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PERDIDO KEY BEACH NOURISHMENT PROJECT: GULF ISLANDS NATIONAL SEASHORE

1992 Annual Report

by

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and
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16. Abstract

This report is the third annual report in a continuing series documenting a field project within the Gulf Islands National Seashore at Perdido Key, Florida. The field project includes the monitoring of a number of physical parameters related to the evolution of the Perdido Key beach nourishment project. Approximately 4.1 million m^3 of dredge spoil from Pensacola Pass were placed upon approximately 7 km of the Gulf of Mexico beaches and 3 million m^3 offshore of Perdido Key between November, 1989, and October, 1991.

Beach profile data describing the evolution of the nourished beach are included, as well as wave, current, tide, wind, temperature, and rainfall data to describe the forces influencing the evolution. Data describing the sediment sizes throughout the project area are also included. A brief discussion of the data is included with an emphasis on evolution of the beach and offshore nourishment.

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TABLE OF CONTENTS

LIST OF FIGURES

FIGURE PAGE

LIST OF TABLES

DRAFT

PERDIDO KEY BEACH NOURISHMENT PROJECT:

GULF ISLANDS NATIONAL SEASHORE

1992 ANNUAL REPORT

1 INTRODUCTION

This report is one in a series of annual summaries of a continuing field project within Gulf Islands National Seashore at Perdido Key, Florida (Figure 1). Between November 1989 and September 1990 approximately 4.1 million m^3 of dredge material were placed along the eastern 7 km of the Gulf of Mexico shoreline of Perdido Key. From September 1990 to October 1991, an additional approximately 3 million m^3 of material were placed as an underwater deposit between DNR Monuments R-48 and R-60, extending 3.8 km in the longshore direction and up to 700 m in the cross-shore direction (see Figure 2).

Earlier reports (Work et al. 1990a, 1990b, 1991a, 1991b, 1991c, 1992a) discussed the site and physical data collection methods in detail. The focus of this report will be the results of the field work and physical data collection for 1992. The data describe topographic and bathymetric changes of the area, waves, currents, tides, sediment sizes, winds, temperatures and rainfall.

2 DATA COLLECTION

The study area and the data collection sites are shown in Figure 2. Table 1 presents a chronological summary of the ongoing field efforts since commencement of the project. A discussion of the data collection and analysis methods can be found in previous reports; only a brief summary will be included here.

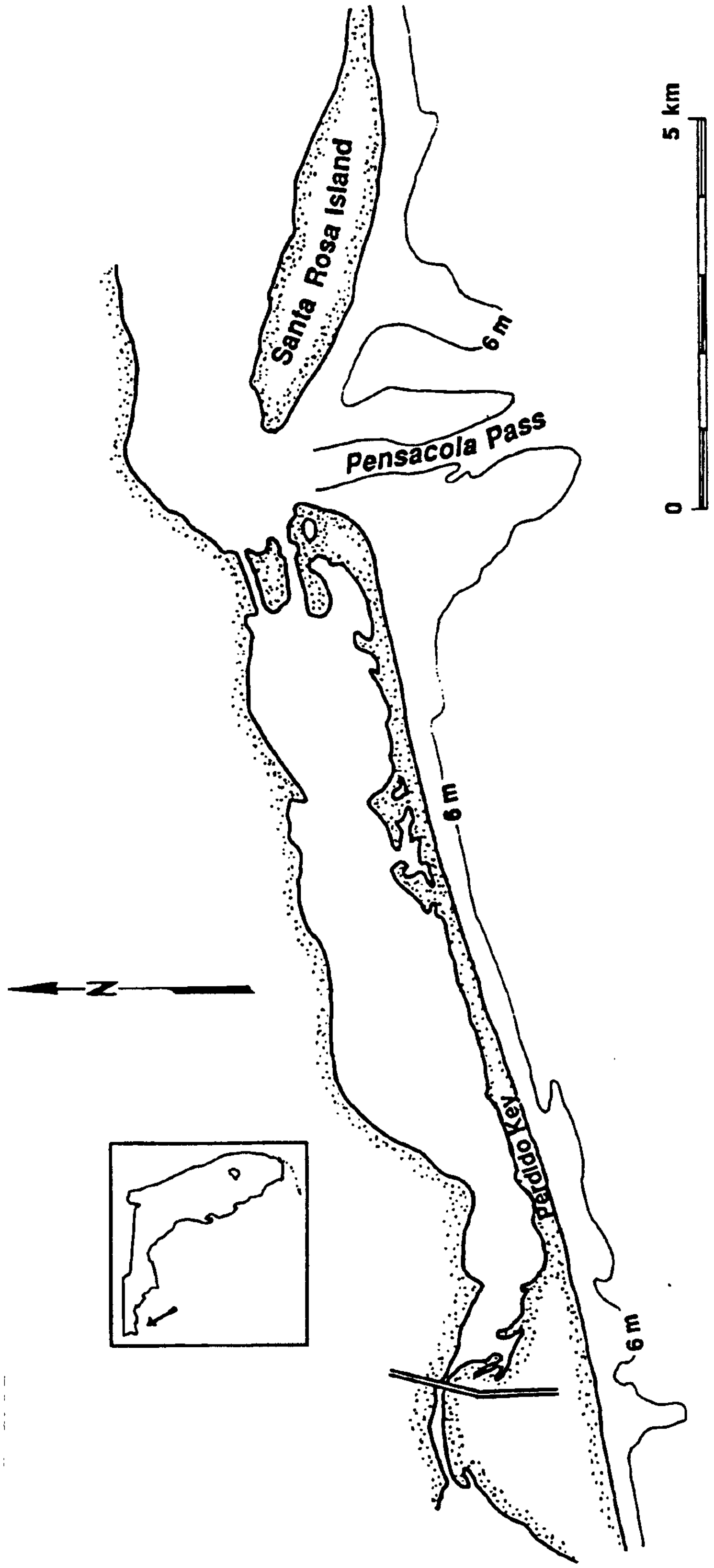

Figure 1: Site location chart

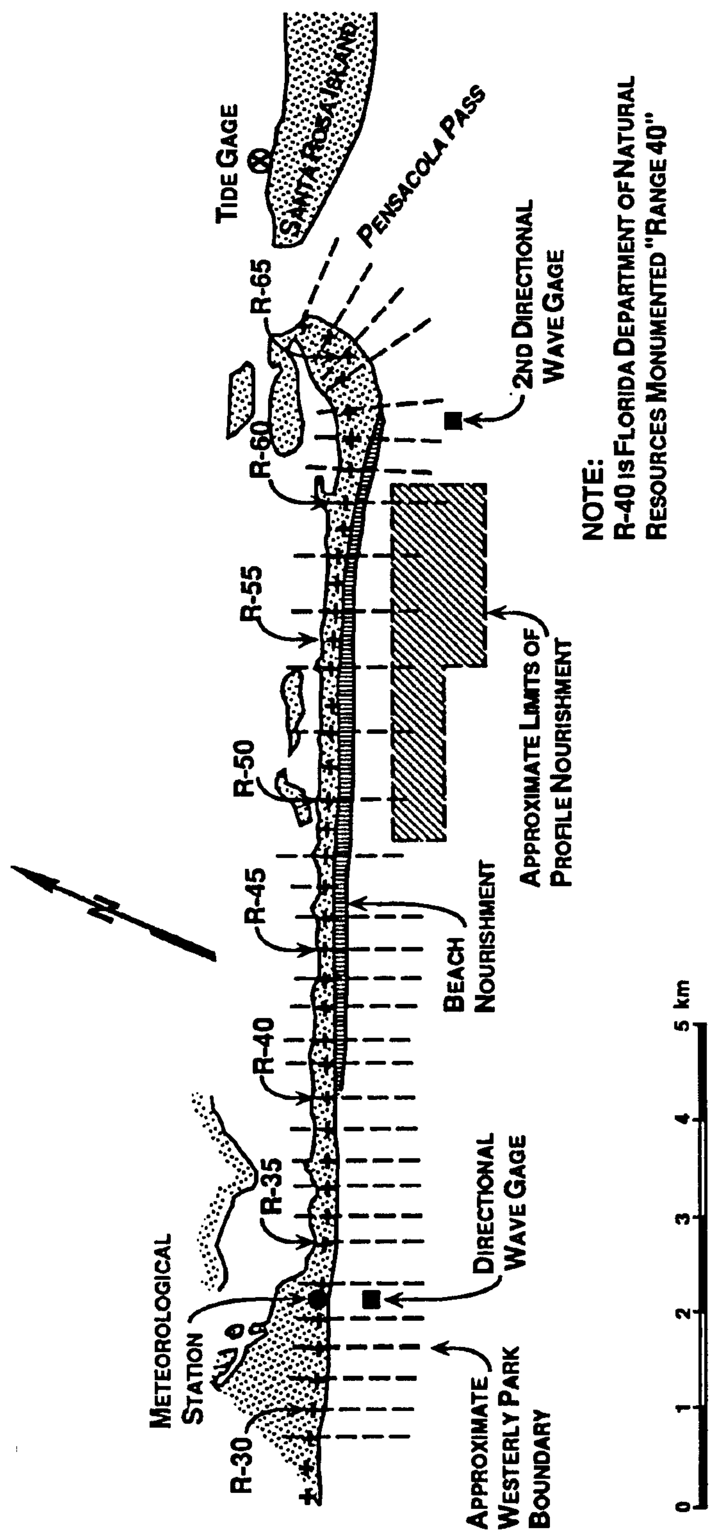

Figure 2: Components of beach nourishment monitoring project

Table 1: Chronology of Perdido Key field efforts

Date	Task
10/28-11/1/89	Pre-nourishment survey: Wading/swimming profiles (Gulf and Bay) Offshore bathymetry Sand samples, photos
11/17/89	Placement of nourishment material begins
1/18/90	Wave gage tripod and standalone gage installed Tide gage with small stilling well installed at Ft. Pickens Pier, Santa Rosa Island
1/29/90	Mechanical (analog) weather station installed
1/30/90	Large stilling well installed for Ft. Pickens tide gage
3/7-3/9/90	56 sand samples collected, to replace those destroyed or not collected during pre-nourishment survey
5/2/99	Standalone wave data collection package replaced with new package
6/24/90	Digital weather station installed
8/8/90	Standalone wave data collection package replaced with new package
8/17/90	Placement of nourishment material completed
9/22-9/26/90	First post-nourishment survey: Wading/swimming profiles (Gulf side) Offshore bathymetry Sand samples, photos
12/6/90	Standalone wave data collection package replaced with new package Ft. Pickens pier tide gage re-surveyed
1/29-2/3/91	Wading/swimming profile survey (Gulf side) Sand samples
5/15-5/16/91	Wave gage cable re-buried
5/28-6/1/91	Wading/swimming profile survey (Gulf side) Sand samples
6/18-6/19/91	Shore-connected wave gage removed; cable cut Standalone wave gage installed
7/29-7/30/91	Wind vane and anemometer replaced
9/10/91	Standalone wave gage removed Fresh standalone wave gage installed
9/28-10/2/91	Wading/swimming profile survey (Gulf side) Sand samples, photos Reattached Ft. Pickens pier tide gage
10/12-10/20/91	yearly survey: Wading/swimming profiles (Gulf side) Offshore bathymetry Installed heavyweight data/power cable for wave gage Replaced standalone wave gage near Ranger Station Installed shore-connected wave gage near Ranger Station Sand samples, photos

Table 1: Chronology of Perdido Key field efforts (cont'd)

Date	Task
10/23-10/24/91	Replaced shore-connected wave gage near Ranger Station
1/16-1/22/92	Wading/swimming profiles (Gulf side) Replaced wind vane/anemometer Replaced shore-connected wave gage near Ranger Station Replaced standalone wave gage near Ranger Station
4/15-4/16/92	Replaced shore-connected wave gage near Ranger Station Removed standalone wave gage from Ranger Station Installed new standalone wave gage near Caucus Shoal
7/8/92	Replaced shore-connected wave gage near Ranger Station Replaced standalone wave gage near Caucus Shoal
10/17-10/20/92	yearly survey: Wading/swimming profiles (Gulf side) Replaced shore-connected wave gage near Ranger Station Replaced standalone wave gage near Caucus Shoal Sand samples, photos Replaced weather station
10/27-10/29/92	bathymetric survey of range lines (Gulf side) bathymetric survey of "Profile Nourishment"
1/22-1/25/93	Wading/swimming profiles (Gulf side) Cleaned shore-connected wave gage near Ranger Station Replaced standalone wave gage near Caucus Shoal Reset weather station
5/14-5/18/93	Wading/swimming profiles (Gulf side) Bathymetric survey of 8 lines along "Profile Nourishment" Bathymetric survey of "Profile Nourishment" Wading/swimming surveys of beach cusps Cleaned shore-connected wave gage near Ranger Station Replaced standalone wave gage near Caucus Shoal Reset weather station

2.1 Hydrographic and Topographic Surveys

The survey equipment and methodology used were unchanged from previous surveys. The beach profiles were surveyed to approximate depths of 4 to 5 m employing standard rod-and-level techniques, by first wading and then swimming over the deeper portions of the profiles. The offshore profile was surveyed by a boat equipped with a fathometer to measure depths and a microwave rangefinder system to measure horizontal distances. The profile lines were surveyed using the same azimuth values as in the previous surveys.

During the annual survey in October, 1992 twenty-five profiles were surveyed by boat, and an additional eight have been surveyed to wading/swimming depth (generally 4-5 m) only, in order to improve spatial resolution of the evolution of the beach nourishment. A total of eleven surveys have been conducted to date: the annual bathymetric surveys of 11/89, 9/90, 10/91 and 10/92 and the additional wading/swimming surveys of 1/91, 5/91, 9/91, 1/92, 6/92, 1/93 and 5/93. Data from the four annual surveys are presented in Appendix I.

2.2 Wave/Current/Tide Data

Waves, currents and tides are measured at two stations, one located offshore from the Ranger Station near DNR Monument R-34, and the other on Caucus Shoal near R-62. Both stations comprise P-U-V type electronic gages mounted on tetrapod shaped steel frames placed on the ocean floor. The P-U-V gages consist of two electronic sensors; a pressure transducer and a electromagnetic current meter. Raw data include a pressure signal and two velocity signals measured on a horizontal plane perpendicular to each other. All signals are collected once every 6 hours at 1 Hz sampling frequency for a 17 minute duration.

The gage near the Ranger Station is connected by a cable to a shore station which serves as a link for the remote control operation. The P-U-V data from this gage can be retrieved from the University of Florida via telephone. The gage near Caucus Shoal carries a self contained storage device which can store data until divers retrieve the package every 3-4 months. Additional information about wave packages can be found in previous reports by Work et al., 1990 and 1991.

The P-U-V data are analyzed using directional spectrum methods to obtain wave height, wave period, wave direction, tide, current velocity and current direction. The computed wave, current and tide parameters are presented in Appendix II for the period of January to December 1992. There are seven plots per month for each gage. The first four plots present wave related parameters. These are: Wave period, significant wave height, modal wave direction and the spreading parameters of the wave spectrum. Wave information is followed by current and tide variables presented in three plots which show the current velocity, mean current direction and the tidal elevation.

2.3 Sand Samples

Sand samples are collected at eight locations along the profiles: Dune, mid-beach, berm, beachface, -1 m, -2 m, -5 m and -8 m. Details about the sampling locations and methodology can be found in the previous reports by Work et al., 1990 and 1991.

Grain size distributions have been determined by mechanical sieve analysis of each sample, using a series of twelve U.S. standard sieves with mesh numbers 10, 20, 30, 40, 50, 60, 70, 80, 100, 120, 140, 160. The analysis results are presented in Appendix III. Each figure shows grain size distributions at a particular location for different sample years. Several characteristic parameters of the grain size statistics have been analyzed, such as D_{50}, mean diameter, sorting index, skewness and kurtosis. In this report only results related to D_{50} are presented. Other parameters can be obtained from the authors. A further discussion on sediment characteristics and spatial/temporal variations in grain sizes can be found in Chapter 4.

2.4 Weather Data

The electronic weather station was installed in June 1990 and collected data until May 1992. In October 1992 it was replaced with a similar unit. This new station operates with a locally installed data acquisition unit and a storage device. The weather station can be controlled remotely from the University of Florida and the stored data can be retrieved via telephone. The data acquisition unit consists of electronic sensors to measure wind velocity, wind direction, air temperature and rainfall. Data are sampled at 1 Hz frequency and the hourly mean, minimum and maximum values are saved in the storage device. Approximately once a week an operator calls the weather station from the University of Florida and retrieves the stored data into a computer. Appendix IV presents the analyzed data in biweekly time series of wind velocity, wind direction, air temperature and rainfall.

2.5 Photographic Documentation

Oblique color ground photography has been taken throughout the study to document changes as the nourished beach evolves. Photography is conducted in conjunction with each survey. Three photos are generally taken along each profile, viewing to the left along the beach, perpendicular to the beach and to the right along the beach. The reader may contact the authors regarding availability of the photographs.

3 ISSUES CURRENTLY UNDER INVESTIGATION

In addition to the information presented in the preceding sections of this report, three problems are under active study and are discussed here only briefly.

3.1 Nearshore Berm Evolution

As noted, following the beach nourishment, approximately 3 million cubic meters of sand were placed underwater in the area shown in Figure 2. Figures 3 and 4 show cross-sections through the entire profiles including the profile nourishment area for DNR Monuments R-50 and R-58. This portion of the nourishment is referred to as "profile nourishment" as distinguished from the "beach" nourishment which advanced the dry beach and its underwater extension. The profile nourishment sand was placed by bottom-dump barges such that each placement results in a more or less identifiable mound with the entire placement appearing as a very "hummocky" terrain (see Figure 5). Although the original program did not call for study of this portion of the nourishment, the program scope was modified in Spring, 1992 to include this element. Starting with the Fall survey of 1992, our annual surveys have encompassed the profile nourishment area. These efforts have included an extension of the profile lines in the area of profile nourishment and additional surveys "blanketing" the area. The results from the bathymetric survey in October, 1992 are presented in Figures 5 and 6 which show a three-dimensional view and a contour map of the nourished area.

The major issues concerning the profile nourishment center around the movement of the sand ashore with special emphasis on the rate. The rationale for hypothesizing landward movement is that if the profile was initially in equilibrium and "active", placement of additional material such as occurred here will result in a profile with an "excess of sand" leading to onshore sediment transport. Methods currently being employed to address this question include a focus on the landward edge of the placed material and the bathymetric evolution with particular emphasis on smoothing of the surface features. Perdido Key was impacted by Hurricane Andrew in October 1992 with peak significant waves at the two gages measured at 2.7 m. Based upon analysis of the profile nourishment data, it appears that there may be a small net landward

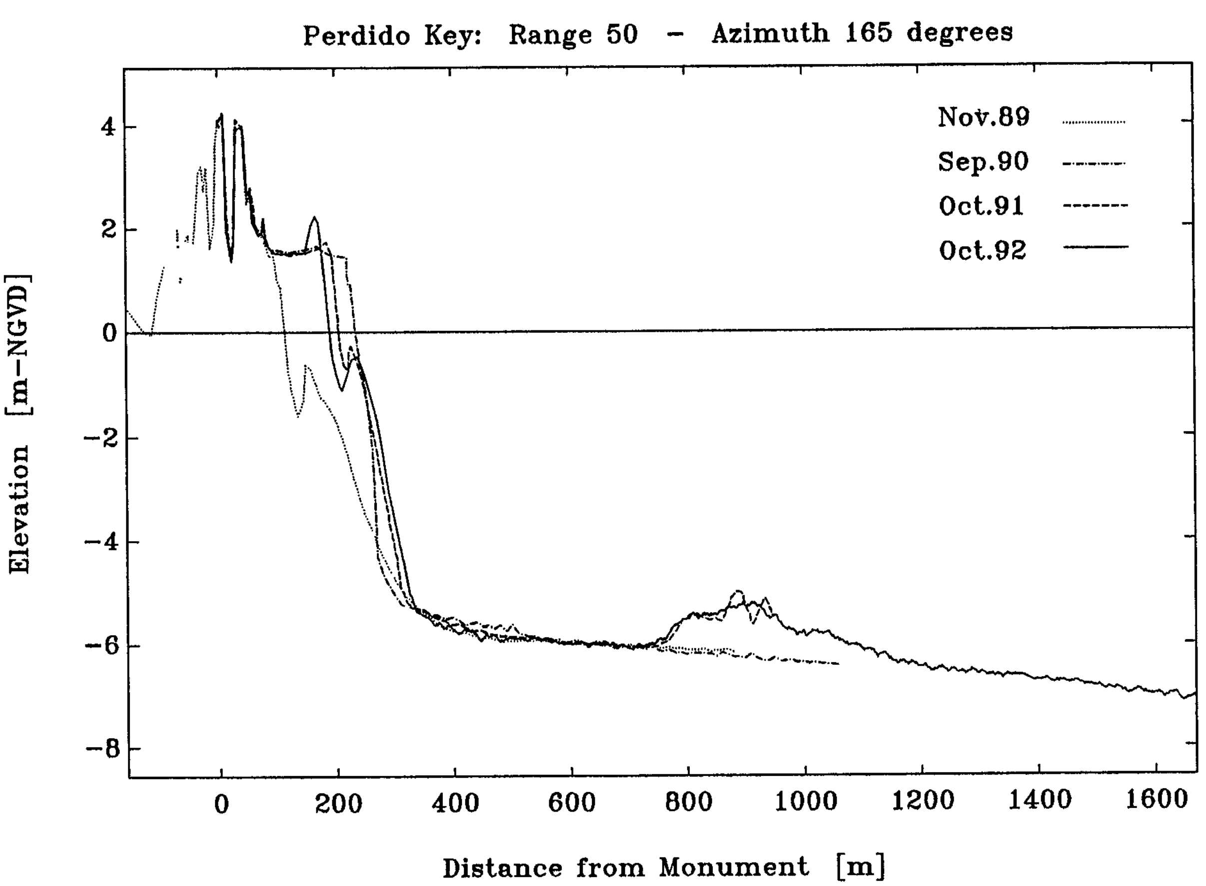

Figure 3: Cross-section of the profile nourishment at R-50.

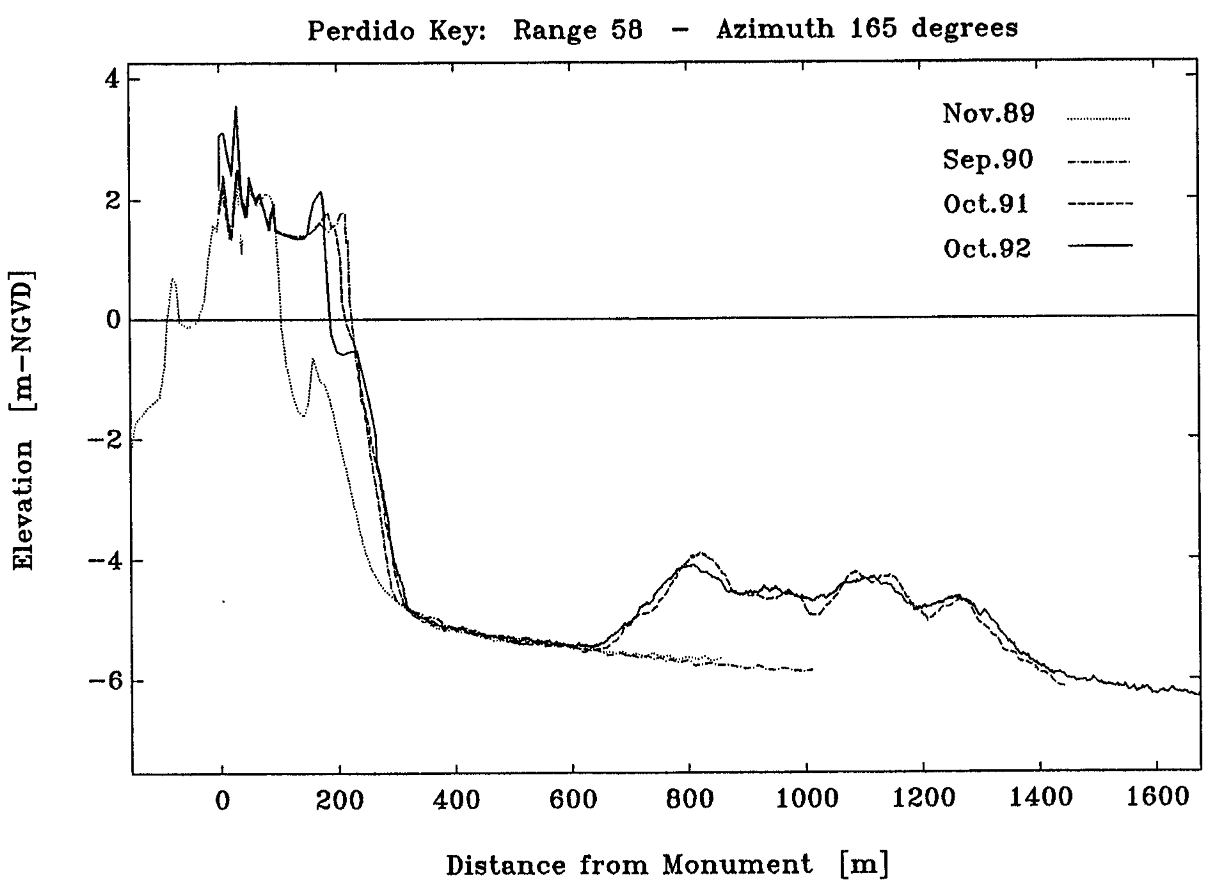

Figure 4: Cross-section of the profile nourishment at R-58.

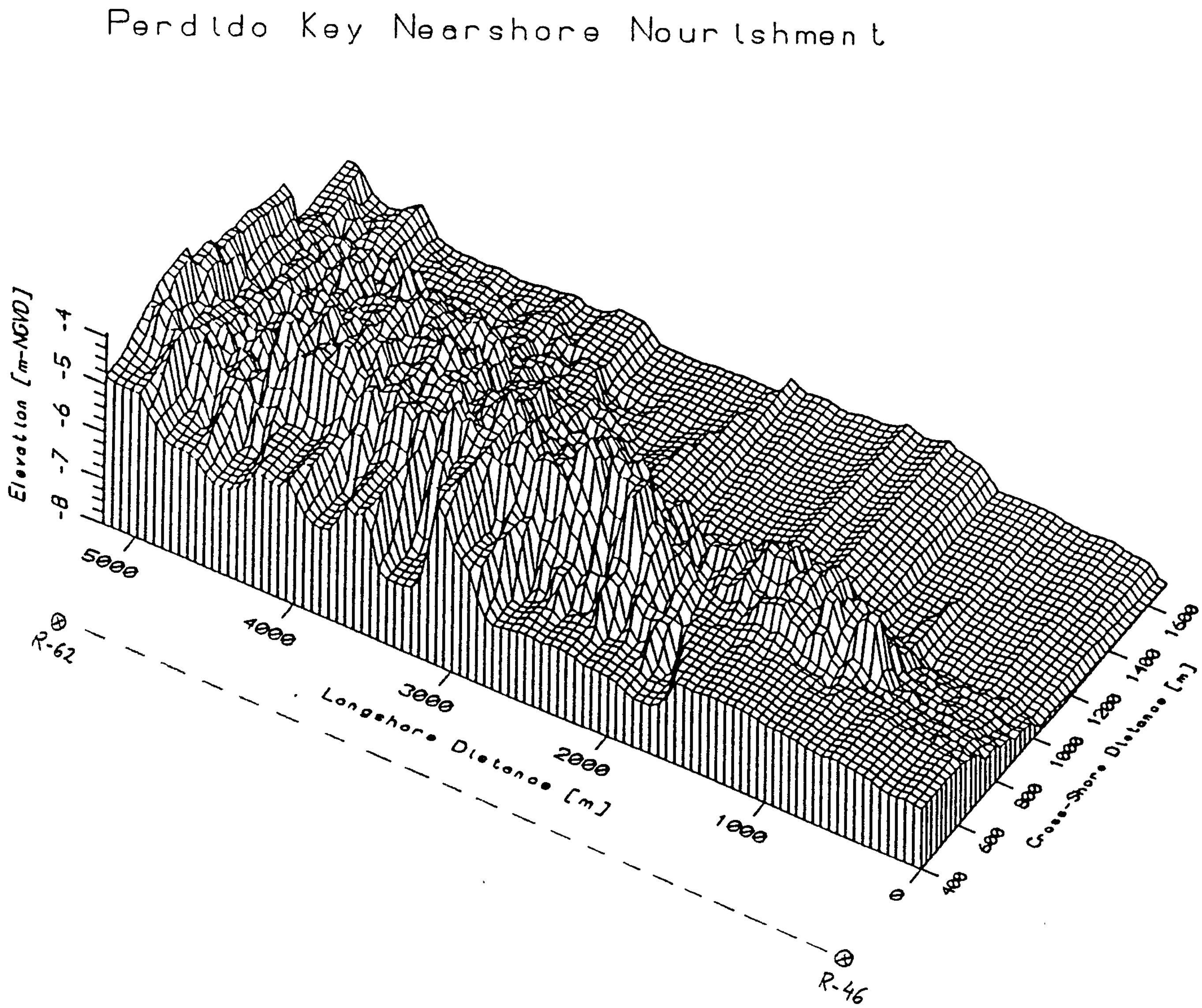

Figure 5: Three-dimensional view of the profile nourished area as measured in October, 1992.

Perdido Key Nearshore Nourishment

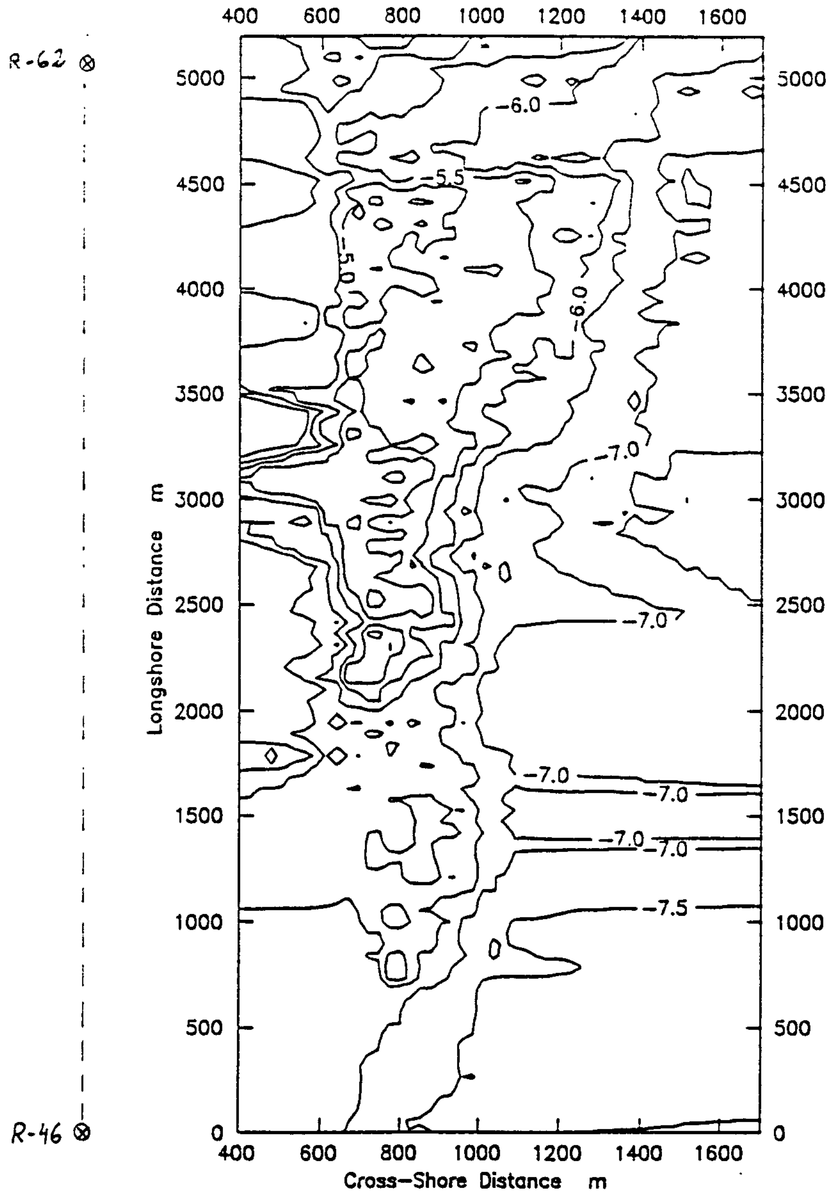

Figure 6: Contour map of the profile nourished area as measured in October, 1992.

movement of the underwater berm forming the profile nourishment; however, most of the evolution is apparent as a "spreading out" of the placed material. This is evident in Figures 3 and 4 for Monuments R-50 and R-58.

In addition to continuing to monitor the profile placement geometry, future efforts will be directed to the development of methodology for the prediction of the evolution of the underwater mound, including the rate of landward migration and the smoothing of the surface features.

3.2 Wave Data Comparison

As discussed previously, a second wave gage was installed in the vicinity of Caucus Shoals in April, 1992. One purpose of this gage was to identify and document any localized effects of the Entrance to Pensacola Bay, including the effects of Caucus Shoals. It is expected that causes of different wave properties at the two sites could include both wave refraction and wave diffraction, each of which can modify the wave height and wave direction. The effects of these processes are important as they can cause localized changes in the longshore sediment transport over the length of the nourishment project. These wave transformation phenomena are complicated due to the fact that they are functions of the incident wave direction and wave period. Also wave gages have a tendency to malfunction. The pressure sensor which provides the basis for determining wave heights is the most reliable element of the gage and the current meter which provides the basis for establishing wave direction is the least reliable.

At present, efforts are underway to identify portions of the wave records which are well-suited for identifying the wave transformation effects. Figures 7 and 8 present the wave characteristics at the two gages during the passage of Hurricane Andrew where it can be seen that the wave heights were approximately the same, at least until the Caucus Shoals gage ceased to

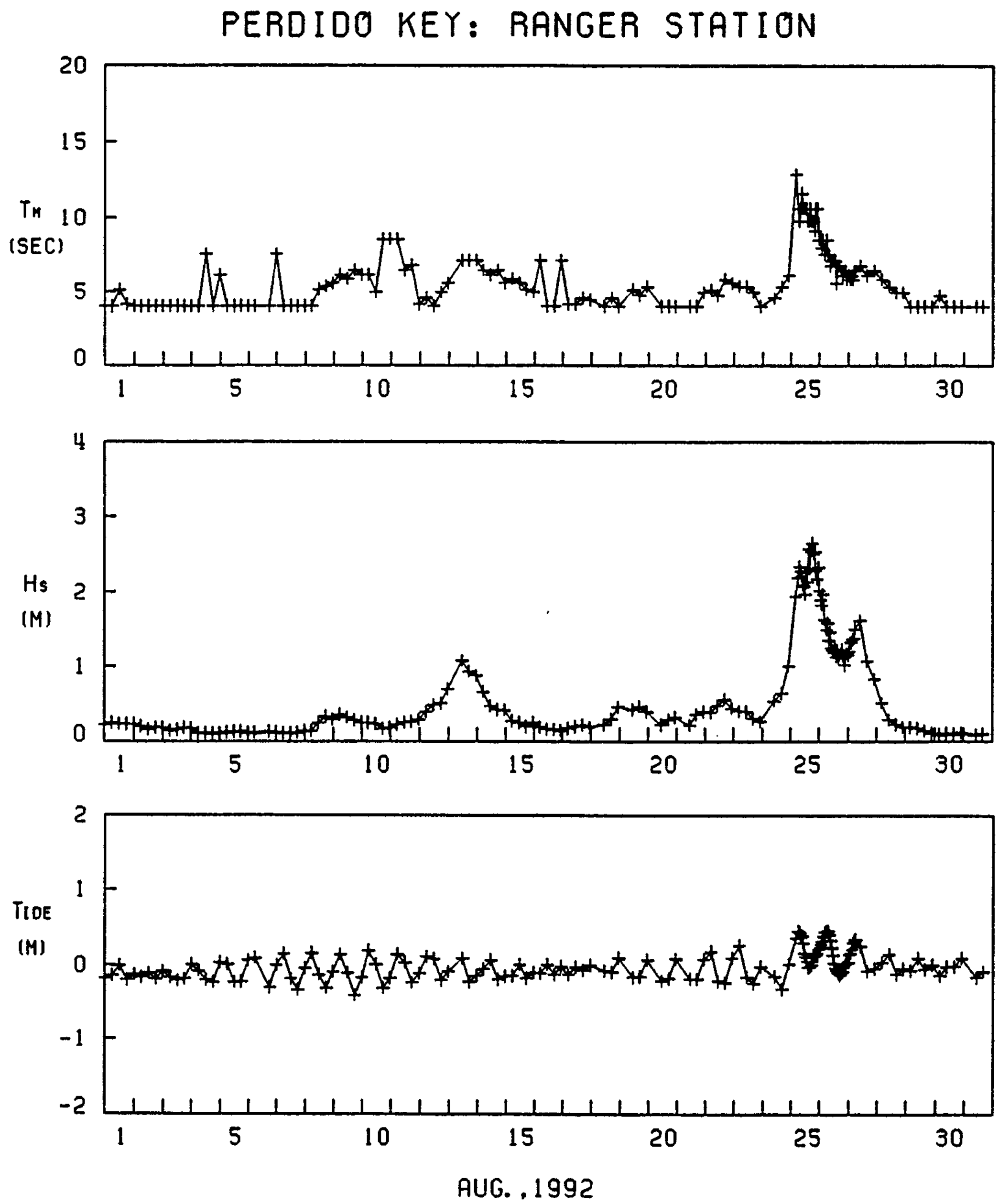

Figure 7: Representative wave period (T_m), significant wave height (H_s) and tidal stage recorded at Ranger Station during Hurricane Andrew.

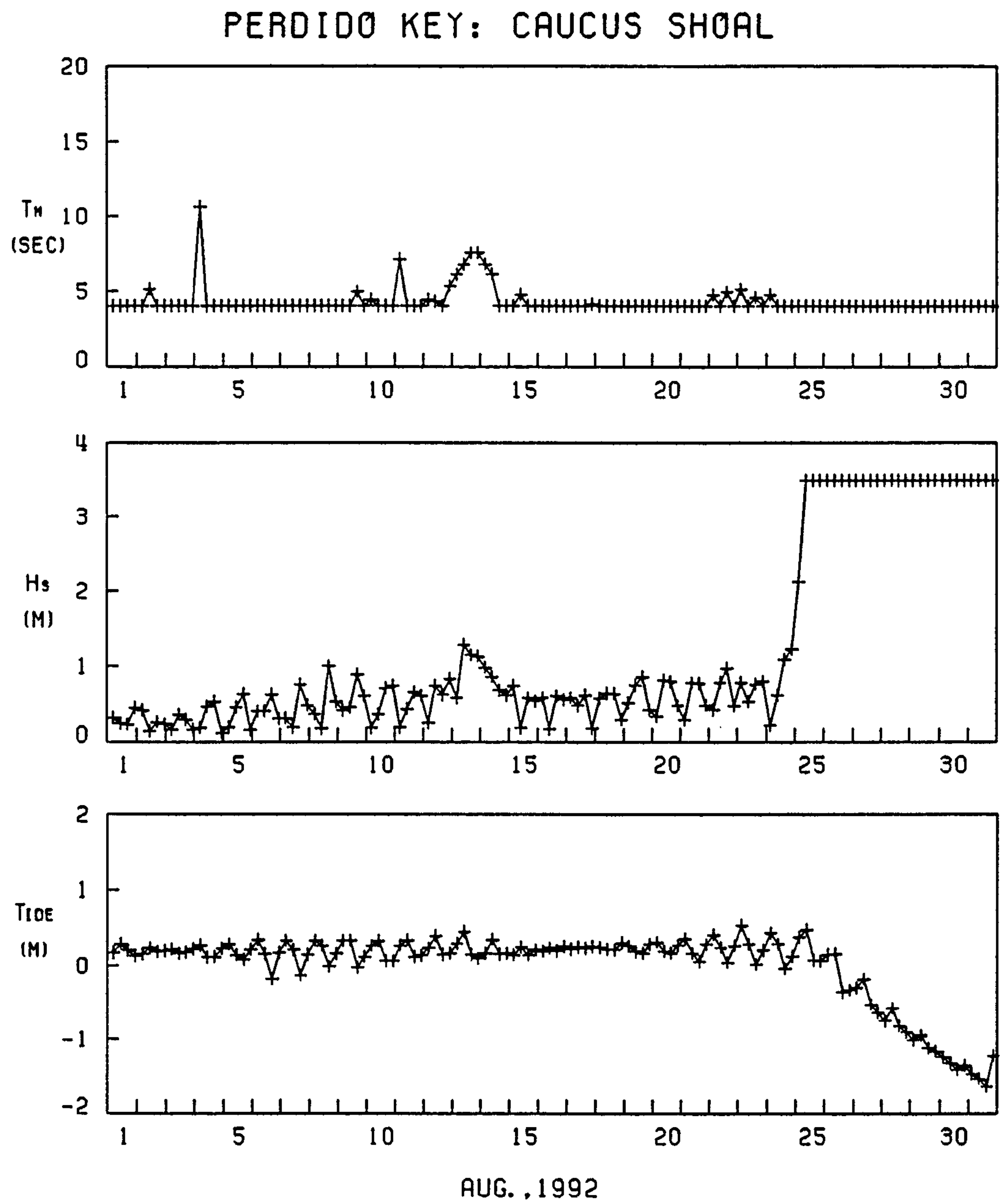

Figure 8: Representative wave period (T_m), significant wave height (H_s) and tidal stage recorded at Caucus Shoal during Hurricane Andrew.

function near the period of highest waves at about noon on August 24, 1992. During this period, the wave direction was not well established at either gage.

3.3 Washover Deposits Due to Hurricane Andrew

Hurricane Andrew caused washover deposits along portions of Perdido Key. These deposits can be characterized as extending approximately 25 m inland from the seaward limit of the berm and with a thickness of approximately 50 cm. Figure 9 presents an example of a cross-section (R-54) through the profile showing the washover deposit This deposit of sand has had the intended purpose of allowing the beach berm to build up naturally rather than to prevent overwash as would occur if the constructed berm were high as was the case for the 1985 beach nourishment. A very strong recovery "ridge" is also present in Figure 9. A manuscript is being developed for journal publication consideration describing this washover event and evaluating various methods for predicting the washover process and magnitudes.

4 DISCUSSION

Several features of the monitoring program, based on data collected last year merit discussion as presented below.

4.1 Concentration of Fines

The concentration of fines, located primarily between Ranges R-42 and R-59, are shown in Figures 10 and 11 respectively for the 5 and 8 m contours, and appear to be decreasing with time. The origin of these fines is the Pleistocene mud deposits that were excavated in the dredging operation. The decrease of fines with time is to be expected due to suspension during energetic wave events which causes suspension of the fines and distribution over wide areas.

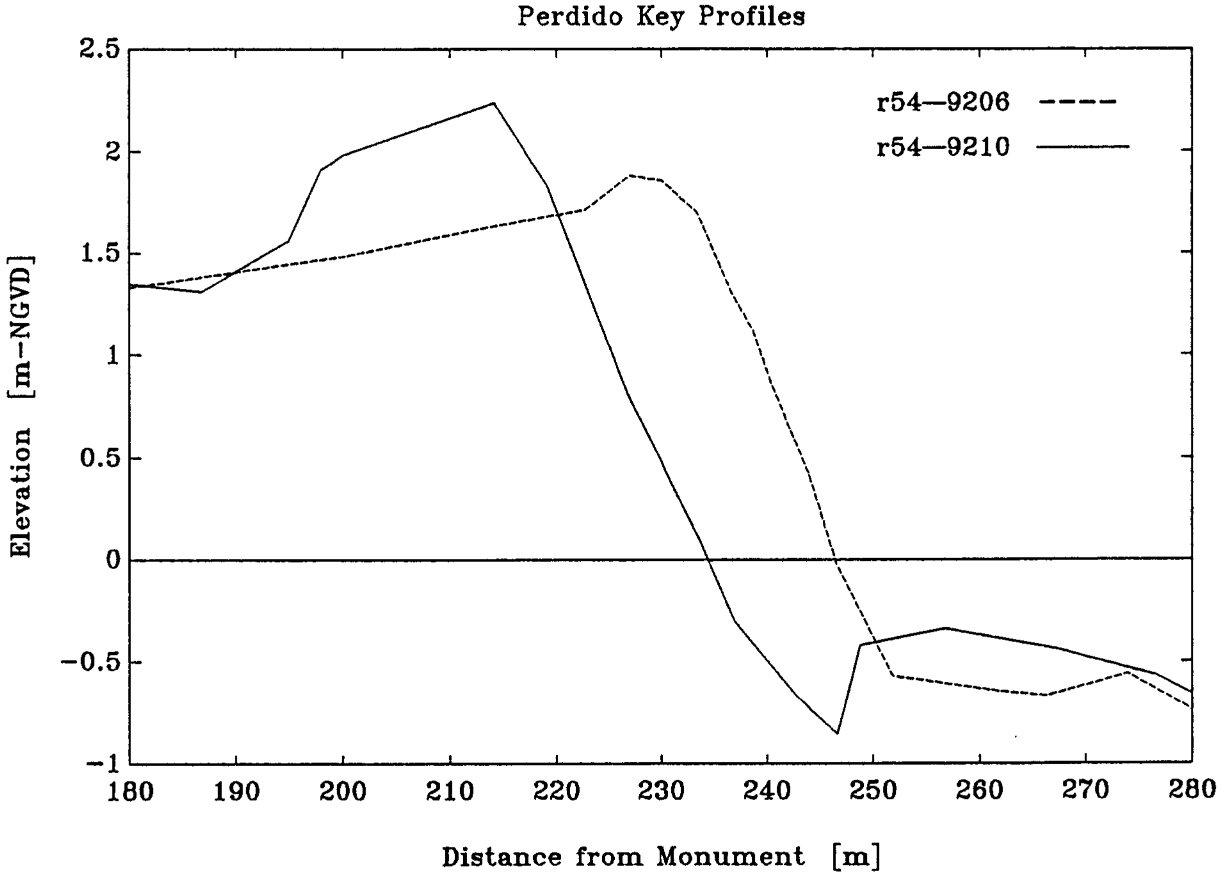

Figure 9: Profiles at R-54 before and after Hurricane Andrew, showing shoreline recession and overwash.

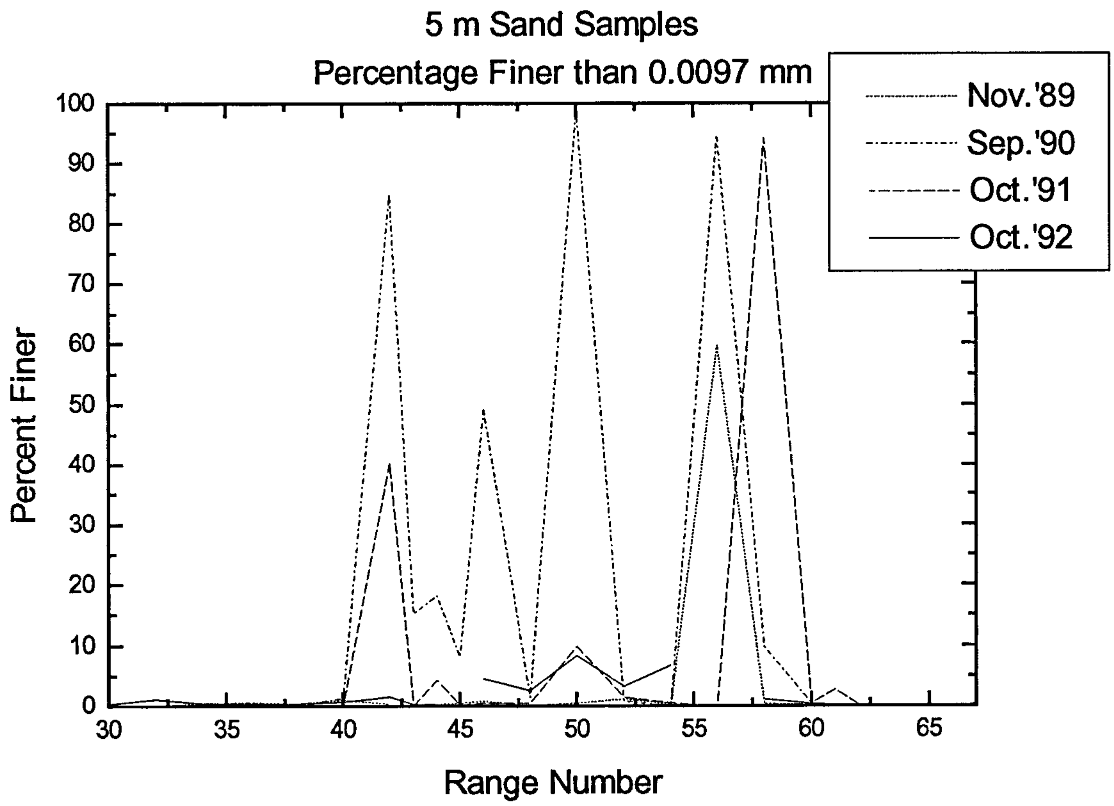

Figure 10: Percentage of fines for 5 m samples for all years of study.

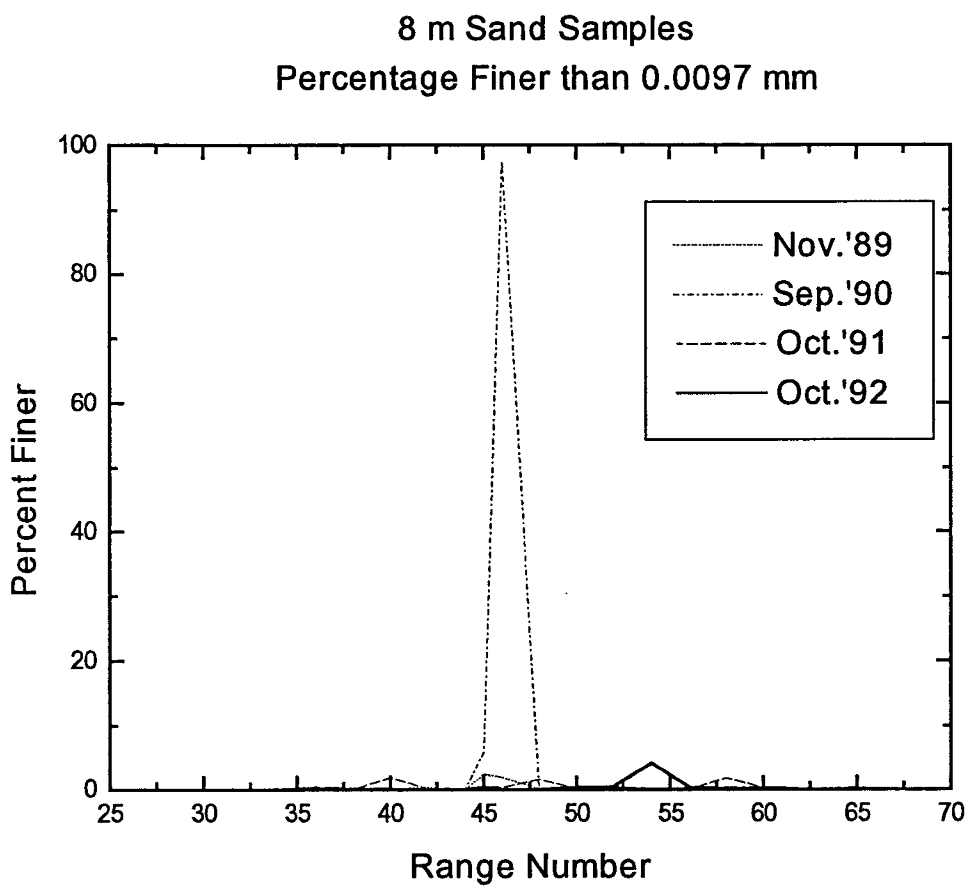

Figure 11: Percentage of fines for 8 m samples for all years of study.

However the interpretation of the suspension and transport of fines must be tempered with the understanding that the distribution can be somewhat "spotty" due to local depressions and thus the data must be interpreted in the "aggregate" sense rather than on the basis of individual samples.

4.2 Sediment Characteristics

Sediment characteristics are summarized in Figure 12a for the dune, mid-beach, berm and beach face locations and in Figure 12b for the 1m, 2m, 5m and 8m depths. The solid line in each of these figures represents the October, 1992 median diameters and the dotted lines represent the envelope of the size distributions measured including pre-nourishment. It is seen that in general the 1992 sizes are nearer the lower limit of the envelope than the upper limit. This is also shown in Figure 13 which shows the temporal variation of the longshore averaged median values. There is a discernible but slight trend toward the smaller sizes. The reason for this is not known as many times it is found that new deposits will experience "natural armoring" in which the finer sand will be removed by wind or water action leaving the less erodible coarser material. It is possible that Hurricane Andrew contributed to this effect. The two planned future sediment collections and analysis efforts may provide a basis for further interpretation and understanding.

