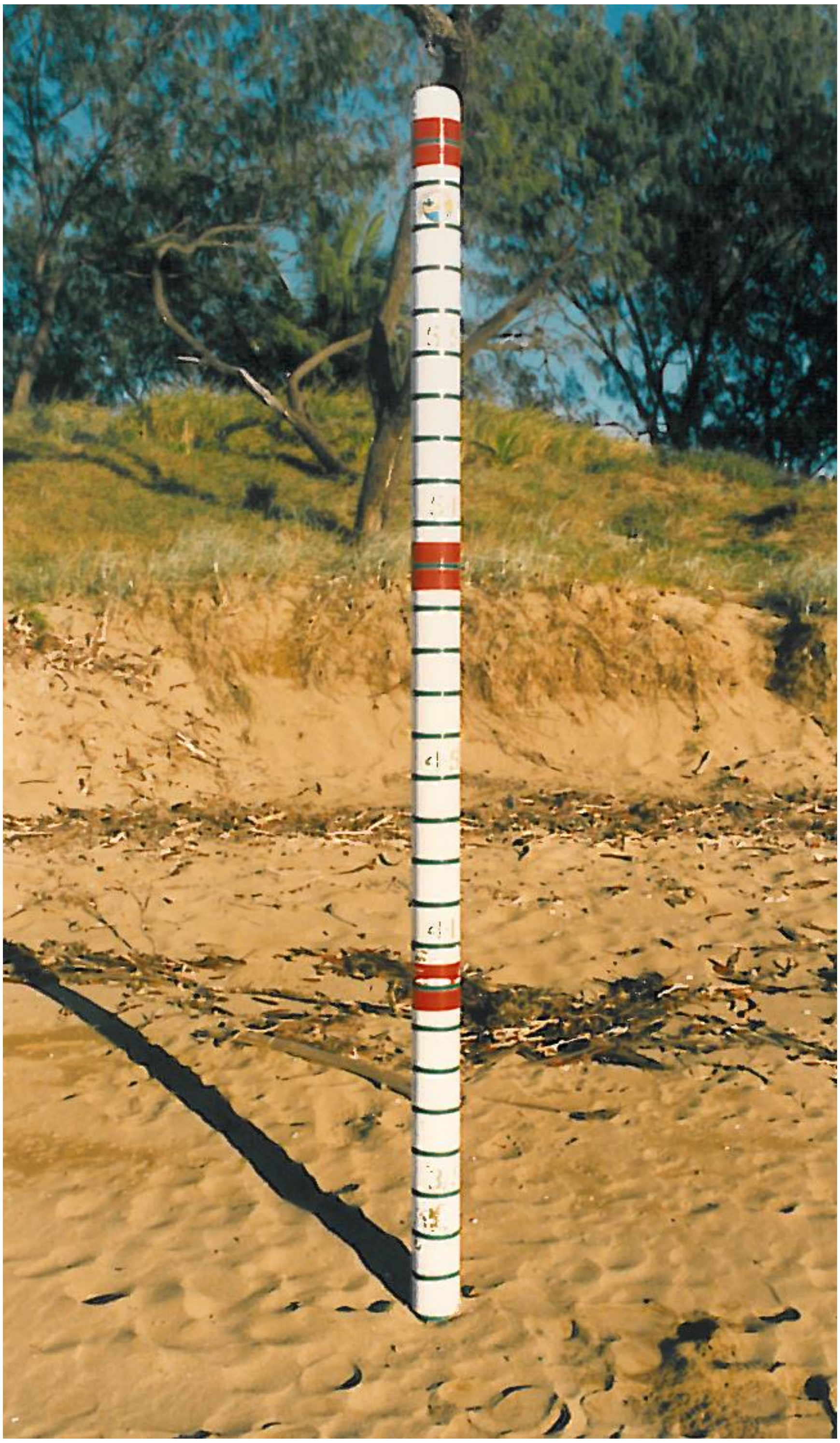


Figure 2 Sarina Beach COPE pole, 7 June 1989

2.5 Observed Parameters

The observers at this station recorded the majority of observations in the afternoon between 3pm and 6pm at the beginning of the recording period, and earlier in the day towards the end of the recording period usually between 8am and 10am.

Data was recorded on the original recording sheet shown in Figure 8 from 5 April 1981 to 7 February 1986, with the following parameters being recorded:

- Wave period (s);
- Wave height (average) (m);
- Wave angle (degrees);
- Wave type;
- Surf zone width (s);
- Offshore bar (presence);
- Wind speed (mph);
- Wind direction (degrees);
- State of tide;
- Berm elevation (m);
- Distance to berm (m);
- Distance to the vegetation (m);
- Foreshore slope (degrees);
- Current speed longshore (m/min);
- Current direction longshore;
- Sand sample;
- Sand level at pole (COPE reference pole) (m).

Data was recorded on the new recording sheet shown in Figure 10 from 8 February 1986 to 31 March 1993, with the following parameters being recorded:

- Wave height (average) (m);
- Wave height (maximum) (m);
- Wave height method;
- Wave period (s);
- Wave direction (degrees);
- Surf zone width (s);
- Current speed longshore (m/min);
- Current direction longshore;
- Distance from shore (m);
- Offshore bar presence;
- Wind speed (mph);
- Wind direction (degrees);
- Fixed contour elevation (m);
- Distance to fixed contour (m);

- Distance to the vegetation (m);
- Sand level at pole (COPE reference pole) (m); and
- Sand sample.

Surf zone width on the original recording sheet was the estimated distance between the shore and the breakers offshore. With the new recording sheet surf zone width was measured as the time (in seconds) it took for a wave to traverse the surf zone from its break point until its final run-up position.

All directions in this report are magnetic. Sector bearings derived from True North were converted to magnetic bearings using the magnetic variation shown on marine charts.

The first recorded sand sample was taken in May 1981, and from then on, samples were taken every few months.

A profile of the beach was recorded semi frequently throughout the recording period with additional profiles recorded within the month depending on the state of the beach and the occurrence of storm events from 1981 to 1996. The beach profiles are shown in Figure 75 to Figure 87. It should be noted that the COPE pole location is always located at chainage 0 and that the first beach profile recorded in June 1981 has been repeated on each chart as a reference level.

Based on the information provided, no offshore slopes were recorded at Sarina Beach.

2.6 Tidal Information

Tidal information from the 1981 Official Tide Tables (H&M 1981) for Sarina Inlet and Hay Point is presented in Table 2. The levels have been assumed to be on Lowest Astronomical Tide (LAT).

It should be noted that in 2010, the tidal plane levels were updated for the current Tidal Datum Epoch 1992 - 2011, using the latest available tidal observations, prediction information and allowance for sea level rise. The current tidal plane levels are provided by Maritime Safety Queensland (MSQ 2015) and the levels for Hay Point (being the nearest location to Sarina Beach) are presented in Table 2. The datum of the 2015 levels is LAT.

Table 2 Tidal planes

Tidal Plane	1981 (m Datum of Predictions)		2015 (m LAT)
	Sarina Inlet	Hay Point	Hay Point
1. Highest Astronomical Tide (HAT)		6.70	7.14
2. Mean High Water Springs (MHWS)	5.9	5.49	5.80
3. Mean High Water Neaps (MHWN)	4.6	4.23	4.48

Tidal Plane	1981 (m Datum of Predictions)		2015 (m LAT)
4. Australian Height Datum (AHD)			3.34
5. Mean Sea Level (MSL)	3.35	3.11	3.37
6. Mean Low Water Neaps (MLWN)	2.1	1.99	2.25
7. Mean Low Water Springs (MLWS)	0.8	0.74	0.94
8. Lowest Astronomical Tide (LAT)		-0.1	0.0

Assuming that the Datum of Predictions and LAT are close, the tidal plane levels have increased by around 0.20 m for MLWS and 0.44 m for HAT.

2.7 Beach Description

The beach at the Sarina Beach COPE station exhibits the following characteristics:

- Typical beach slopes: Based on the original recording between 4 May 1981 and 2 July 1986 the beach slope oscillated between 0 and 8 degrees, with an average of 3.3 degrees; as shown on Figure 106.
- Beach width: Varied from 40 to 150 m measured from the seaward toe of the frontal dune to the Low Water Mark over the 15 year period (1981 - 1996) (by inspection of the monthly beach profiles in to Figure 87);
- D_{50} grain size: 0.34 mm averaged over 75 samples collected over the six years (1976 – 1995); and
- Adjoining landform: Low vegetated dune seaward of residential housing.

Images of the beach are provided in Figure 3 and Figure 4.

Figure 3 Sarina Beach, August 1983 – Looking north

Figure 4 Sarina Beach, August 1983 – Looking south

2.8 Meteorological Events

The following cyclones were recorded by the Brisbane Bureau of Meteorology as having tracks within 400 km of Sarina Beach between January 1976 and January 1999. It is considered that these meteorological events may have had some effect on the condition of Sarina Beach.

- Cyclone DAVID: 13 January – 21 January 1976
- Cyclone BETH: 13 February – 22 February 1976
- Cyclone COLIN: 25 February – 04 March 1976
- Cyclone HOPE: 24 February – 06 March 1976
- Cyclone DAWN: 03 March – 06 March 1976
- Cyclone WATOREA: 25 April – 28 April 1976
- Cyclone JUNE: 16 January – 19 January 1977
- Cyclone OTTO: 06 March – 10 March 1977
- Cyclone HAL: 06 April – 11 April 1978
- Cyclone GORDON: 08 January – 11 January 1979
- Cyclone KERRY: 12 February – 04 March 1979
- Cyclone PAUL: 02 January – 08 January 1980

- Cyclone RUTH: 11 February – 18 February 1980
- Cyclone SIMON: 21 February – 28 February 1980
- Cyclone FREDA: 24 February – 07 March 1981
- Cyclone ABIGAIL: 22 January – 05 February 1982
- Cyclone DOMINIC: 01 April – 14 April 1982
- Cyclone DES 14 January – 23 January 1983
- Cyclone ELINOR: 10 February – 03 March 1983
- Cyclone FRITZ: 09 December – 13 December 1983
- Cyclone GRACE: 11 January – 20 January 1984
- Cyclone HARVEY: 03 February – 09 February 1984
- Cyclone INGRID: 20 February – 25 February 1984
- Cyclone LANCE: 04 April – 07 April 1984
- Cyclone MONICA; 25 December – 28 December 1984
- Cyclone NIGEL: 14 January - 16 January 1985
- Cyclone PIERRE: 18 February – 24 February 1985
- Cyclone VERNON: 21 January – 24 January 1986
- Cyclone ALFRED: 02 March – 08 March 1986
- Cyclone BLANCH: 21 May – 27 May 1987
- Cyclone CHARLIE: 21 February – 01 March 1988
- Cyclone DELILAH: 28 December 1988 – 01 January 1989
- Cyclone AIVU: 01 April – 05 April 1989
- Cyclone FELICITY: 13 December – 20 December 1989
- Cyclone NANCY: 28 January – 04 February 1990
- Cyclone HILDA: 04 March – 07 March 1990
- Cyclone IVOR: 16 March – 26 March 1990
- Cyclone JOY: 18 December – 27 December 1990
- Cyclone KELVIN: 24 February – 05 March 1991
- Cyclone FRAN: 09 March – 17 March 1992
- Cyclone OLIVER: 05 February – 12 February 1993
- Cyclone ROGER: 12 March – 21 March 1993
- Cyclone REWA: 28 December 1993 – 21 January 1994
- Cyclone VIOLET: 03 March – 08 March 1995
- Cyclone CELESTE: 26 January – 29 January 1996
- Cyclone DENNIS: 15 February – 18 February 1996

See Figure 108 to Figure 113 for the cyclone tracks for a 400 km radius centred just east of Mackay over the recording period of 1975 – 1979, 1980 – 1982, 1983 – 1984, 1985 – 1988, 1989 – 1991 and 1992 - 1996.

2.9 Station Supervision

The observers were instructed in the recording program by the BPA COPE Field Officer and the initial instruction period was followed by regular visits to the station during the period of recordings presented in this report.

Installation of the reference pole for this station was carried out by the Sarina Shire Council. Maintenance of the pole was carried out by the BPA COPE Field Officer.

3 Data

3.1 General

COPE data for this station for the thirteen year period April 1981 to March 1993 is presented in the tables in Section 5 - Tabular Results and the figures in Section 6 - Data Presentation. The data has been analysed statistically and/or smoothed to reveal long term averages or trends. A brief description of each of the observed parameters is given below with the relevant figure references.

3.2 Wind

The observer recorded the wind speed at the beach using a hand held wind meter at 1.5 m above beach level. Initially, the wind direction was recorded as a cardinal direction, and the speed was recorded in knots (kn). From 8 February 1986 the wind direction was recorded in degrees by compass, and the speed was recorded in miles per hour (mph). Wind speed data in this report is presented in metres per second (m/s).

A summary of annual wind speed direction percentage occurrences is shown as a wind rose in Figure 12.

3.3 Waves

The average and maximum breaker height (trough to crest) was usually estimated to the nearest 0.1 metre. Previous studies (Patterson and Blair, 1983) have shown that the estimate of average breaker height is comparable with the equivalent deep water significant wave height. The wave height was measured using one of the methods described on page two of the recording sheet (Figure 11), the method chosen being dependent on the wave height.

The observers estimated the wave period by recording the time taken for eleven wave crests (the duration of 10 waves) to pass a point.

Prior to 4 November 1981 wave direction at Sarina beach was recorded using the protractor in Figure 9 placed parallel to the shore. Between 4 November 1981 and 7 February 1986, wave direction was recorded as a compass bearing (refer Figure 11). The direction recorded was then converted to a sector, as shown in the following paragraph.

Wave direction is estimated as one of five direction sectors in relation to the shore normal direction from which the waves were approaching the beach. From aerial photography the shore normal direction (True North) was determined to be 93 degrees for the Sarina Beach COPE site. The compass bearings (Adjusted for magnetic declination) for the sectors are displayed in Table 3 and in the diagram below:

Table 3 Sector directions (Magnetic North)

Sector	Direction
1	11° to 71°
2	71° to 96°
3	96° to 106°
4	106° to 131°
5	131° to 191°

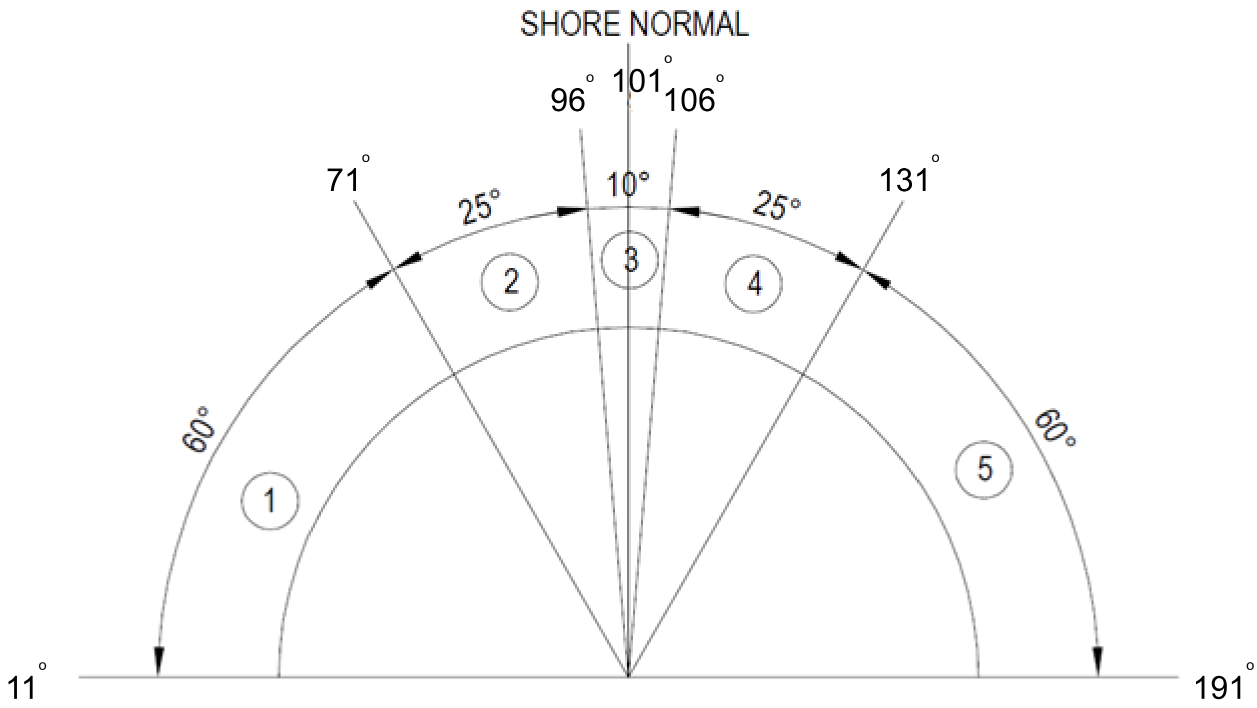


Figure 5 Sector Distribution (Magnetic North)

Note: At the Sarina beach COPE station, the shore normal direction is approximately 101 degrees east of magnetic north.

Statistical representations of the observed wave data include:

- The percentage of wave height recordings which exceed any given wave height for all directions combined (Figure 13);
- The percentage occurrence of various combinations of wave heights, periods and directions (Figure 14 to Figure 18);
- Surf zone width with an indication of existence or otherwise of an offshore bar (Figure 19 to Figure 31); and
- Tabulation of the occurrence of various wave heights, periods, types and directions (Table 4 to Table 16).

Post 7 February 1986, wave direction was recorded as a compass bearing (Refer Figure 11). Wave direction data in this report is presented as per the sectors summarised in Table 3.

3.4 Longshore Currents

The observer measured the distance parallel to the shoreline that a float or dye patch in the surf zone moved in one minute. Current direction is either upcoast (positive) or downcoast (negative), with the upcoast direction being to the left when facing the sea from the beach.

The readings were then converted to a velocity which was plotted on a monthly basis (Figure 32 to Figure 44). A summary table for the mean upcoast and downcoast components and overall annual averages are provided on each of these yearly figures.

3.5 Beach Profile Parameters

Fixed contour elevation was measured by using the supplied level and the 1.5 m support pole. The observer would stand the pole in the top of the berm, and by using the level, would site and record the elevation from the graduated COPE pole. The distance to the fixed contour was recorded using a tape measure. The fixed contour has been interpreted as being on top of a berm.

Sand level at the reference pole and the distance to the vegetation line were also recorded.

Changes in these parameters with time indicate how the beach moves in response to varying wave conditions. Plots of these parameters are shown in Figure 45 to Figure 70.

Foreshore slopes were recorded at this station between 4 May 1981 and 2 July 1986 (using the original recording form) and are shown in Figure 106.

Figure 71 show summaries of monthly averages of the distance to berm and the distance to vegetation line for the full recording period.

3.6 Monthly Beach Profiles

Measurements of beach profiles at Sarina were usually taken monthly. However, if the beach experienced appreciable erosion or accretion during the month, the observer was requested to take an additional beach profile. Monthly beach profiles are shown in to Figure 87. It should be noted that the profile taken in June 1981 has been repeated in each graph so comparisons between profiles can be easily made.

3.7 Sand Sample Particle Size Distribution

A total of 75 sand samples were collected over twelve years (1981 to 1992) when the station was operational. Additionally two yearly samples were collected at Sarina beach prior to the COPE station starting. The data indicates that samples underwent a standard sieve analysis to determine the particle size distribution. The lower boundary (D_{16}), upper boundary (D_{84}) and the average D_{50} were derived from the data and are summarised in Figure 105. Particle Size Distribution D_{50} is the value of the particle diameter at 50% in the cumulative distribution. For Sarina, the average D_{50}=0.34 mm, then 50% of the particles in the sample are larger than 0.34 mm, and 50% smaller than 0.34 mm with the same concept applied for D_{16} and D_{84}.

4 References

1. BC No 27 – Jones, C.M., *COPE (Coastal Observation Programme Engineering)*, Beach Conservation newsletter No 21, October 1975.
2. BC No 69 – Andrews, M.J. and Blair, R.J., *Coastal Observation Programme – Engineering (COPE)*, Beach Conservation newsletter No. 69, June 1990.
3. H&M 1981 - *1981 Official Tide Tables*, Department of Harbours and Marine Queensland, 1981.
4. Beach Surveys and Data Assessment, Gold Coast Region, COPE Data – Bilinga beach Coastal Impact Unit February 2014 – GHD Pty Ltd, *COPE Data Bilinga Beach*, for Department of Science, Information Technology, Innovation and Arts, February 2014.
5. MSQ 2015 – *Semi diurnals and diurnal tidal planed, http://www.msq.qld.gov.au/tides/tidal -planes.aspx*, Maritime Safety Queensland, 2015.
6. Patterson & Blair 1983 - Patterson, D.C. and Blair, R.J., *Visually Determined Wave Parameters*, 6th Australian Conference on Coastal and Ocean Engineering, Gold Coast, July 1983.
7. Robinson & Jones 1977 – Robinson, D.A. and Jones, C.M., *Queensland Volunteer Coastal Observation Programme – Engineering (COPE)*, 3rd Australian Conference on Coastal and Ocean Engineering, Melbourne, April 1977.

5 Tabular Results

Table 4 Monthly and annual – mean wave height/mean wave period and wave direction occurrences. Sarina Beach. Year 1981

Month	No. Observations	Mean Wave Period (s)	Mean Wave Height (m)	No of Obs.	Percentage occurences - wave direction (Sector)					
					1	2	3	4	5	Calm
Jan	0			0						
Feb	0			0						
Mar	0			0						
Apr	21	3.5	0.5	21	2	2	5	10	2	0
May	23	4.4	0.4	23	1	4	1	11	6	0
Jun	19	3.6	0.2	19	2	2	2	8	1	4
Jul	27	3.9	0.5	27	0	1	7	16	0	3
Aug	24	3.6	0.4	24	0	7	9	5	0	3
Sep	26	3.4	0.7	26	0	5	13	8	0	0
Oct	27	4.6	0.7	27	3	1	15	8	0	0
Nov	25	3.0	0.5	25	0	12	8	2	0	3
Dec	23	3.0	0.4	23	0	10	9	0	0	4
Whole Year	**215**	**3.7**	**0.5**	**215**	**8**	**44**	**69**	**68**	**9**	**17**

Table 5 Monthly and annual – mean wave height/mean wave period and wave direction occurrences. Sarina Beach. Year 1982

Month	No. Observations	Mean Wave Period (s)	Mean Wave Height (m)	No of Obs.	Percentage occurences - wave direction (Sector)					
					1	2	3	4	5	Calm
Jan	17	3.1	0.5	17	0	7	5	0	0	5
Feb	26	3.3	0.7	26	0	5	13	0	0	8
Mar	25	3.2	0.7	25	0	1	11	0	0	13
Apr	23	3.4	0.8	23	0	0	17	0	0	6
May	27	3.1	0.5	27	0	0	13	0	0	14
Jun	26	3.3	0.6	26	0	0	14	0	0	12
Jul	23	3.3	0.6	23	0	0	16	0	0	7
Aug	25	3.8	0.9	25	0	0	14	0	0	11
Sep	10	2.7	0.4	10	0	0	5	0	0	5
Oct	29	2.9	0.4	29	0	6	12	0	0	11
Nov	26	3.4	0.7	26	0	0	7	2	0	17
Dec	22	3.0	0.5	22	0	7	12	0	0	3
Whole Year	**279**	**3.2**	**0.6**	**279**	**0**	**26**	**139**	**2**	**0**	**112**

Table 6 Monthly and annual – mean wave height/mean wave period and wave direction occurrences. Sarina Beach. Year 1983

Month	No. Observations	Mean Wave Period (s)	Mean Wave Height (m)	No of Obs.	Percentage occurences - wave direction (Sector)					
					1	2	3	4	5	Calm
Jan	0			0						
Feb	5	3.2	0.6	5	0	0	3	0	0	2
Mar	0			0						
Apr	0			0						
May	0			0						
Jun	0			0						
Jul	0			0						
Aug	0			0						
Sep	0			0						
Oct	0			0						
Nov	0			0						
Dec	0			0						
Whole Year	**5**	**3.2**	**0.6**	**5**	**0**	**0**	**3**	**0**	**0**	**2**

Table 7 Monthly and annual – mean wave height/mean wave period and wave direction occurrences. Sarina Beach. Year 1984

Month	No. Observations	Mean Wave Period (s)	Mean Wave Height (m)	No of Obs.	Percentage occurences - wave direction (Sector)					
					1	2	3	4	5	Calm
Jan	0			0						
Feb	0			0						
Mar	0			0						
Apr	0			0						
May	0			0						
Jun	0			0						
Jul	0			0						
Aug	0			0						
Sep	0			0						
Oct	0			0						
Nov	30	2.8	0.4	30	0	3	18	0	0	9
Dec	31	2.7	0.2	31	0	0	25	0	0	6
Whole Year	**61**	**2.8**	**0.3**	**61**	**0**	**3**	**43**	**0**	**0**	**15**

Table 8 Monthly and annual – mean wave height/mean wave period and wave direction occurrences. Sarina Beach. Year 1985

Month	No. Observations	Mean Wave Period (s)	Mean Wave Height (m)	No of Obs.	Percentage occurences - wave direction (Sector)					
					1	2	3	4	5	Calm
Jan	31	3.1	0.3	31	0	0	17	0	0	14
Feb	28	3.2	0.4	28	0	0	13	0	0	15
Mar	31	3.4	0.6	31	0	0	18	0	0	13
Apr	30	3.3	0.6	30	0	0	22	3	0	5
May	31	3.8	0.9	31	0	2	13	5	0	11
Jun	30	3.6	0.6	30	0	1	15	9	0	5
Jul	31	3.7	0.4	31	0	0	13	6	0	12
Aug	31	3.5	0.3	31	0	9	11	8	0	3
Sep	30	3.5	0.4	30	0	9	11	7	0	3
Oct	31	3.3	0.5	31	0	13	9	3	0	6
Nov	30	3.5	0.5	30	0	17	13	0	0	0
Dec	31	3.2	0.3	31	0	31	0	0	0	0
Whole Year	**365**	**3.4**	**0.5**	**365**	**0**	**82**	**155**	**41**	**0**	**87**

Table 9 Monthly and annual – mean wave height/mean wave period and wave direction occurrences. Sarina Beach. Year 1986

Month	No. Observations	Mean Wave Period (s)	Mean Wave Height (m)	No of Obs.	Percentage occurences - wave direction (Sector)					
					1	2	3	4	5	Calm
Jan	31	4.0	0.6	31	0	5	14	8	0	4
Feb	28	3.9	0.4	28	6	8	5	9	0	0
Mar	31	4.5	0.6	31	1	6	9	15	0	0
Apr	30	4.2	0.5	30	0	12	12	6	0	0
May	31	4.1	0.3	31	0	10	8	13	0	0
Jun	30	4.4	0.3	30	0	10	8	11	1	0
Jul	31	3.8	0.2	31	8	6	8	9	0	0
Aug	31	4.0	0.2	31	4	13	4	10	0	0
Sep	30	3.7	0.2	30	4	13	7	6	0	0
Oct	32	3.1	0.2	32	6	25	0	1	0	0
Nov	29	3.7	0.2	29	4	13	8	4	0	0
Dec	31	3.7	0.2	31	12	17	1	1	0	0
Whole Year	**365**	**3.9**	**0.3**	**365**	**45**	**138**	**84**	**93**	**1**	**4**

Table 10 Monthly and annual – mean wave height/mean wave period and wave direction occurrences. Sarina Beach. Year 1987

Month	No. Observations	Mean Wave Period (s)	Mean Wave Height (m)	No of Obs.	Percentage occurences - wave direction (Sector)					
					1	2	3	4	5	Calm
Jan	31	3.5	0.2	31	20	11	0	0	0	0
Feb	28	3.9	0.3	28	6	11	6	5	0	0
Mar	31	4.1	0.2	31	2	16	10	2	0	0
Apr	30	5.5	0.3	30	0	7	8	14	0	0
May	31	5.1	0.2	31	0	4	12	15	0	0
Jun	30	4.8	0.2	30	0	7	7	16	0	0
Jul	31	5.7	0.2	31	0	8	13	10	0	0
Aug	31	4.5	0.2	31	0	12	4	15	0	0
Sep	30	4.0	0.2	30	2	18	3	7	0	0
Oct	31	3.8	0.2	31	15	10	3	3	0	0
Nov	30	4.0	0.2	30	19	8	2	1	0	0
Dec	31	3.8	0.2	31	15	14	1	1	0	0
Whole Year	**365**	**4.4**	**0.2**	**365**	**79**	**126**	**69**	**89**	**0**	**0**

Table 11 Monthly and annual – mean wave height/mean wave period and wave direction occurrences. Sarina Beach. Year 1988

Month	No. Observations	Mean Wave Period (s)	Mean Wave Height (m)	No of Obs.	Percentage occurences - wave direction (Sector)					
					1	2	3	4	5	Calm
Jan	31	4.5	0.3	31	5	10	12	4	0	0
Feb	18	4.3	0.3	18	5	8	3	1	0	0
Mar	29	5.3	0.4	29	8	14	7	0	0	0
Apr	30	4.7	0.2	30	10	11	6	3	0	0
May	31	4.5	0.2	31	0	9	17	4	0	0
Jun	30	4.7	0.2	30	0	13	7	10	0	0
Jul	31	4.5	0.3	31	1	23	4	2	0	0
Aug	31	4.0	0.3	31	0	10	12	9	0	0
Sep	30	4.0	0.2	30	1	11	9	8	0	0
Oct	31	3.5	0.2	31	15	15	0	1	0	0
Nov	30	4.4	0.3	30	7	15	7	1	0	0
Dec	31	4.3	0.3	31	6	17	6	2	0	0
Whole Year	**353**	**4.4**	**0.3**	**353**	**58**	**156**	**90**	**45**	**0**	**0**

Table 12 Monthly and annual – mean wave height/mean wave period and wave direction occurrences. Sarina Beach. Year 1989

Month	No. Observations	Mean Wave Period (s)	Mean Wave Height (m)	No of Obs.	Percentage occurences - wave direction (Sector)					
					1	2	3	4	5	Calm
Jan	31	4.3	0.3	31	4	14	7	5	0	0
Feb	28	4.3	0.3	28	5	6	10	7	0	0
Mar	31	3.9	0.3	31	6	16	6	3	0	0
Apr	29	4.5	0.3	29	1	26	1	0	0	0
May	31	4.2	0.3	31	1	22	8	0	0	0
Jun	30	4.6	0.2	30	1	20	8	1	0	0
Jul	31	3.8	0.2	31	0	11	15	5	0	0
Aug	31	4.6	0.2	31	0	15	10	6	0	0
Sep	30	3.9	0.2	30	9	9	7	5	0	0
Oct	31	3.8	0.2	31	15	5	7	4	0	0
Nov	30	3.9	0.3	30	11	12	6	1	0	0
Dec	31	4.0	0.2	31	9	14	5	3	0	0
Whole Year	**364**	**4.2**	**0.2**	**364**	**62**	**170**	**90**	**40**	**0**	**0**

Table 13 Monthly and annual – mean wave height/mean wave period and wave direction occurrences. Sarina Beach. Year 1990

Month	No. Observations	Mean Wave Period (s)	Mean Wave Height (m)	No of Obs.	Percentage occurences - wave direction (Sector)					
					1	2	3	4	5	Calm
Jan	31	4.1	0.3	31	2	21	8	0	0	0
Feb	28	4.6	0.2	28	15	10	2	0	0	0
Mar	31	4.3	0.4	31	0	21	8	2	0	0
Apr	30	4.4	0.4	30	2	26	1	0	0	0
May	31	4.4	0.3	31	0	18	13	0	0	0
Jun	30	4.4	0.3	30	0	15	11	4	0	0
Jul	31	4.2	0.2	31	2	15	7	6	0	0
Aug	31	4.3	0.2	31	3	9	8	11	0	0
Sep	27	3.8	0.2	27	0	11	11	5	0	0
Oct	33	3.8	0.2	33	21	9	2	1	0	0
Nov	28	3.9	0.2	28	11	13	2	2	0	0
Dec	21	4.1	0.3	21	14	7	0	0	0	0
Whole Year	**352**	**4.2**	**0.3**	**352**	**70**	**175**	**73**	**31**	**0**	**0**

Table 14 Monthly and annual – mean wave height/mean wave period and wave direction occurrences. Sarina Beach. Year 1991

Month	No. Observations	Mean Wave Period (s)	Mean Wave Height (m)	No of Obs.	Percentage occurences - wave direction (Sector)					
					1	2	3	4	5	Calm
Jan	31	3.9	0.2	31	23	8	0	0	0	0
Feb	28	4.2	0.3	28	13	13	2	0	0	0
Mar	27	4.1	0.3	27	13	14	0	0	0	0
Apr	30	4.6	0.3	30	8	15	7	0	0	0
May	31	4.6	0.4	31	1	22	8	0	0	0
Jun	30	5.4	0.2	30	0	29	1	0	0	0
Jul	31	4.7	0.2	31	2	24	4	1	0	0
Aug	31	4.6	0.2	31	1	27	3	0	0	0
Sep	30	4.4	0.1	30	3	20	4	3	0	0
Oct	28	4.2	0.3	28	3	20	4	1	0	0
Nov	20	3.9	0.3	20	4	14	1	1	0	0
Dec	31	3.7	0.2	31	13	14	2	0	0	0
Whole Year	**348**	**4.4**	**0.3**	**348**	**84**	**220**	**36**	**6**	**0**	**0**

Table 15 Monthly and annual – mean wave height/mean wave period and wave direction occurrences. Sarina Beach. Year 1992

Month	No. Observations	Mean Wave Period (s)	Mean Wave Height (m)	No of Obs.	Percentage occurences - wave direction (Sector)					
					1	2	3	4	5	Calm
Jan	31	3.9	0.3	31	18	10	2	1	0	0
Feb	29	3.7	0.3	29	16	12	1	0	0	0
Mar	31	4.5	0.4	31	7	18	1	5	0	0
Apr	29	4.6	0.6	29	0	28	1	0	0	0
May	31	4.6	0.3	31	0	29	1	0	0	0
Jun	30	5.4	0.3	30	0	28	0	0	0	0
Jul	31	4.7	0.3	31	0	22	0	0	1	0
Aug	31	4.4	0.2	31	1	24	0	0	0	0
Sep	30	3.7	0.2	30	7	16	0	1	0	0
Oct	31	3.9	0.3	31	11	18	2	0	0	0
Nov	30	3.9	0.3	30	18	12	0	0	0	0
Dec	31	4.2	0.4	31	11	17	0	0	0	0
Whole Year	**365**	**4.3**	**0.3**	**365**	**89**	**234**	**8**	**7**	**1**	**0**

Table 16 Monthly and annual – mean wave height/mean wave period and wave direction occurrences. Sarina Beach. Year 1993

Month	No. Observations	Mean Wave Period (s)	Mean Wave Height (m)	No of Obs.	Percentage occurences - wave direction (Sector)					
					1	2	3	4	5	Calm
Jan	31	4.1	0.4	31	2	27	0	0	0	0
Feb	0			0						
Mar	31	4.8	0.4	31	0	28	0	0	0	0
Apr	0			0						
May	0			0						
Jun	0			0						
Jul	0			0						
Aug	0			0						
Sep	0			0						
Oct	0			0						
Nov	0			0						
Dec	0			0						
Whole Year	**62**	**4.4**	**0.4**	**62**	**2**	**55**	**0**	**0**	**0**	**0**

6 Data Presentation

The data analysis for the Sarina Beach COPE stations is presented in the following figures.

LEGEND

- COPE Station
- Major Watercourses
- Secondary Road
- Local Connector Road
- Street/Local Road
- Railway
- Suburb

Department of Natural Resources and Mines and Department of Transport and Main Roads (DNRM, DTMR) makes no representations or warranties about the accuracy, reliability, completeness, or suitability for any particular purpose of the data. By using the data you agree that DNRM and DTMR is under no liability for any loss or damage (including consequential damage) that you may suffer from use of data. Further, you agree to continually indemnify the State of Queensland, DNRM, DTMR and their officers and employees against any loss, cost, expense, damage and liability of any kind (including consequential damage) arising directly or indirectly from or related to any claim relating to your use of the data or any product made from the data. Department of Natural Resources and Mines, Department of Transport and Main Roads © State of Queensland 2013

The Commonwealth gives no warranty regarding the Data's accuracy, completeness, currency or suitability for any particular purpose. Geoscience Australia © Commonwealth of Australia 2013

1:10,000 @ A4

0 100 200 300 400

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Department of Science, Innovation Technology and Innovation
Sarina Beach COPE Site

Job Number	41-28646
Revision	A
Date	06 May 2015

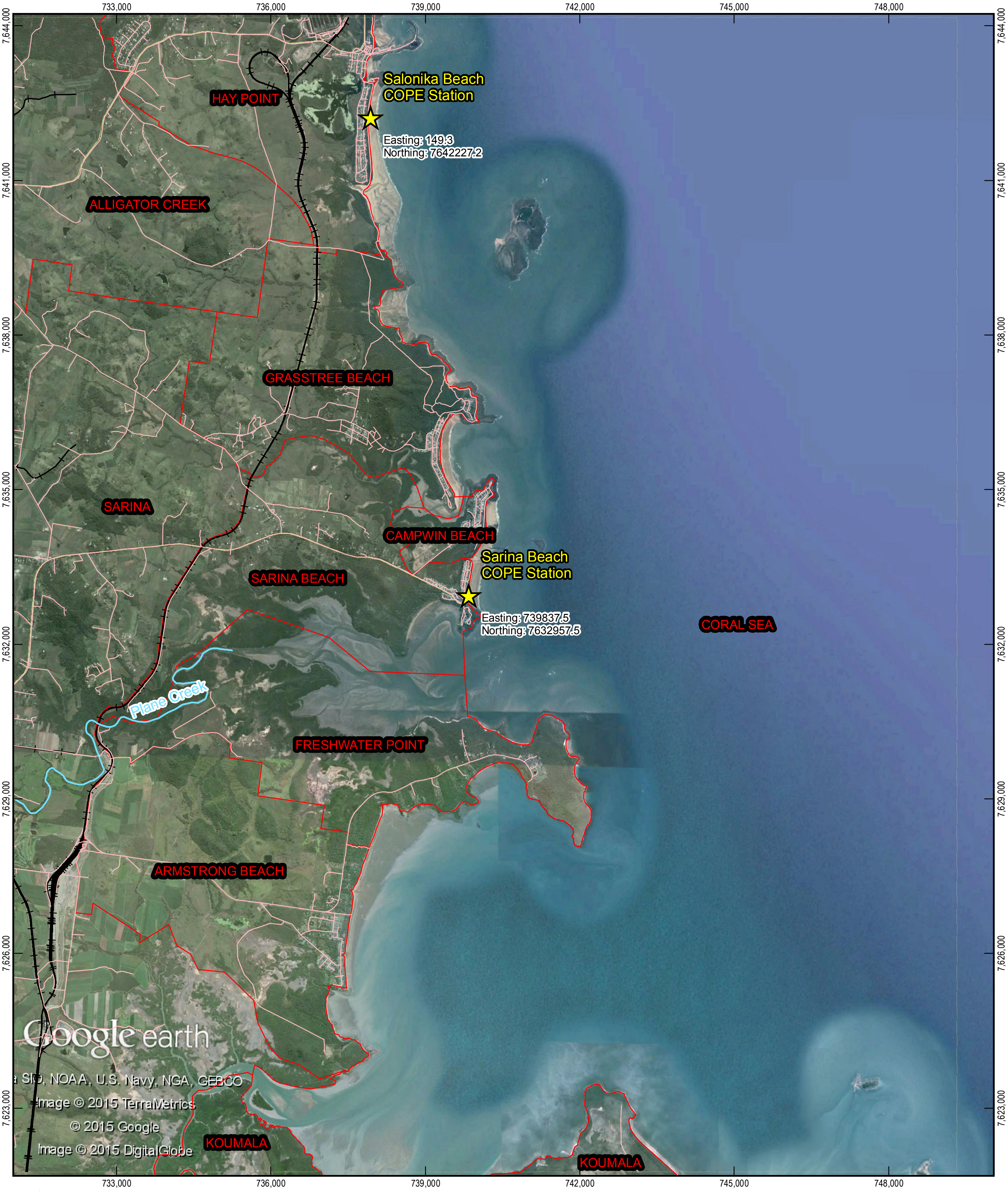
Site Plan

Figure 6 Sarina Beach COPE Site Plan

G:\41\28646\GIS\Maps\MXD\Latest Cope Pole Maps\41_28646_006_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data source: GHD: Cope Station (2015); DNRM: Rail; Major Watercourse (2014) Baseline Roads (2015); ABS: Suburb Boundaries (2014); Google Earth Pro: Imagery (Extracted 01/04/15). Created by: CW



LEGEND

- COPE Station
- Major Watercourses
- Roads
- Railway
- Suburb

Department of Natural Resources and Mines and Department of Transport and Main Roads (DNRM, DTMR) makes no representations or warranties about the accuracy, reliability, completeness, or suitability for any particular purpose of the data. By using the data you agree that DNRM and DTMR is under no liability for any loss or damage (including consequential damage) that you may suffer from use of data. Further, you agree to continually indemnify the State of Queensland, DNRM, DTMR and their officers and employees against any loss, cost, expense, damage and liability of any kind (including consequential damage) arising directly or indirectly from or related to any claim relating to your use of the data or any product made from the data. Department of Natural Resources and Mines, Department of Transport and Main Roads © State of Queensland 2013

The Commonwealth gives no warranty regarding the Data's accuracy, completeness, currency or suitability for any particular purpose. Geoscience Australia © Commonwealth of Australia 2013

1:100,000 @ A4

0 1,000 2,000 3,000 4,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

Department of Science, Innovation Technology and Innovation
Sarina Beach COPE Site

Job Number	41-28646
Revision	A
Date	06 May 2015

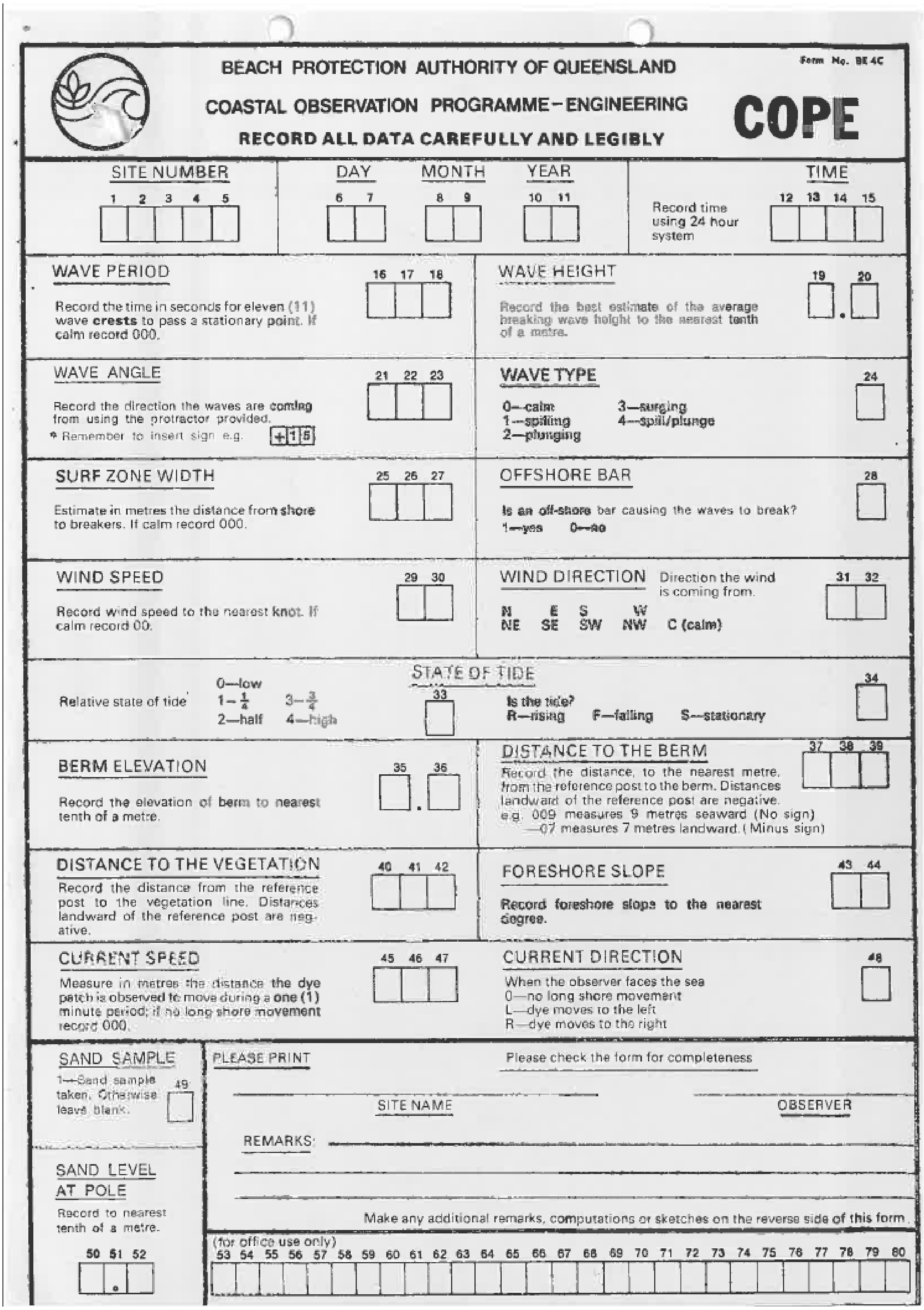
Locality Plan

Figure 7 Sarina Beach COPE Locality Plan

G:\41\28646\GIS\Maps\MXD\locality plans\41_28646_006_rev_a.mxd

145 Ann Street Brisbane QLD 4000 Australia **T** 61 7 3316 3000 **F** 61 7 3316 3333 **E** bnemail@ghd.com **W** www.ghd.com

Data source: GHD: Cope Station (2015); DNRM: Rail; Major Watercourse (2014) Physical Roads (2010); ABS: Suburb Boundaries (2014); Google Earth Pro: Imagery (Extracted 01/04/29). Created by: CW



BEACH PROTECTION AUTHORITY OF QUEENSLAND

COASTAL OBSERVATION PROGRAMME – ENGINEERING

RECORD ALL DATA CAREFULLY AND LEGIBLY

Form No. BE 4C

COPE

SITE NUMBER 1 2 3 4 5

DAY 6 7 | MONTH 8 9 | YEAR 10 11

TIME 12 13 14 15 — Record time using 24 hour system

WAVE PERIOD 16 17 18 — Record the time in seconds for eleven (11) wave **crests** to pass a stationary point. If calm record 000.

WAVE HEIGHT 19 . 20 — Record the best estimate of the average breaking wave height to the nearest tenth of a metre.

WAVE ANGLE 21 22 23 — Record the direction the waves are coming from using the protractor provided. * Remember to insert sign e.g. +15

WAVE TYPE 24 — 0—calm 1—spilling 2—plunging 3—surging 4—spill/plunge

SURF ZONE WIDTH 25 26 27 — Estimate in metres the distance from shore to breakers. If calm record 000.

OFFSHORE BAR 28 — Is an off-shore bar causing the waves to break? 1—yes 0—no

WIND SPEED 29 30 — Record wind speed to the nearest knot. If calm record 00.

WIND DIRECTION 31 32 — Direction the wind is coming from. N E S W NE SE SW NW C (calm)

STATE OF TIDE — Relative state of tide 0—low 1—¼ 2—half 3—¾ 4—high 33 — Is the tide? R—rising F—falling S—stationary 34

BERM ELEVATION 35 . 36 — Record the elevation of berm to nearest tenth of a metre.

DISTANCE TO THE BERM 37 38 39 — Record the distance, to the nearest metre, from the reference post to the berm. Distances landward of the reference post are negative. e.g. 009 measures 9 metres seaward (No sign) —07 measures 7 metres landward. (Minus sign)

DISTANCE TO THE VEGETATION 40 41 42 — Record the distance from the reference post to the vegetation line. Distances landward of the reference post are negative.

FORESHORE SLOPE 43 44 — Record foreshore slope to the nearest degree.

CURRENT SPEED 45 46 47 — Measure in metres the distance the dye patch is observed to move during a one (1) minute period; if no long shore movement record 000.

CURRENT DIRECTION 48 — When the observer faces the sea 0—no long shore movement L—dye moves to the left R—dye moves to the right

SAND SAMPLE 49 — 1—Sand sample taken. Otherwise leave blank.

PLEASE PRINT — Please check the form for completeness

SITE NAME — OBSERVER

REMARKS:

Make any additional remarks, computations or sketches on the reverse side of this form.

SAND LEVEL AT POLE 50 51 . 52 — Record to nearest tenth of a metre.

(for office use only) 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

Figure 8 COPE Recording Sheet – Old Format, Page 1

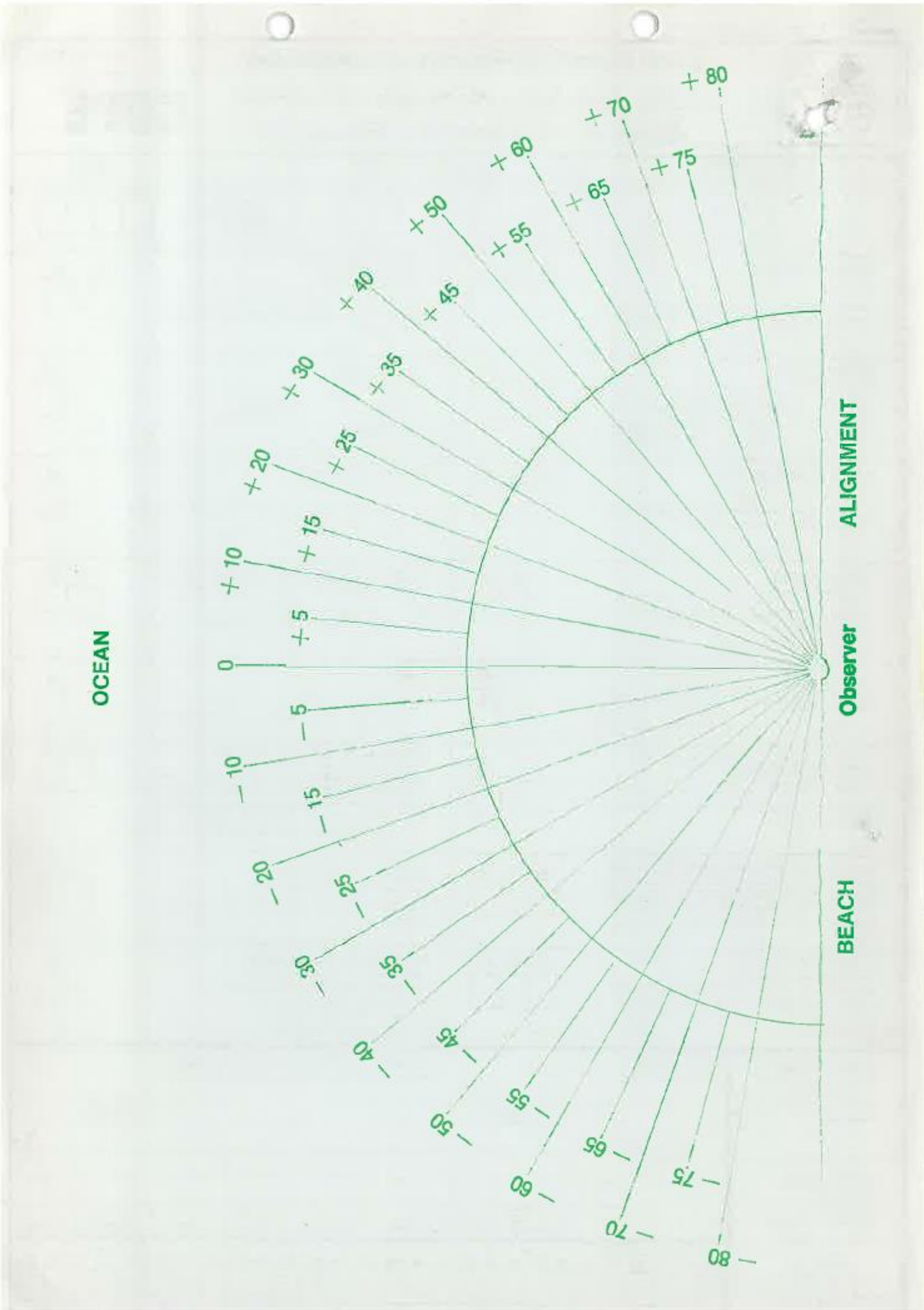
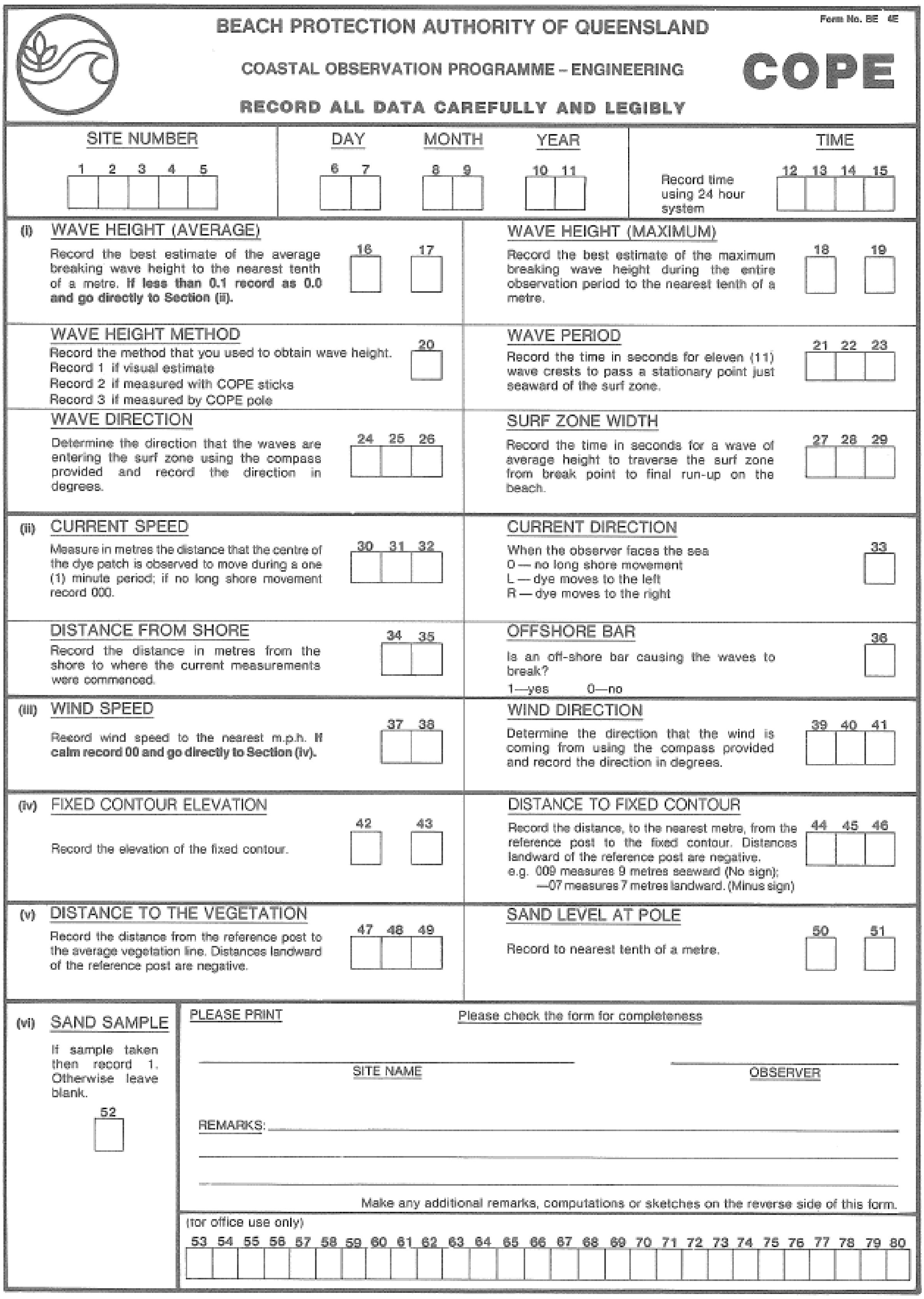


Figure 9 COPE Recording Sheet – Old Format, Page 2



BEACH PROTECTION AUTHORITY OF QUEENSLAND

Form No. BE 4E

COASTAL OBSERVATION PROGRAMME – ENGINEERING

COPE

RECORD ALL DATA CAREFULLY AND LEGIBLY

SITE NUMBER 1 2 3 4 5

DAY 6 7 MONTH 8 9 YEAR 10 11

TIME 12 13 14 15 — Record time using 24 hour system

(i) WAVE HEIGHT (AVERAGE) 16 17

Record the best estimate of the average breaking wave height to the nearest tenth of a metre. **If less than 0.1 record as 0.0 and go directly to Section (ii).**

WAVE HEIGHT (MAXIMUM) 18 19

Record the best estimate of the maximum breaking wave height during the entire observation period to the nearest tenth of a metre.

WAVE HEIGHT METHOD 20

Record the method that you used to obtain wave height.
Record 1 if visual estimate
Record 2 if measured with COPE sticks
Record 3 if measured by COPE pole

WAVE PERIOD 21 22 23

Record the time in seconds for eleven (11) wave crests to pass a stationary point just seaward of the surf zone.

WAVE DIRECTION 24 25 26

Determine the direction that the waves are entering the surf zone using the compass provided and record the direction in degrees.

SURF ZONE WIDTH 27 28 29

Record the time in seconds for a wave of average height to traverse the surf zone from break point to final run-up on the beach.

(ii) CURRENT SPEED 30 31 32

Measure in metres the distance that the centre of the dye patch is observed to move during a one (1) minute period; if no long shore movement record 000.