4.3 Profile Equilibration and Cross-Shore Sediment Transport

The profiles in the nourishment project were placed steeper than those present prior to the nourishment project. Because the nourishment sediment is compatible to the native, it is expected that the final equilibrated profile will be very similar to the original. This equilibration is evident from Figures 14 and 15 which present respectively the alongshore changes in the dry beach width since November, 1989 and the alongshore change in the position of the 4 m contour

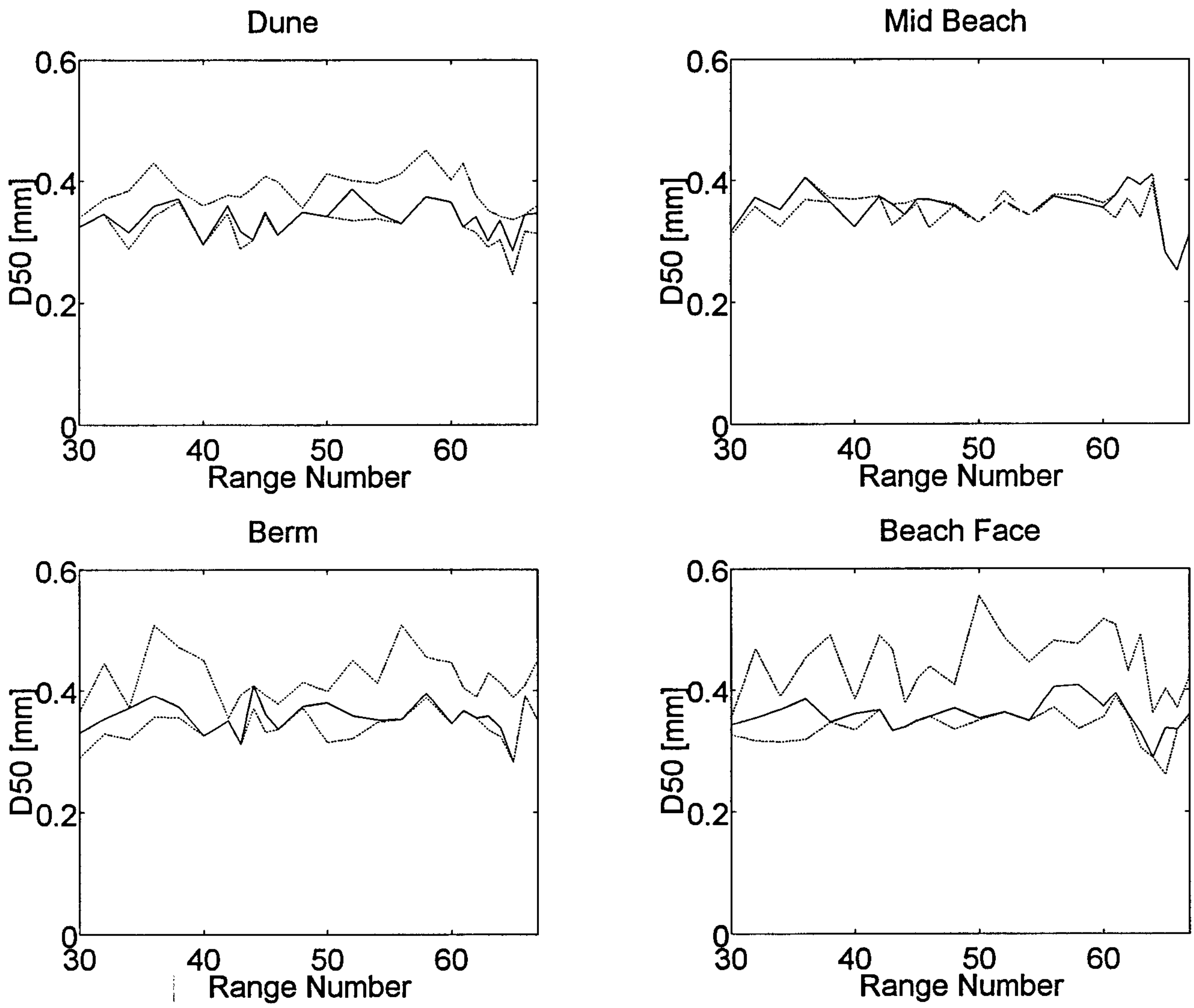

Figure 12a: Longshore distribution of D50 for October, 1992 (solid line) with envelope (dashed lines) of sizes for 1989, 1990, 1991 and 1992.

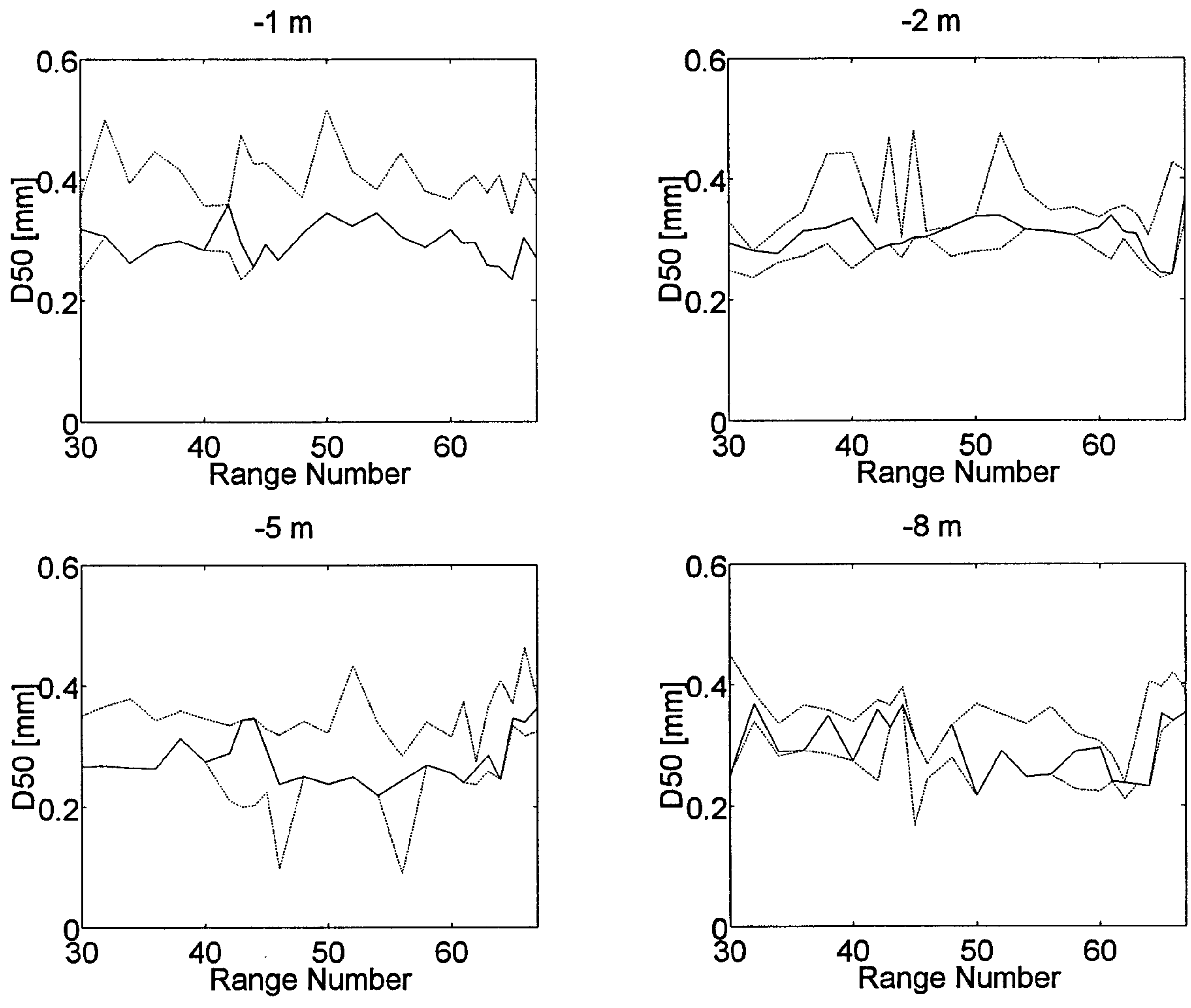

Figure 12b: Longshore distribution of D50 for October, 1992 (solid line) with envelope (dashed lines) of sizes for 1989, 1990, 1991 and 1992.

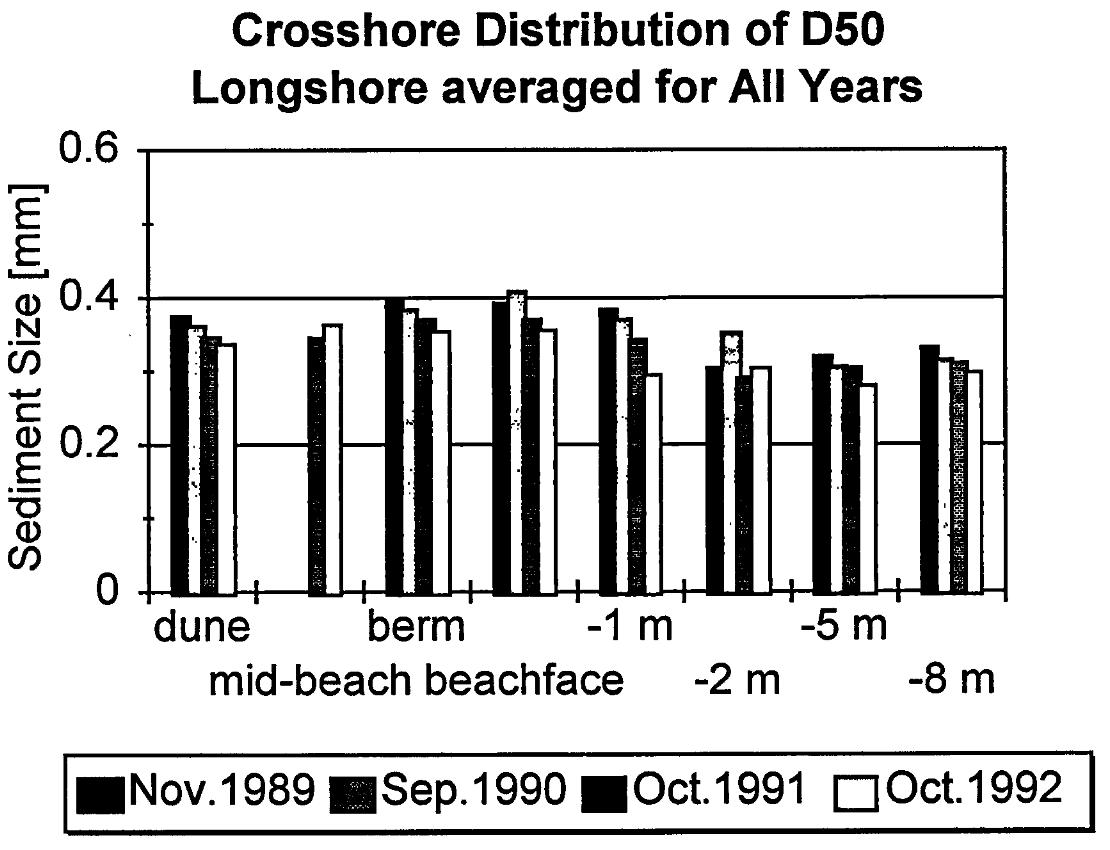

Figure 13: Cross-shore distribution of D_{50}. Temporal variation for all years of study.

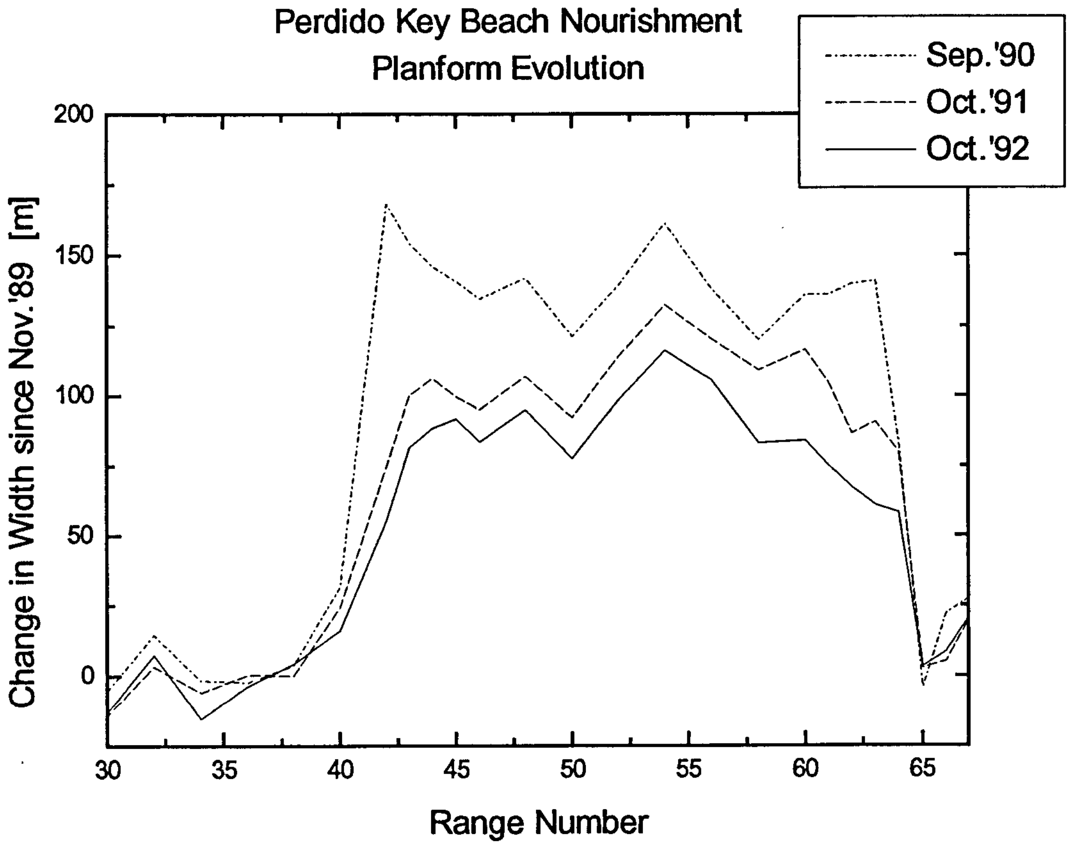

Figure 14: Evolution of dry beach width since completion of beach nourishment.

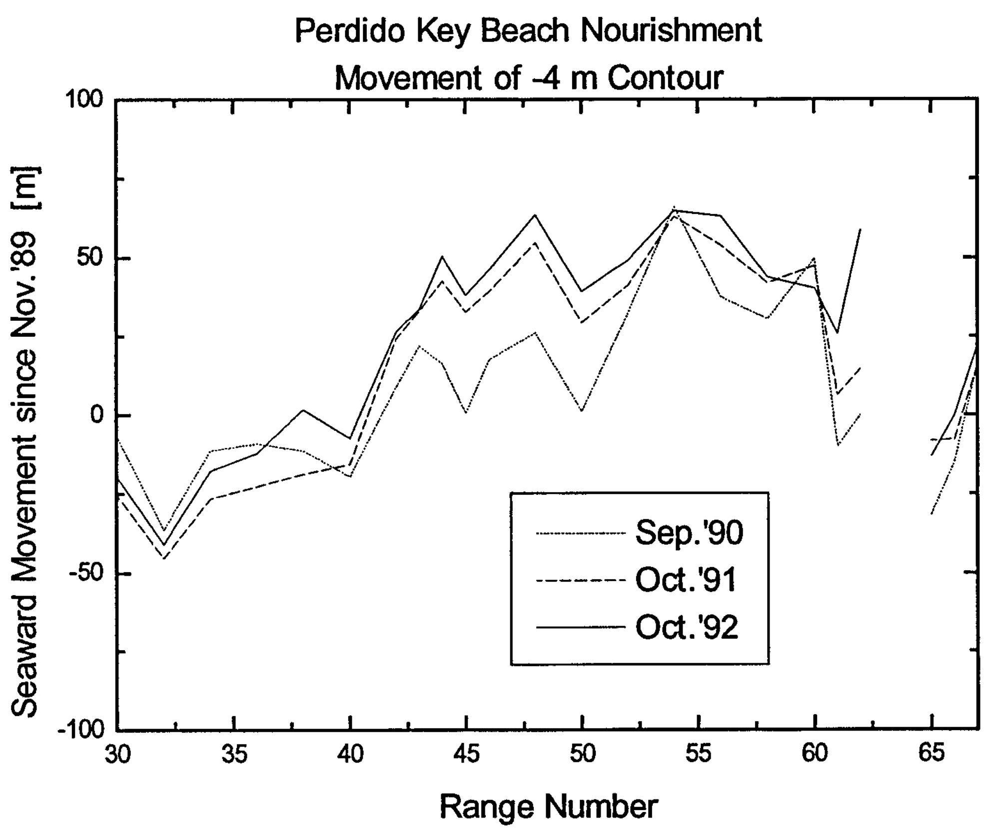

Figure 15: Movement of -4 m contour since completion of beach nourishment.

since November, 1989. The post nourishment recession of the dry beach and advancement of the 4 m contour within the nourishment area are indications of a reduction in profile slope. This slope equilibration is also evident in Figure 16 which presents the average of eight profiles within the nourishment area. The upper portions of the profiles (down to an elevation of approximately -0.6 m) appear to have always had approximately the same slope as prior to nourishment. This could be due to very rapid adjustment before the first post-nourishment survey or could be due to the placement slope coinciding with the equilibrium slope. It is likely that both explanations are correct to some degree. Proceeding to greater depths, the offshore bar is not as well developed as for the pre-nourishment profiles. In fact the average profile one year after nourishment has only a small indication of a bar whereas after two years, the bar is now better developed. The slopes seaward of the bar are still substantially steeper than the pre-nourishment values. The features discussed above are consistent with the fact that the upper portions of the water column experience more wave energy and thus equilibrate more rapidly than the lower portions. Profile equilibration was hastened by the maximum 2.7 m peak significant wave heights (Figures 7 and 8) which occurred during Hurricane Andrew. However waves of this height had occurred previously at least twice during this study. It is generally believed, based on very limited data, that cross-shore equilibration requires approximately 2 to 5 years. Although the data collected in conjunction with this study seem reasonably consistent with this time frame, they provide more detail in particular the progressive evolution toward equilibrium with increasing water depth. Finally, it should be noted that these profile equilibration data provide the best documentation for any beach nourishment project to date. Figure 17 presents, for comparison the average of five profiles west of the nourishment.

An estimate of the average cross-shore sediment transport can be determined from sequential average profiles as presented in Figures 16 and 17. These calculated cross-shore transport rates which are presented in Figures 18 and 19 do not account for sand removed by

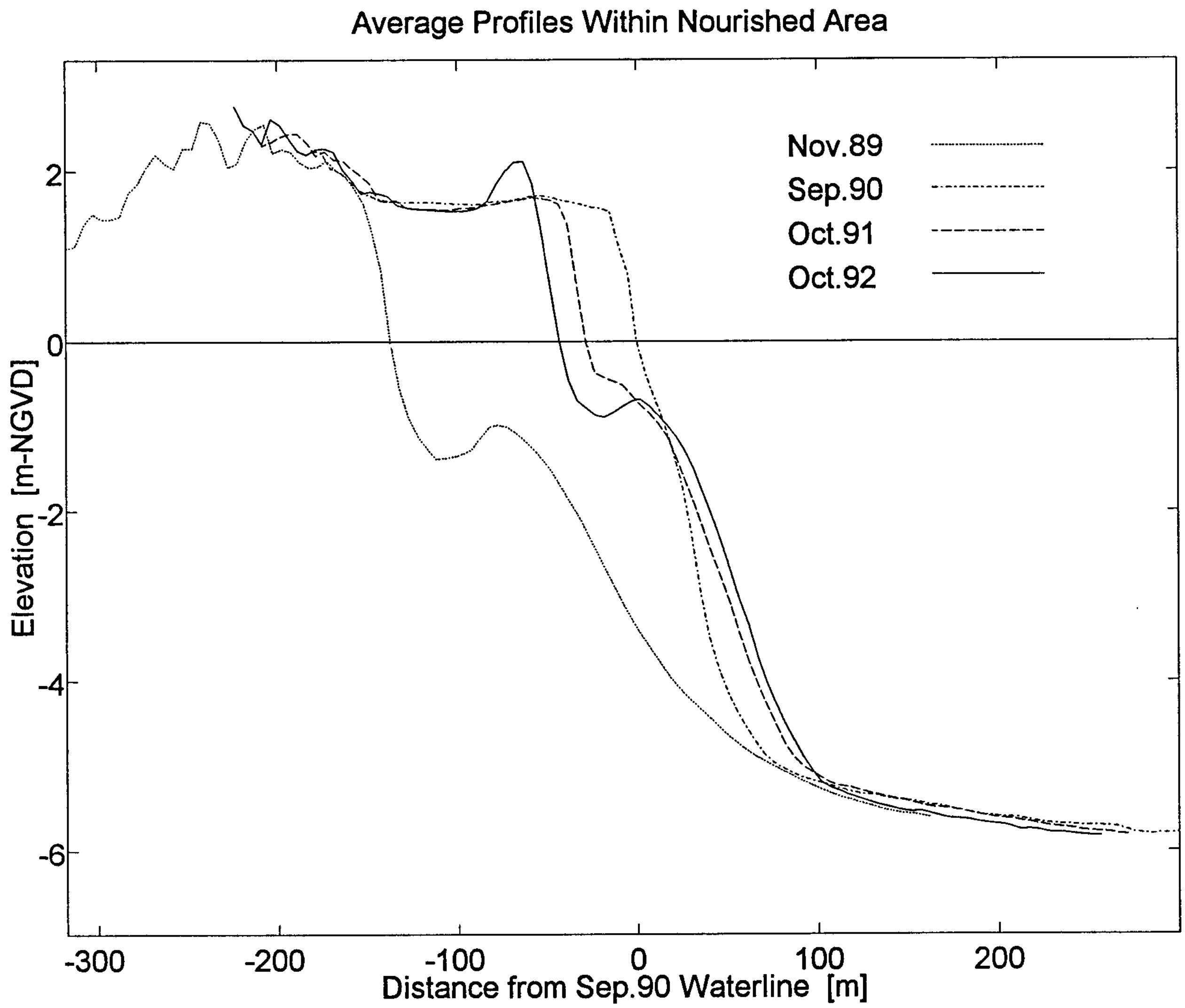

Figure 16: Average of profiles within nourished area. Averages based on profiles at R-45, R-46, R-48, R-50, R-52, R-54, R-56 and R-58.

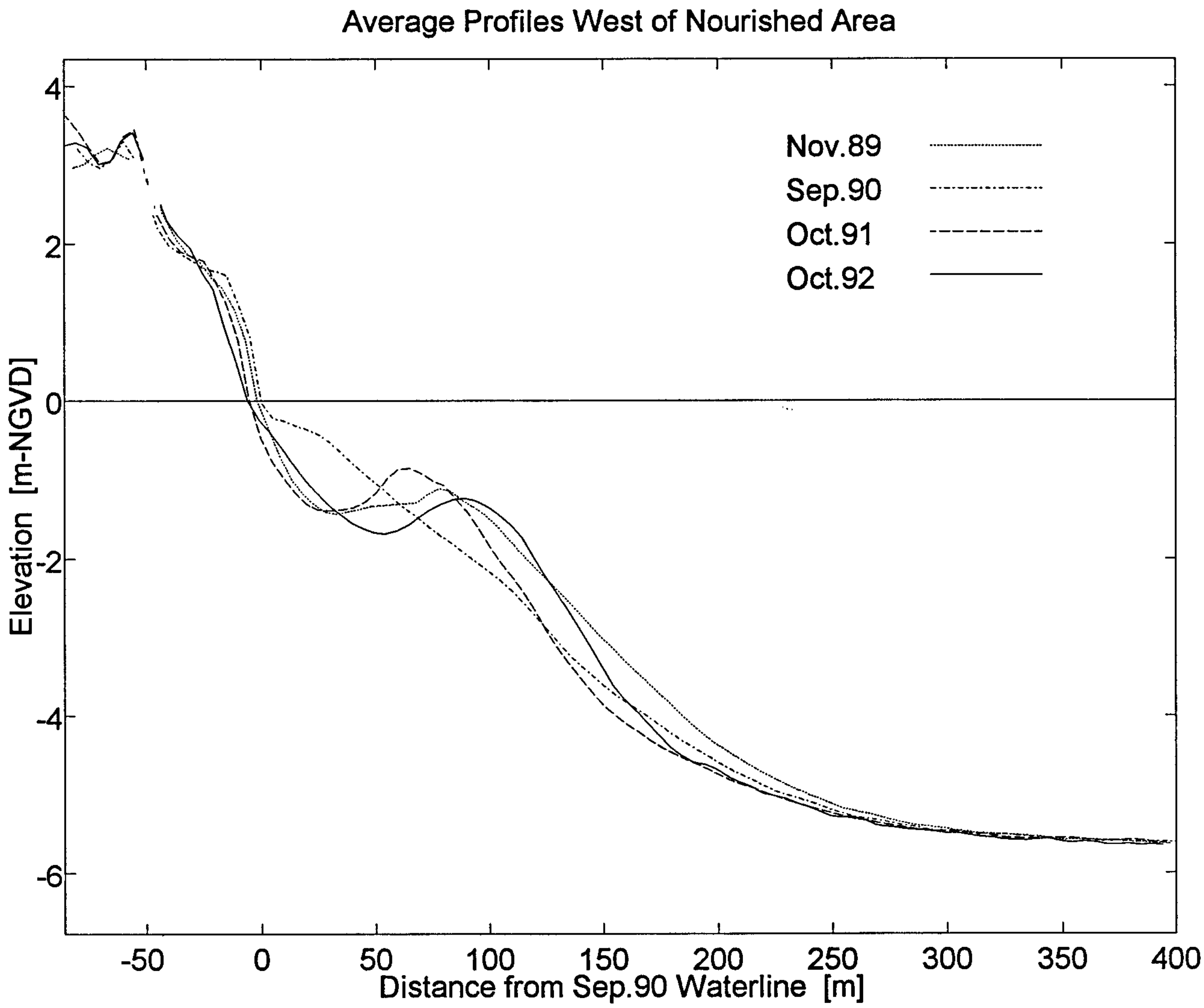

Figure 17: Average of profiles west of nourished area. Averages based on profiles at R-30, R-32, R-34, R-36 and R-38.

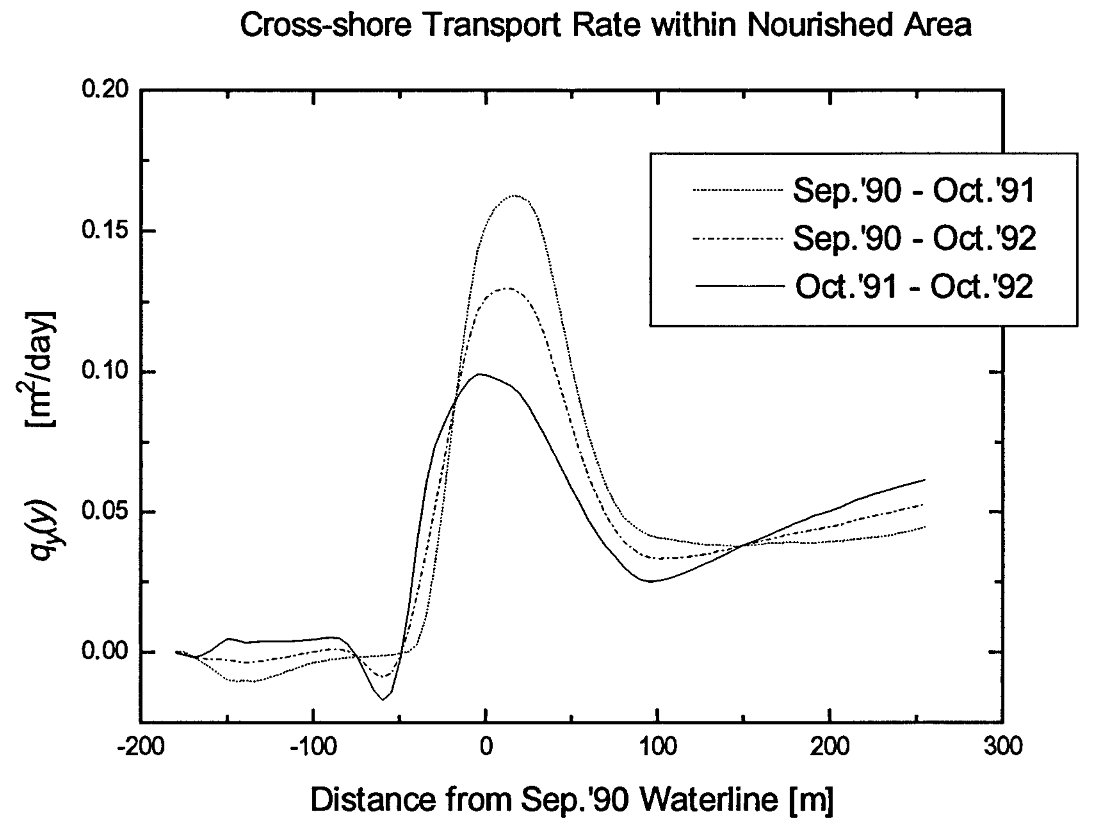

Figure 18: Cross-shore sediment transport within nourished area, based on average profiles shown in Figure 16. Results based on profile deformations occurring between September, 1990 and October, 1992.

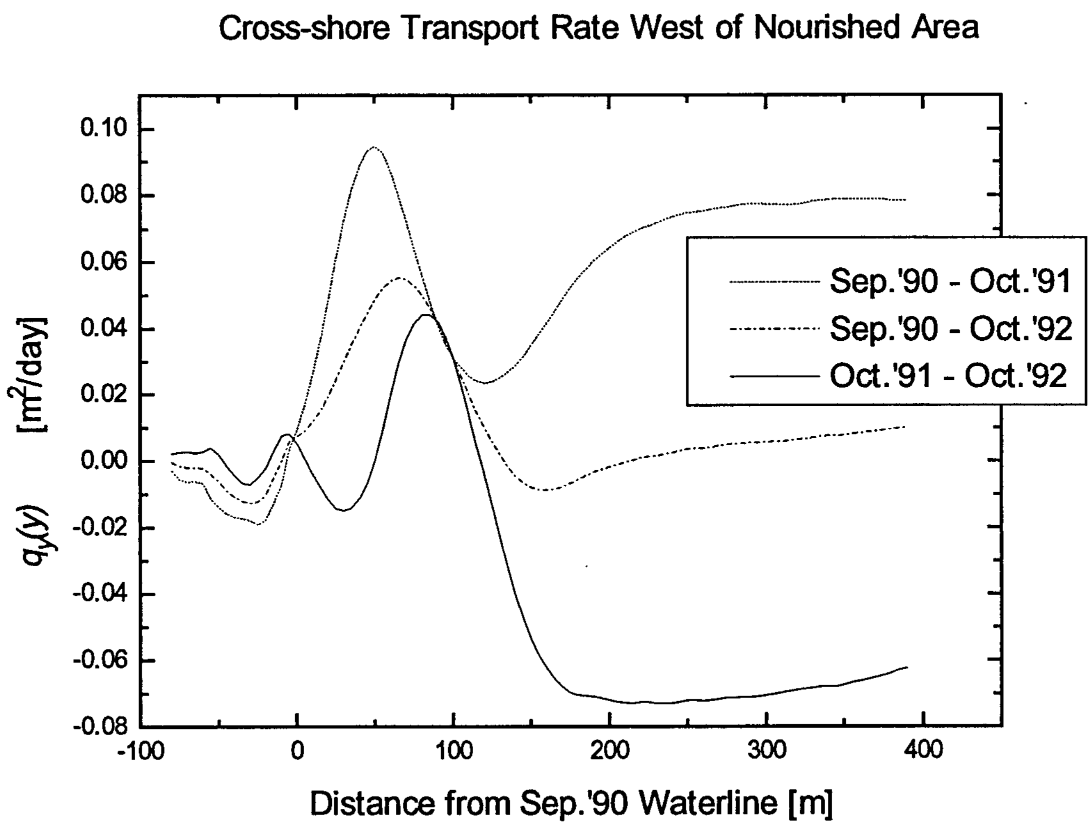

Figure 19: Cross-shore sediment transport west of nourished area, based on average profiles shown in Figure 17. Results based on profile deformations occurring between September, 1990 and October, 1992.

longshore transport. It is seen that within the nourished area (Figure 18), the maximum cross-shore transport during the second year after nourishment is approximately 60% to 70% of the value during the first year, even with the mobilizing activity of Hurricane Andrew during the second year. The approximate cross-shore sediment transport for the profiles west of the nourishment project is shown in Figure 19. Without discussing the details, the peak offshore transport magnitudes within the nourishment area are approximately 2.5 times greater than the transport magnitudes west of the nourishment area.

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APPENDIX I

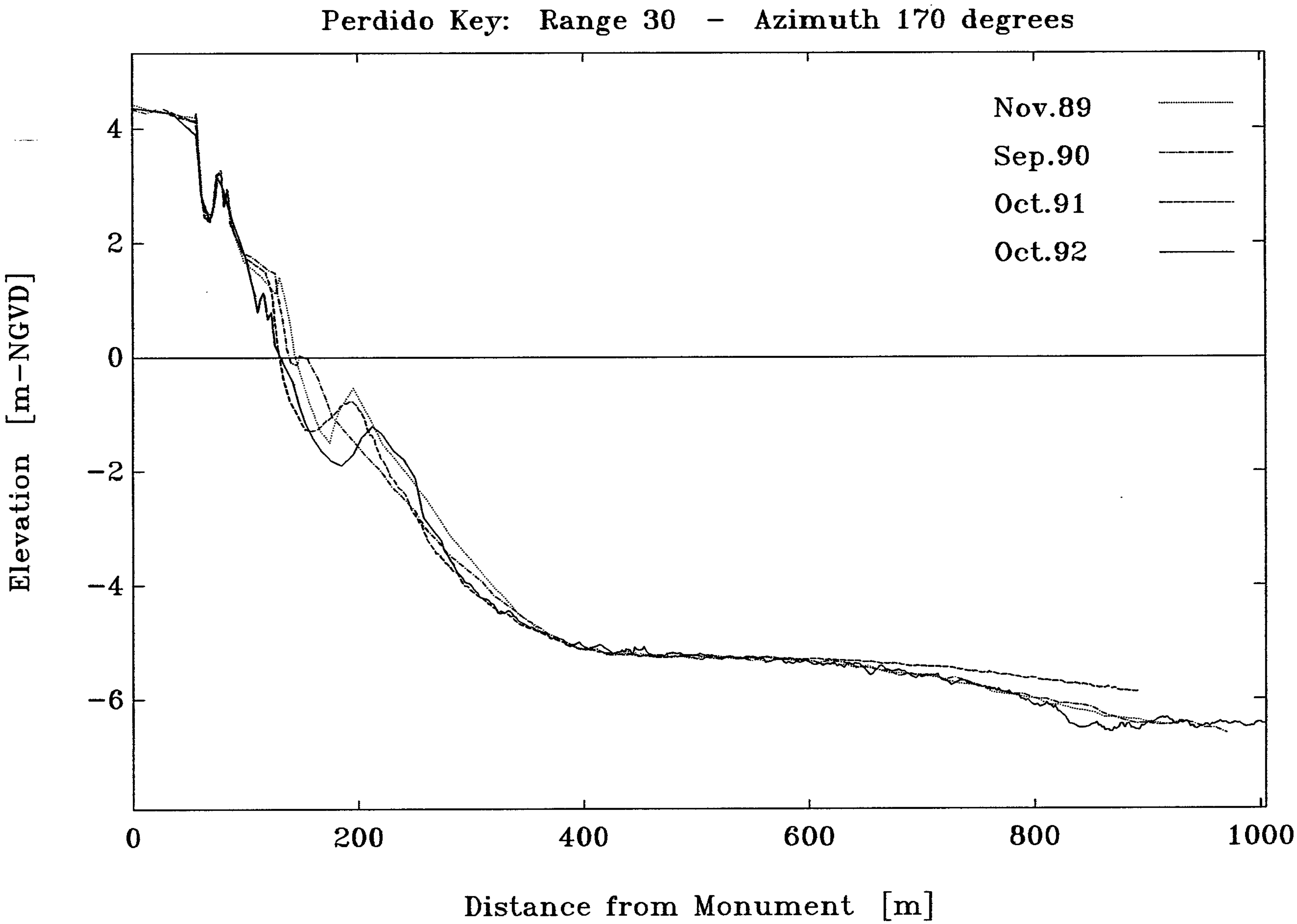
BEACH and OFFSHORE PROFILES

Notes:

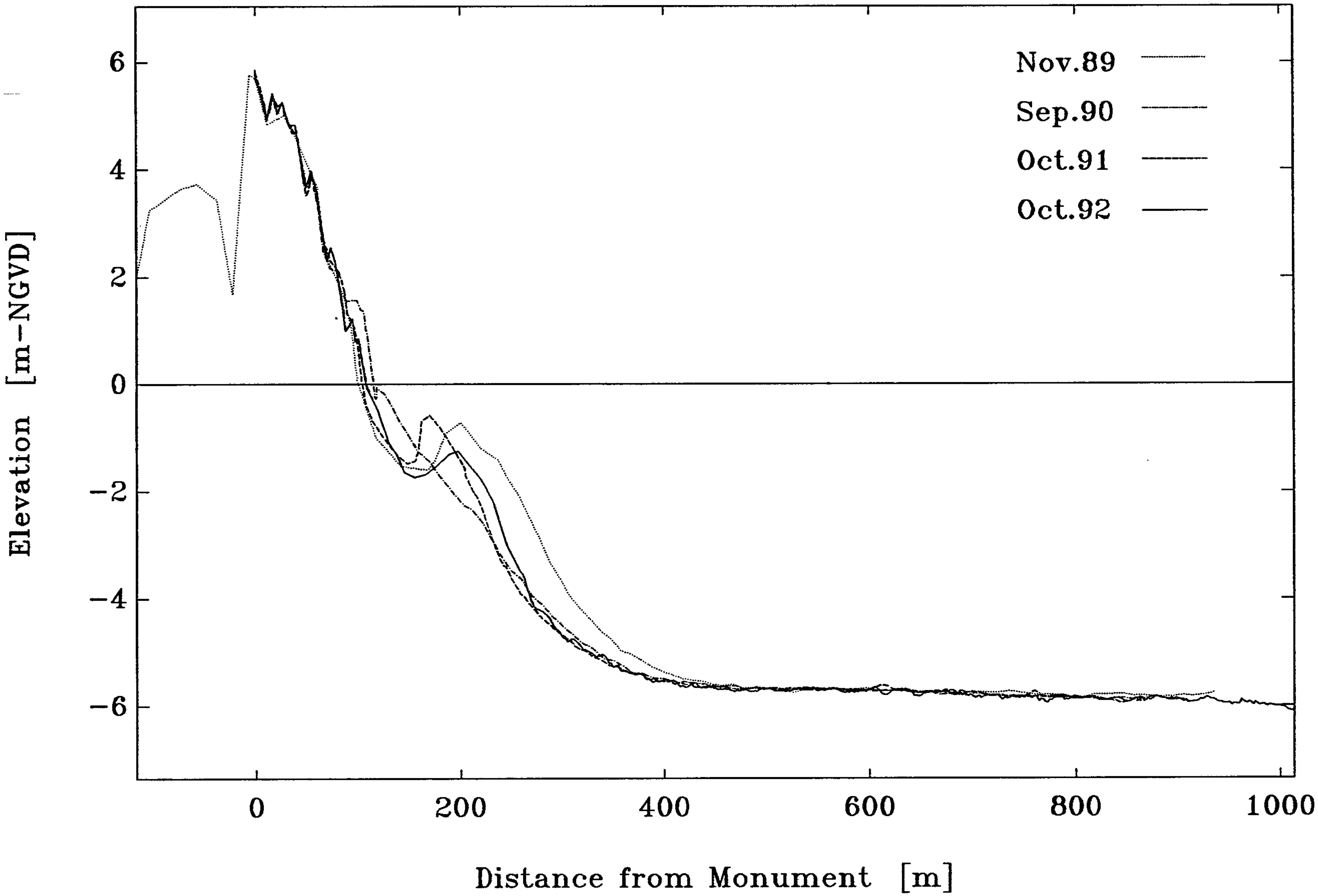
1) All elevations are in meters, relative to NGVD.

2) Horizontal origin is the survey monument, with distances toward the Gulf of Mexico defined as positive.

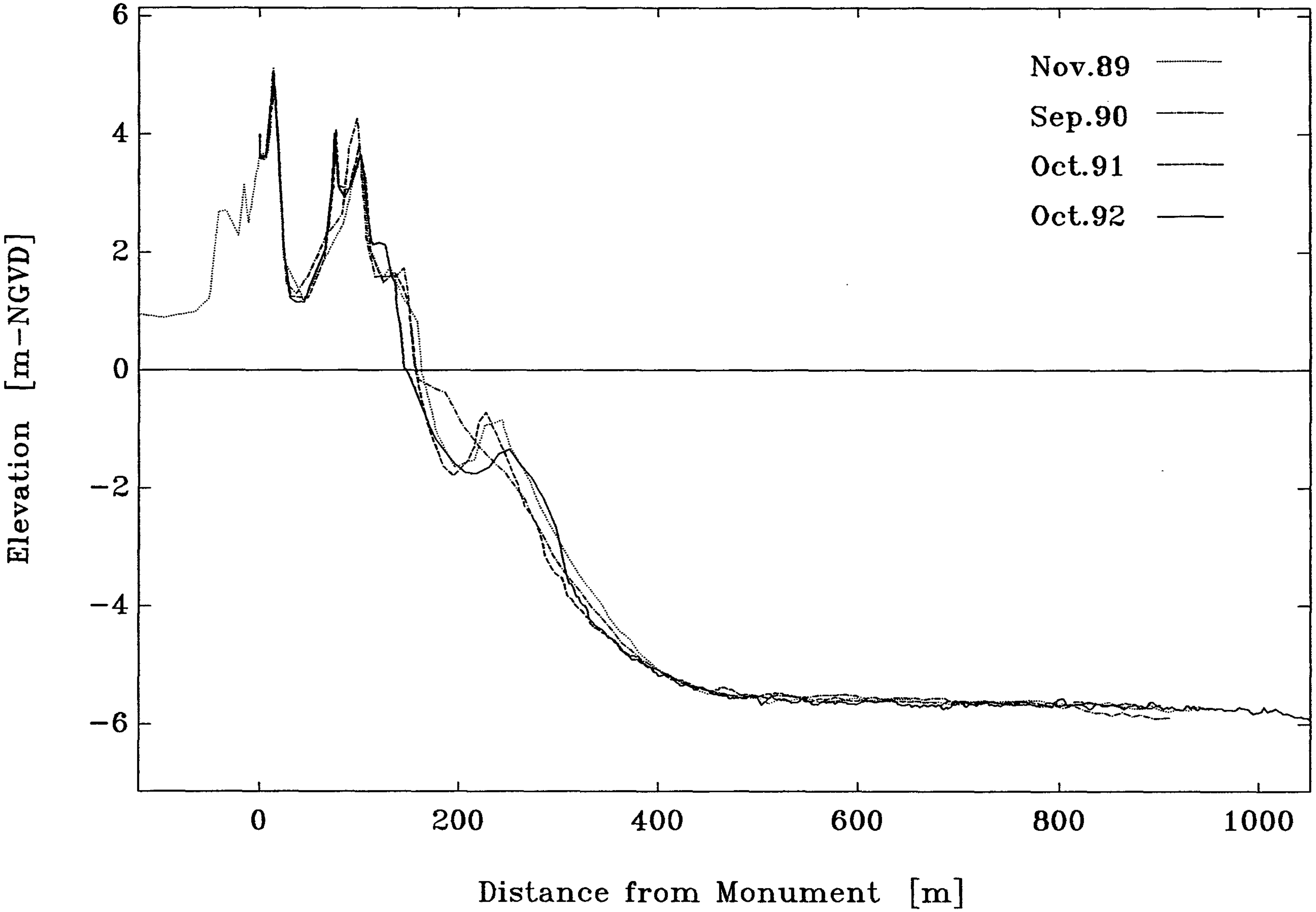
3) Reported bearings are for observer standing on monument, looking offshore along survey line.

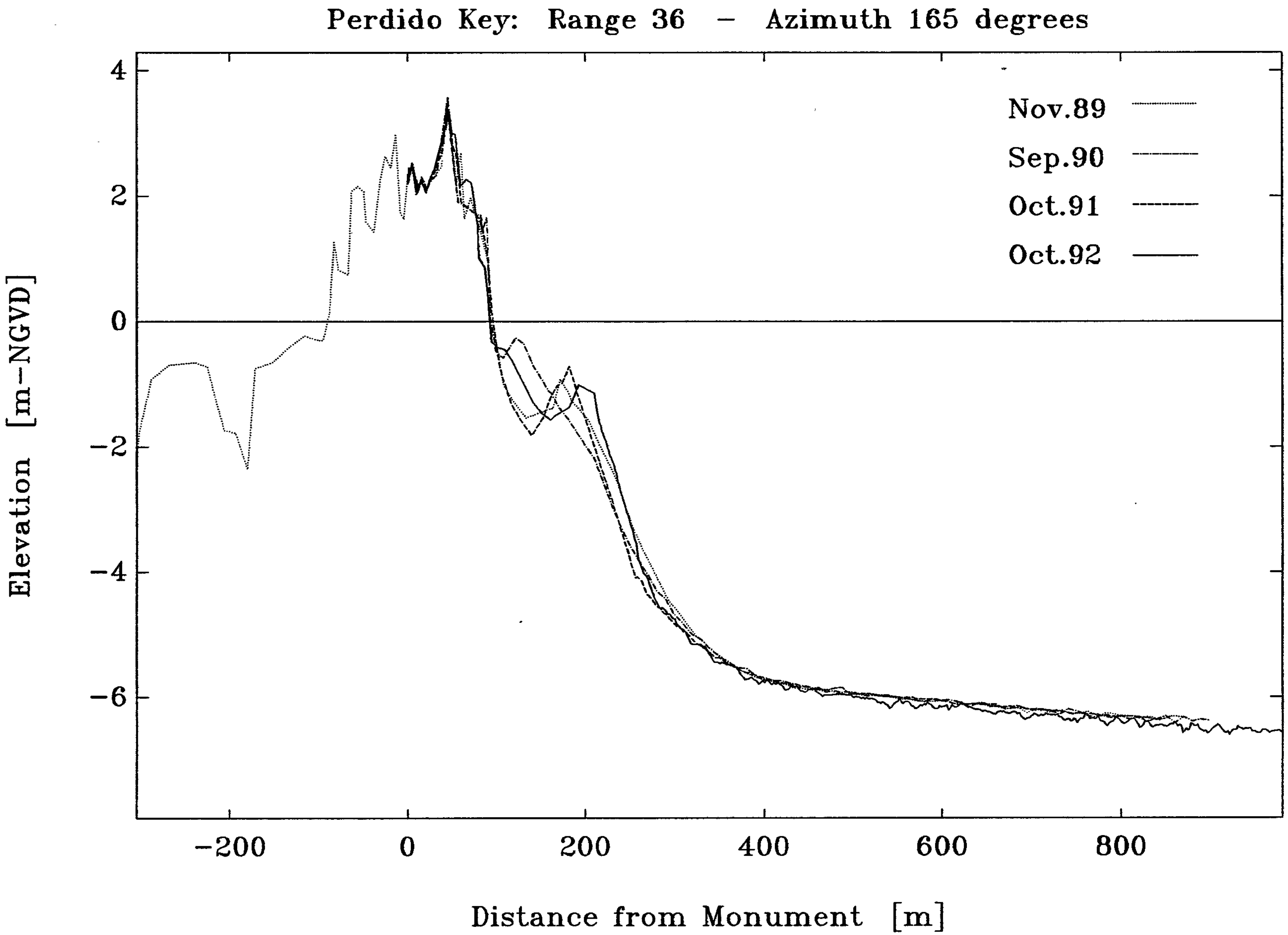

Perdido Key: Range 30 – Azimuth 170 degrees
Nov.89
Sep.90
Oct.91
Oct.92
Elevation [m-NGVD]
4
2
0
-2
-4
-6
0
200
400
600
800
1000
Distance from Monument [m]

Perdido Key: Range 32 – Azimuth 170 degrees

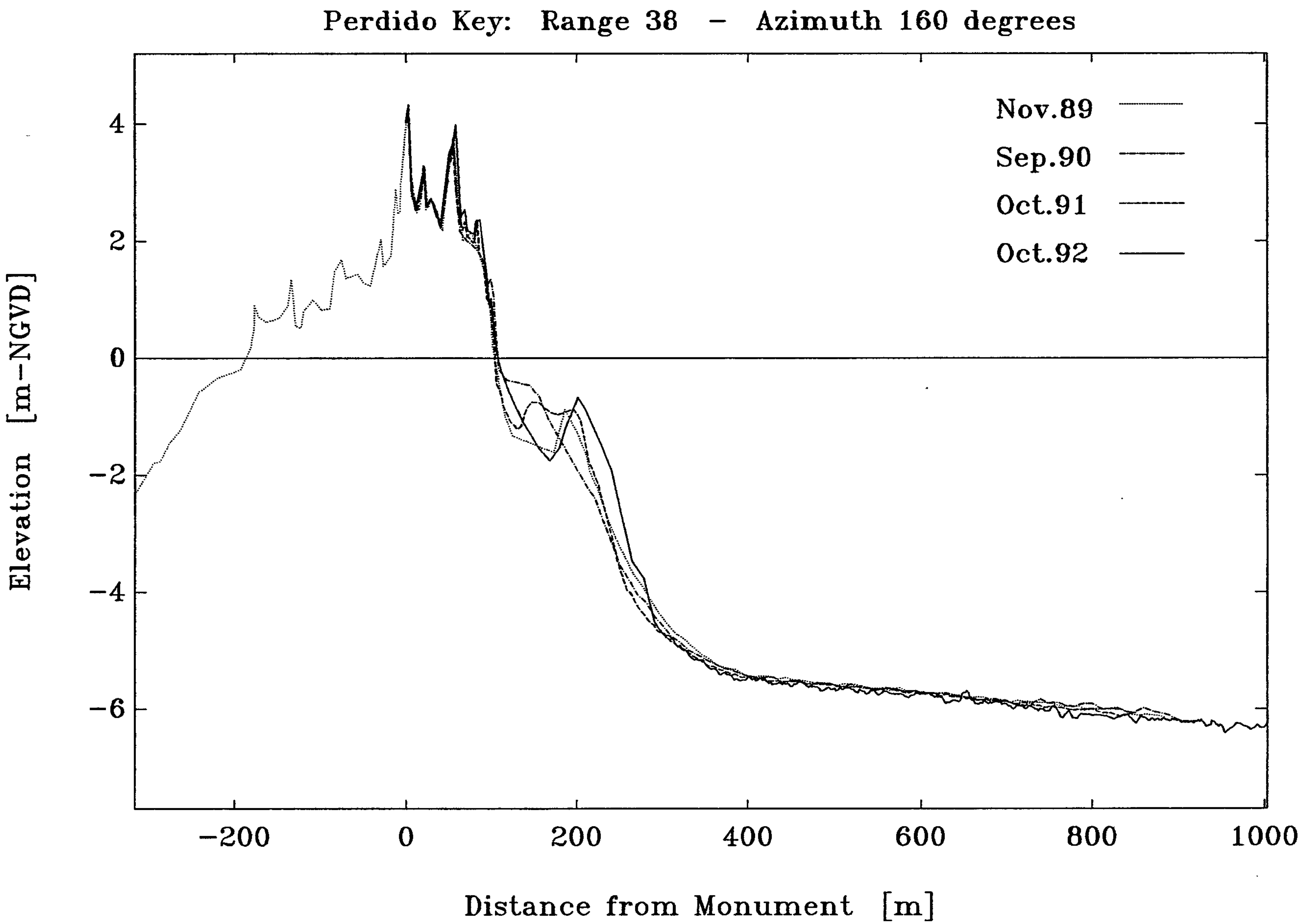


Perdido Key: Range 34 – Azimuth 165 degrees

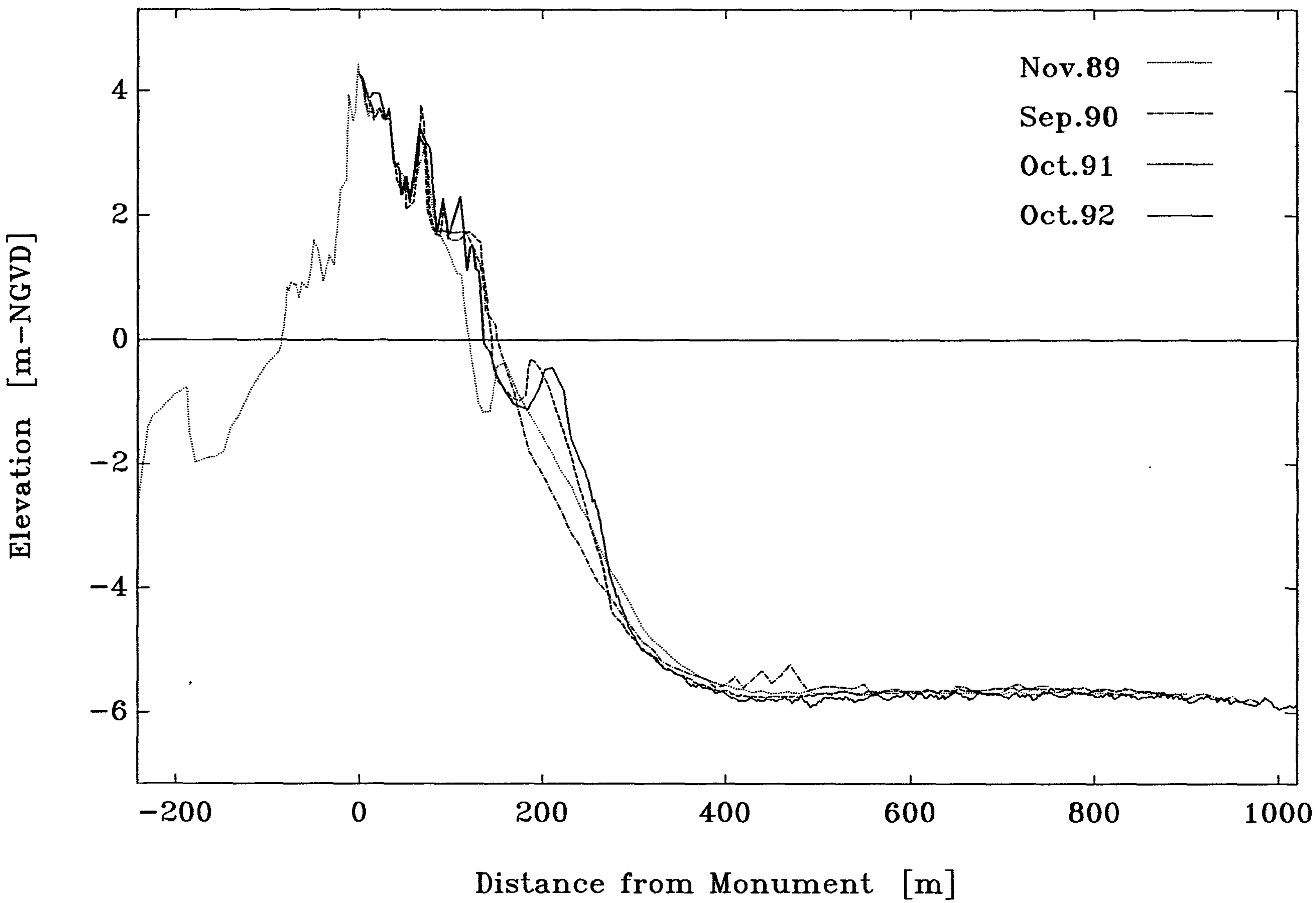


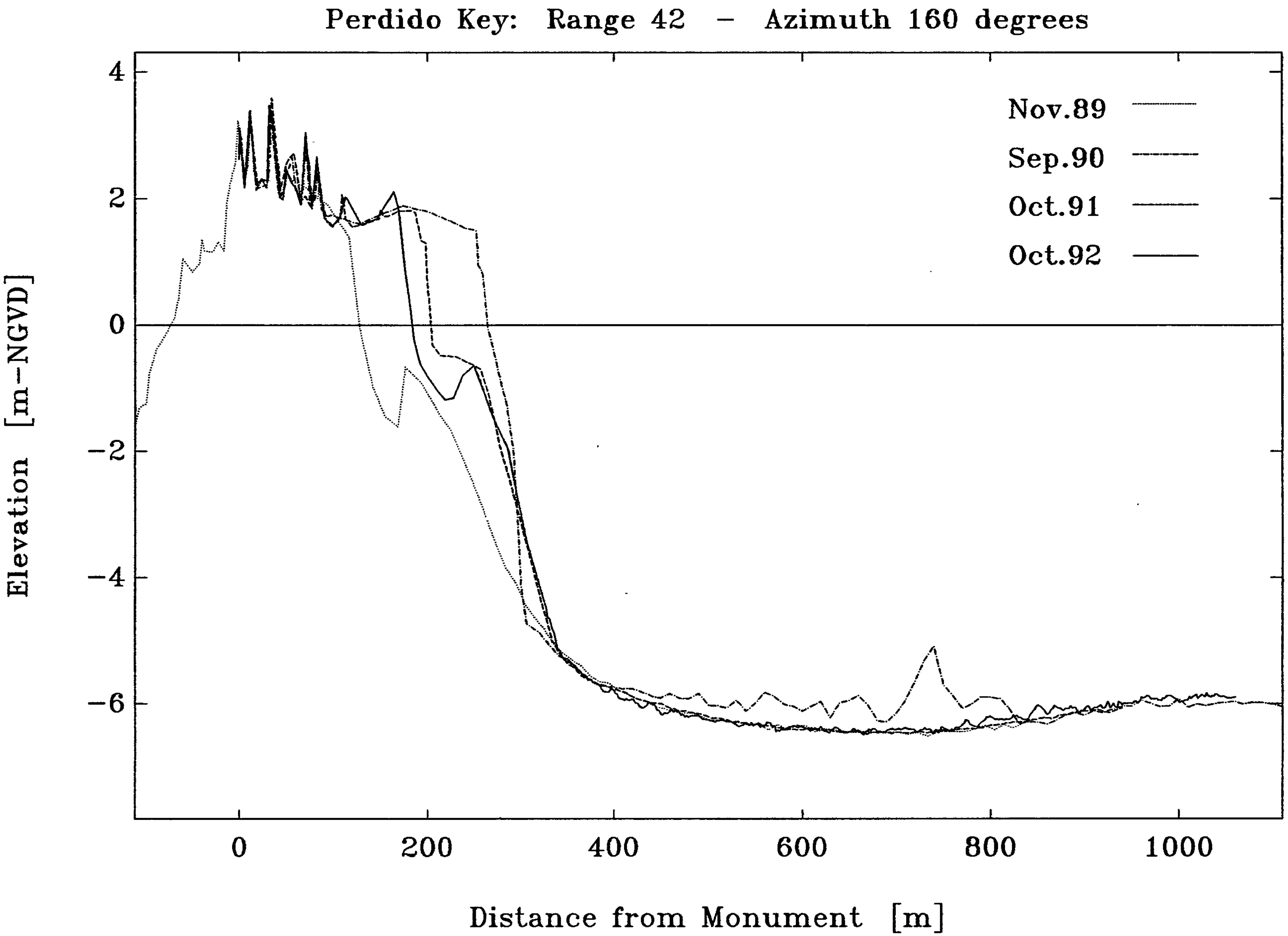


Perdido Key: Range 36 – Azimuth 165 degrees
Nov.89
Sep.90
Oct.91
Oct.92
Elevation [m-NGVD]
4
2
0
-2
-4
-6
-200
0
200
400
600
800
Distance from Monument [m]

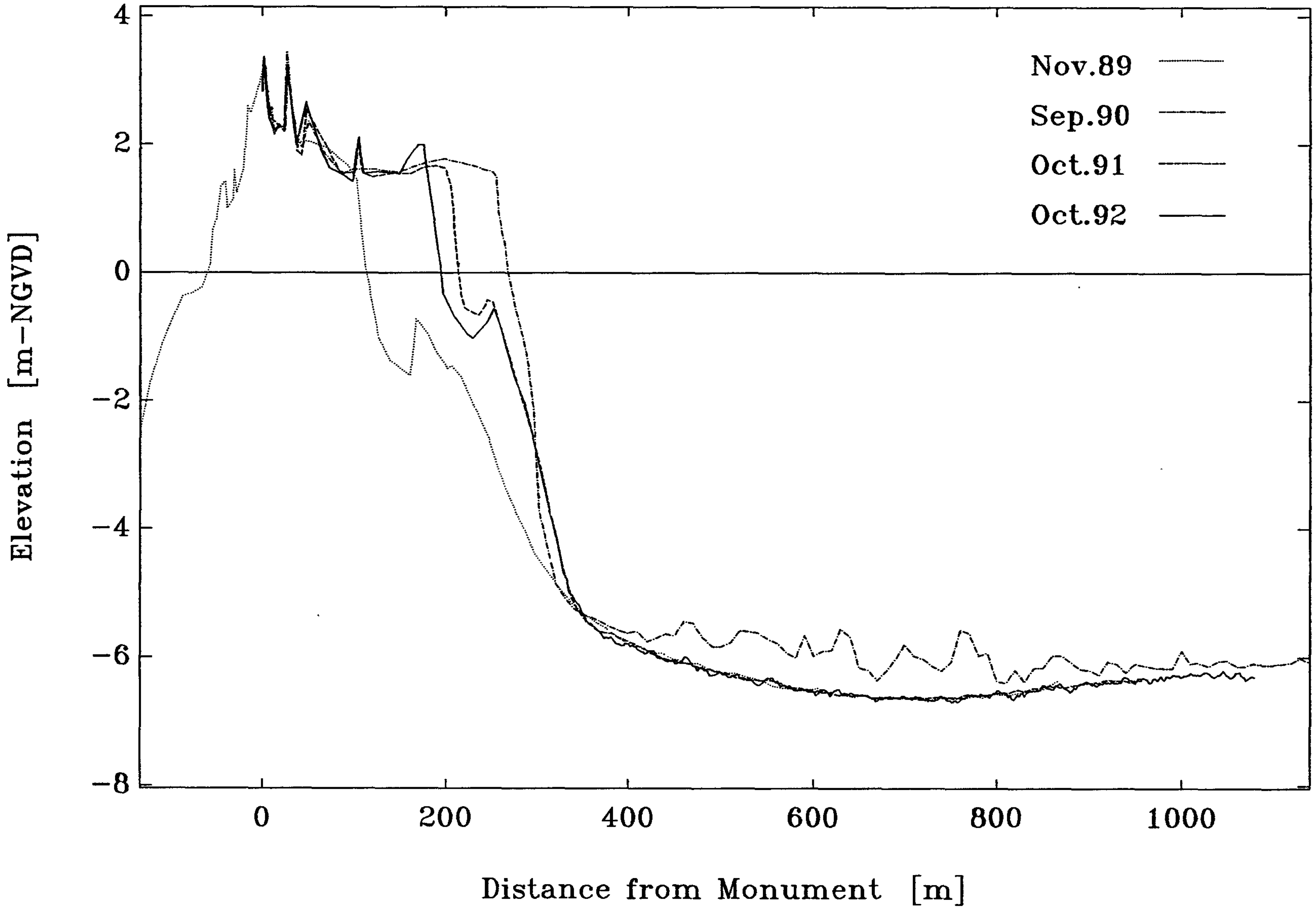

Perdido Key: Range 38 - Azimuth 160 degrees
Nov.89
Sep.90
Oct.91
Oct.92
4
2
0
-2
-4
-6
-200
0
200
400
600
800
1000
Elevation [m-NGVD]
Distance from Monument [m]

Perdido Key: Range 40 – Azimuth 160 degrees

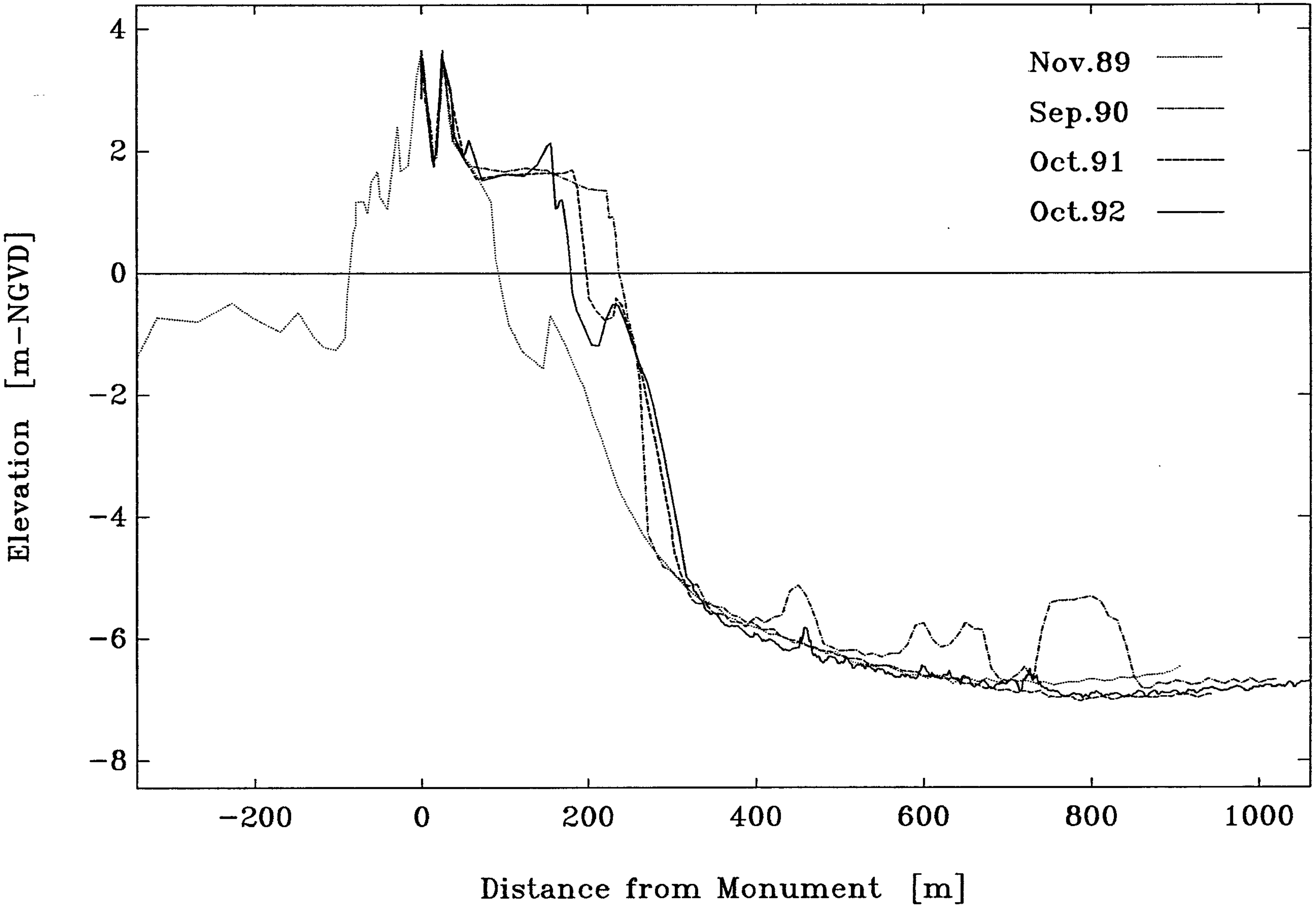



Perdido Key: Range 42 – Azimuth 160 degrees
Nov.89
Sep.90
Oct.91
Oct.92
Elevation [m-NGVD]
Distance from Monument [m]
4
2
0
-2
-4
-6
0
200
400
600
800
1000

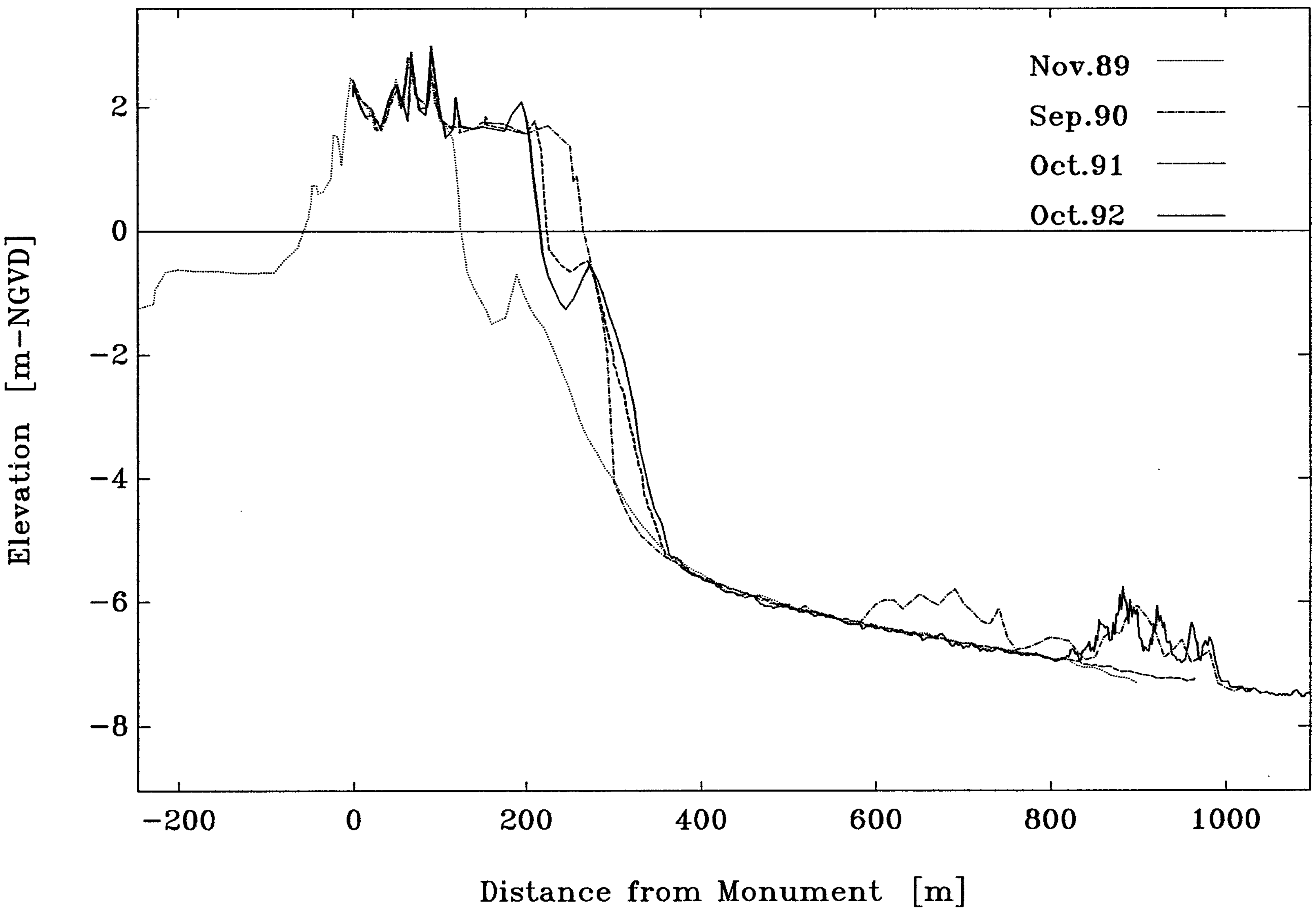
Perdido Key: Range 43 – Azimuth 160 degrees



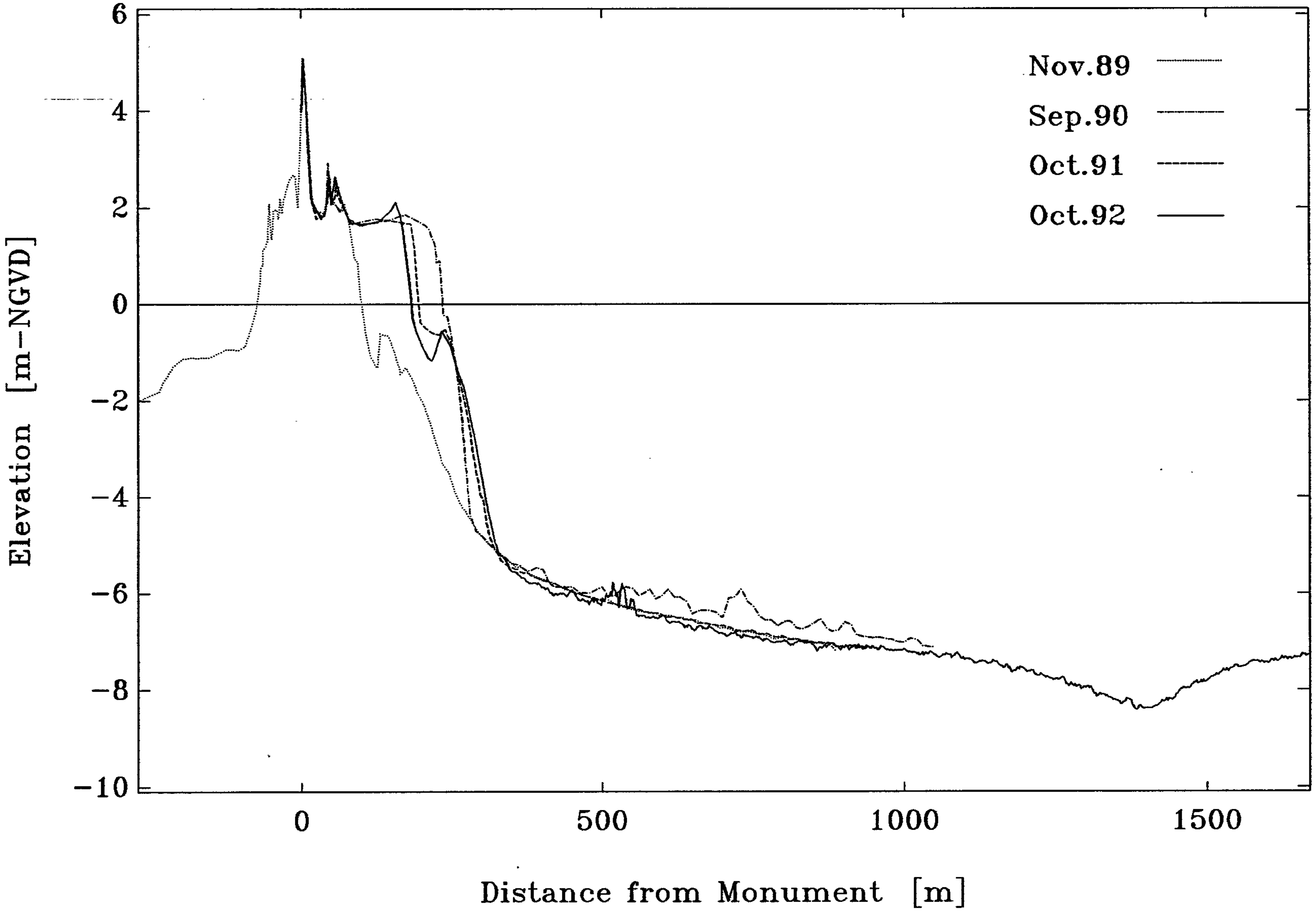
Perdido Key: Range 44 – Azimuth 160 degrees



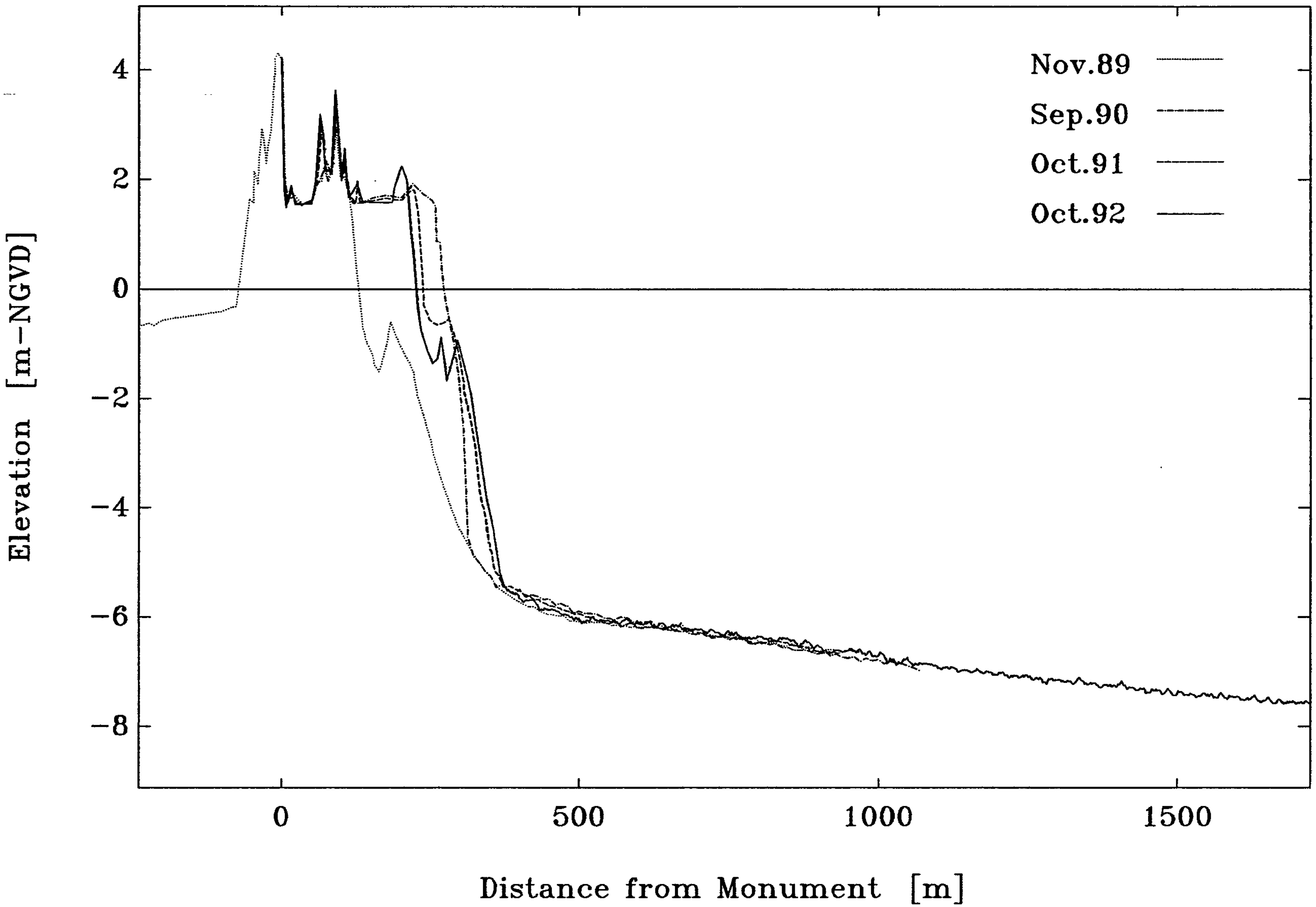
Perdido Key: Range 45 – Azimuth 160 degrees

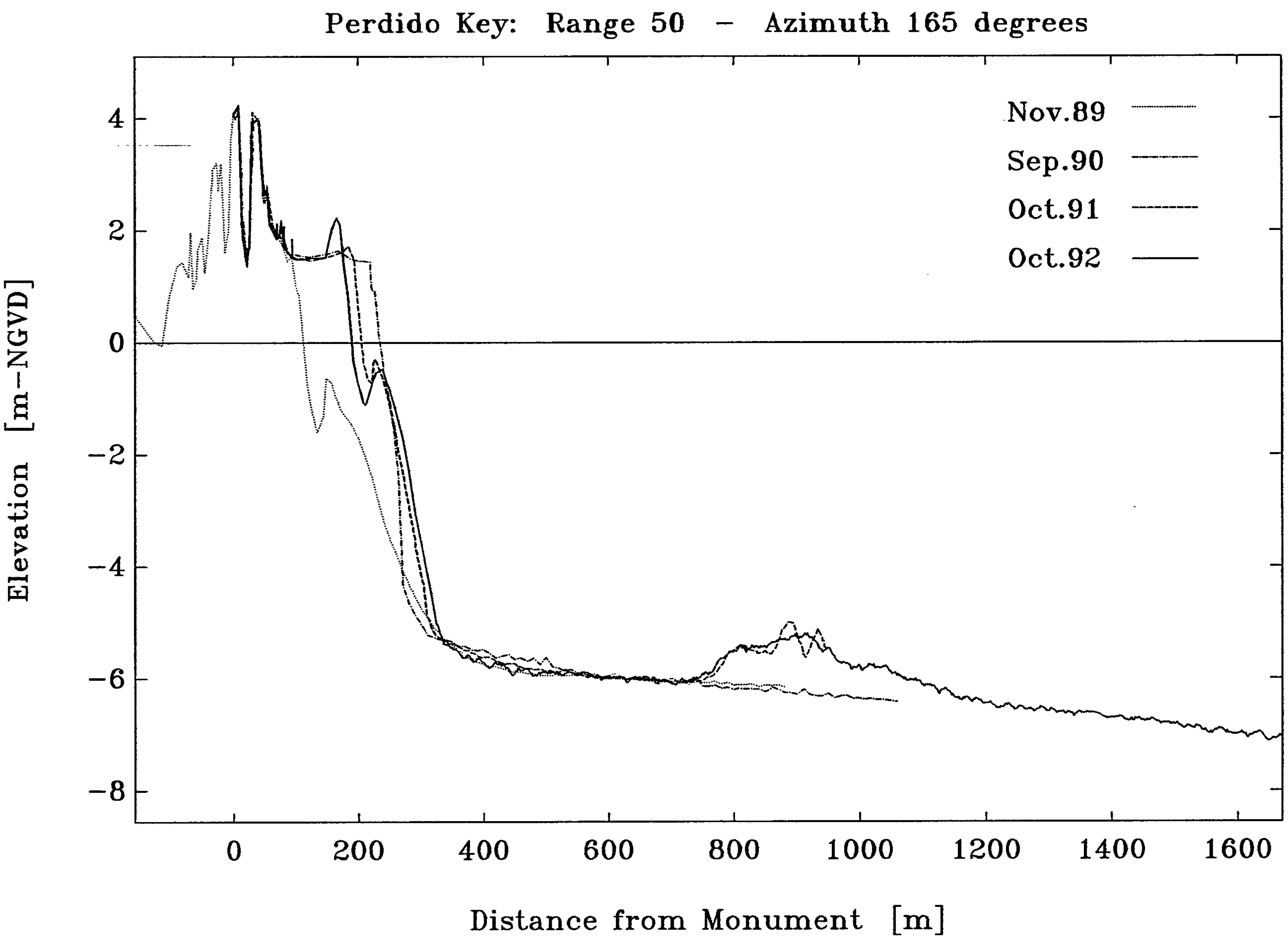


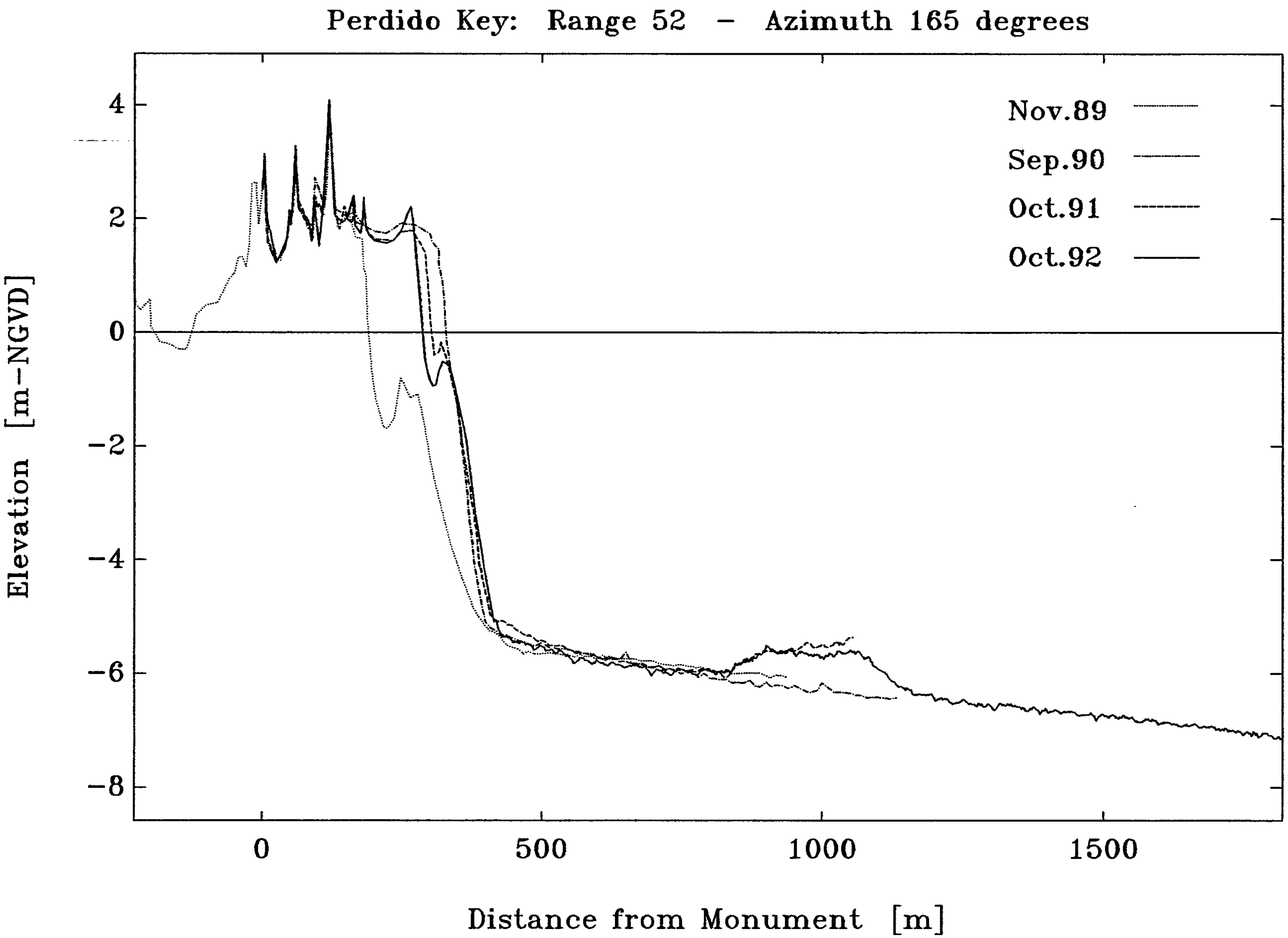
Perdido Key: Range 46 – Azimuth 165 degrees



Perdido Key: Range 48 – Azimuth 165 degrees

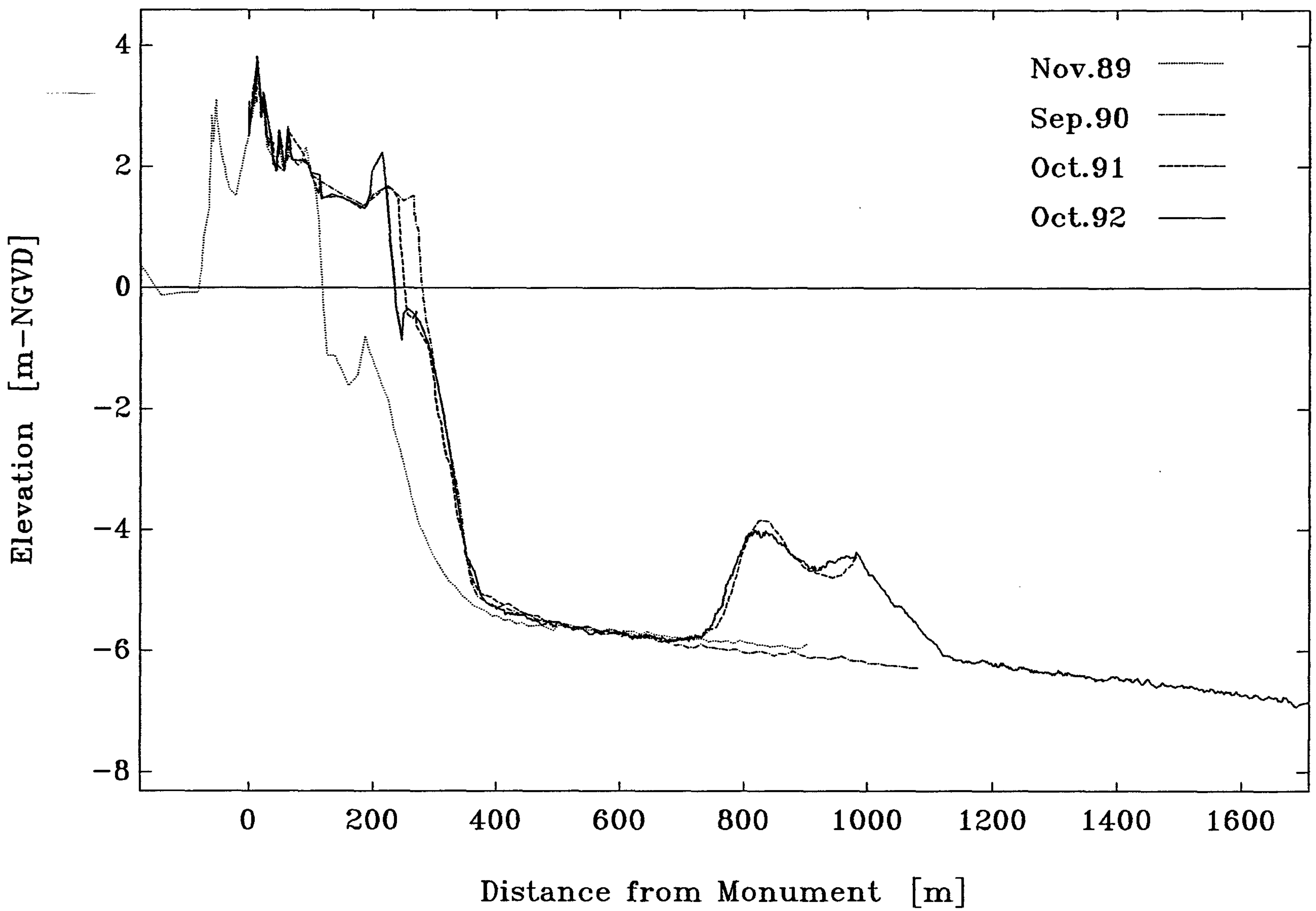


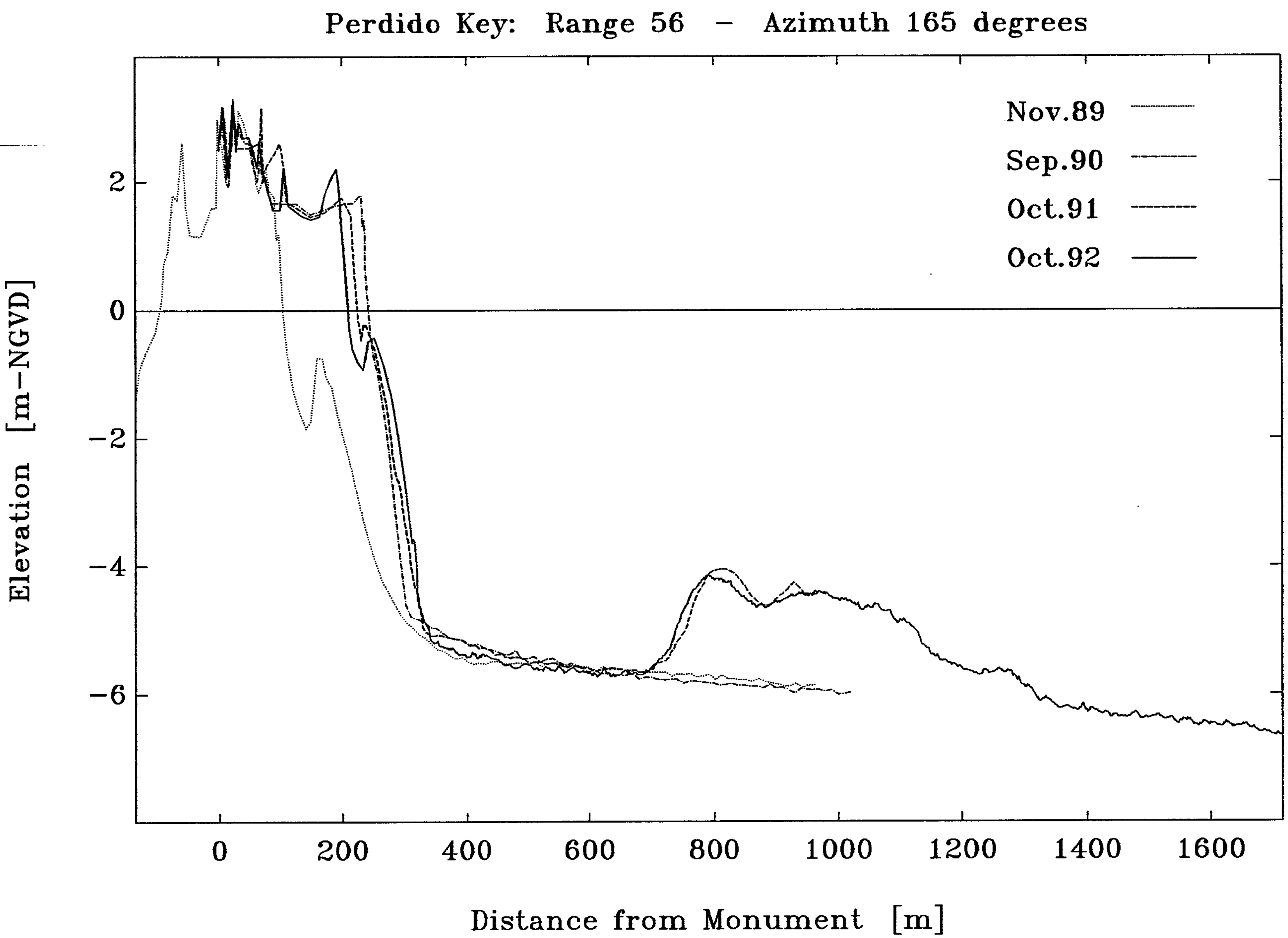

Perdido Key: Range 50 – Azimuth 165 degrees
Nov.89
Sep.90
Oct.91
Oct.92
Elevation [m-NGVD]
4
2
0
−2
−4
−6
−8
0
200
400
600
800
1000
1200
1400
1600
Distance from Monument [m]



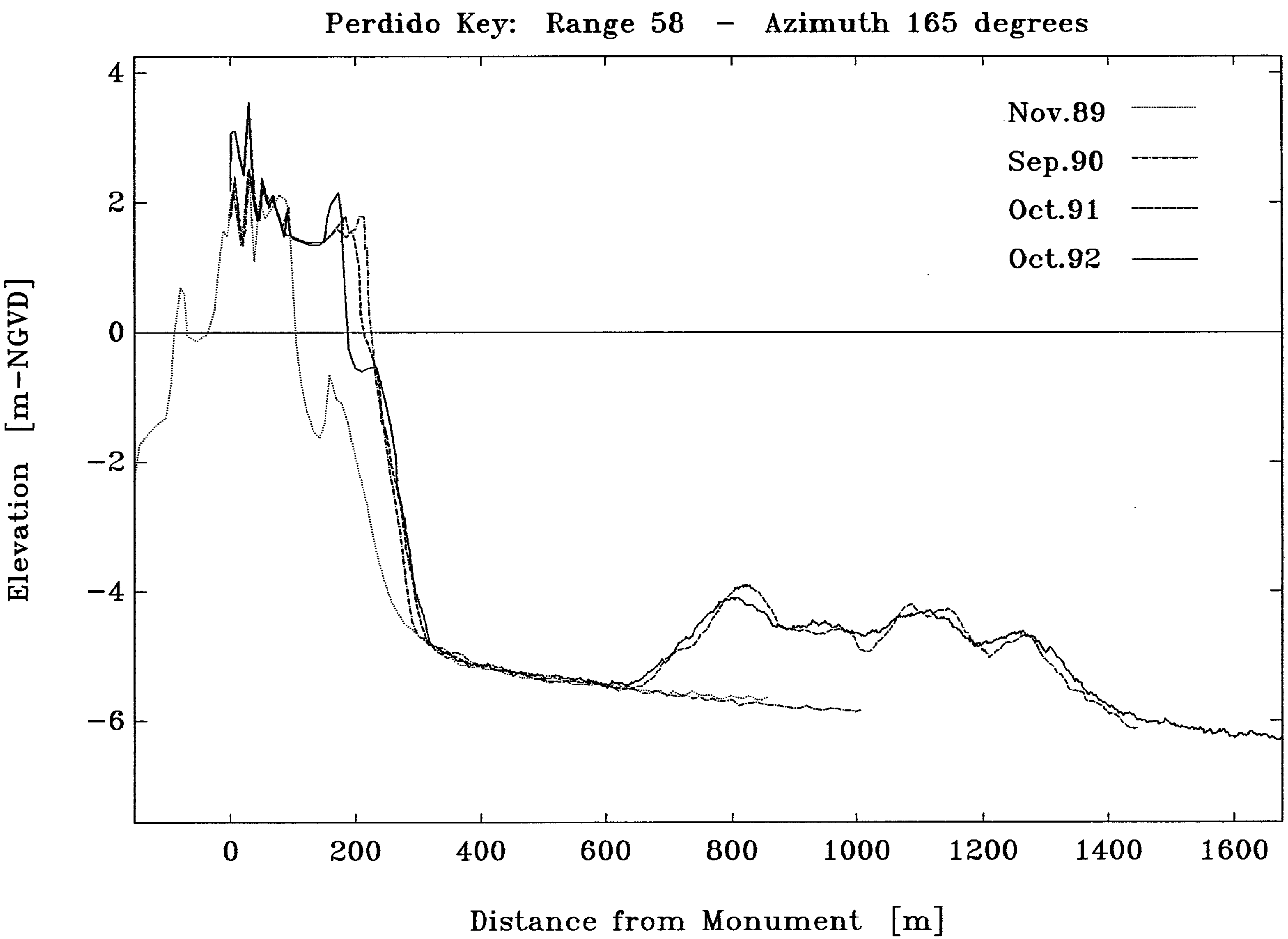
Perdido Key: Range 52 – Azimuth 165 degrees
Nov.89
Sep.90
Oct.91
Oct.92
4
2
0
−2
−4
−6
−8
Elevation [m-NGVD]
0
500
1000
1500
Distance from Monument [m]

Perdido Key: Range 54 – Azimuth 165 degrees

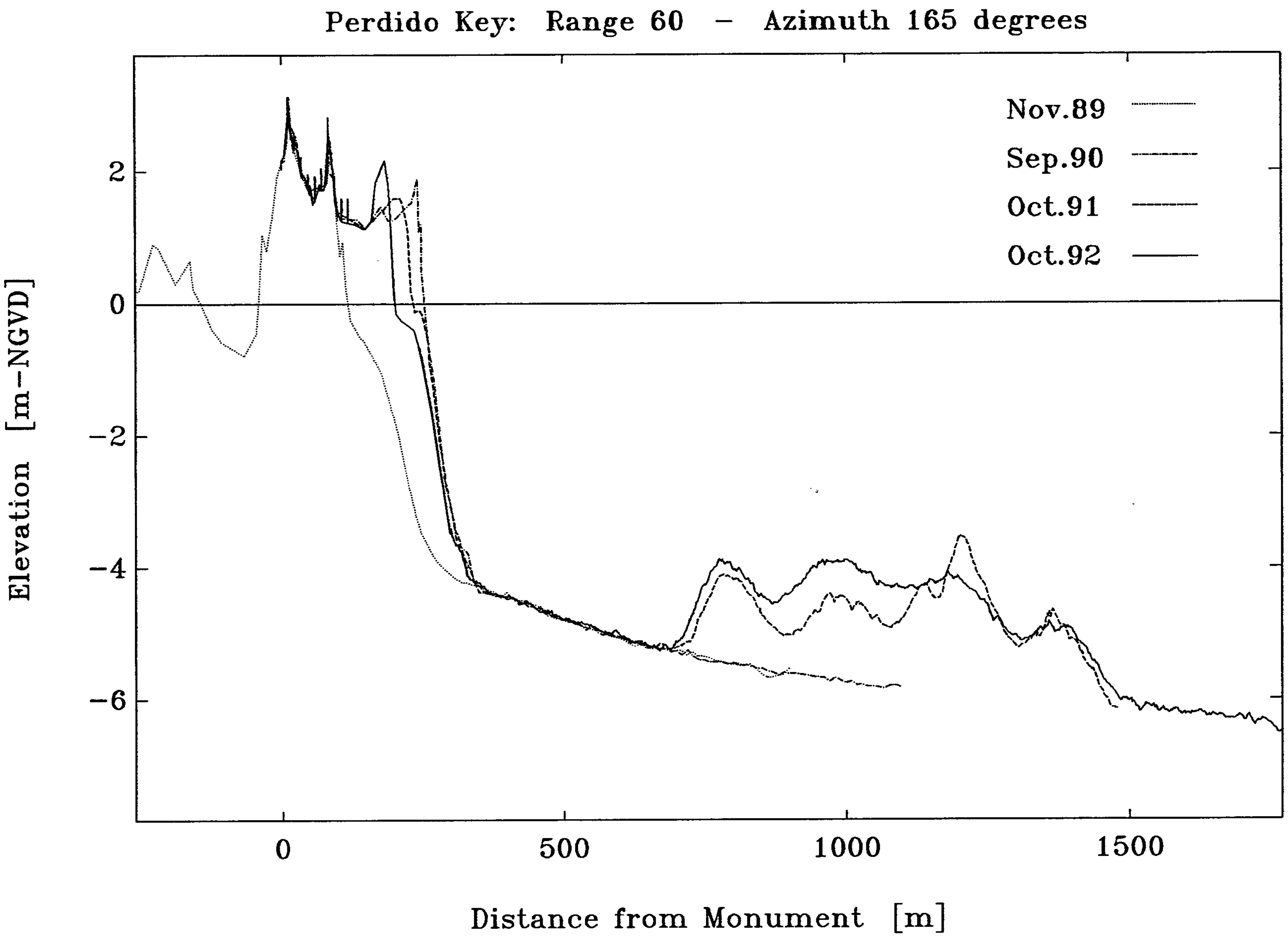


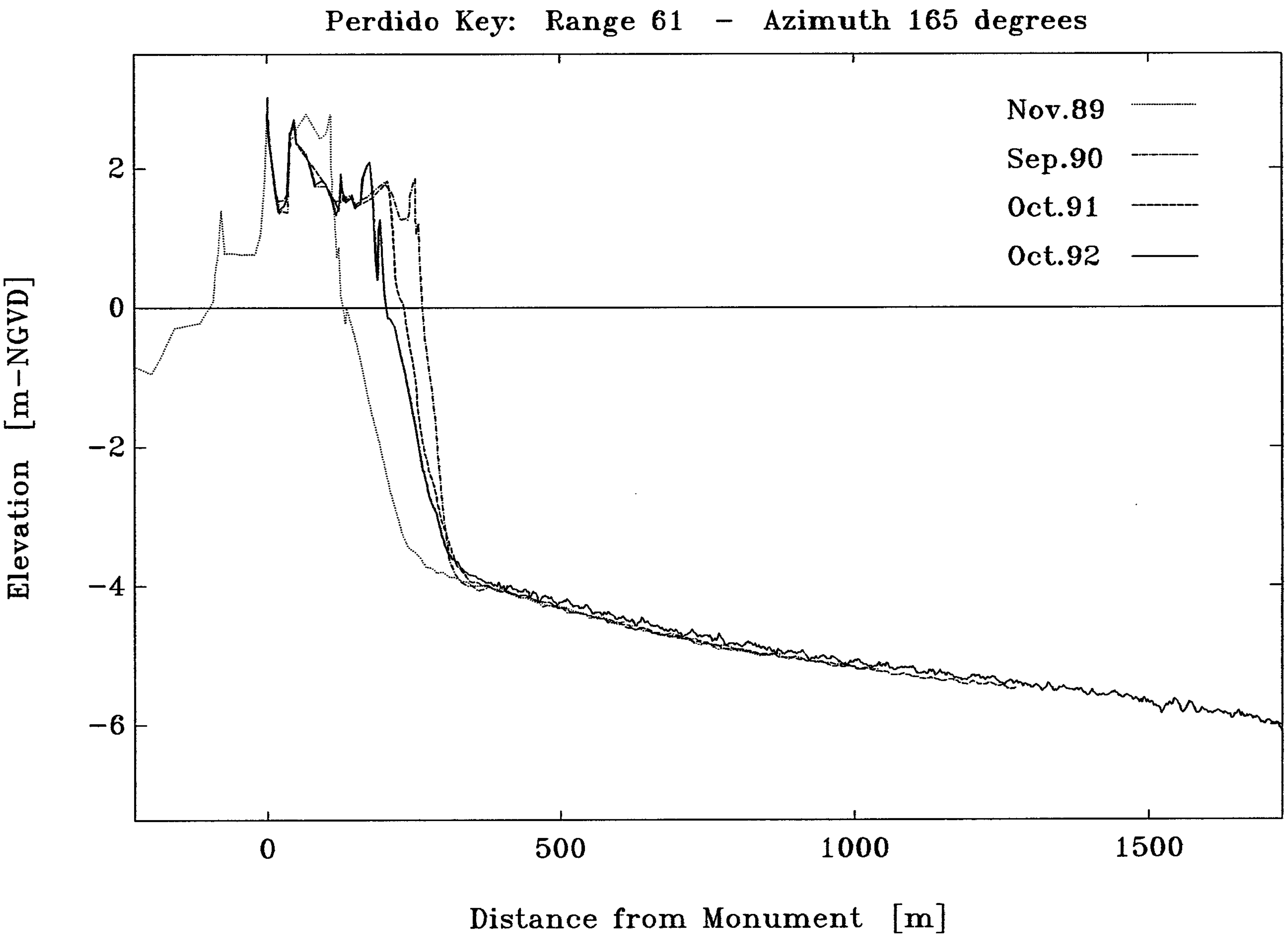


Perdido Key: Range 56 – Azimuth 165 degrees
Nov.89
Sep.90
Oct.91
Oct.92
Elevation [m-NGVD]
2
0
-2
-4
-6
0
200
400
600
800
1000
1200
1400
1600
Distance from Monument [m]