CURRENT DIRECTION 33

When the observer faces the sea
0 — no long shore movement
L — dye moves to the left
R — dye moves to the right

DISTANCE FROM SHORE 34 35

Record the distance in metres from the shore to where the current measurements were commenced.

OFFSHORE BAR 36

Is an off-shore bar causing the waves to break?
1—yes 0—no

(iii) WIND SPEED 37 38

Record wind speed to the nearest m.p.h. **If calm record 00 and go directly to Section (iv).**

WIND DIRECTION 39 40 41

Determine the direction that the wind is coming from using the compass provided and record the direction in degrees.

(iv) FIXED CONTOUR ELEVATION 42 43

Record the elevation of the fixed contour.

DISTANCE TO FIXED CONTOUR 44 45 46

Record the distance, to the nearest metre, from the reference post to the fixed contour. Distances landward of the reference post are negative.
e.g. 009 measures 9 metres seaward (No sign);
—07 measures 7 metres landward. (Minus sign)

(v) DISTANCE TO THE VEGETATION 47 48 49

Record the distance from the reference post to the average vegetation line. Distances landward of the reference post are negative.

SAND LEVEL AT POLE 50 51

Record to nearest tenth of a metre.

(vi) SAND SAMPLE 52

If sample taken then record 1. Otherwise leave blank.

PLEASE PRINT

Please check the form for completeness

SITE NAME

OBSERVER

REMARKS:

Make any additional remarks, computations or sketches on the reverse side of this form.

(for office use only)

53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

Figure 10 COPE Recording Sheet – New Format, Page 1

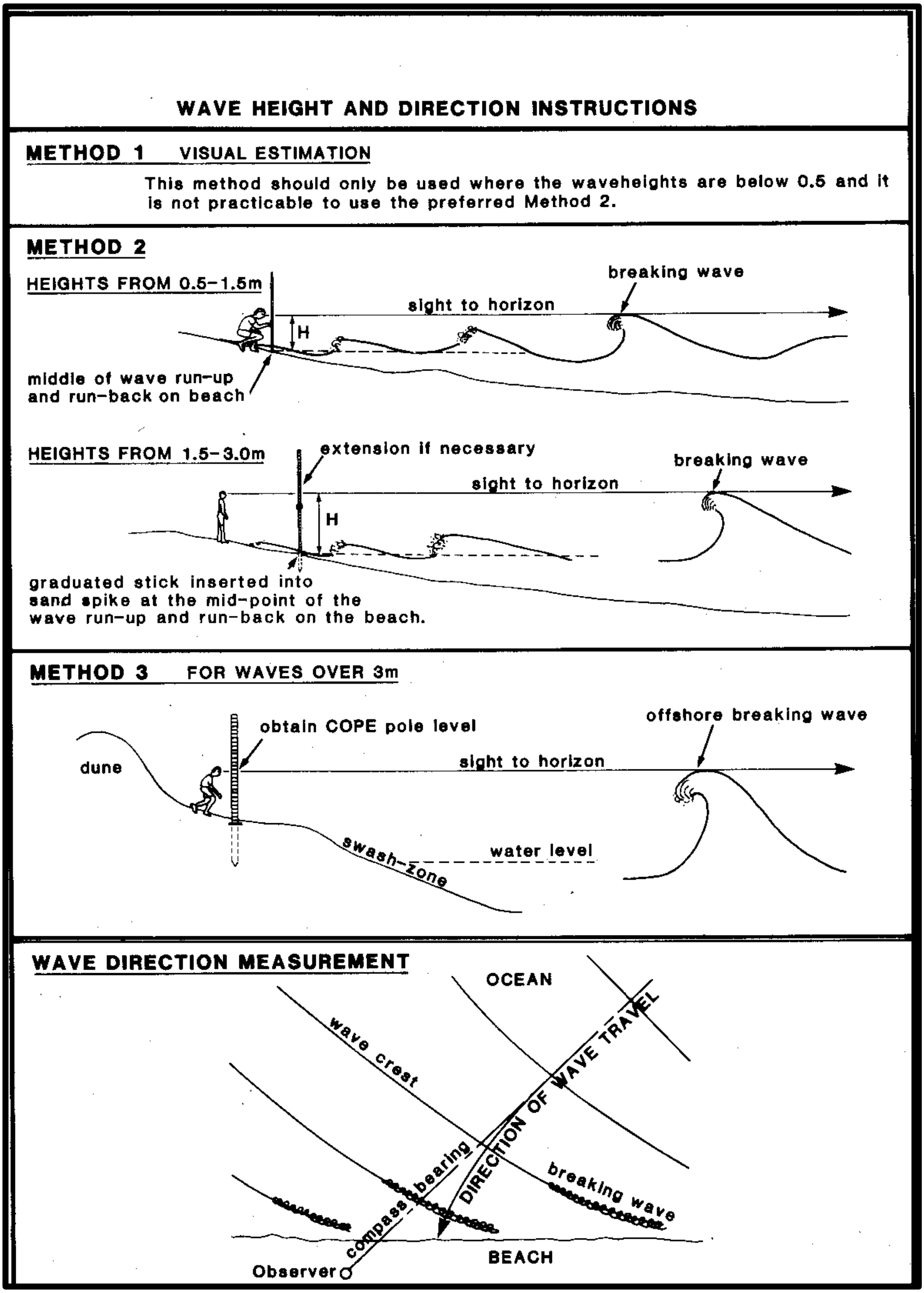


Figure 11 COPE Recording Sheet – New Format, Page 2

Wind Rose – Sarina Beach

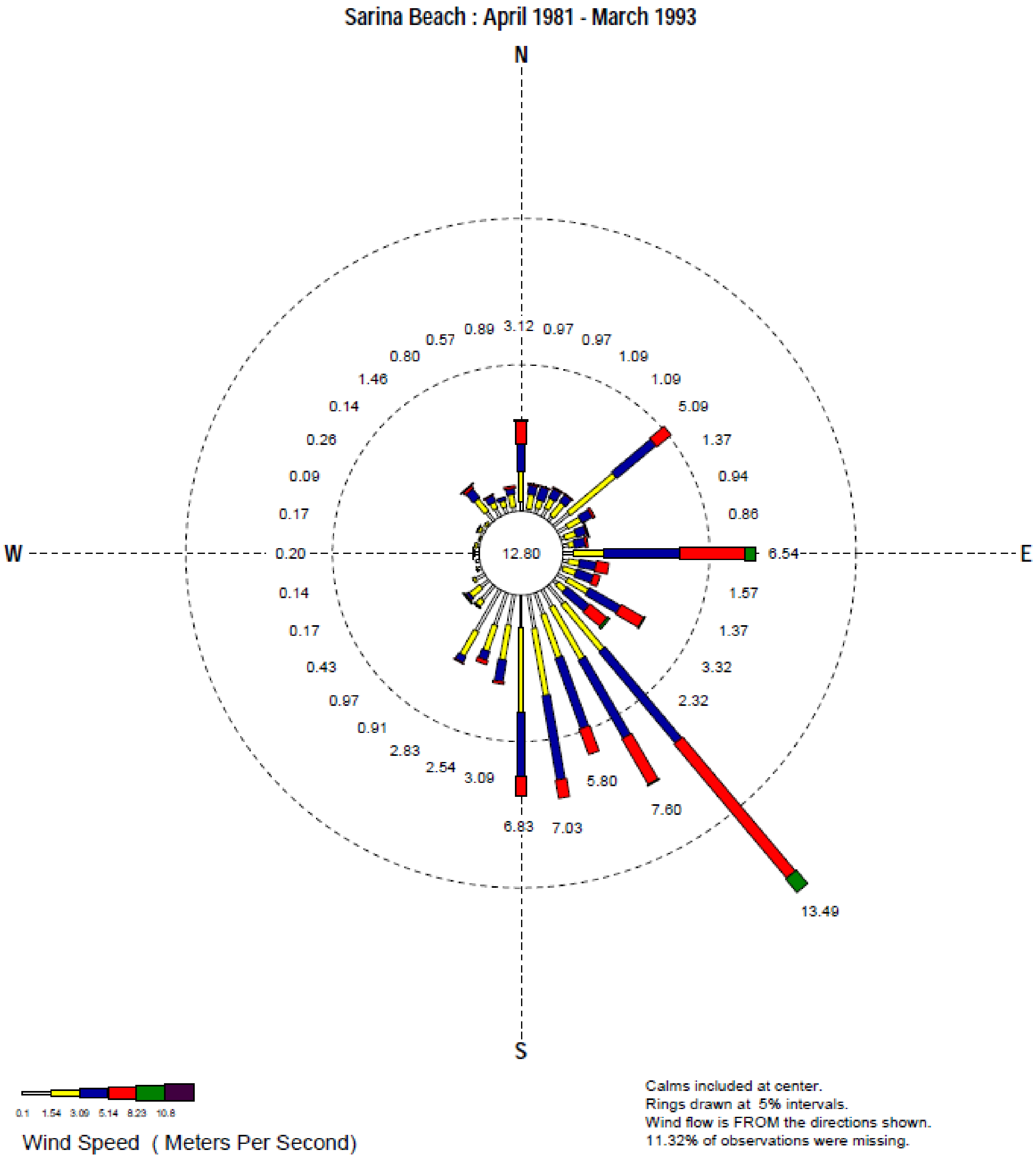


Figure 12 Wind Rose Diagram – Sarina Beach (Wind speed percentage occurrences)

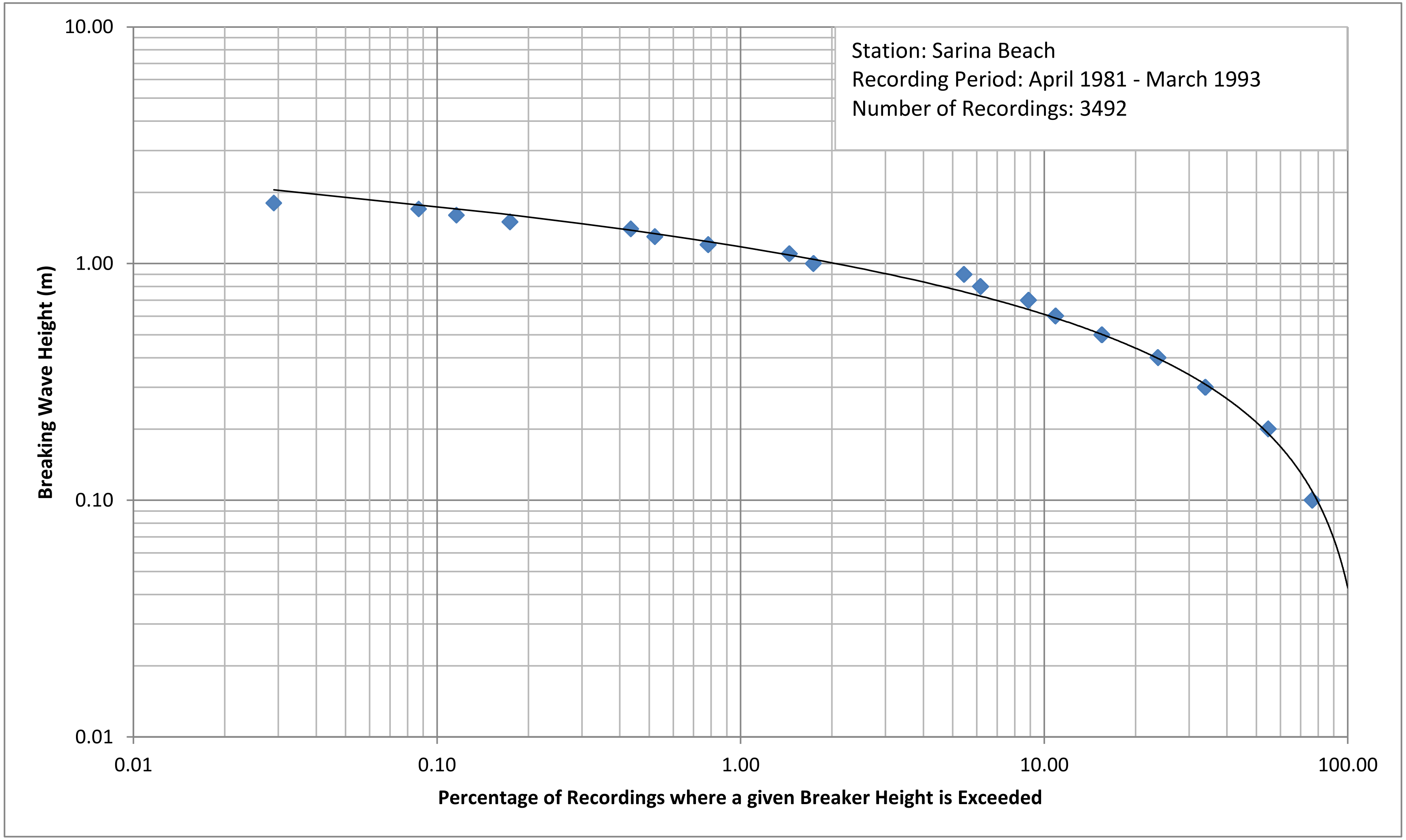


Figure 13 Wave height percentage exceedance

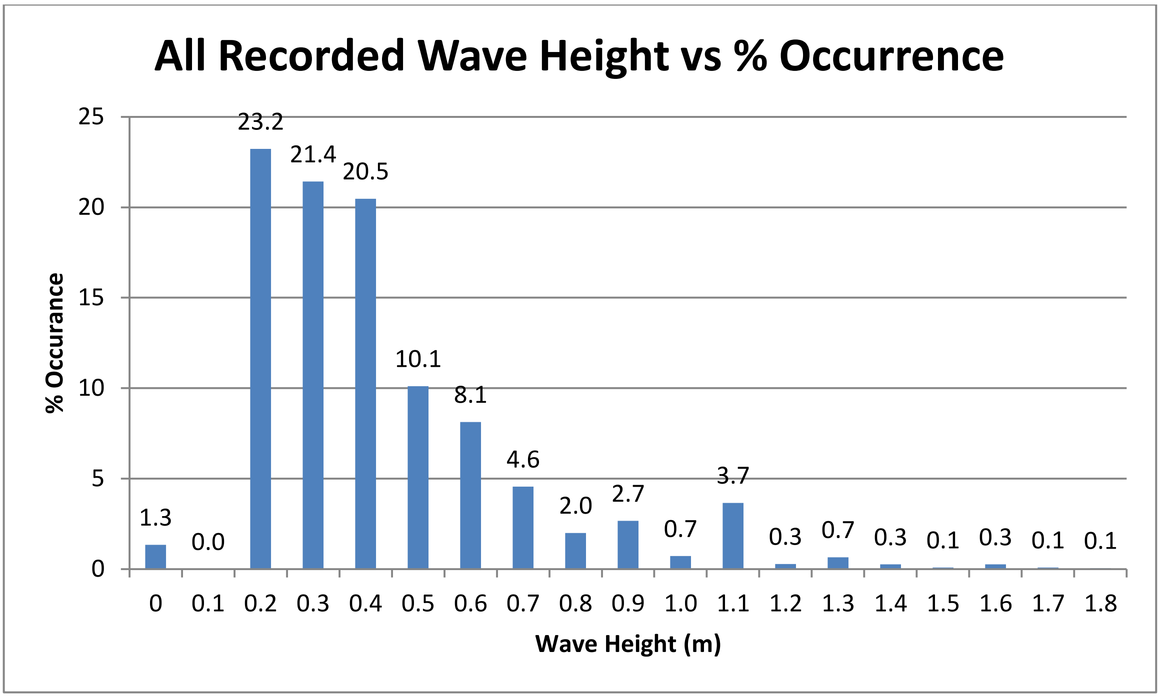


Figure 14 Percentage occurrence of wave height Apr 1981 to Mar 1993

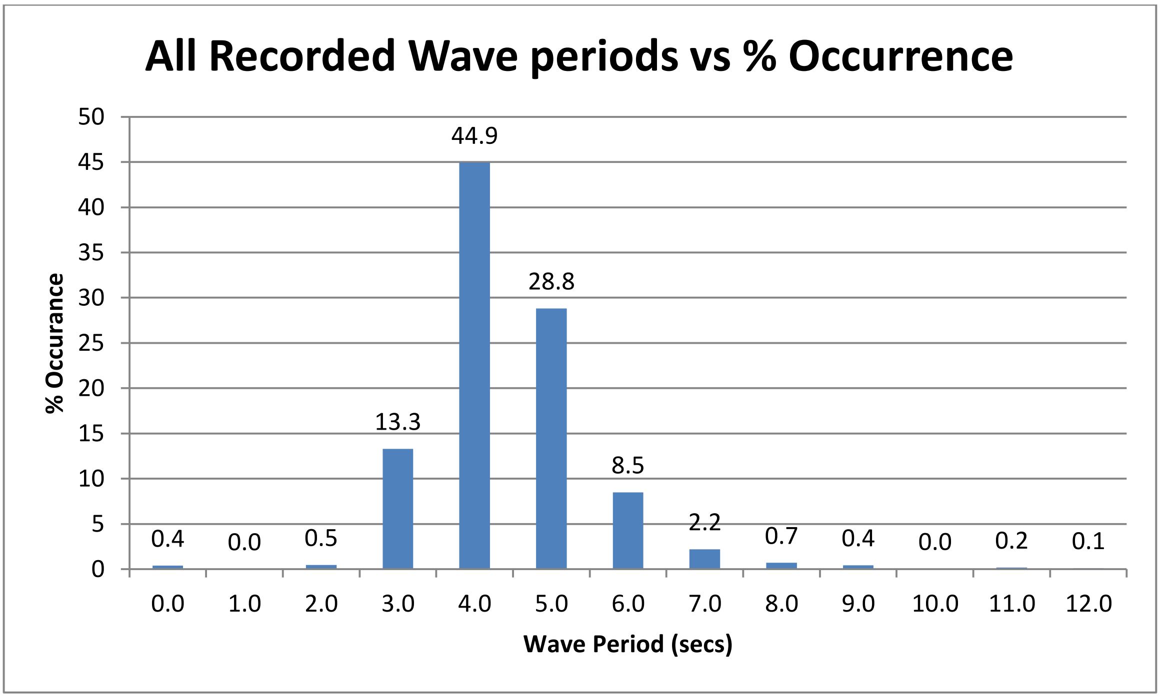


Figure 15 Percentage occurrence of wave period Apr 1981 to Mar 1993

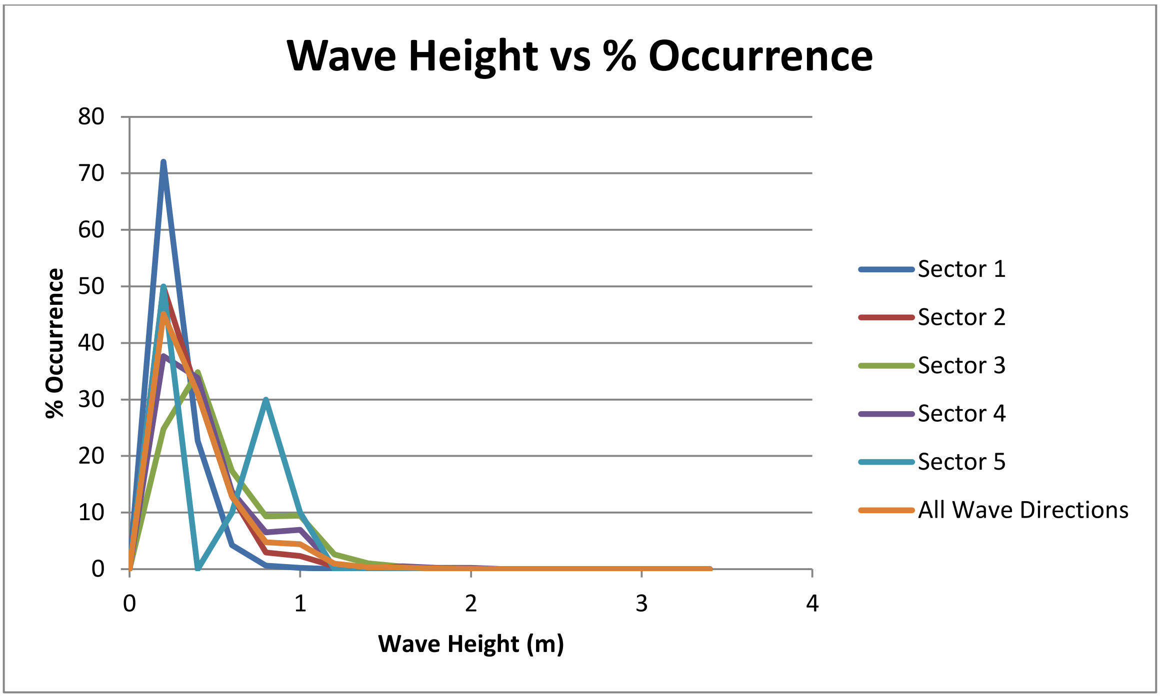


Figure 16 Wave direction analysis – wave height vs occurrence Apr 1981 to Mar 1993

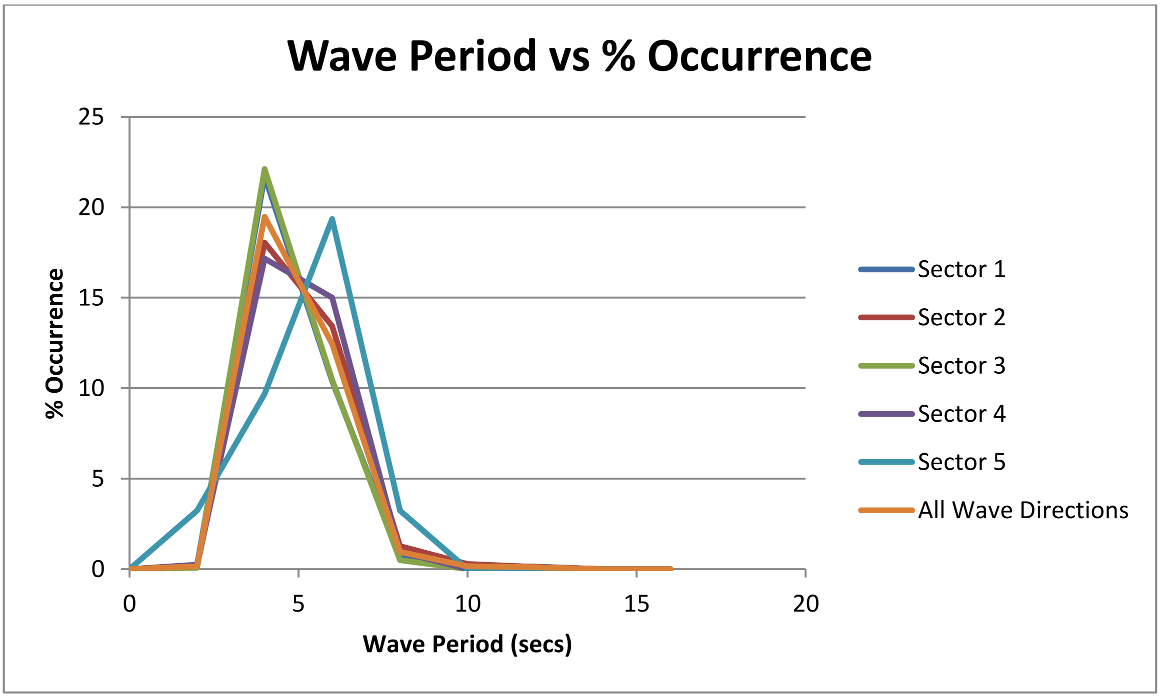


Figure 17 Wave direction analysis – wave period vs occurrence Apr 1981 to Mar 1993

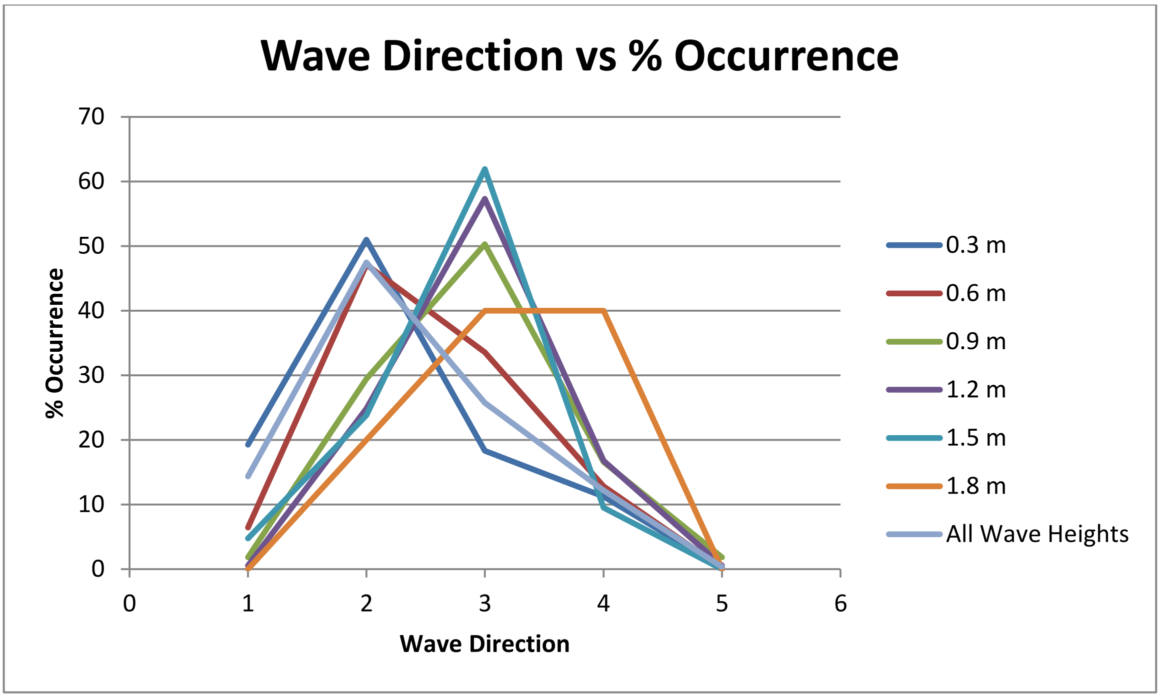


Figure 18 **Wave direction analysis – wave direction vs occurrence Apr 1981 to Mar 1993**