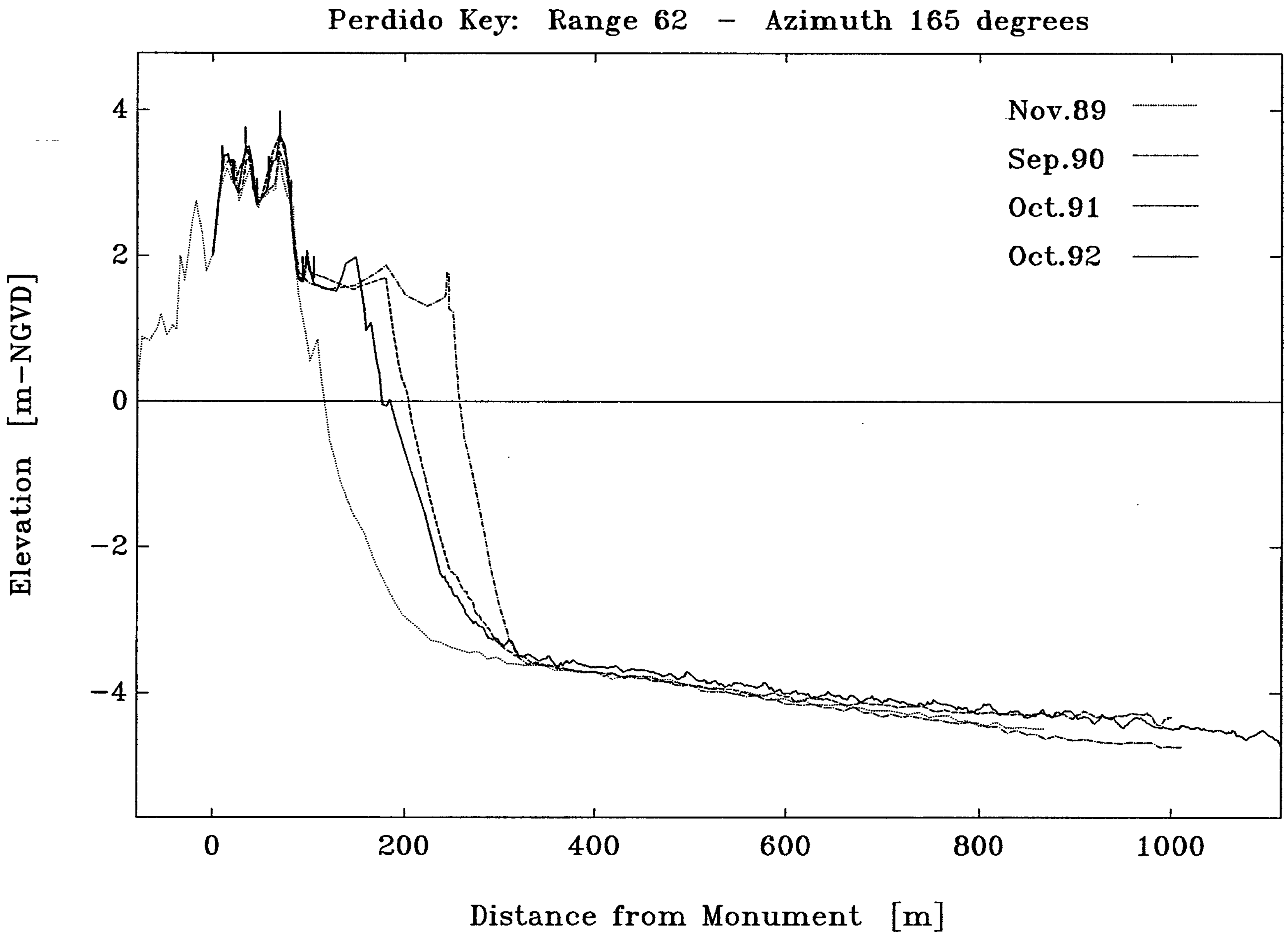


Perdido Key: Range 58 – Azimuth 165 degrees
Nov.89
Sep.90
Oct.91
Oct.92
Elevation [m-NGVD]
4
2
0
-2
-4
-6
0
200
400
600
800
1000
1200
1400
1600
Distance from Monument [m]

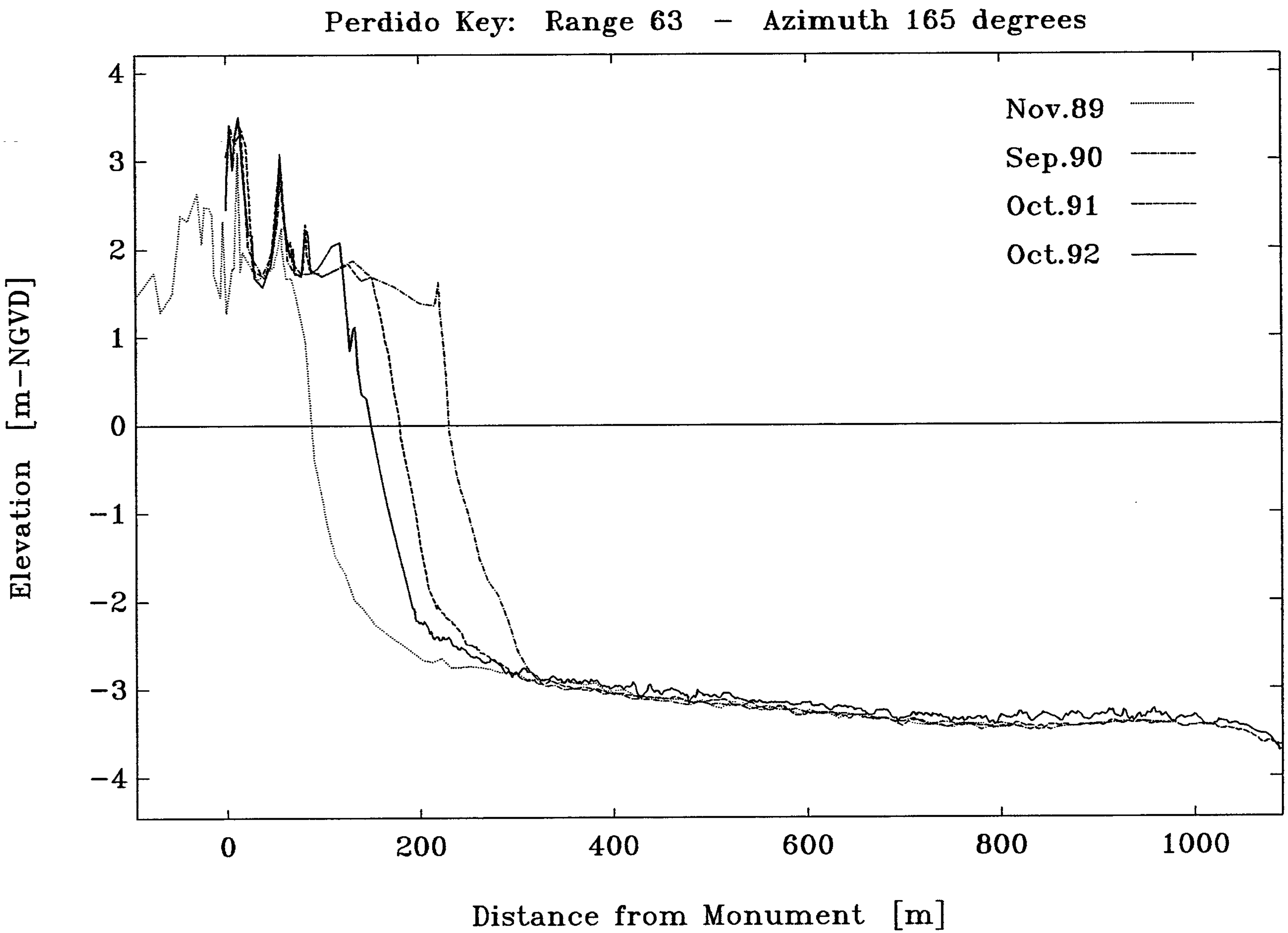

Perdido Key: Range 60 – Azimuth 165 degrees
Nov.89
Sep.90
Oct.91
Oct.92
Elevation [m-NGVD]
2
0
-2
-4
-6
0
500
1000
1500
Distance from Monument [m]



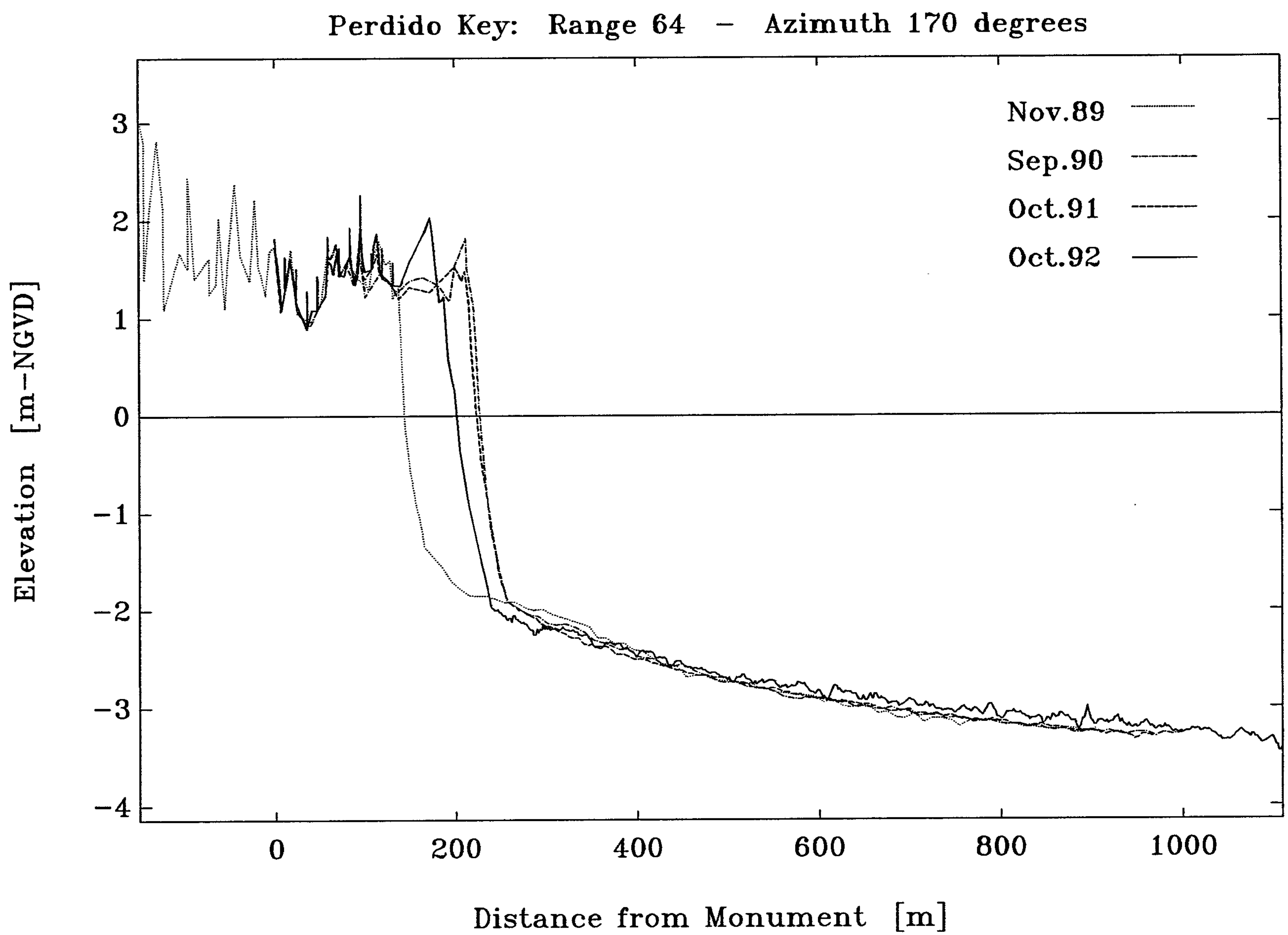
Perdido Key: Range 61 – Azimuth 165 degrees
Nov.89
Sep.90
Oct.91
Oct.92
2
0
-2
-4
-6
Elevation [m-NGVD]
0
500
1000
1500
Distance from Monument [m]



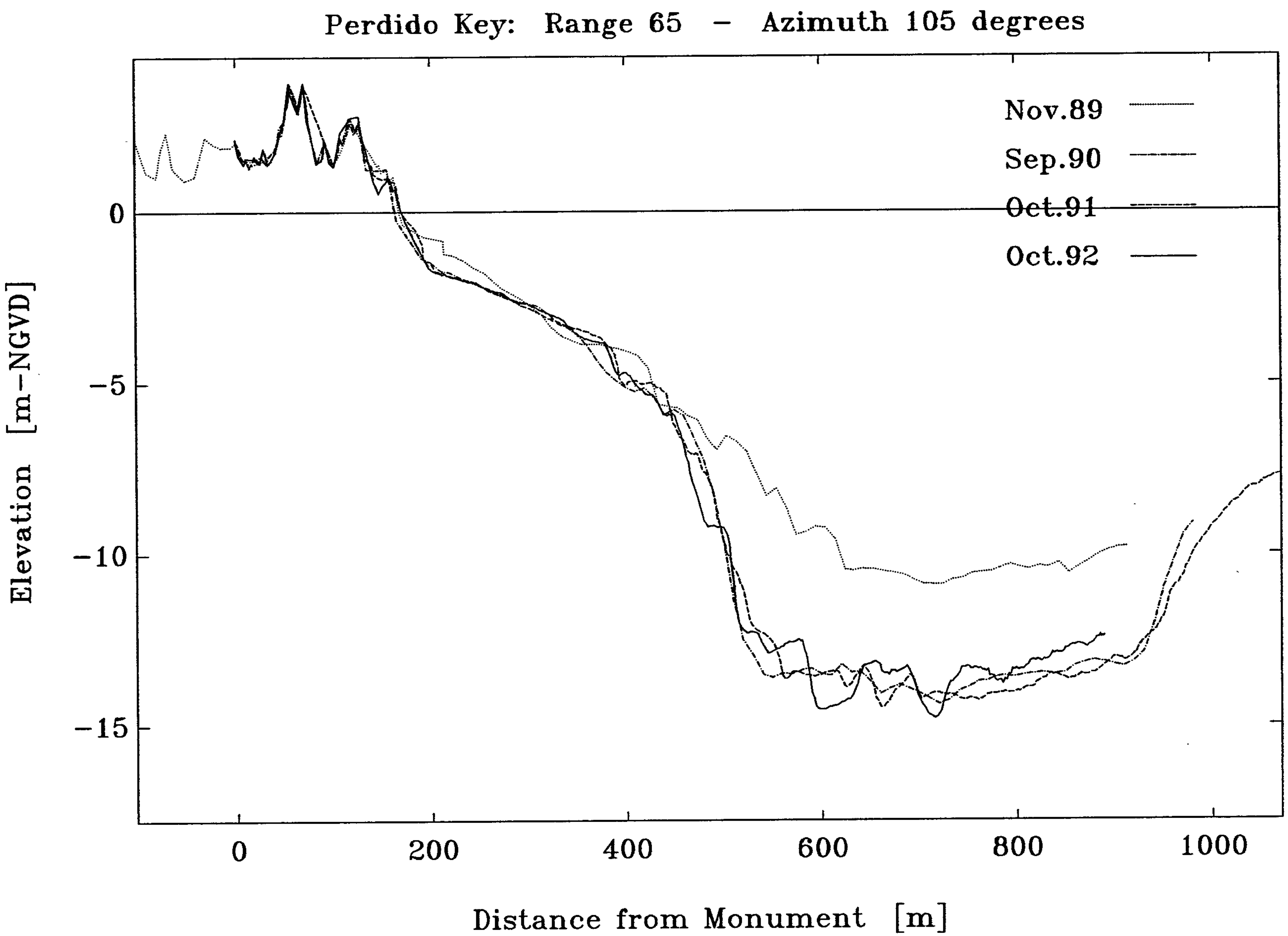
Perdido Key: Range 62 – Azimuth 165 degrees
Nov.89
Sep.90
Oct.91
Oct.92
Elevation [m-NGVD]
4
2
0
−2
−4
0
200
400
600
800
1000
Distance from Monument [m]



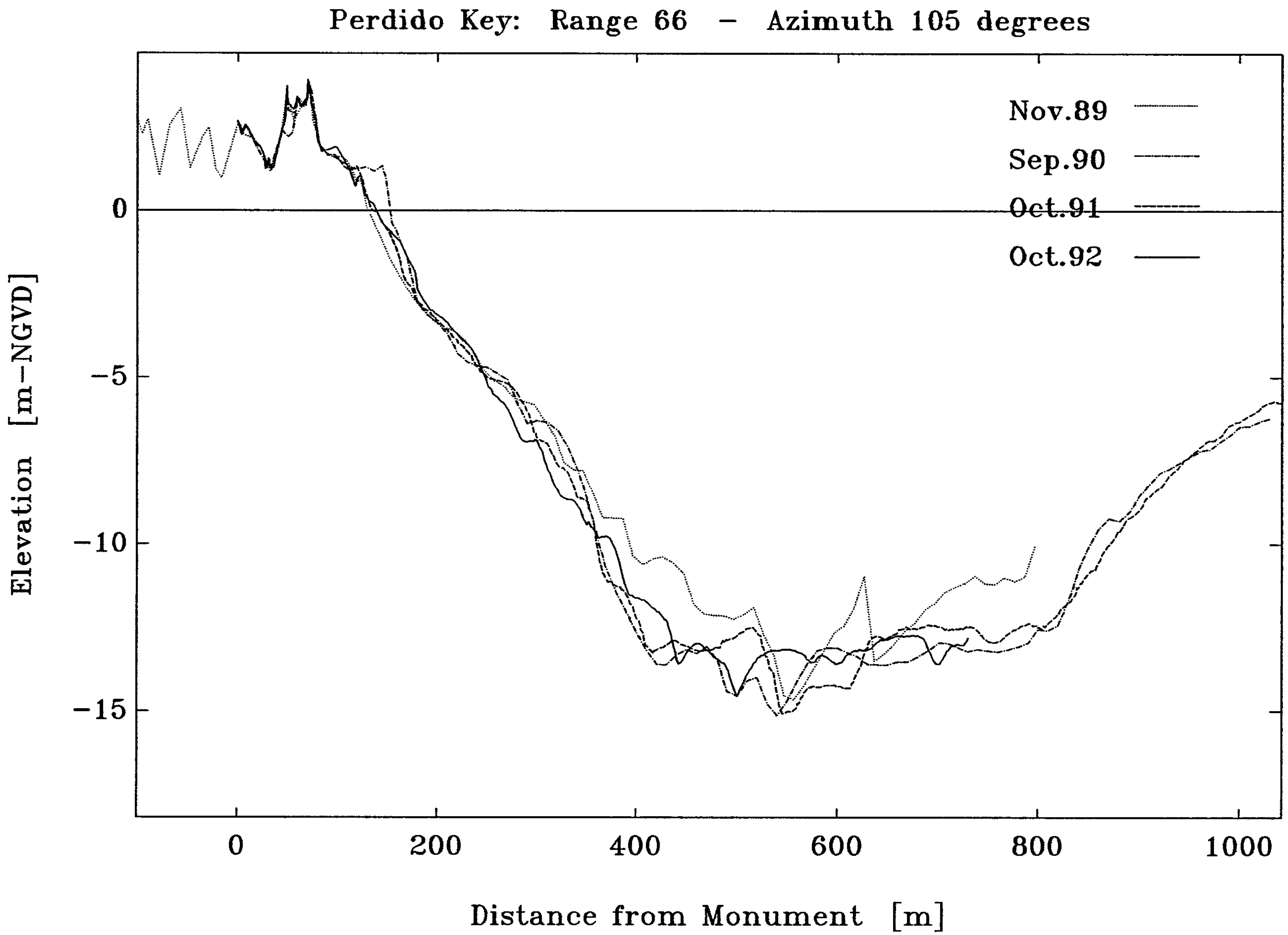
Perdido Key: Range 63 – Azimuth 165 degrees
Nov.89
Sep.90
Oct.91
Oct.92
Elevation [m-NGVD]
Distance from Monument [m]
4
3
2
1
0
−1
−2
−3
−4
0
200
400
600
800
1000



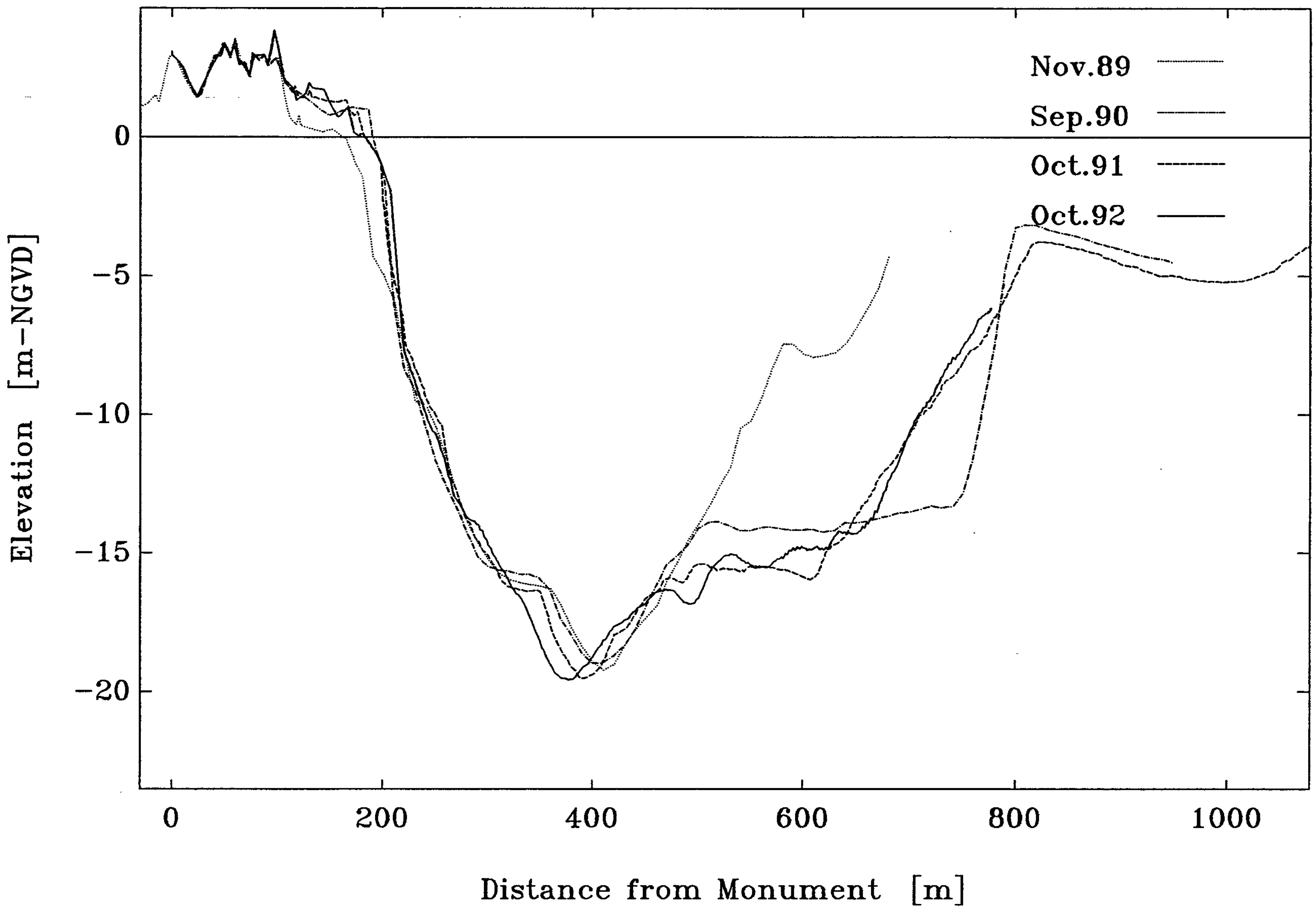
Perdido Key: Range 64 – Azimuth 170 degrees
Nov.89
Sep.90
Oct.91
Oct.92
3
2
1
0
−1
−2
−3
−4
Elevation [m−NGVD]
0
200
400
600
800
1000
Distance from Monument [m]



Perdido Key: Range 65 – Azimuth 105 degrees
Nov.89
Sep.90
Oct.91
Oct.92
Elevation [m-NGVD]
0
-5
-10
-15
0
200
400
600
800
1000
Distance from Monument [m]


Perdido Key: Range 66 – Azimuth 105 degrees
Nov.89
Sep.90
Oct.91
Oct.92
0
−5
−10
−15
Elevation [m−NGVD]
0
200
400
600
800
1000
Distance from Monument [m]

Perdido Key: Range 67 - Azimuth 90 degrees



APPENDIX II

WAVE, CURRENT, and TIDE DATA

from Offshore Gages

located near Ranger Station and near Caucus Shoal

January, 1992 - December, 1992

- Representative Wave Period
- Significant Wave Height
- Central Wave Direction
- Spreading Parameters

- Mean Current Velocity
- Mean Current Direction
- Tidal Stage

Notes:

1) Mean wave direction, $\bar{\theta}$, is the direction that the wave is heading. It is measured clockwise from magnetic north.

2) Mean current direction, θ_c, is the direction toward which the current is heading. It is measured clockwise from magnetic north.

3) Horizontal axis denotes day of month.

4) Tidal datum is mean sea level.

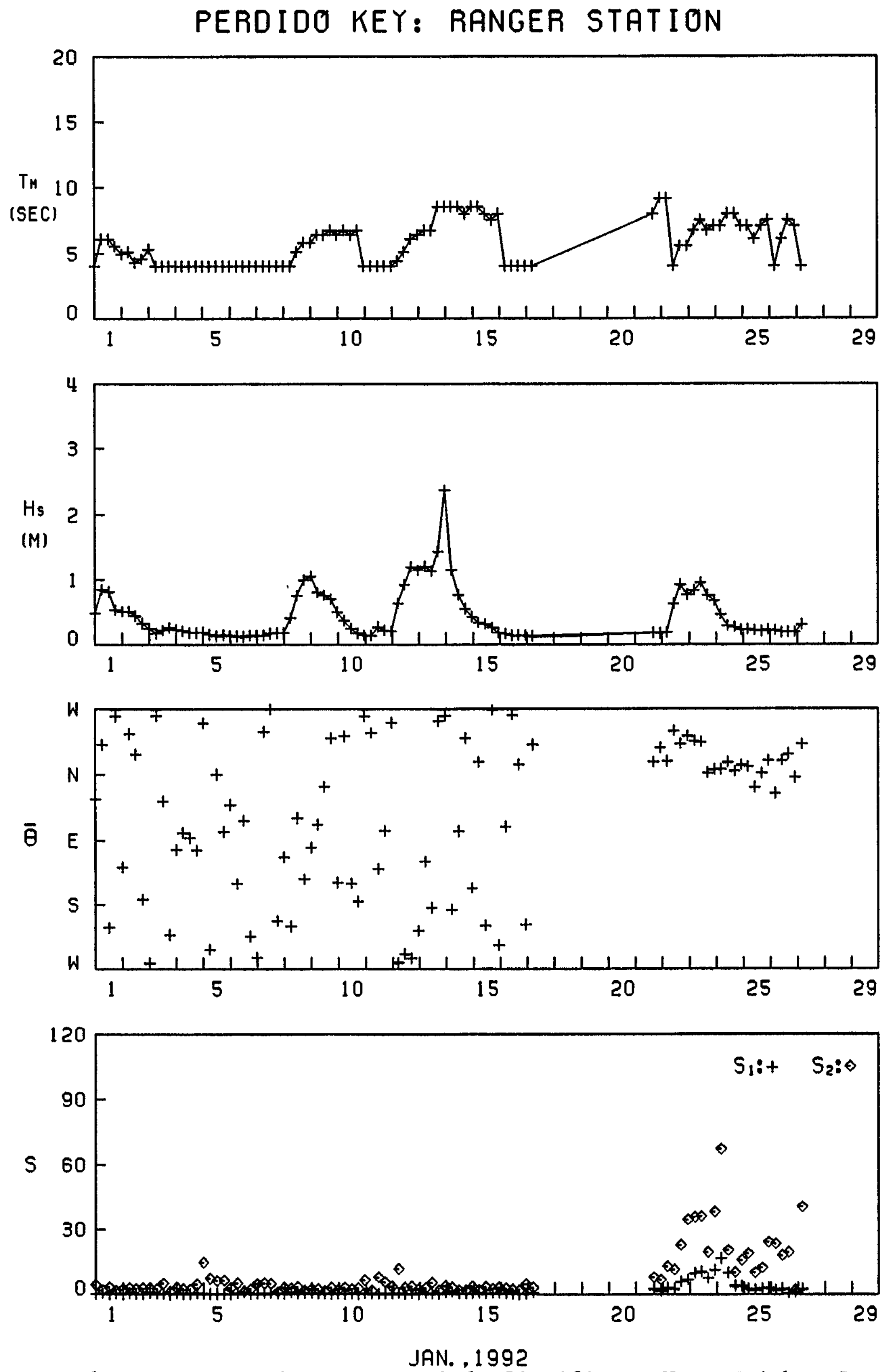


Figure II-1: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, January, 1992.

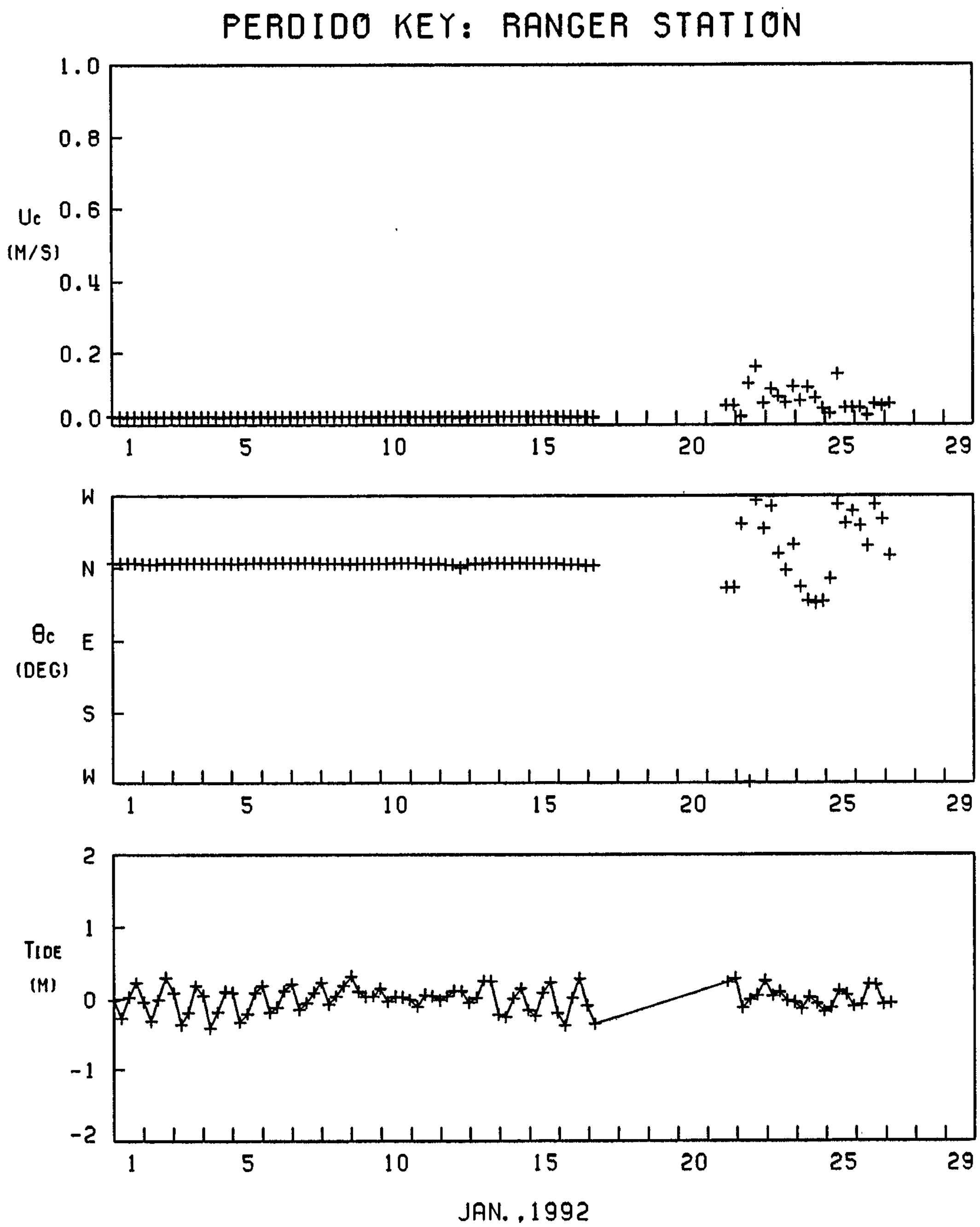


Figure II-2: Magnitude and Direction of Mean Current and Tidal Stage, January, 1992.

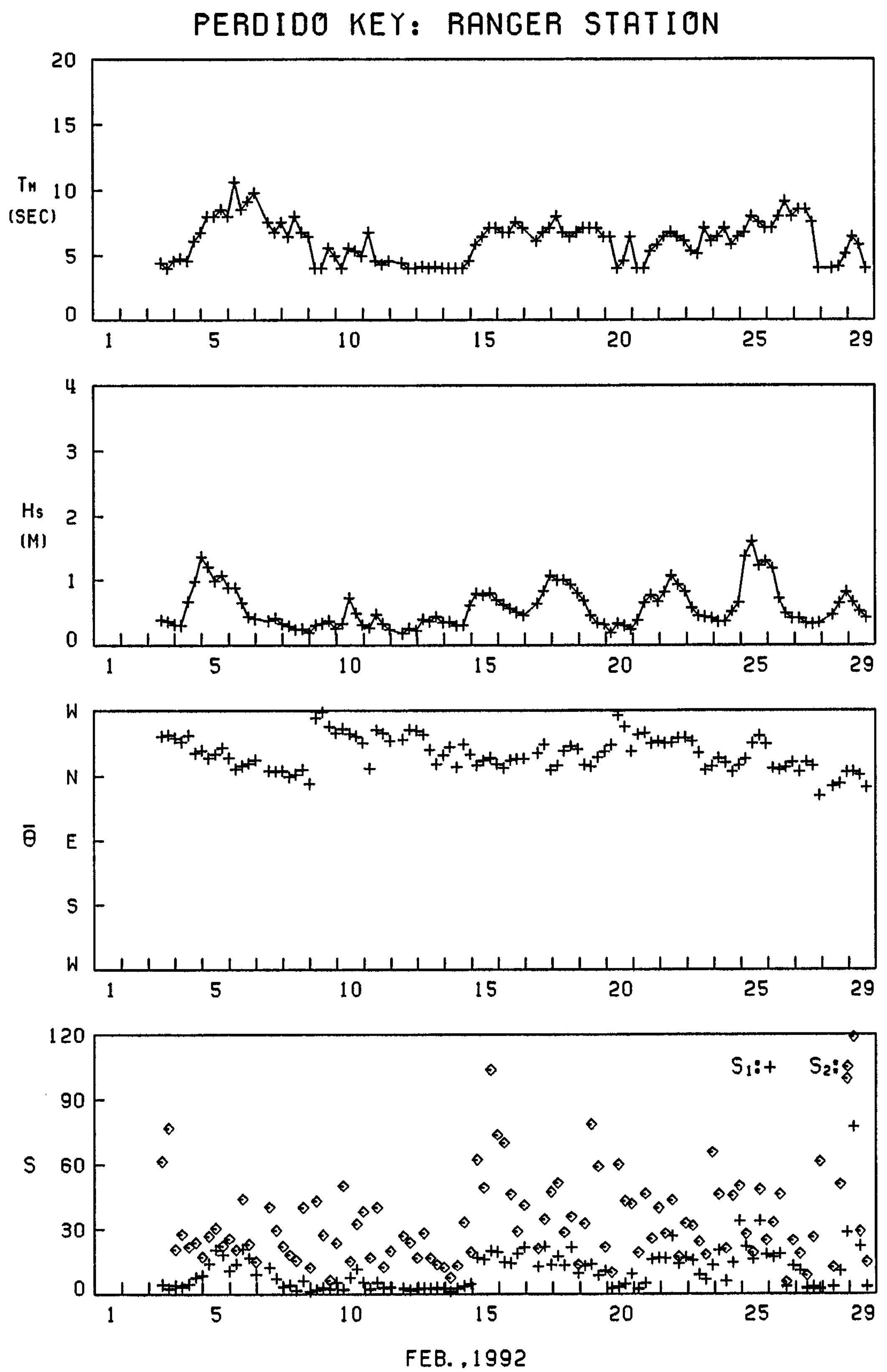


Figure II-3: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, February, 1992.

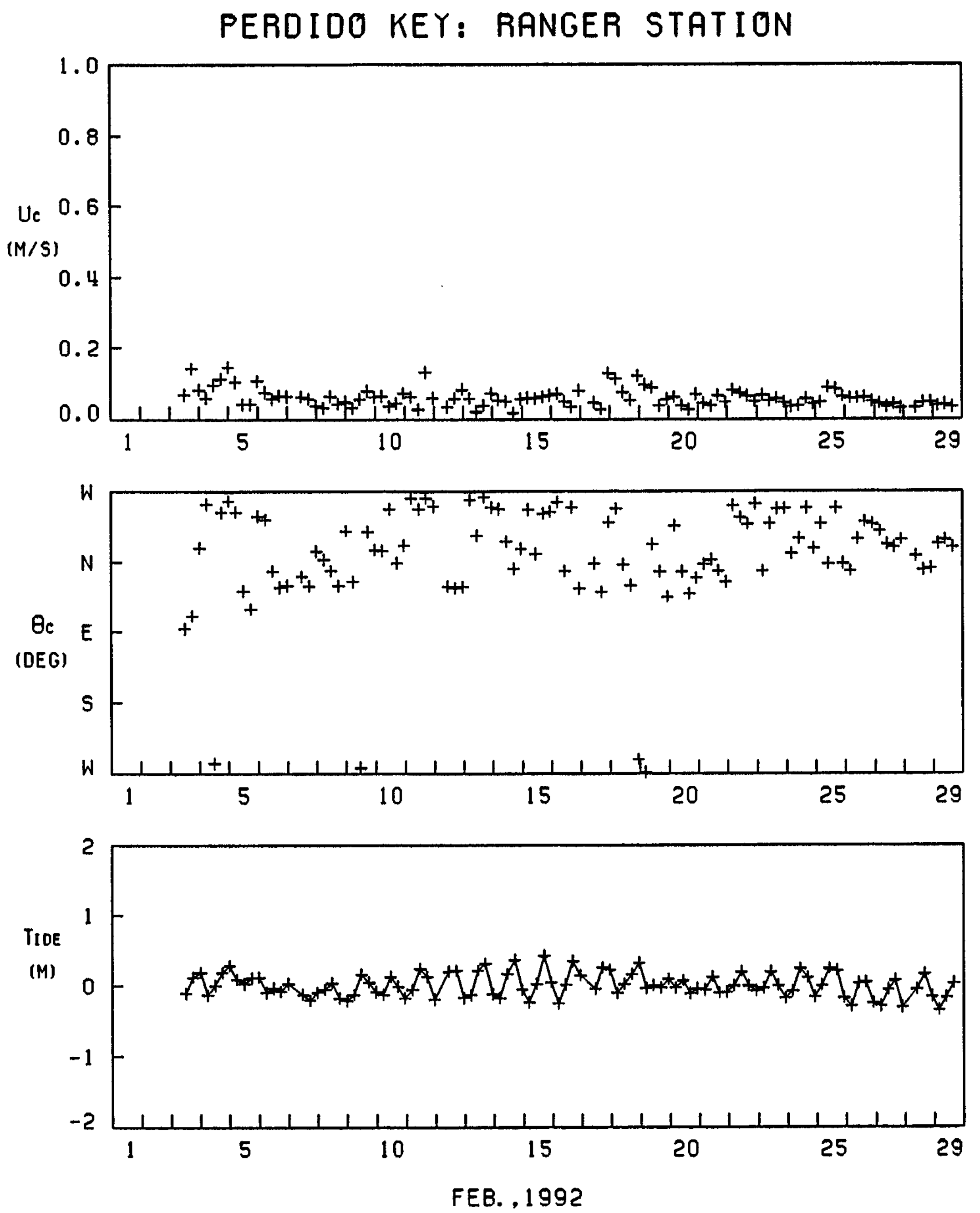


Figure II-4: Magnitude and Direction of Mean Current and Tidal Stage, February, 1992.

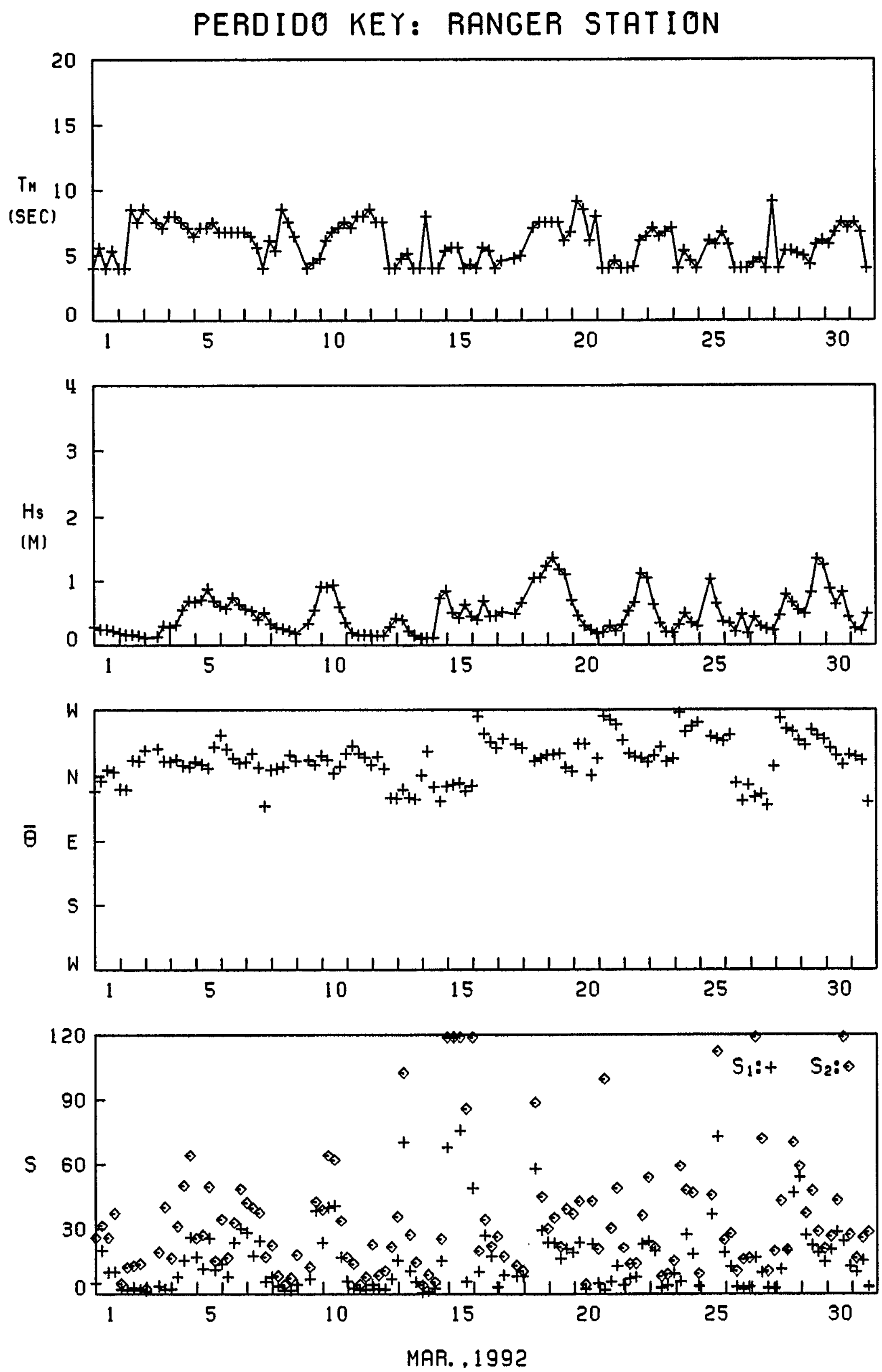


Figure II-5: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, March, 1992.

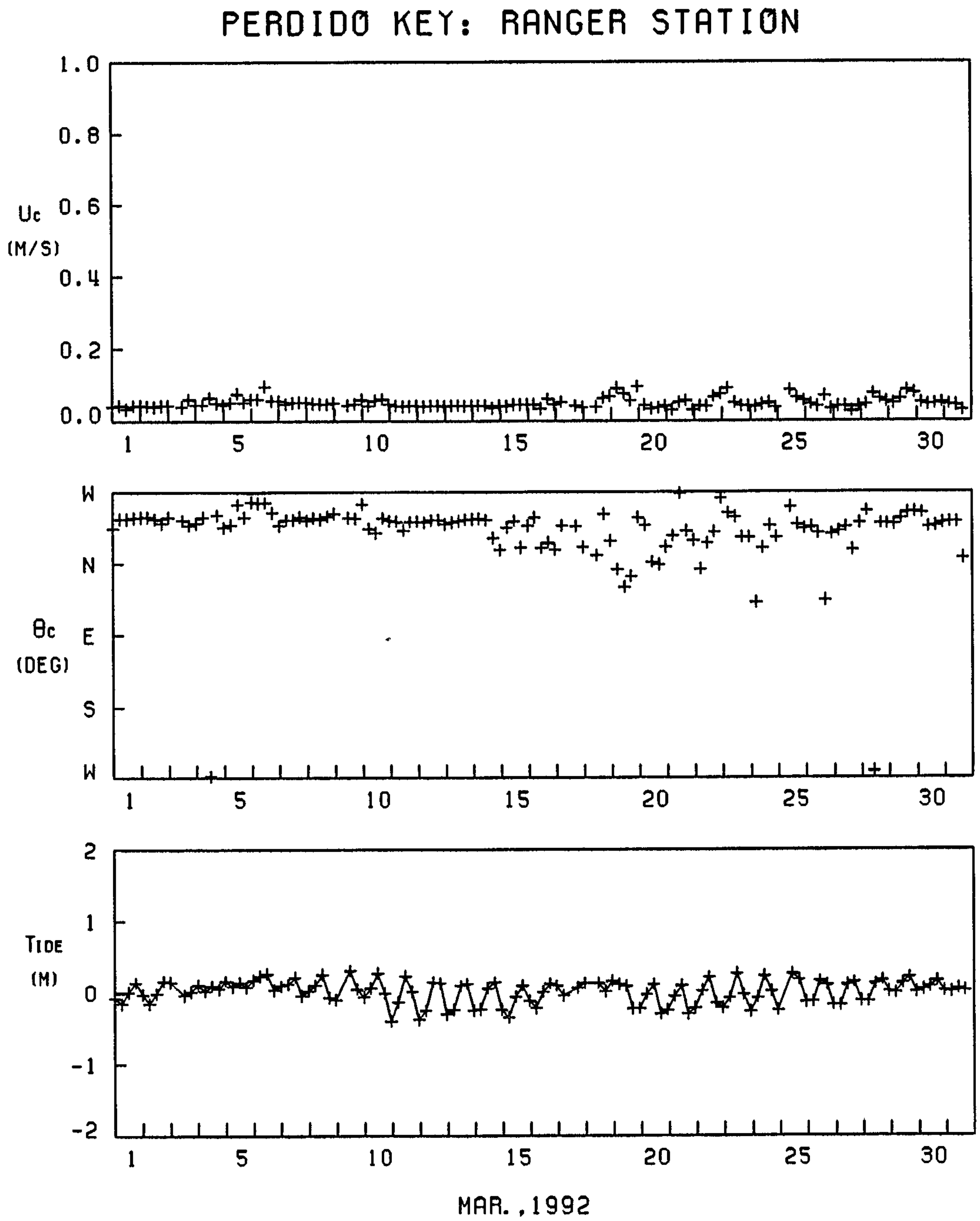


Figure II-6: Magnitude and Direction of Mean Current and Tidal Stage, March, 1992.

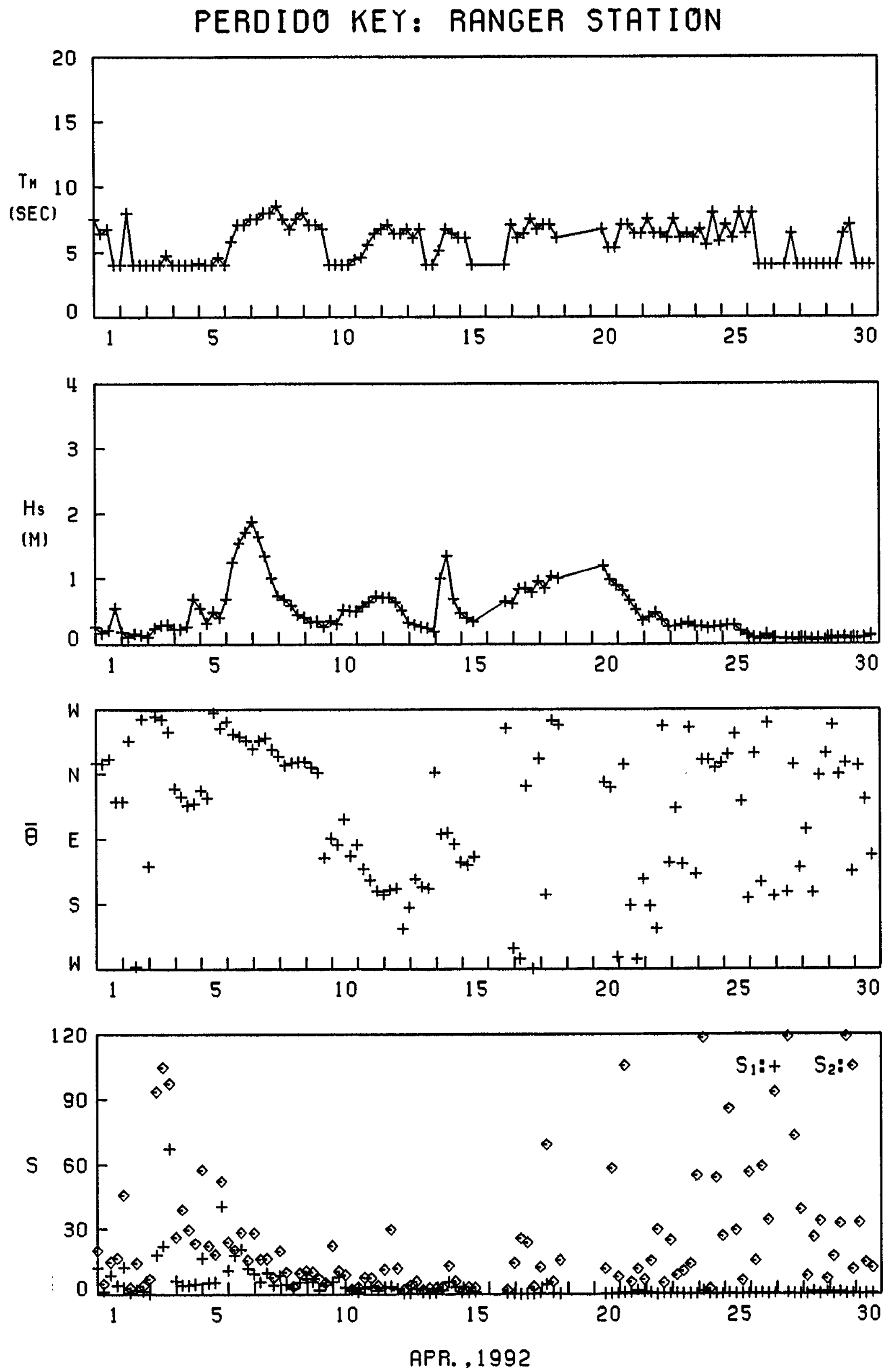


Figure II-7: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, April, 1992.

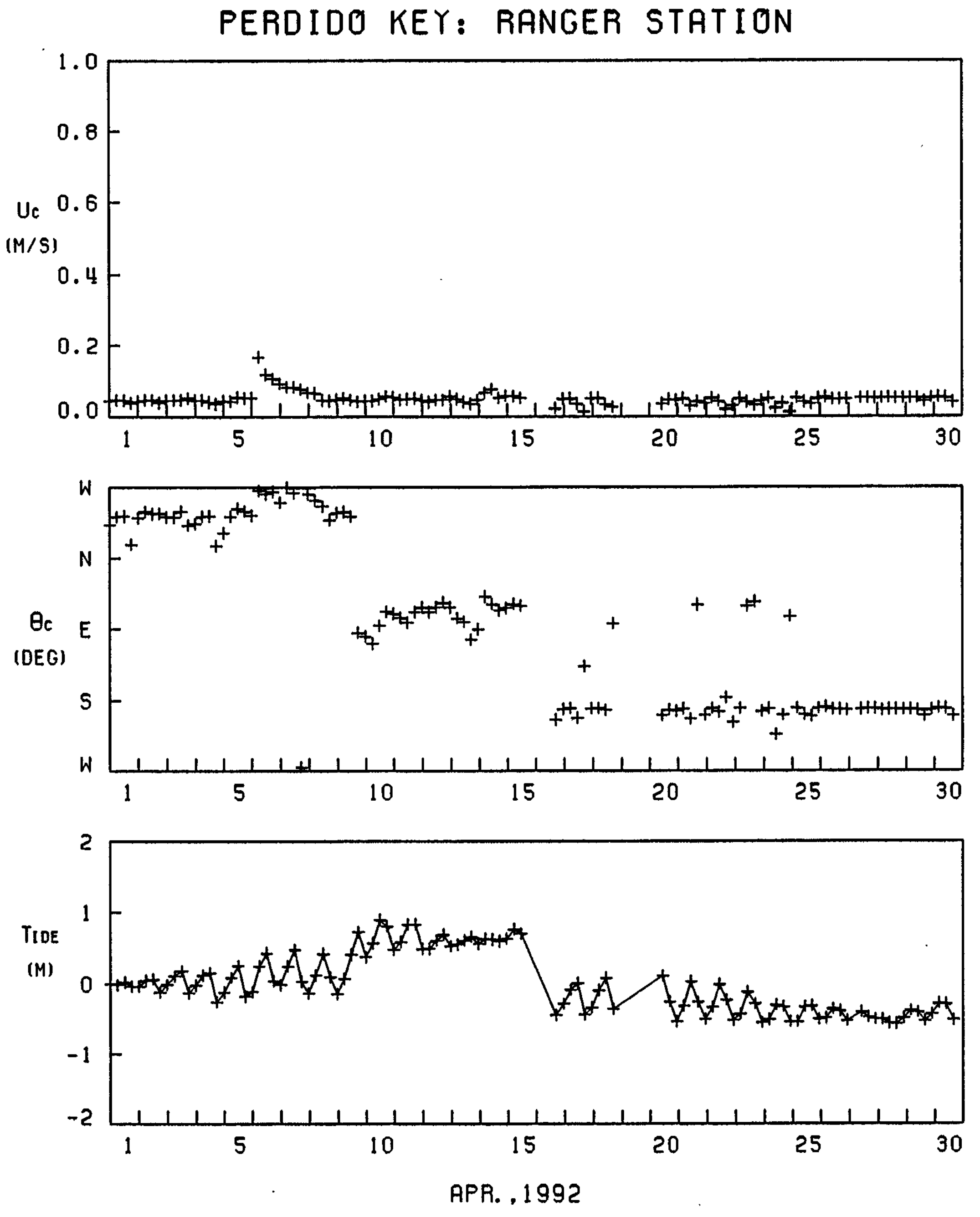


Figure II-8: Magnitude and Direction of Mean Current and Tidal Stage, April, 1992.

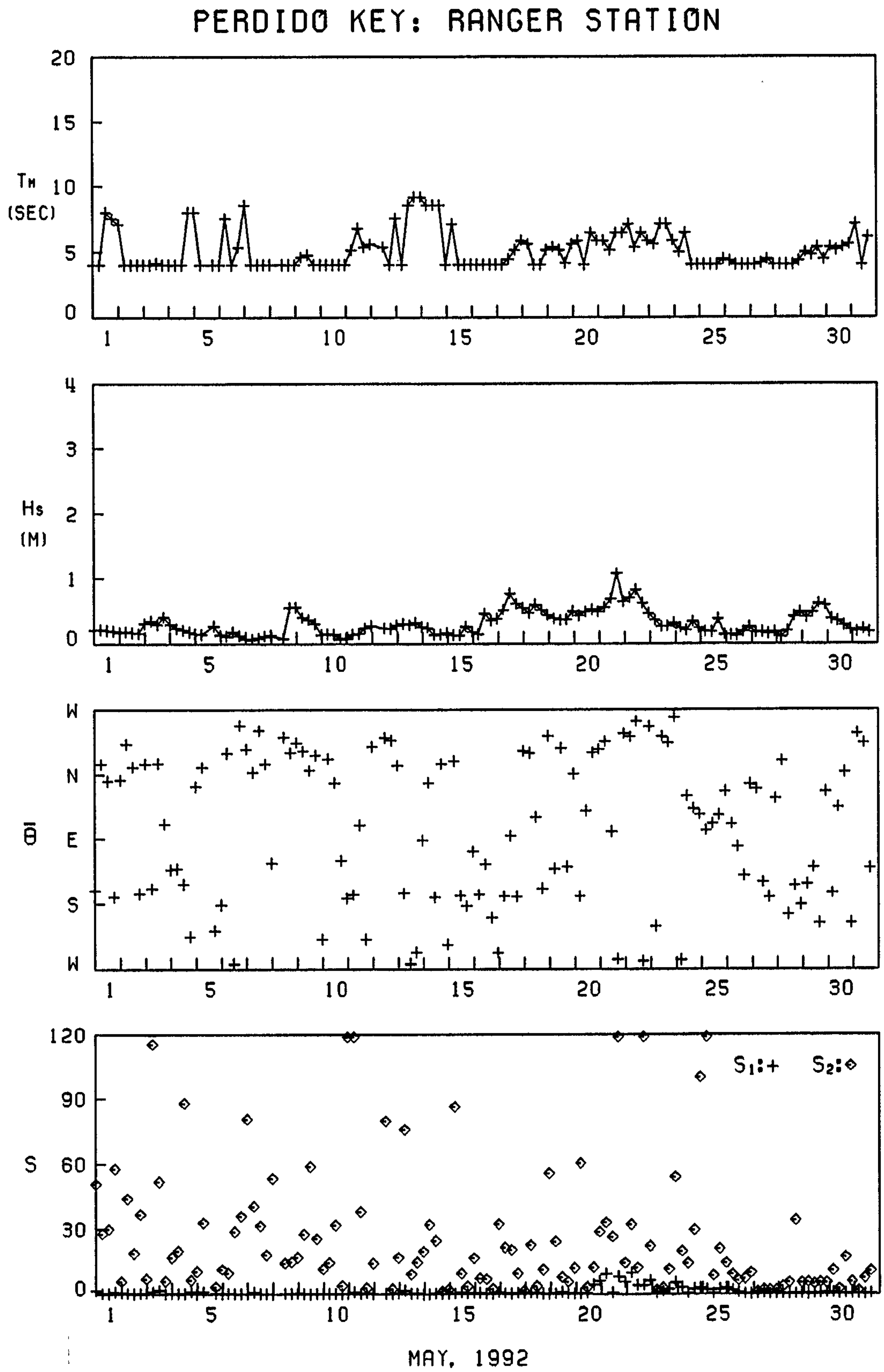


Figure II-9: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, May, 1992.

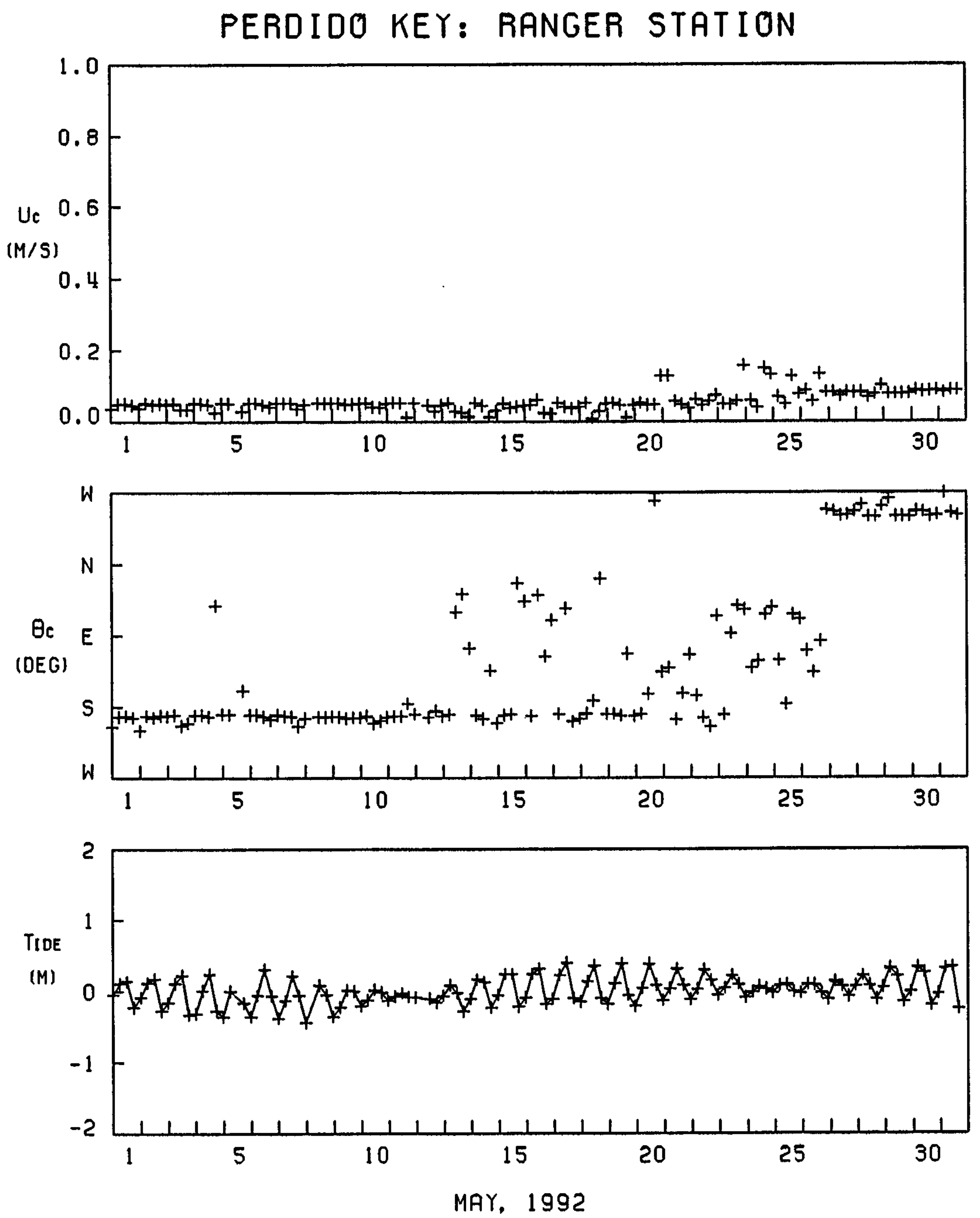


Figure II-10: Magnitude and Direction of Mean Current and Tidal Stage, May, 1992.

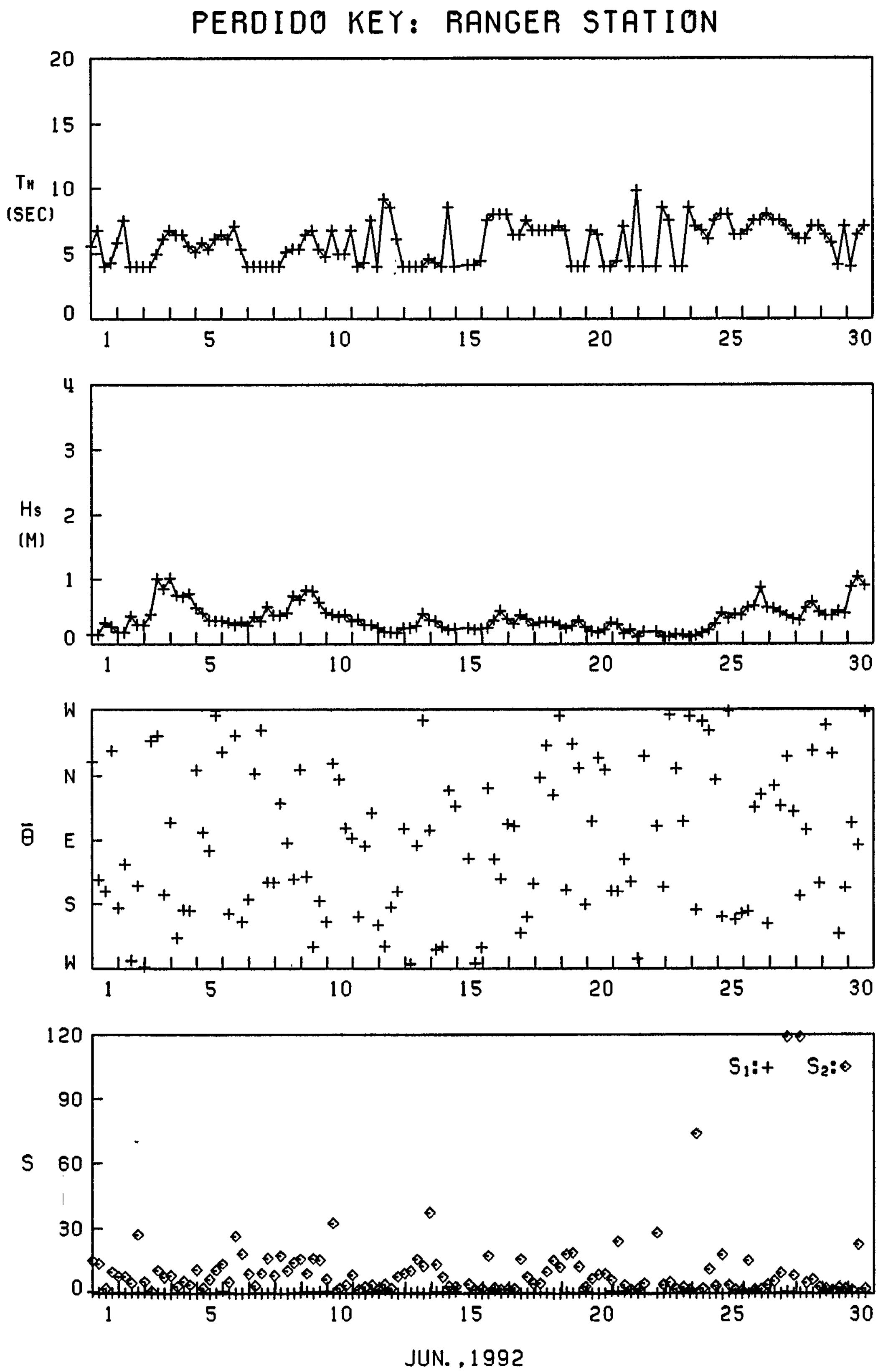


Figure II-11: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, June, 1992.

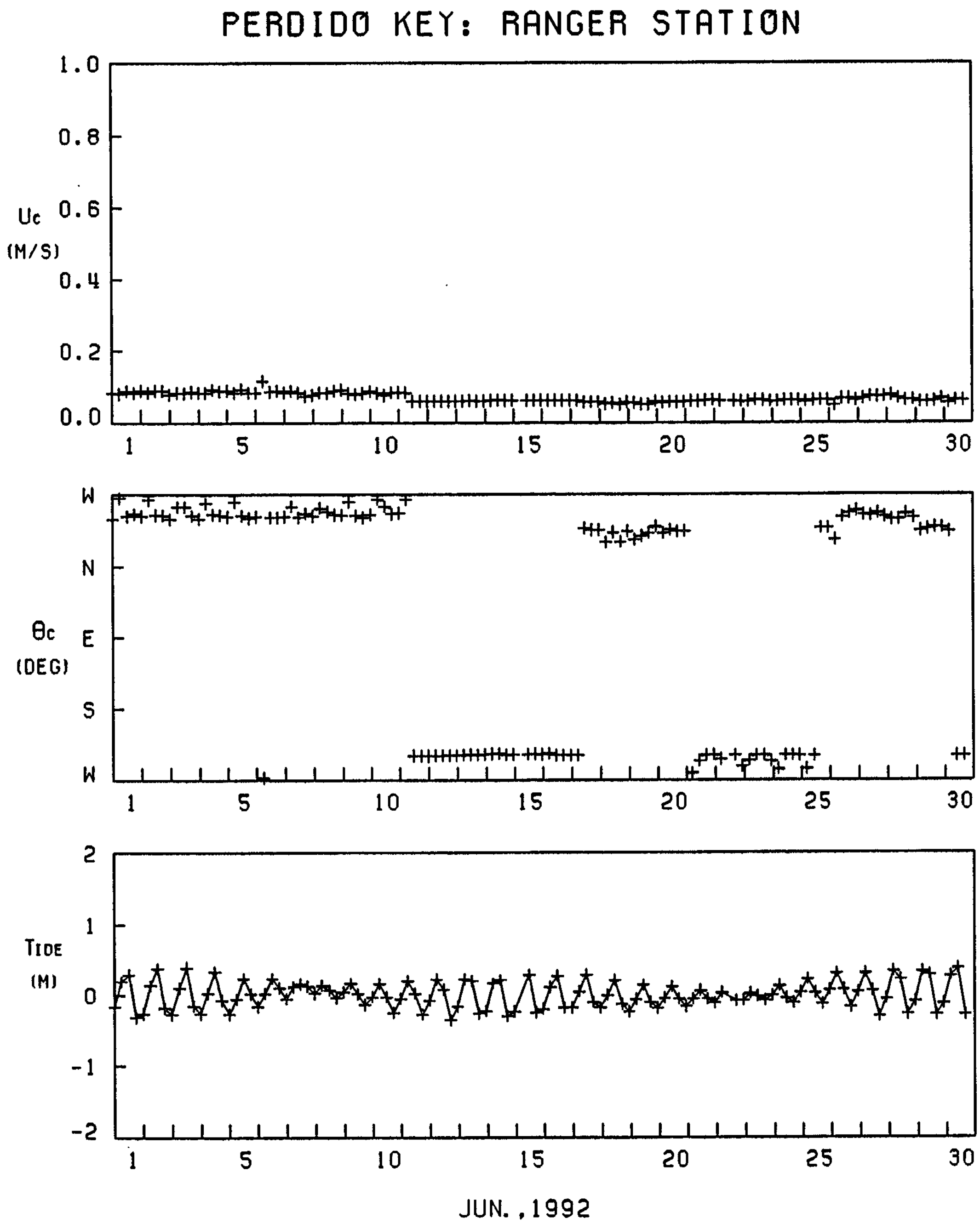


Figure II-12: Magnitude and Direction of Mean Current and Tidal Stage, June, 1992.

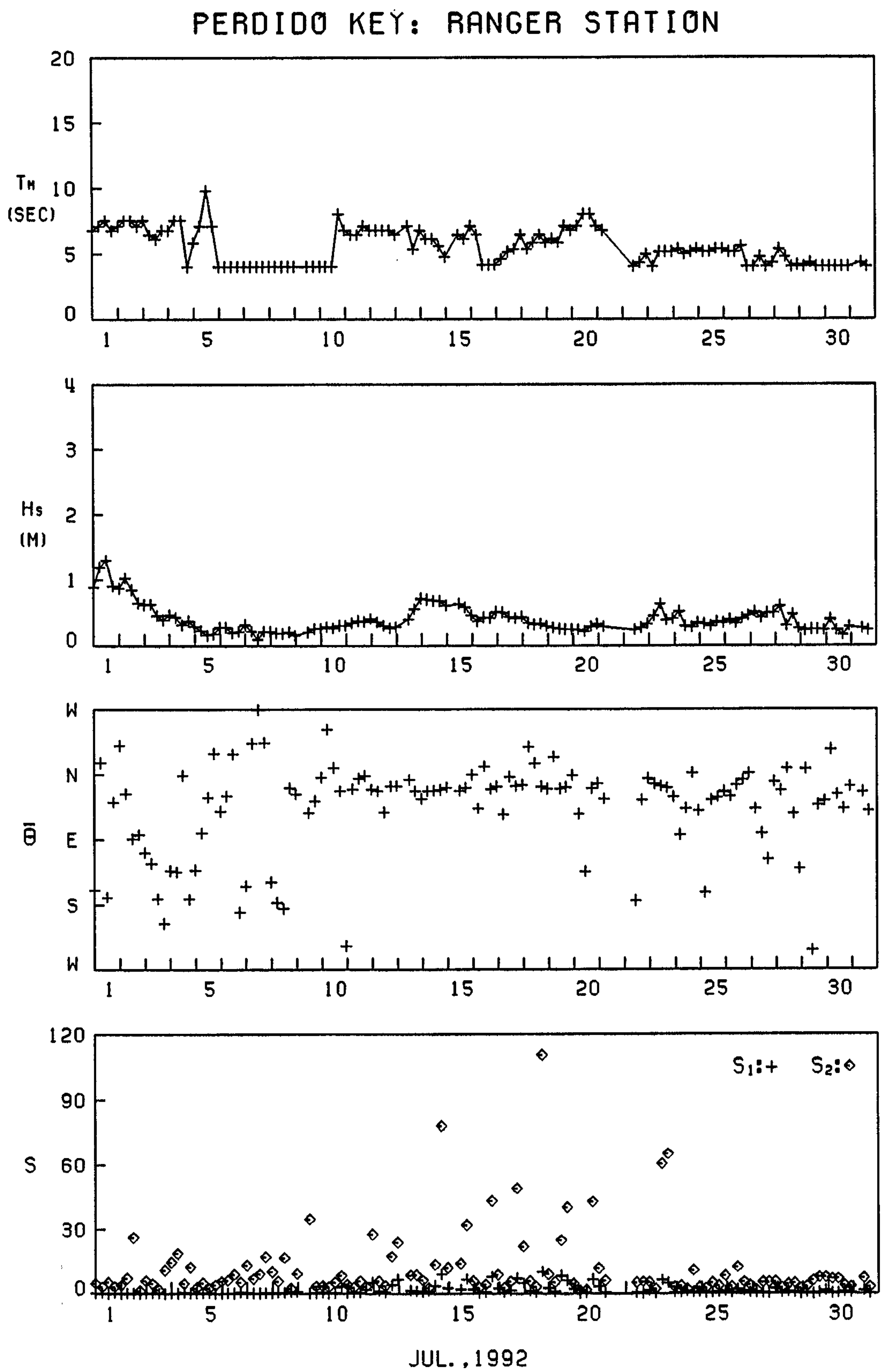


Figure II-13: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, July, 1992.

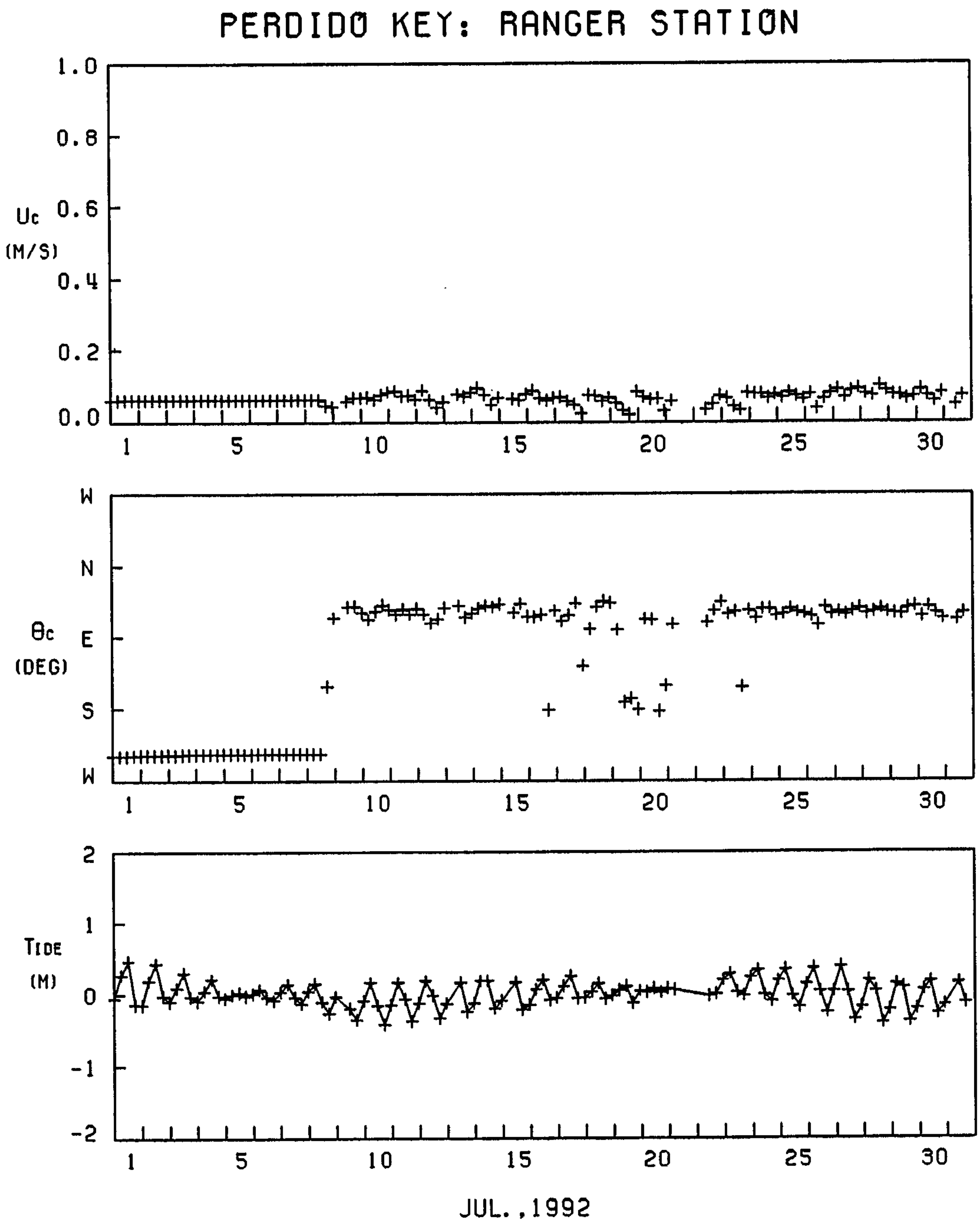


Figure II-14: Magnitude and Direction of Mean Current and Tidal Stage, July, 1992.

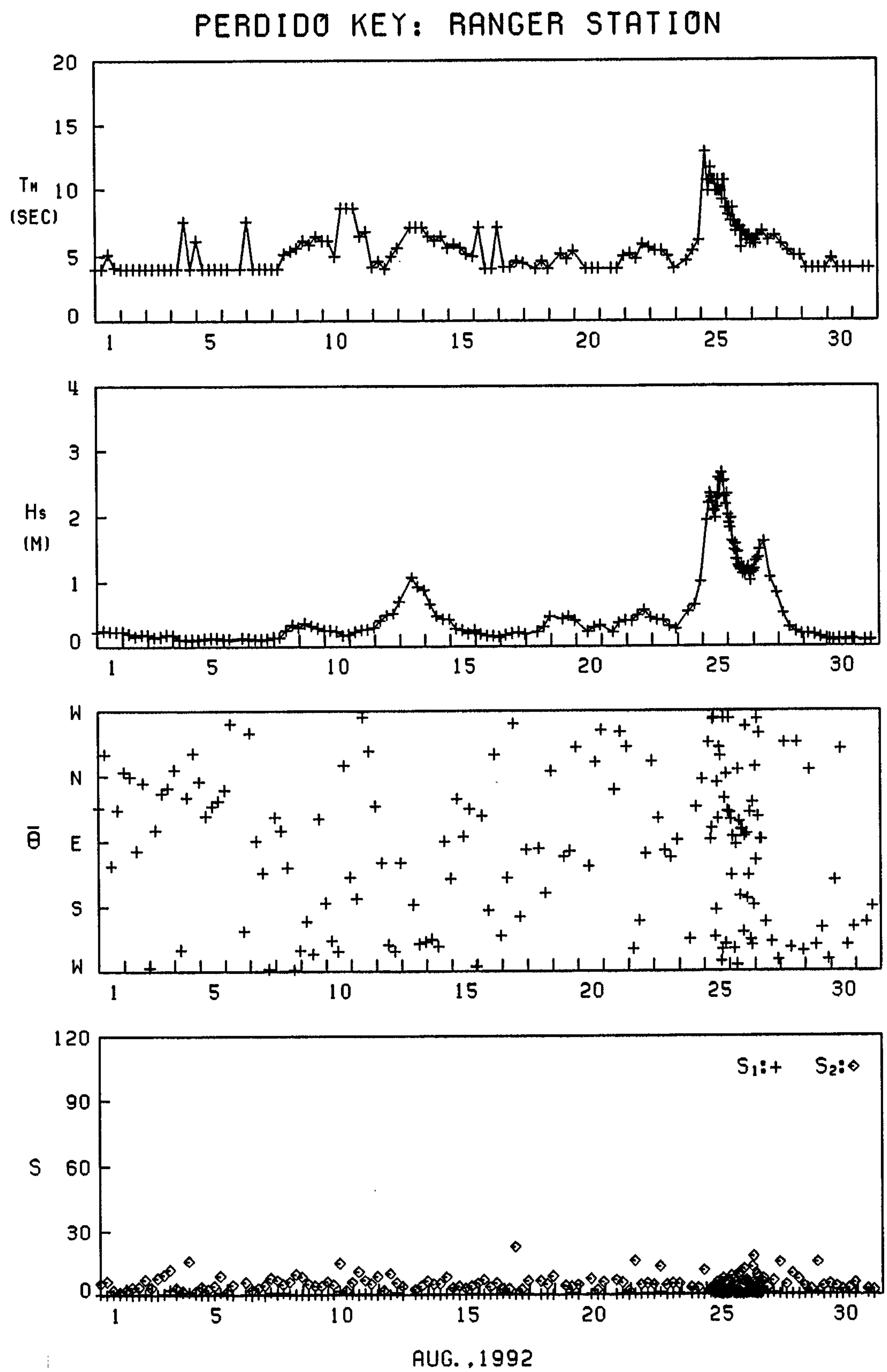


Figure II-15: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, August, 1992.

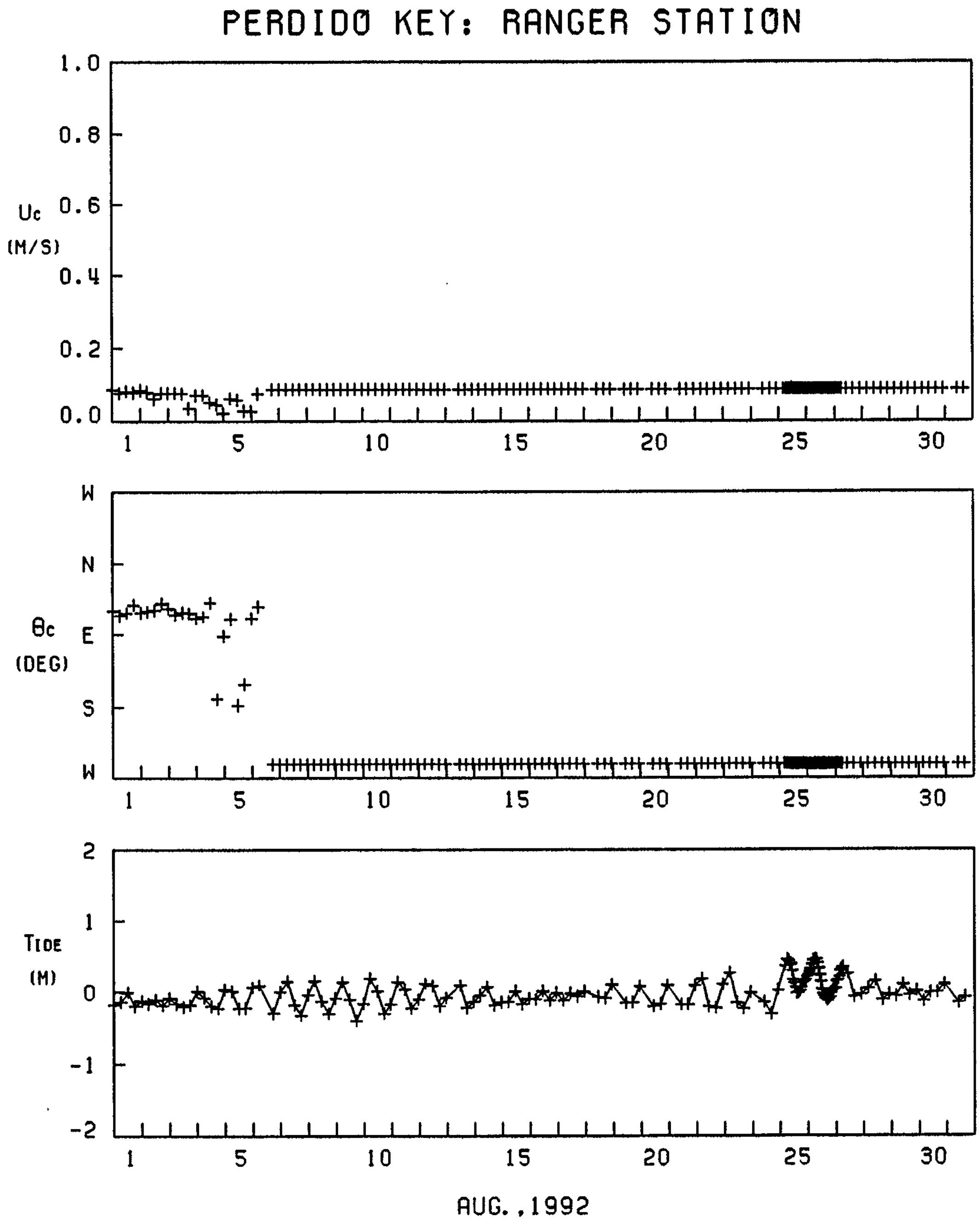


Figure II-16: Magnitude and Direction of Mean Current and Tidal Stage, August, 1992.

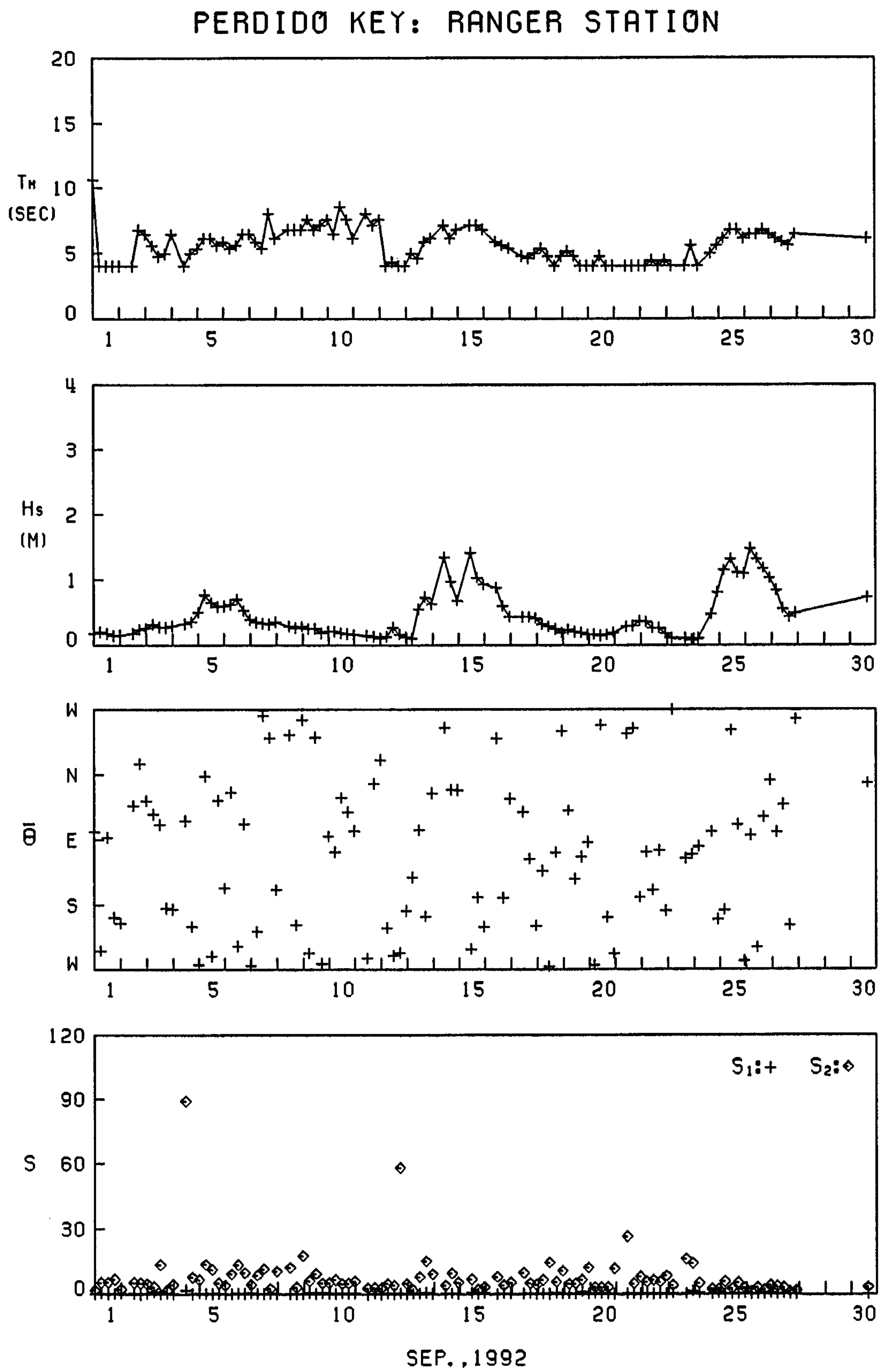


Figure II-17: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, September, 1992.

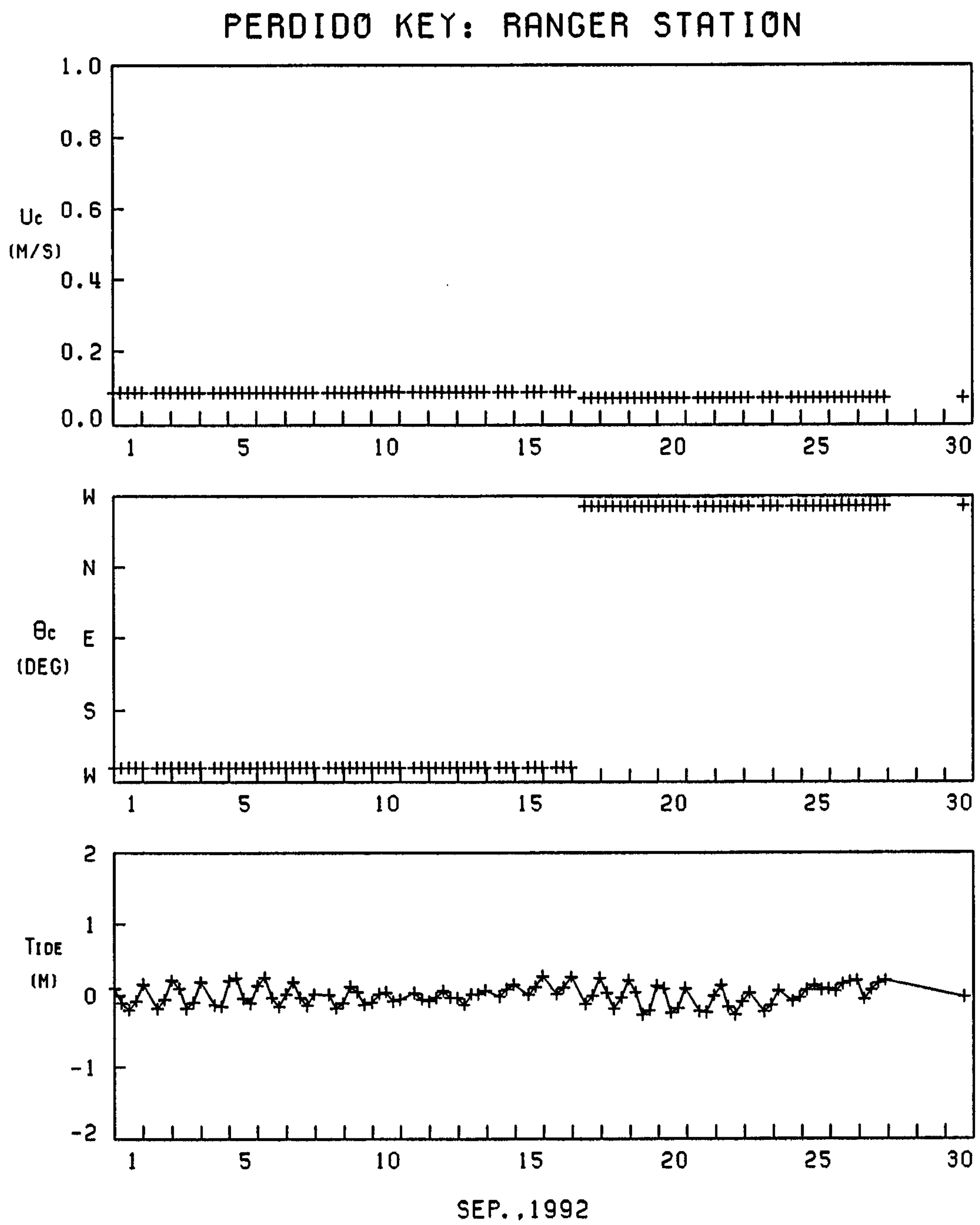


Figure II-18: Magnitude and Direction of Mean Current and Tidal Stage, September, 1992.

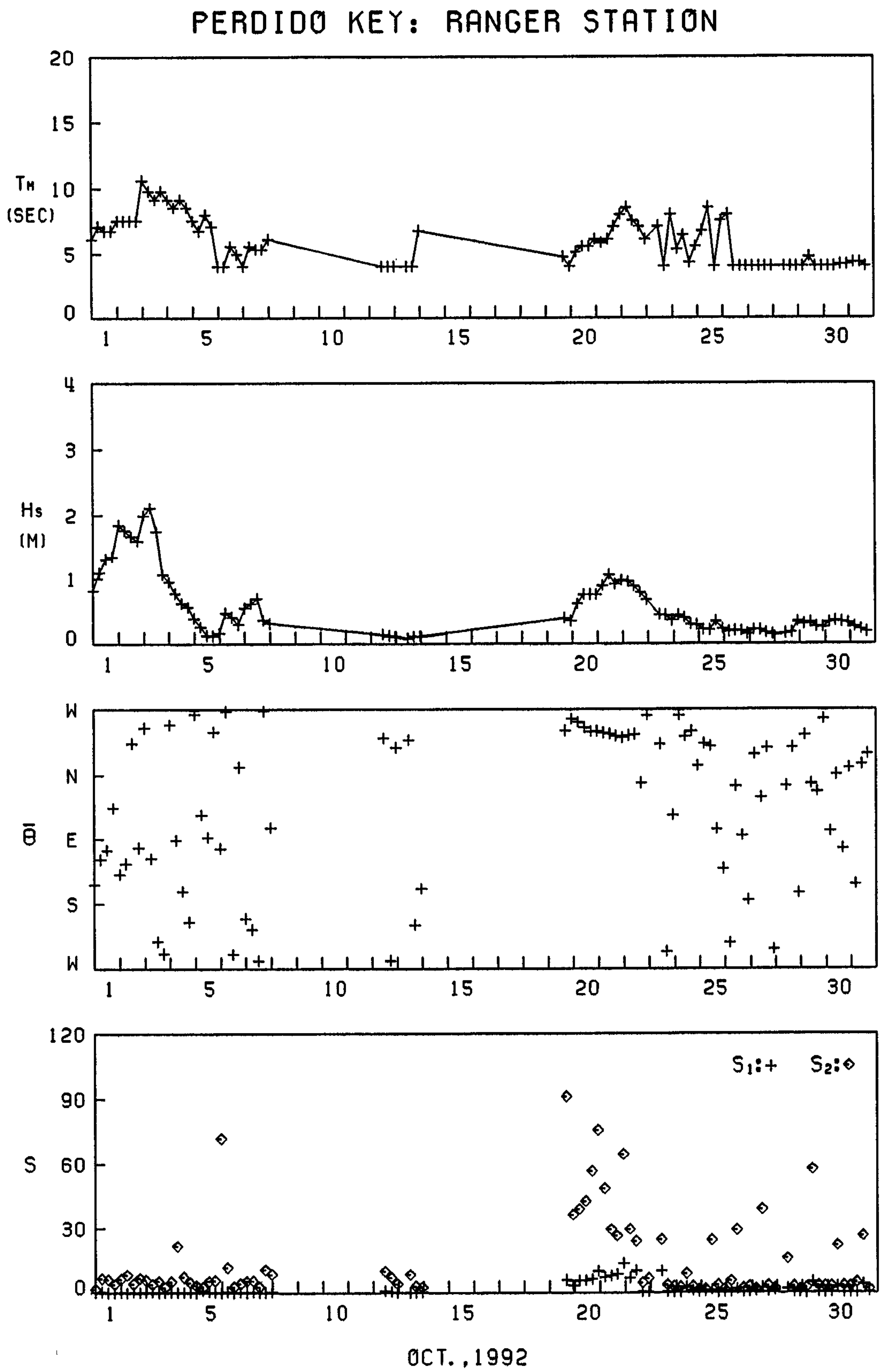


Figure II-19: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, October, 1992.

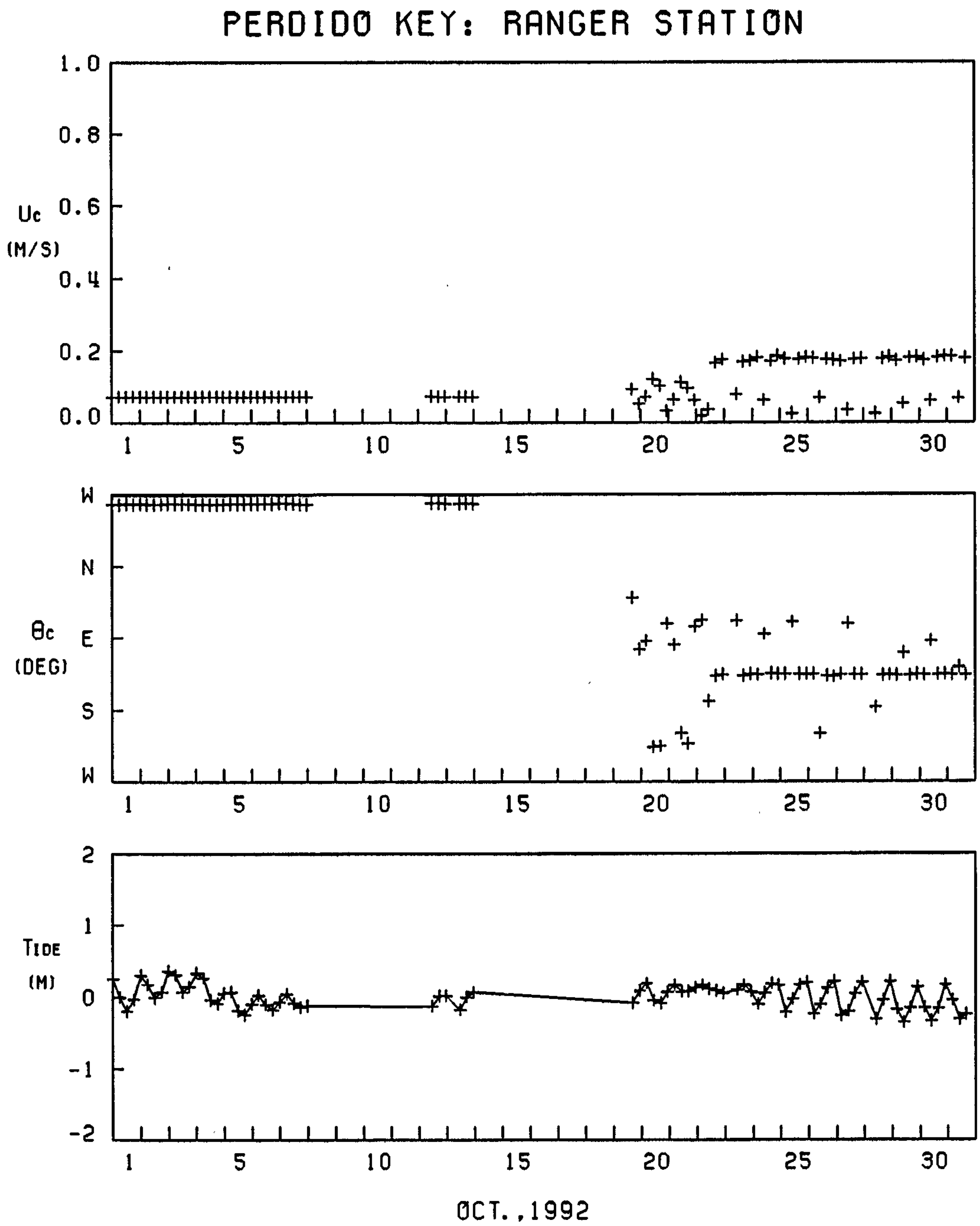


Figure II-20: Magnitude and Direction of Mean Current and Tidal Stage, October, 1992.

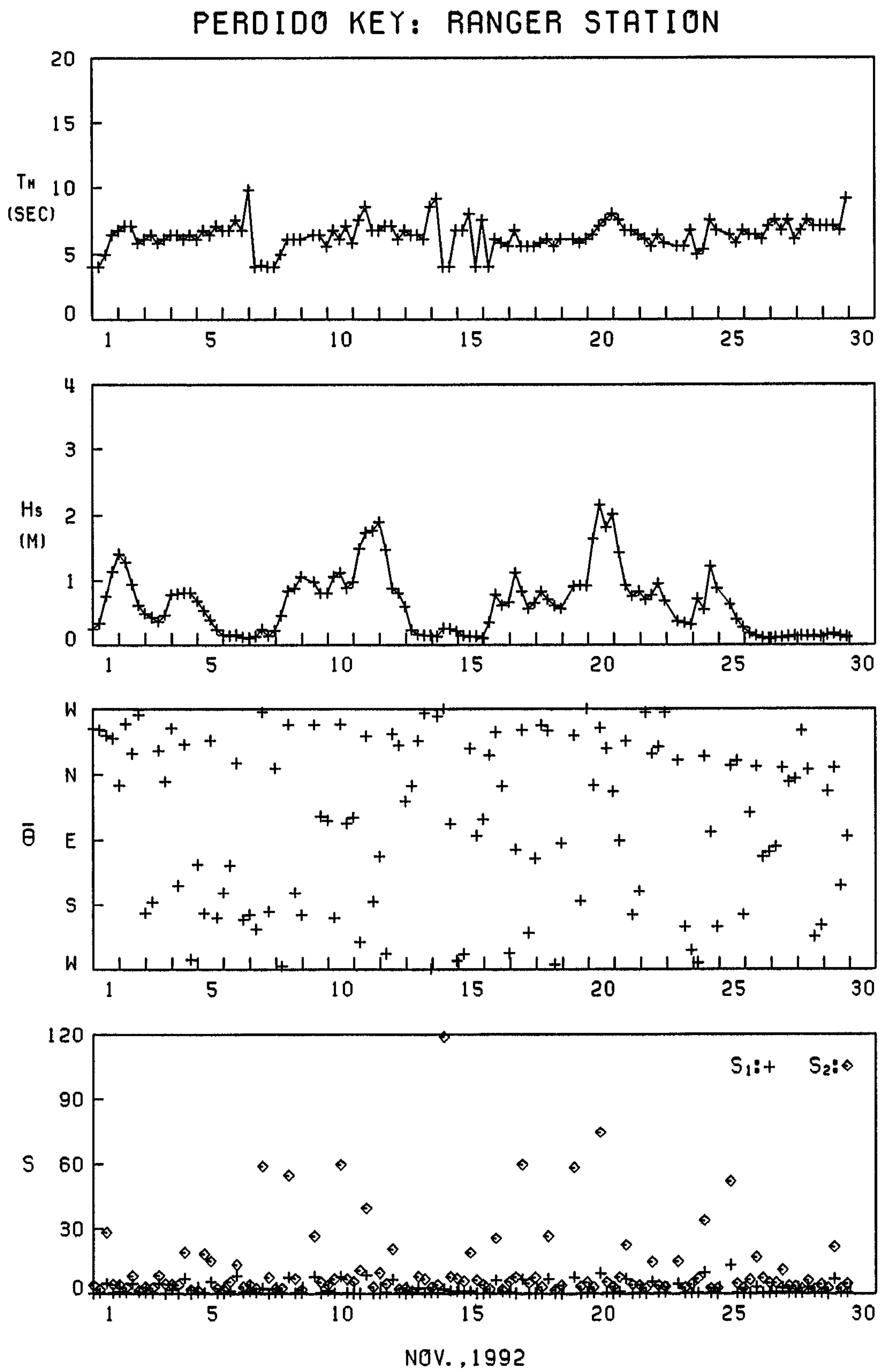


Figure II-21: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, November, 1992.