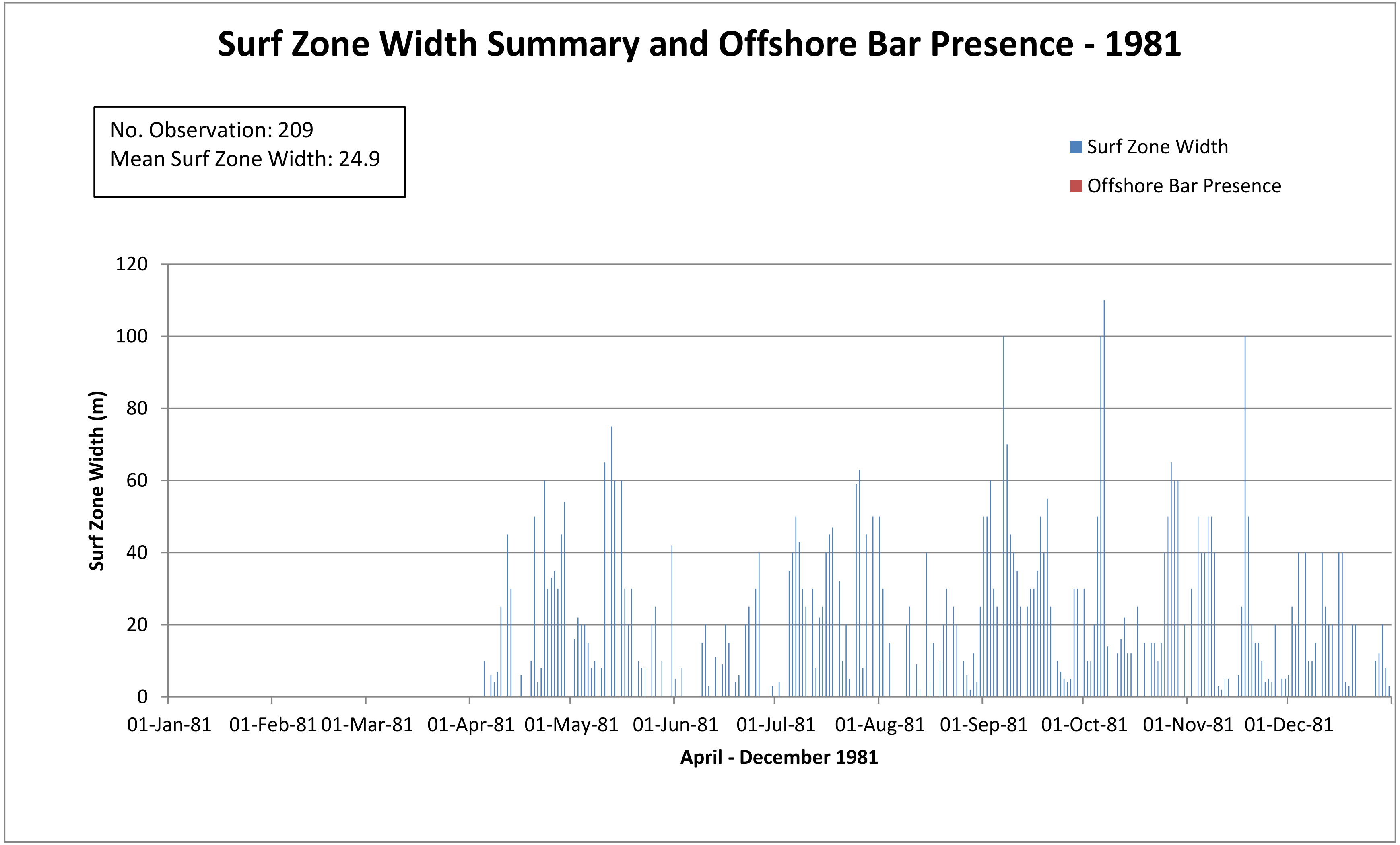


Figure 19 **Surf Zone Width - 1981**

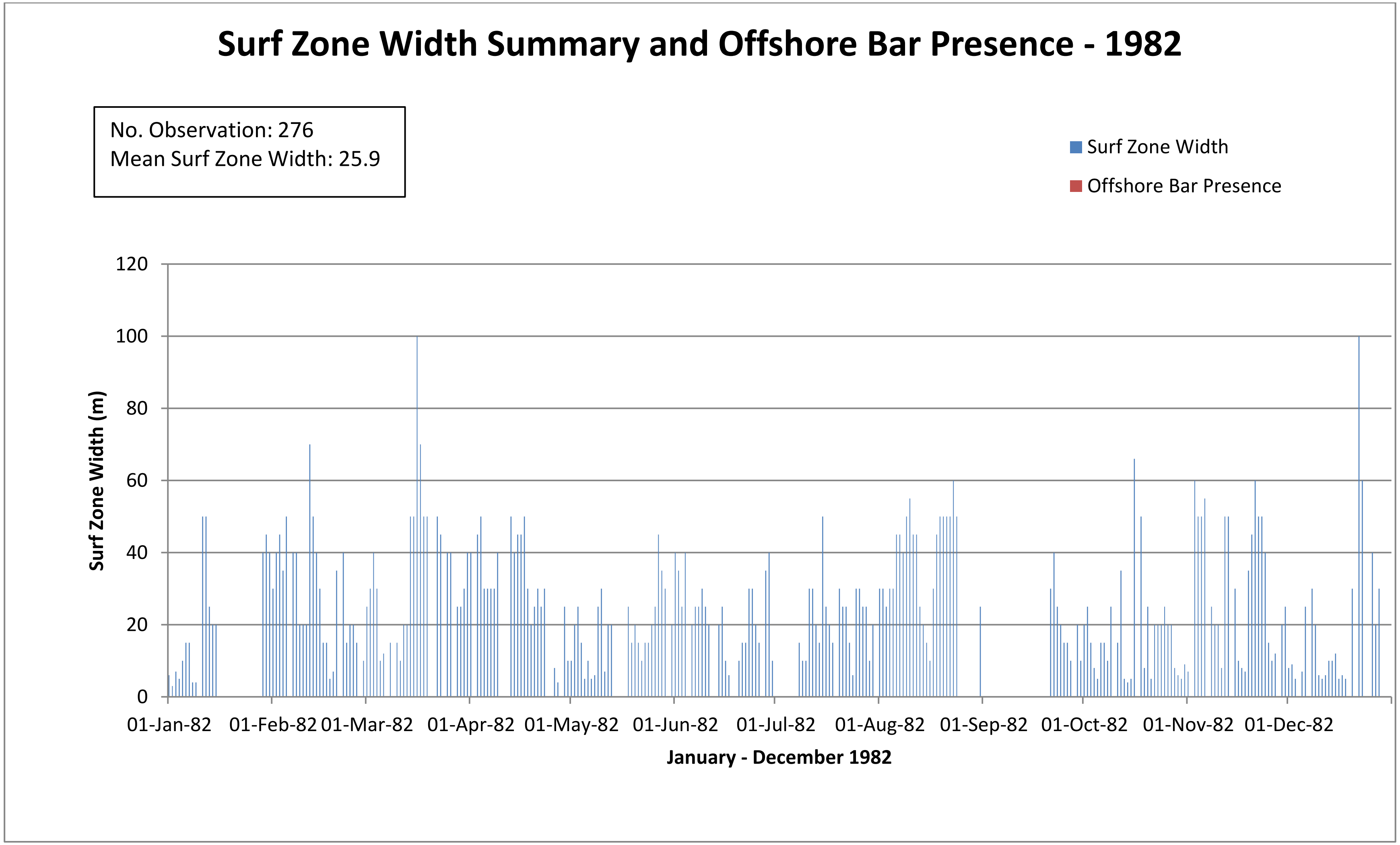


Figure 20 Surf Zone Width - 1982

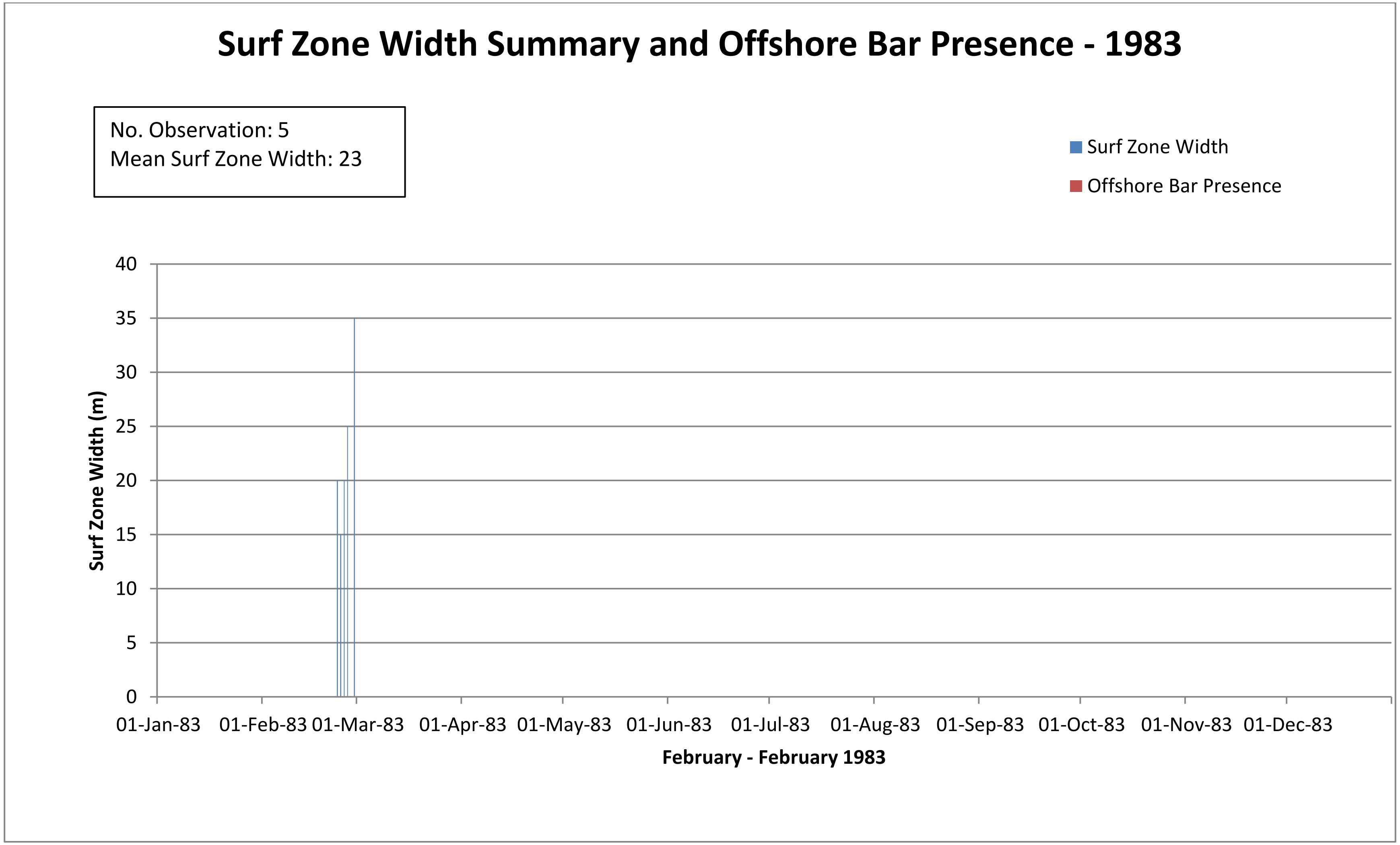


Figure 21 Surf Zone Width - 1983

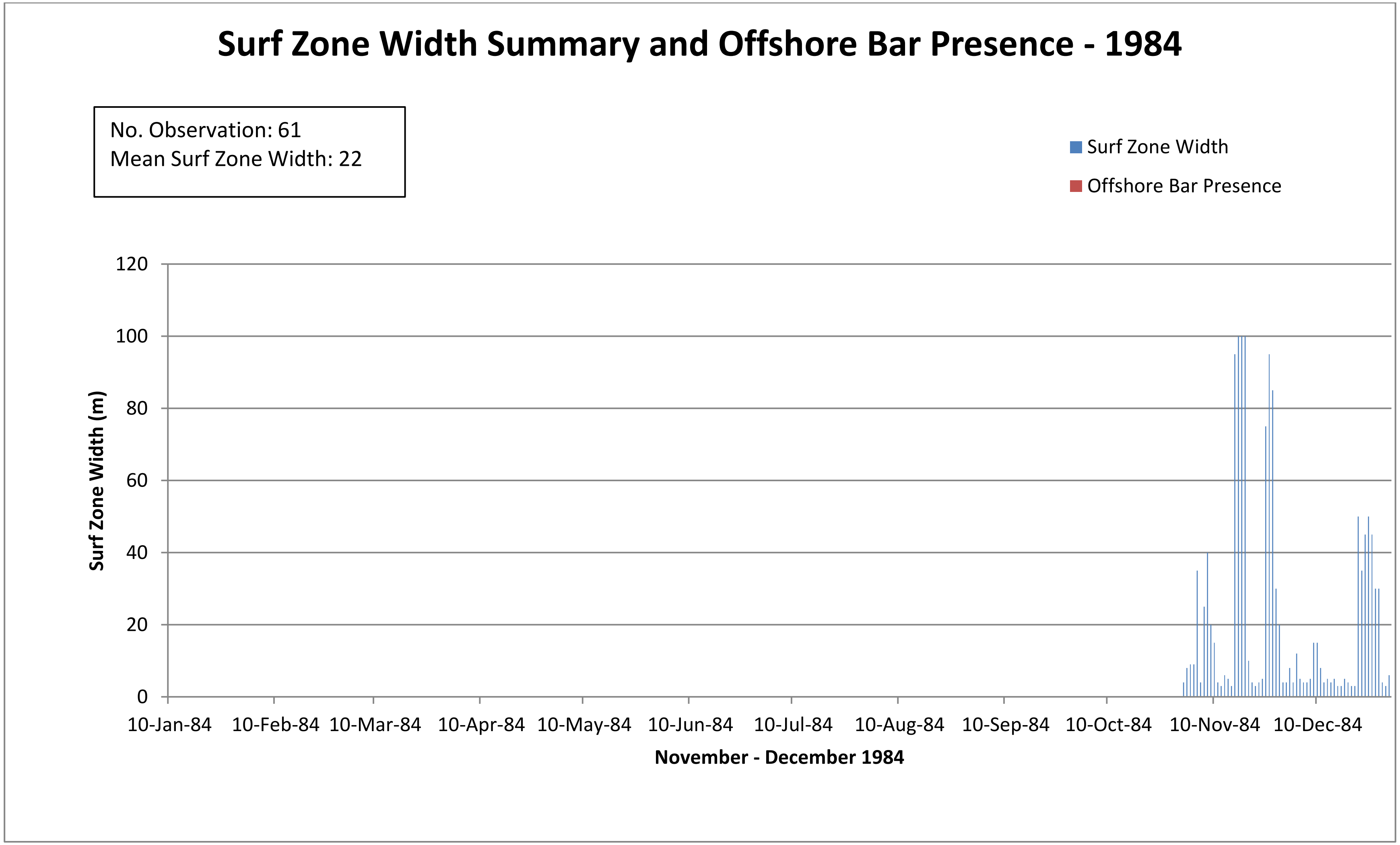


Figure 22 Surf Zone Width - 1984

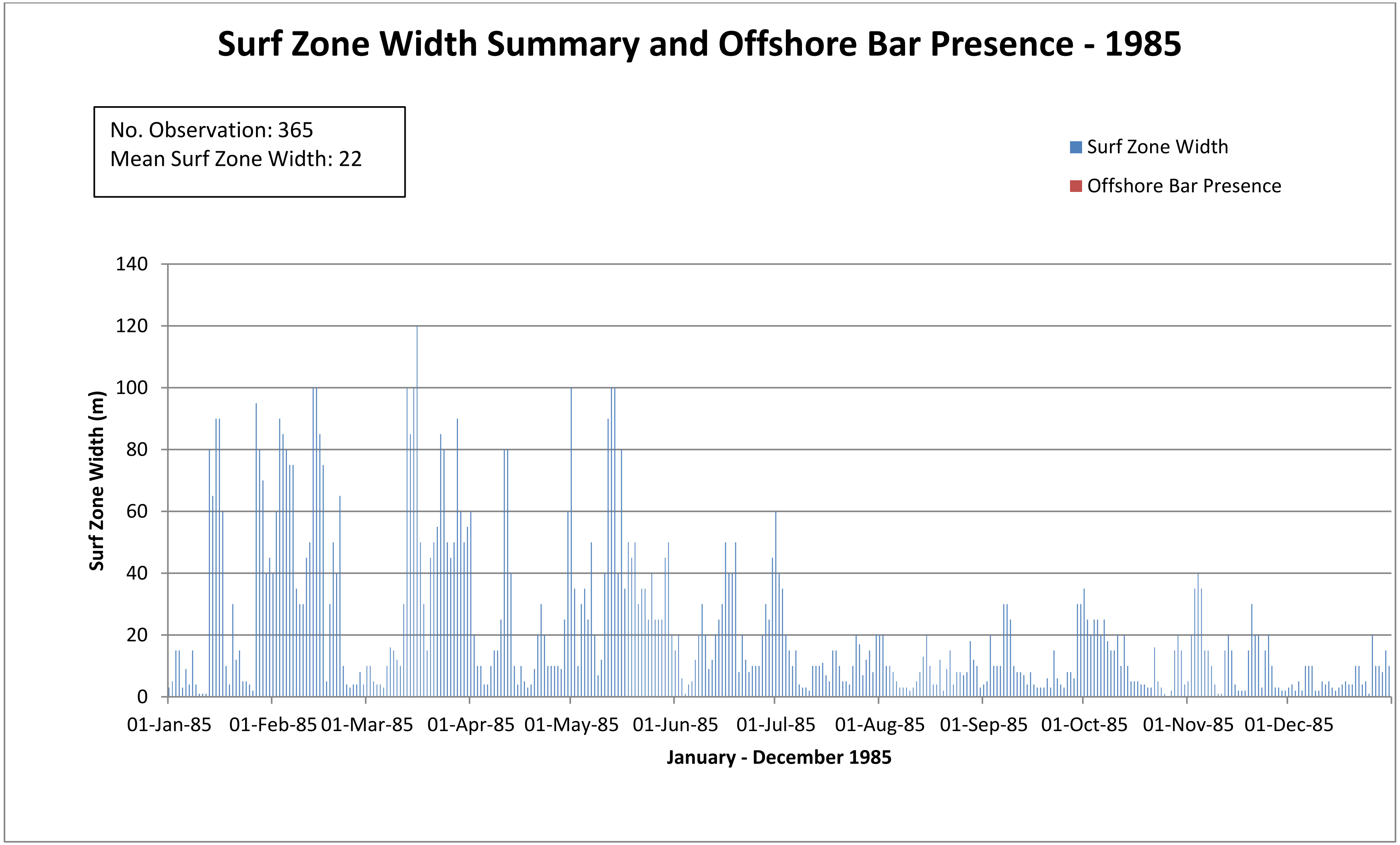


Figure 23 Surf Zone Width - 1985

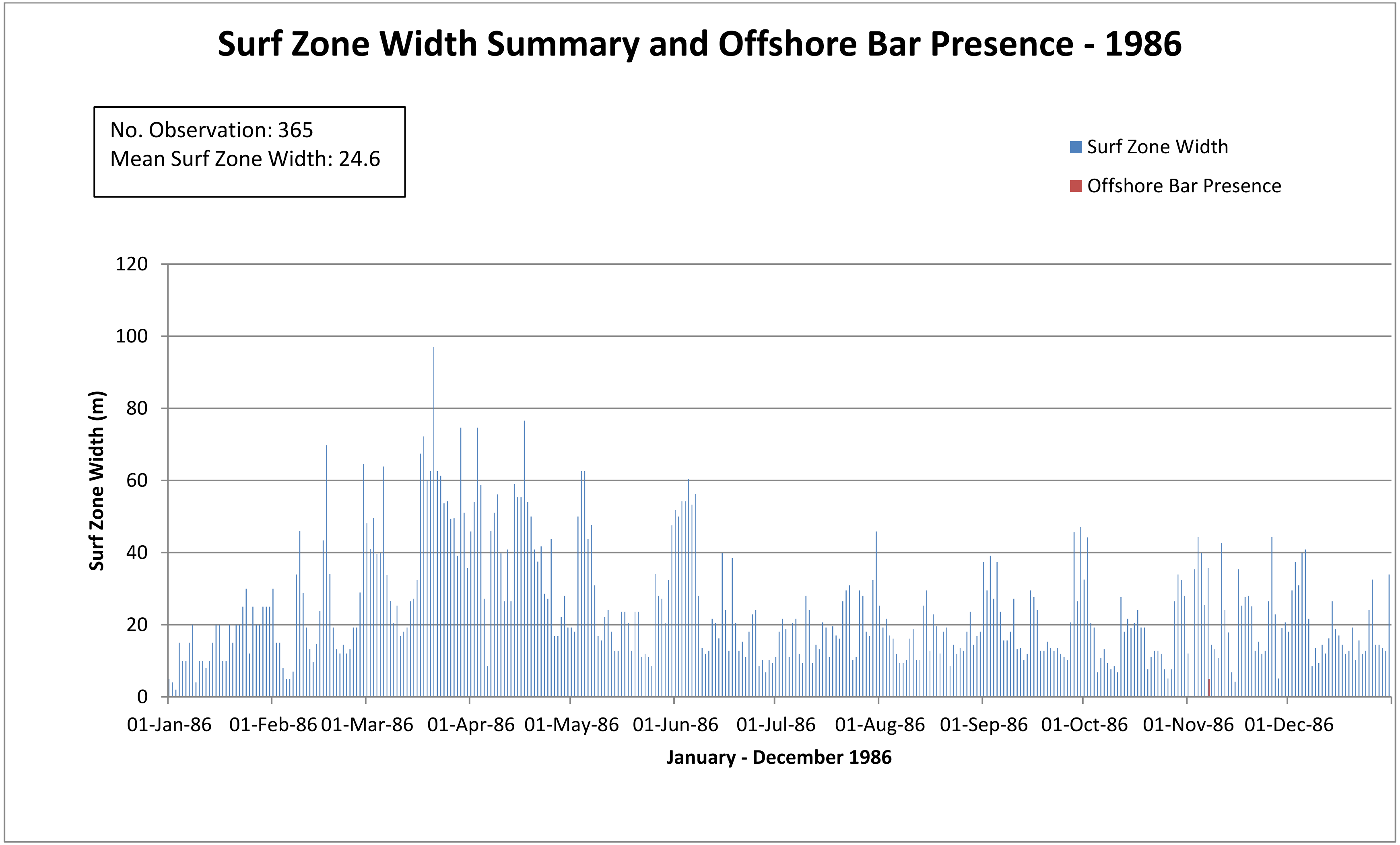


Figure 24 Surf Zone Width - 1986

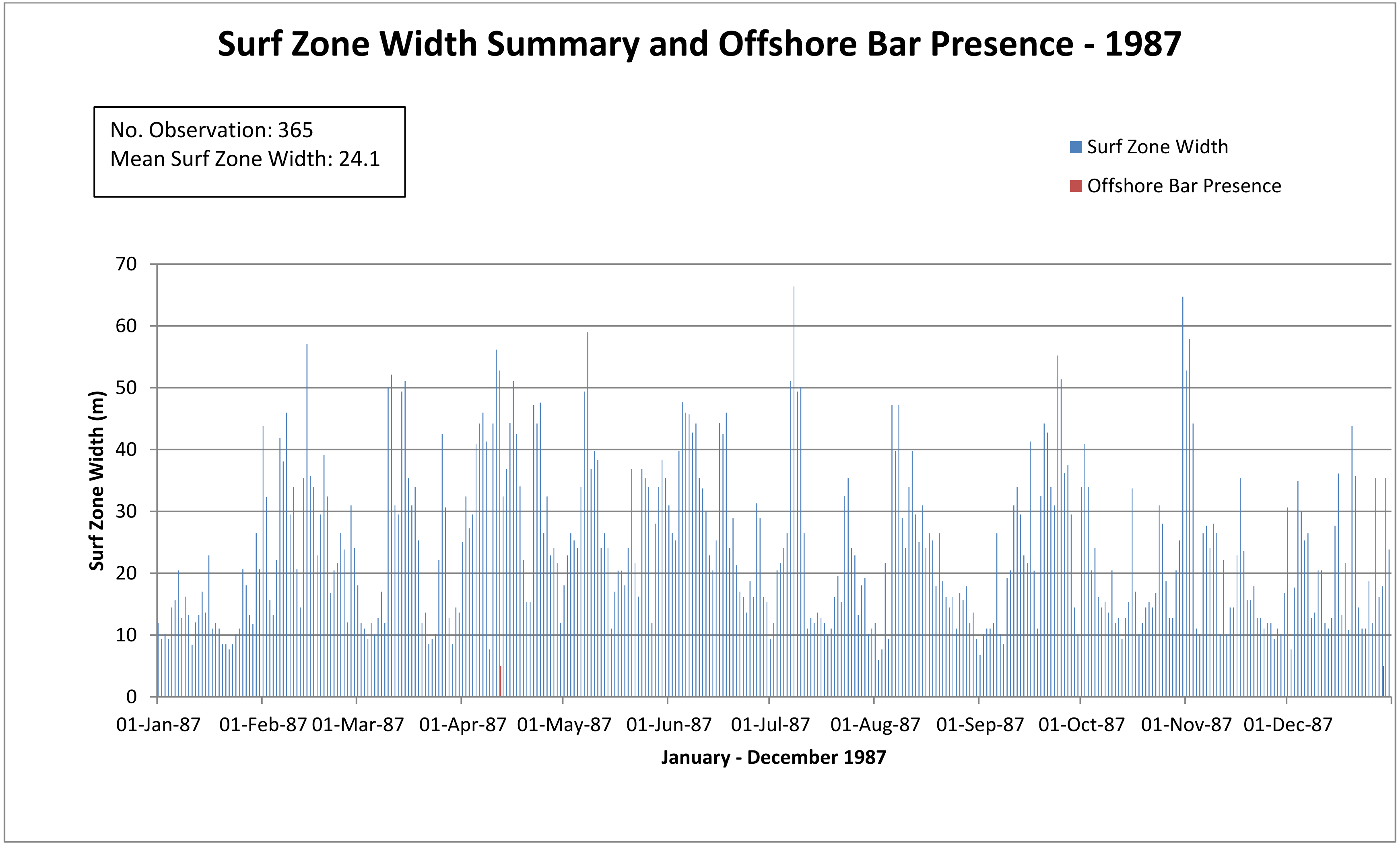


Figure 25 Surf Zone Width - 1987

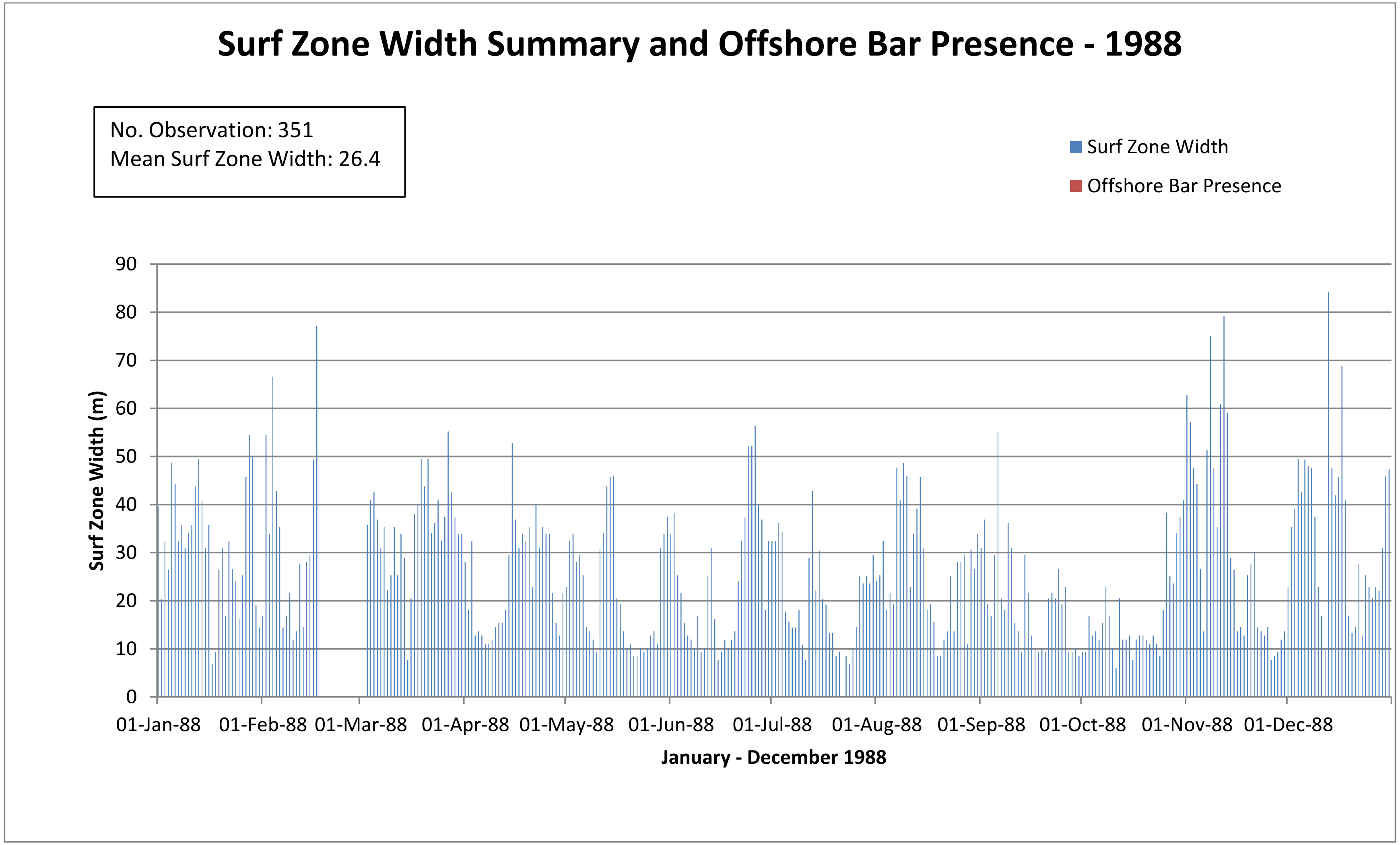


Figure 26 Surf Zone Width - 1988

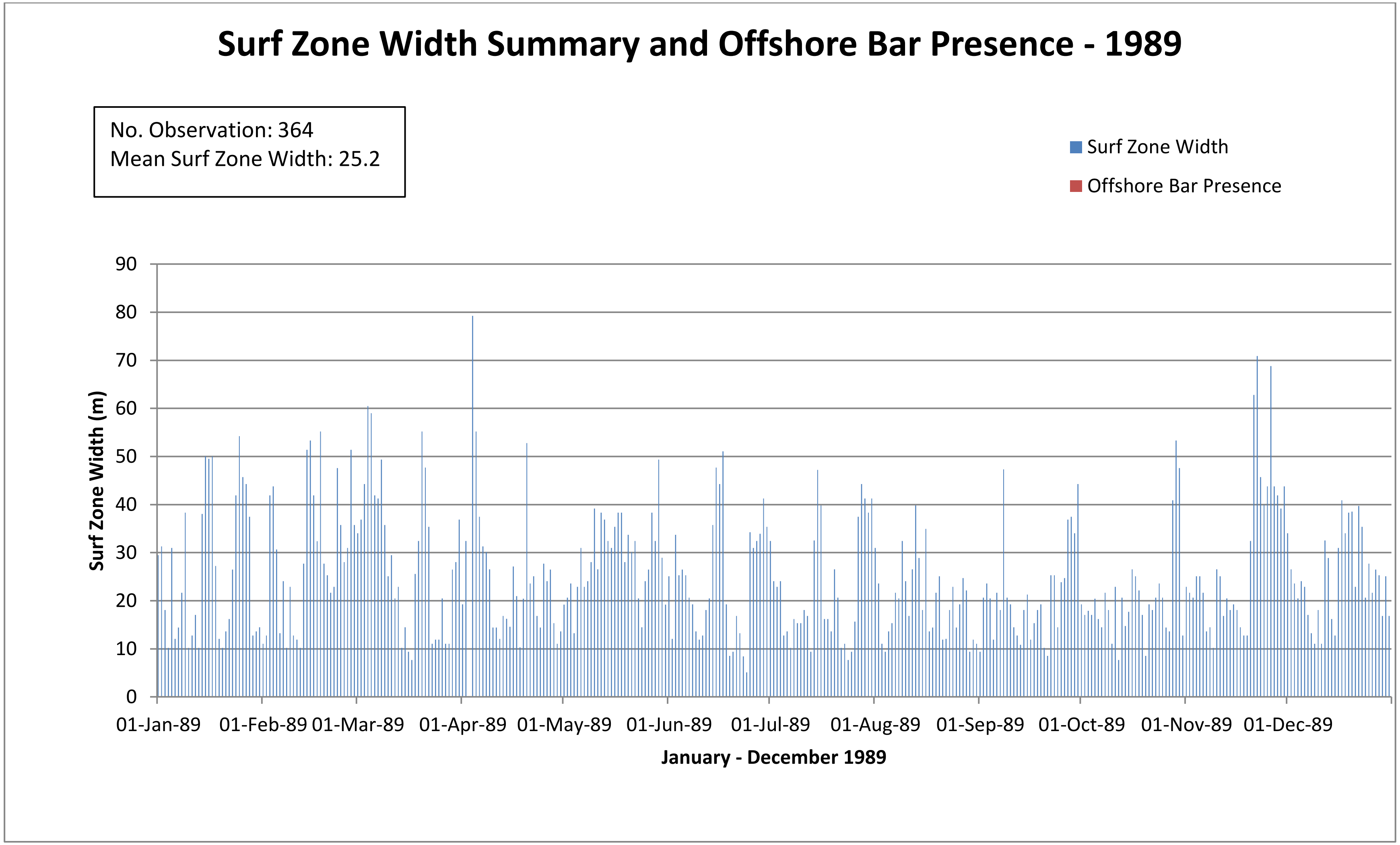


Figure 27 **Surf Zone Width - 1989**

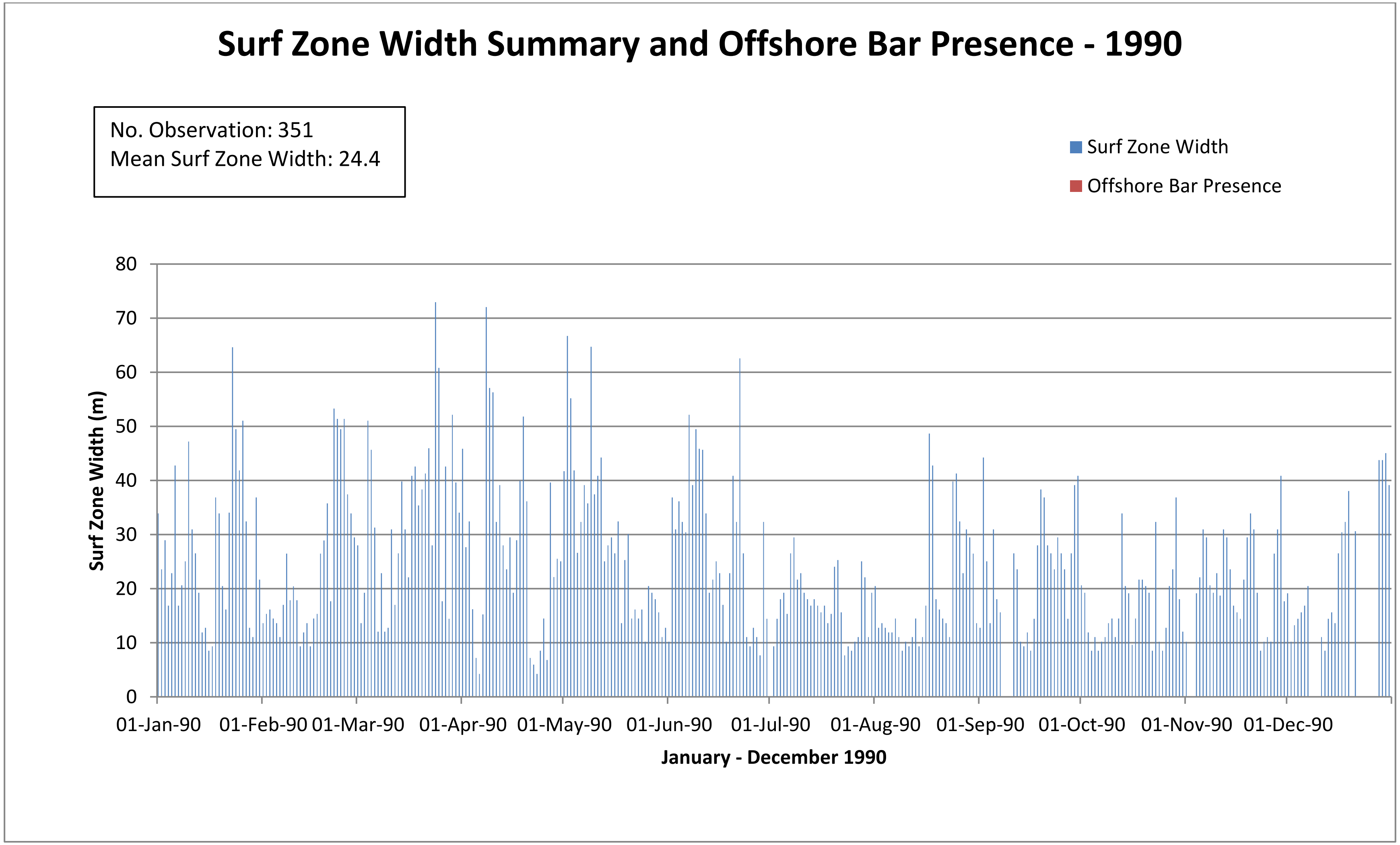


Figure 28 Surf Zone Width - 1990

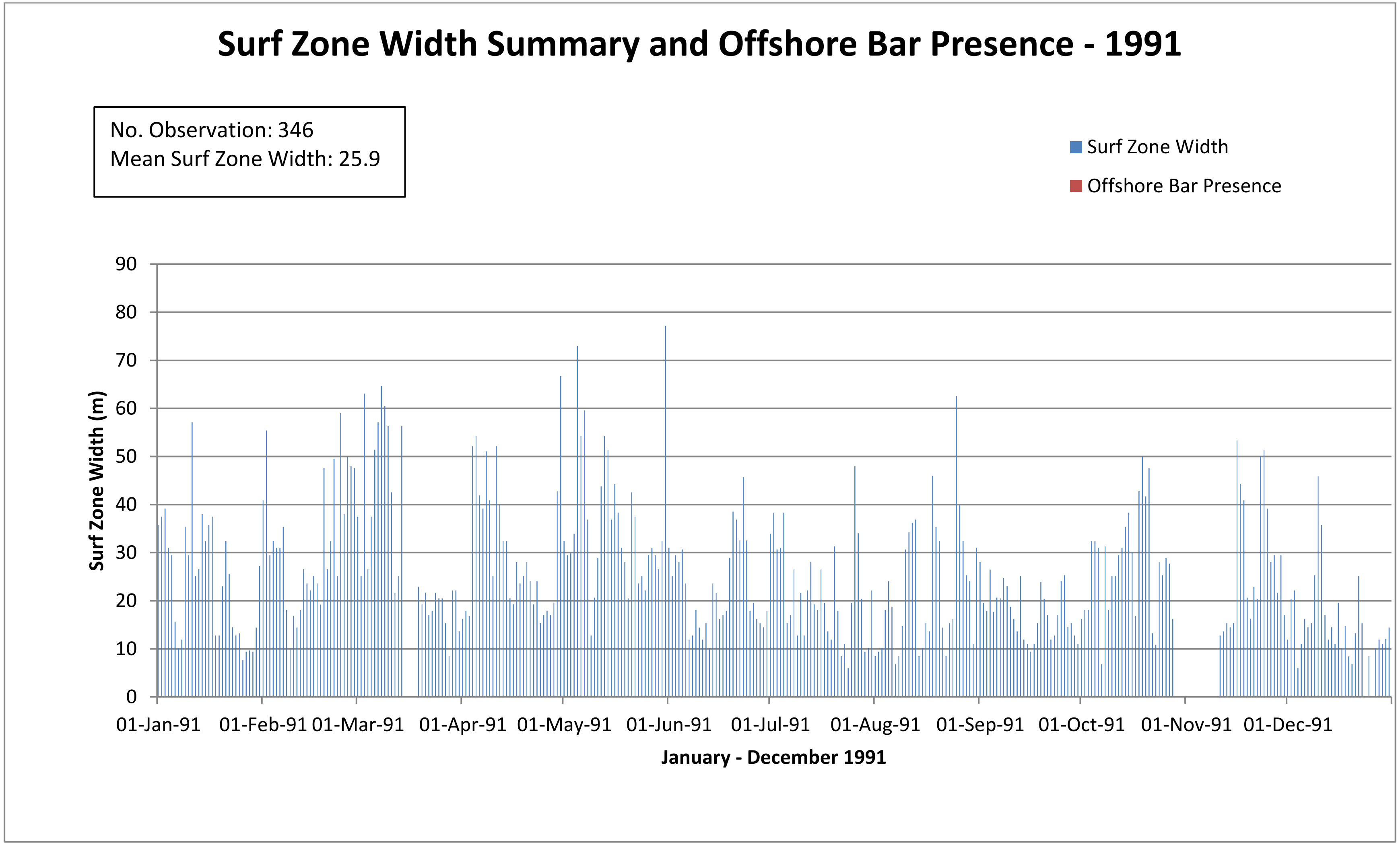


Figure 29 Surf Zone Width - 1991

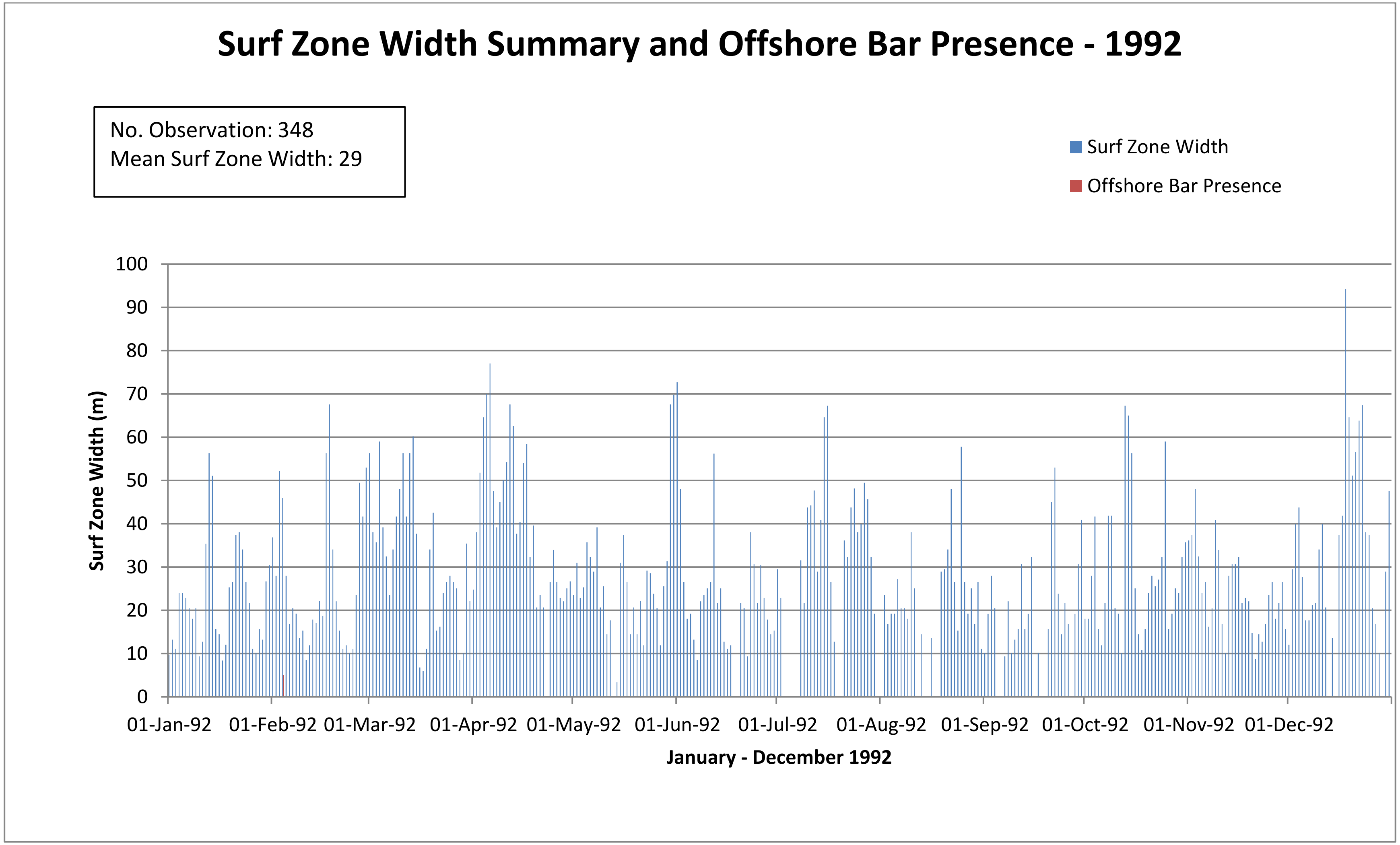


Figure 30 Surf Zone Width - 1992

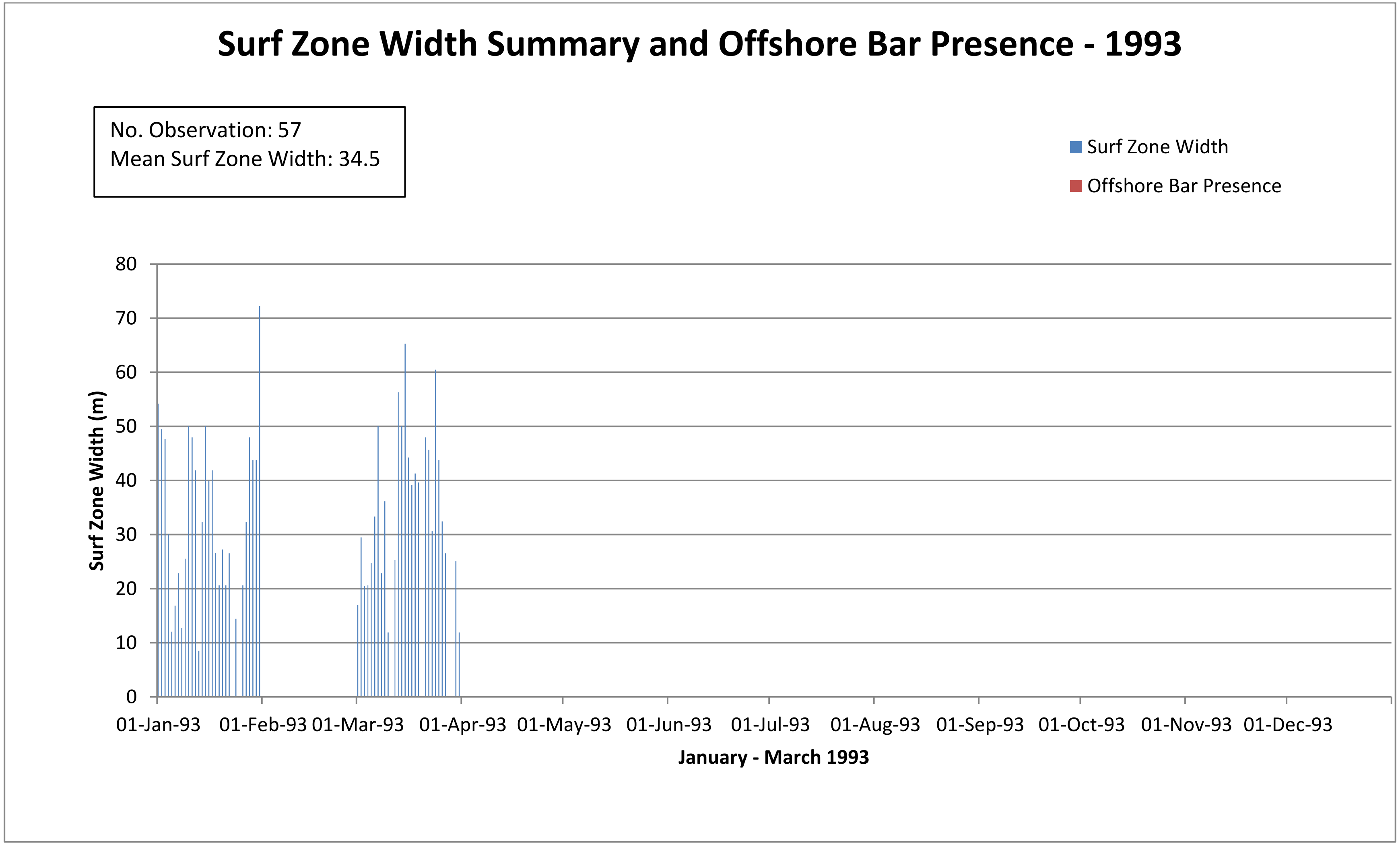


Figure 31 Surf Zone Width – 1993

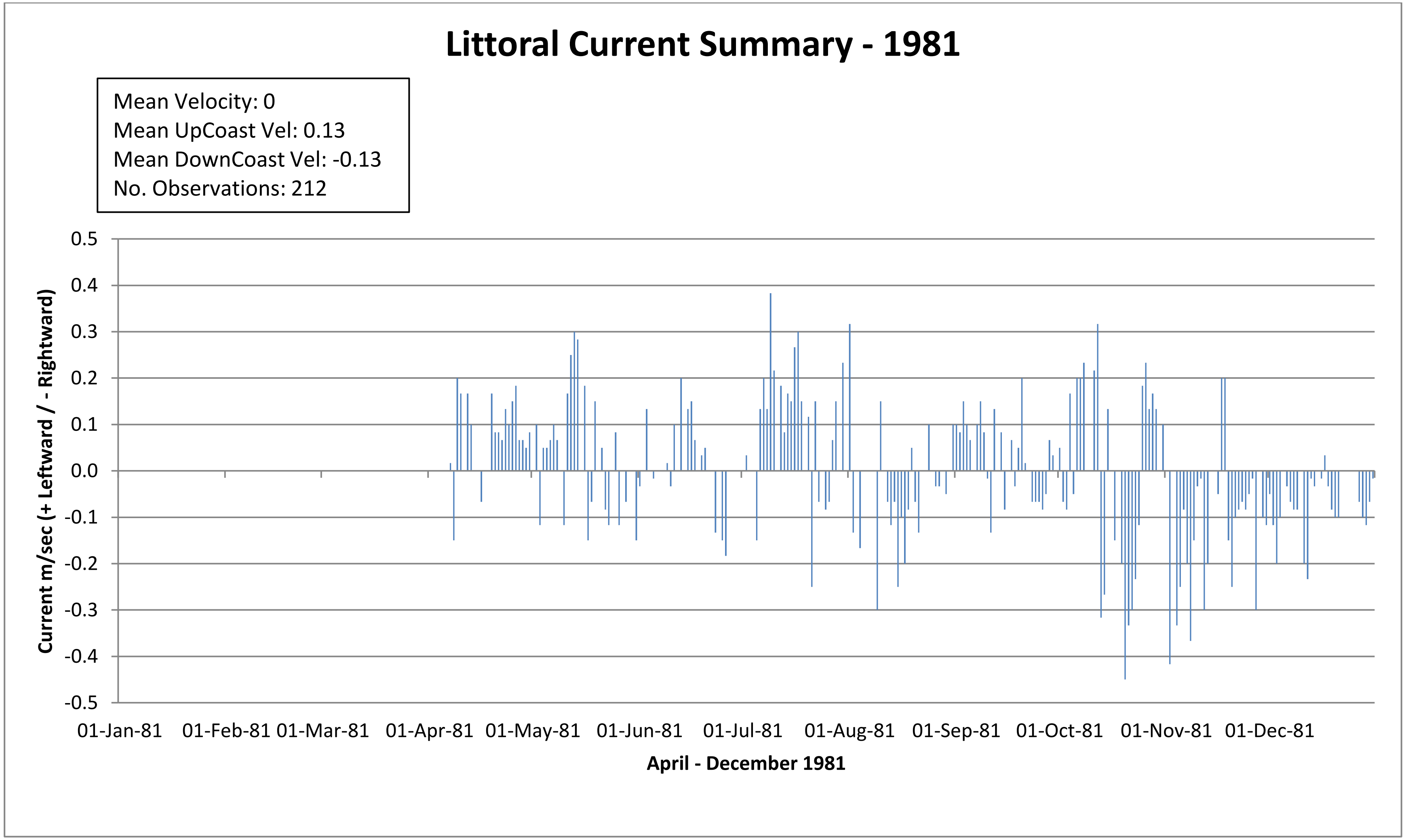


Figure 32 Littoral Current Summary 1981

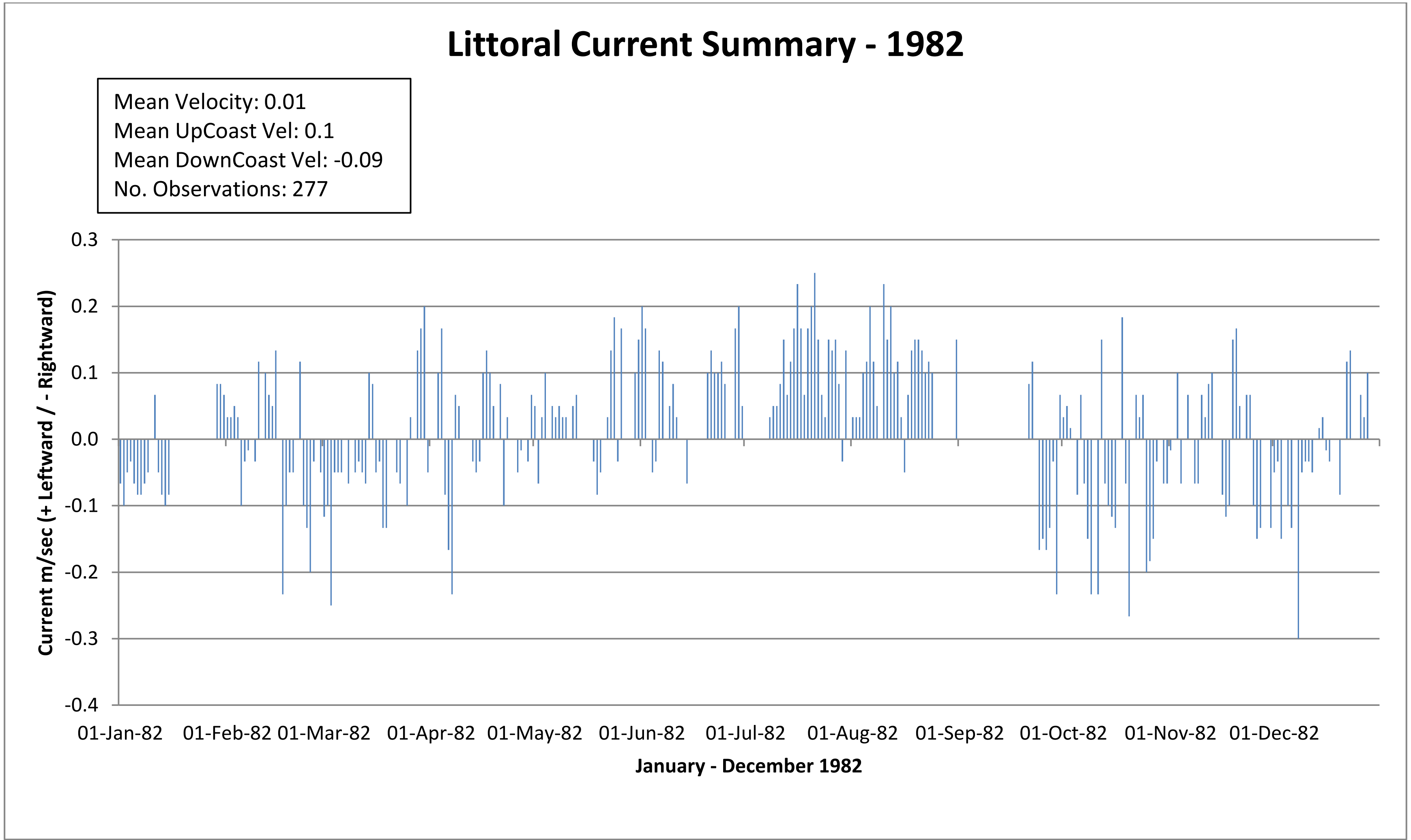


Figure 33 Littoral Current Summary 1982

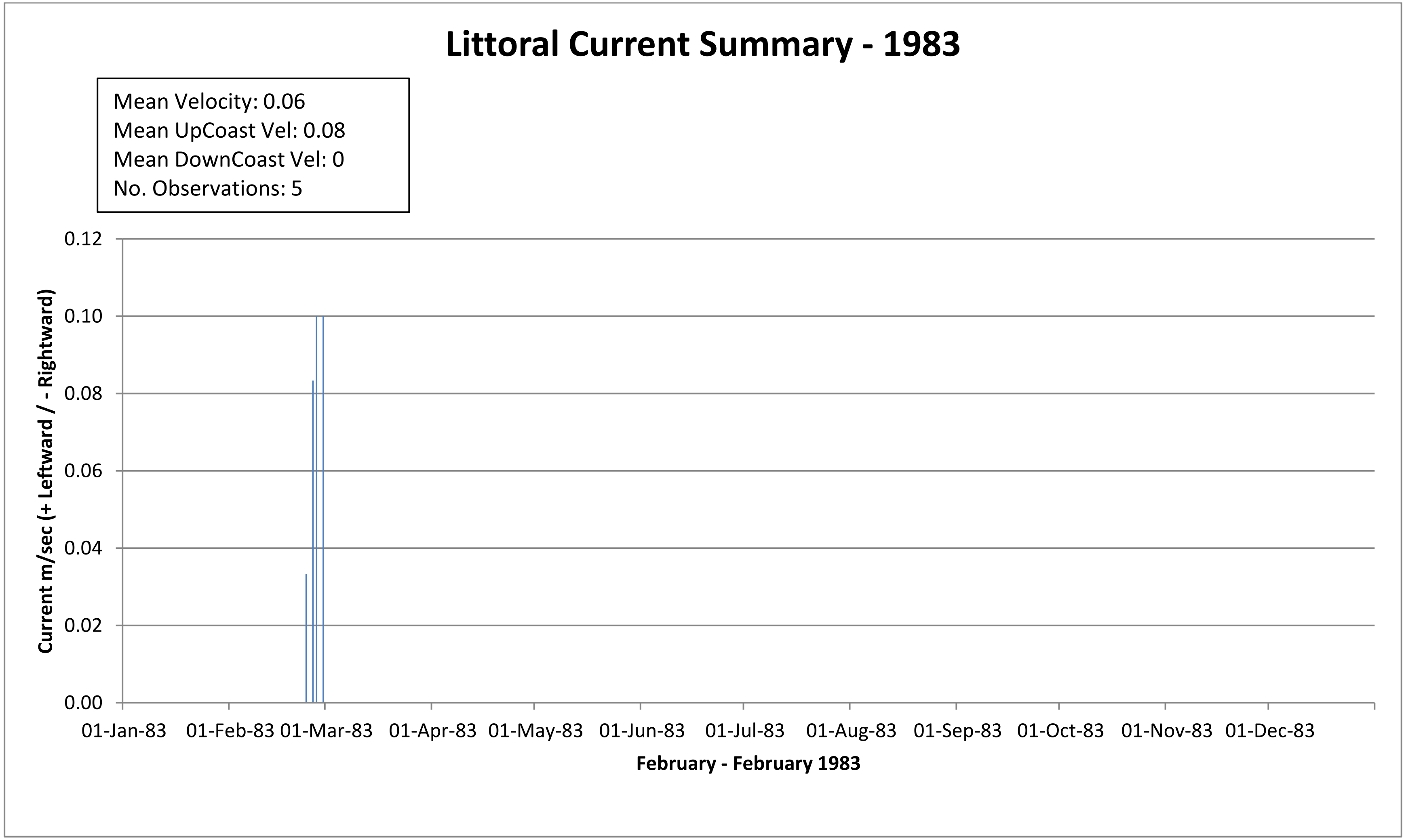


Figure 34 Littoral Current Summary 1983

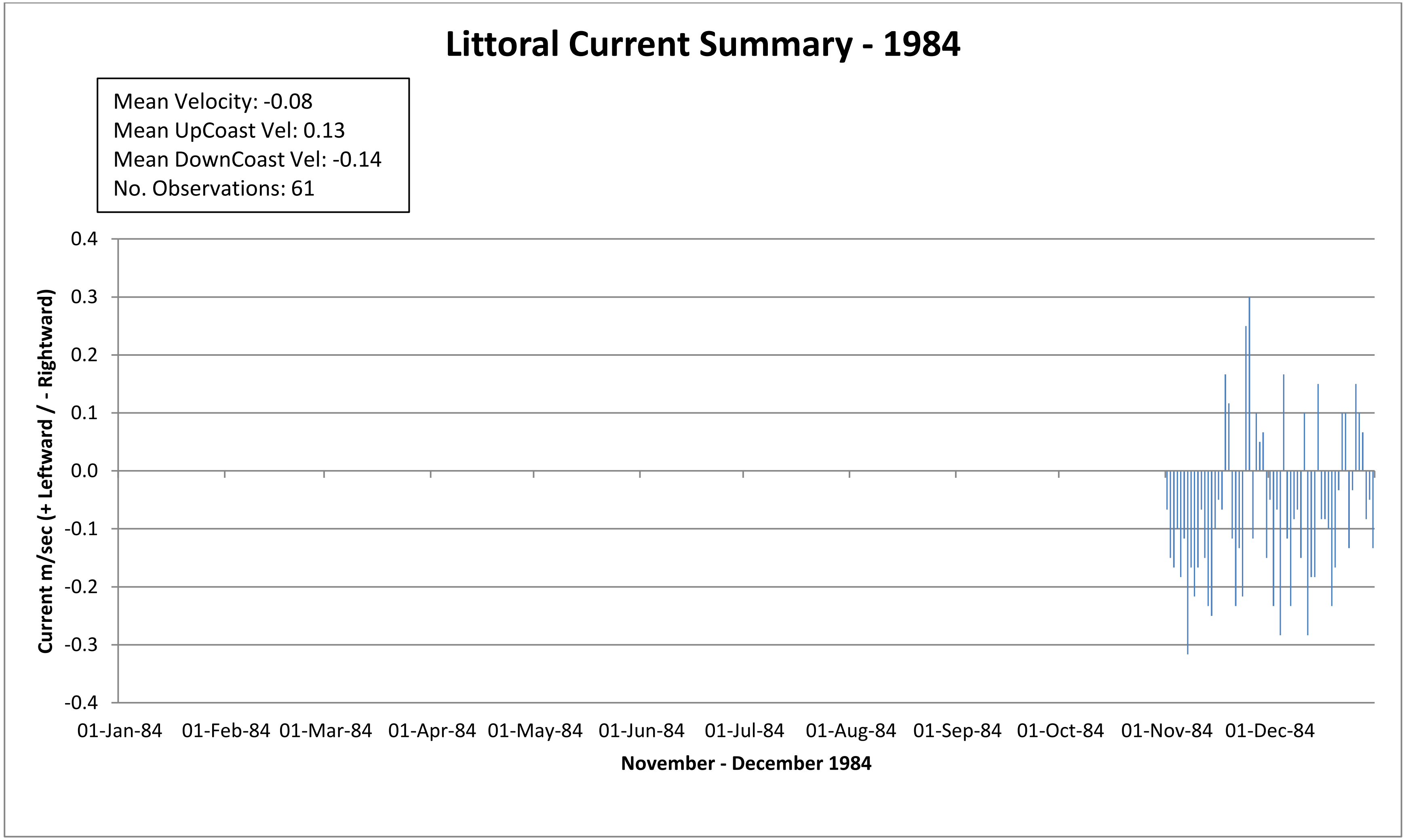


Figure 35 Littoral Current Summary 1984

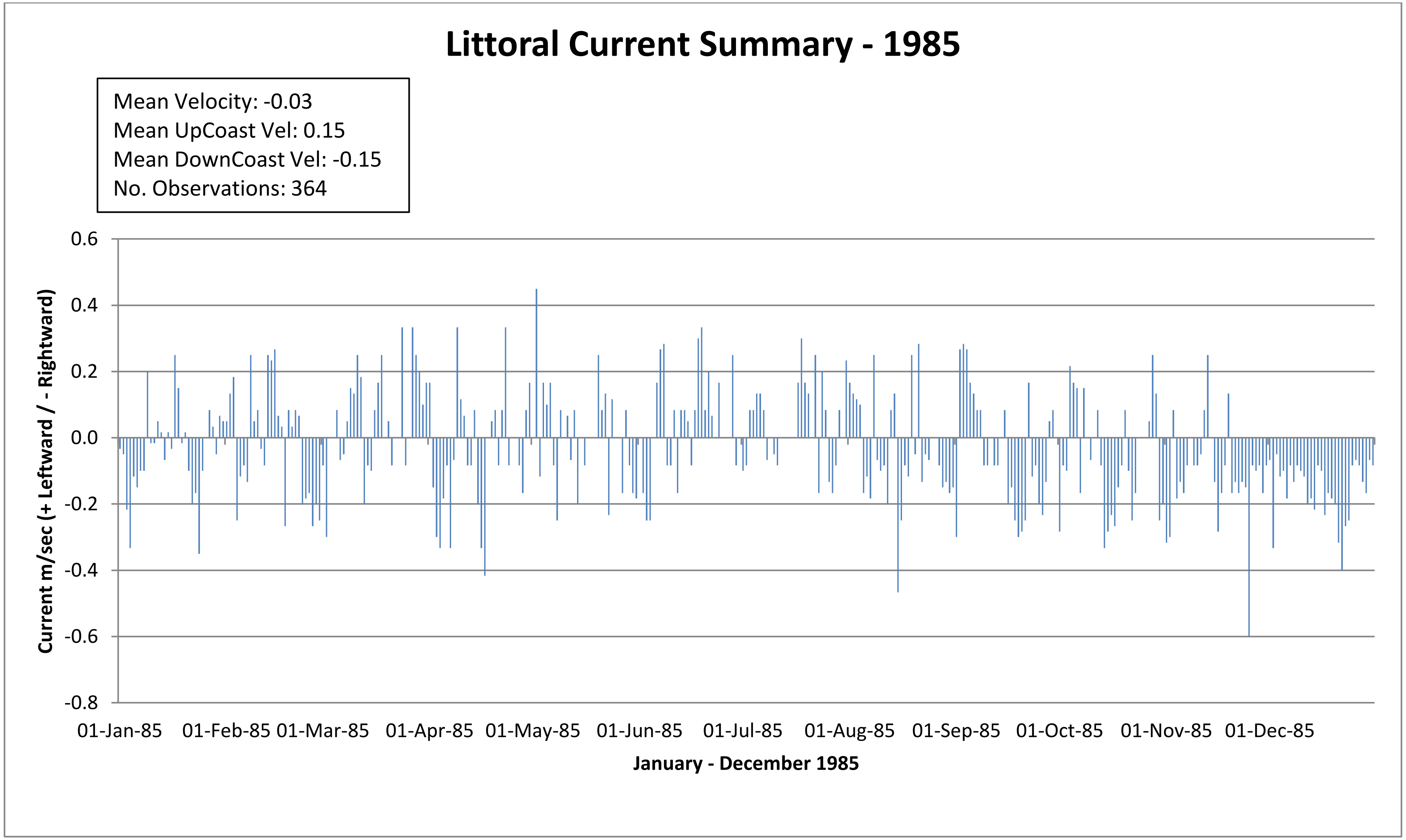


Figure 36 Littoral Current Summary 1985

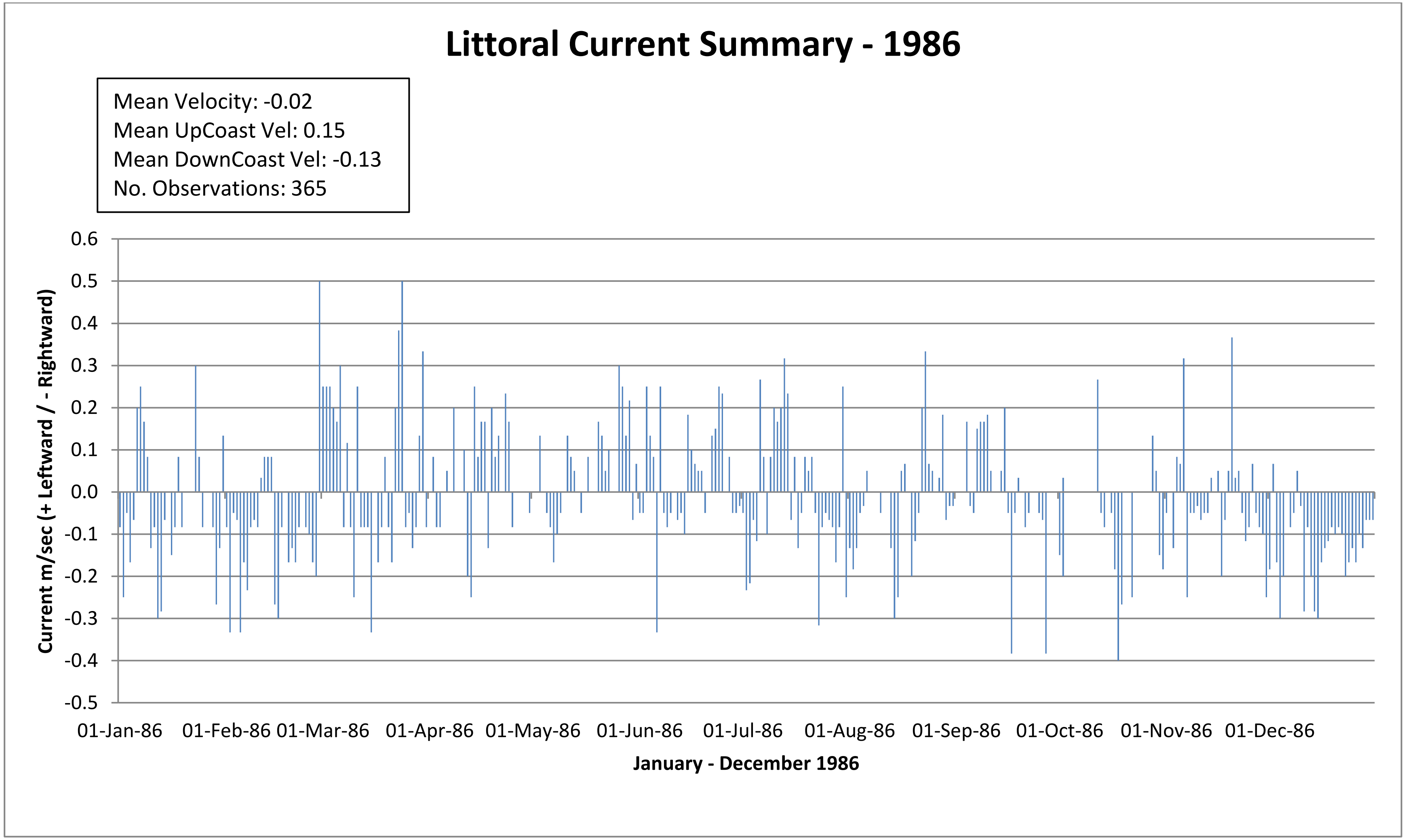


Figure 37 Littoral Current Summary 1986

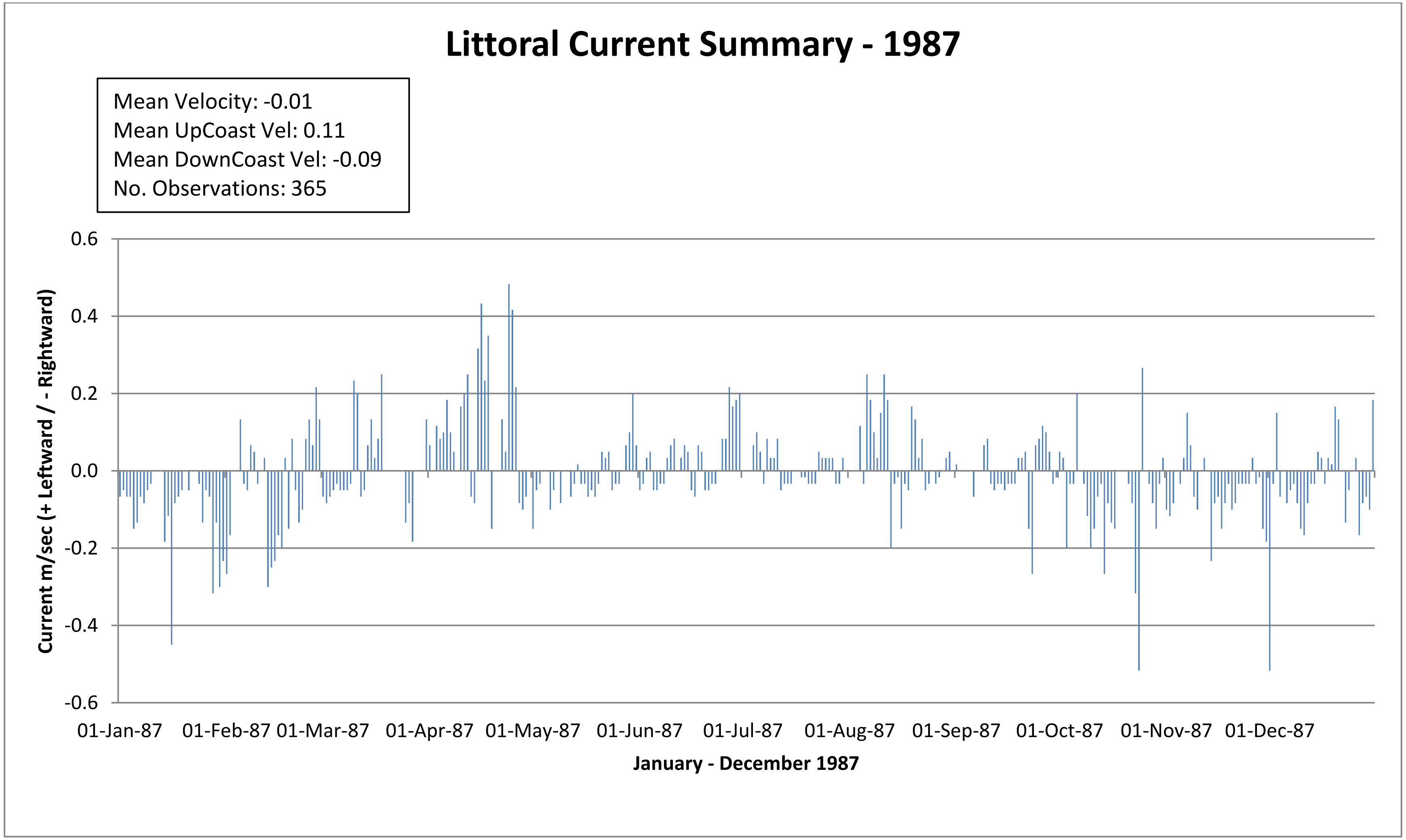


Figure 38 Littoral Current Summary 1987

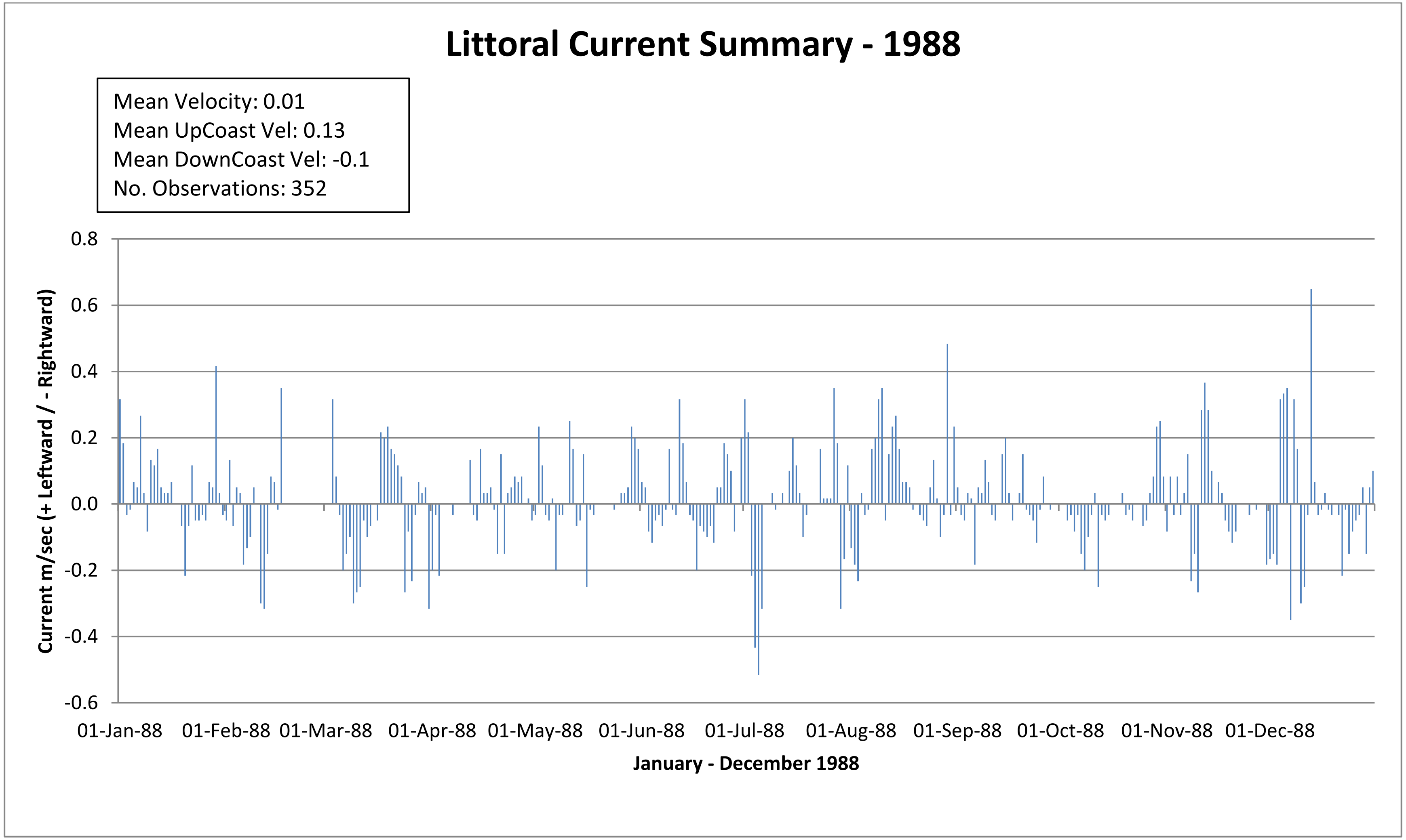


Figure 39 Littoral Current Summary 1988

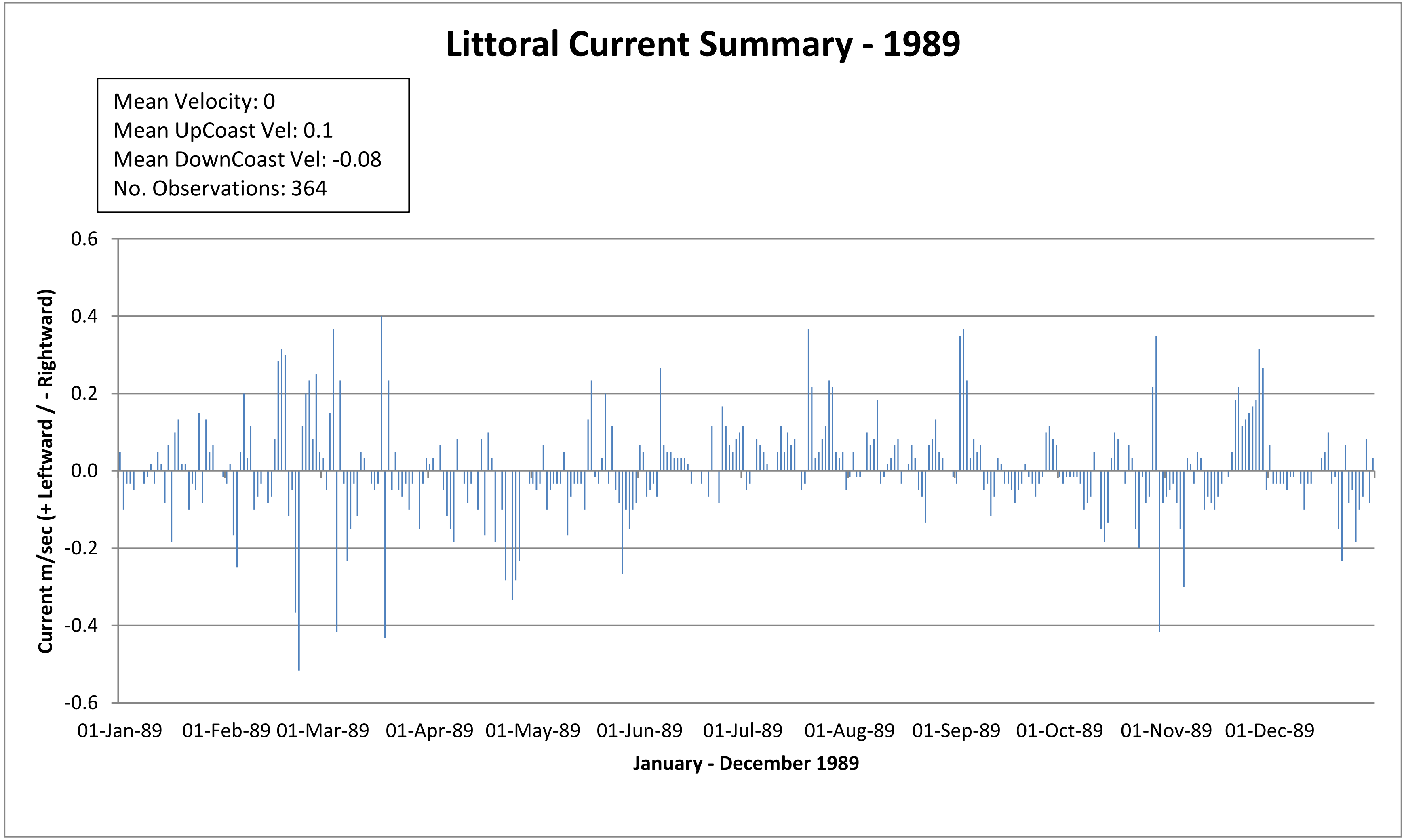


Figure 40 Littoral Current Summary 1989

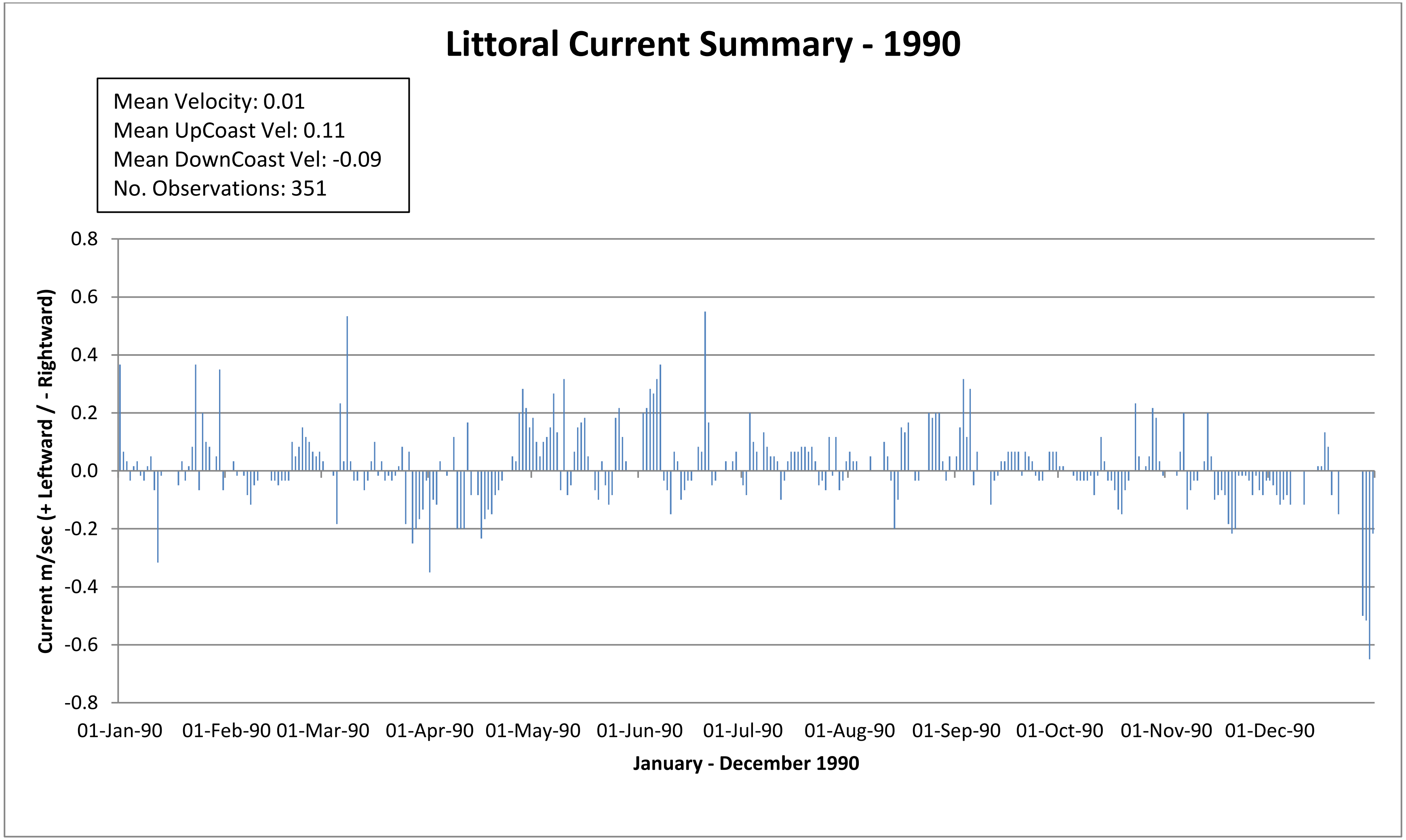


Figure 41 Littoral Current Summary 1990

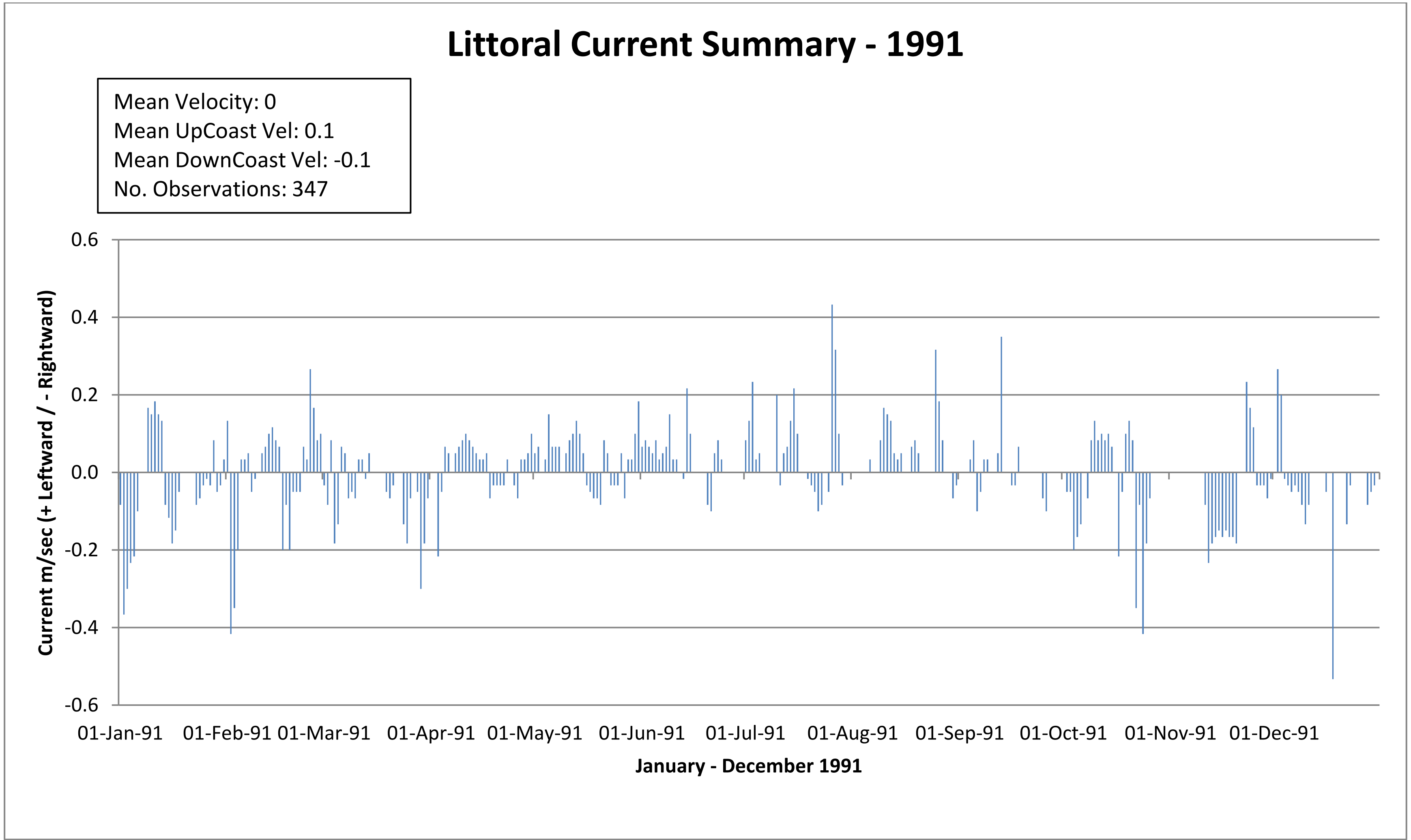


Figure 42 Littoral Current Summary 1991