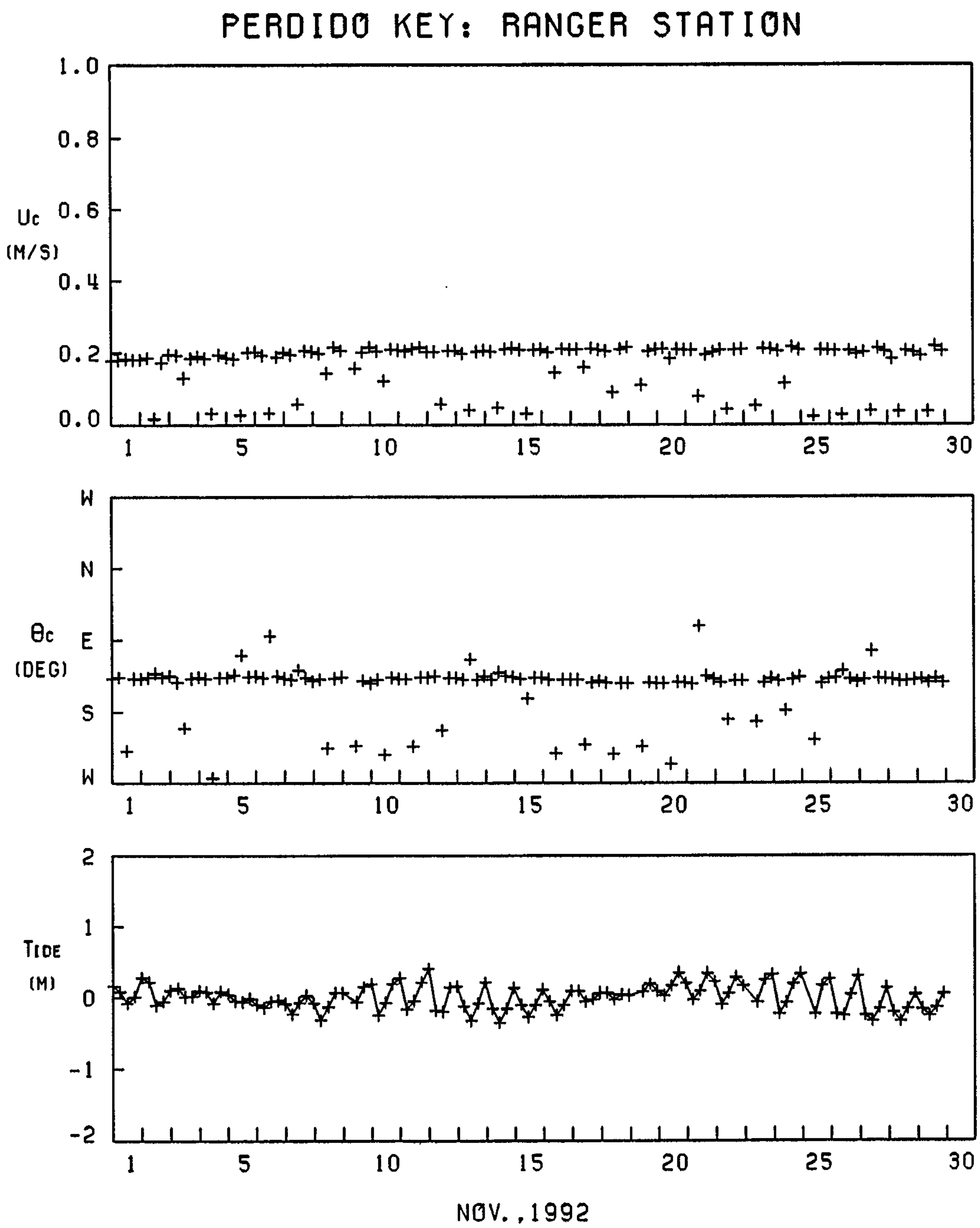


Figure II-22: Magnitude and Direction of Mean Current and Tidal Stage, November, 1992.

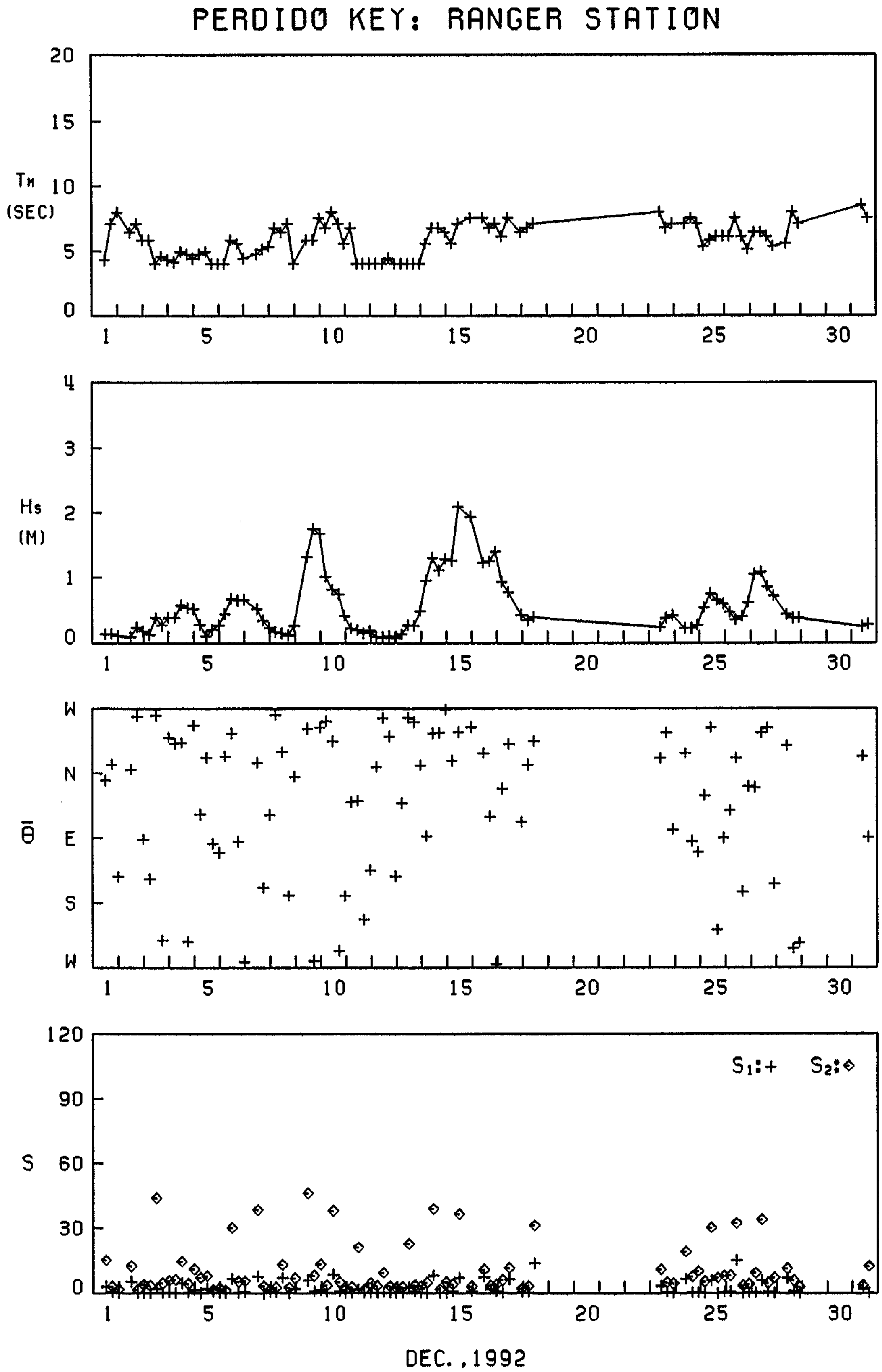


Figure II-23: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, December, 1992.

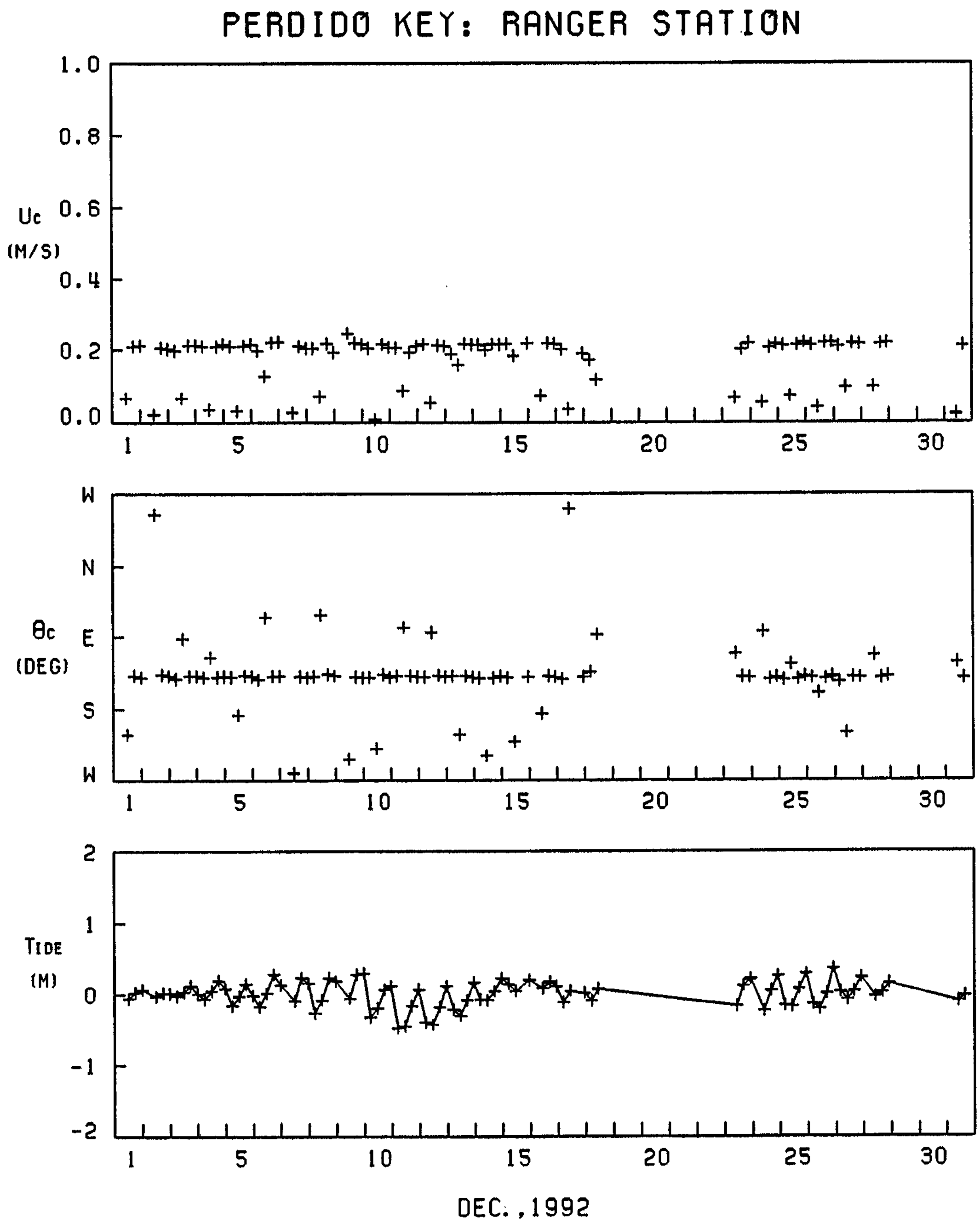


Figure II-24: Magnitude and Direction of Mean Current and Tidal Stage, December, 1992.

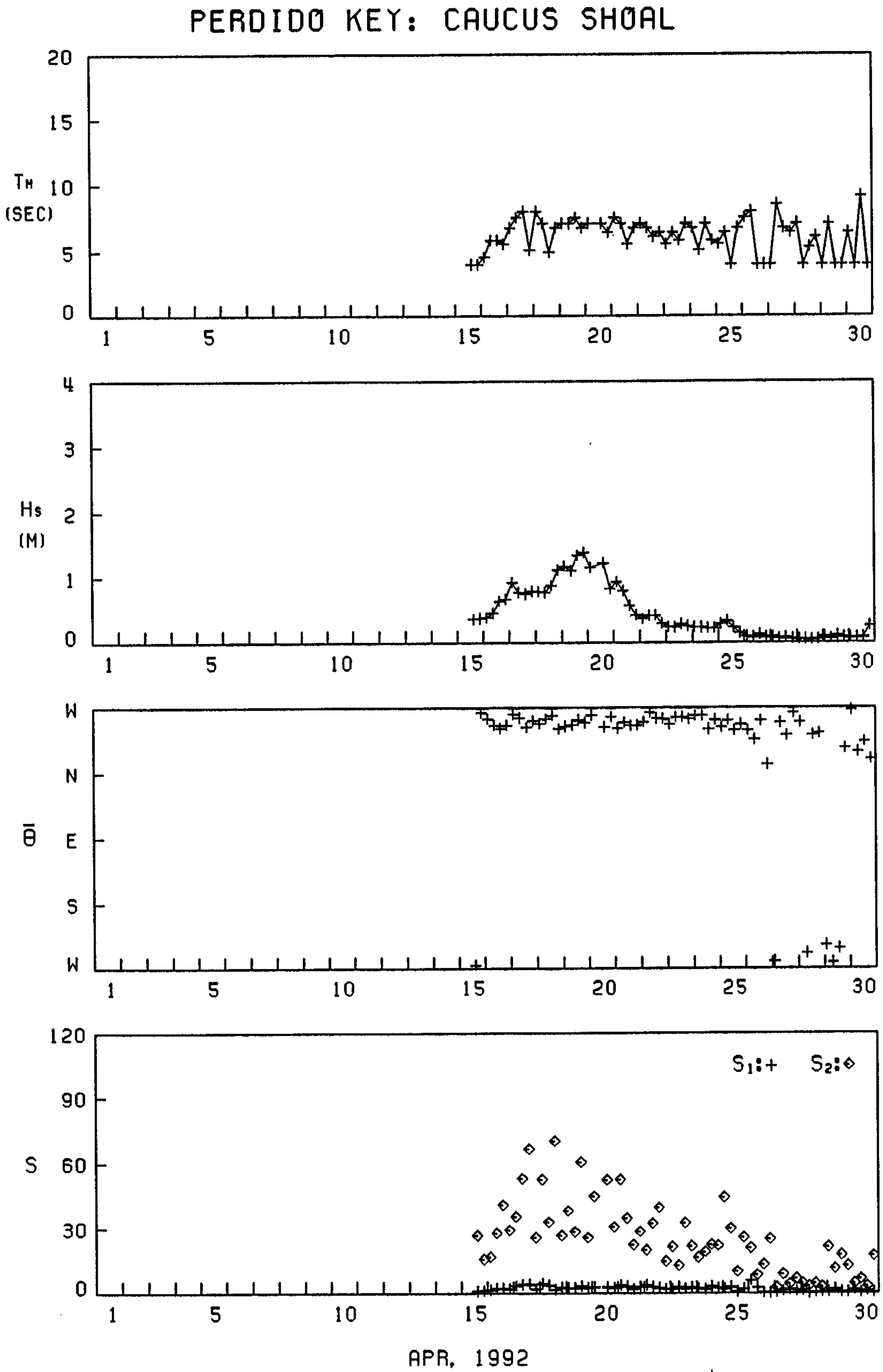


Figure II-25: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, April, 1992.

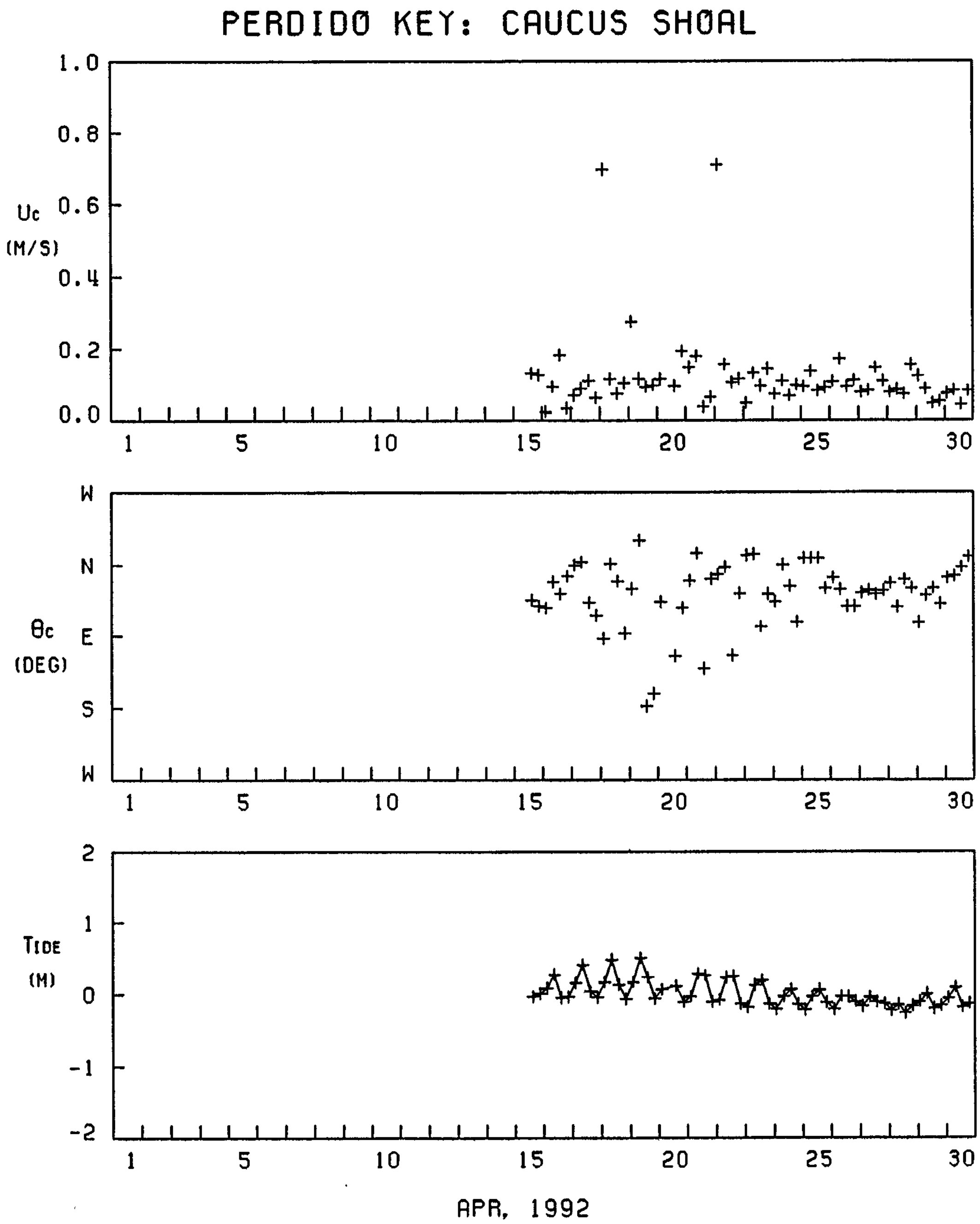


Figure II-26: Magnitude and Direction of Mean Current and Tidal Stage, April, 1992.

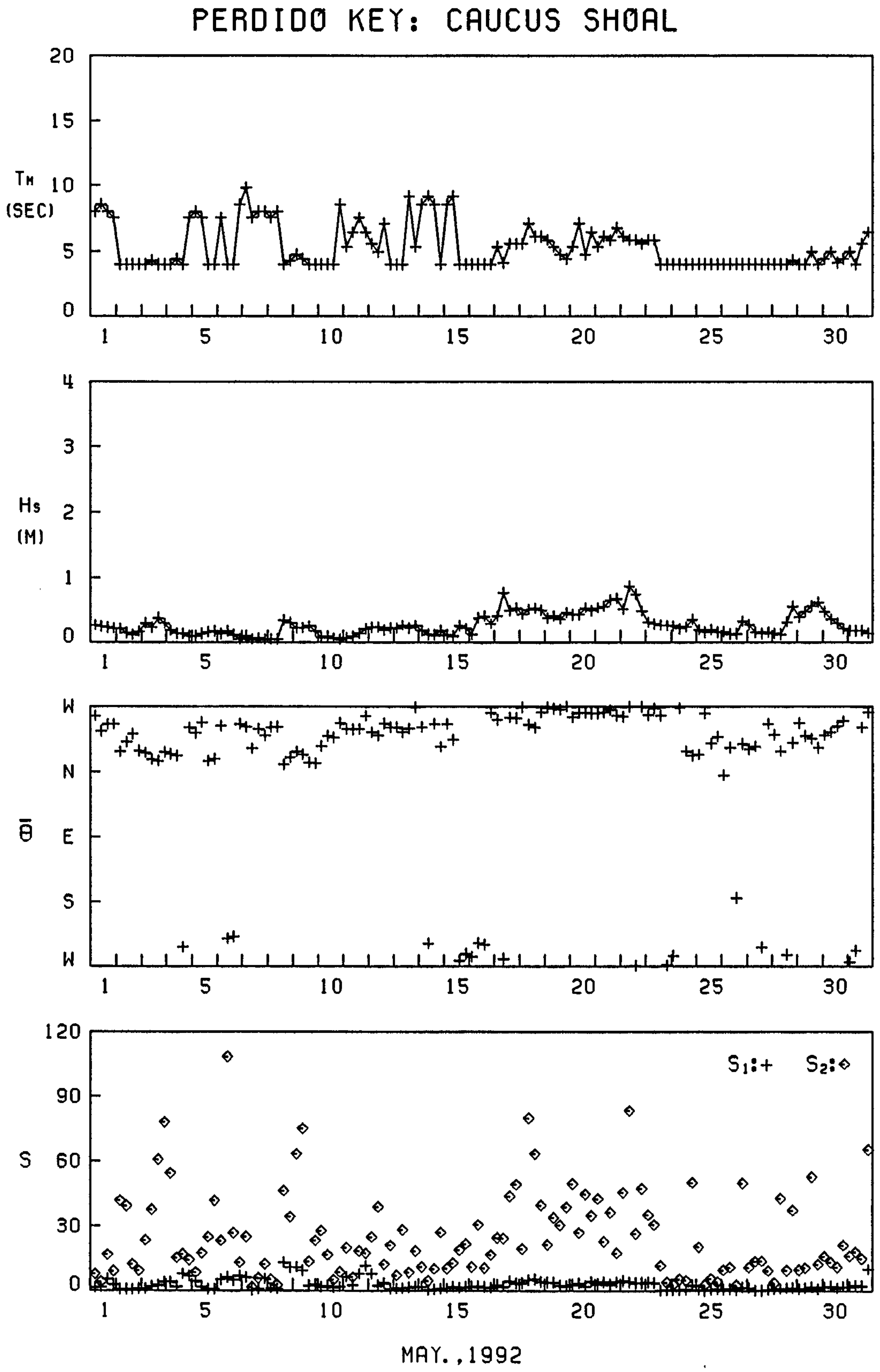


Figure II-27: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, May, 1992.

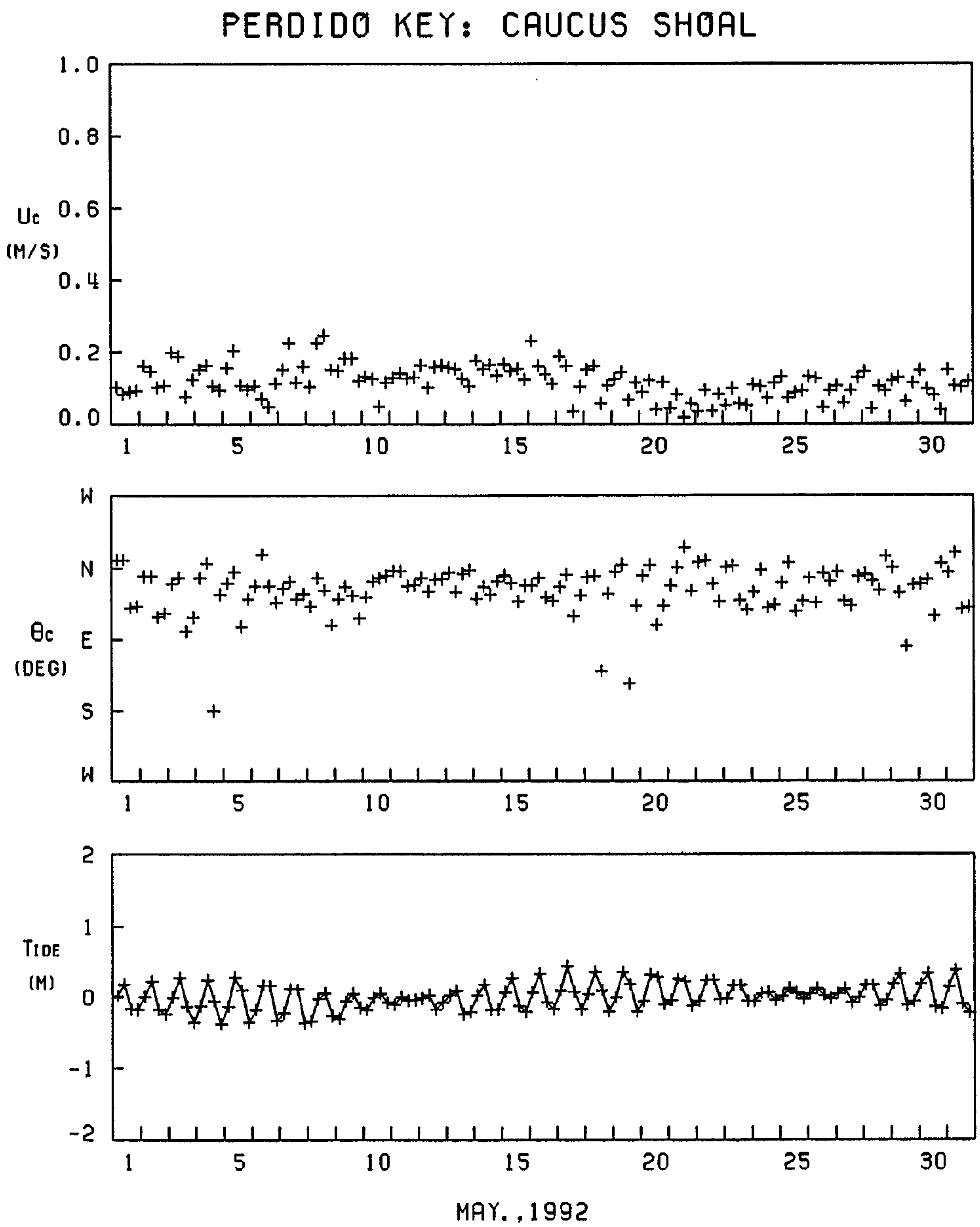


Figure II-28: Magnitude and Direction of Mean Current and Tidal Stage, May, 1992.

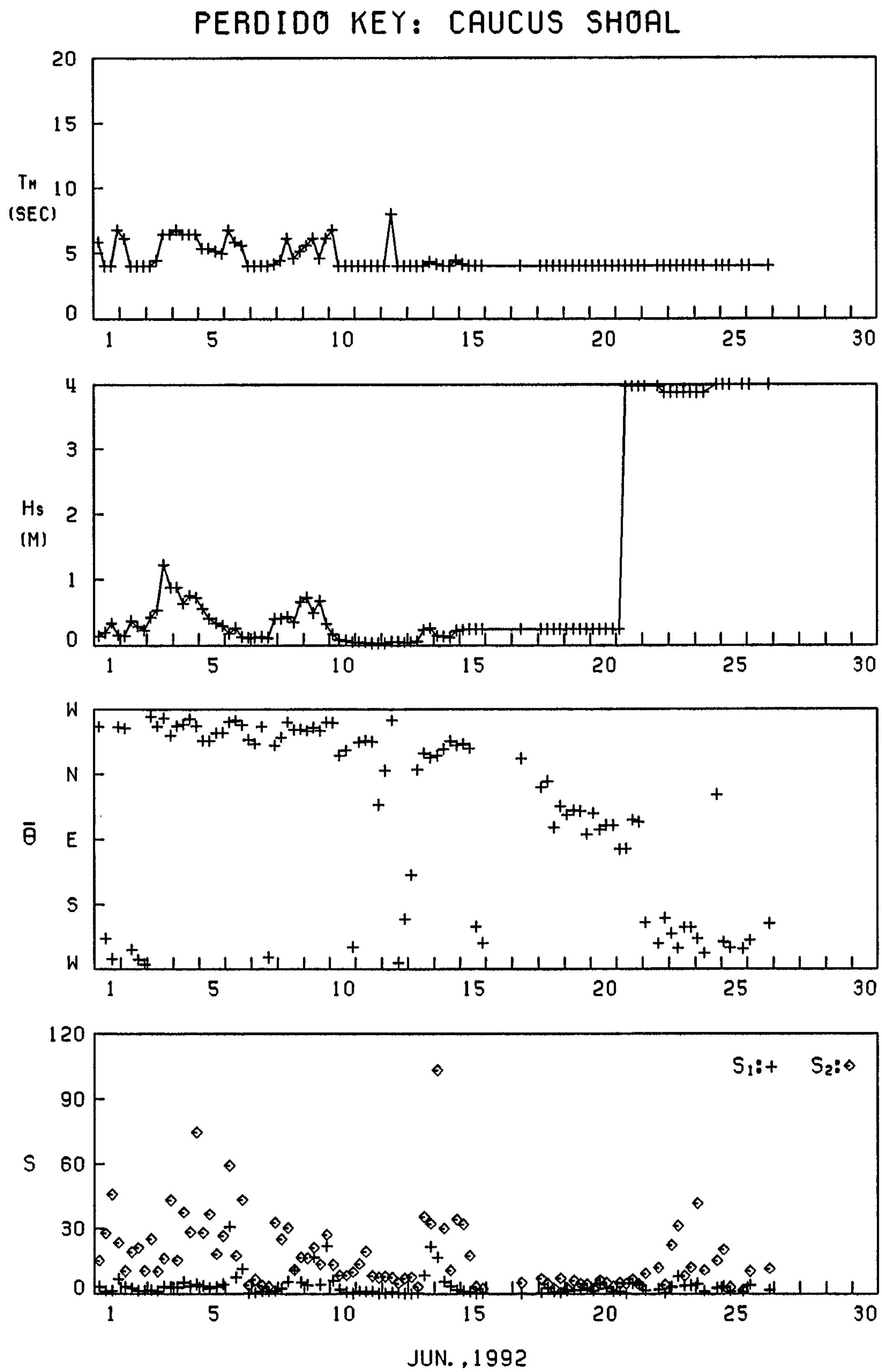


Figure II-29: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, June, 1992.

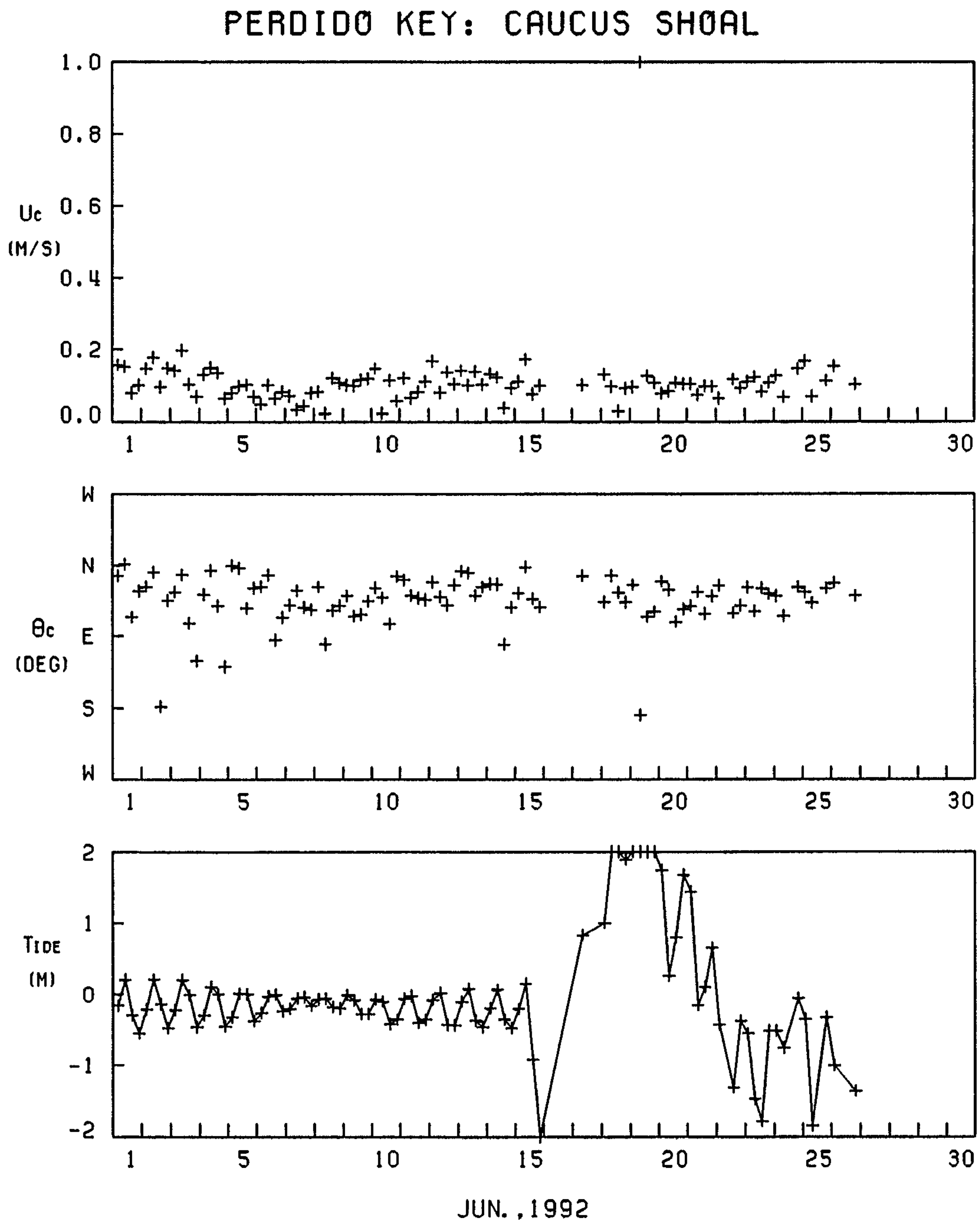


Figure II-30: Magnitude and Direction of Mean Current and Tidal Stage, June, 1992.

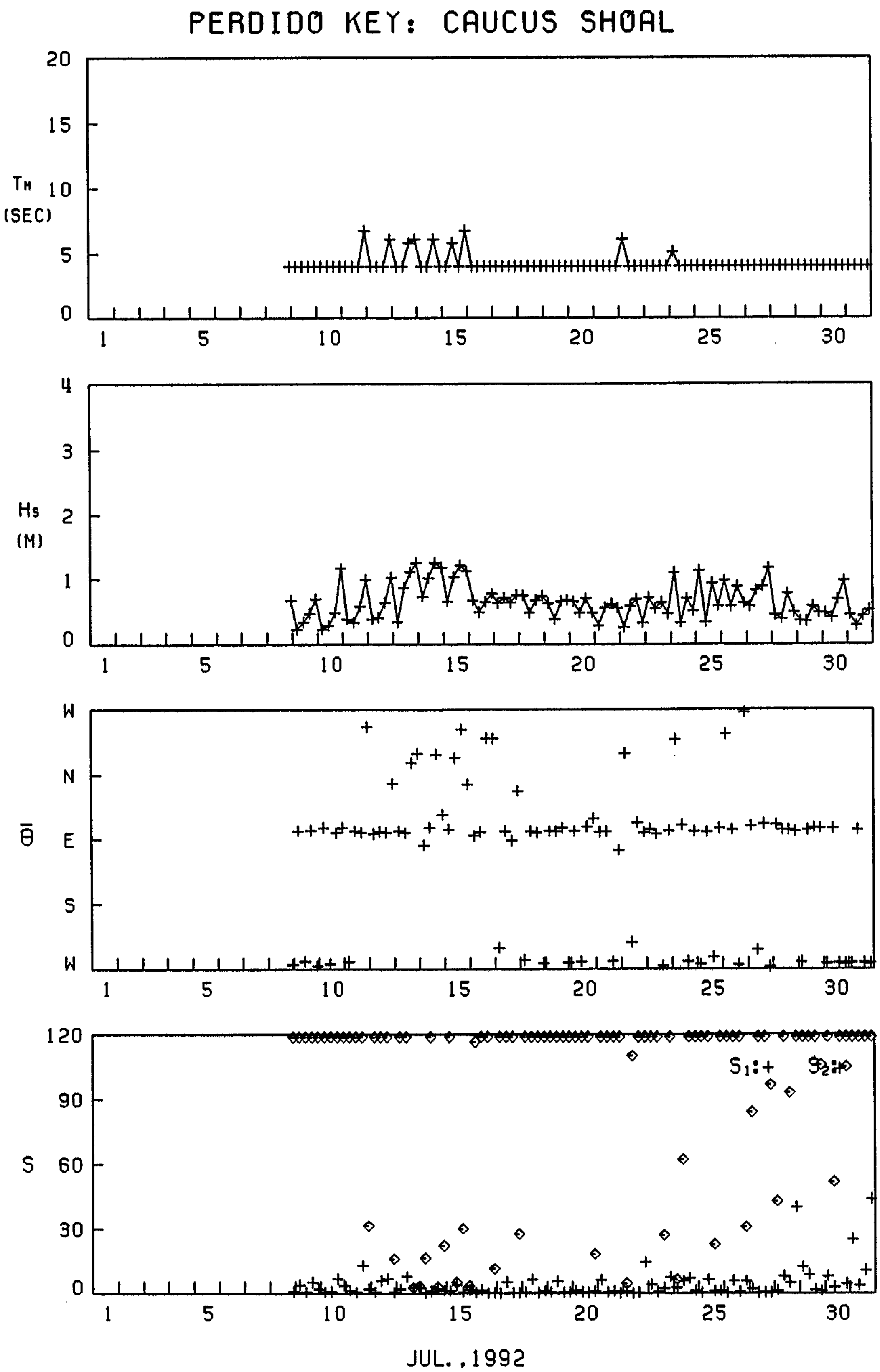


Figure II-31: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, July, 1992.

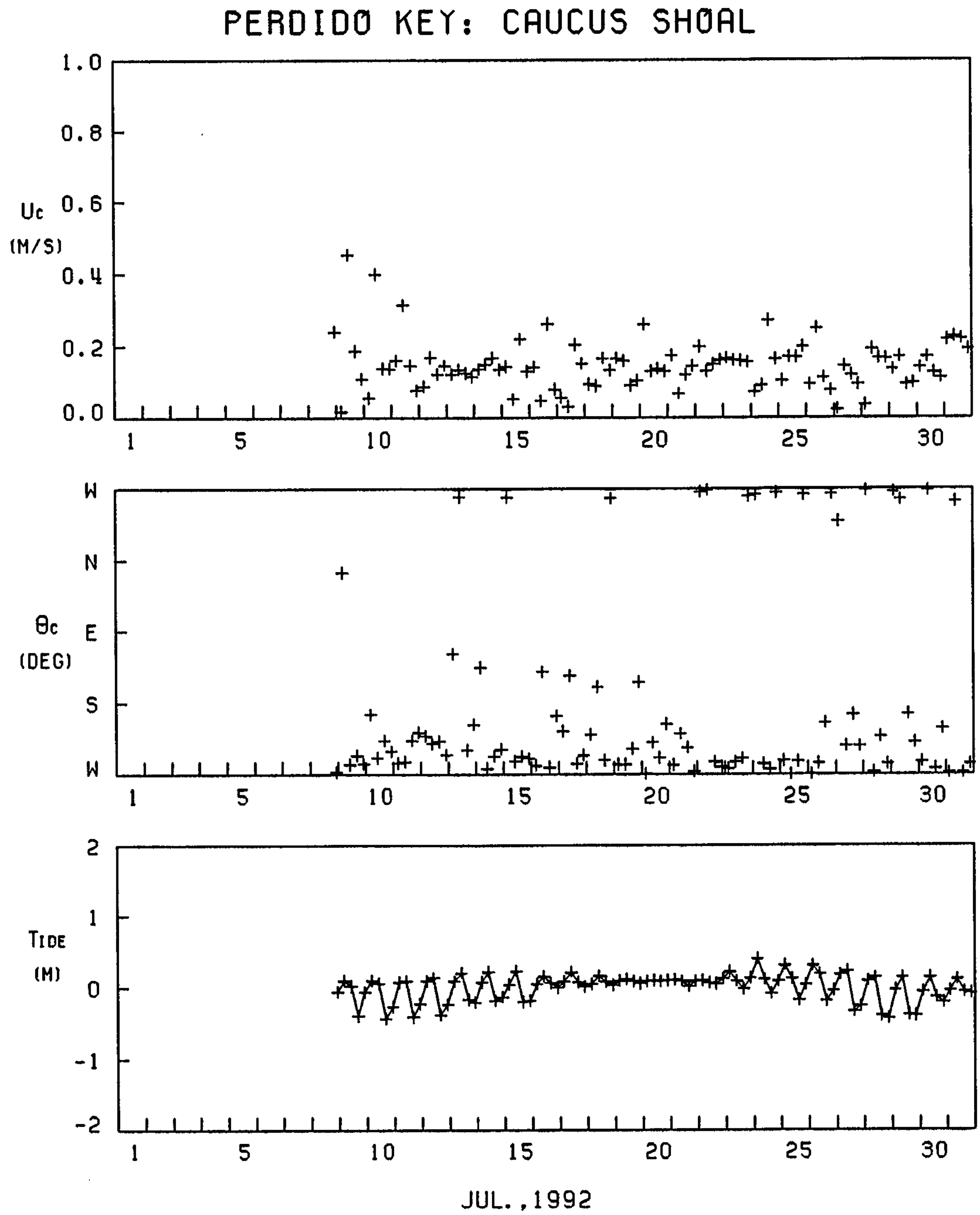


Figure II-32: Magnitude and Direction of Mean Current and Tidal Stage, July, 1992.

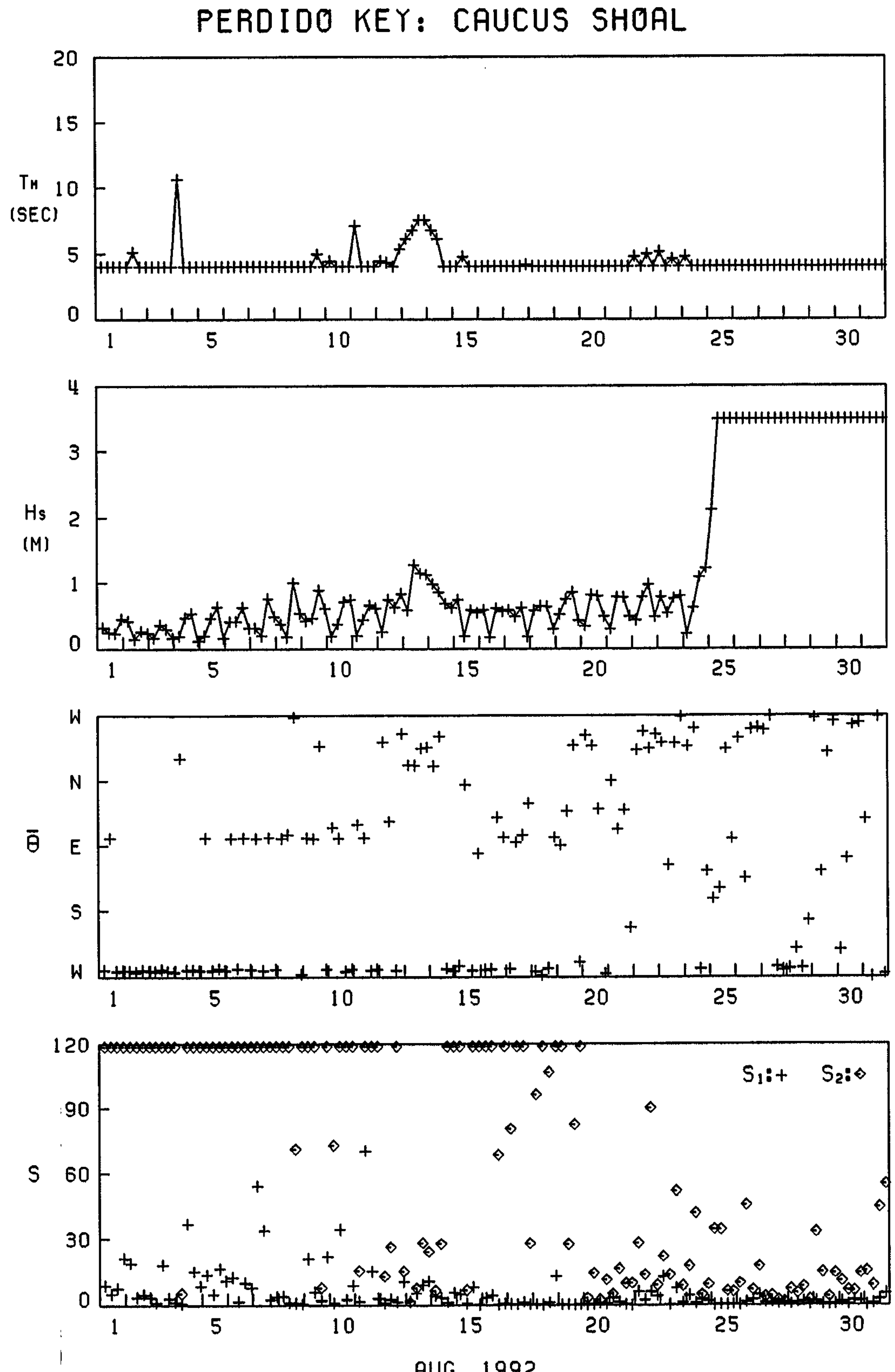


Figure II-33: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, August, 1992.

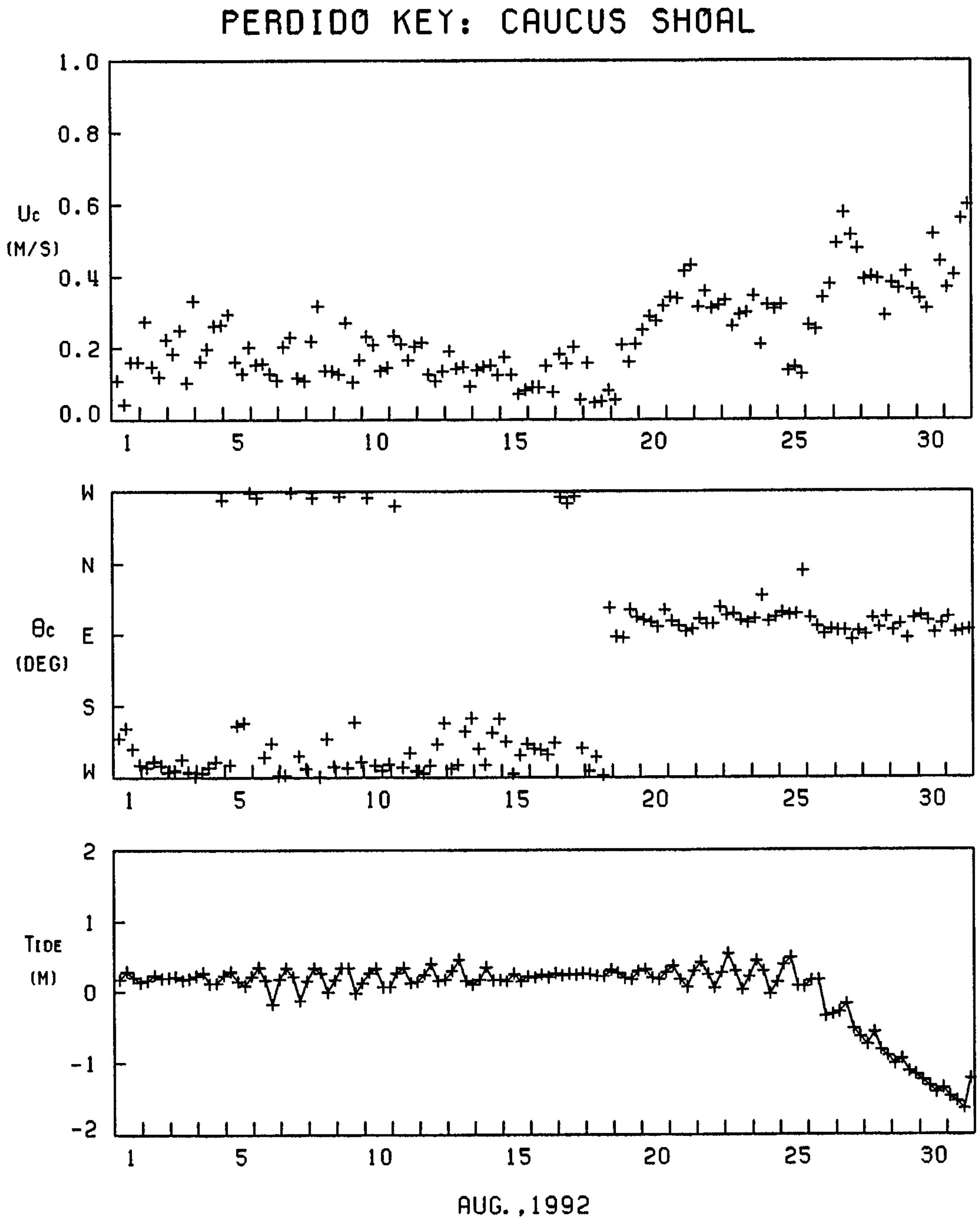


Figure II-34: Magnitude and Direction of Mean Current and Tidal Stage, August, 1992.

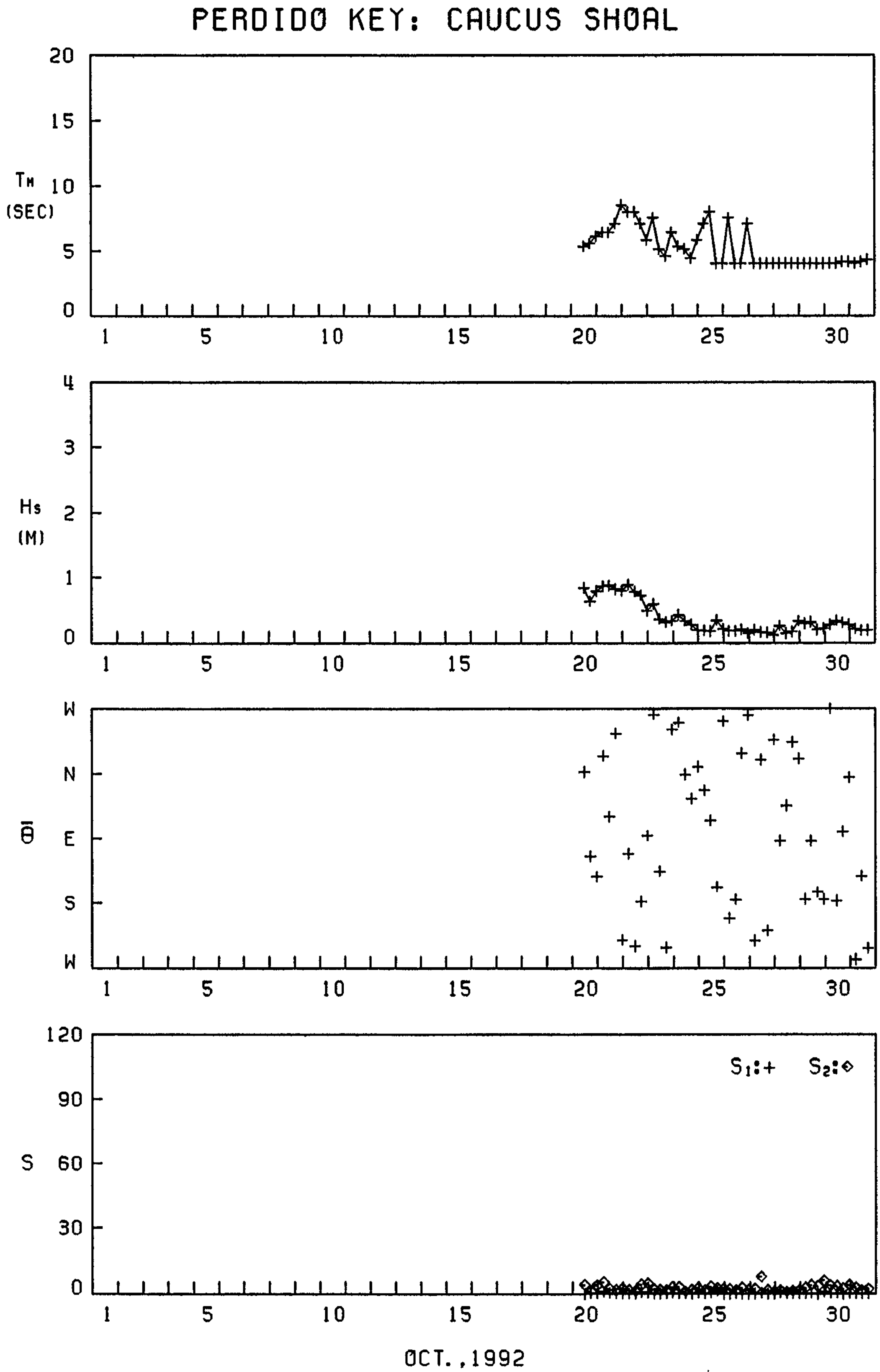


Figure II-35: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, October, 1992.