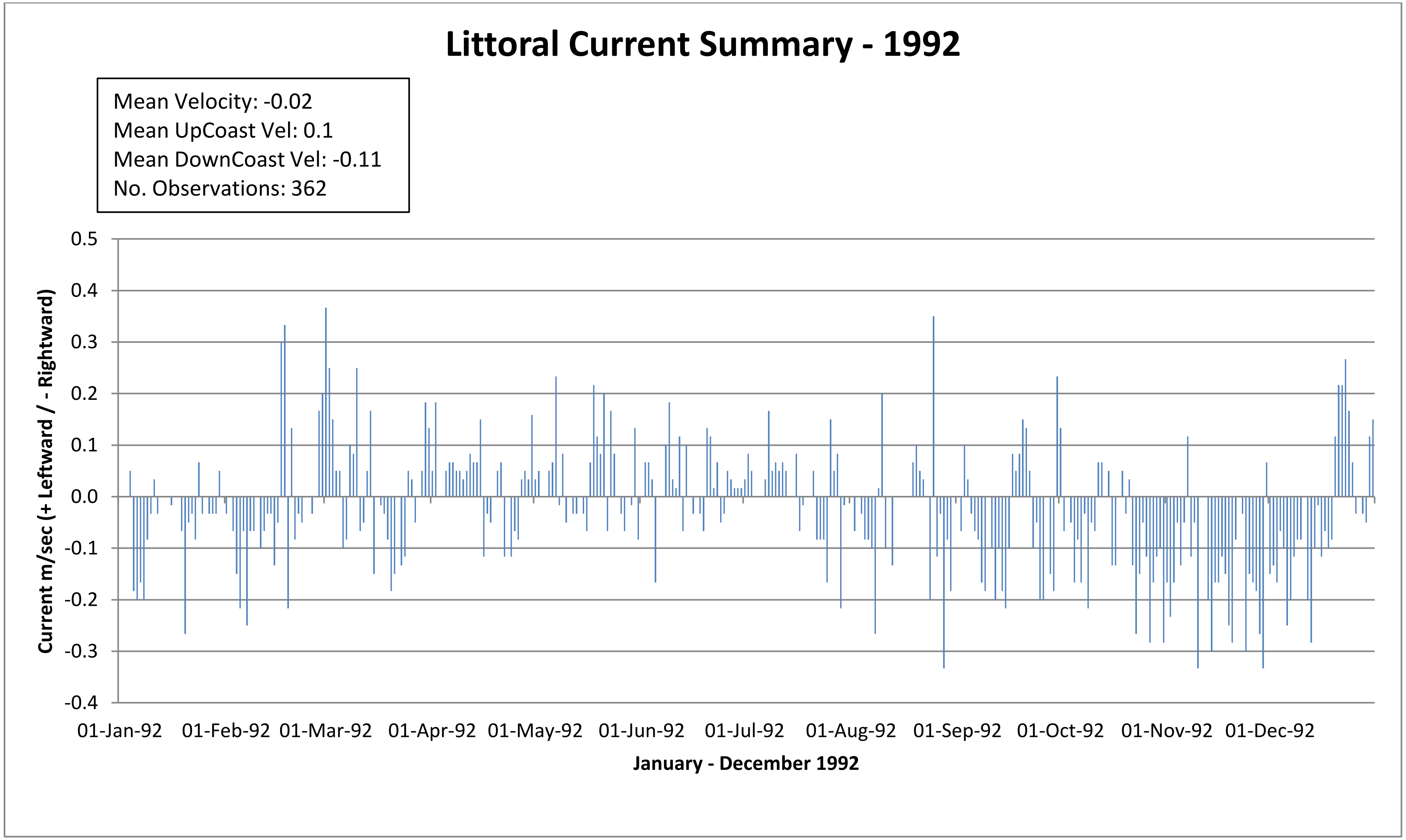


Figure 43 Littoral Current Summary 1992

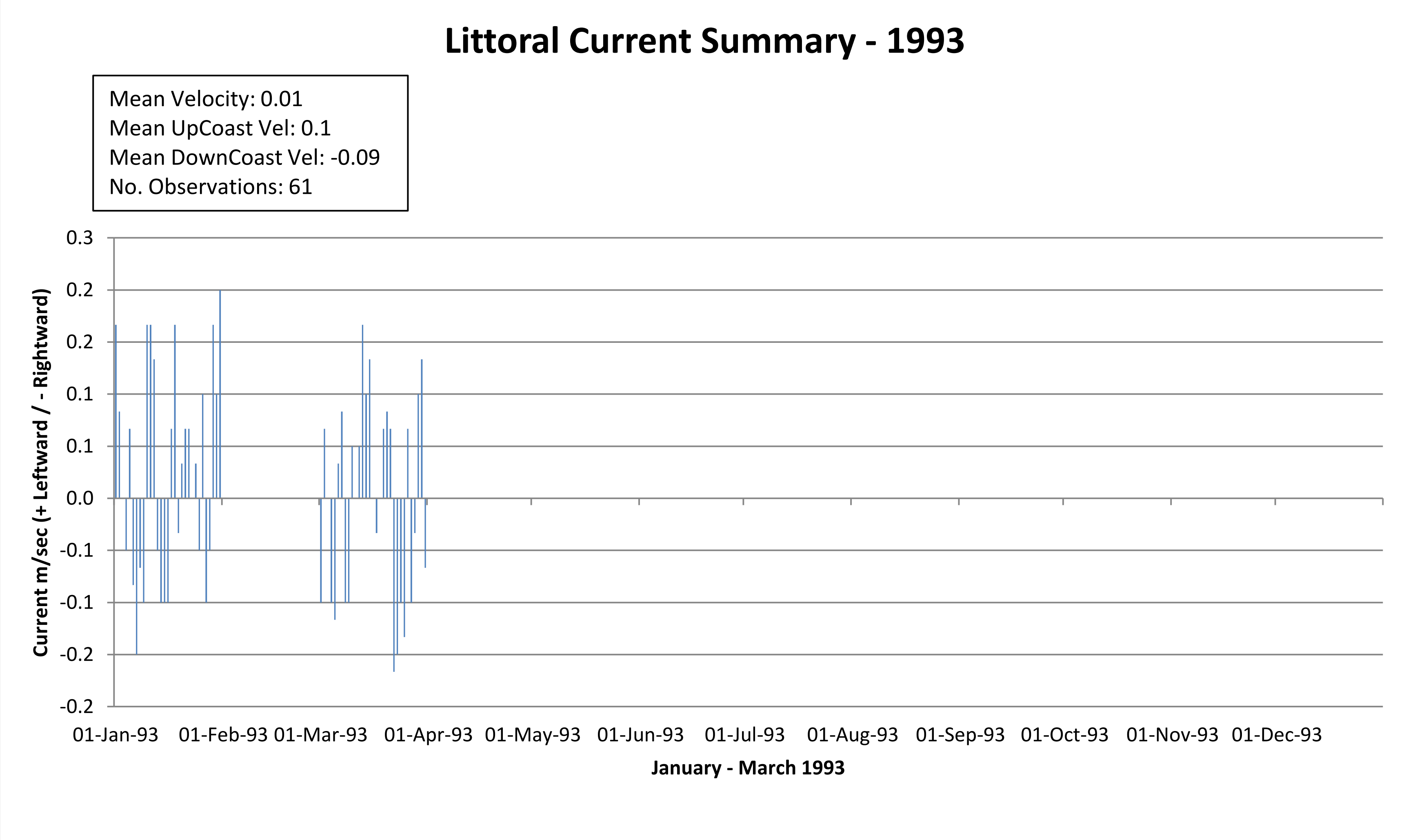


Figure 44 Littoral Current Summary 1993

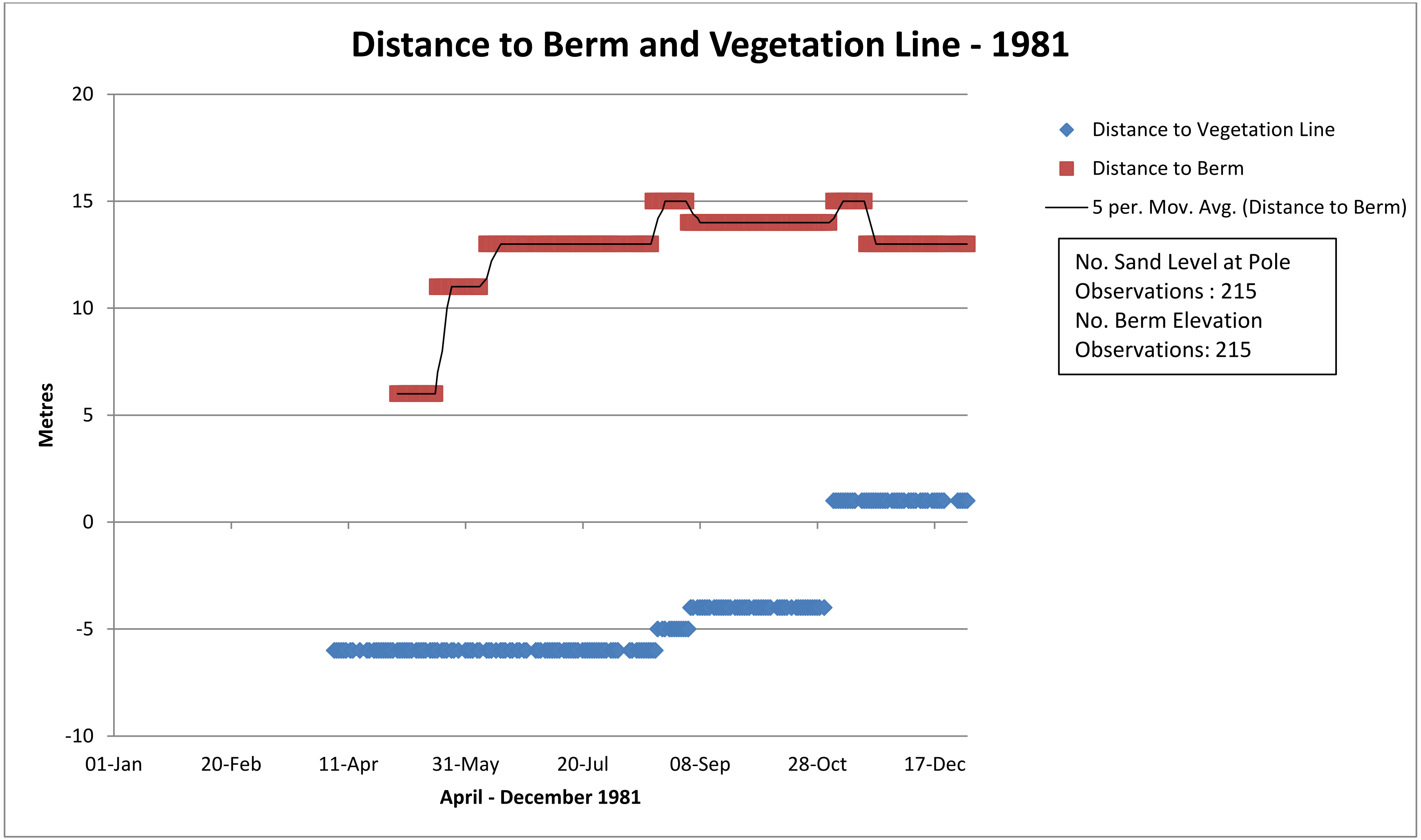


Figure 45 Beach profile parameters – Distance to berm and vegetation line- 1981

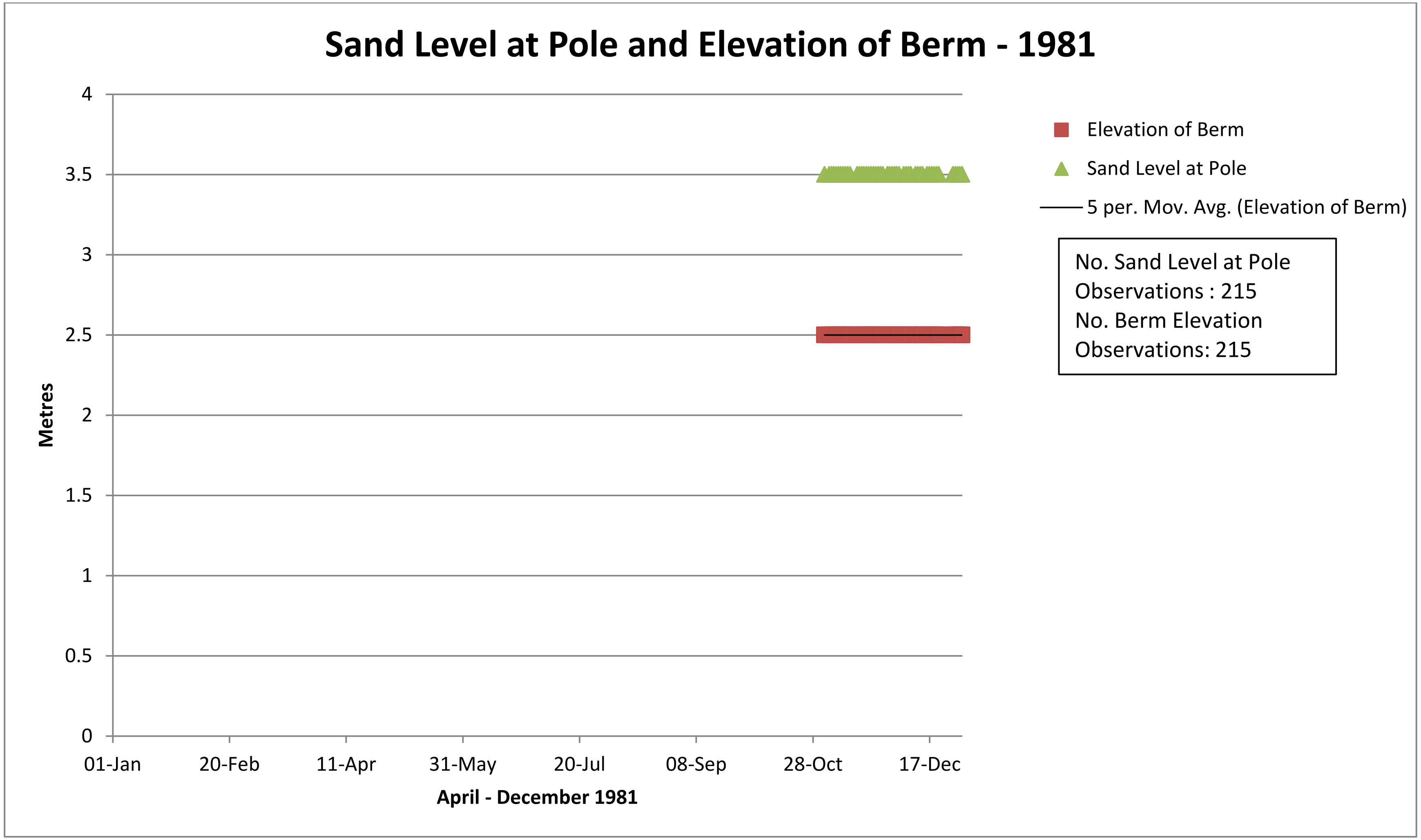


Figure 46 Beach profile parameters – Sand level at pole and elevation of berm- 1981

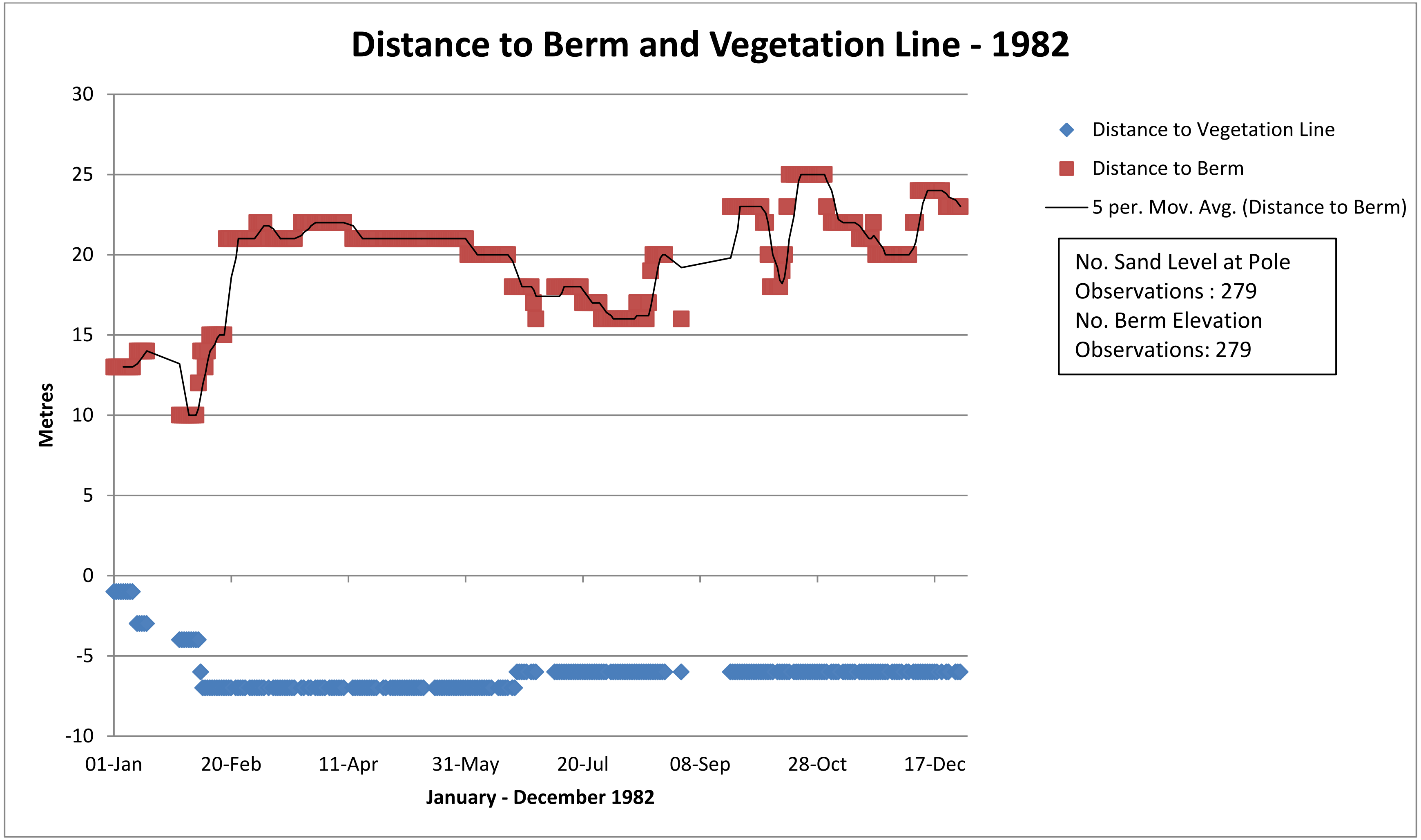


Figure 47 Beach profile parameters – Distance to berm and vegetation line- 1982

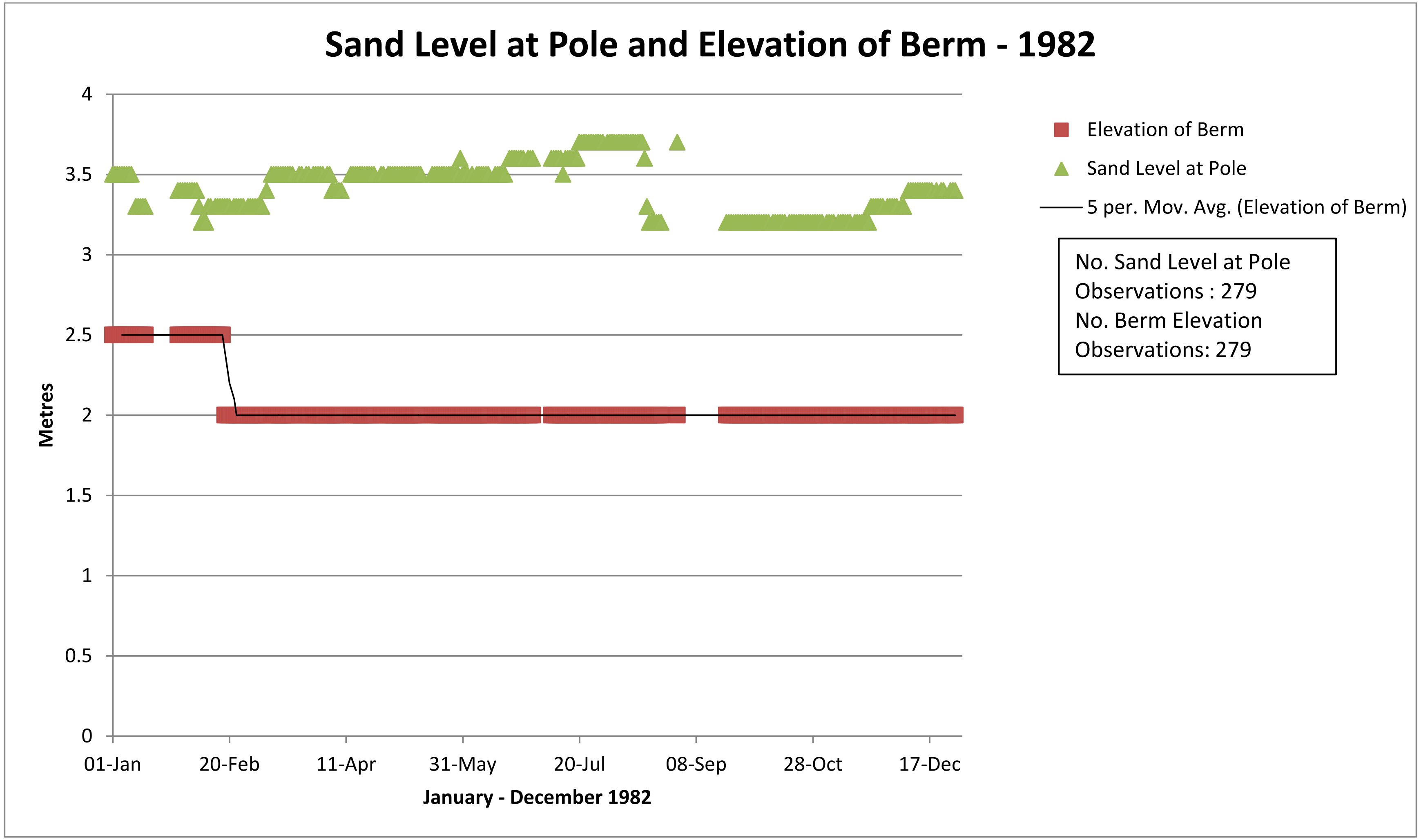


Figure 48 Beach profile parameters – Sand level at pole and elevation of berm- 1982

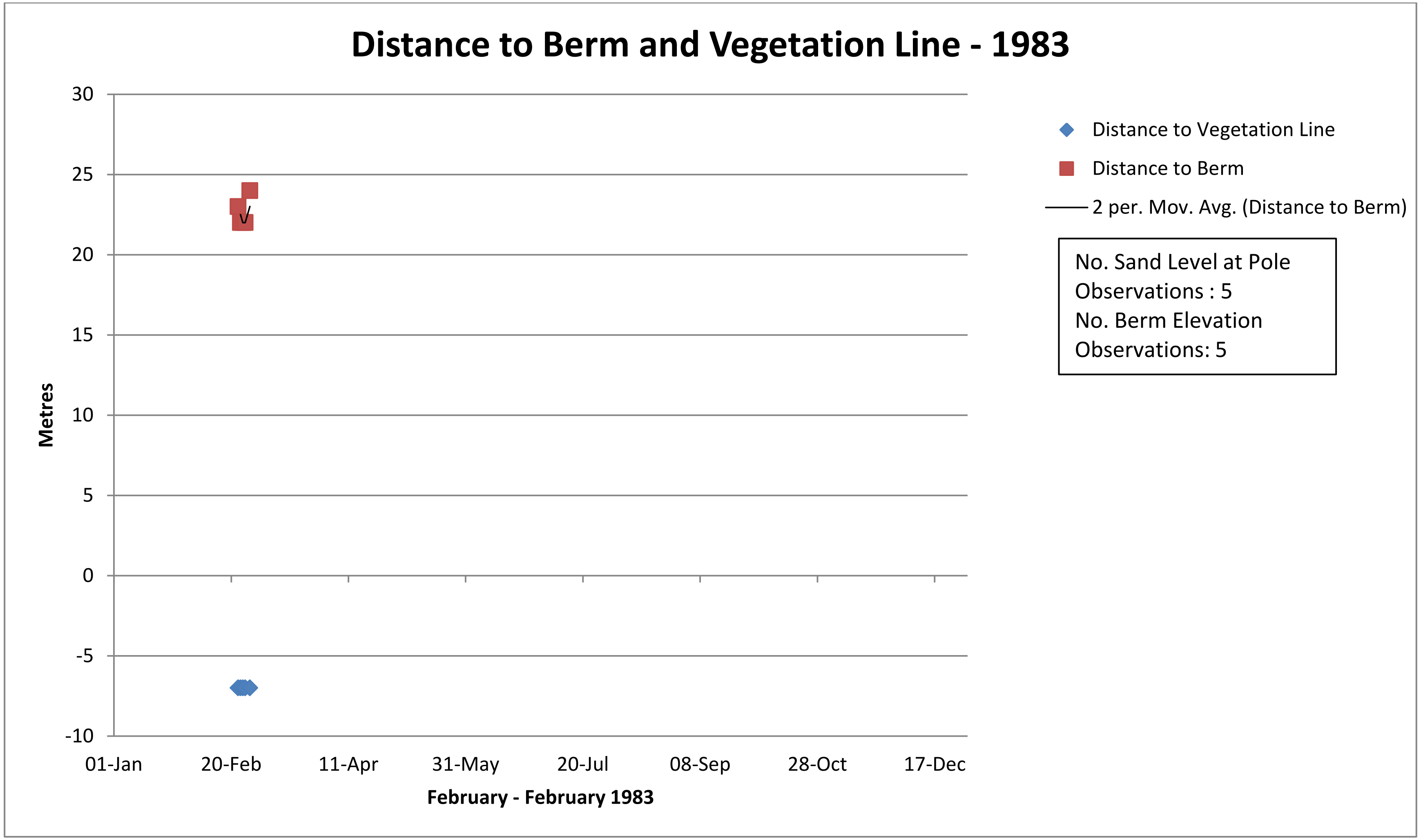


Figure 49 Beach profile parameters – Distance to berm and vegetation line- 1983

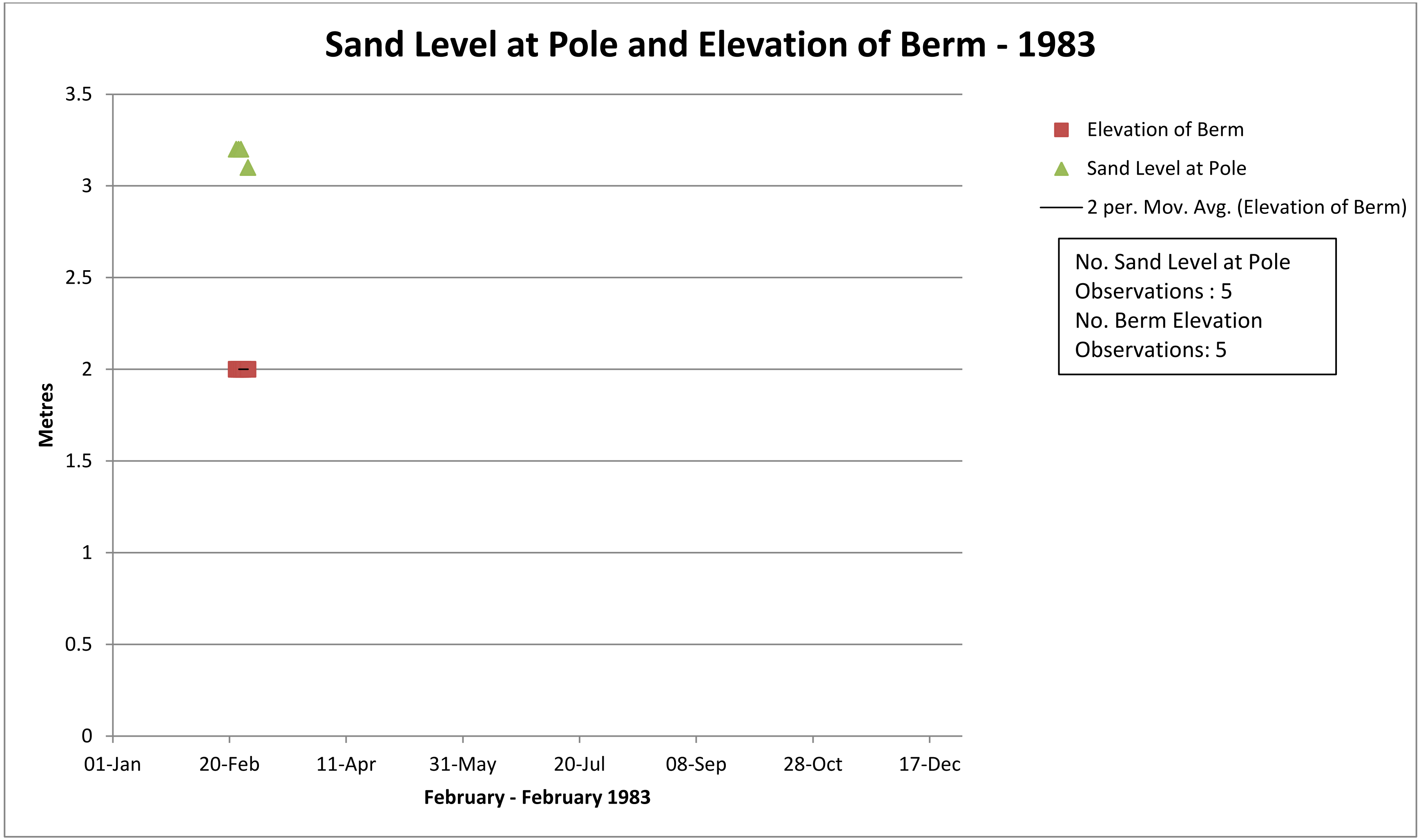


Figure 50 Beach profile parameters – Sand level at pole and elevation of berm- 1983

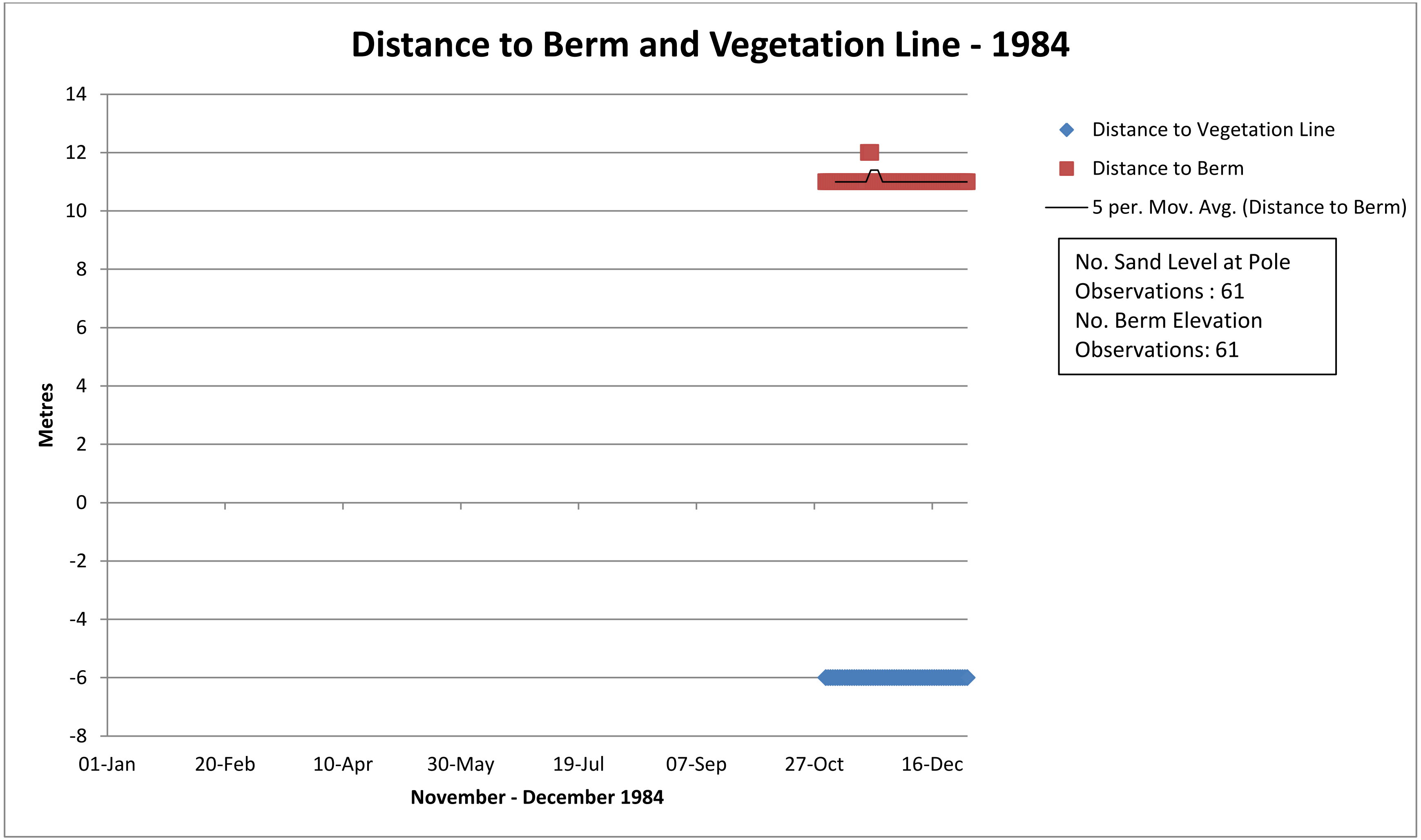


Figure 51 Beach profile parameters – Distance to berm and vegetation line- 1984

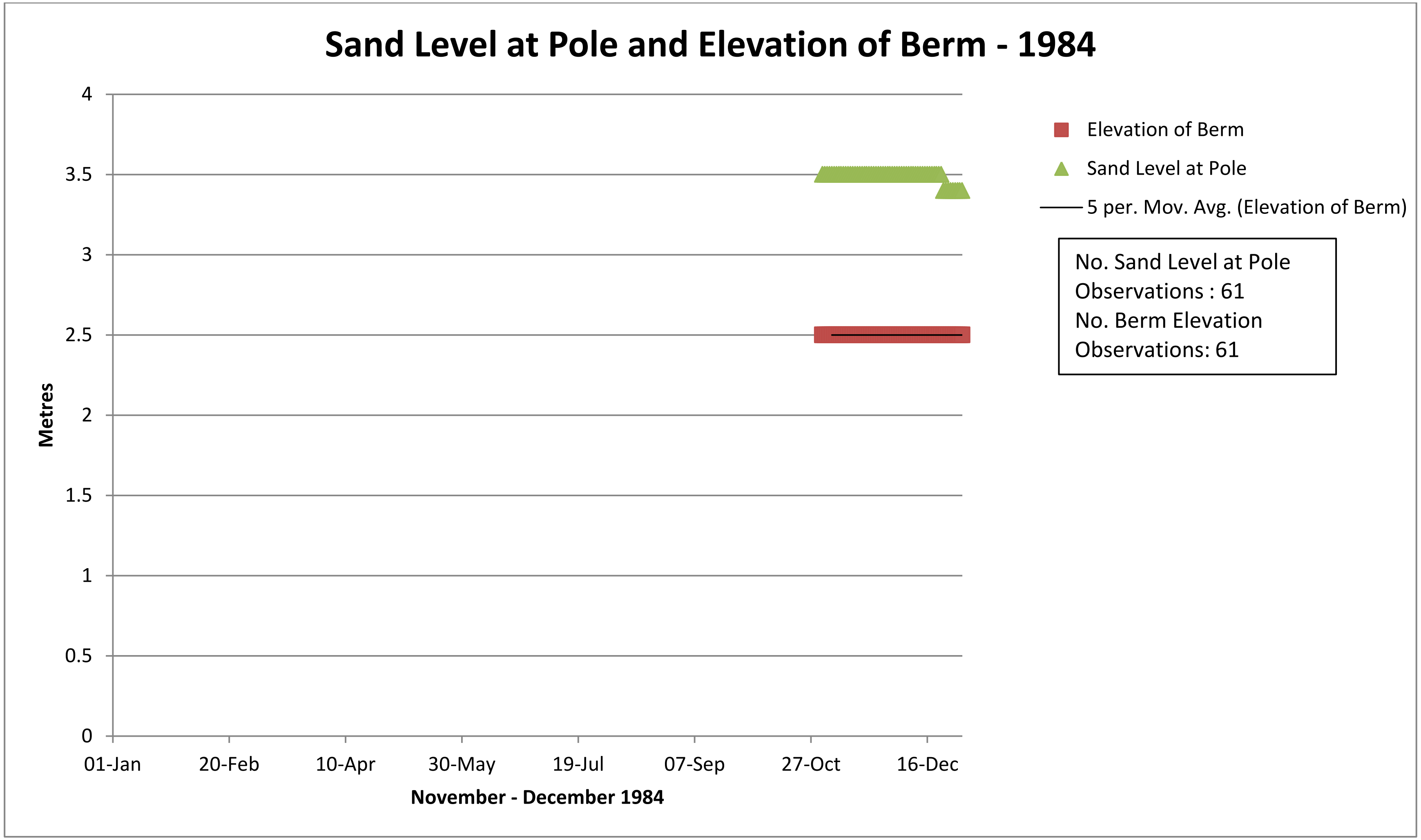


Figure 52 Beach profile parameters – Sand level at pole and elevation of berm- 1984

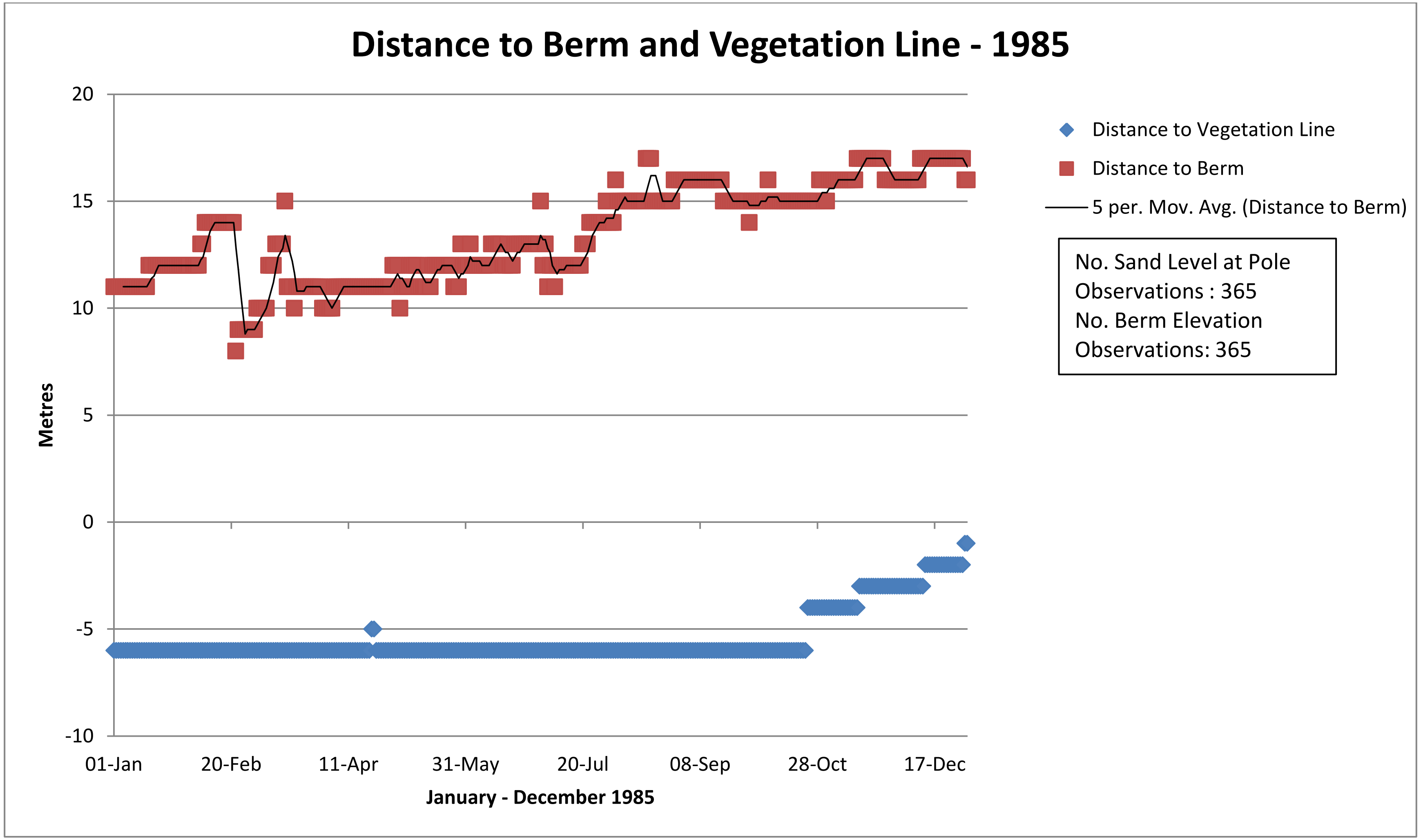


Figure 53 Beach profile parameters – Distance to berm and vegetation line- 1985

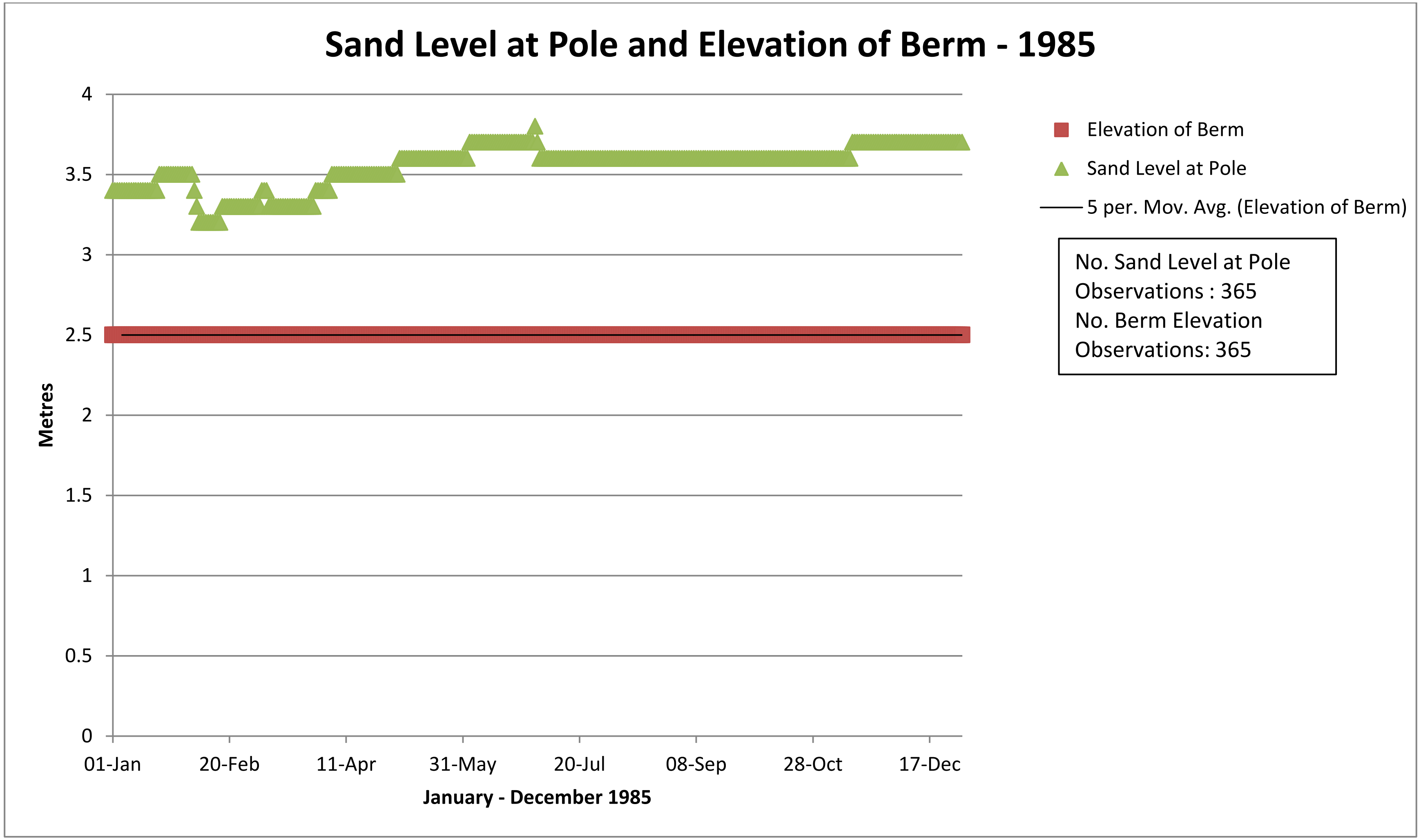


Figure 54 Beach profile parameters – Sand level at pole and elevation of berm- 1985

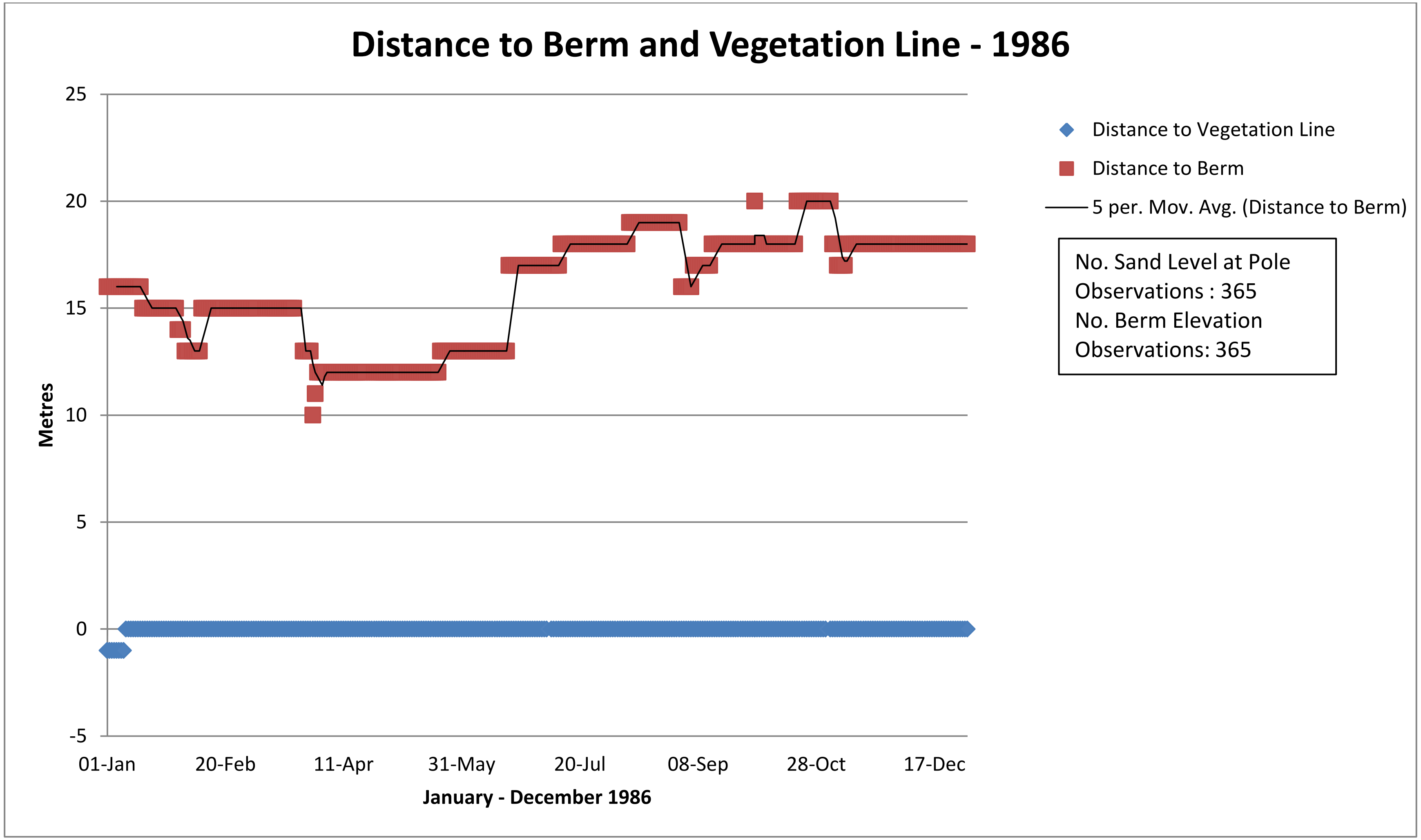


Figure 55 Beach profile parameters – Distance to berm and vegetation line- 1986

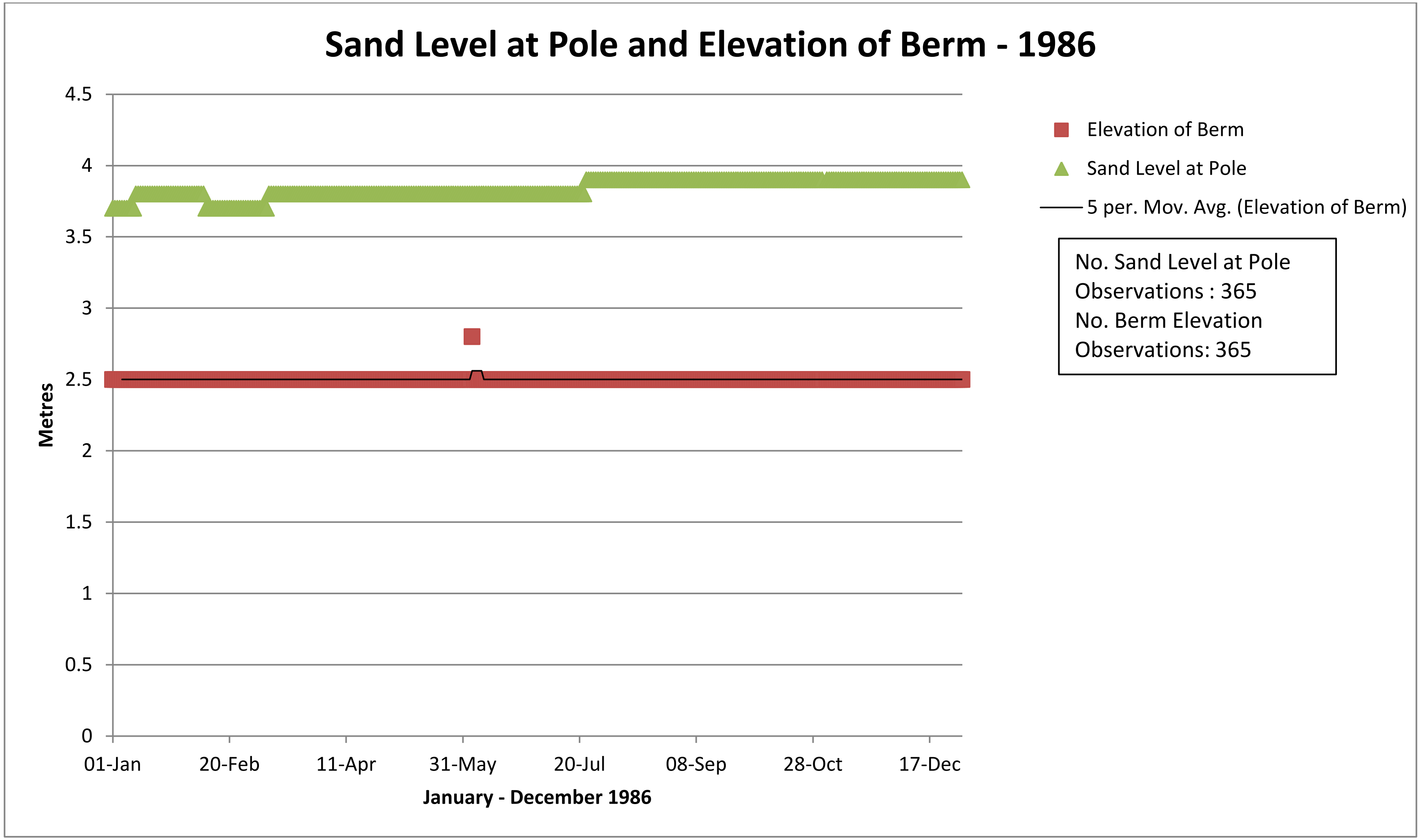


Figure 56 Beach profile parameters – Sand level at pole and elevation of berm- 1986

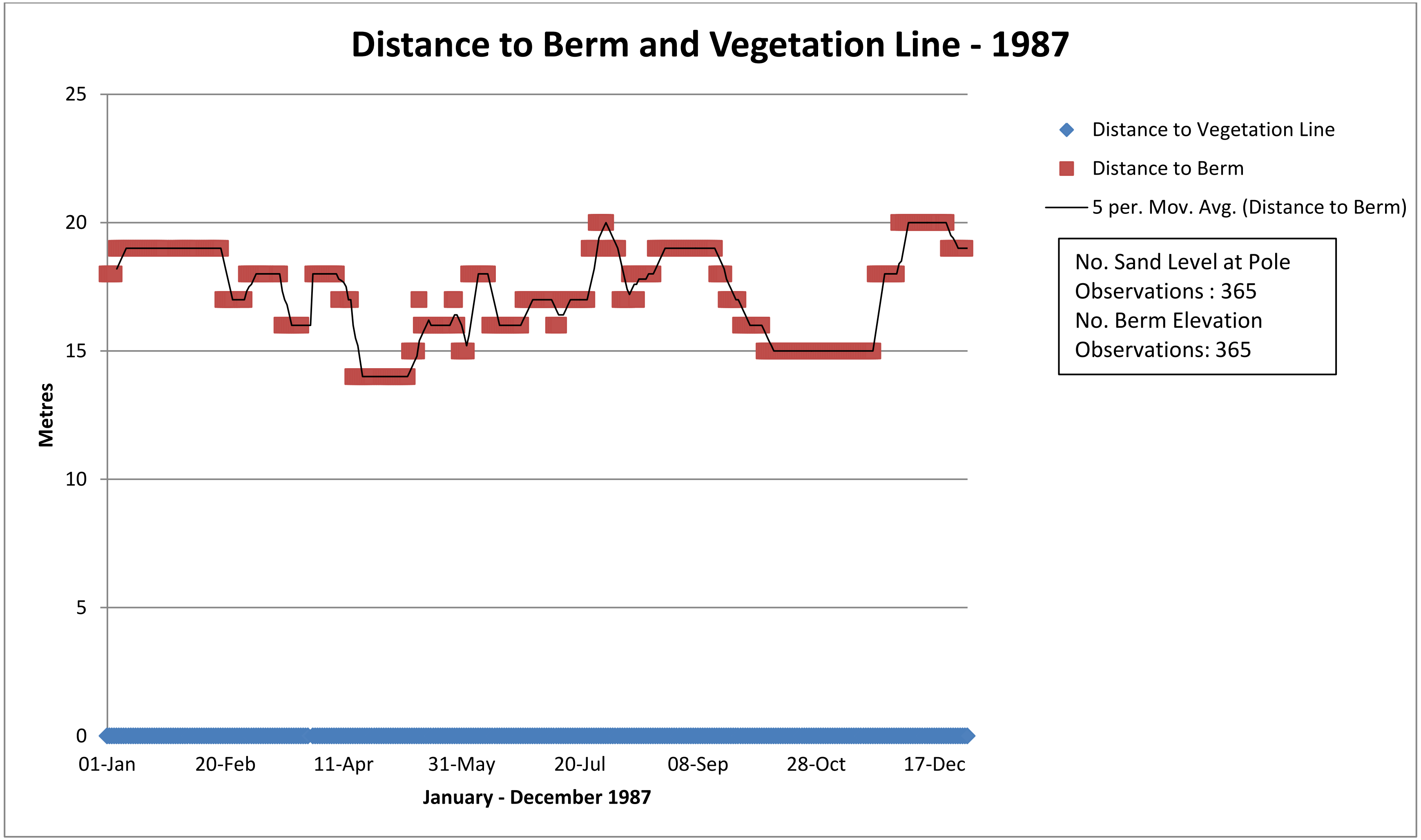


Figure 57 Beach profile parameters – Distance to berm and vegetation line- 1987

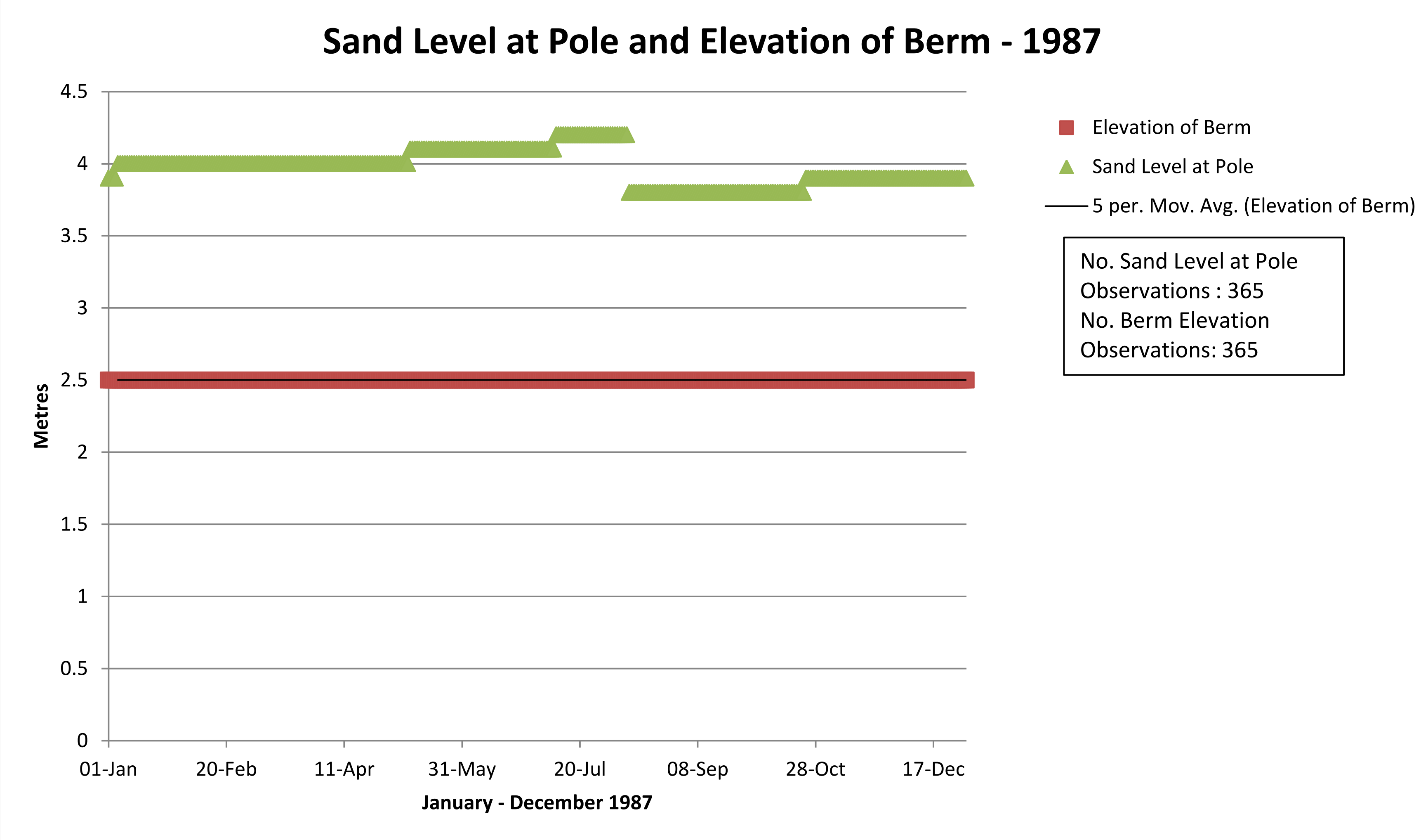


Figure 58 **Beach profile parameters – Sand level at pole and elevation of berm- 1987**

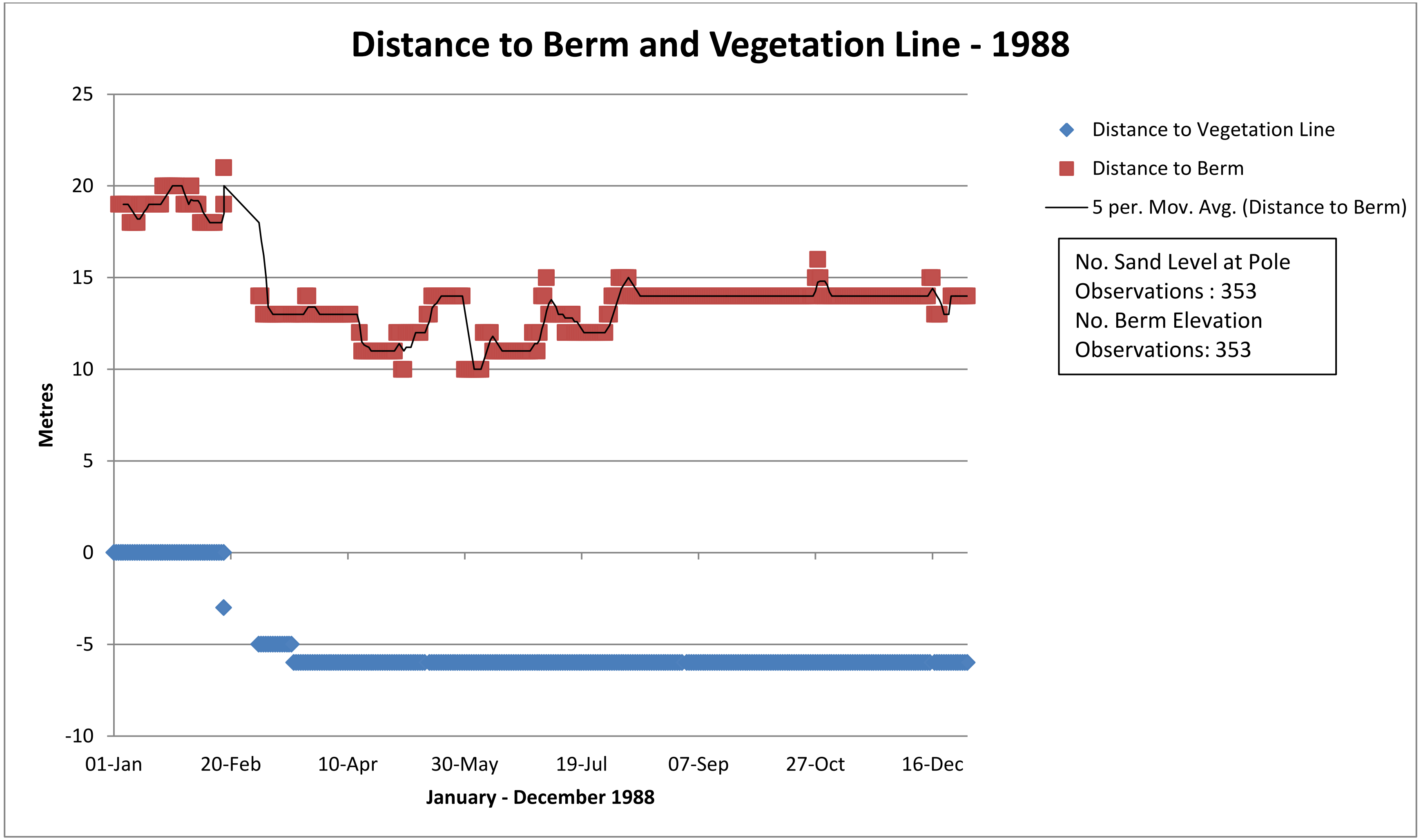


Figure 59 Beach profile parameters – Distance to berm and vegetation line- 1988

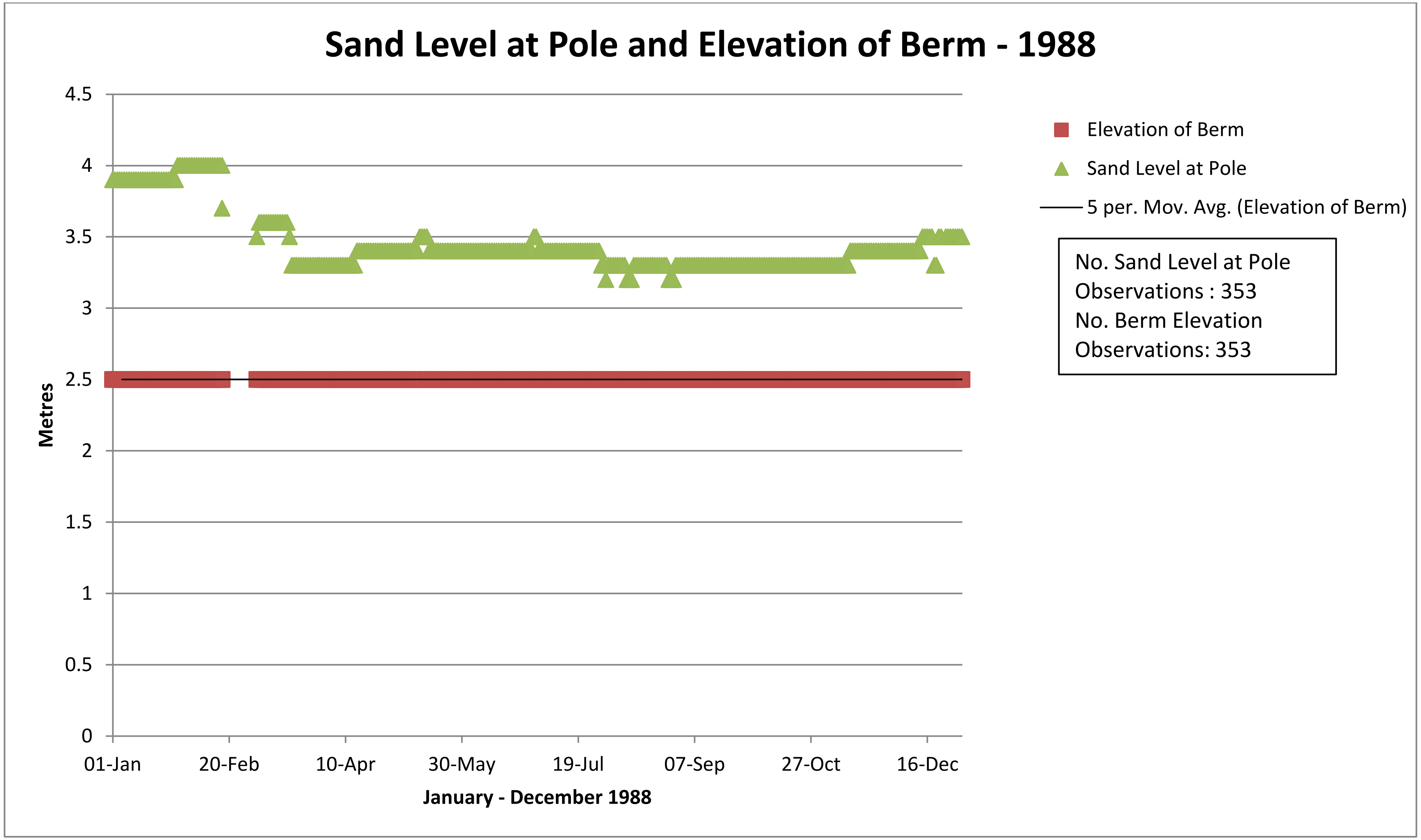


Figure 60 Beach profile parameters – Sand level at pole and elevation of berm- 1988

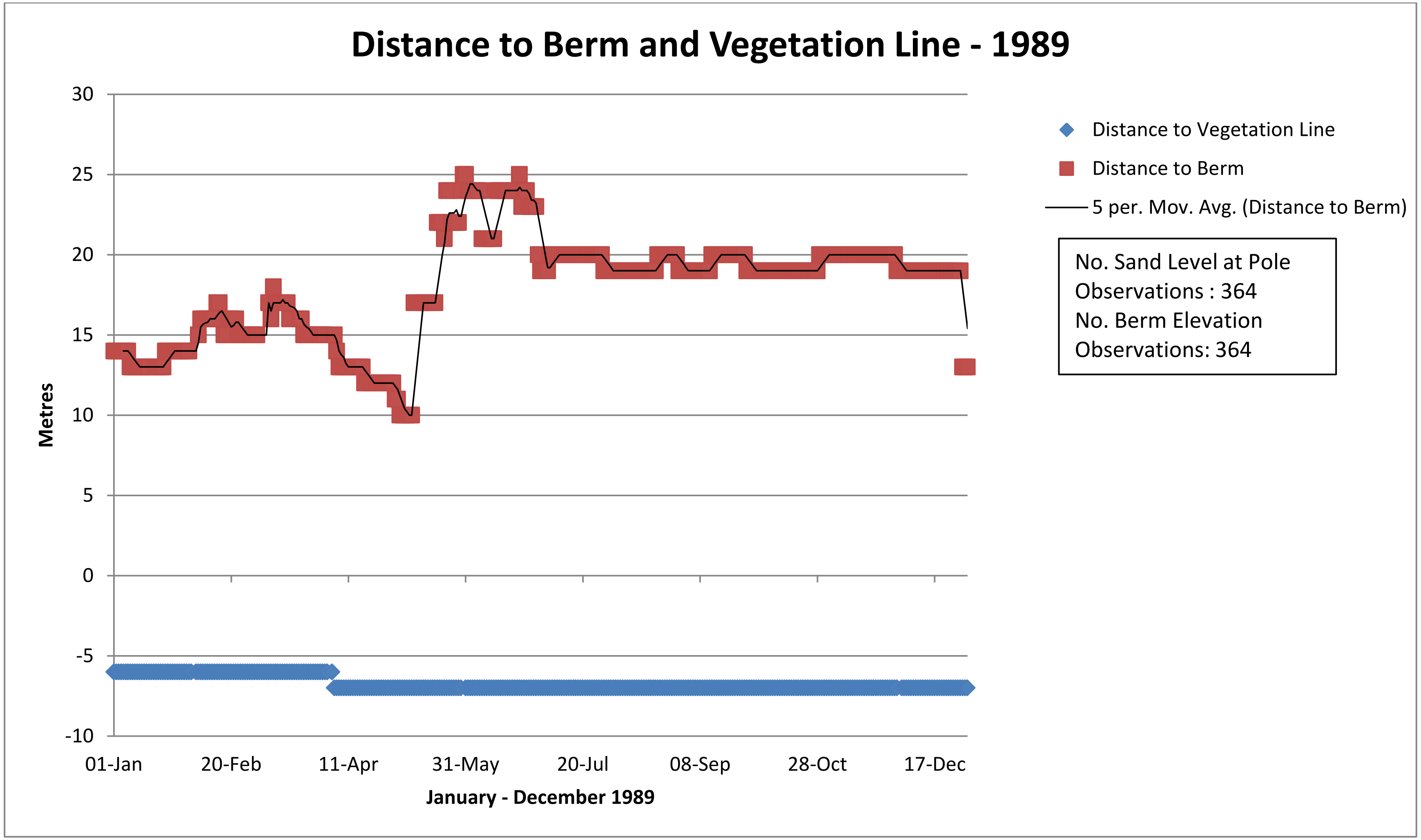


Figure 61 Beach profile parameters – Distance to berm and vegetation line- 1989

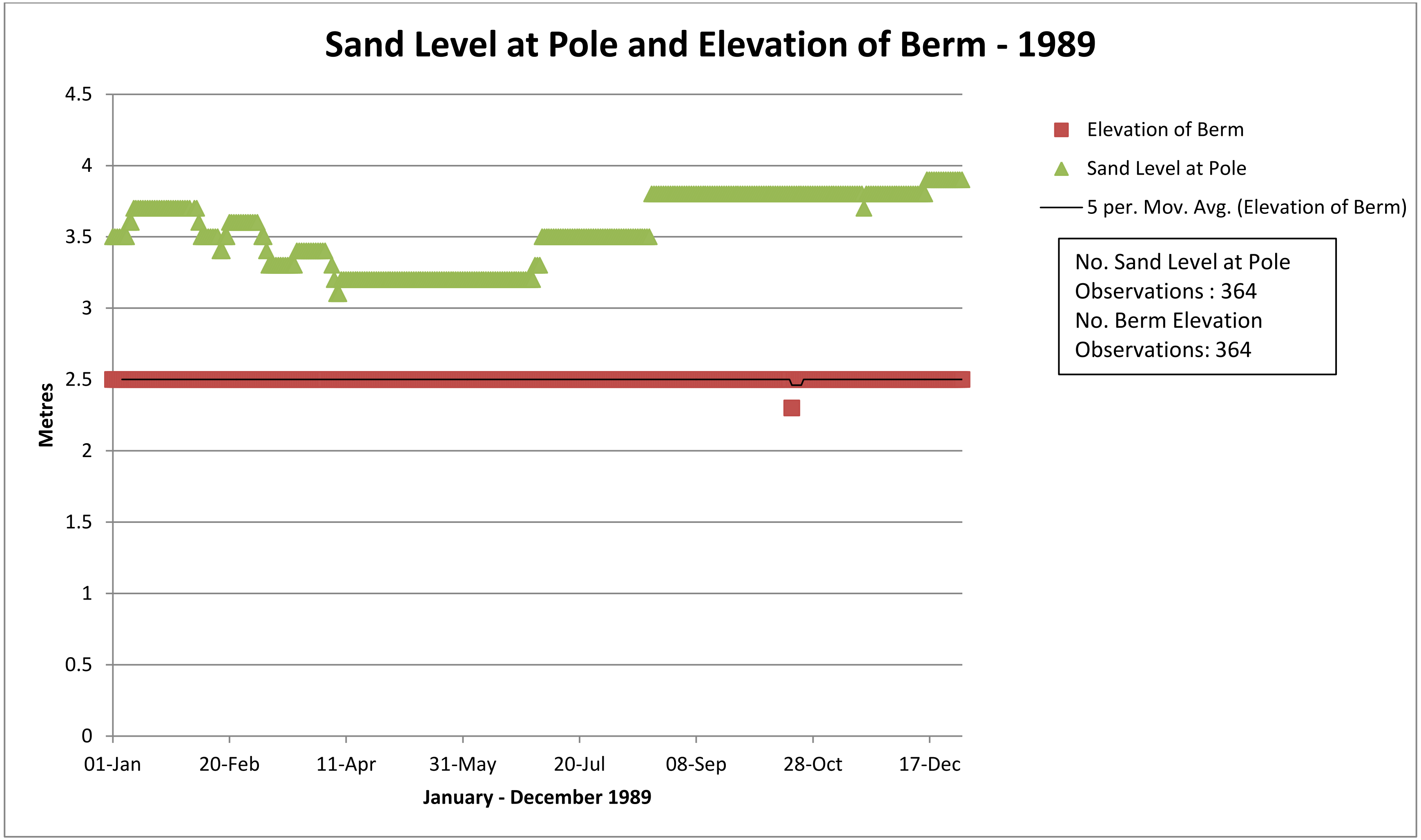


Figure 62 Beach profile parameters – Sand level at pole and elevation of berm- 1989

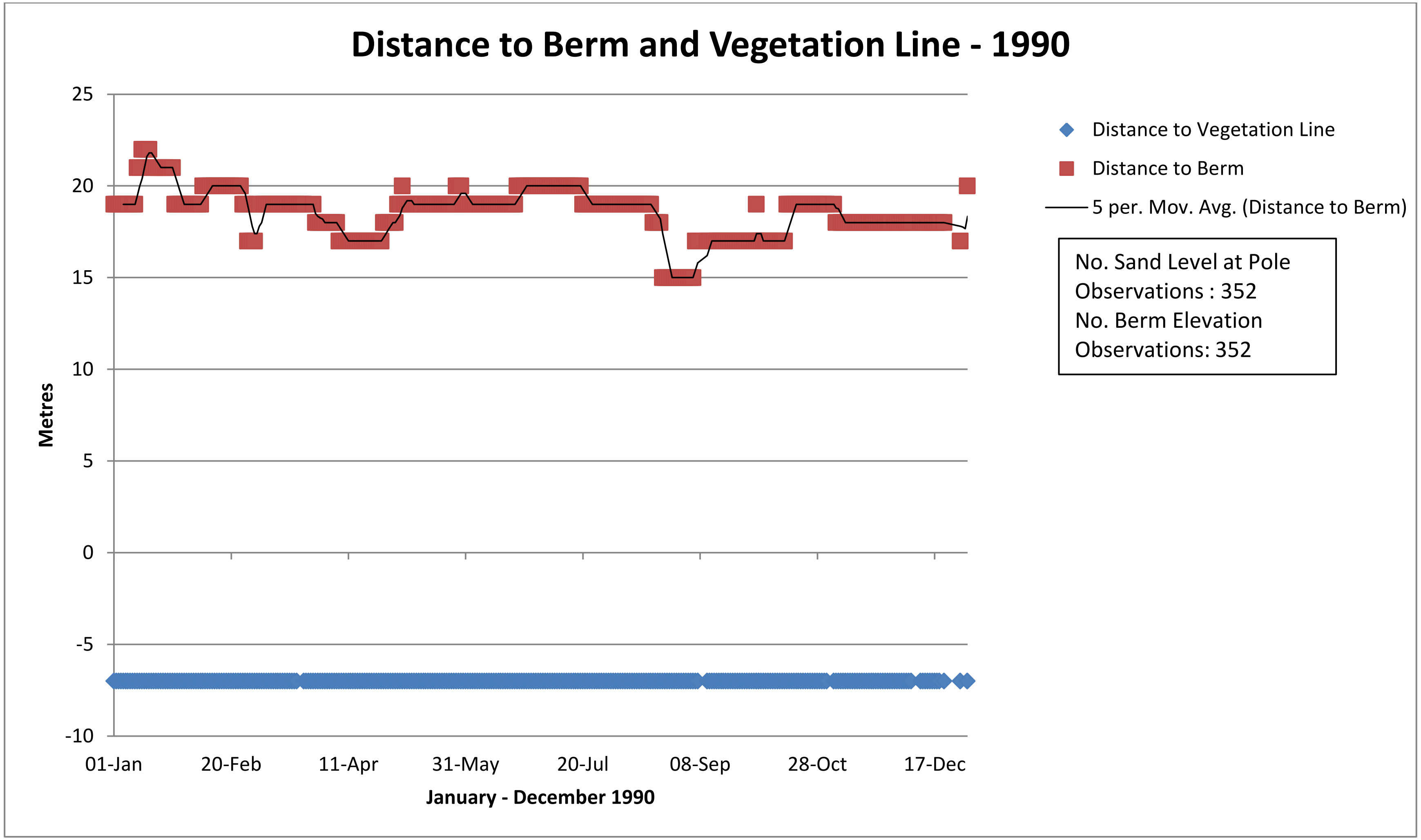


Figure 63 Beach profile parameters – Distance to berm and vegetation line- 1990

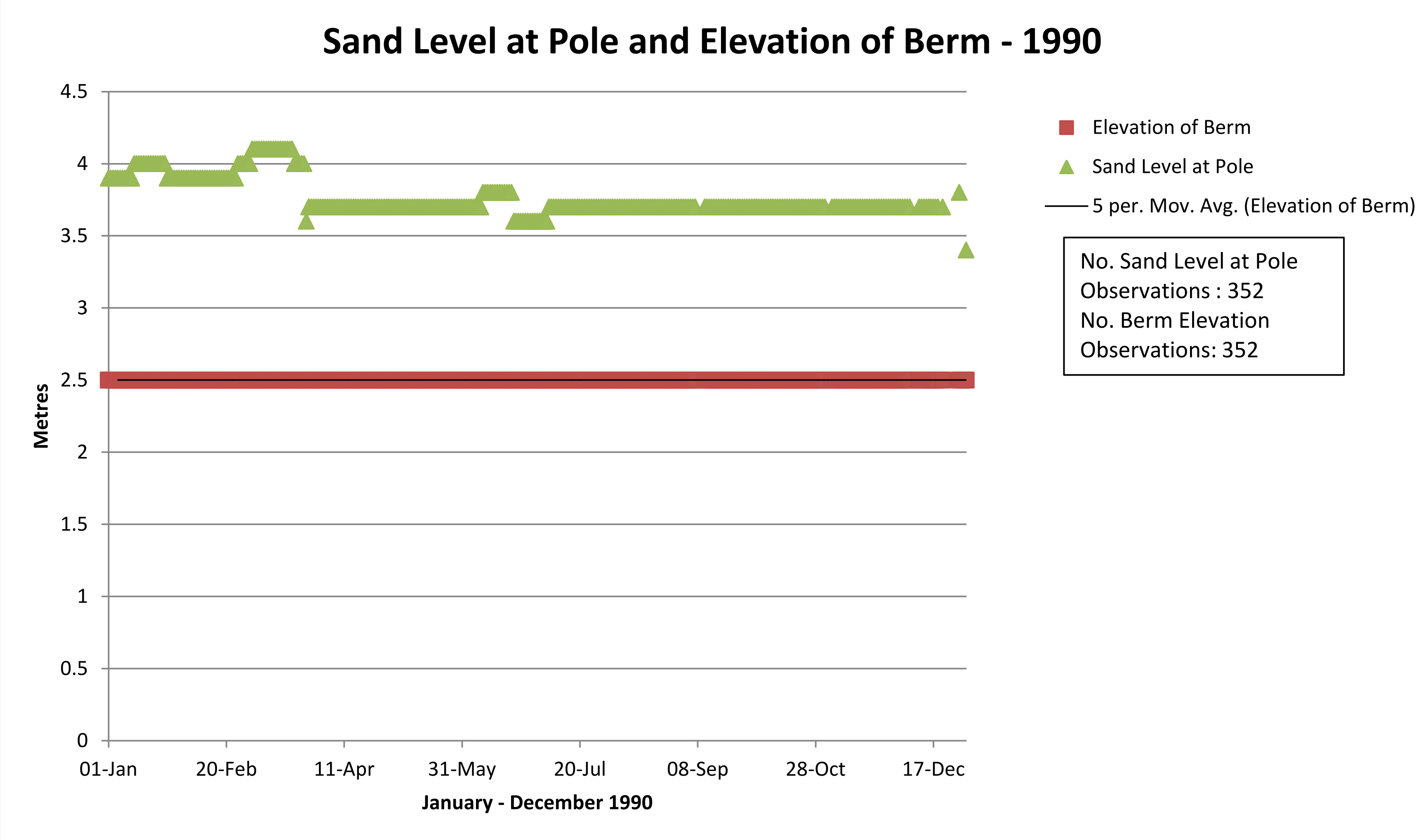


Figure 64 Beach profile parameters – Sand level at pole and elevation of berm- 1990

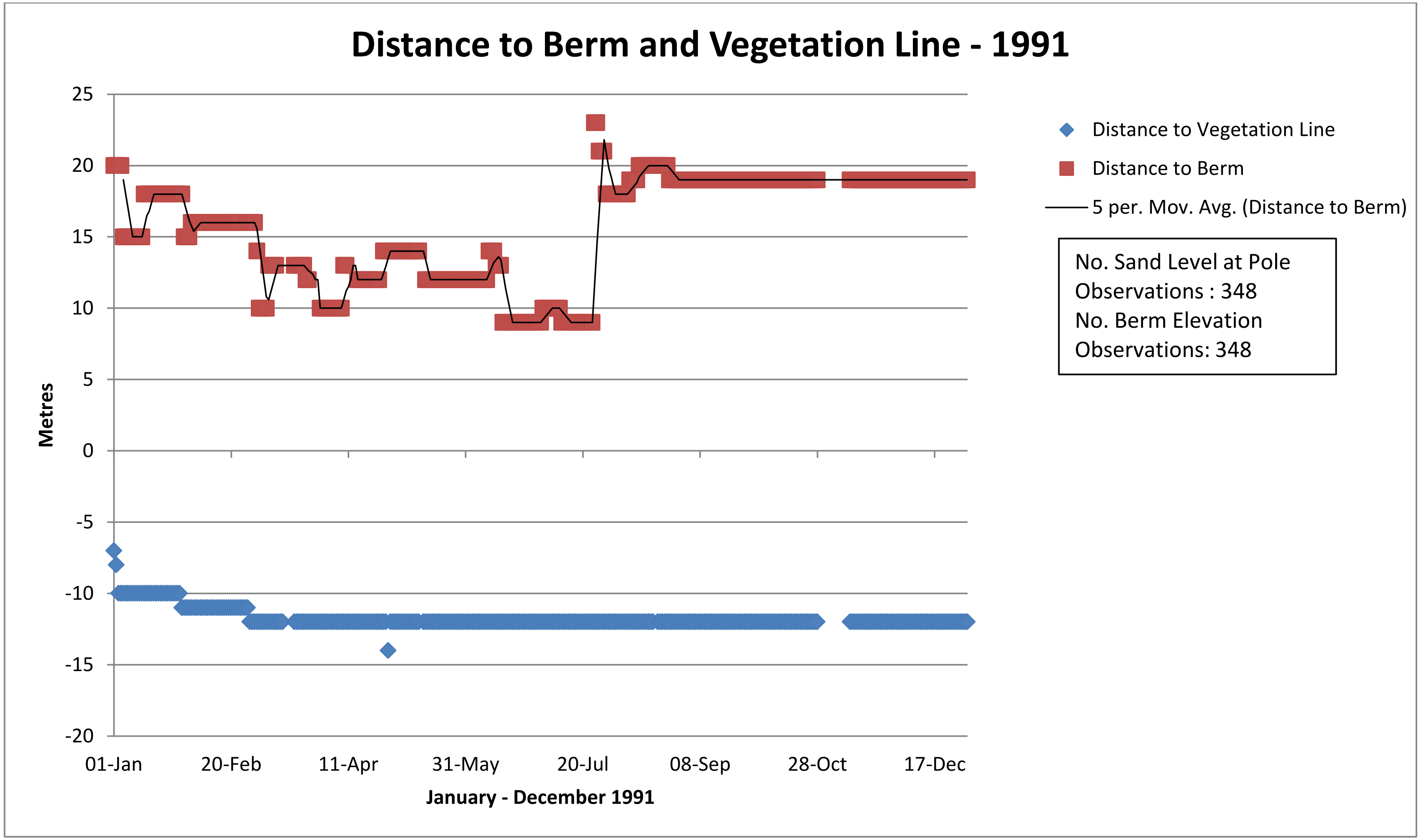


Figure 65 Beach profile parameters – Distance to berm and vegetation line- 1991

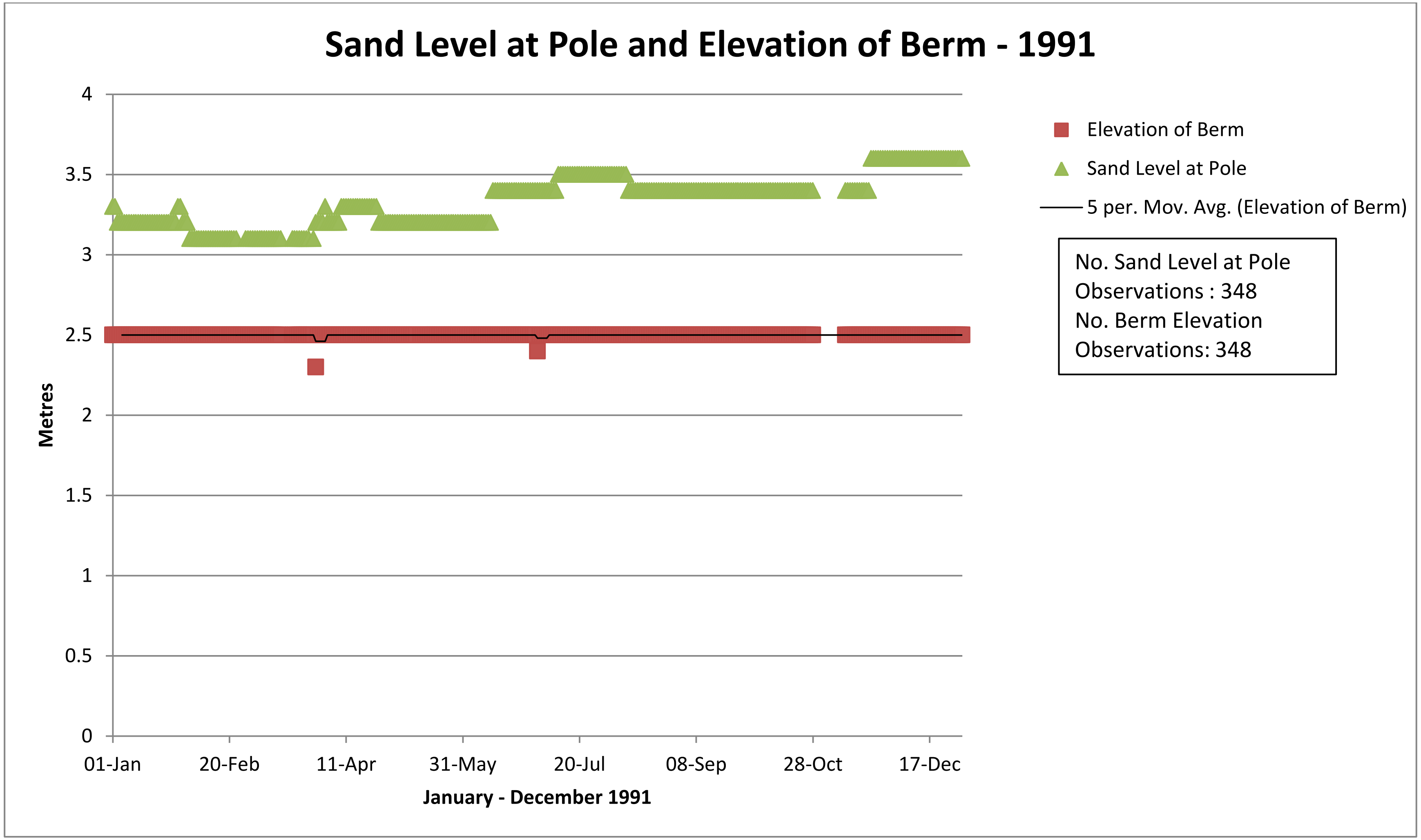


Figure 66 Beach profile parameters – Sand level at pole and elevation of berm- 1991

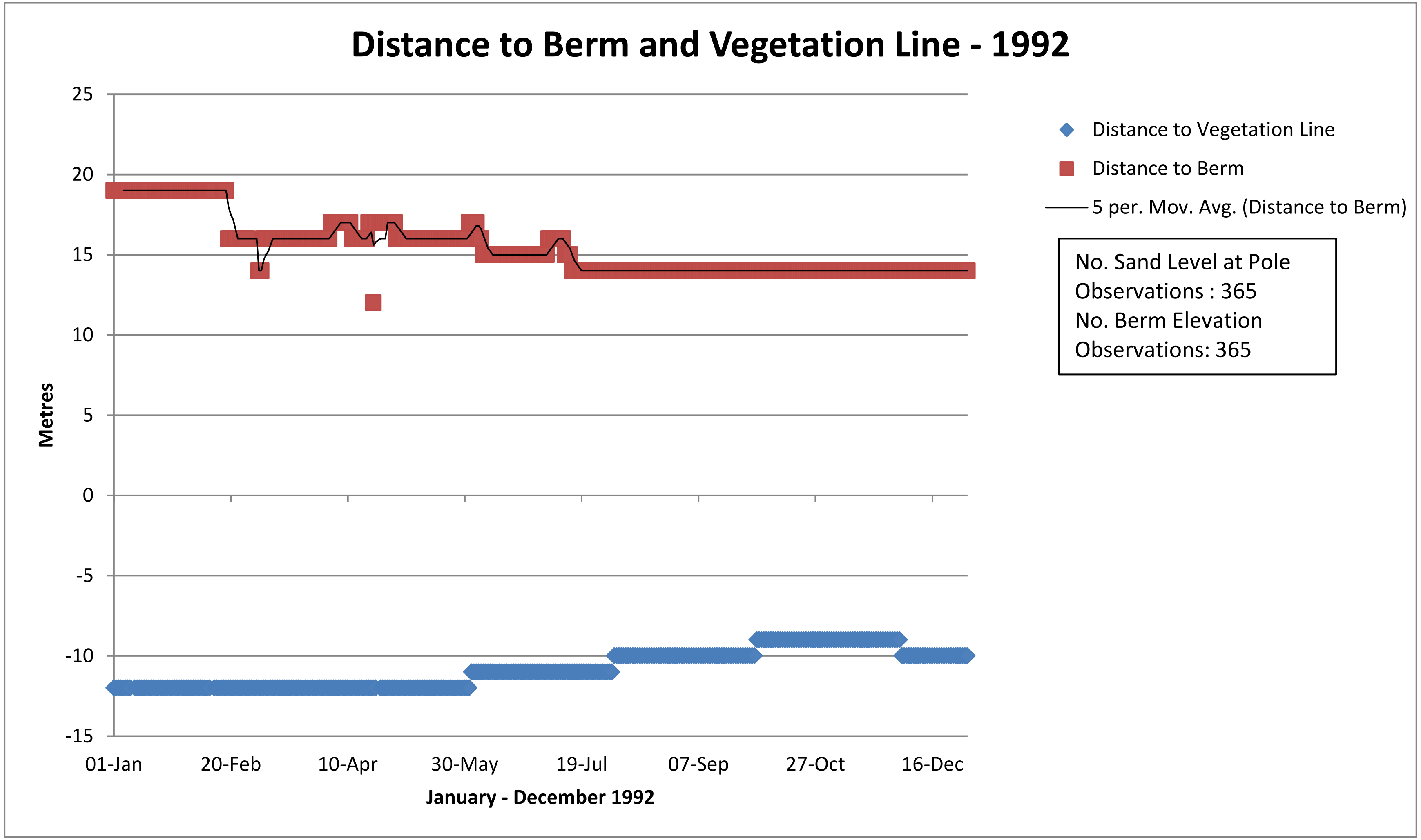


Figure 67 Beach profile parameters – Distance to berm and vegetation line- 1992

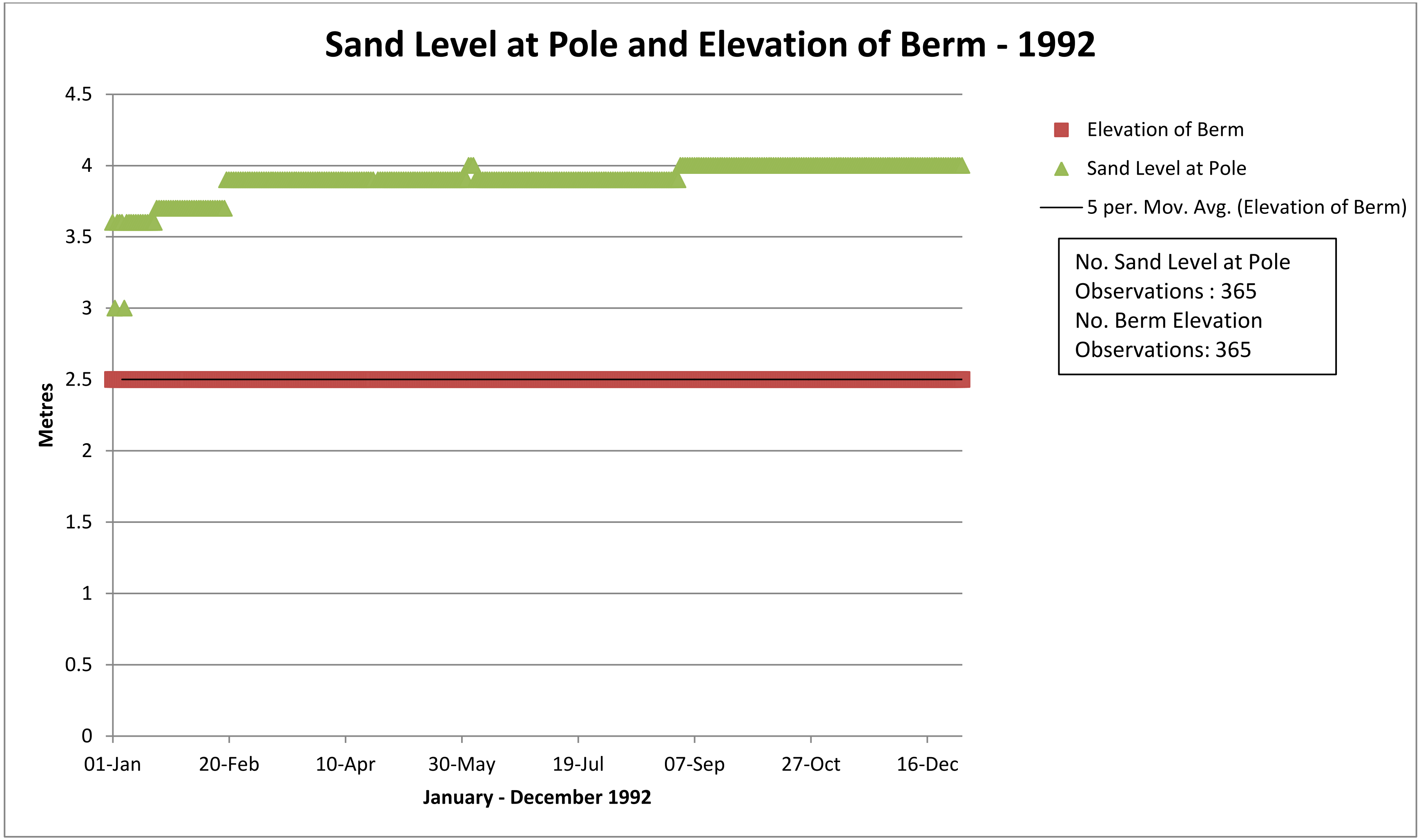


Figure 68 Beach profile parameters – Sand level at pole and elevation of berm- 1992

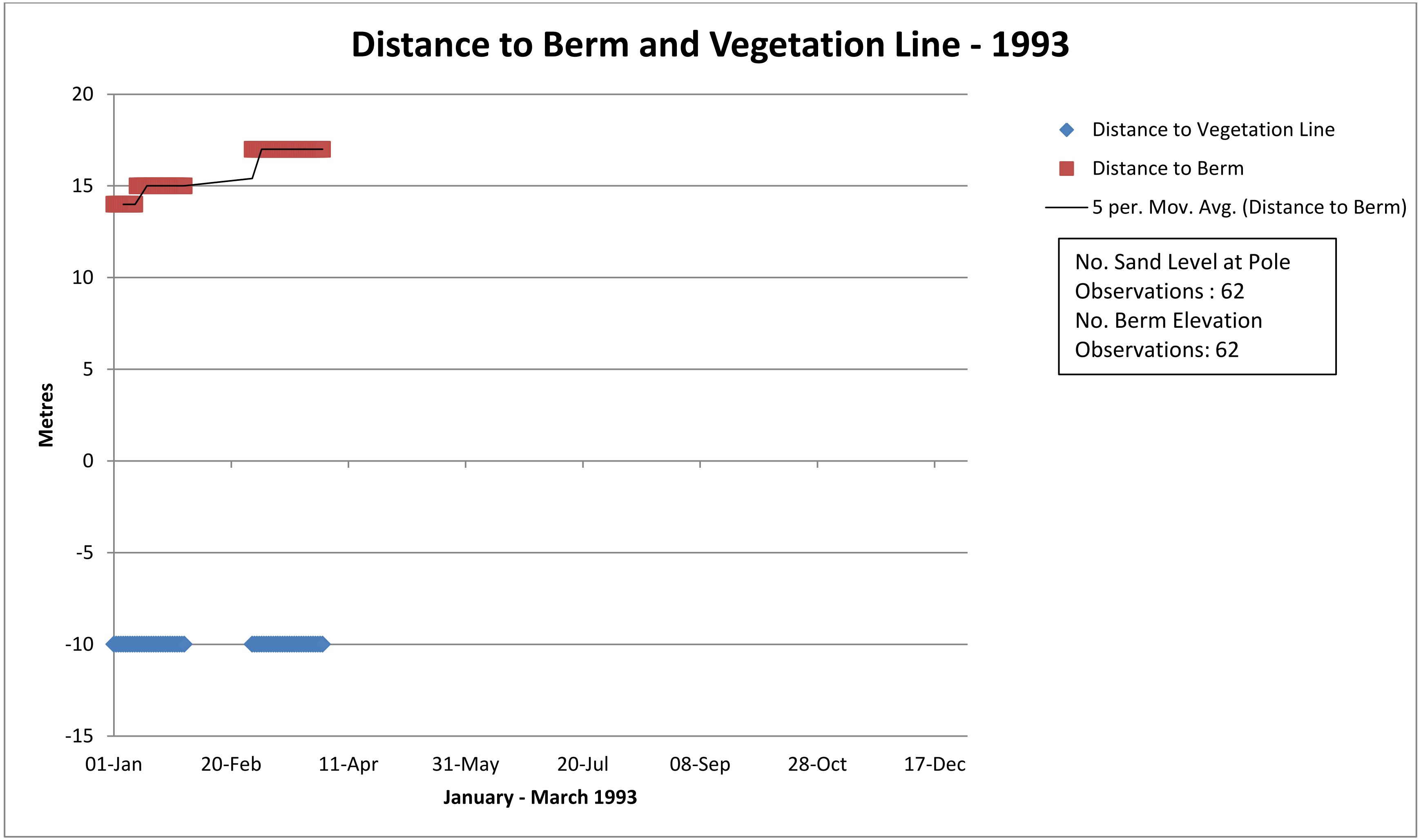


Figure 69 Beach profile parameters – Distance to berm and vegetation line- 1993

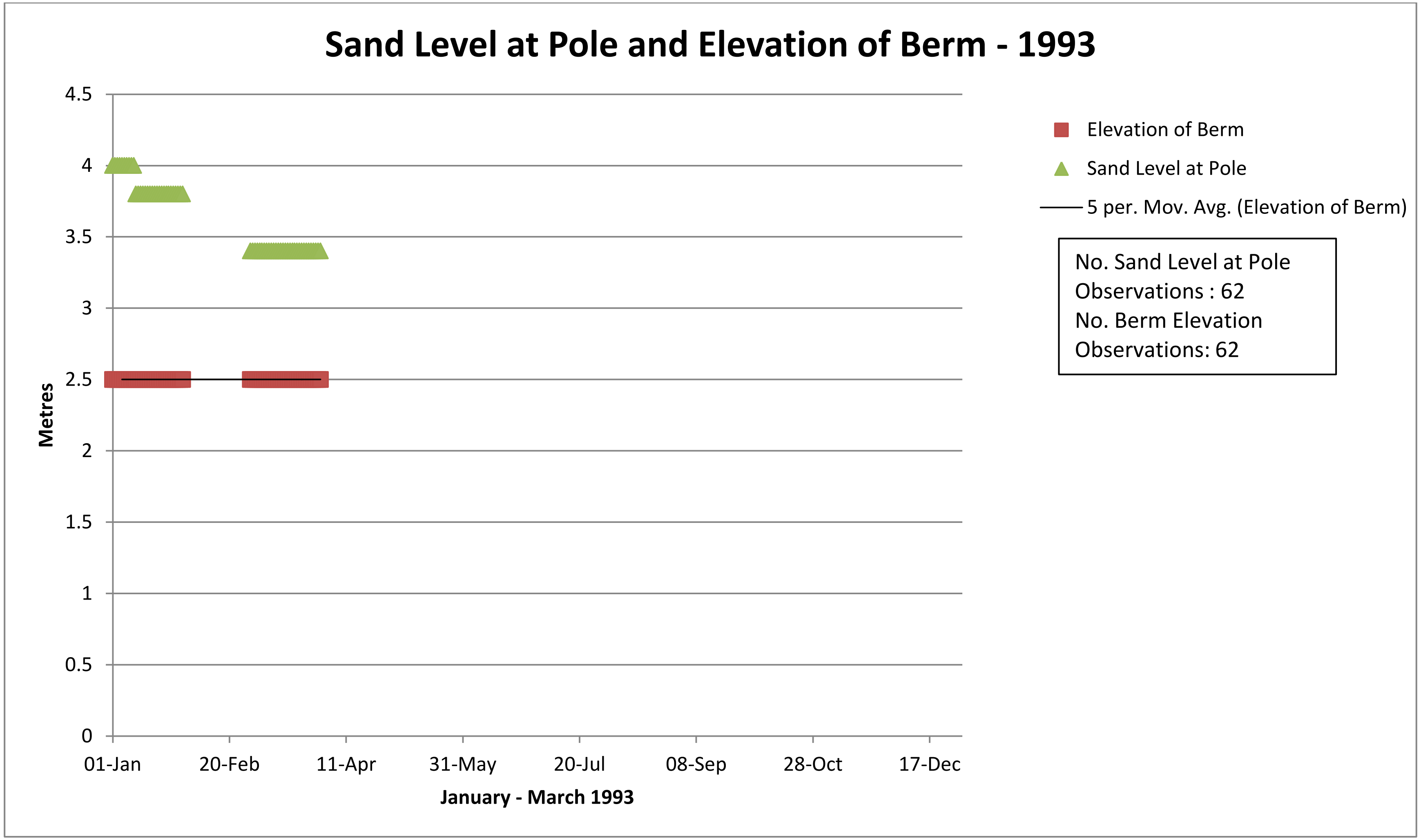


Figure 70 Beach profile parameters – Sand level at pole and elevation of berm- 1993

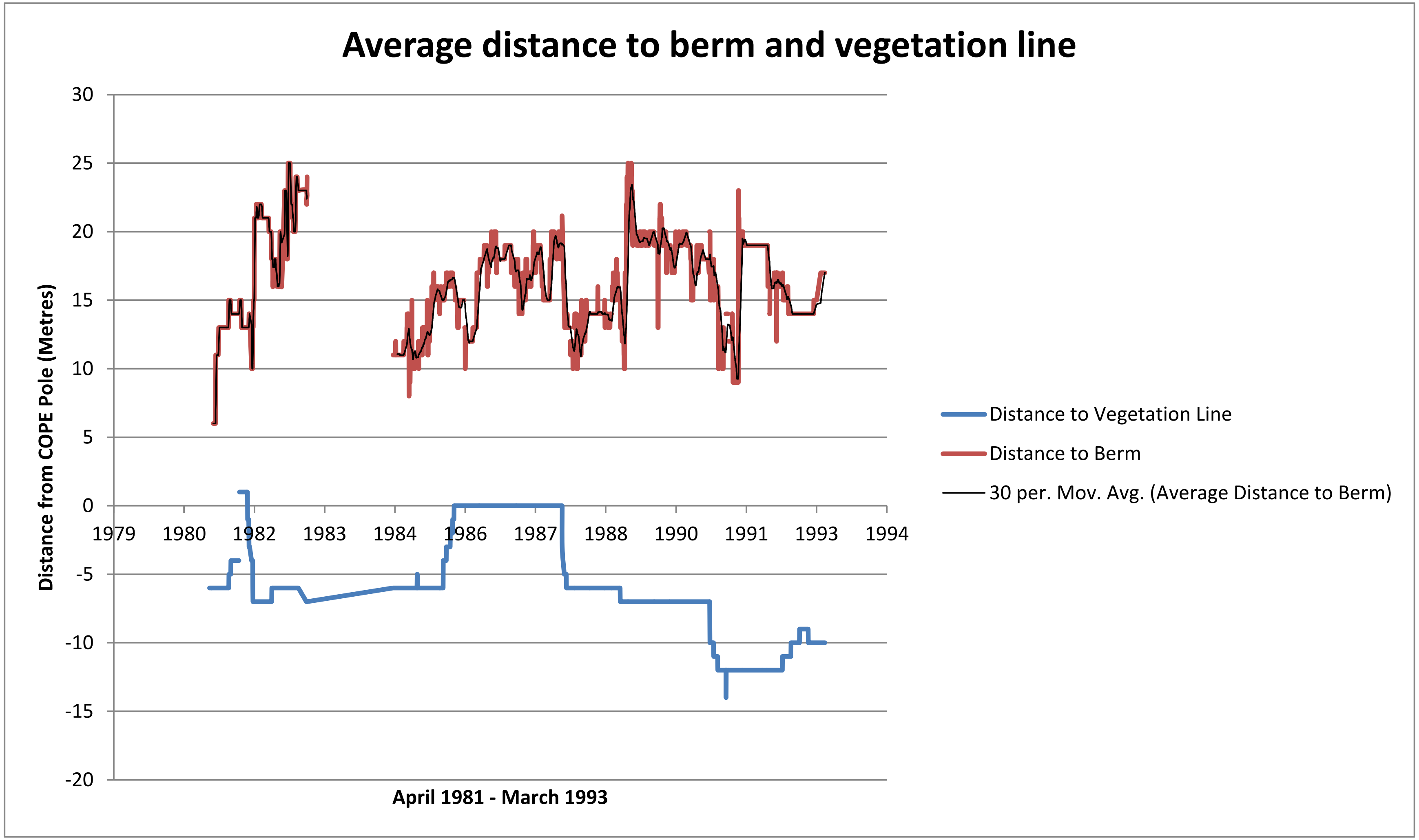


Figure 71 **Average distance to berm and vegetation line**

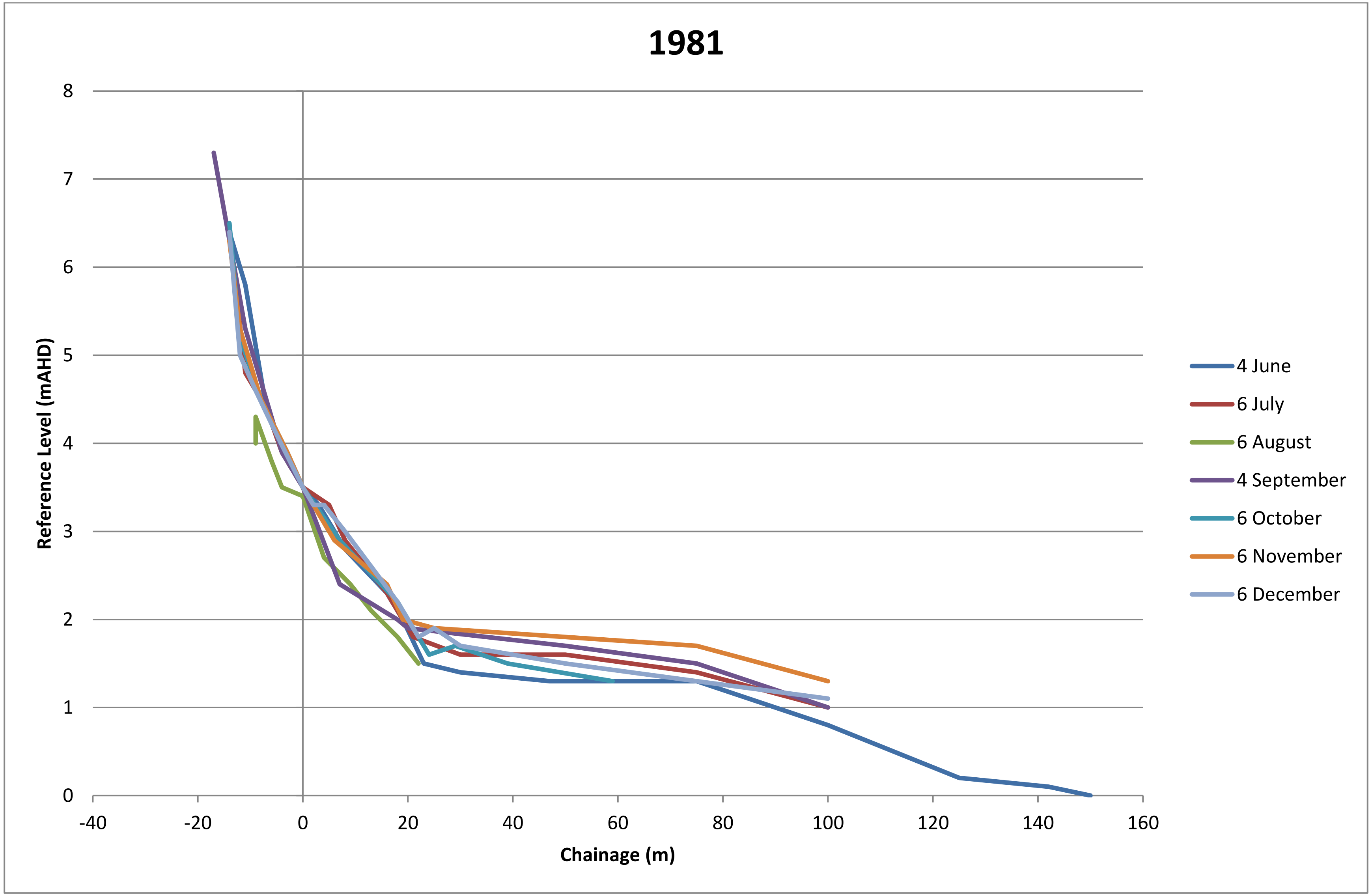


Figure 72 Monthly beach profile – 1981

Coastal Impacts Unit - Department of Science, Information Technology and Innovation
Sarina COPE Data Compilation