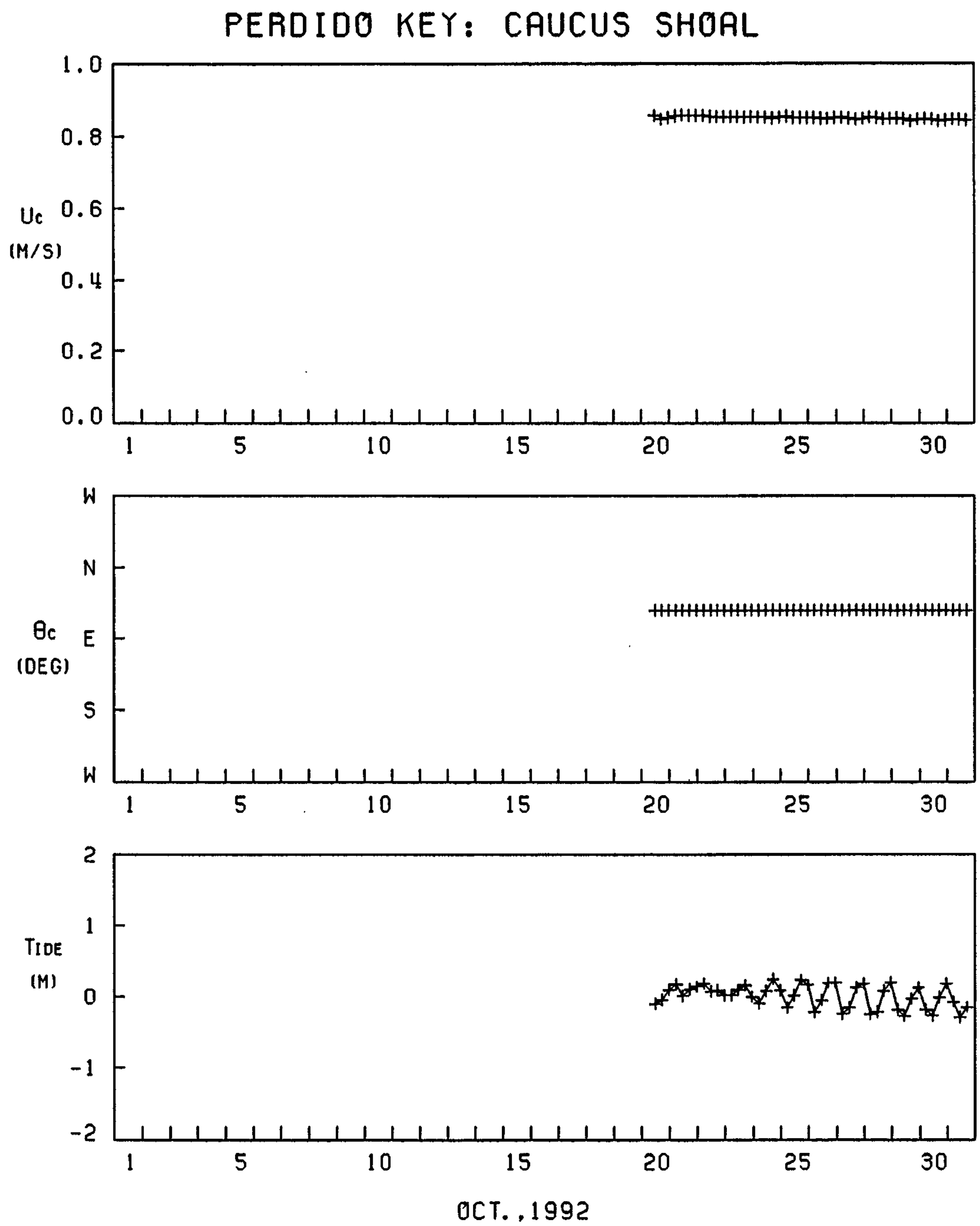


Figure II-36: Magnitude and Direction of Mean Current and Tidal Stage, October, 1992.

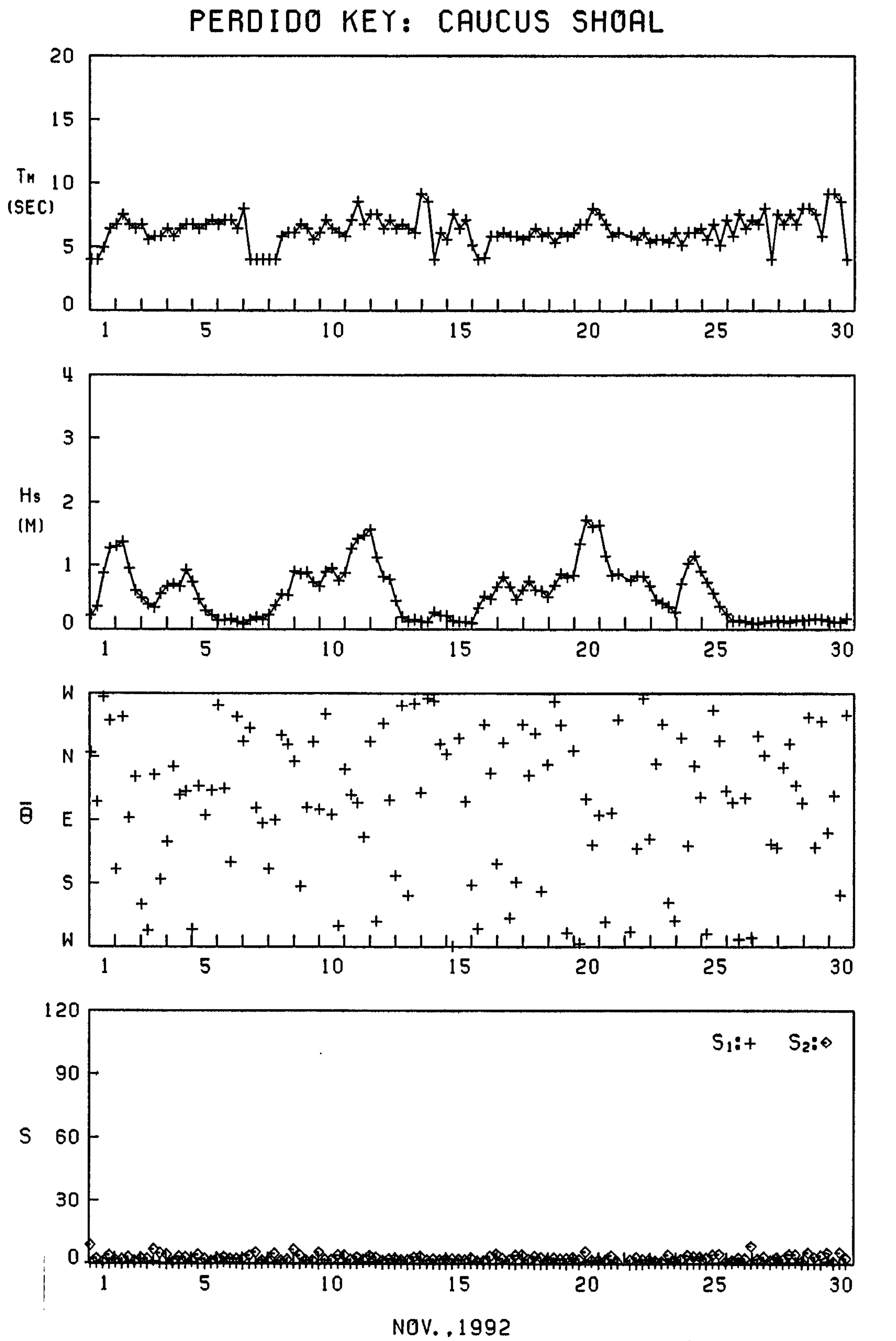


Figure II-37: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, November, 1992.

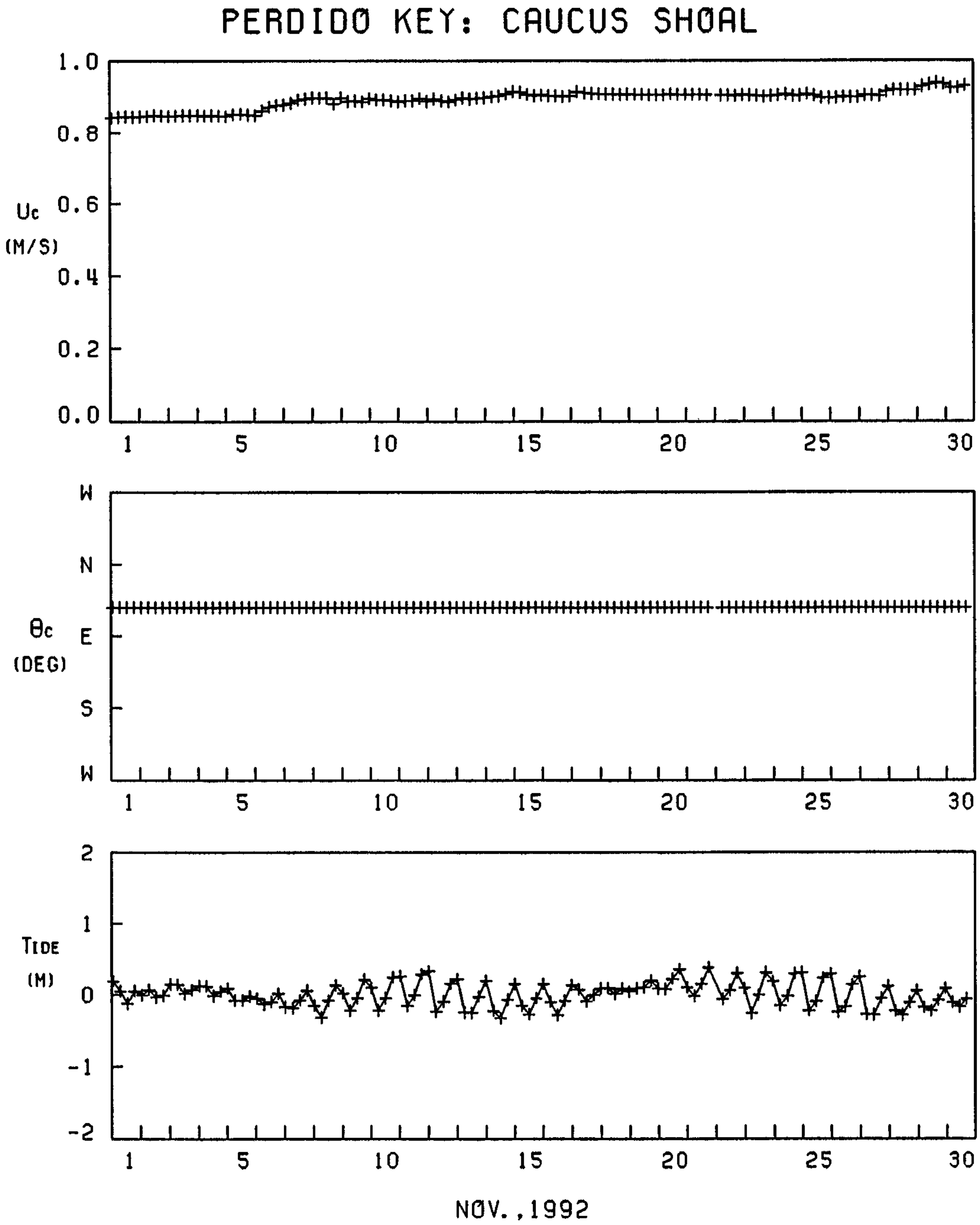


Figure II-38: Magnitude and Direction of Mean Current and Tidal Stage, November, 1992.

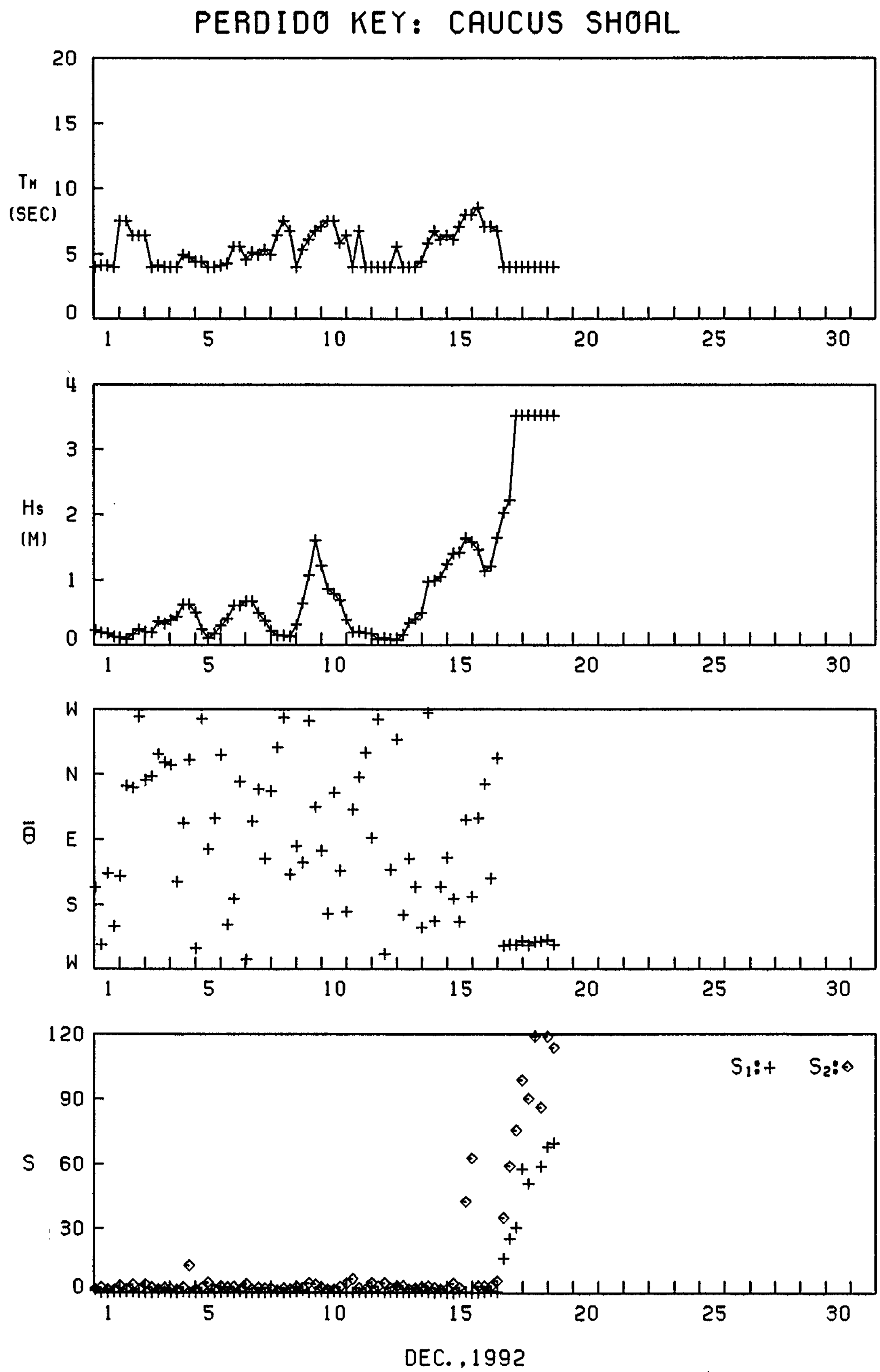


Figure II-39: Representative Wave Period, Significant Wave Height, Central Direction and Spreading Parameters, December, 1992.

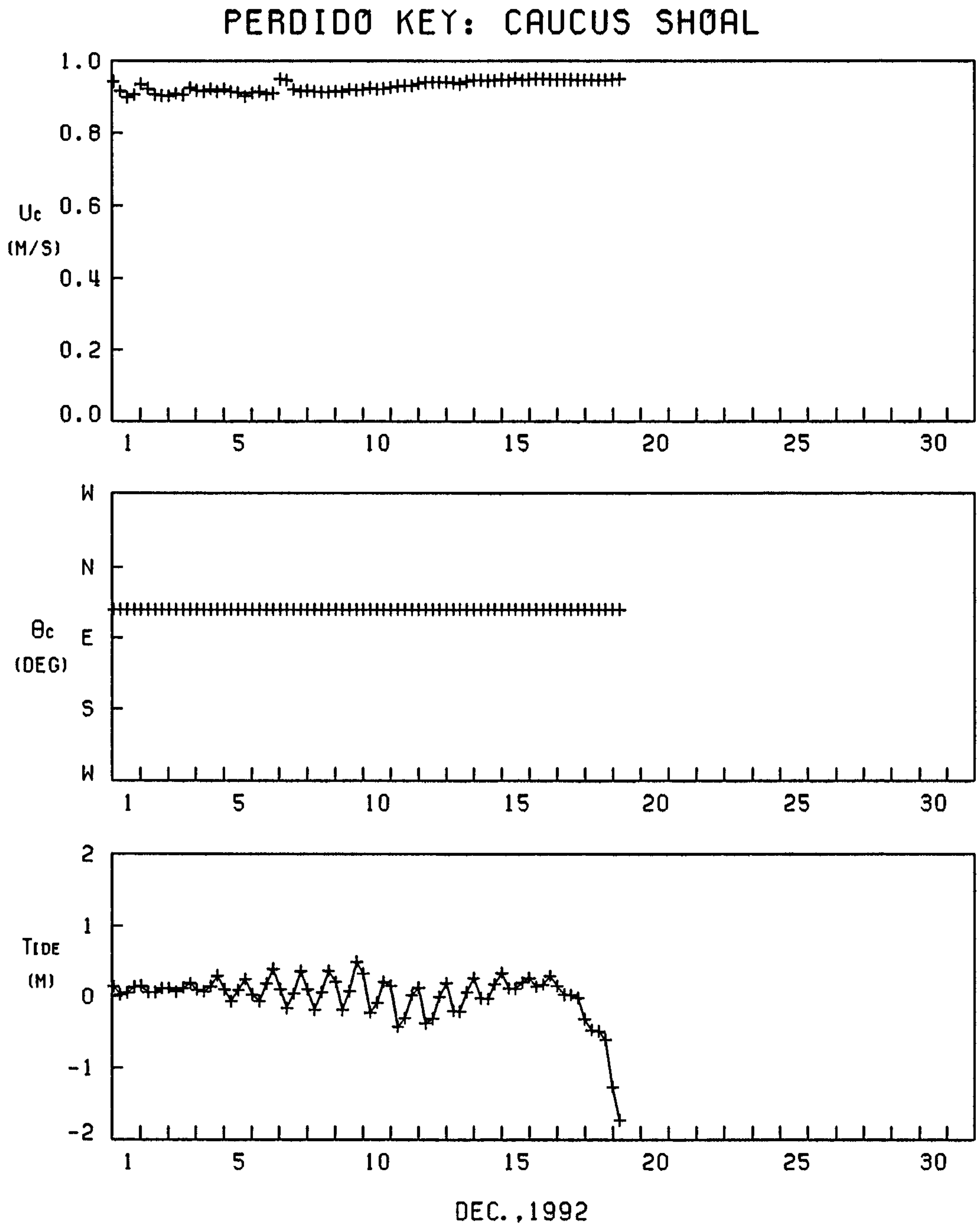


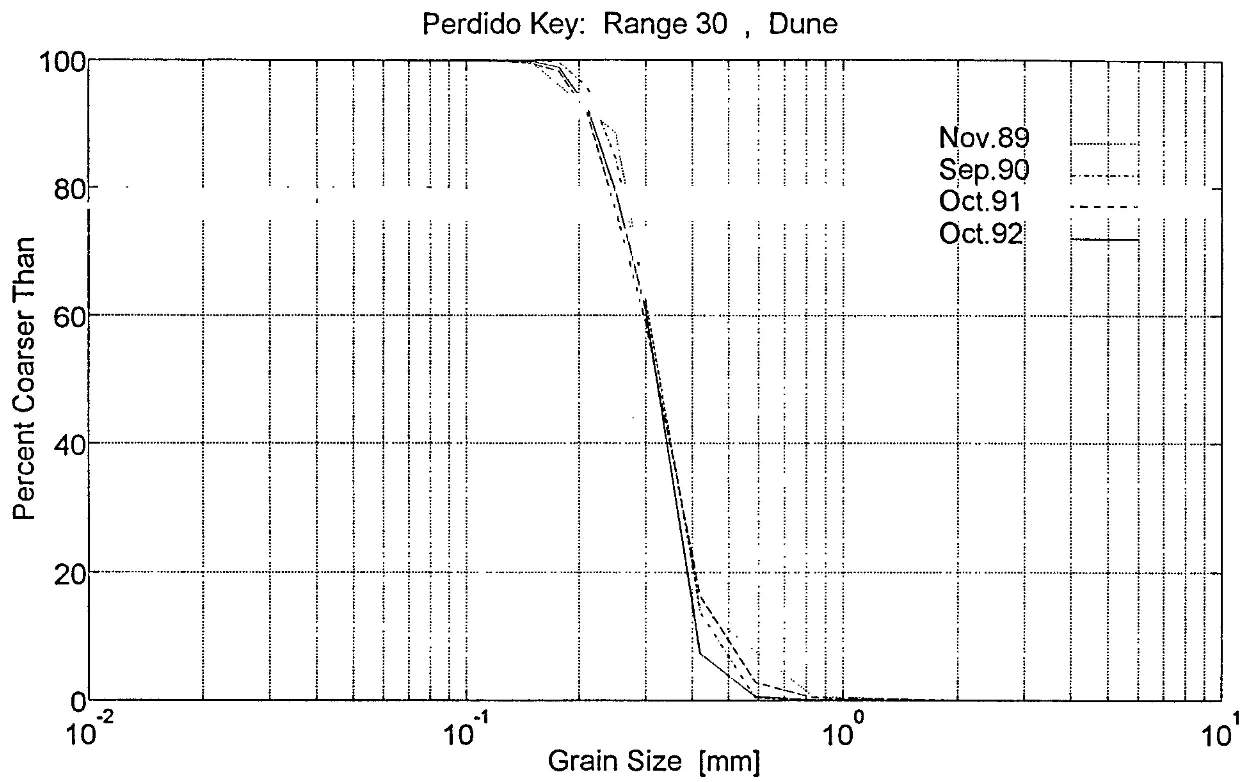
Figure II-40: Magnitude and Direction of Mean Current and Tidal Stage, December, 1992.

APPENDIX III

GRAIN SIZE DISTRIBUTIONS

Notes: 1) All percentages are given by weight.

2) Grain sizes correspond to the sieve opening diameters.



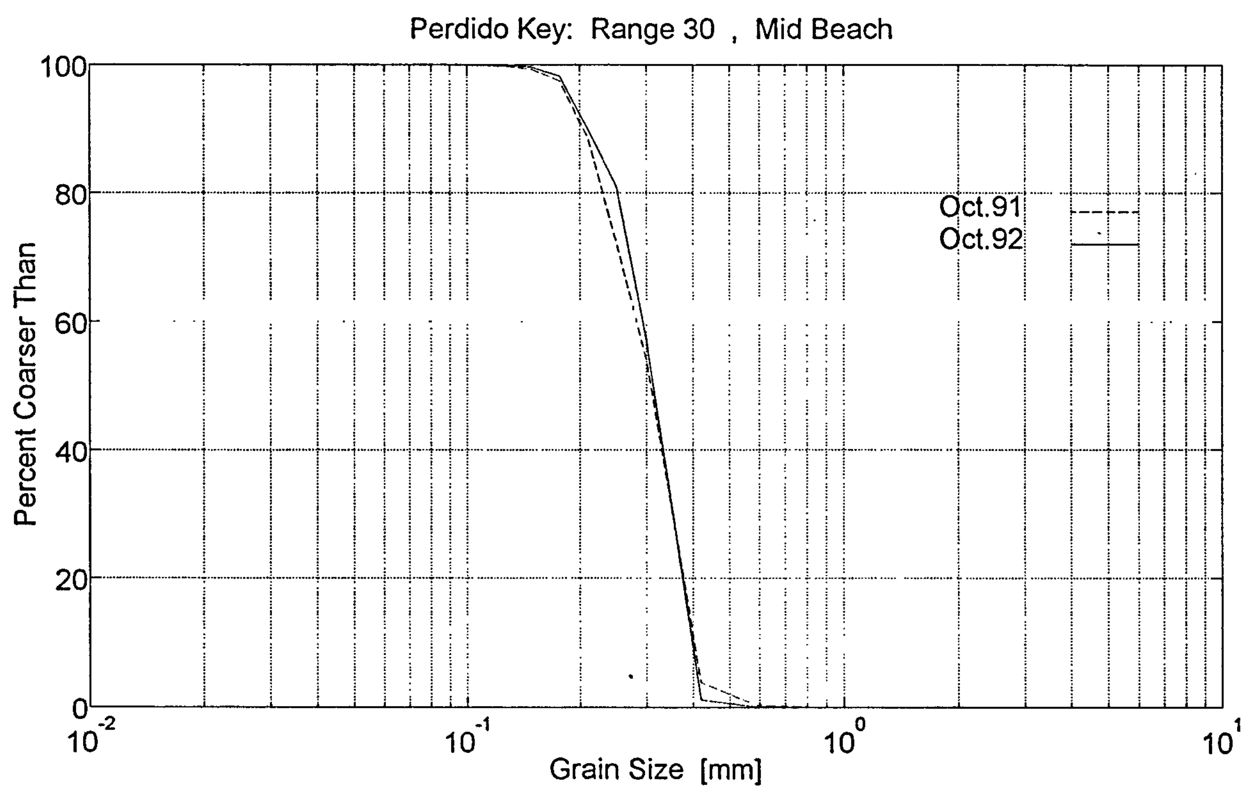
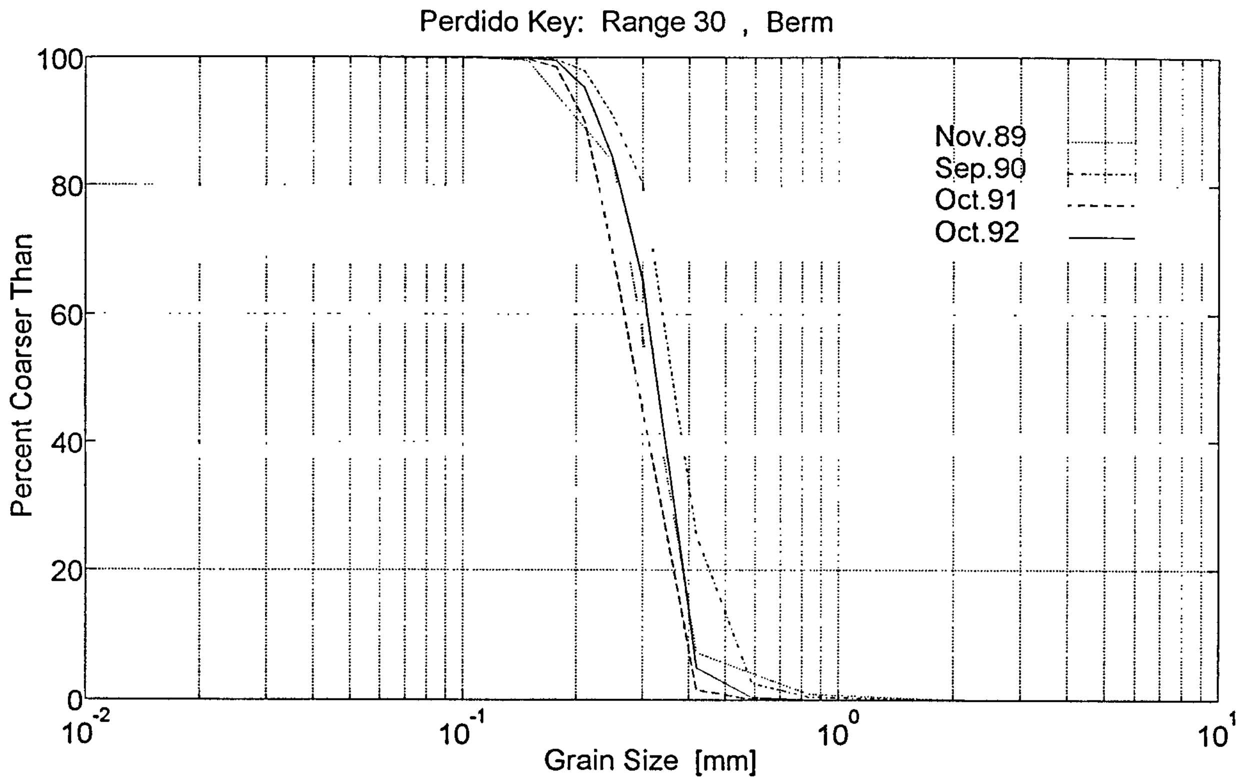


Figure III-1: Grain Size Distributions for Range 30, Dune and Mid-Beach Positions.



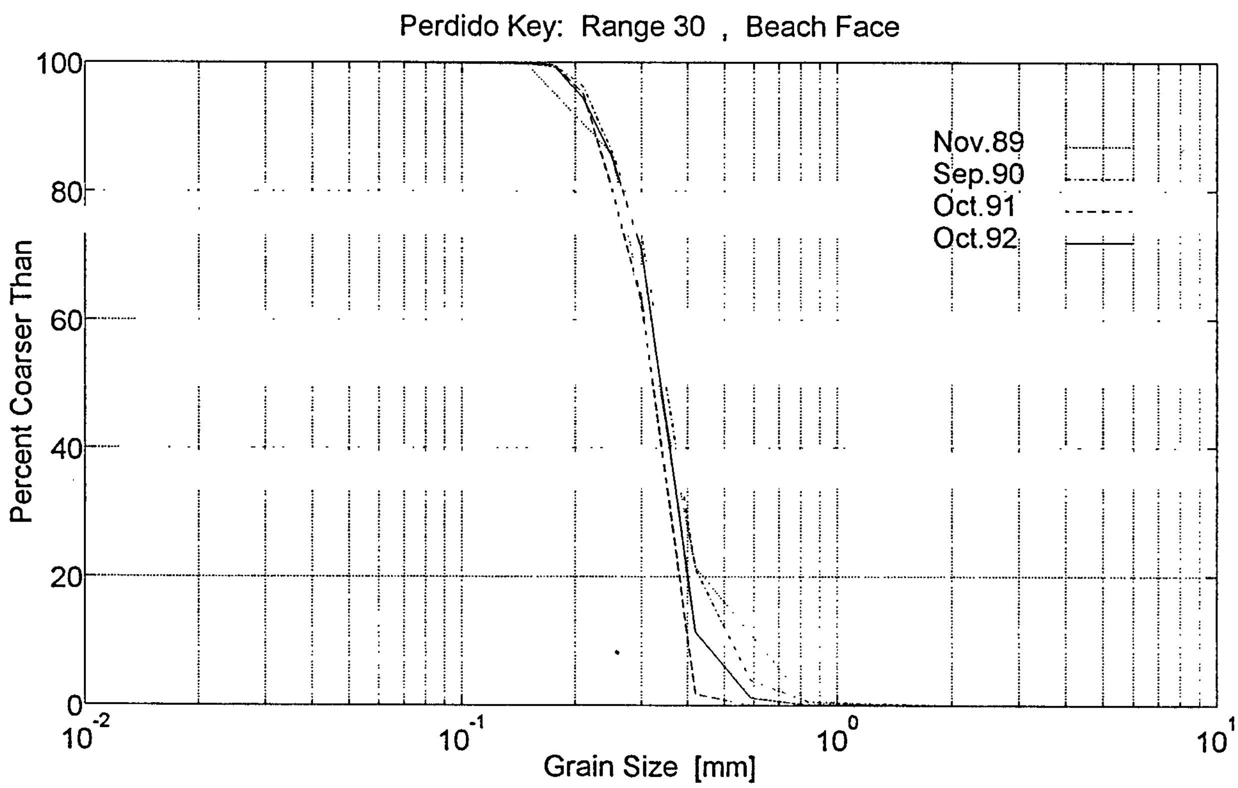
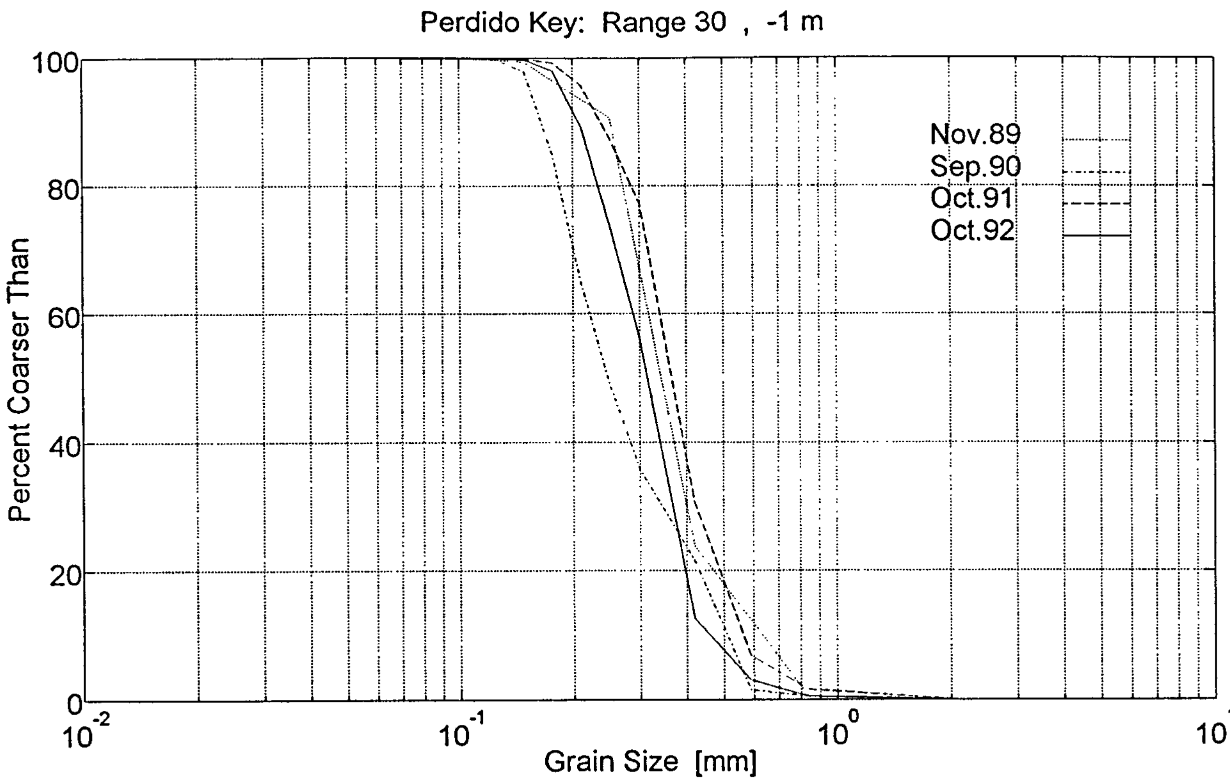


Figure III-2: Grain Size Distributions for Range 30, Berm and Beach Face Positions.



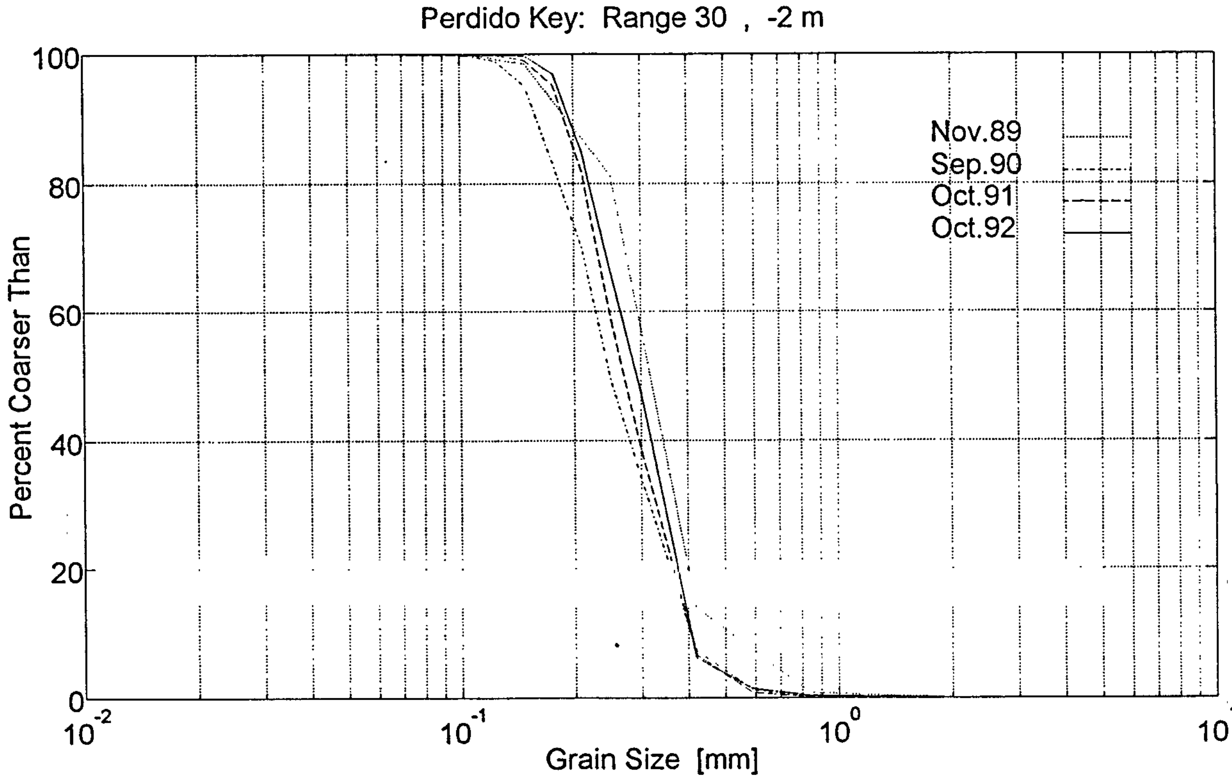
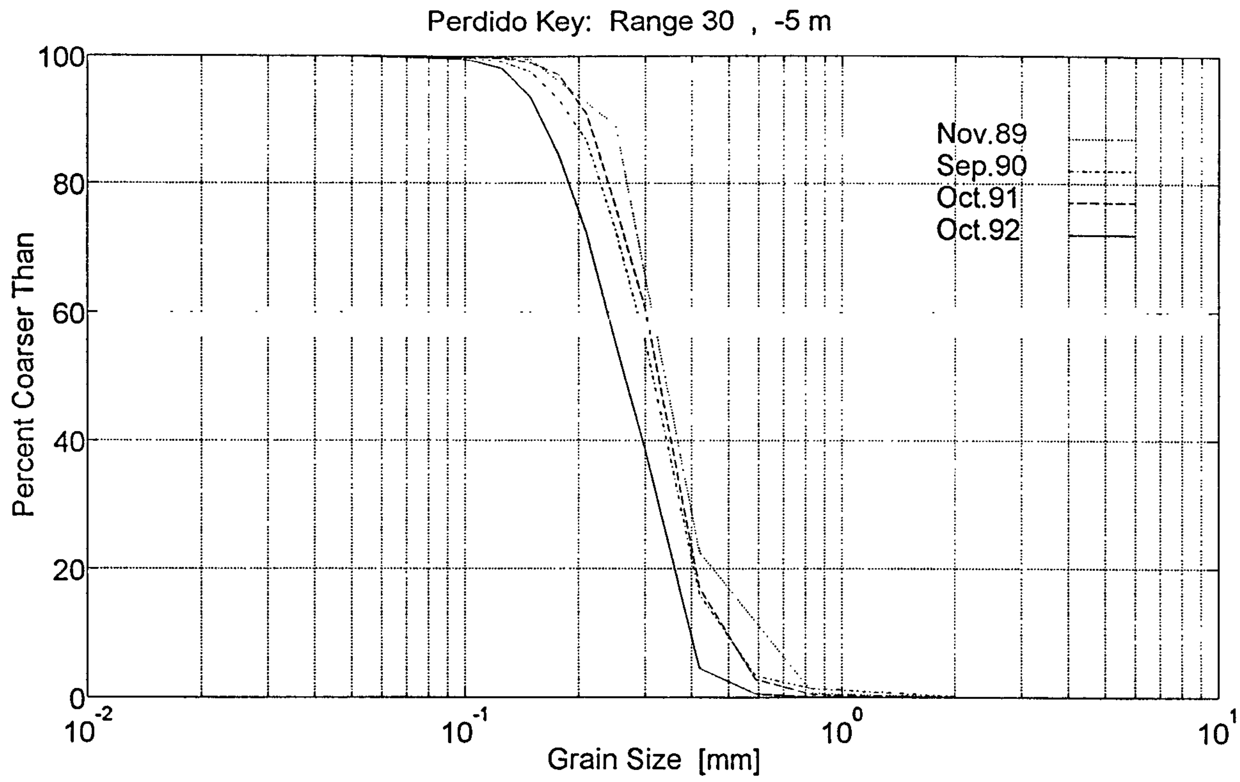


Figure III-3: Grain Size Distributions for Range 30, 1 M Depth and 2 M Depth Positions.



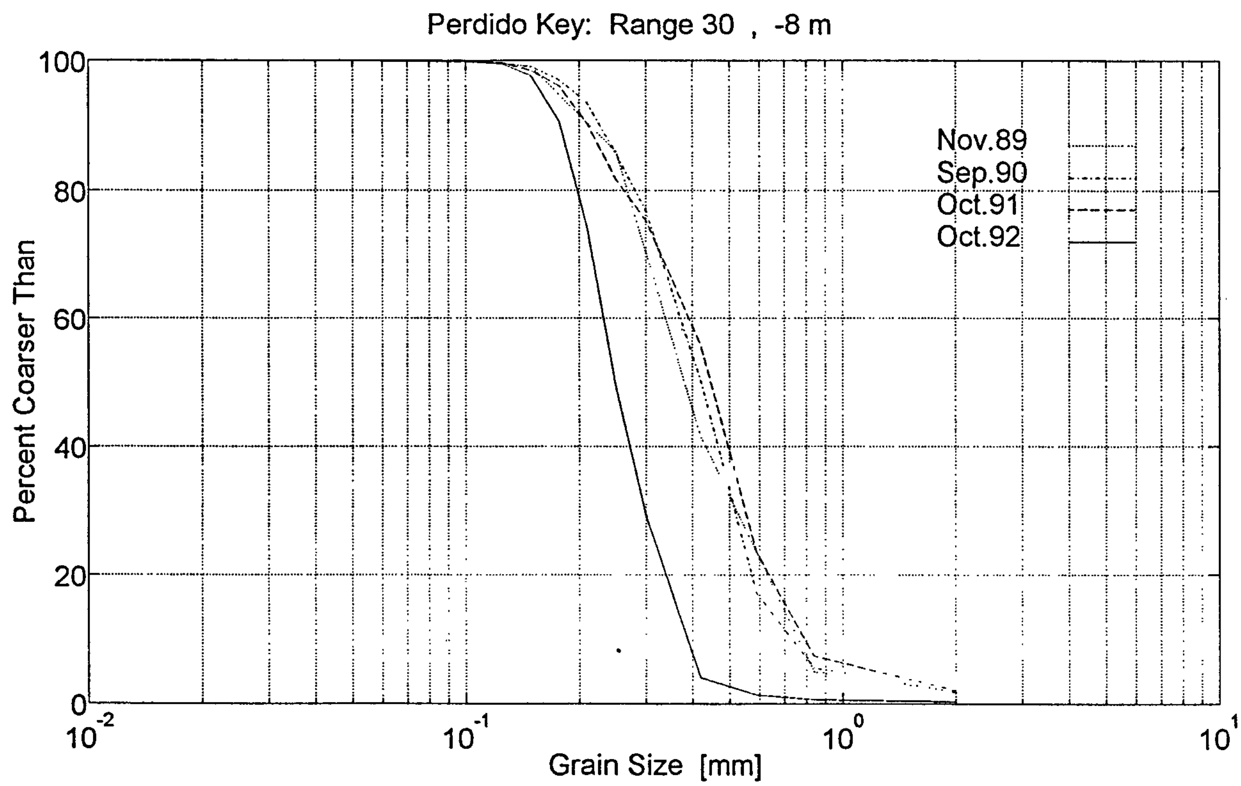
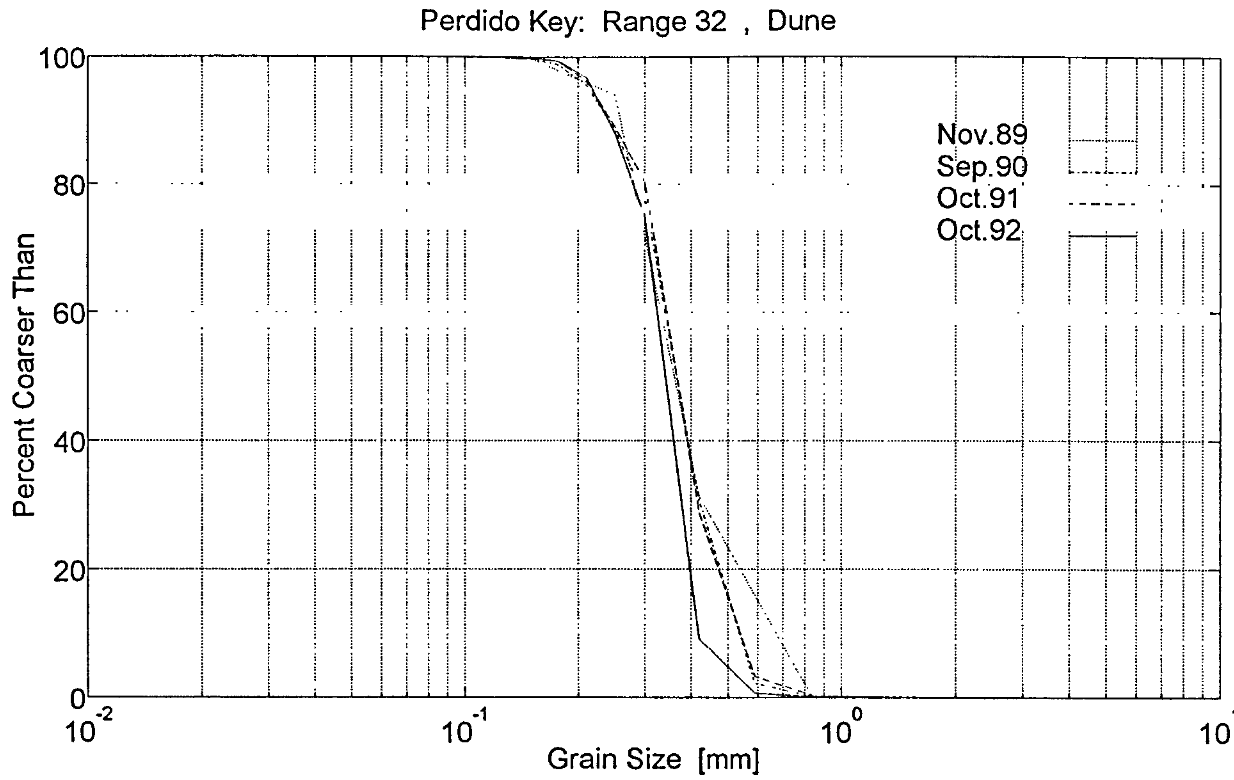


Figure III-4: Grain Size Distributions for Range 30, 5 M Depth and 8 M Depth Positions.



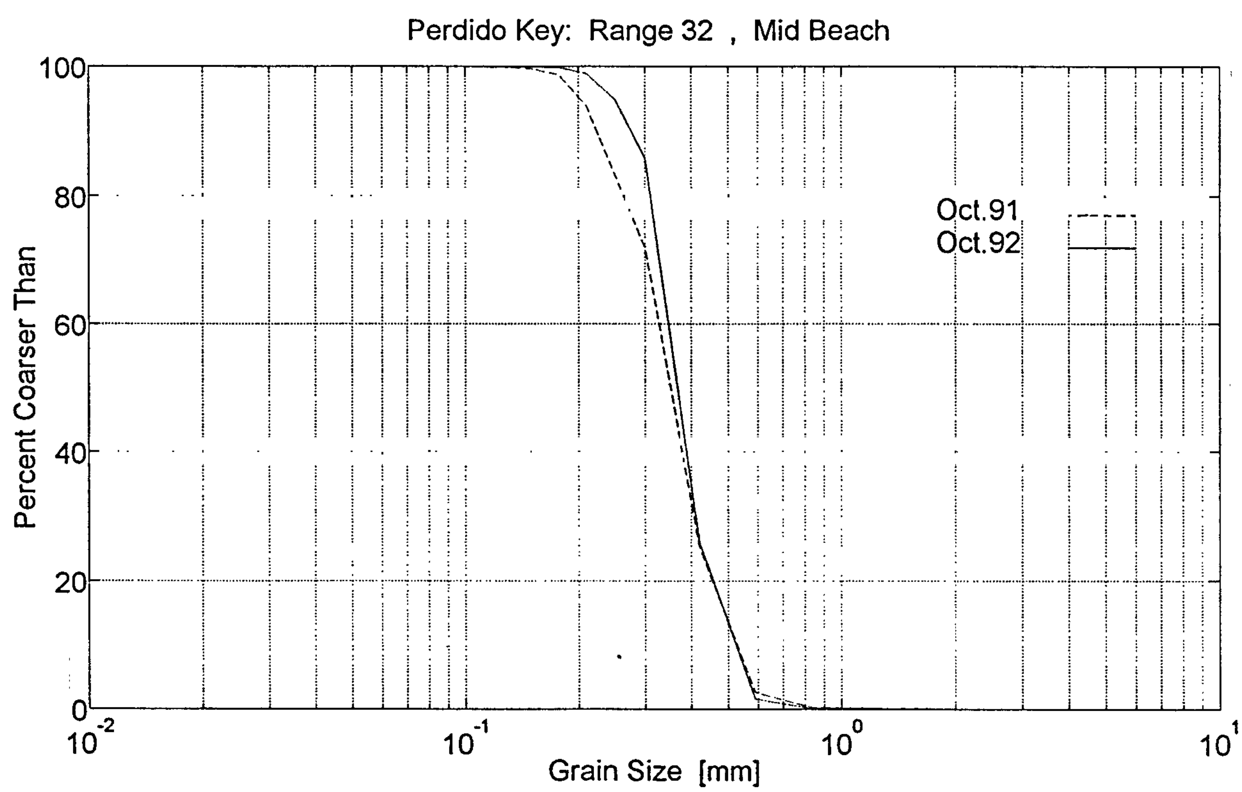
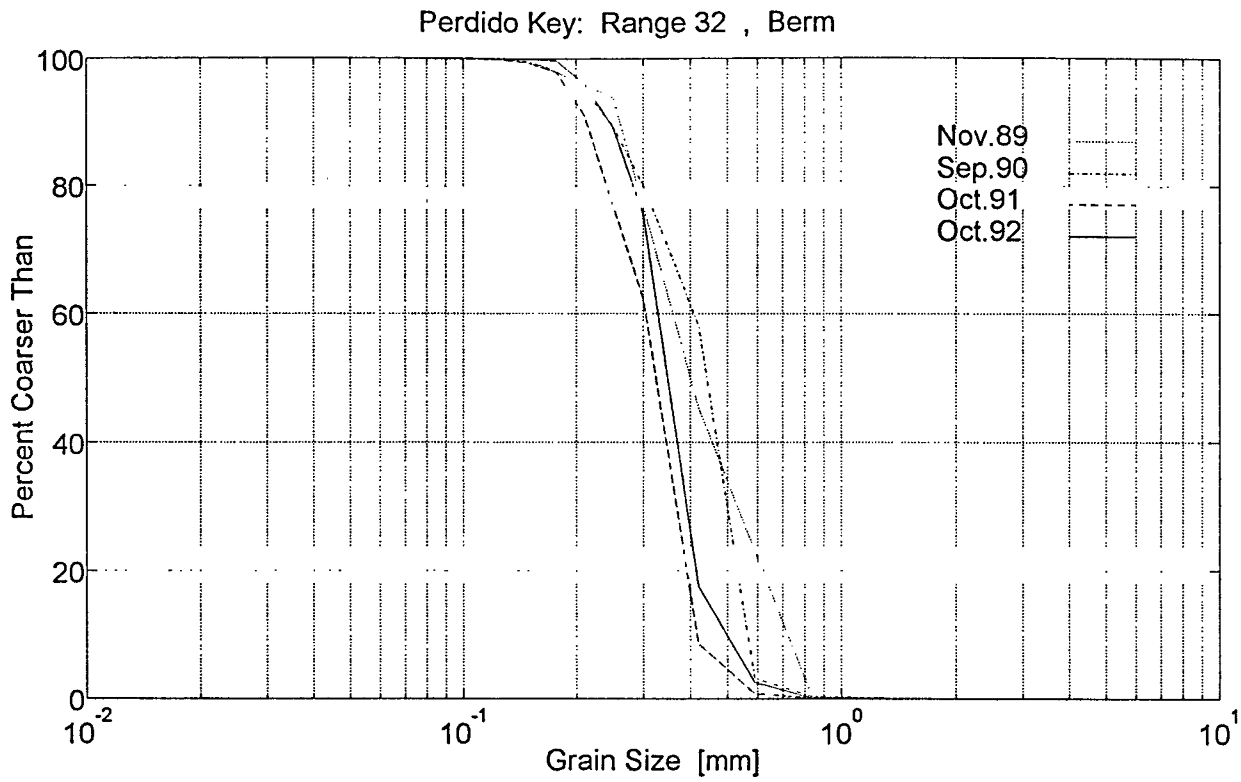


Figure III-5: Grain Size Distributions for Range 32, Dune and Mid-Beach Positions.