Job Number	41-28646
Revision	A
Date	29 April 2014

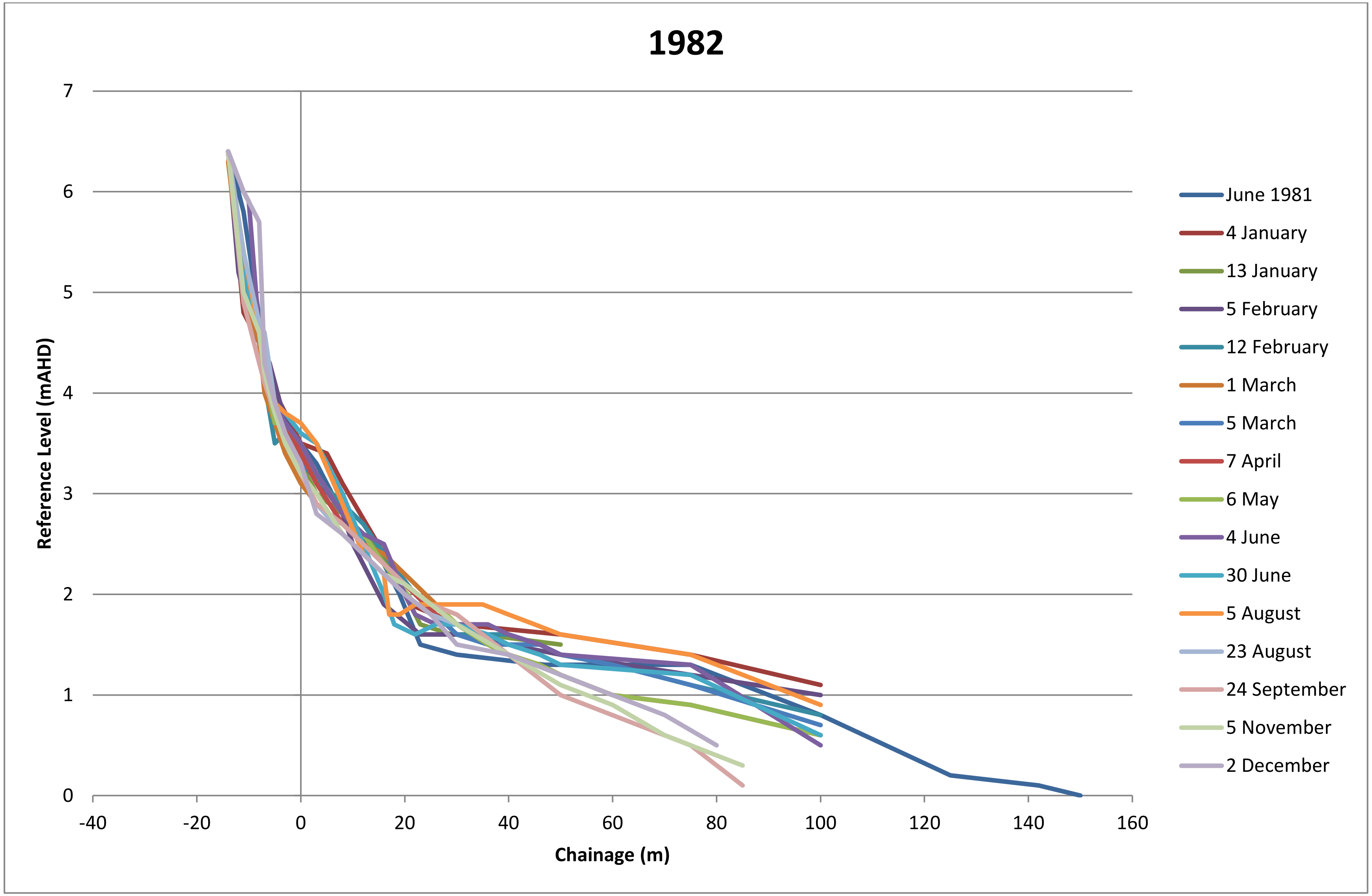


Figure 73 Monthly beach profile - 1982

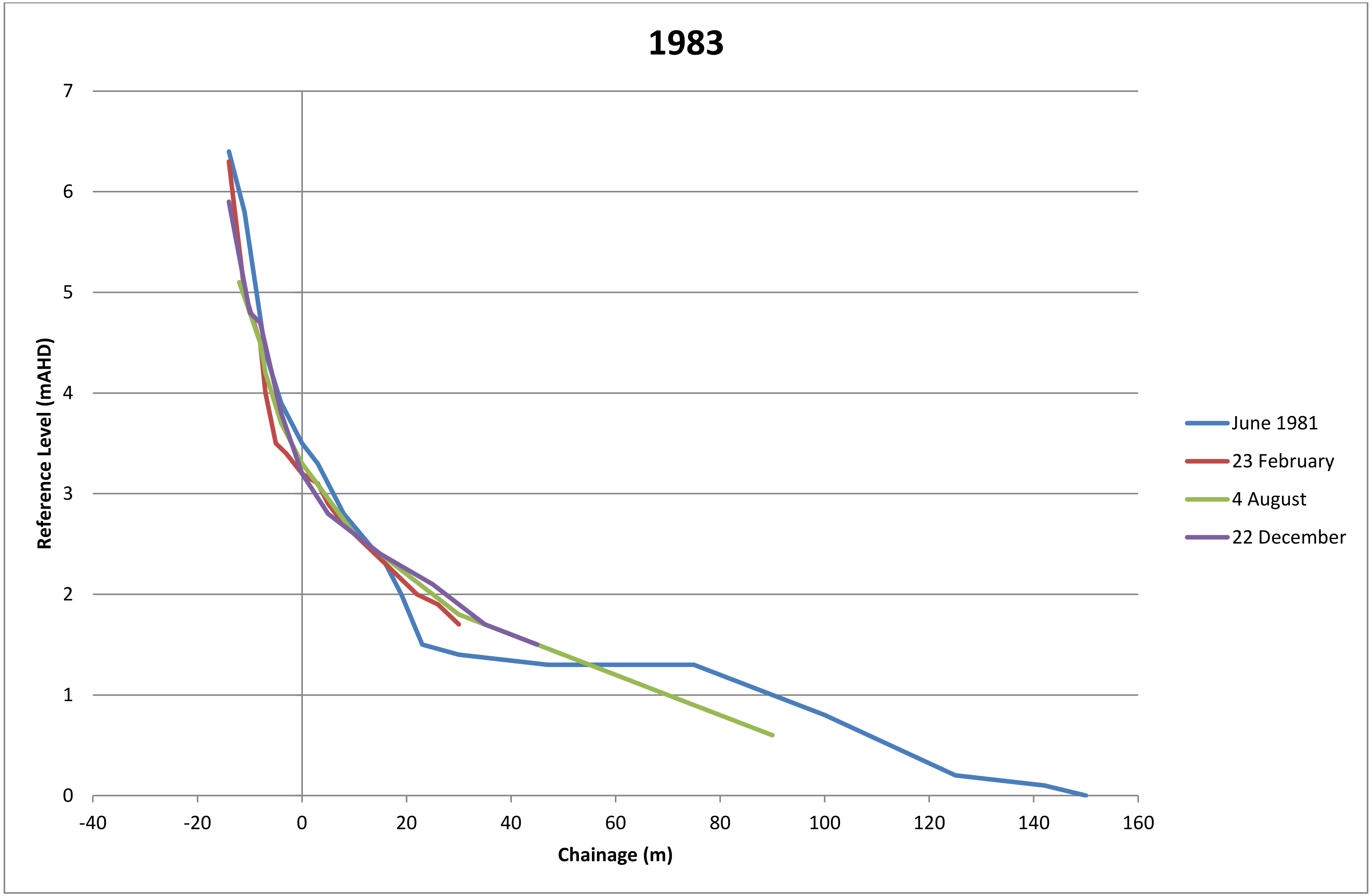


Figure 74 Monthly beach profile - 1983

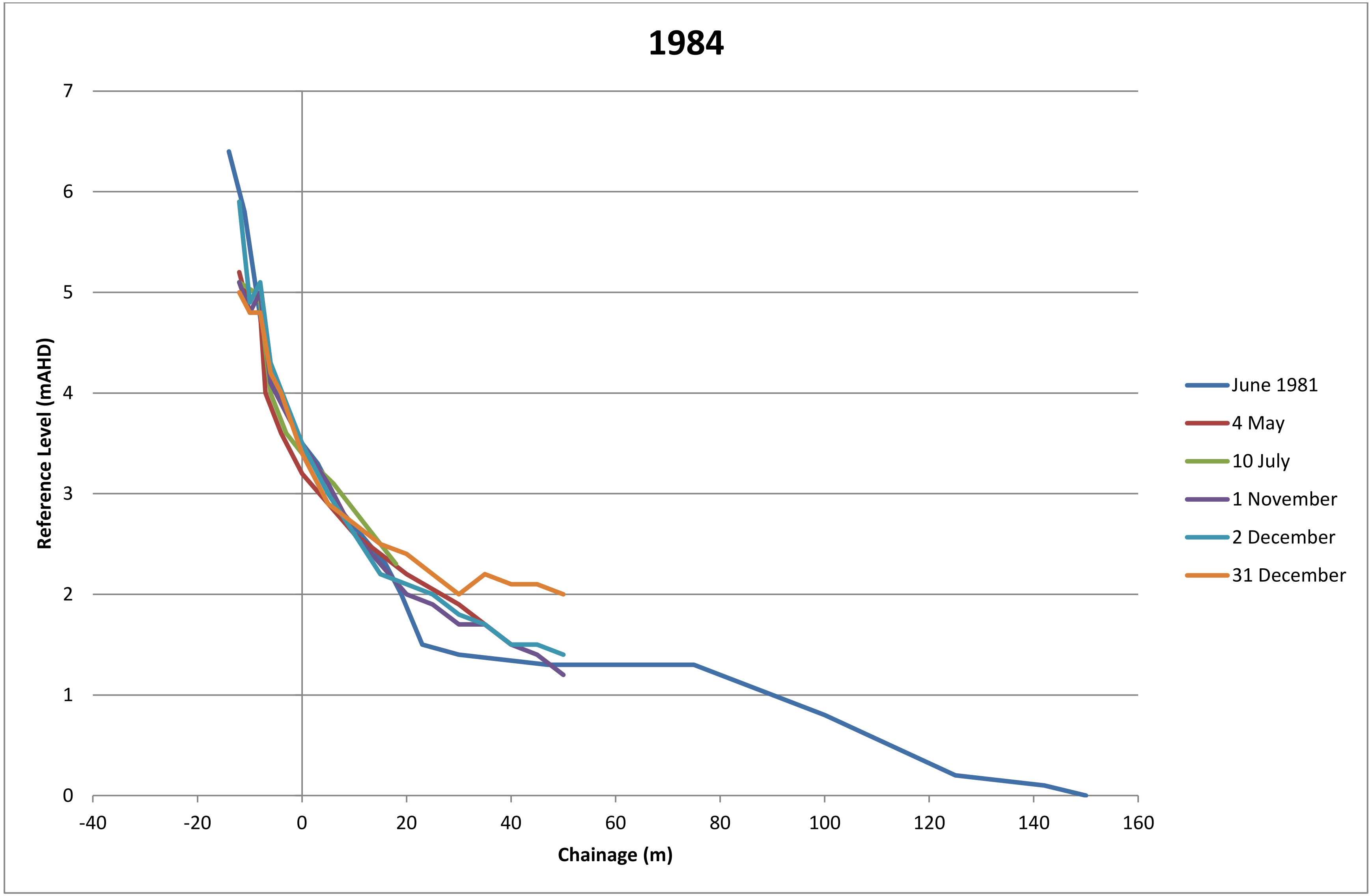


Figure 75 Monthly beach profile – 1984

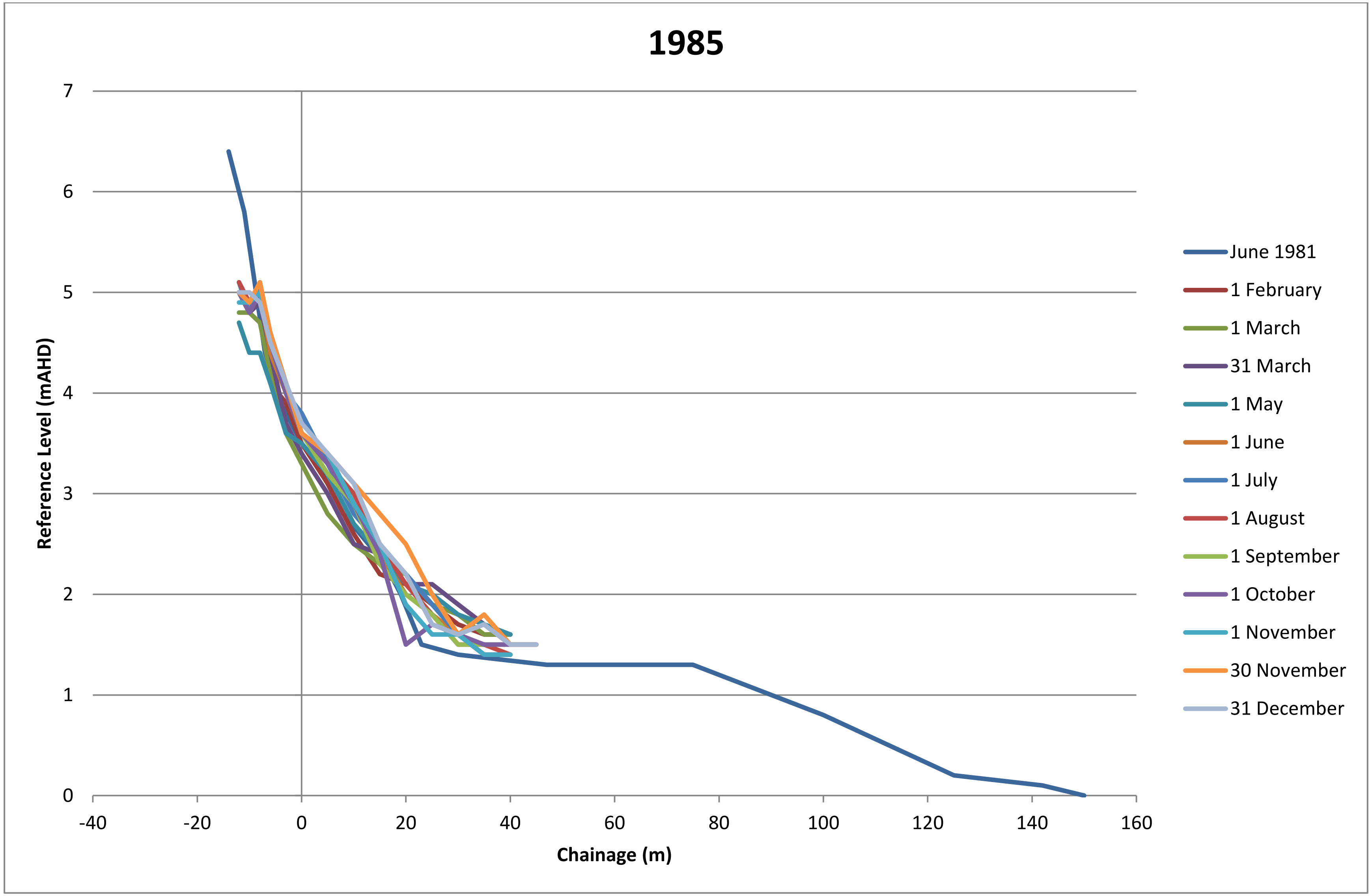


Figure 76 Monthly beach profile – 1985

Coastal Impacts Unit - Department of Science, Information Technology and Innovation
Sarina COPE Data Compilation

Job Number	41-28646
Revision	A
Date	29 April 2014

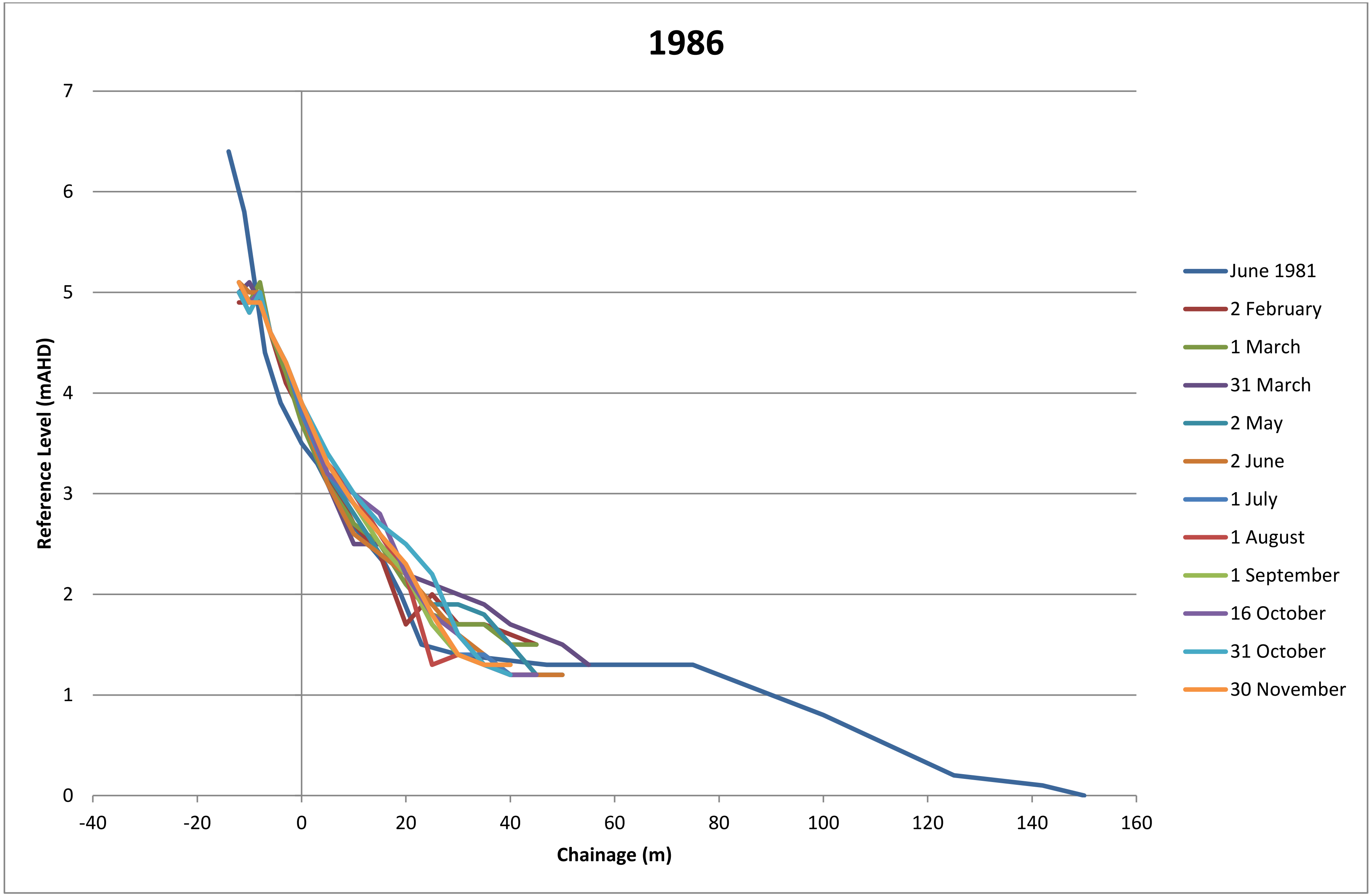


Figure 77 Monthly beach profile – 1986

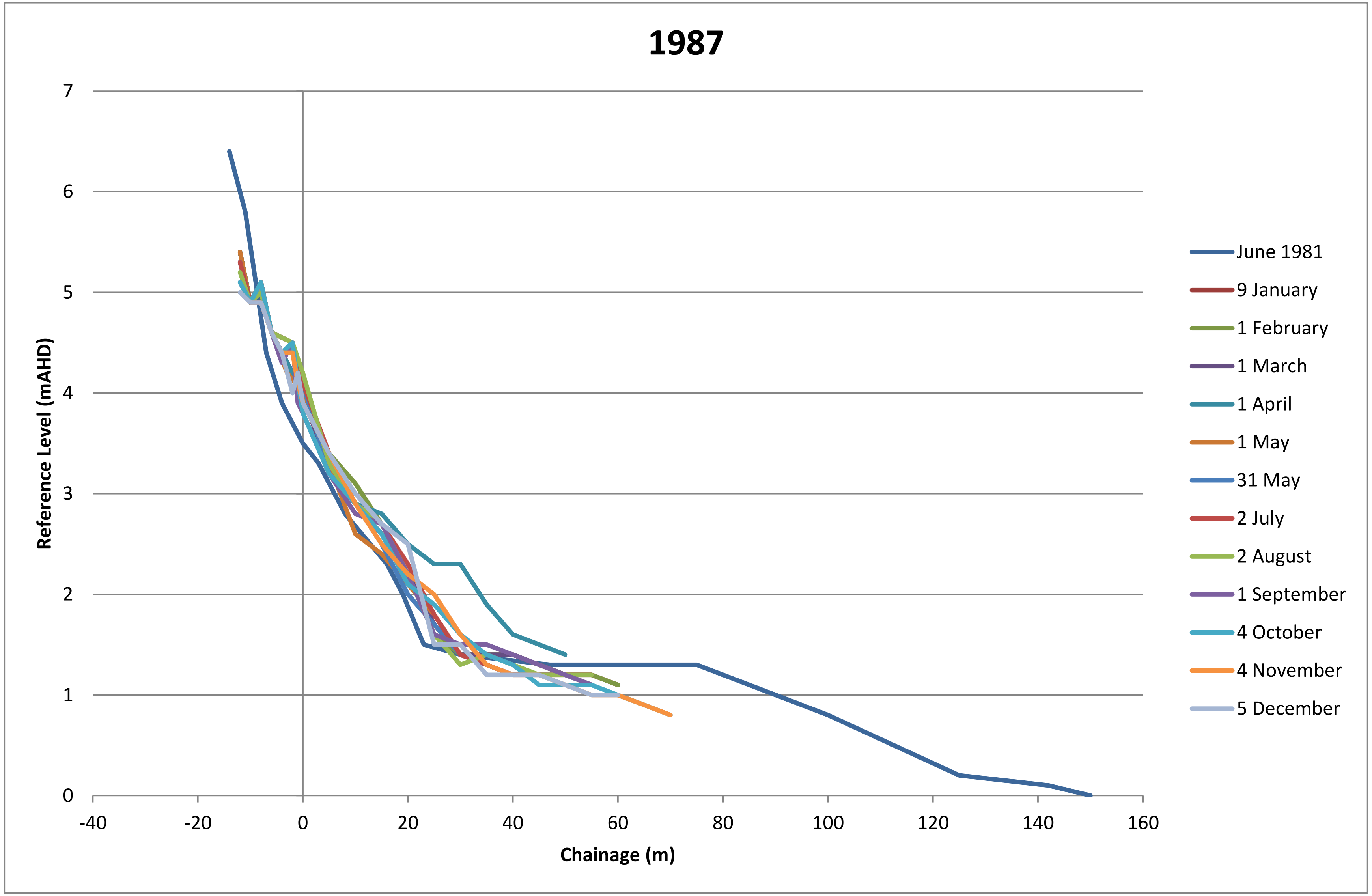


Figure 78 Monthly beach profile – 1987

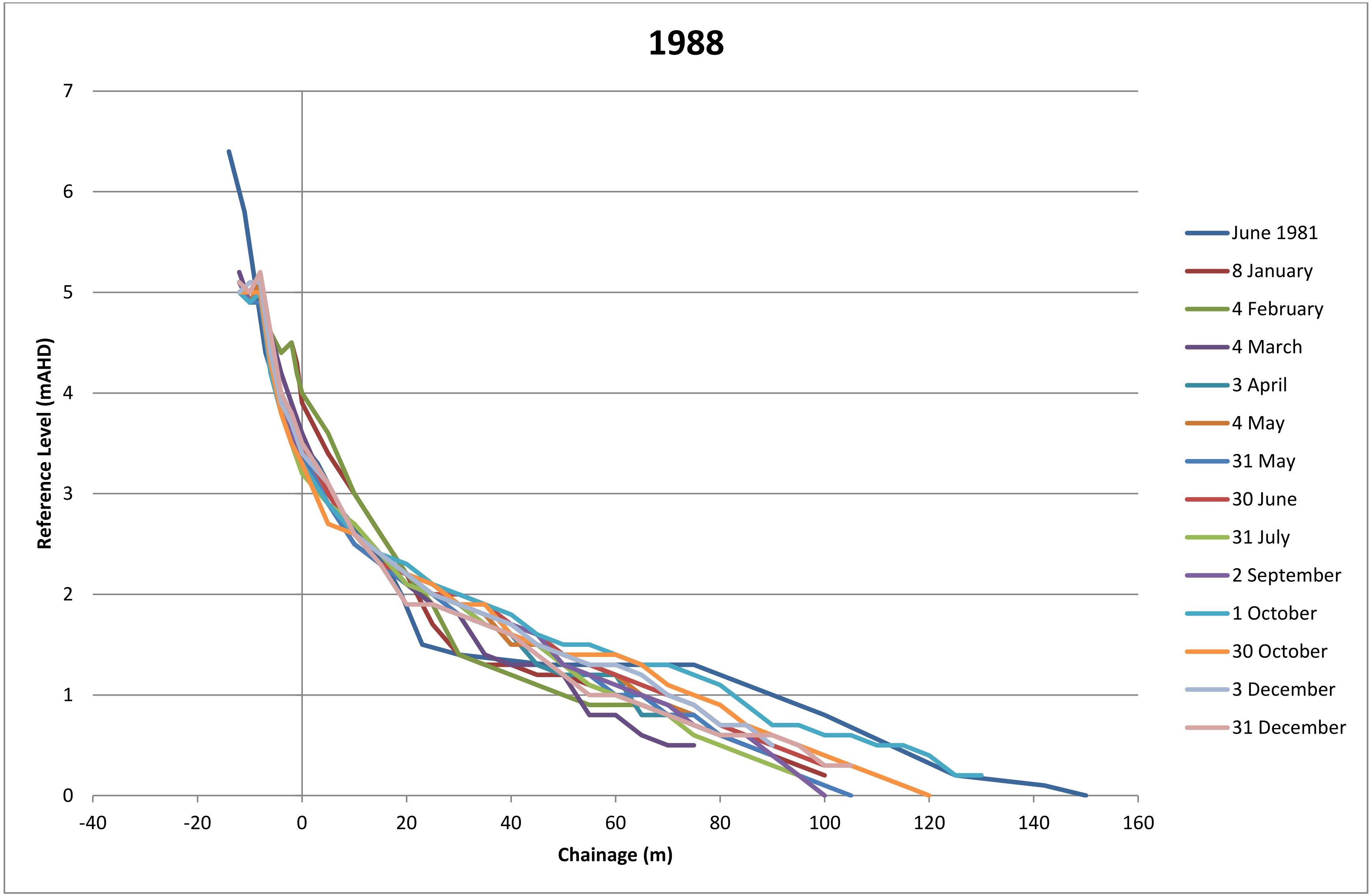


Figure 79 Monthly beach profile – 1988

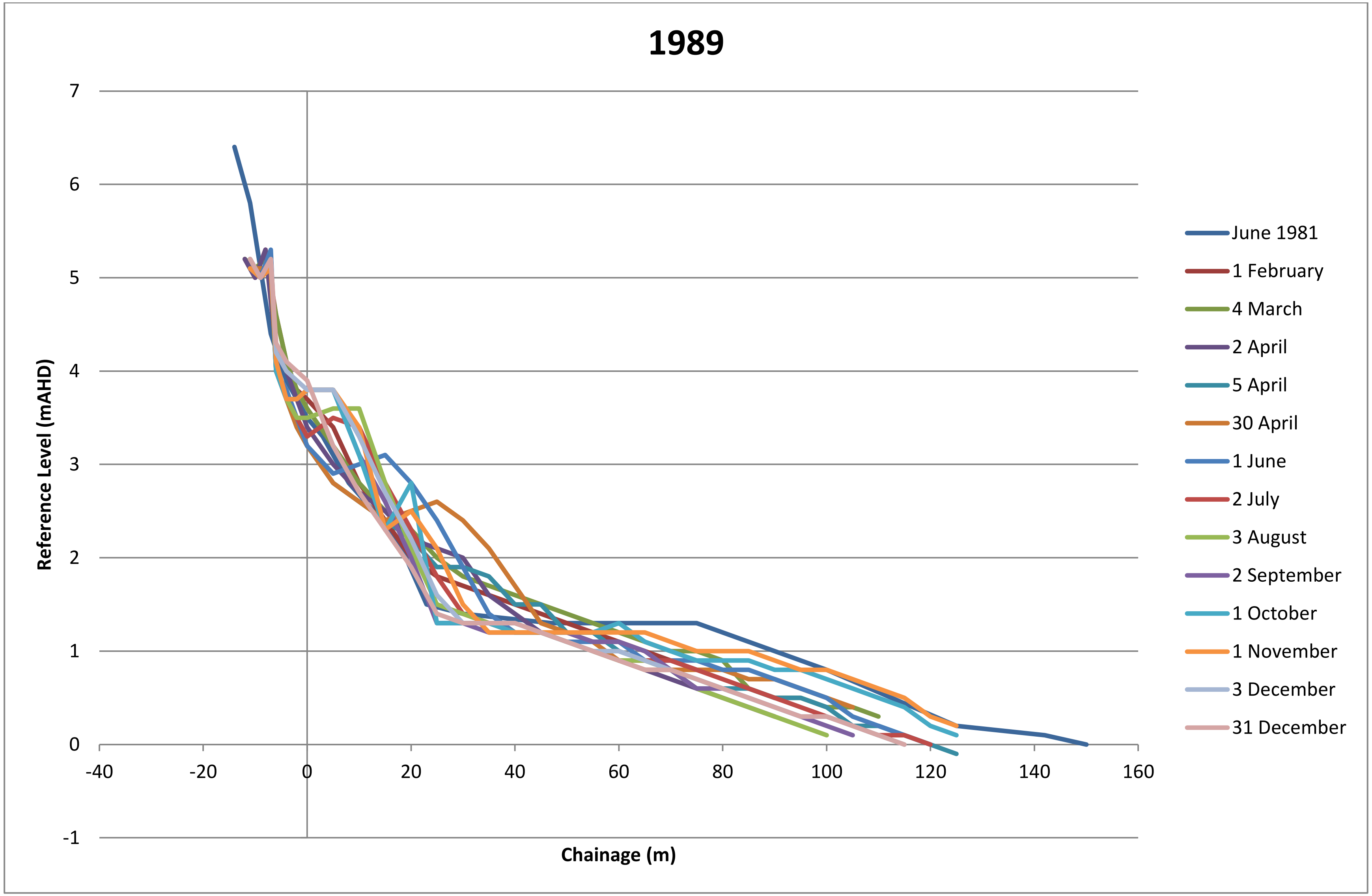


Figure 80 Monthly beach profile – 1989

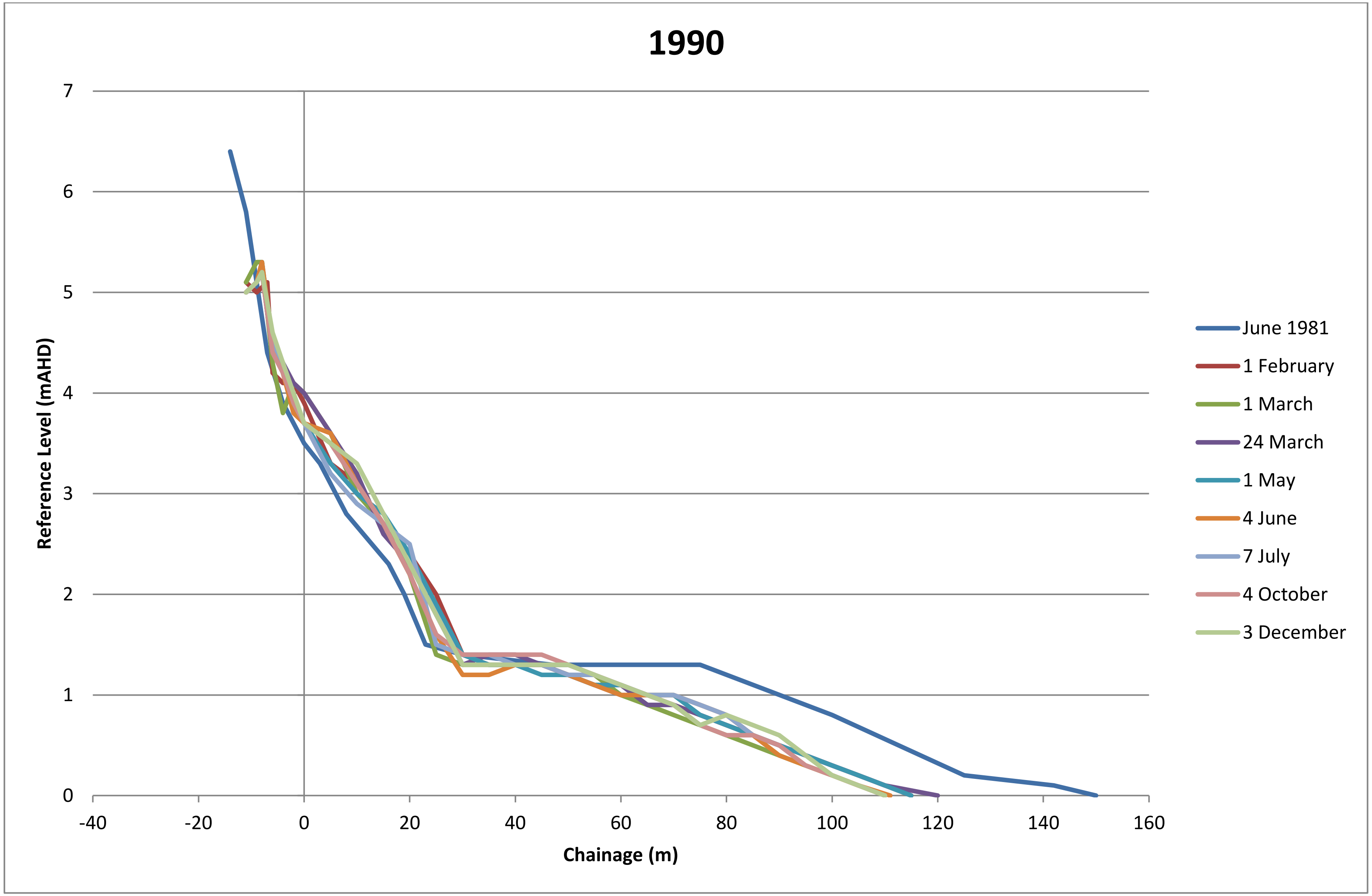


Figure 81 Monthly beach profile – 1990

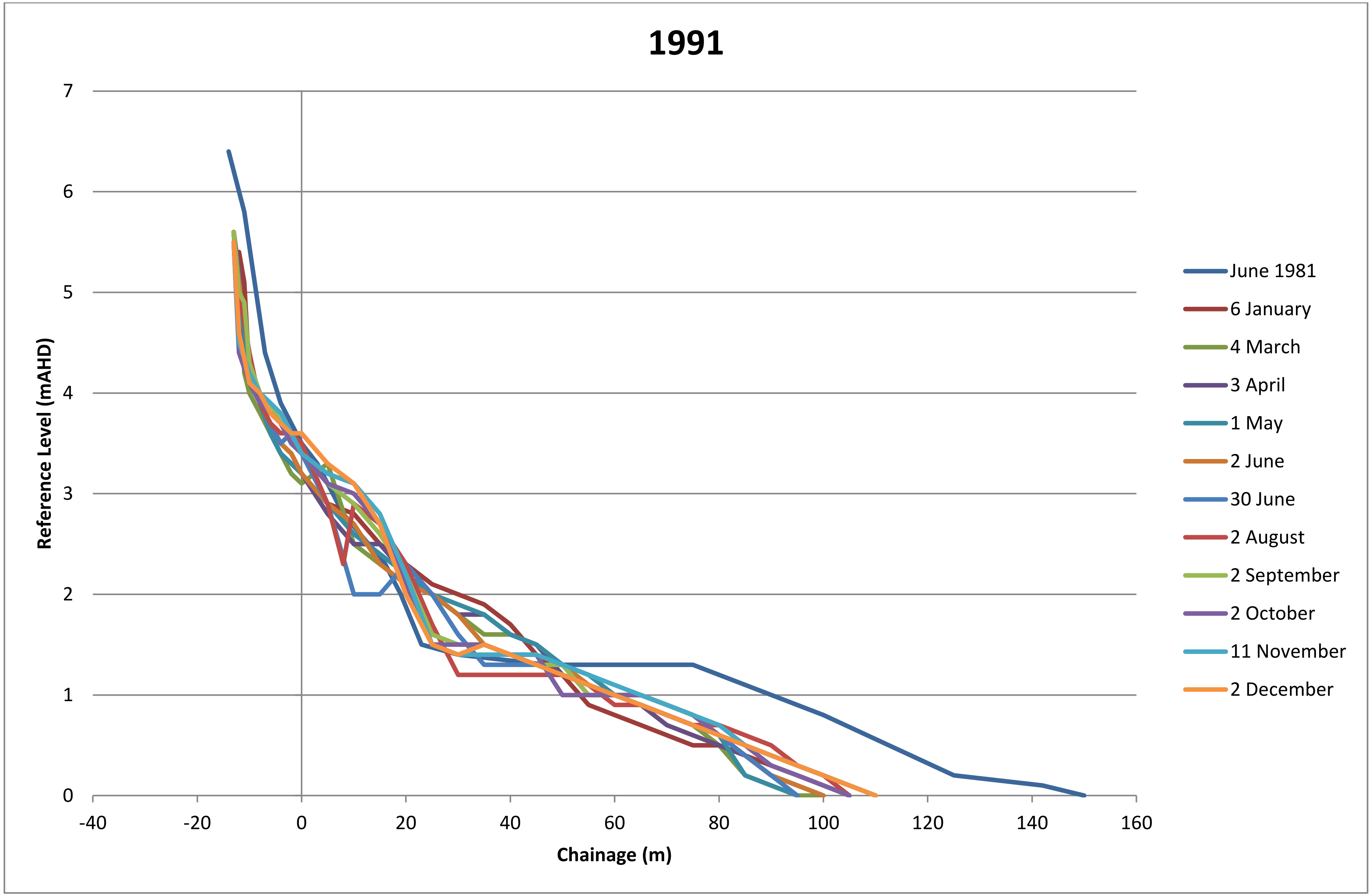


Figure 82 Monthly beach profile – 1991

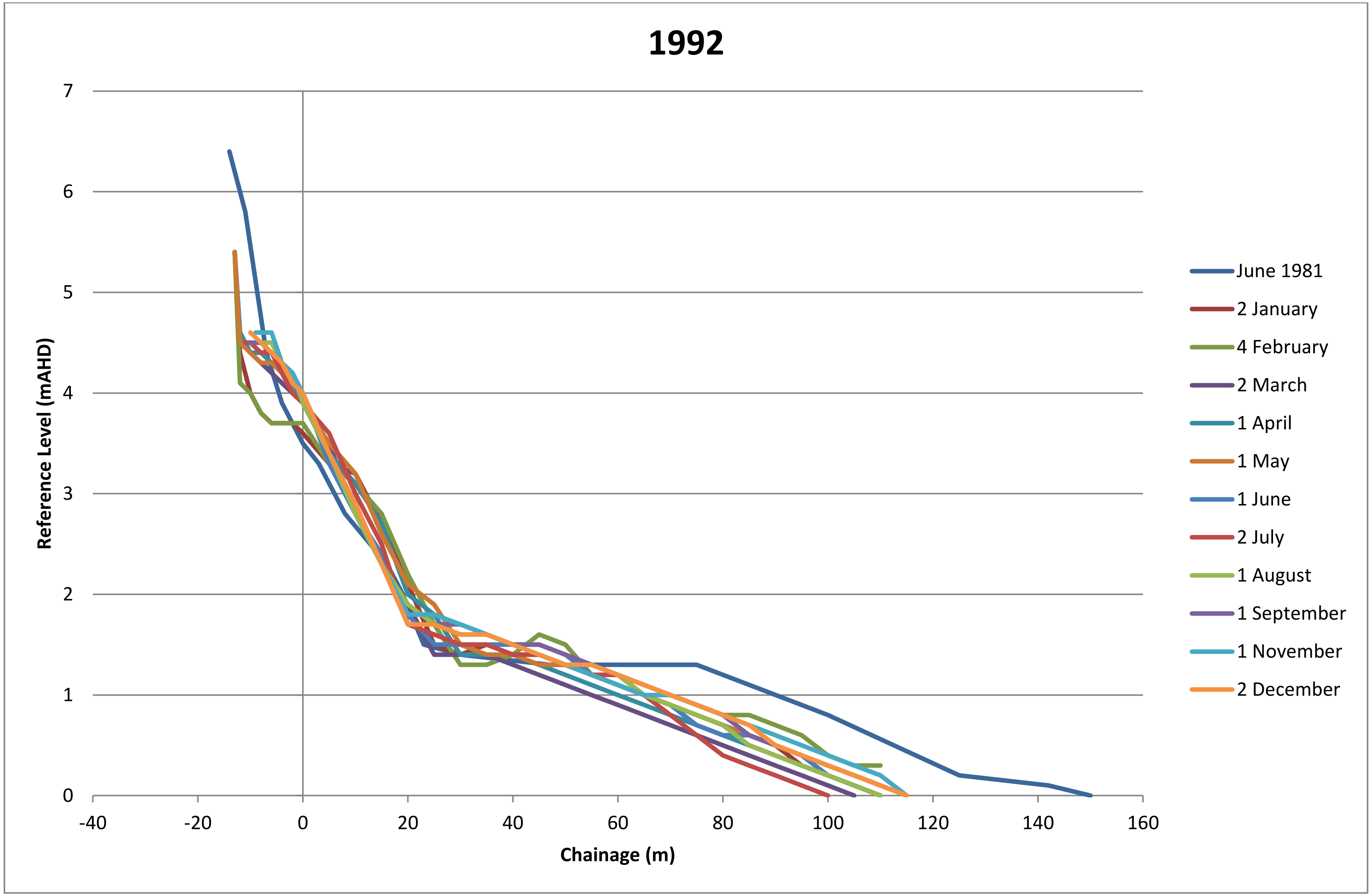


Figure 83 Monthly beach profile – 1992

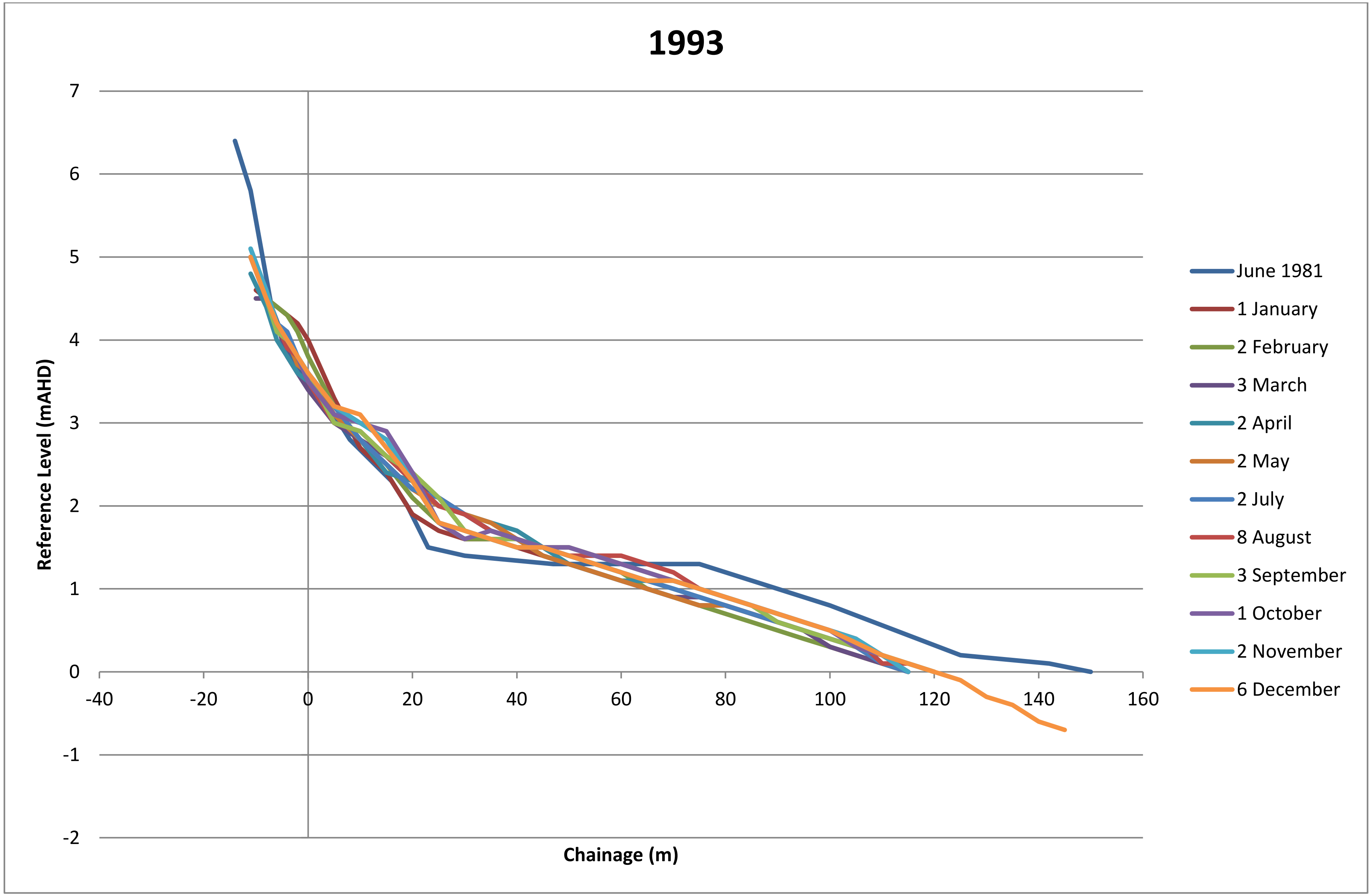


Figure 84 Monthly beach profile – 1993

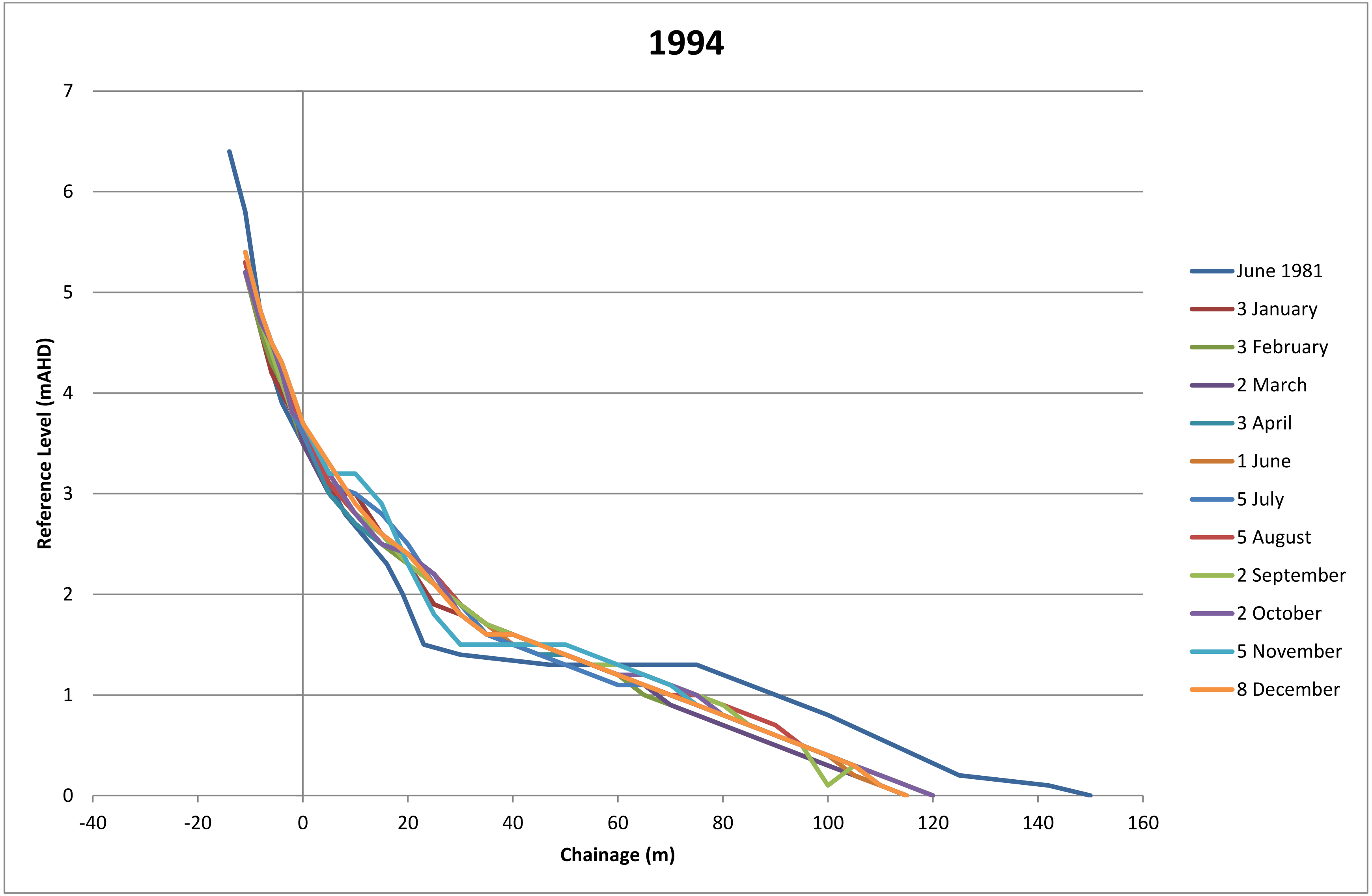


Figure 85 Monthly beach profile – 1994

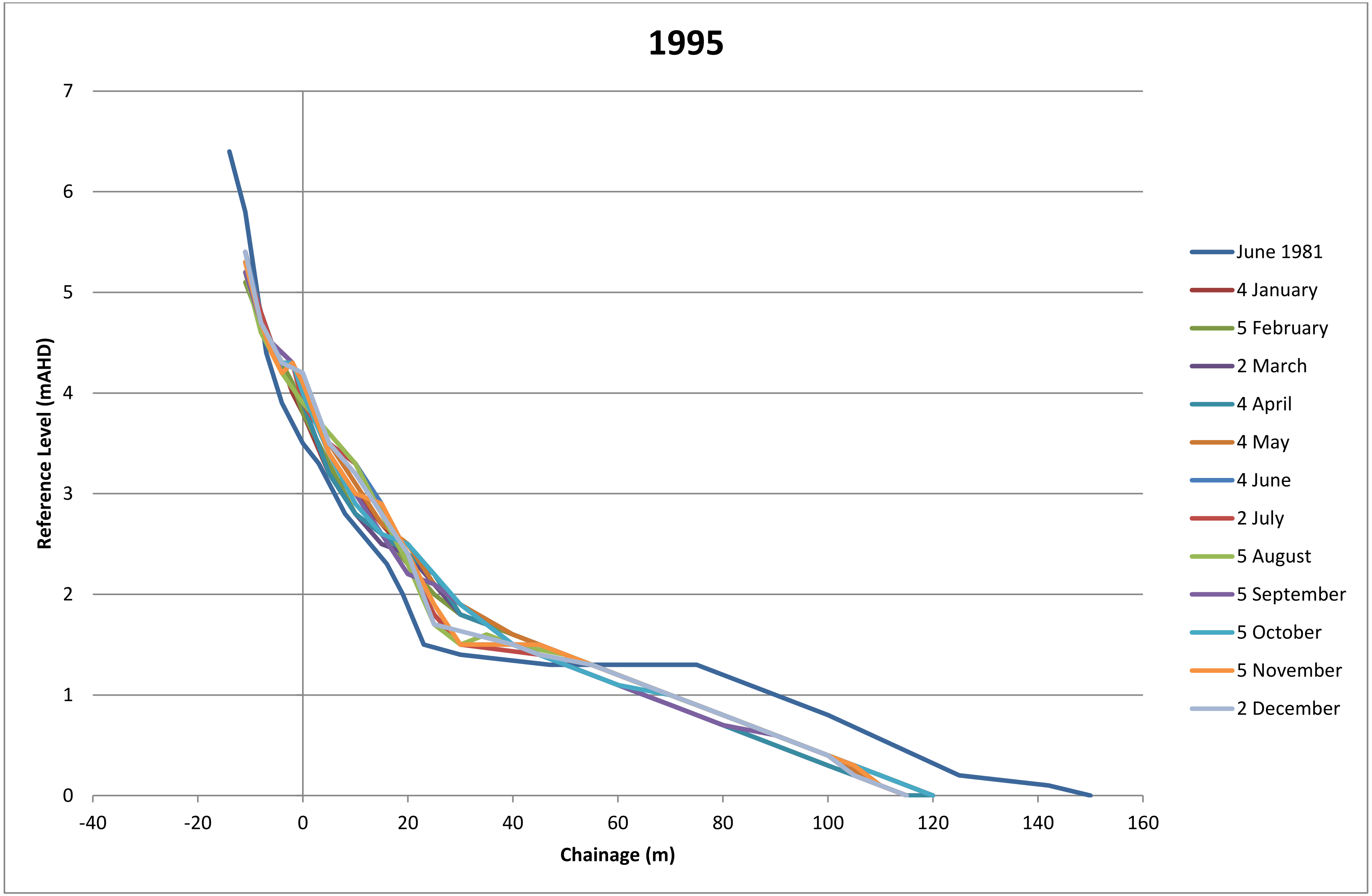


Figure 86 Monthly beach profile – 1995

Coastal Impacts Unit - Department of Science, Information Technology and Innovation
Sarina COPE Data Compilation

Job Number	41-28646
Revision	A
Date	29 April 2014

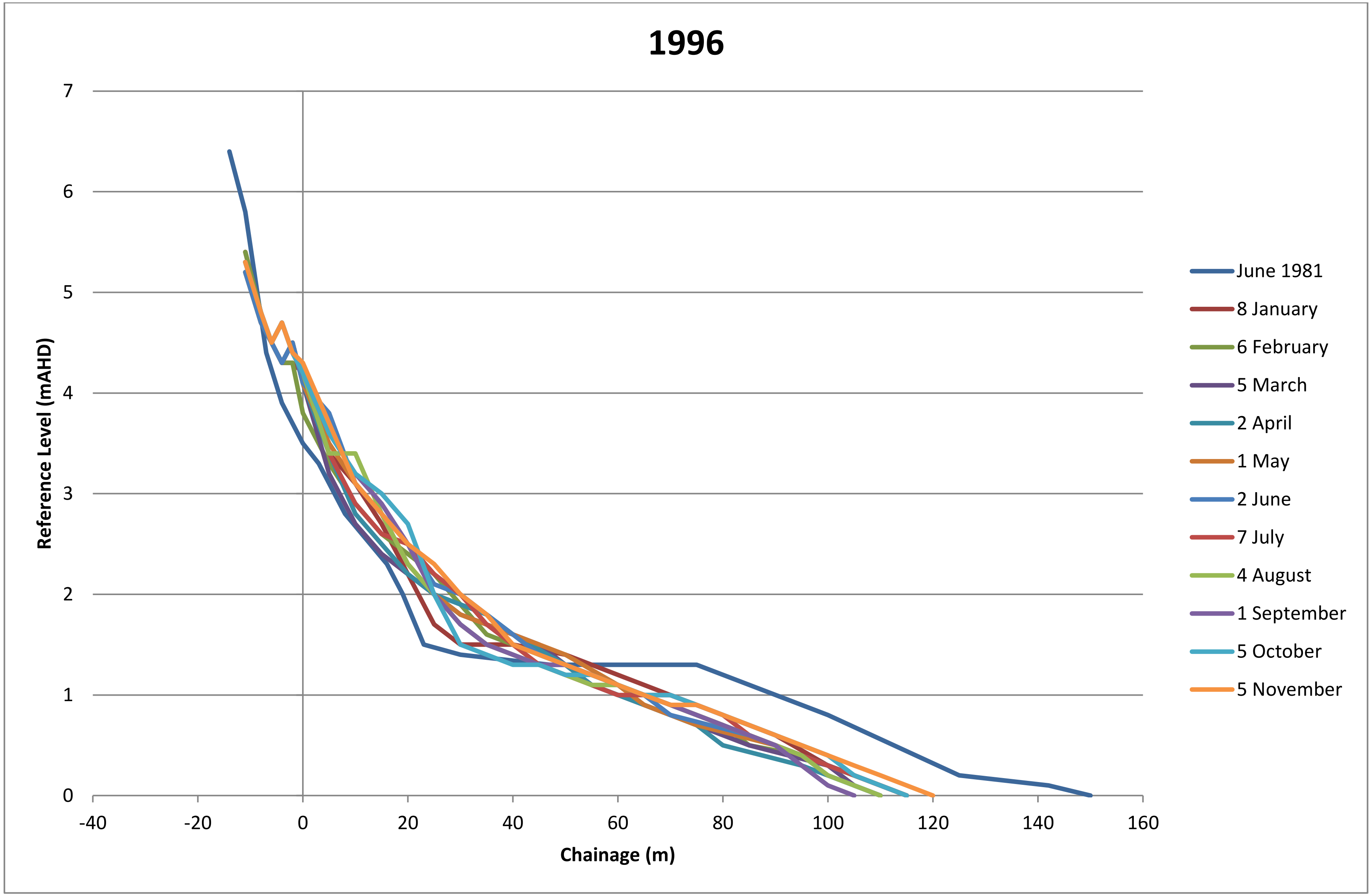


Figure 87 Monthly beach profile – 1996

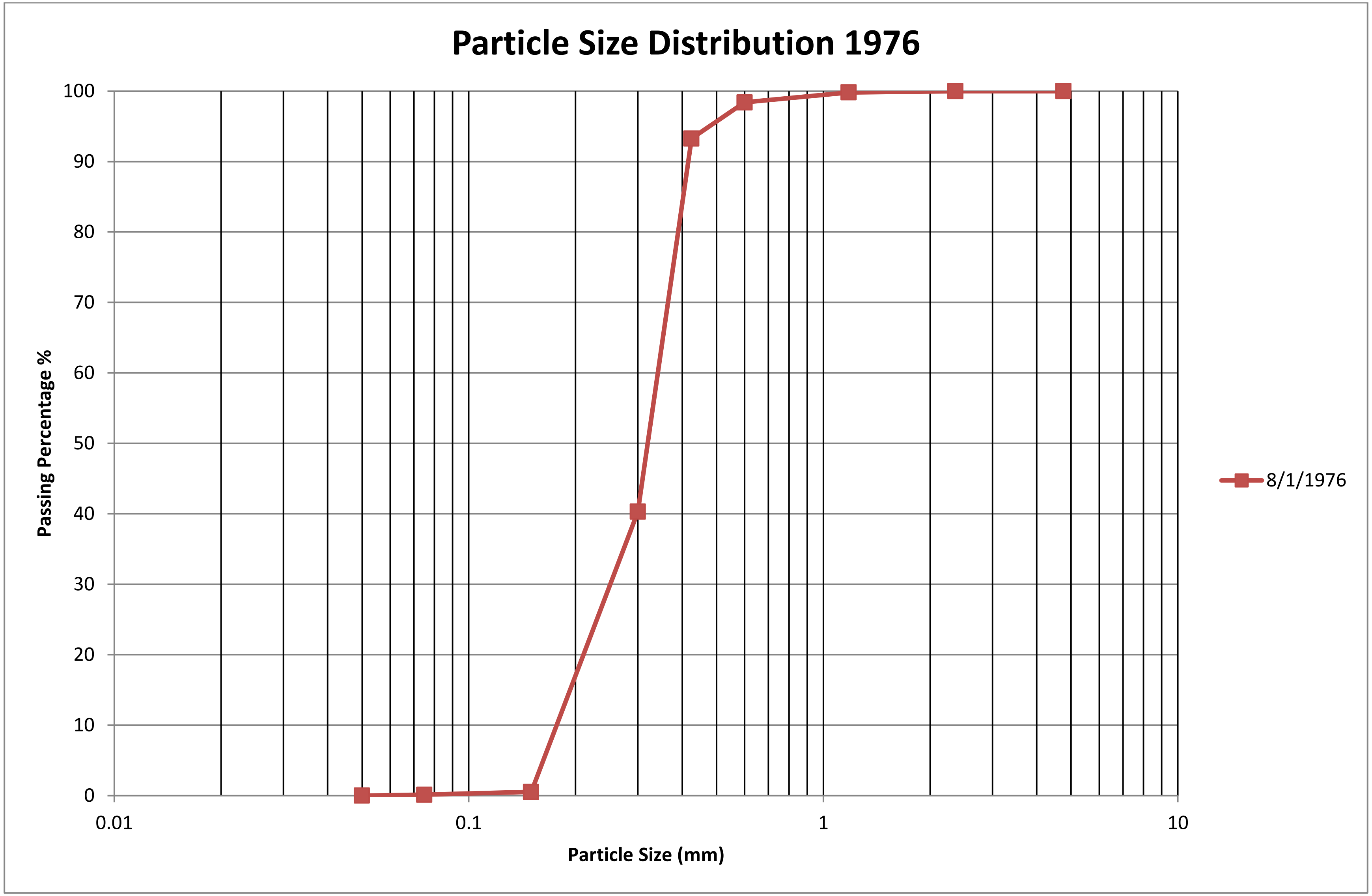


Figure 88 Particle size distribution 1976

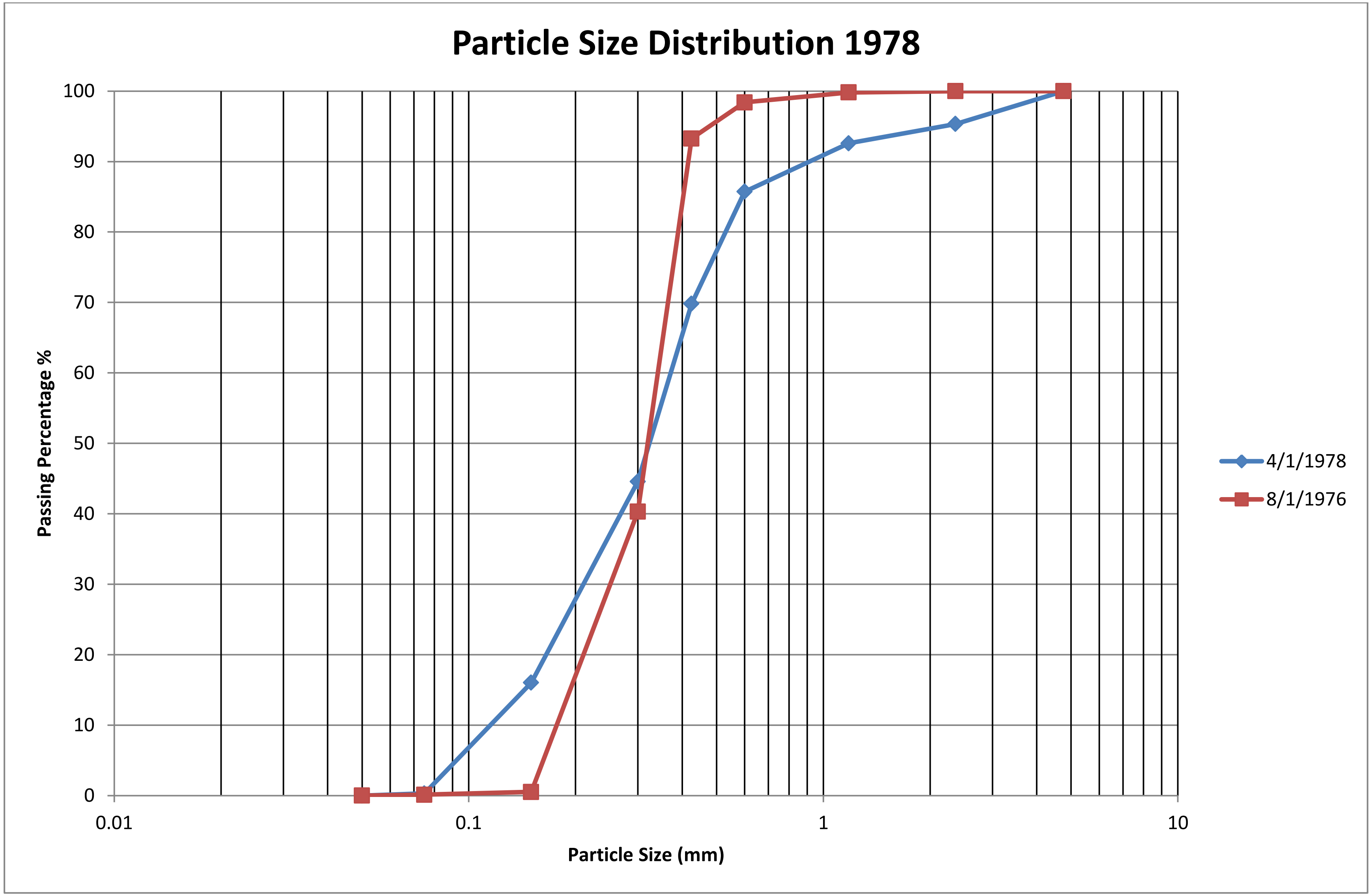


Figure 89 Particle size distribution 1978

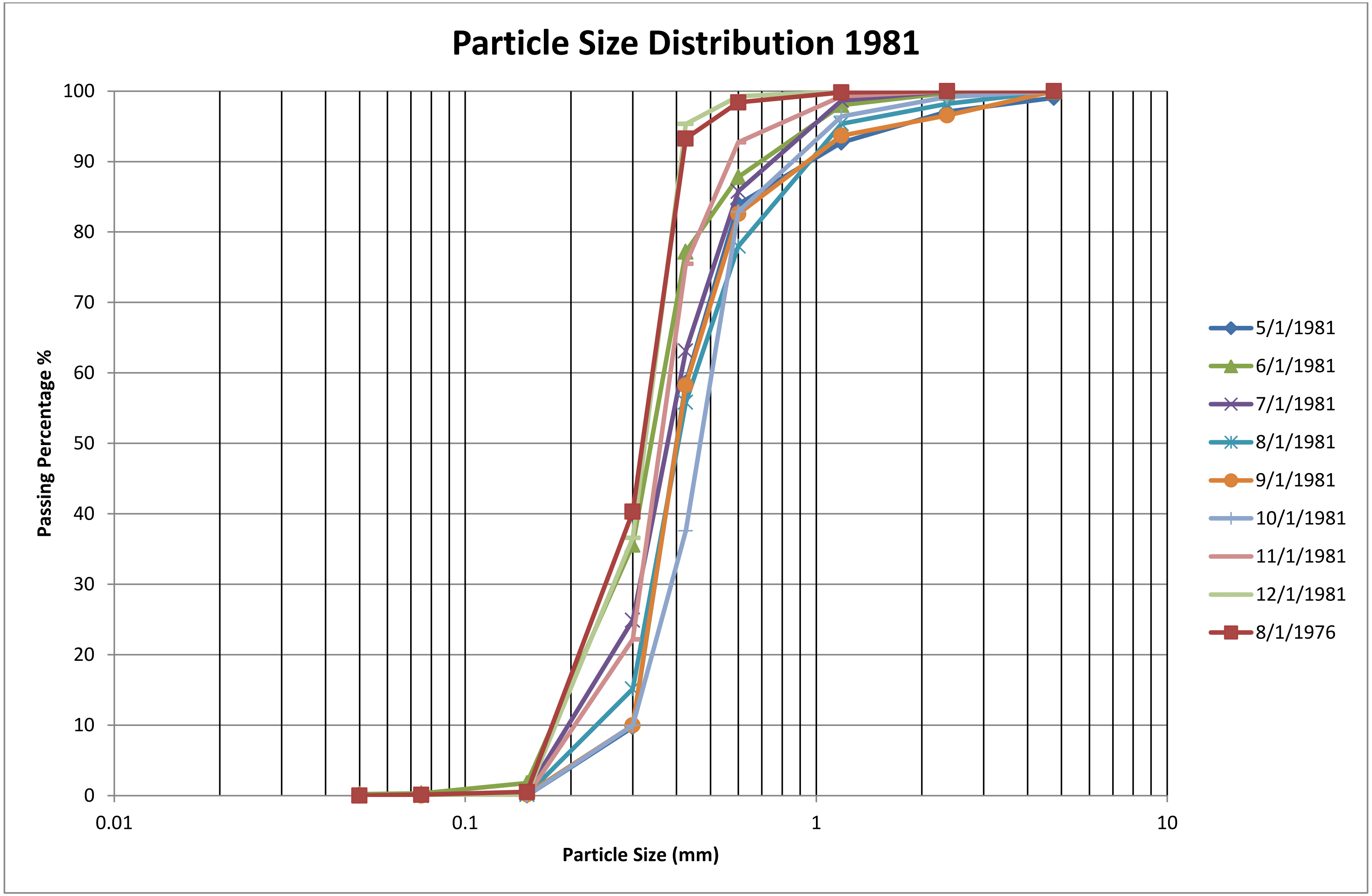


Figure 90 **Particle size distribution 1981**

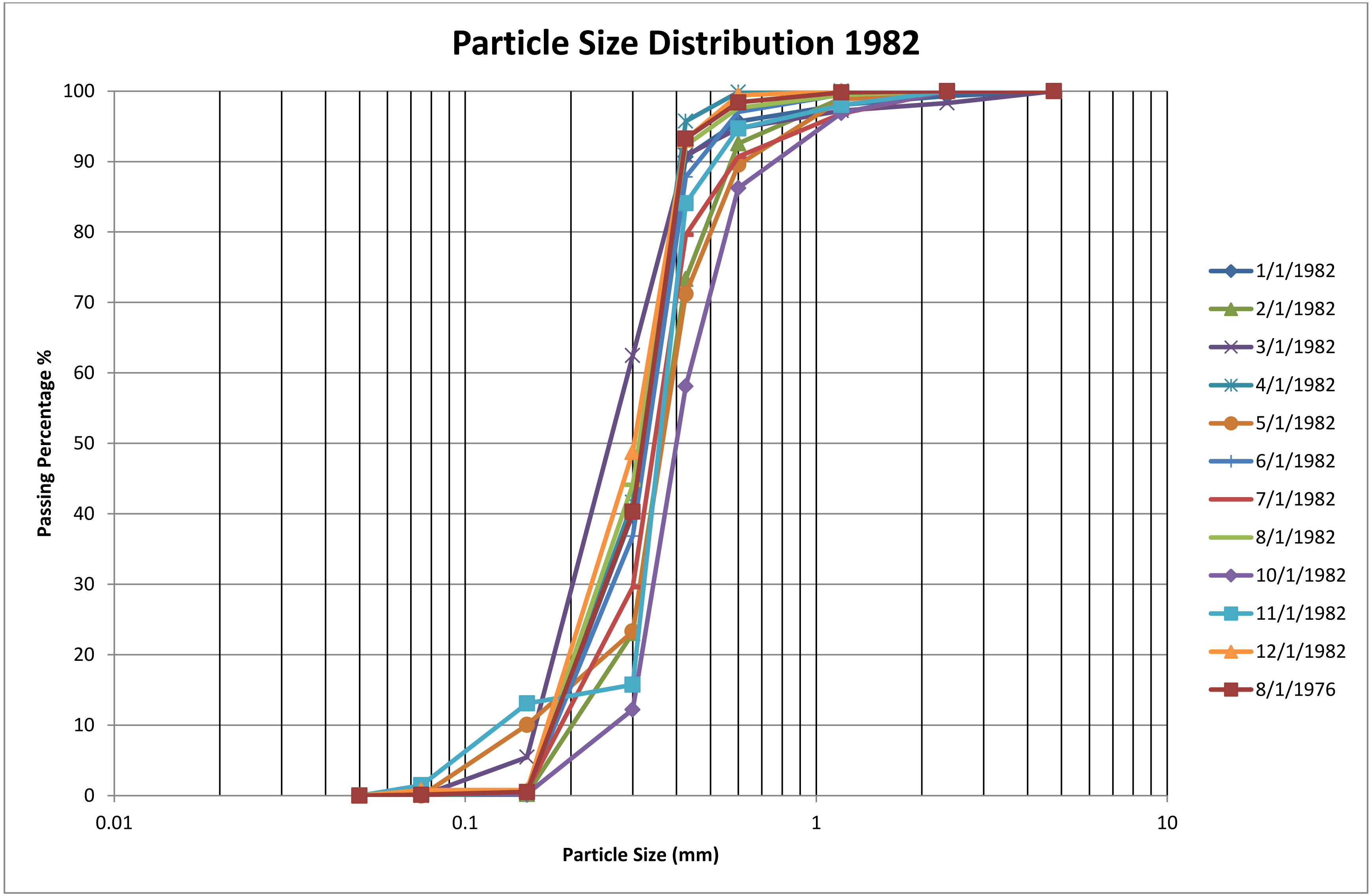


Figure 91 Particle size distribution 1982

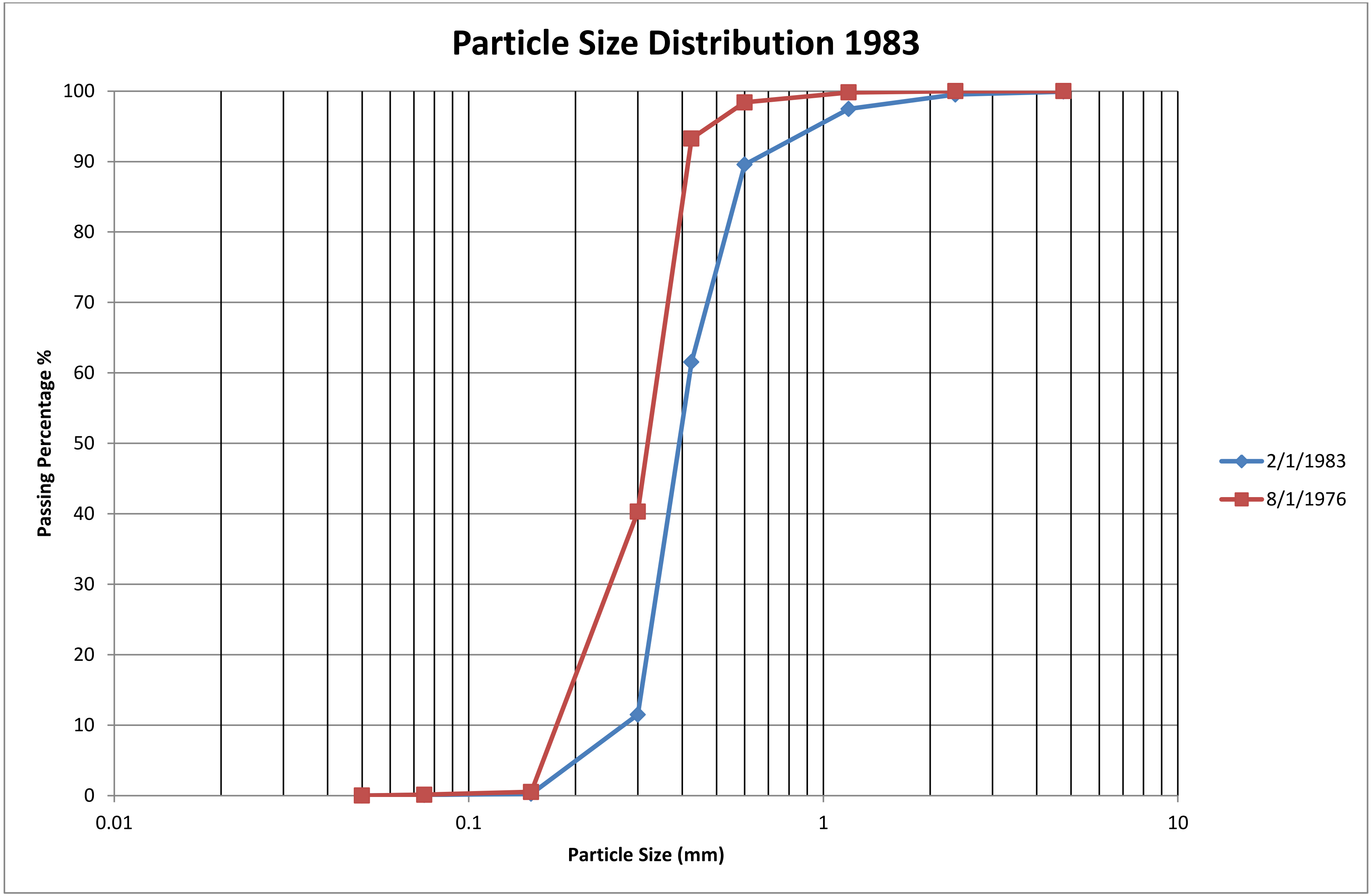


Figure 92 Particle size distribution 1983

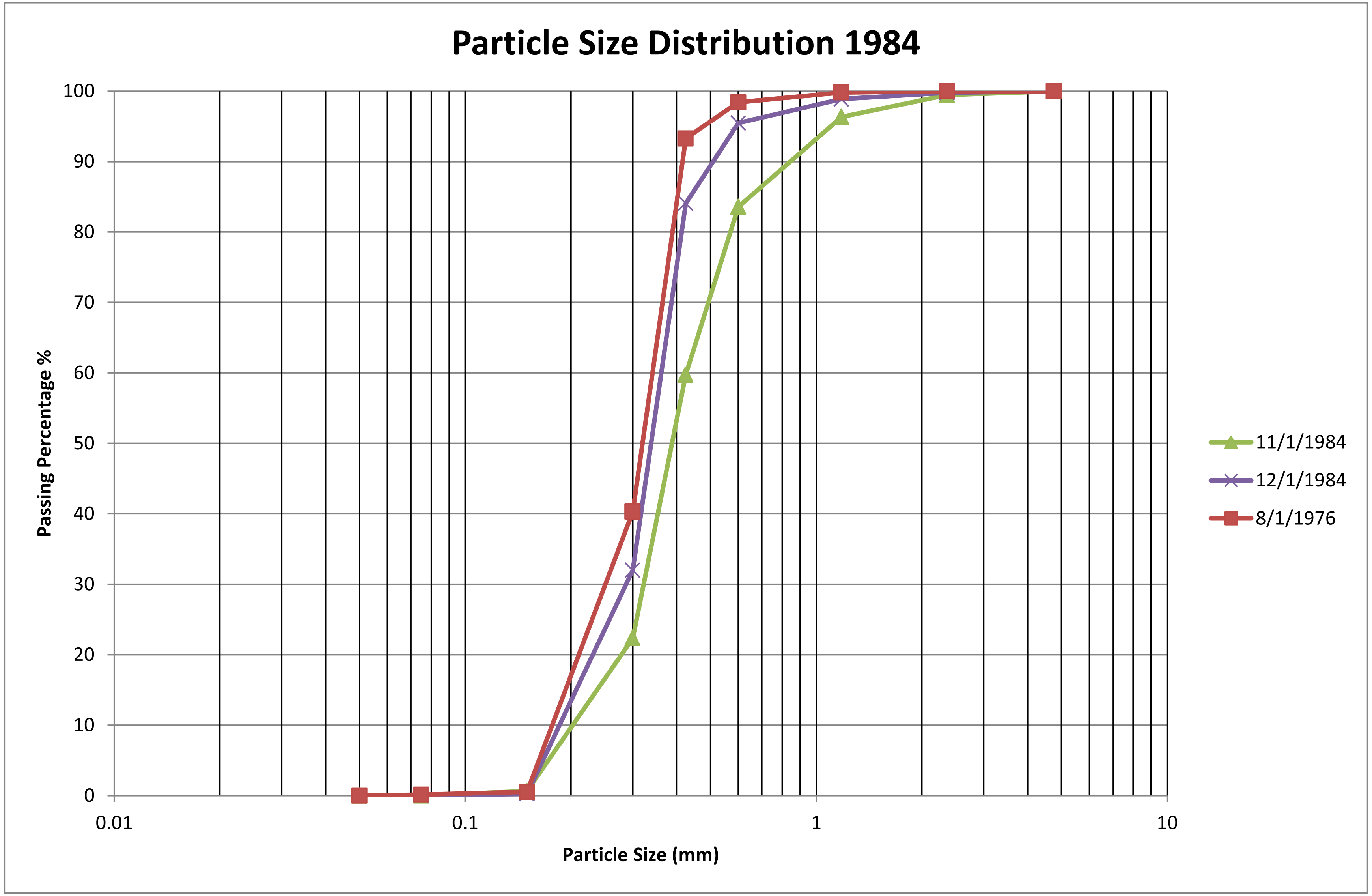


Figure 93 Particle size distribution 1984

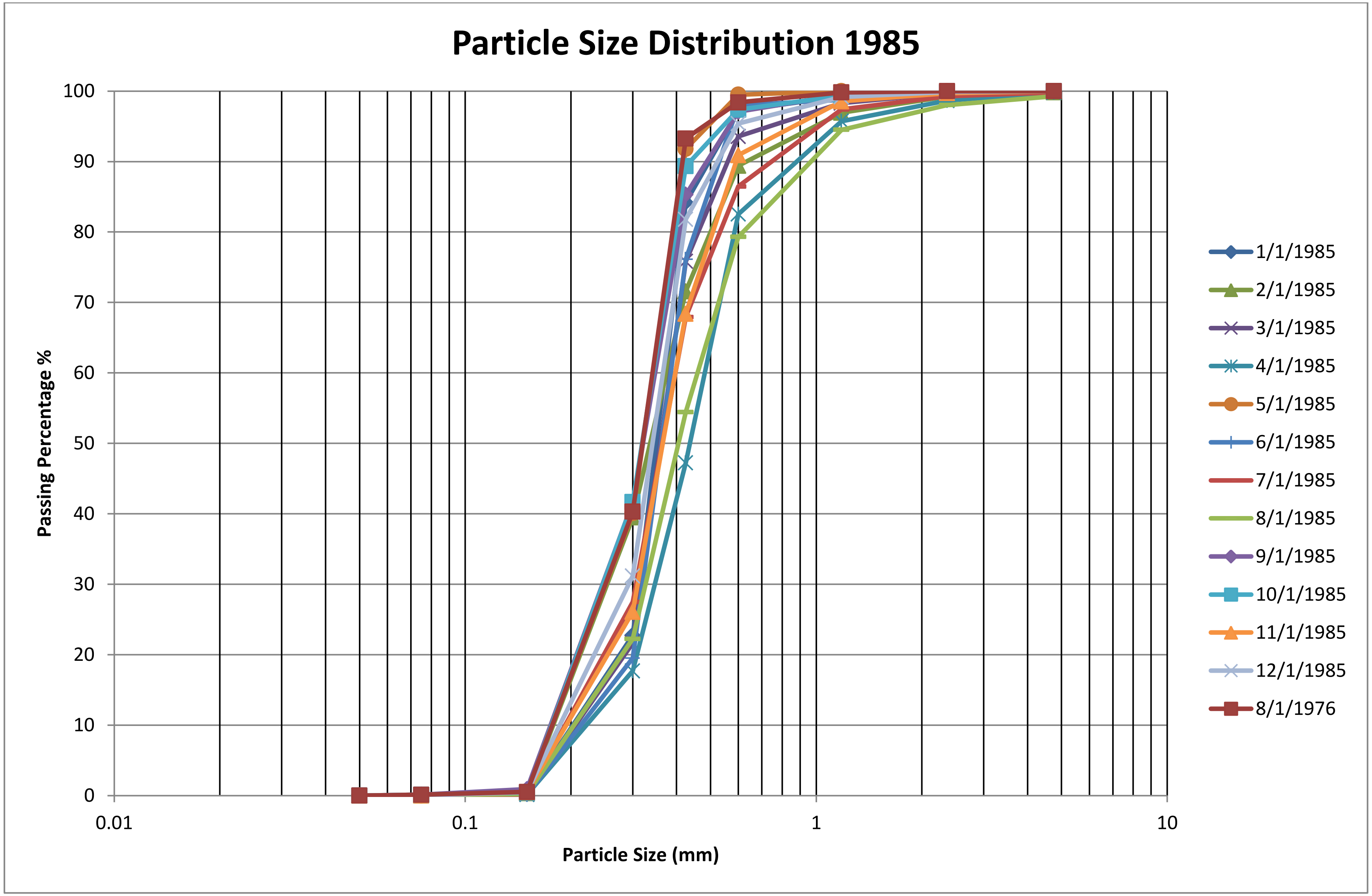


Figure 94 Particle size distribution 1985

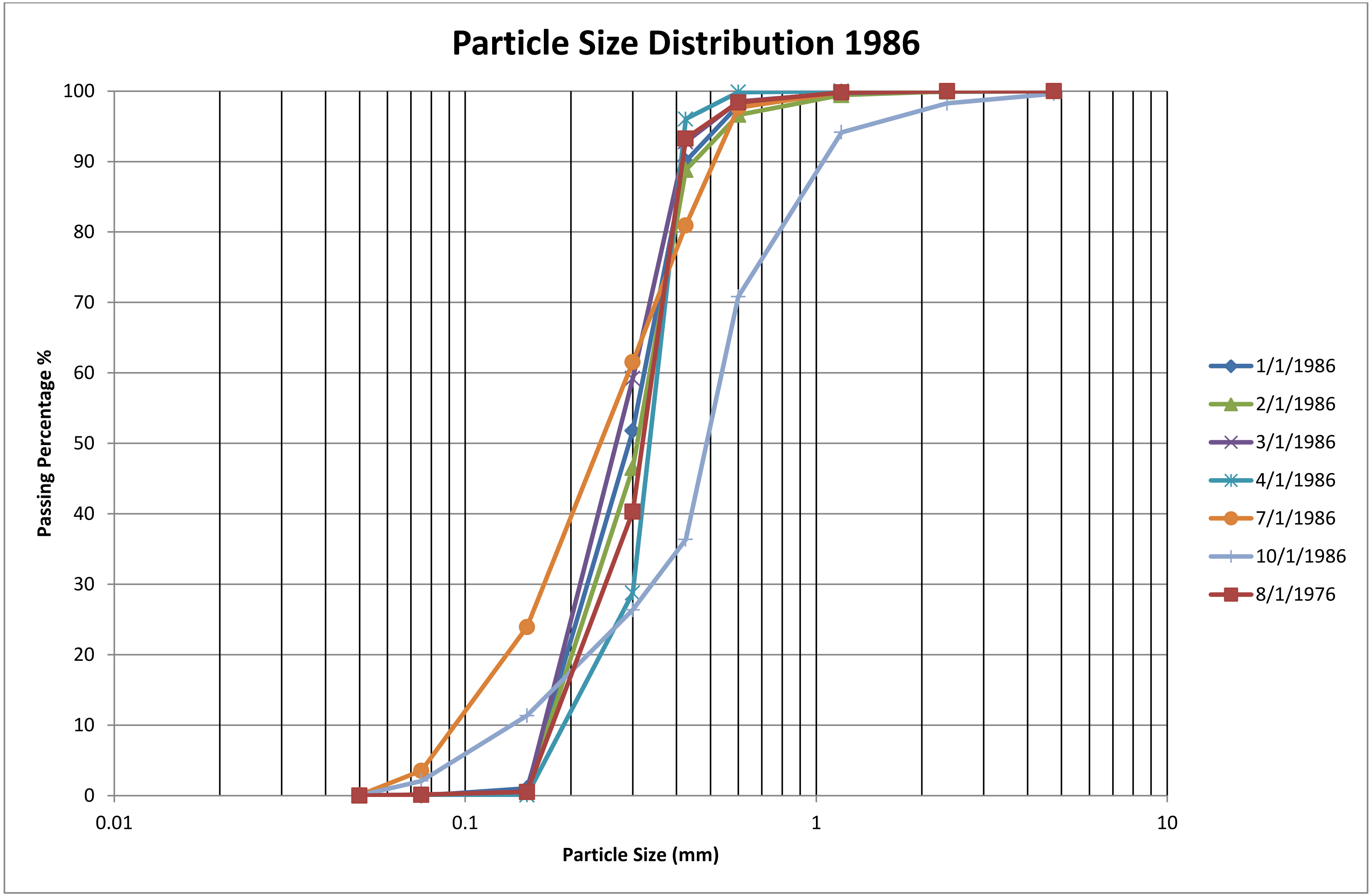


Figure 95 Particle size distribution 1986

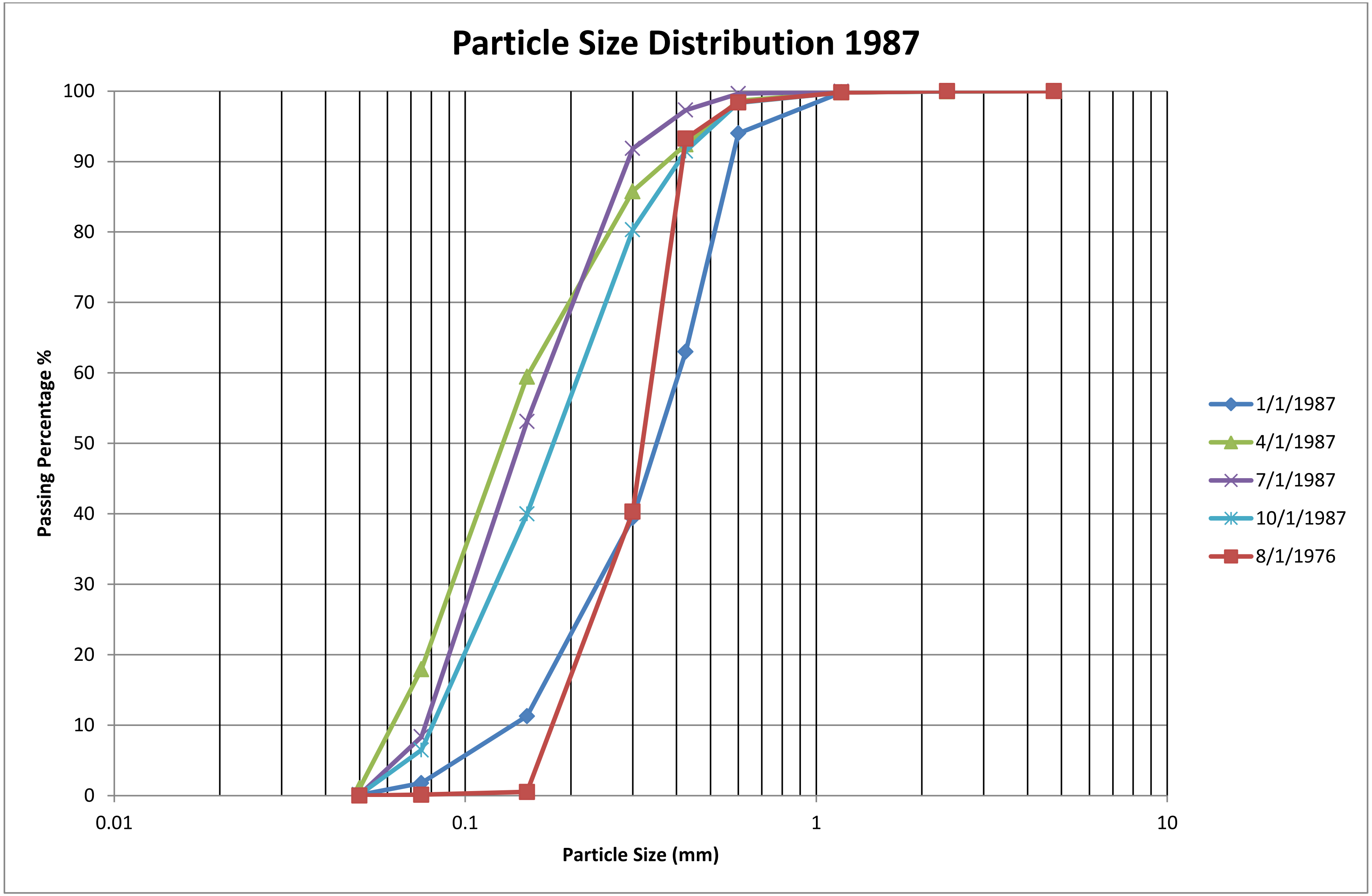


Figure 96 Particle size distribution 1987

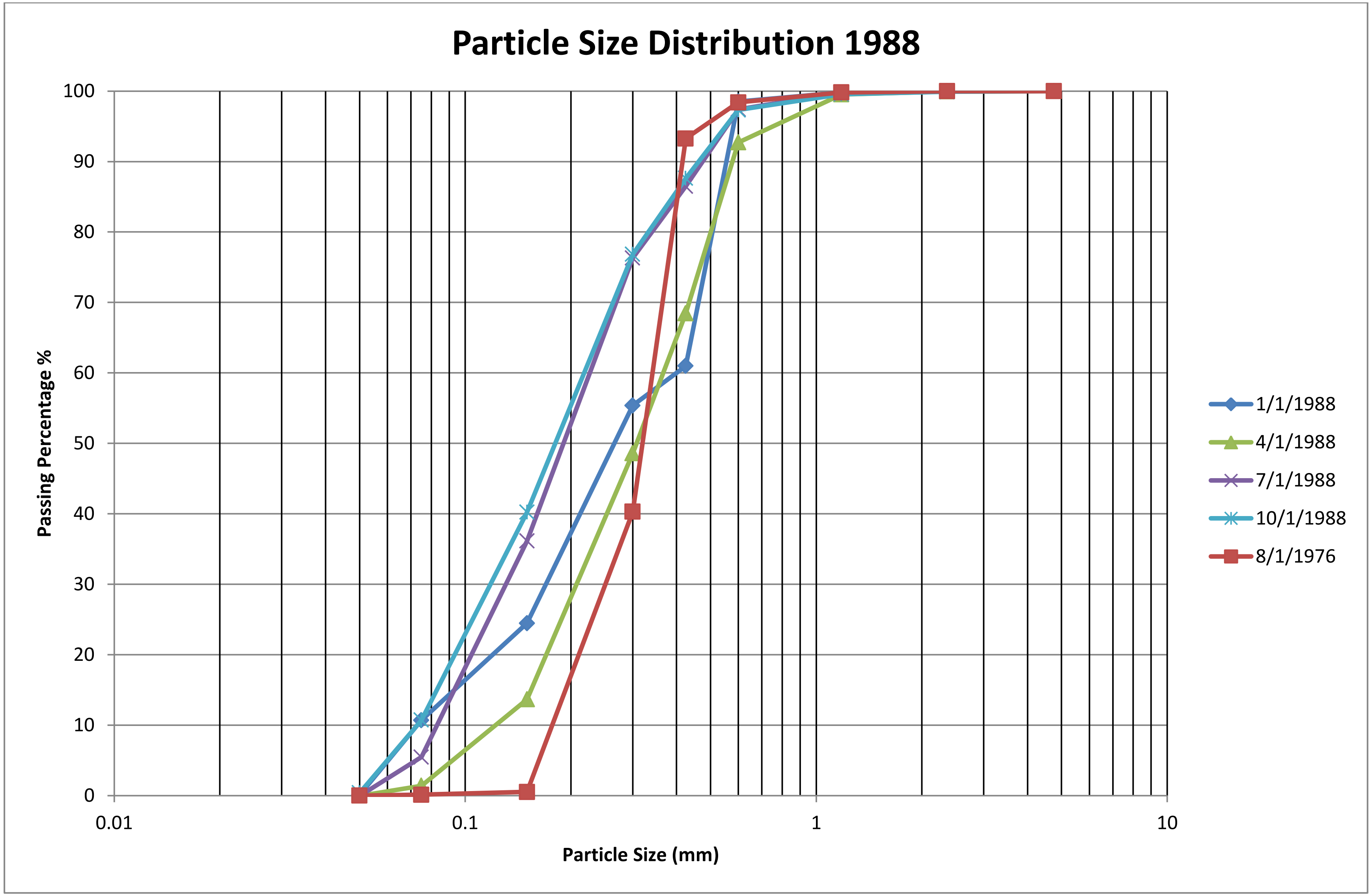


Figure 97 Particle size distribution 1988

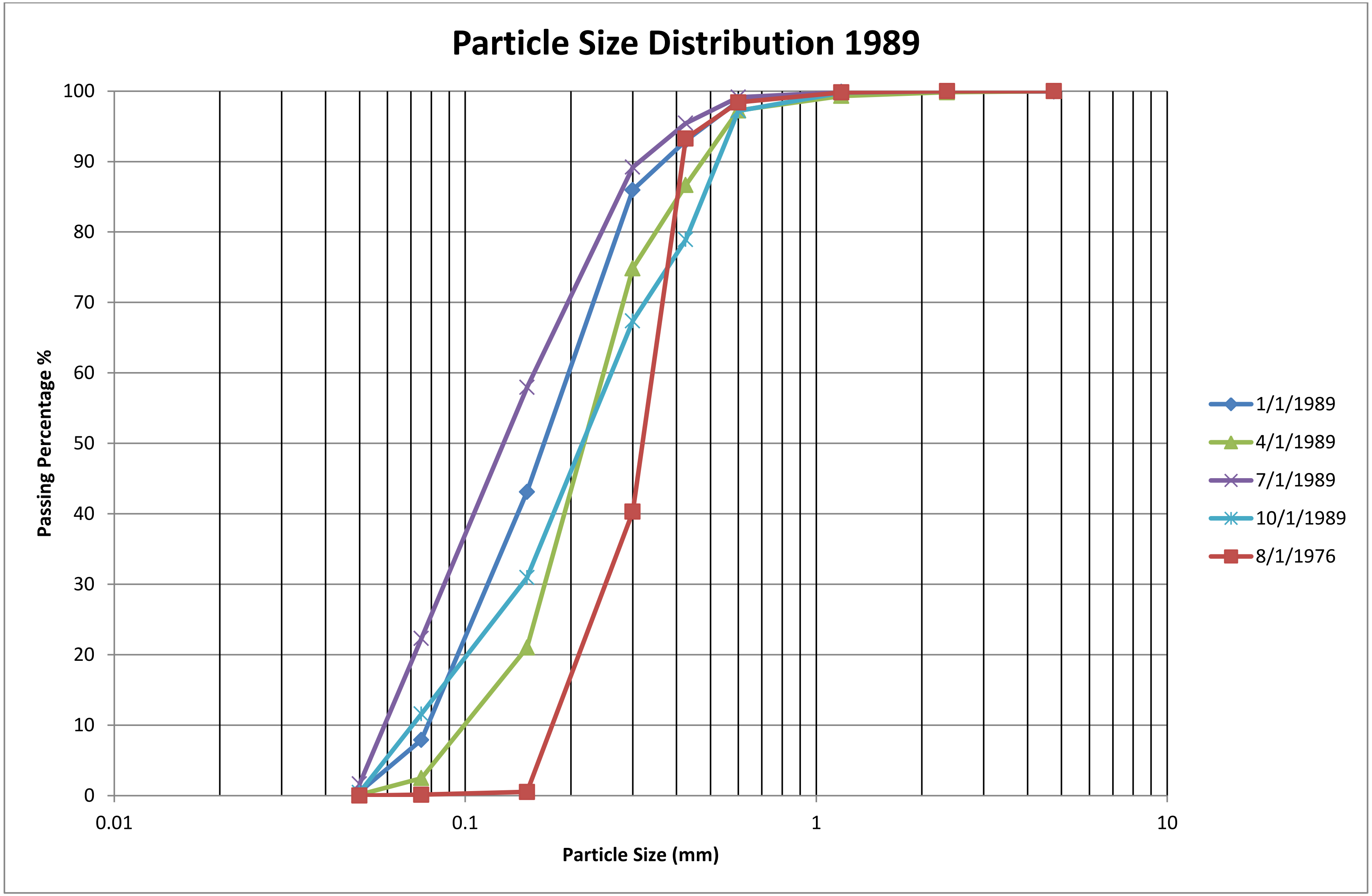


Figure 98 Particle size distribution 1989

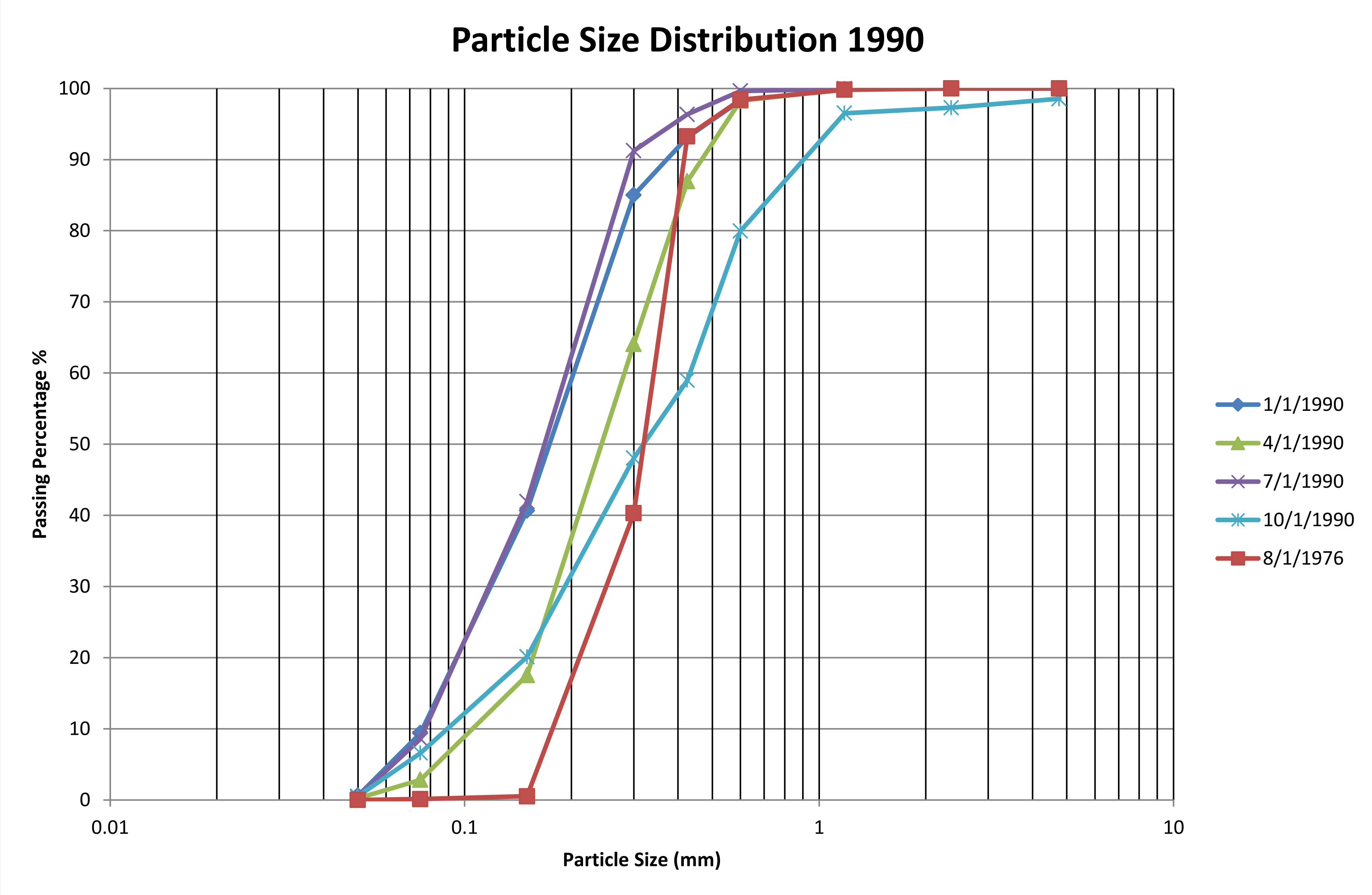


Figure 99 Particle size distribution 1990

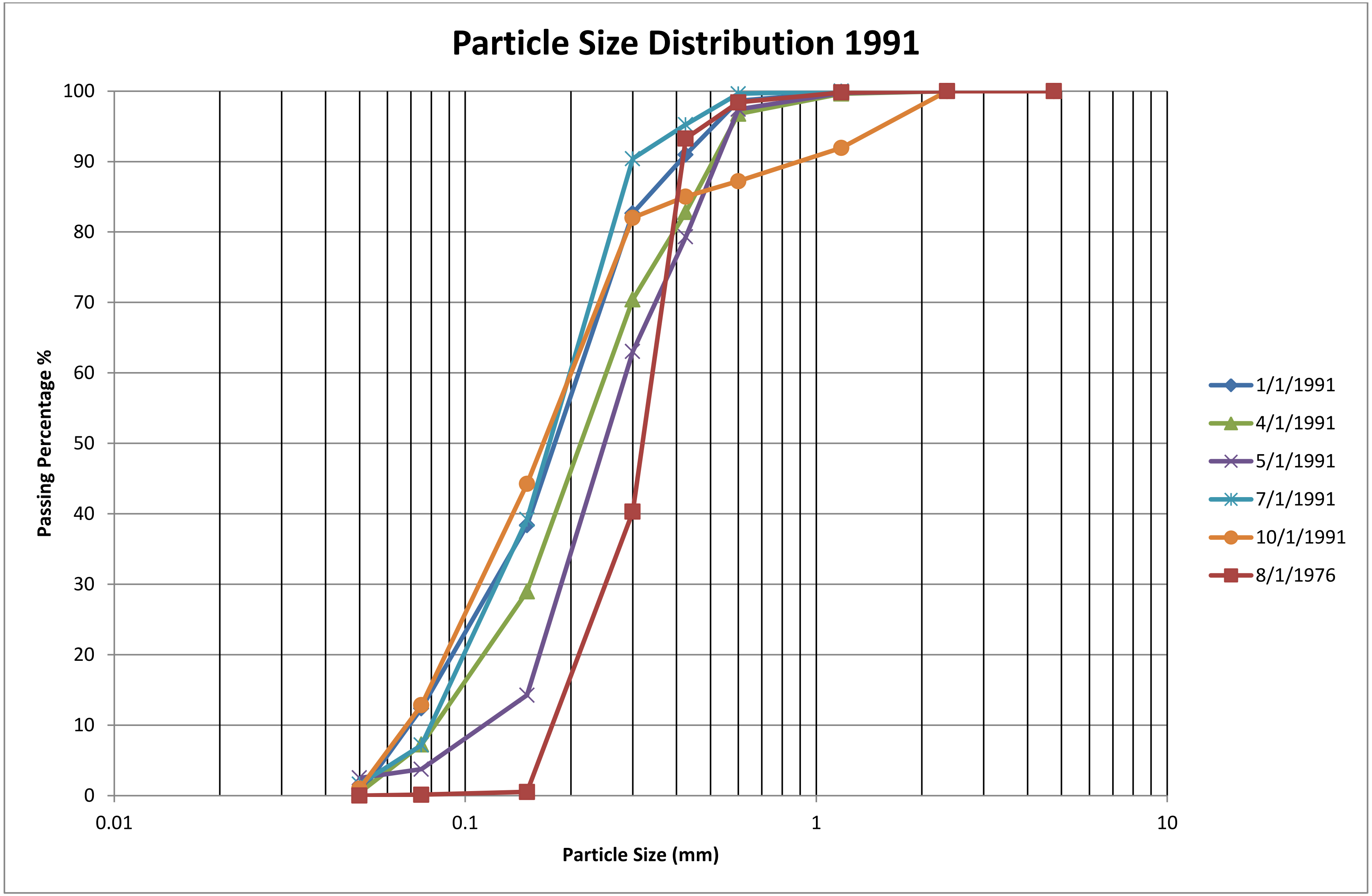


Figure 100 Particle size distribution 1991

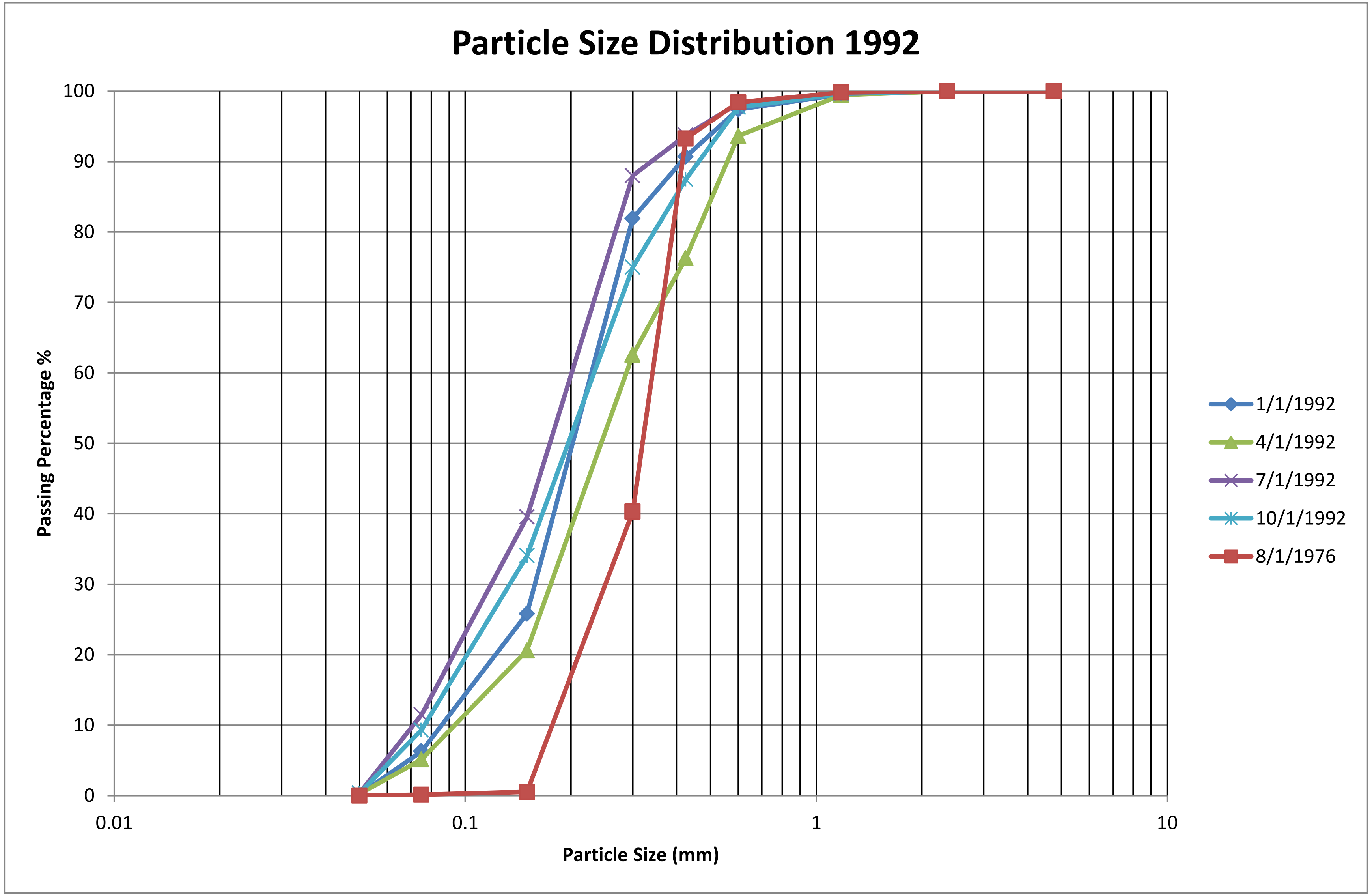


Figure 101 Particle size distribution 1992

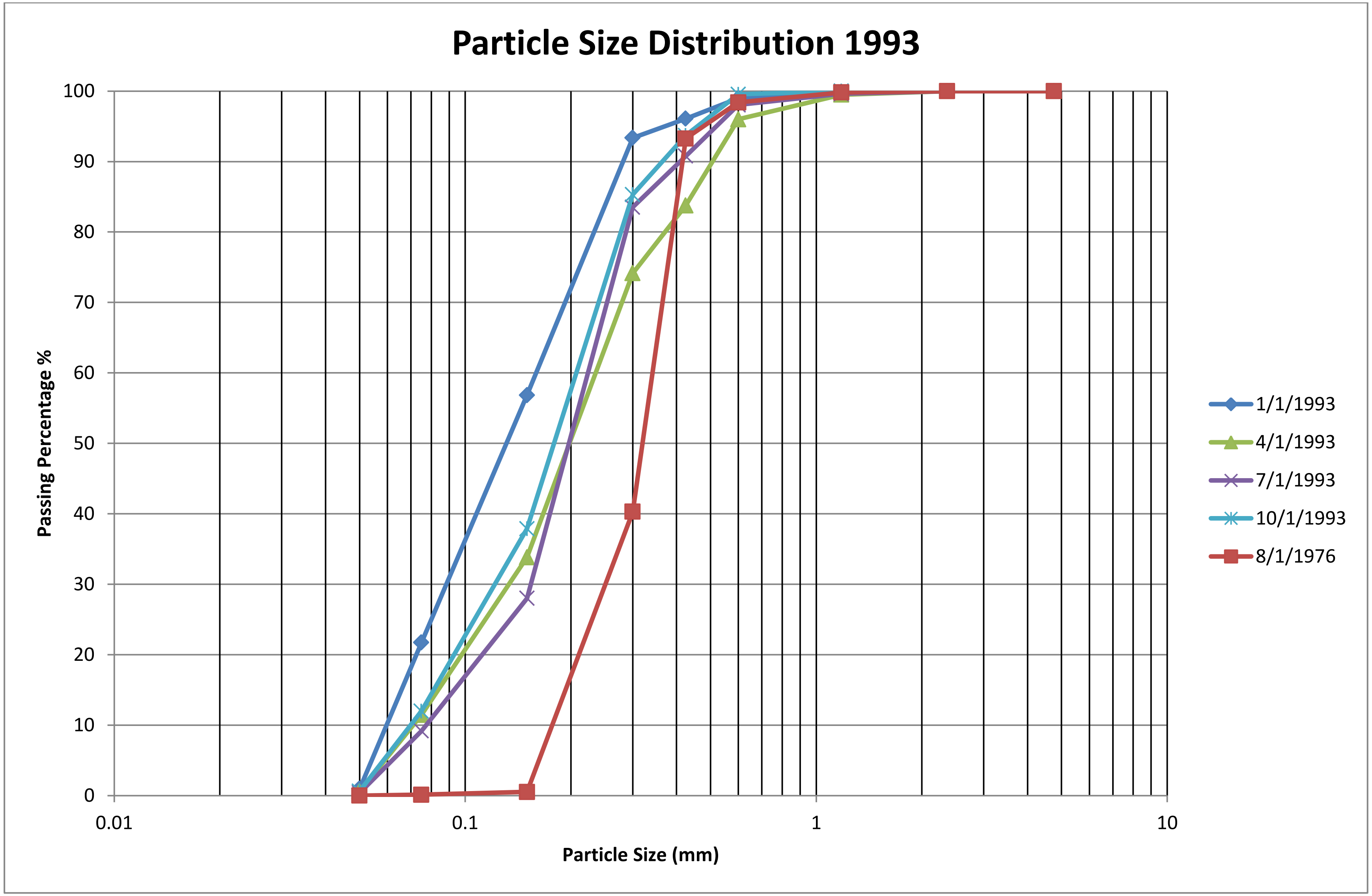


Figure 102 Particle size distribution 1993

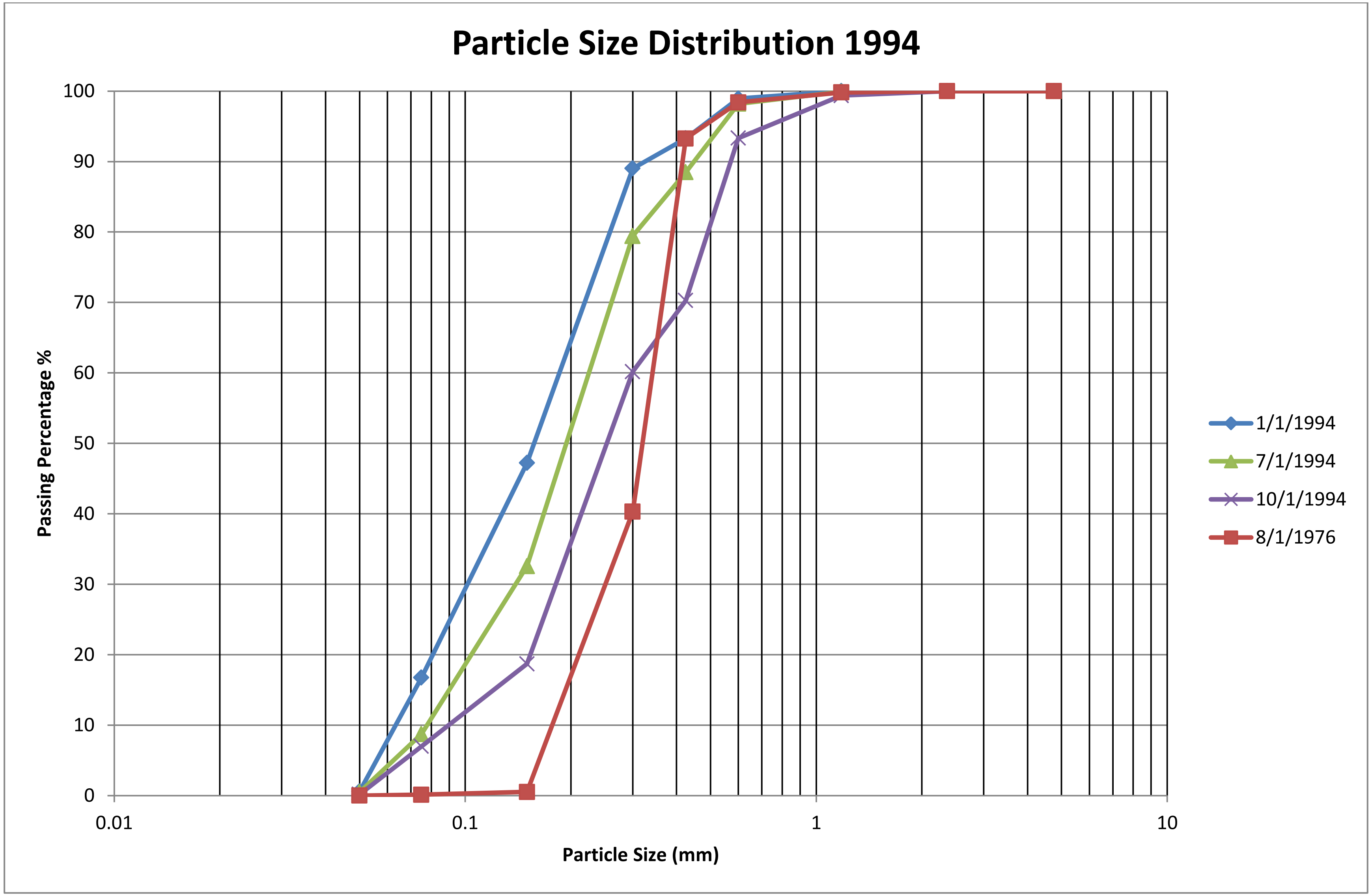


Figure 103 Particle size distribution 1994

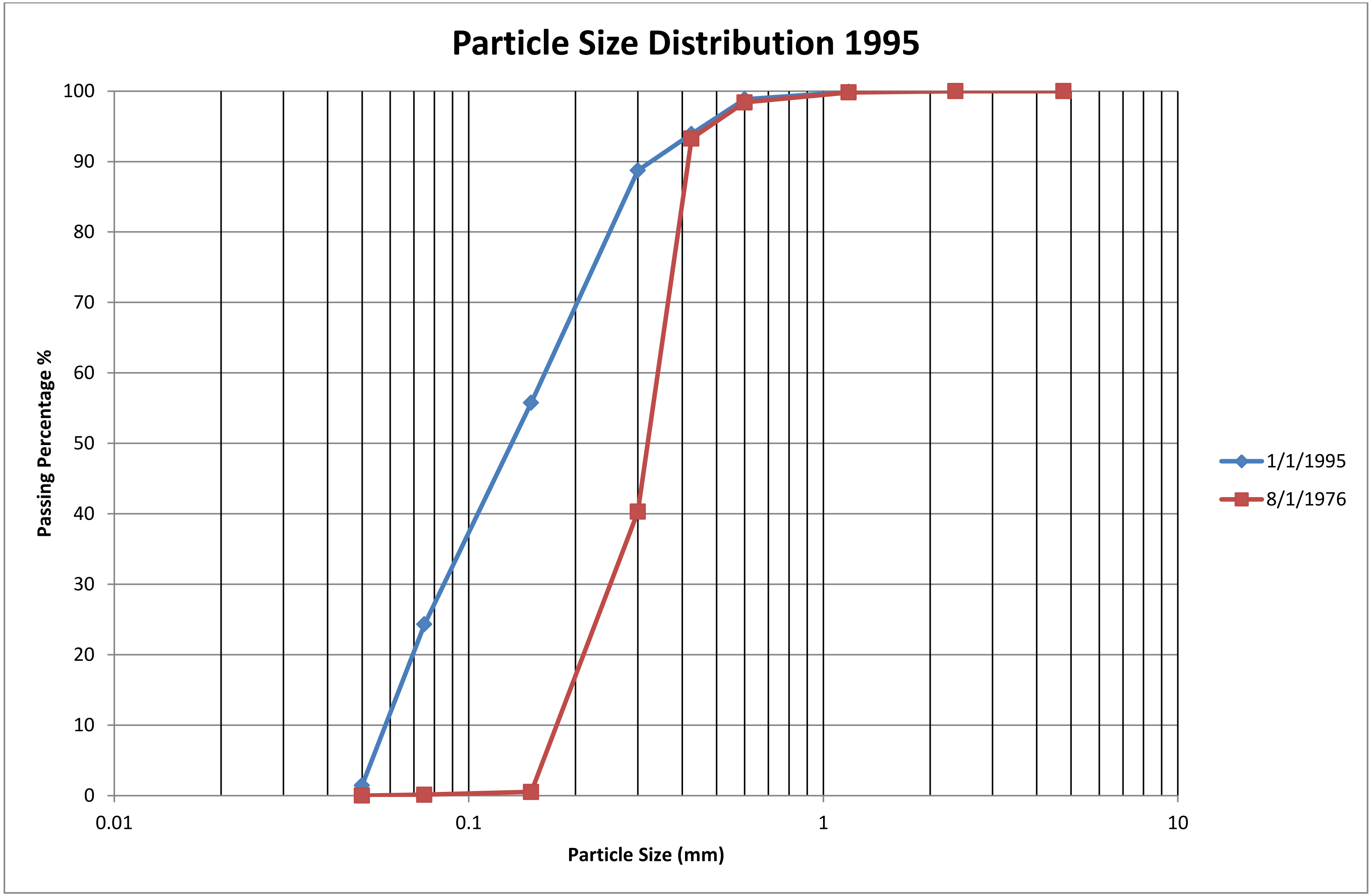


Figure 104 Particle size distribution 1995

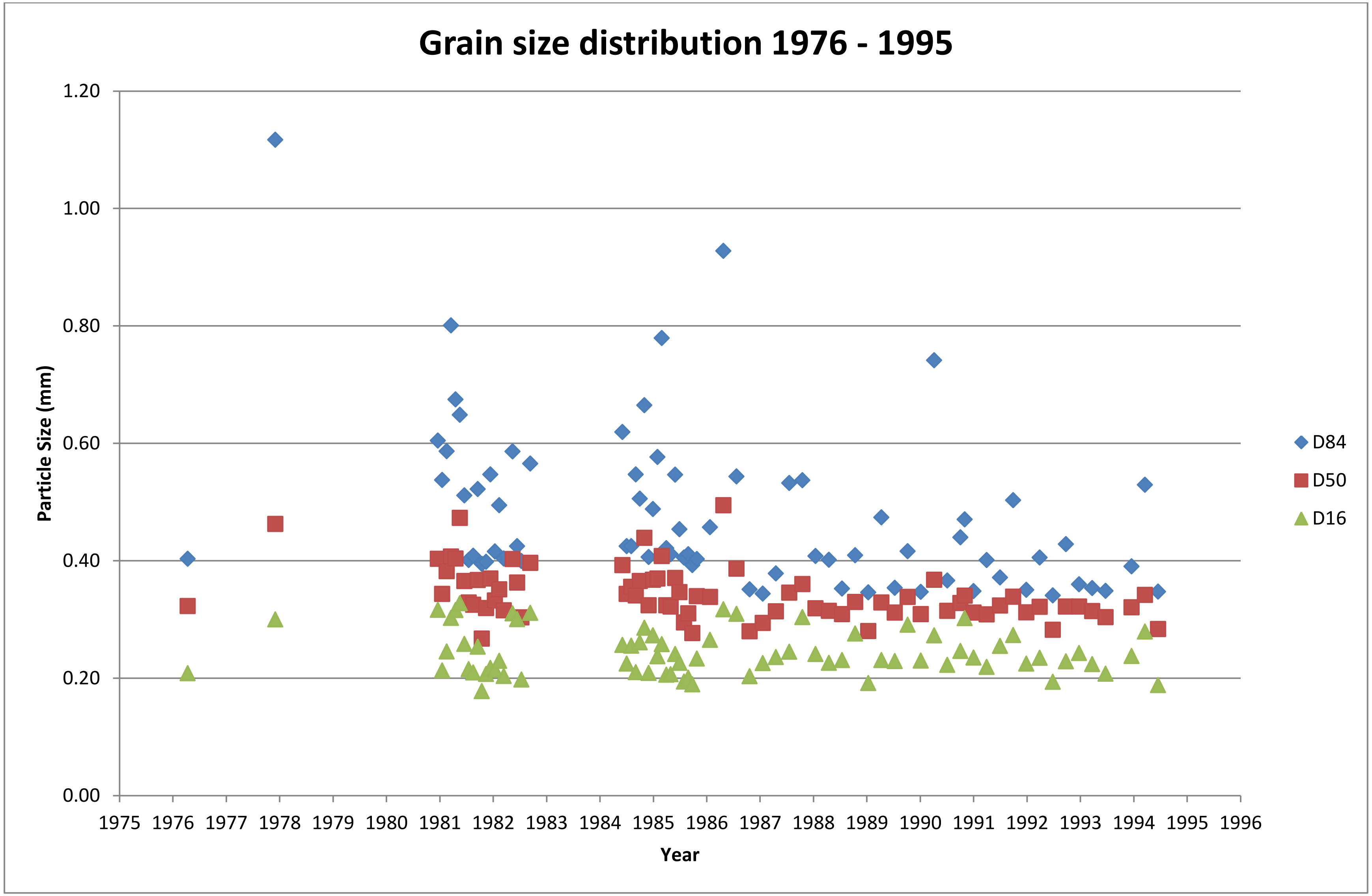


Figure 105 Grain size distribution 1976 - 1995

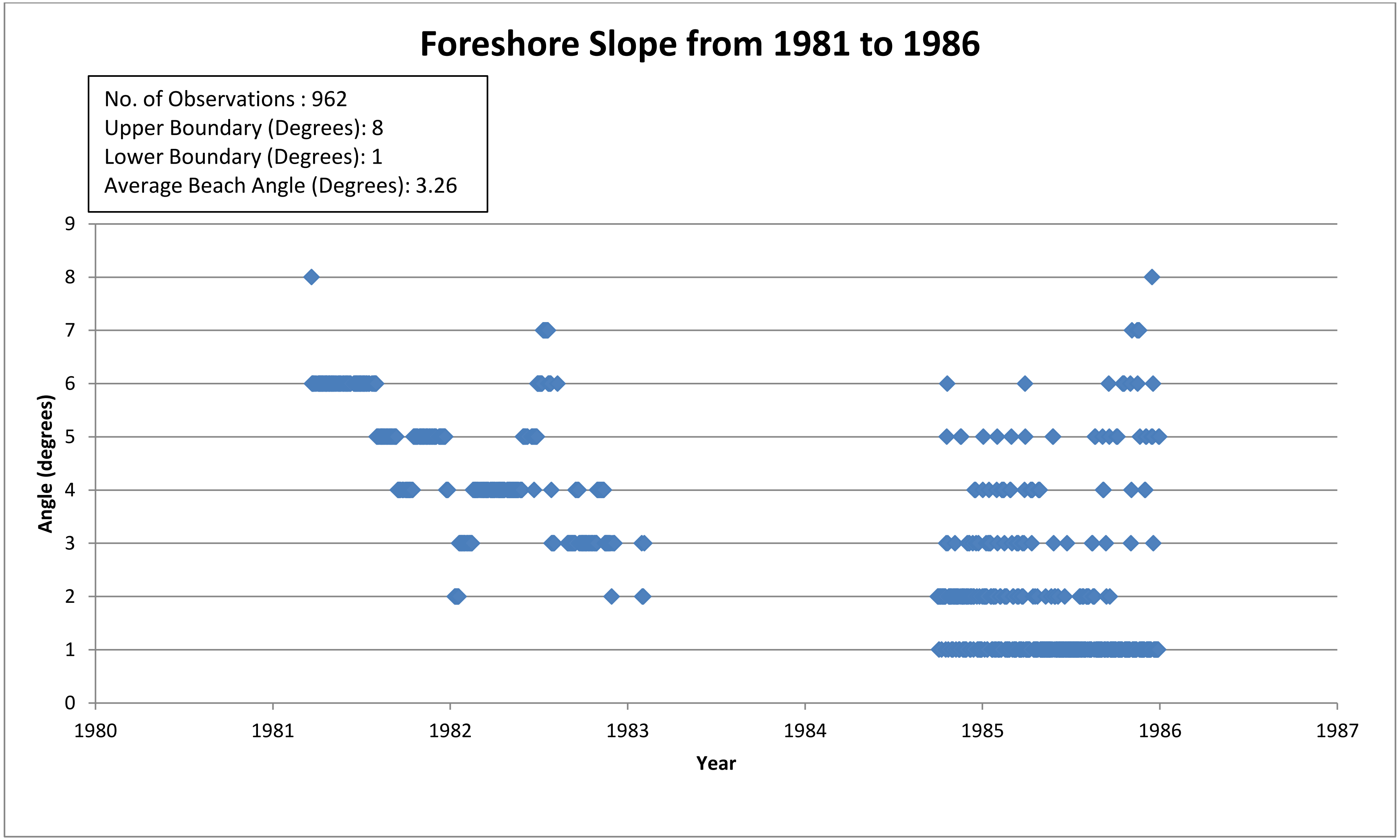


Figure 106 Foreshore slope summary

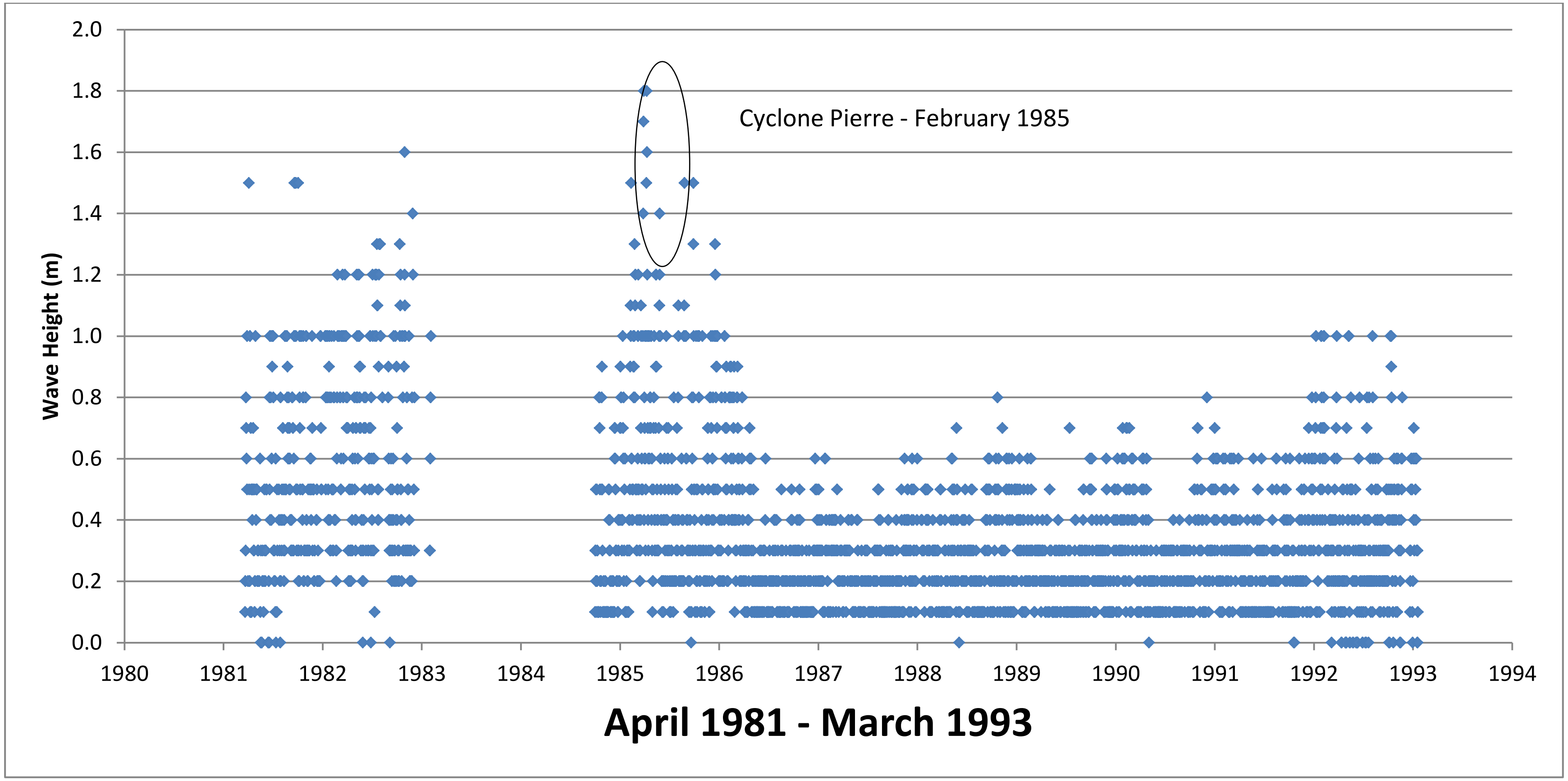


Figure 107 **Wave height and cyclone influence**

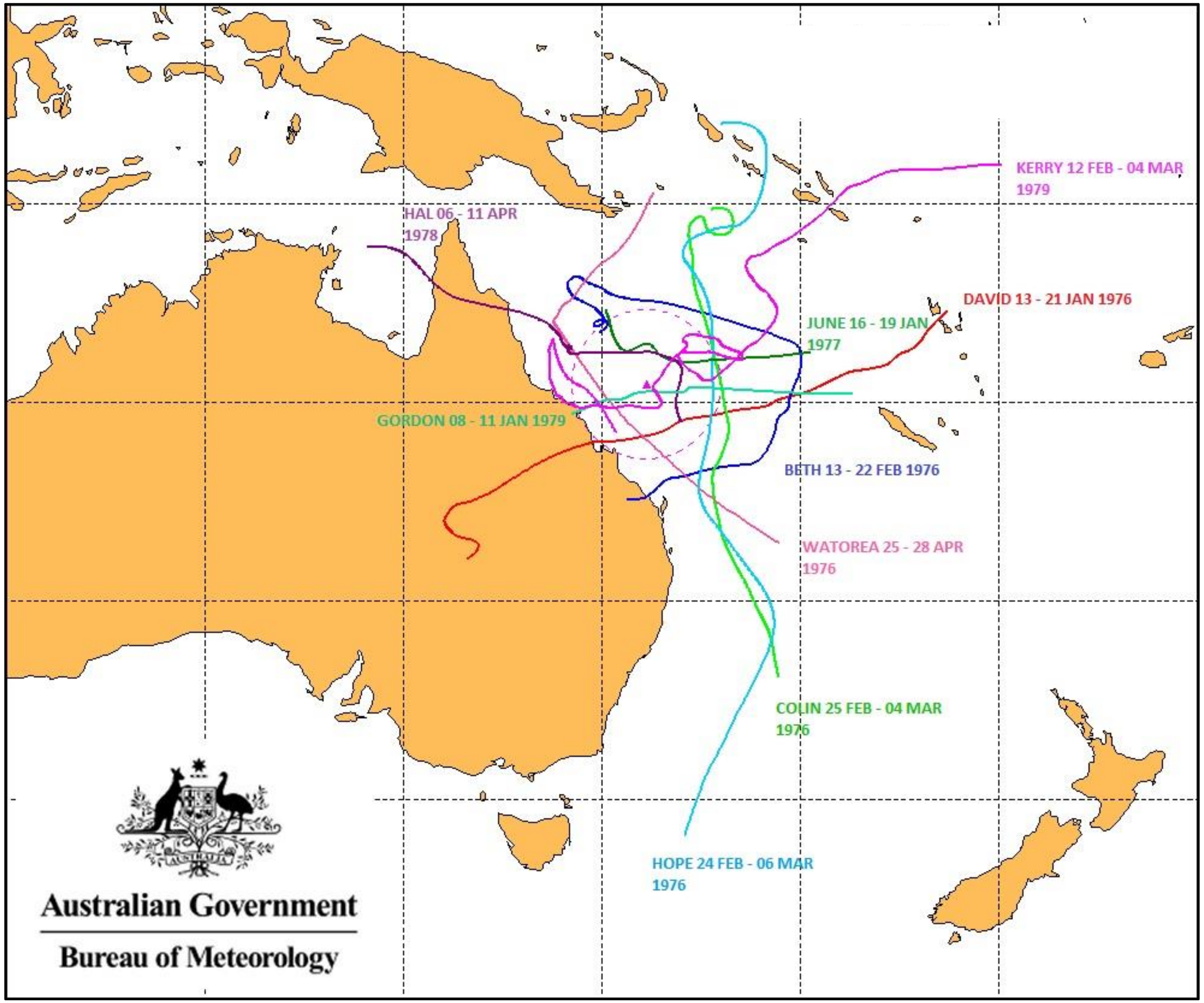


Figure 108 Cyclone tracks 1975 to 1979

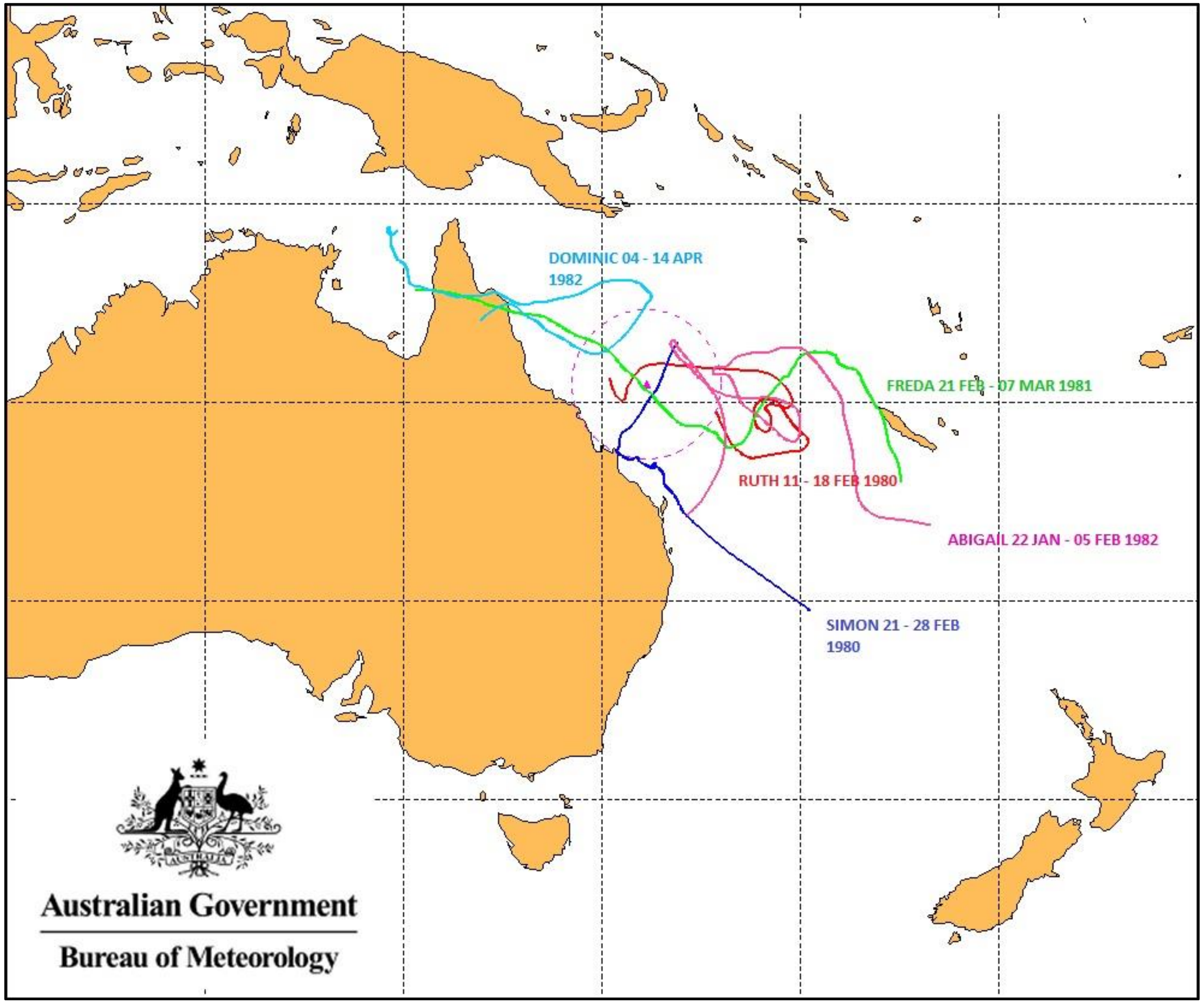


Figure 109 Cyclone tracks 1980 to 1982

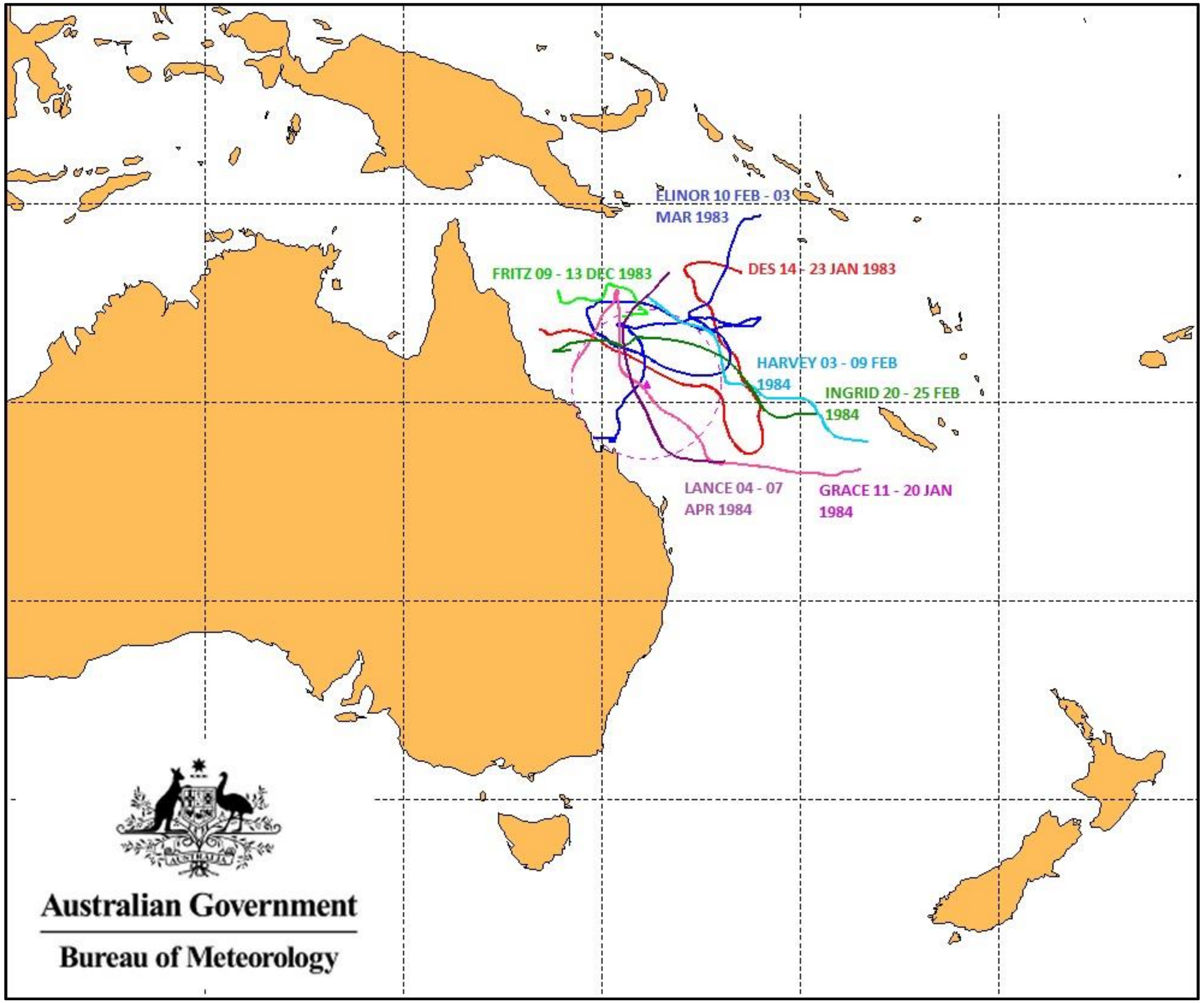


Figure 110 Cyclone tracks 1983 to 1984

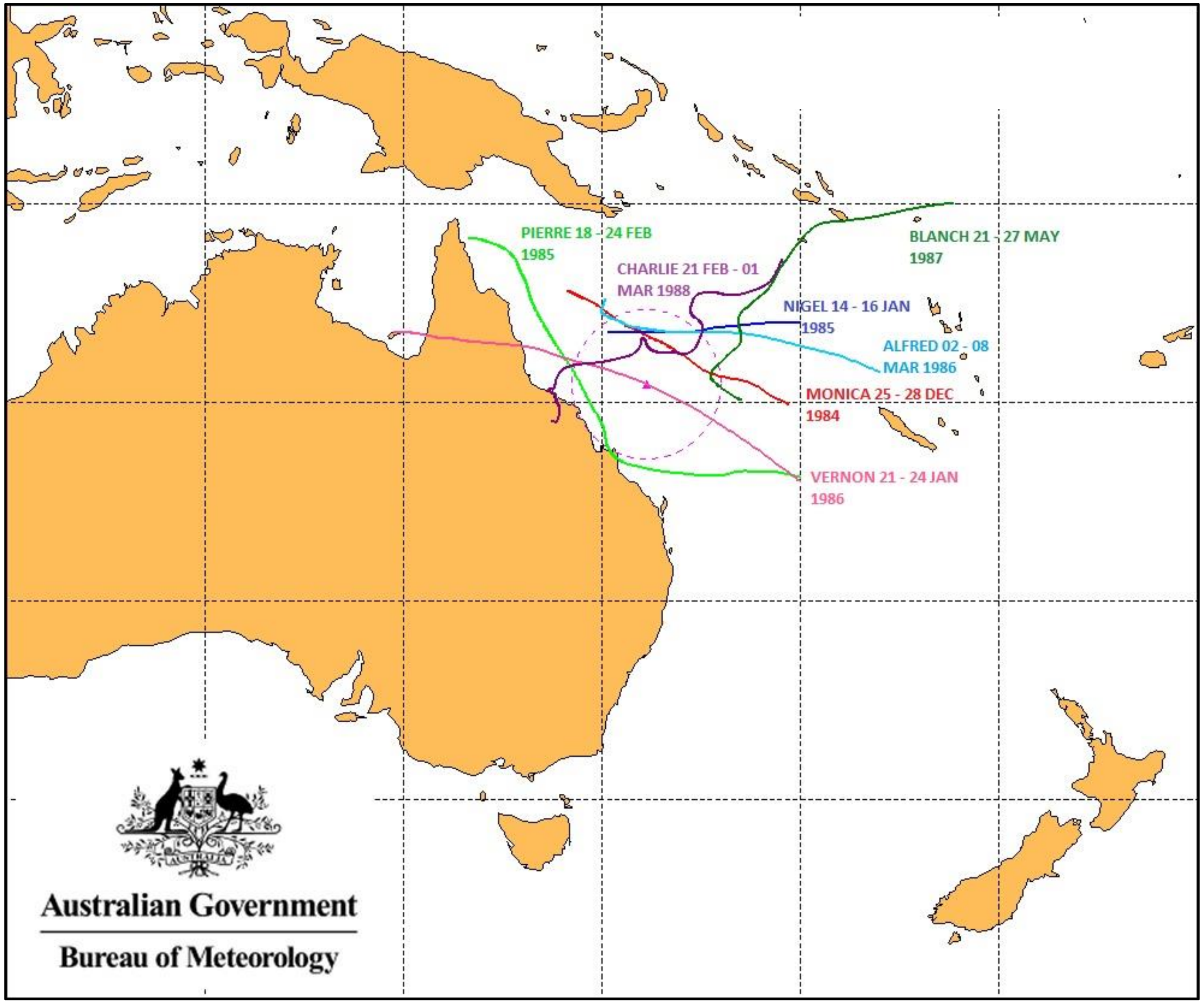


Figure 111 Cyclone tracks 1985 to 1988

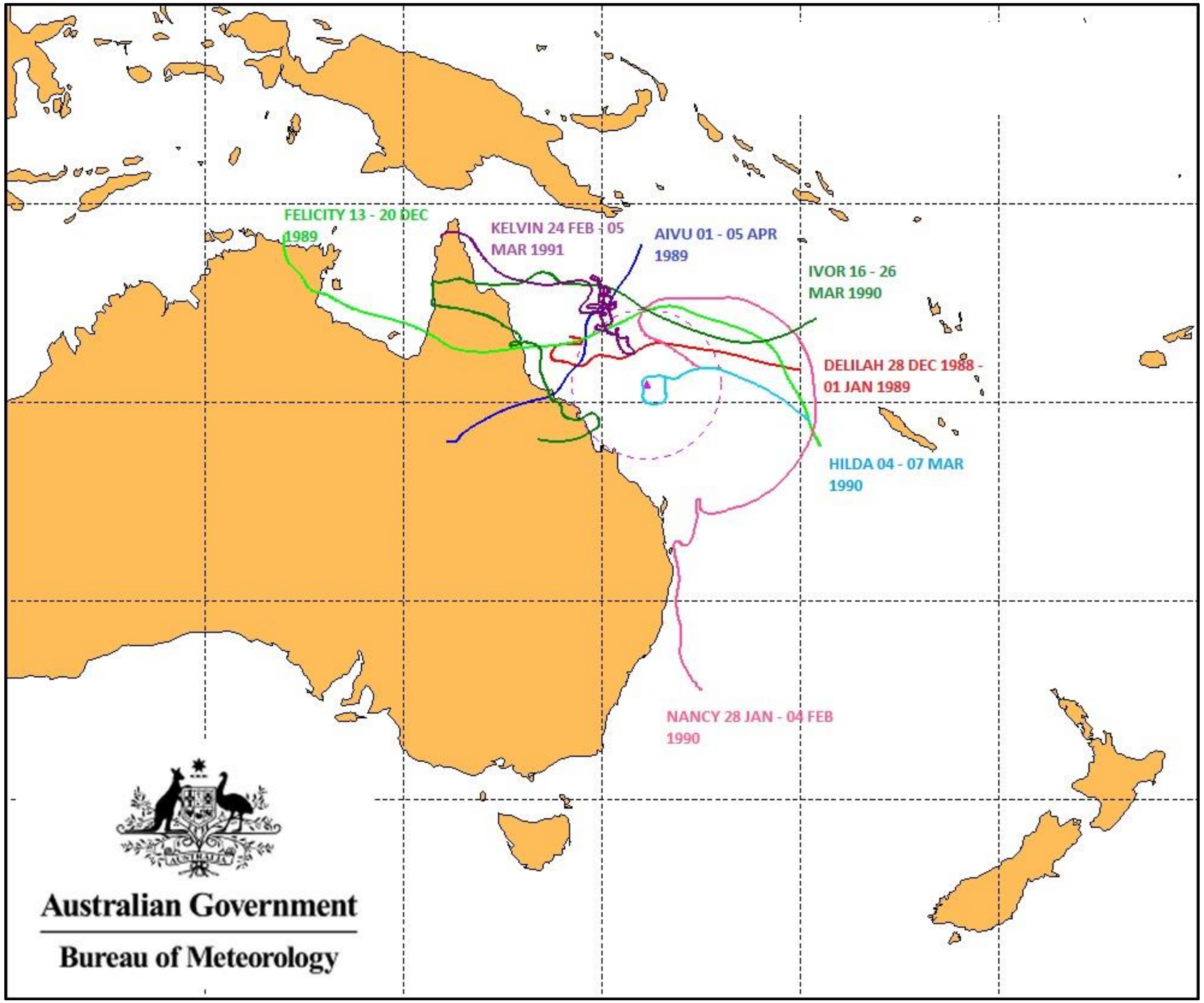


Figure 112 Cyclone tracks 1989 to 1991

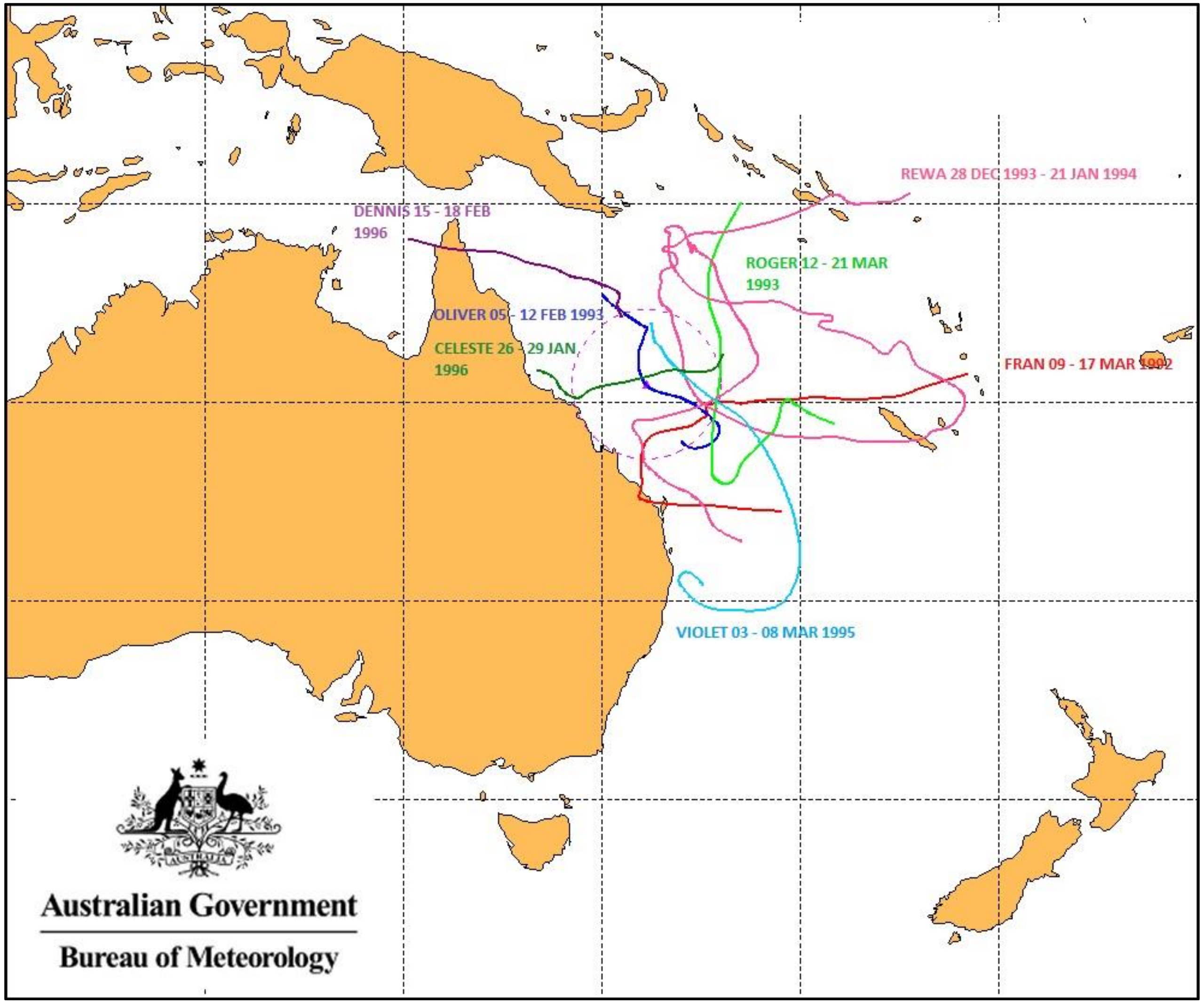


Figure 113 Cyclone tracks 1992 to 1996

Table 17 Amendments to Data

Date	Parameter	Changed From	Changed To	Justification
22/06/81	Wave period	12.3	6.3	Change period from 12.3 to 6.3 on the basis that it was recorded as 2 mins 3 sec when the period on either side indicate that it should be 1 min 3 sec
01/07/81	Berm elevation	0	13	Berm elevation was changed from 0 to 13 for consistency
01/07/81	Distance to vegetation	606	-6	Distance to vegetation was changed from 606 to -6 for consistency
01/07/81	Foreshore slope	0	Blank	Foreshore slope was changed from 0 to blank for consistency
01/10/81	Distance to vegetation	4	-4	Changed from positive to negative for consistency
01/12/81	Berm elevation	4	2.5	Changed 4 to 2.5 to make allowance for the staff height and consistency with data on either side
01/12/82	Distance to vegetation	6	-6	Changed the distance to vegetation from positive to negative for consistency
12/01/81	Foreshore slope	0	Blank	Foreshore slope was changed from 0 to blank for consistency
21/01/81	Foreshore slope	0	Blank	Foreshore slope was changed from 0 to blank for consistency
29/11/86	Fixed contour elevation	0	2.5	Surrounding data is consistent with 2.5, assume transcription error
19/02/89	Fixed contour elevation	3.5	2.5	Surrounding data is consistent with 2.5, assume transcription error
02/05/89	Distance to fixed contour	-	11	Surrounding data is consistent with 11, assume transcription error
08/07/89	Sand level at pole	2.5	3.5	Surrounding data is consistent with 3.5, assume transcription error

11/11/89	Distance to fixed contour	20	28	Surrounding data is consistent with 28, assume transcription error
26/03/90	Distance to vegetation	7	-7	Changed from positive to negative for consistency
29/06/90	Distance to vegetation	7	-7	Changed from positive to negative for consistency
09/07/91	Distance to vegetation	12	-12	Changed from positive to negative for consistency
15/03/92	Distance to fixed contour	-	16	Surrounding data is consistent with 16, assume transcription error
16/03/92	Distance to fixed contour	-	16	Surrounding data is consistent with 16, assume transcription error
17/03/92	Distance to fixed contour	-	16	Surrounding data is consistent with 16, assume transcription error
30/04/92	Current speed	95	9.5	Surrounding data is consistent with 9.5, assume transcription error
17/03/93	Wave period	15.1	9.1	Change period from 15.1 to 9.1 on the basis that it was recorded as 2 mins 31 sec when the period on either side indicate that it should be 1 min 31 sec
18/03/93	Wave period	14.9	8.9	Change period from 14.9 to 8.9 on the basis that it was recorded as 2 mins 29 sec when the period on either side indicate that it should be 1 min 29 sec
19/03/93	Wave period	11.3	5.3	Change period from 11.3 to 5.3 on the basis that it was recorded as 1 mins 53 sec when the period on either side indicate that it should be 53 sec

Note: On the new recording sheet, surf zone widths (m) were recorded as the time (s) it takes for an average wave to traverse the surf zone. Using the following equation from Patterson & Blair 1983, the value was converted into metres:

$$Surf\ Zone\ Width\ (metres) = 0.86 \times g^{\frac{1}{2}} \times H_{obs}^{\frac{1}{2}} \times t_w$$

where:

$g = acceleration\ due\ to\ gravity = 9.81 m/s^2$

$H_{obs} = observed\ wave\ height\ (m)$

$t_w = elapsed\ time\ for\ a\ wave\ of\ average\ height\ to\ transgress\ the\ surf\ zone\ from\ the\ break\ point\ to\ the\ final\ runup\ position\ on\ the\ beach\ (s)$

Where a correction to the surf zone width was required, a value was estimated by using a surf zone parameter for a wave with a similar height and period. This value was then converted from seconds to metres using the above formula.

Appendix A – Cope Instructions

The following text is an extract from BPA newsletter – Beach Conservation No. 69 in which the COPE program was the feature article. The extract describes how the recordings were performed for the **new format** recording sheet, which was introduced in March 1986.

OBSERVATIONS

The data is recorded on special forms which are suitable for computer processing. An example is shown in Figure 2. The wave parameters recorded are:

(i) estimate of wave heights (average and maximum);

(ii) wave period (average time interval between waves);

(iii) wave direction (as a compass bearing);

(iv) surf zone width (traverse time of surf zone by average wave).

The beach parameters recorded, using the installed reference pole are:

(i) elevation of the fixed contour or beach berm;

(ii) distance to the fixed contour or beach berm;

(iii) distance to the average vegetation line;

(iv) sand level at the pole.

Wind speed and compass direction are determined by the use of a hand held wind meter.

The longshore current in the surf zone causes the transportation of sand along the beach, and it is important that this current is measured. This is done by introducing a harmless dye into the water and measuring the distance that the dye patch travels along the beach in one minute. Wave action soon dissipates the dye.

The survey of a monthly beach profile, using the installed reference pole, provides information on beach movements. During periods of change, such as cyclonic wave attack, profiles are usually taken before and after the event. All reference poles are surveyed at the time of installation to allow replacement in the same position if they are destroyed or are washed out by erosion.

The average sand grain size is an element to be considered in the assessment of longshore sand transport rates. Therefore, a monthly sample is taken from a specified beach level and analysed to reveal any seasonal or long term changes.

The following document details the instructions on how to fill out the **old format** recording sheet which was discontinued in March 1986.

FORM No. BE3

BEACH PROTECTION AUTHORITY - QUEENSLAND

Instructions for filling out COPE recording form

COASTAL OBSERVATION PROGRAMME - ENGINEERING

(COPE)

STATION IDENTIFICATION:

Each site for COPE has been assigned a numerical code consisting of five digits. The first two digits define the Shire or City in which the site is located, and the remaining three digits define the particular beach and reference mark position within a particular Local Authority area. A space is provided to write in the name of the beach at which the observation is made.

DATE:

Record the year, month and day in the spaces provided on each page of the recording sheet.

TIME: (Column 2)

Record the time to the nearest quarter-hour **in Eastern Standard Time** (E.S.T.) at which the observation is made. (e.g. 10.00 a.m. Daylight Saving Time is 0900 E.S.T.). The 24-hour clock system of recording time is used to avoid any confusion between a.m. and p.m. (e.g. 0900 is 9.00 a.m. and 1500 is 3.00 p.m.).

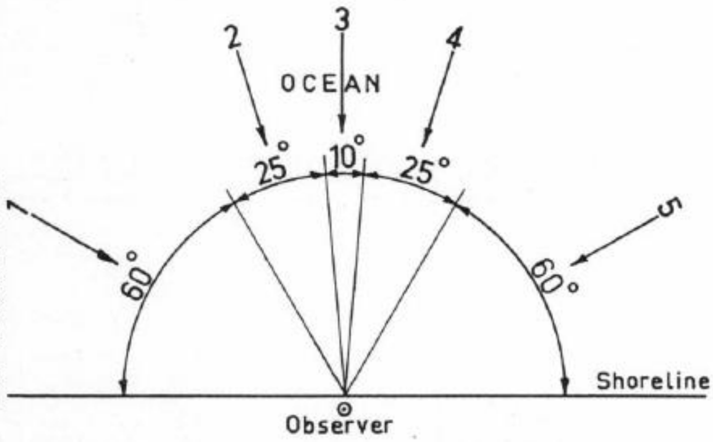
Daily observations should be made as close as possible to 0900 hours, and twice-daily observations should be made once in the morning and once in the afternoon and as close as possible to 0900 and 1500 hours. Observations should be made at the **same** time every day.

WAVE OBSERVATIONS:
(These observations are to be made twice daily.)

(a) **Wave Period:** (Column 3). Record the time in seconds for eleven wave "crests" to pass a stationary point. Eleven "crests" will include ten complete waves (crests and trough). Crest 1 is zero-time, crest 11 is cut time.

(b) **Wave Height:** (Column 4). This observation is based solely on the judgement of the observer. The observer's best estimate will be sufficient. Record the breaking wave height to the nearest one-fifth metre. If wave height is less than one-fifth metre (0.2), the wave height is "O". If no waves exist at all, mark "O" for **both** WAVE HEIGHT and WAVE PERIOD columns.

Fig. 1 WAVE DIRECTION CODE



(c) **Wave Direction:** (Column 5). Darken the space which best describes the direction of the approaching waves according to Fig. 1 above. If no waves exist at all, write the direction as "O".

(d) **Type of Breaking Waves:** (Column 6). If no waves exist, leave the item blank, otherwise choose only **ONE** of the following four types of waves:

Spilling – Spilling occurs when the wave crest becomes unstable at the top and the crest flows down the front face of the wave, producing an irregular, foamy water surface. This wave is sometimes referred to as a "roller" (see Fig. 2 below). Mark "SP" for spilling.

Plunging – Plunging occurs when the wave crest curls over the front face of the wave and falls into the base of the wave, producing a high splash and much foam. This wave is sometimes referred to as a "dumper" (see Fig. 3 below). Mark "PL" for plunging.

Plunging/Spilling – Darken this space only when there is a combination of spilling and plunging waves. Mark "PS" for plunging/spilling.

Surging – Surging occurs when the wave crest remains unbroken while the base of the front of the wave advances up the beach (see Fig. 4 below). Mark "S" for surging.

(e) **Surf Zone Width:** (Column 7). This observation is based on the judgement of the observer. The observer's best estimate is sufficient. Record the distance, to the nearest whole metre, from the water line at the time of observation to the line of the most seaward row of breakers, at the time of observation. If no waves exist at all, mark "O". If two or more breaker zones exist, record the distance to the most seaward row of breakers of the most seaward breaker zone.

(f) **Offshore Bar:** (Column 8). Record whether or not a significant offshore bar exists. This may be determined as "yes" if there is a distinct gutter between the initial breakpoint and the beach, allowing the wave to reform; and "no" if the wave continues in a broken state from the initial breakpoint to the beach (see Fig. 5).

Fig. 2

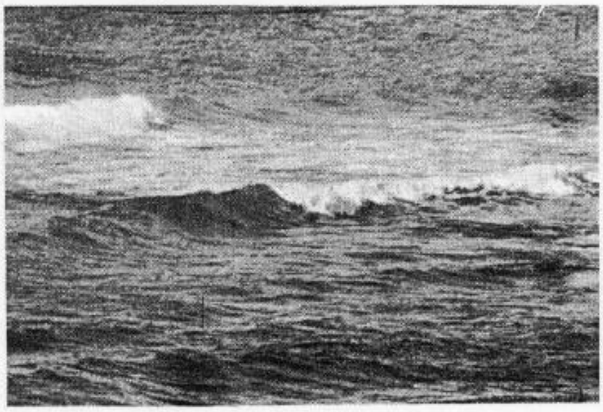


Fig. 3

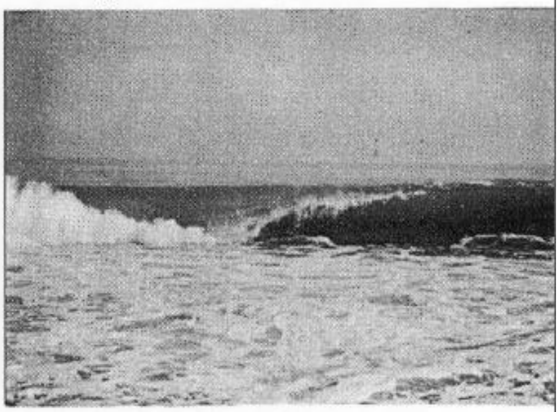


Fig. 4

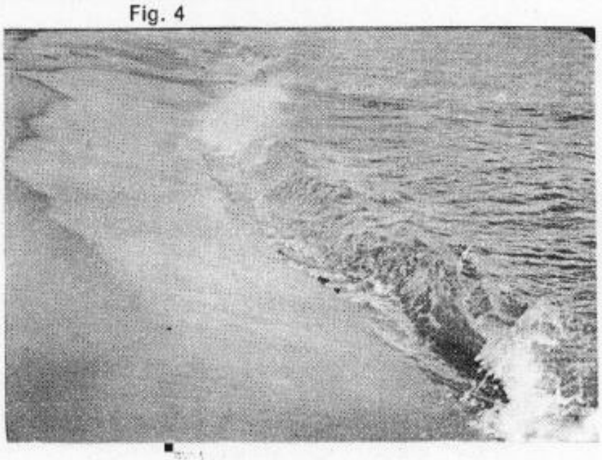
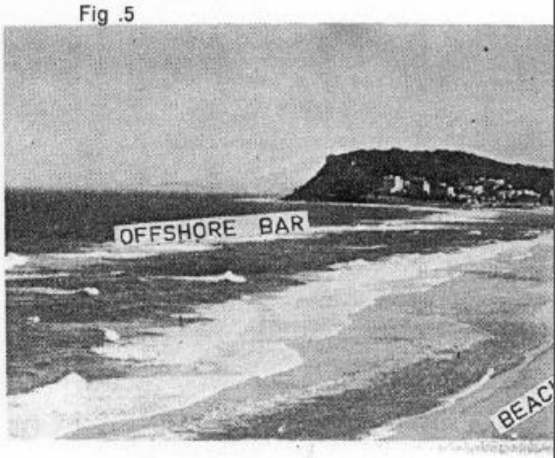


Fig .5



WIND OBSERVATIONS: (These observations are to be made twice daily).

(a) **Wind Velocity:** (Column 9). A wind meter is provided for each observer. The instructions provided with the meter should be followed to obtain wind velocity measurements.

(b) **Wind Direction:** (Column 10). Determine the orientation of the beach with respect to the compass directions, and record the direction **from which** the wind is coming. The direction of true north should be indicated on the reference mark or nearby.

STATE OF TIDE: (Column 11). (This observation is to be made twice daily).

Indicate the relative state of tide by marking one of the ranges: low tide "O/4", quarter tide "1/4", half tide "2/4", three-quarter tide "3/4", full tide "4/4", and mark whether the tide is rising "R", falling "F", or stationary "S" at the time of observation.

BEACH OBSERVATIONS: (These observations are to be made once daily.)

(a) **Elevation of the most seaward beach berm crest:** (Column 12). To obtain this, a graduated reference pole has been installed on the beach and the observer has been provided with a hand level. The observer should also have a 1.5 m-long support for the level. To use the Clinometer as a level, set the bubble lever to zero and sight through the instrument to the reference pole so that the bubble is centred on the cross hair. To obtain this measurement, the observer must place himself on the most seaward berm crest and take a reading of the reference pole (see Fig. 6 below). This reading minus 1.5 metres (length of support) is recorded on the form. If no berm can be easily recognised mark "NB" for no berm.

(b) **Distance to the most seaward berm crest from the reference pole:** (Column 13). Record the distance (to the nearest whole metre) between where the level reading is taken and the reference pole (see Fig. 6 below). If no berm exists, leave the distance **blank: DO NOT** mark the "O". If the distance is measured landward from the reference pole, the distance is a minus value. After erosion the berm may be at the erosion scarp.

(c) **Distance to the vegetation line from the reference pole:** (Column 14). Record the distance to the nearest whole metre between the reference pole and a line along the average seaward extent of the existing perennial vegetation. If the distance is measured landward from the reference pole, the distance is a minus value.

(d) **Angle of Foreshore Slope:** (Column 15). This observation can be made by placing the support pole for the level on the foreshore slope and laying the level on the support, as shown in Fig. 7 below. The foreshore is the uniform sloped section of the beach between H.W.M. and L.W.M. Next, adjust the bubble level so as to centre the bubble in the bubble tube, and then note reading on the DEGREE scale.

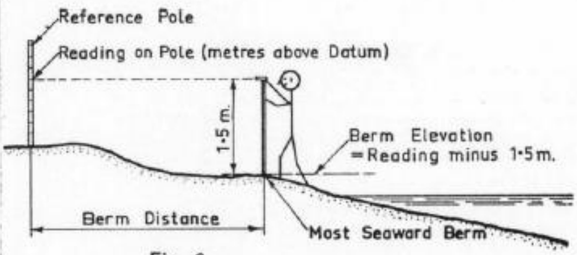


Fig. 6

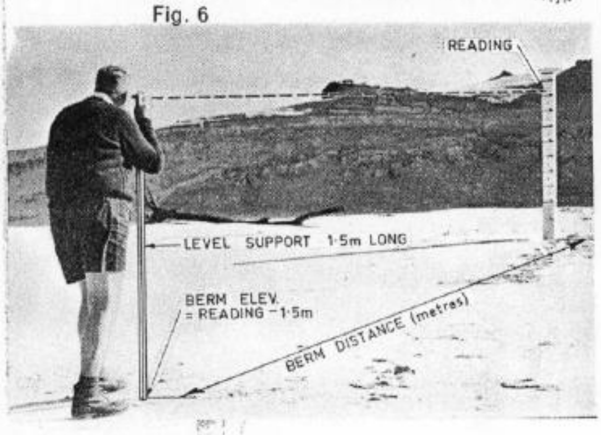


Fig. 7

Continued overleaf

LITTORAL CURRENT OBSERVATIONS: (These observations are to be made once daily.)

(a) **Current Velocity:** (Column 16). For this measurement the observer is provided with dye. The dye is **very** powerful, and care must be observed when handling it so as not to allow any dye to accidentally spill. The dye should be thrown as near as possible to the midpoint of the surf zone. The observer will note the position of the dye at entry to the breaker zone and the position of the dye after an elapsed time of one minute. The distance between these two positions is entered in the spaces provided on the form. If no current is evident, darken the "O" marks.

(b) **Current Direction:** (Column 17). If no current is evident, mark "C" for "calm". Otherwise indicate whether the dye patch moves downcoast or upcoast. In general, current that flows to the north is considered upcoast, and that which flows to the south is considered downcoast.

SAND SAMPLES:

Sand samples should be collected once a month in the special plastic bags provided. The sample should be obtained from the foreshore slope of the beach at about half tide level. Identify the sample with the name and code number of the beach, and record the date and time the sample was collected. Write this information directly on the outside of the specially provided padded envelope.

PHOTOGRAPHS: (Optional)

Photographs are to be taken once a month, preferably early each month and at low tide. General panoramic views of the beach in the up and down coast directions are desired. Photographs should be taken from the same location each time and view the same area with a recognisable landmark in the background. Each photo must be identified with the name and code number of the beach, and the date and time and tide level when it was taken.

COMMENTS:

Note any remarks or sketches or unusual events (e.g. erosion scarps, cyclone damage, surge etc.) in the comments column of the recording form.

Remember: There are about 50 COPE stations in Queensland.

Remember: To mark all recording sheets, sand samples and photographs with your code number, and time and date.

Issued by

BEACH PROTECTION AUTHORITY
OF QUEENSLAND

Department of Harbours and Marine
Edward Street, Brisbane 4000
(G.P.O. Box 2195, Brisbane 4001)

Appendix B – Historical Photographs

Figure 114 Sarina Beach January 1987

Figure 115 Sarina Beach January 1988

Figure 116 Sarina Beach March 1994