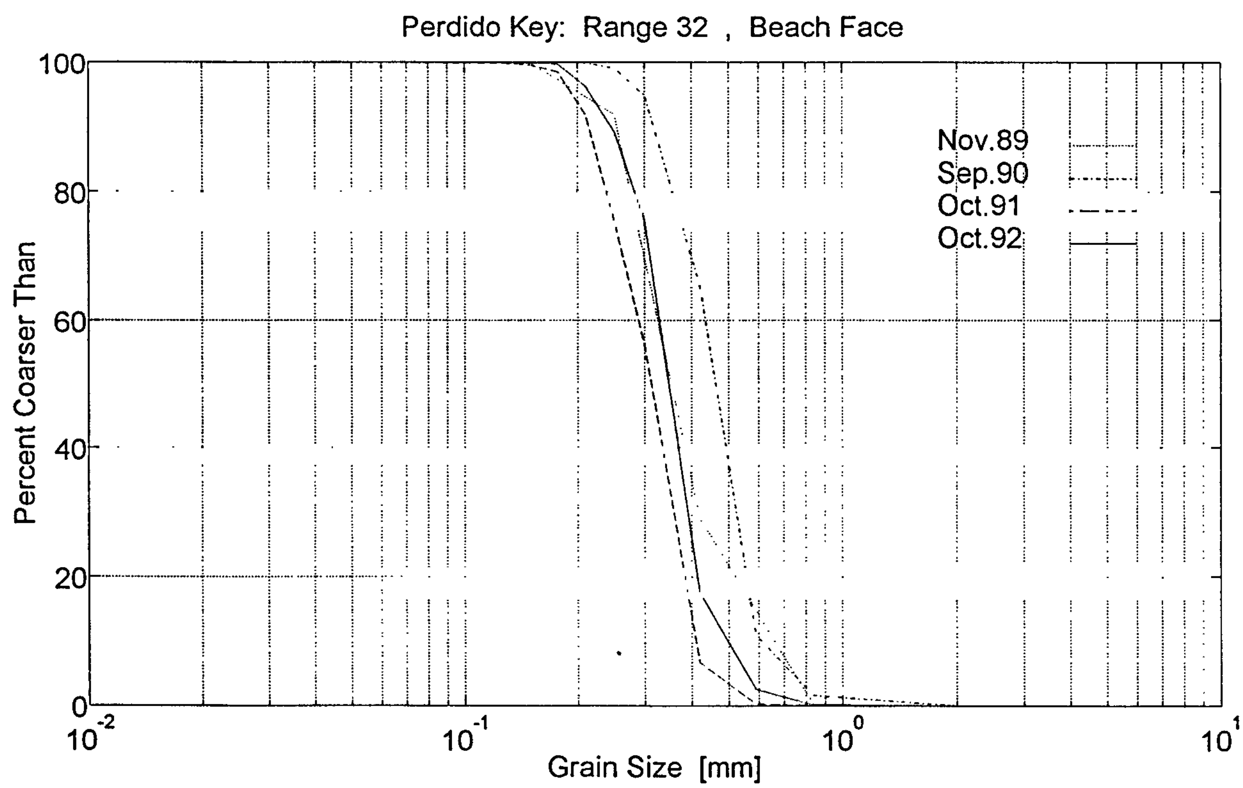


Figure III-6: Grain Size Distributions for Range 32, Berm and Beach Face Positions.

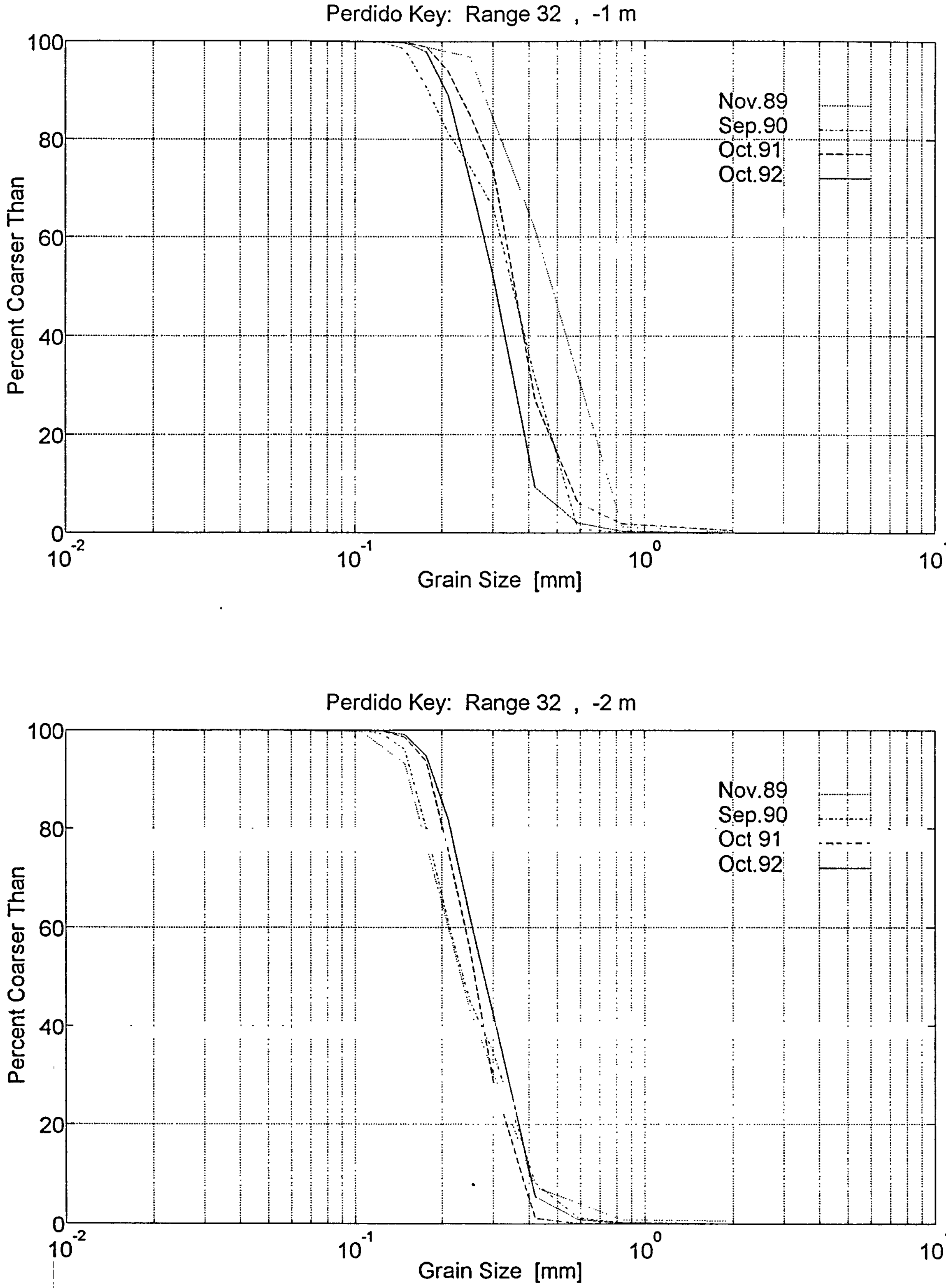
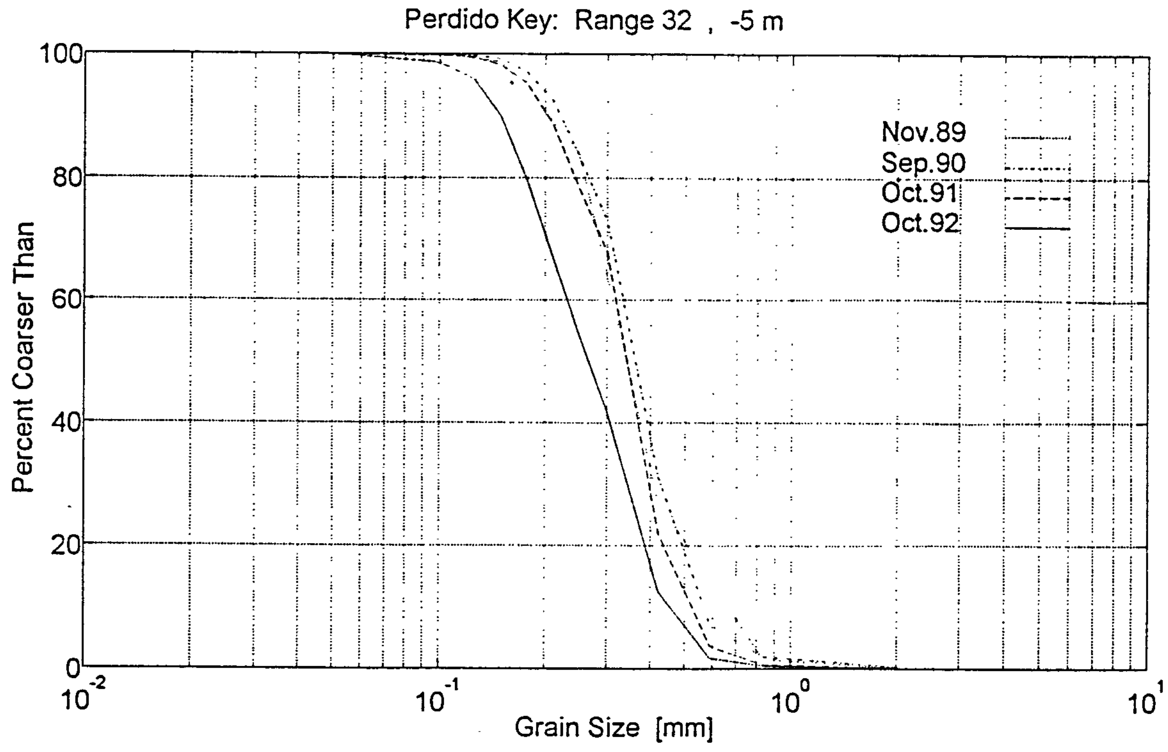


Figure III-7: Grain Size Distributions for Range 32, 1 M Depth and 2 M Depth Positions.



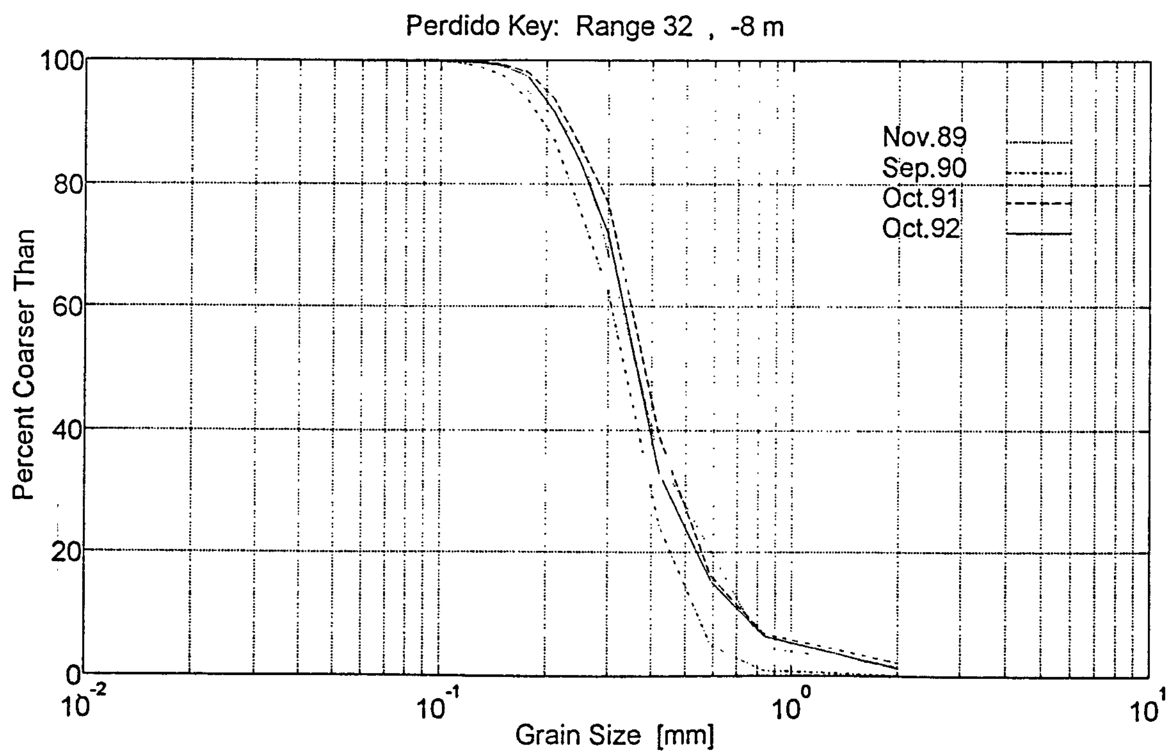
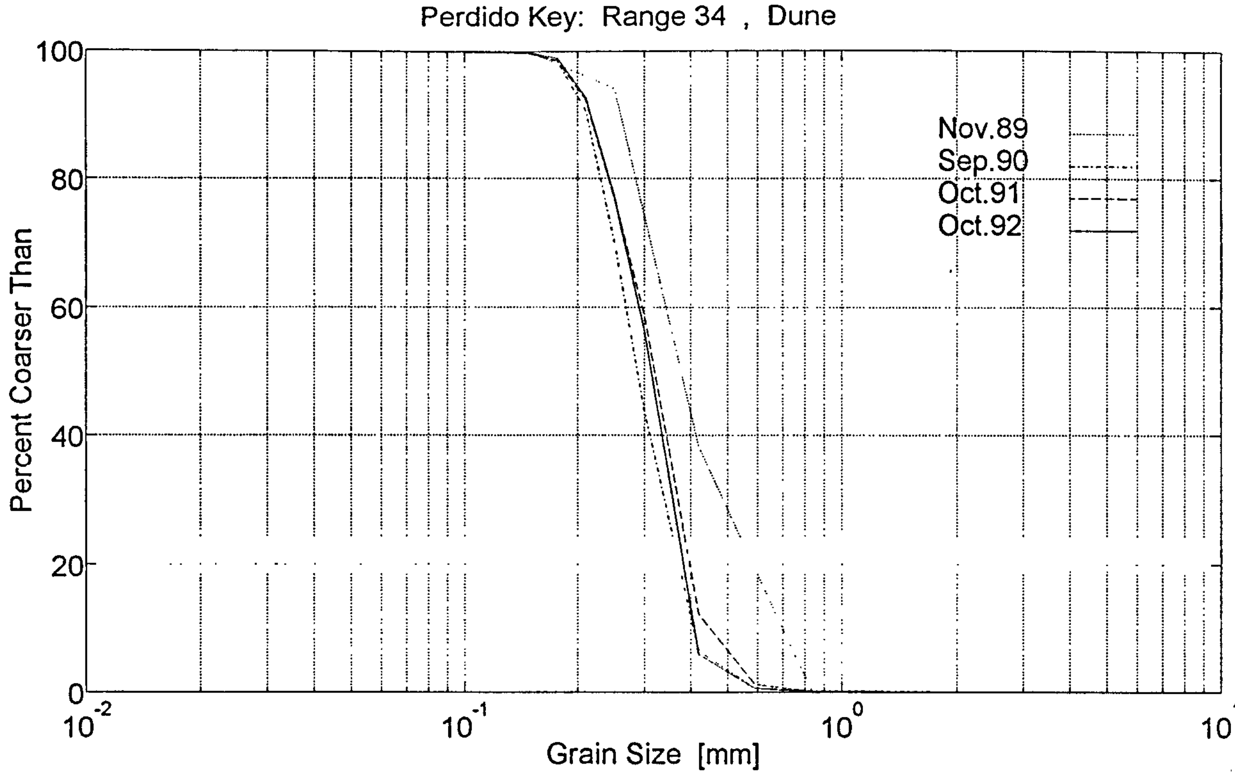


Figure III-8: Grain Size Distributions for Range 32, 5 M Depth and 8 M Depth Positions.



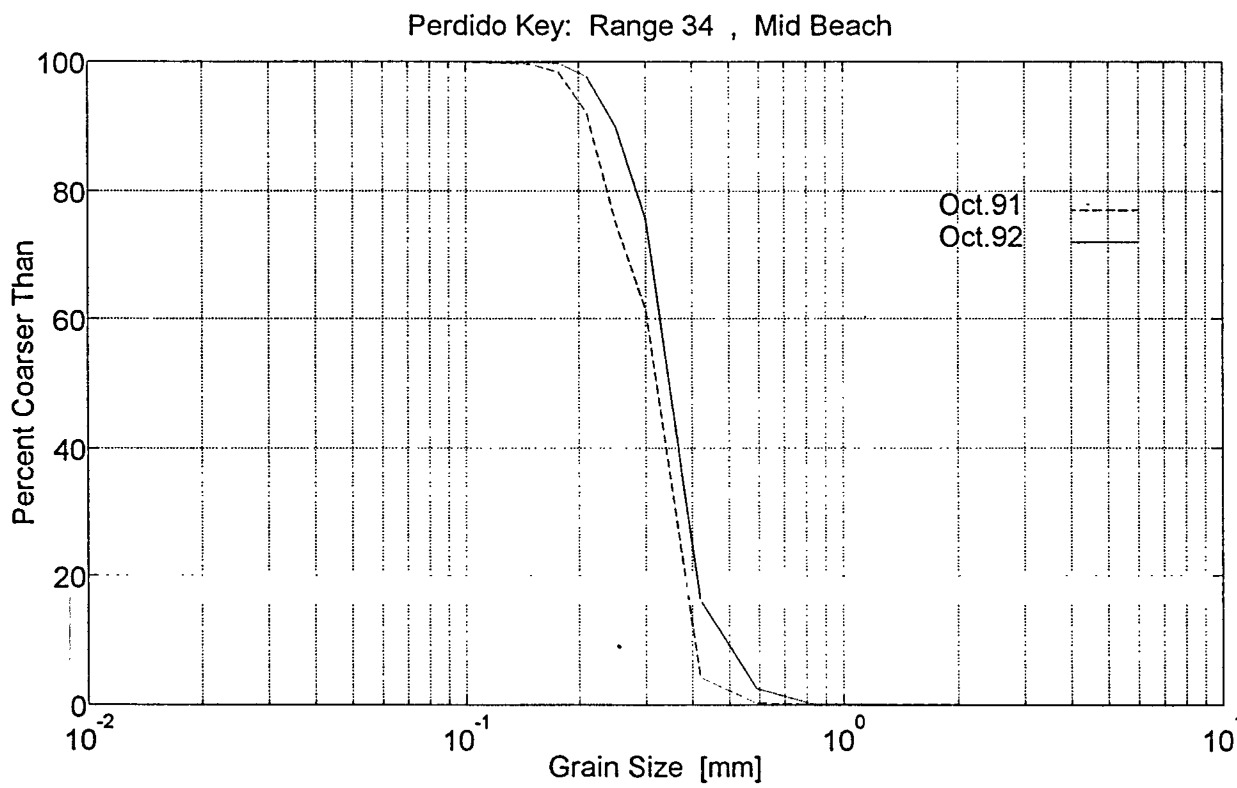
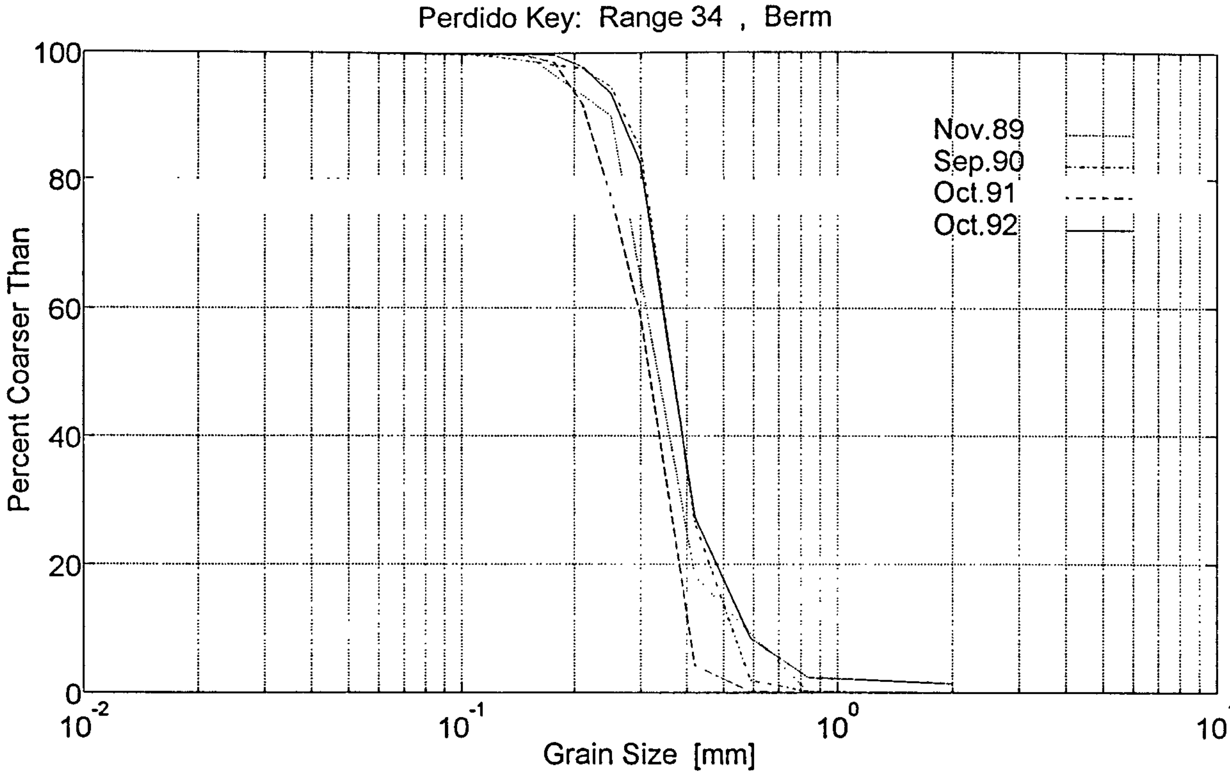


Figure III-9: Grain Size Distributions for Range 34, Dune and Mid-Beach Positions.



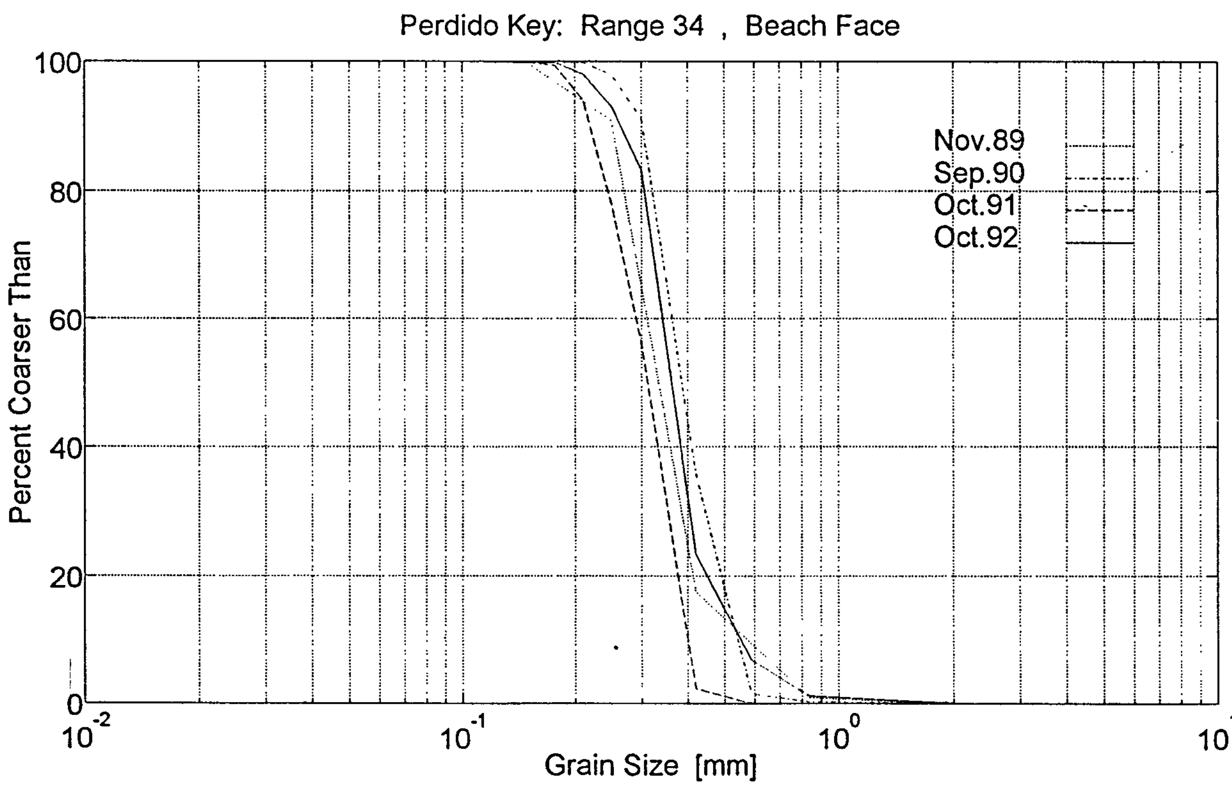
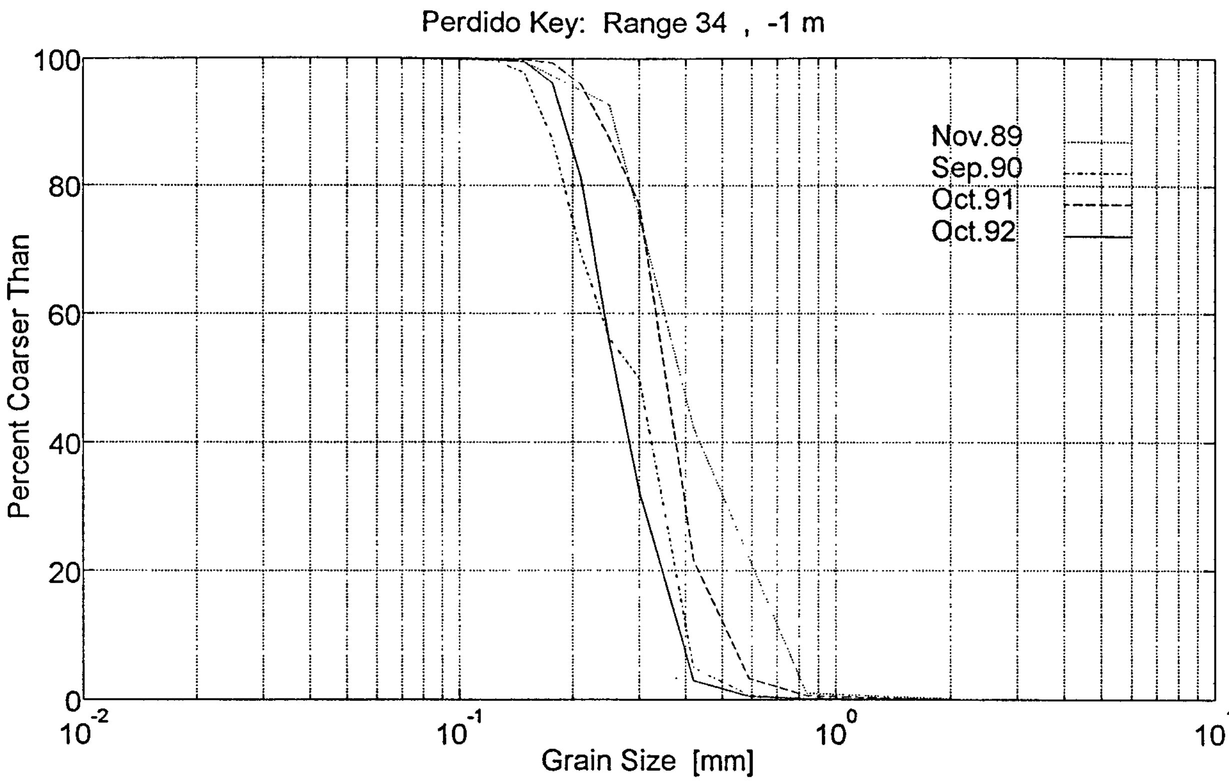


Figure III-10: Grain Size Distributions for Range 34, Berm and Beach Face Positions.



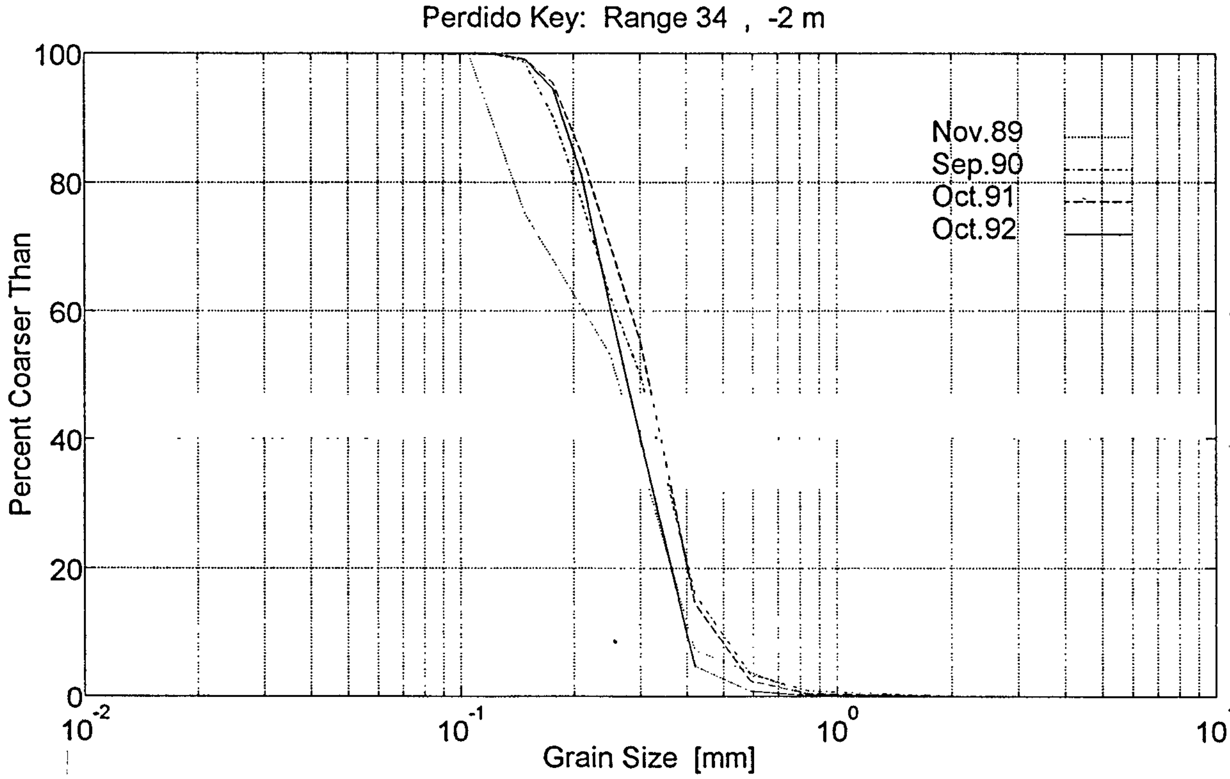
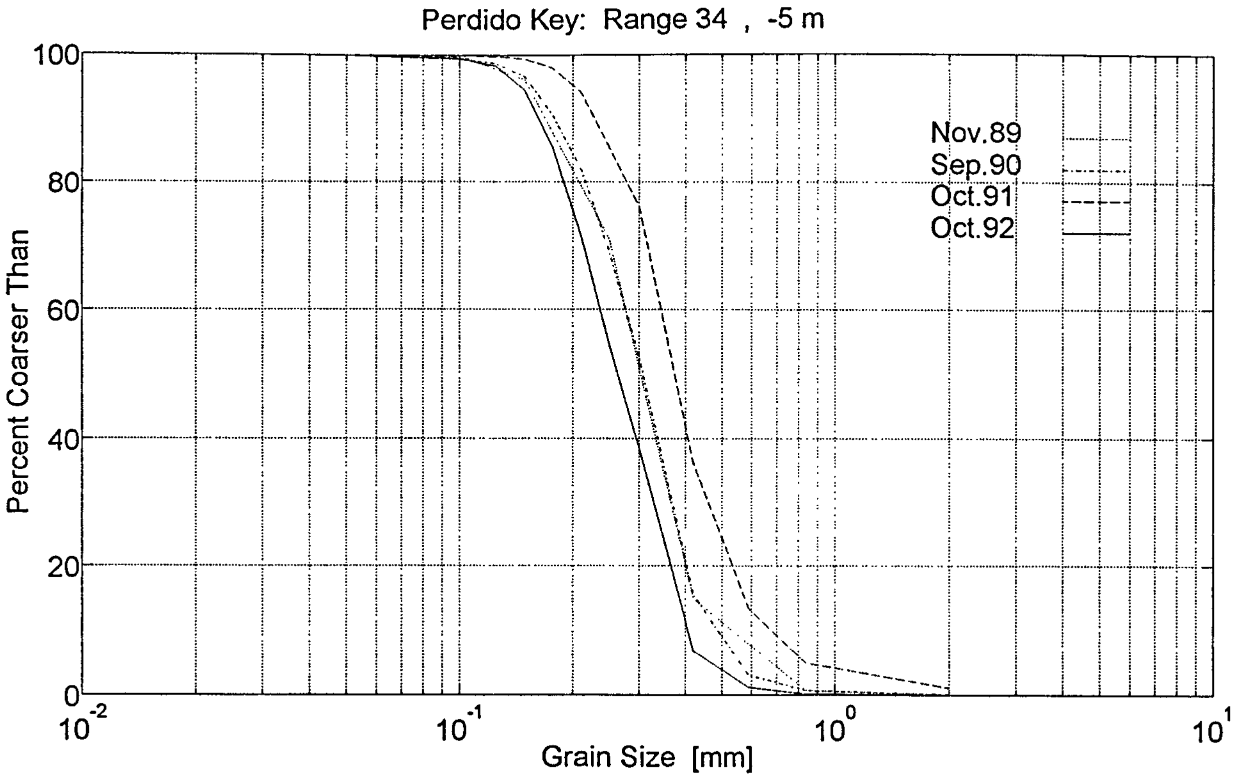


Figure III-11: Grain Size Distributions for Range 34, 1 M Depth and 2 M Depth Positions.



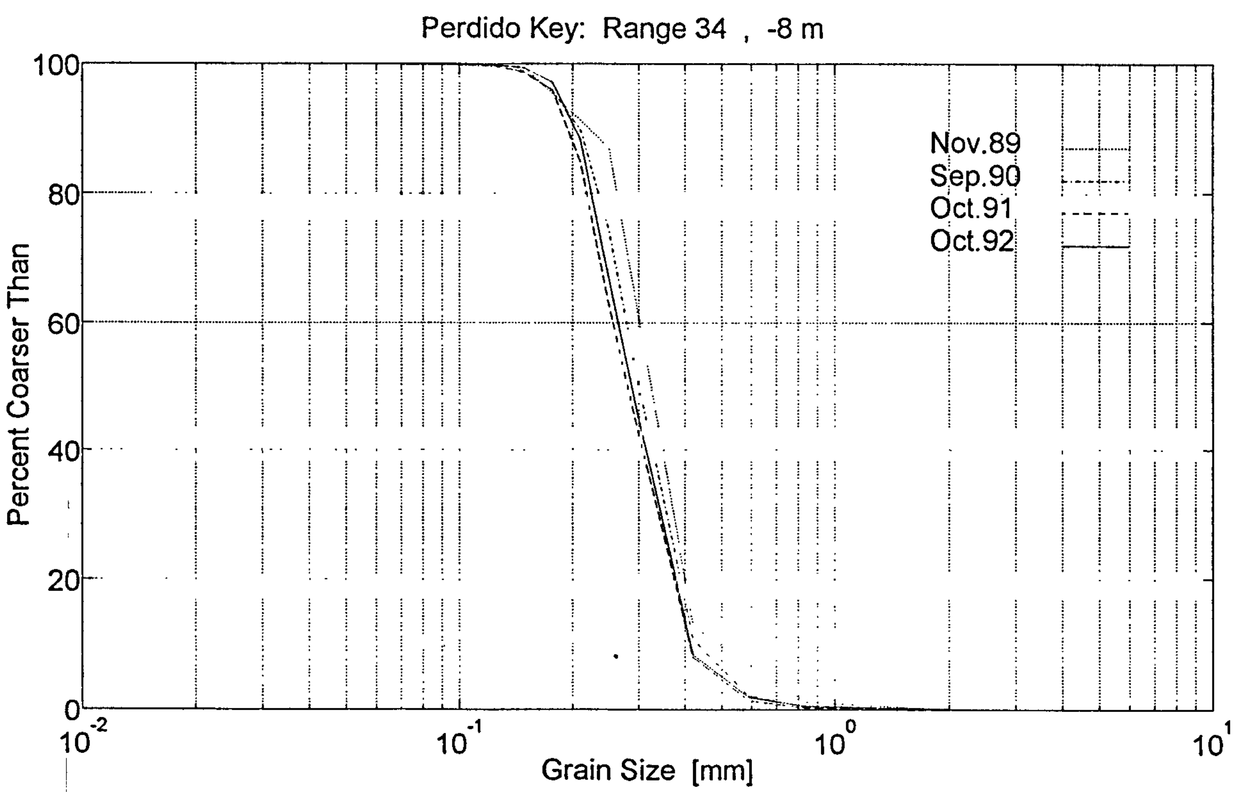
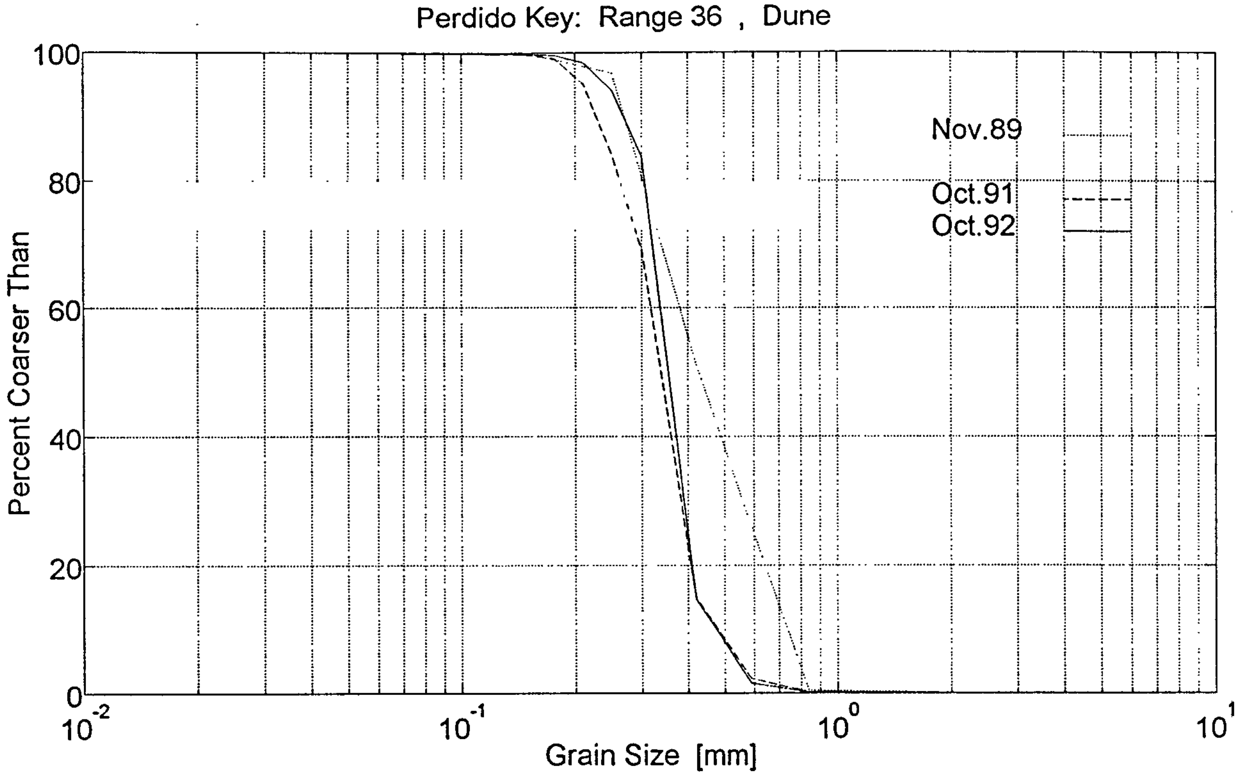


Figure III-12: Grain Size Distributions for Range 34, 5 M Depth and 8 M Depth Positions.



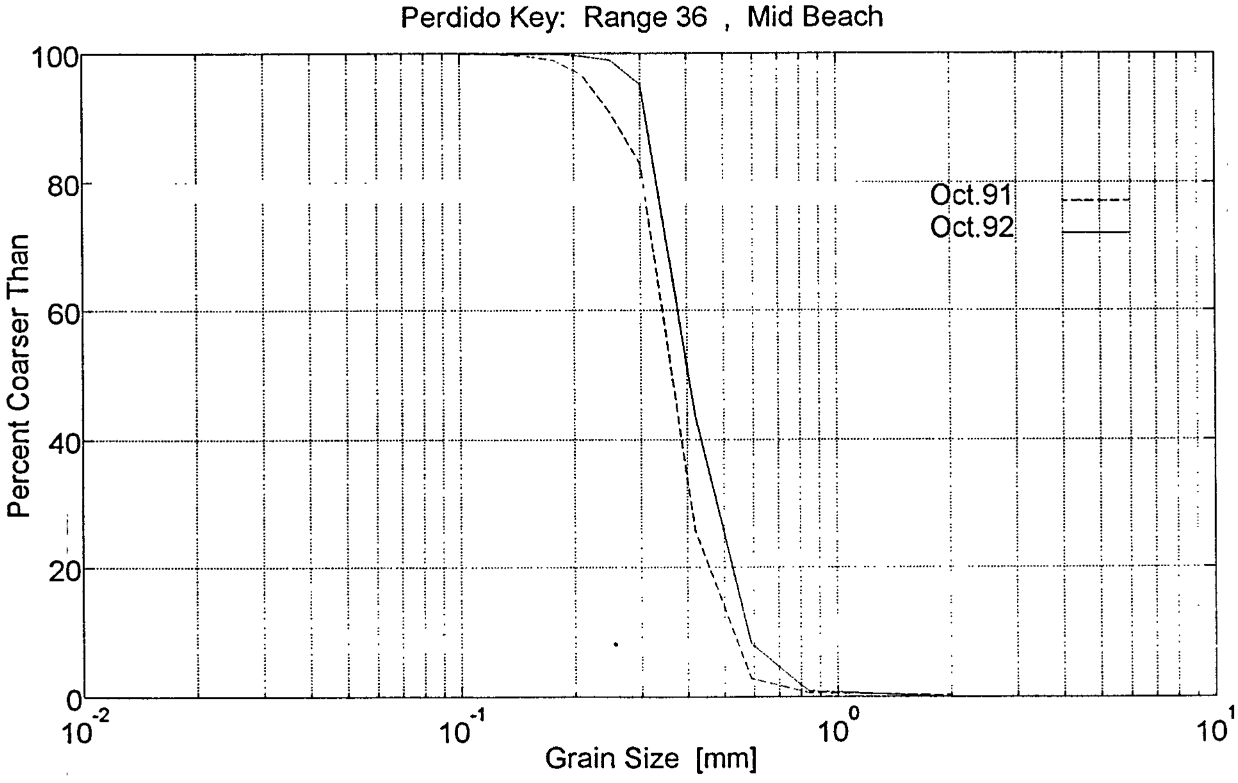
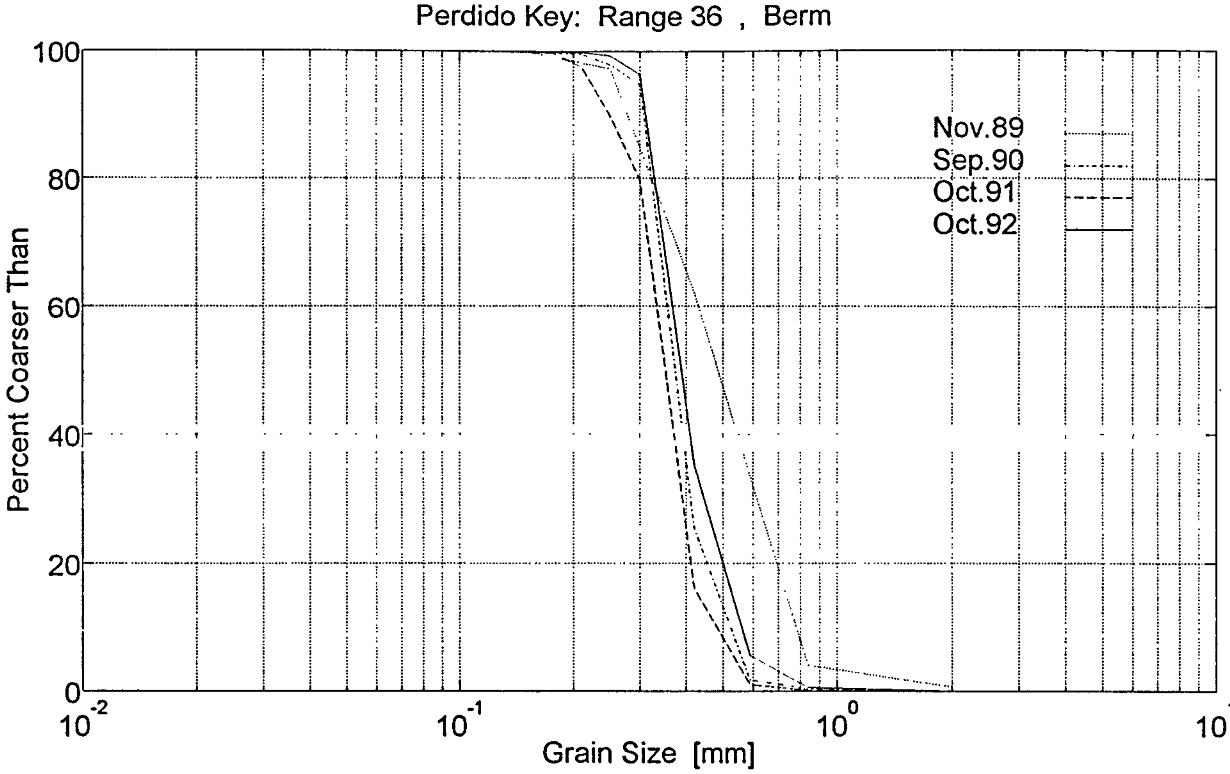


Figure III-13: Grain Size Distributions for Range 36, Dune and Mid-Beach Positions.



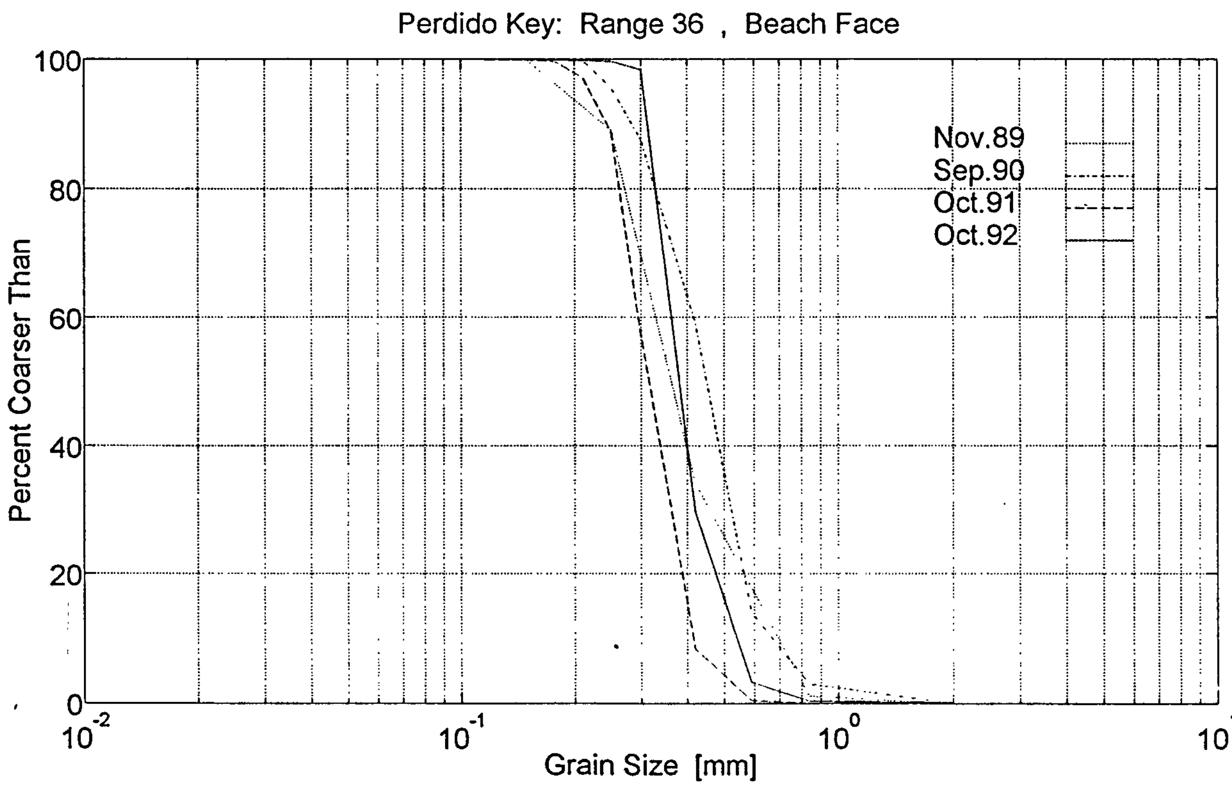
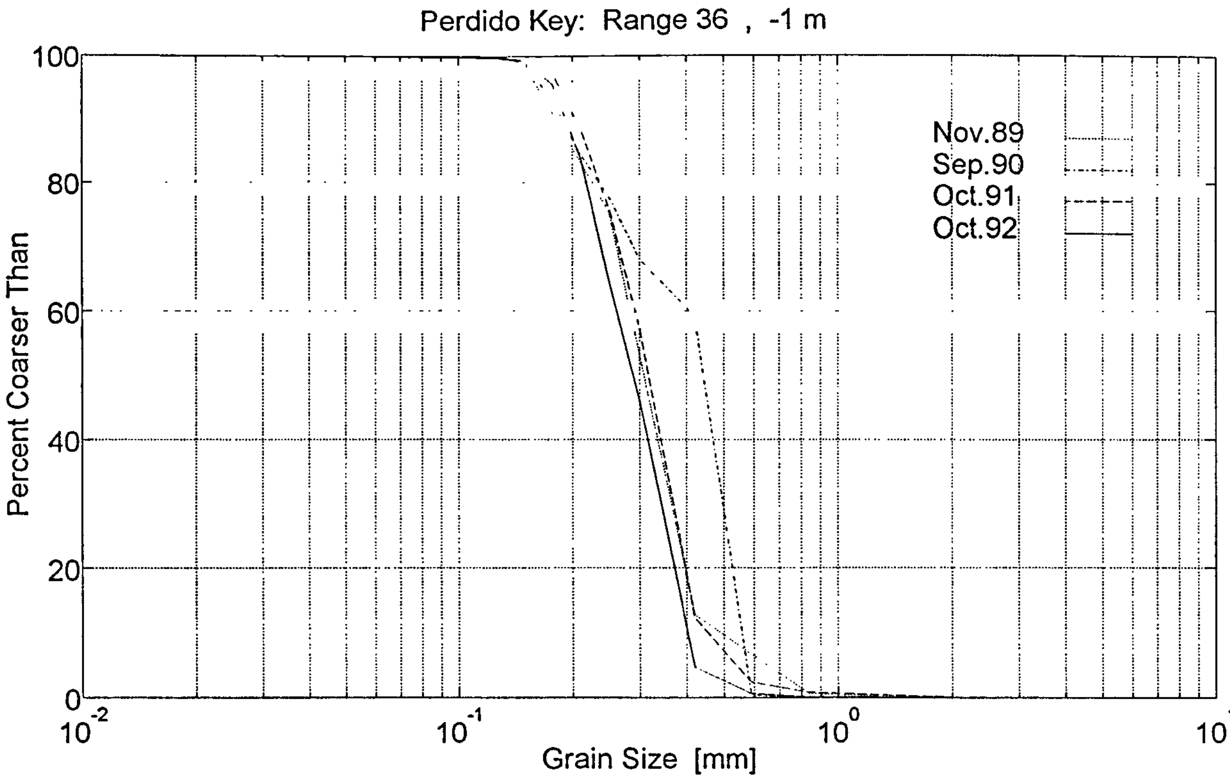


Figure III-14: Grain Size Distributions for Range 36, Berm and Beach Face Positions.



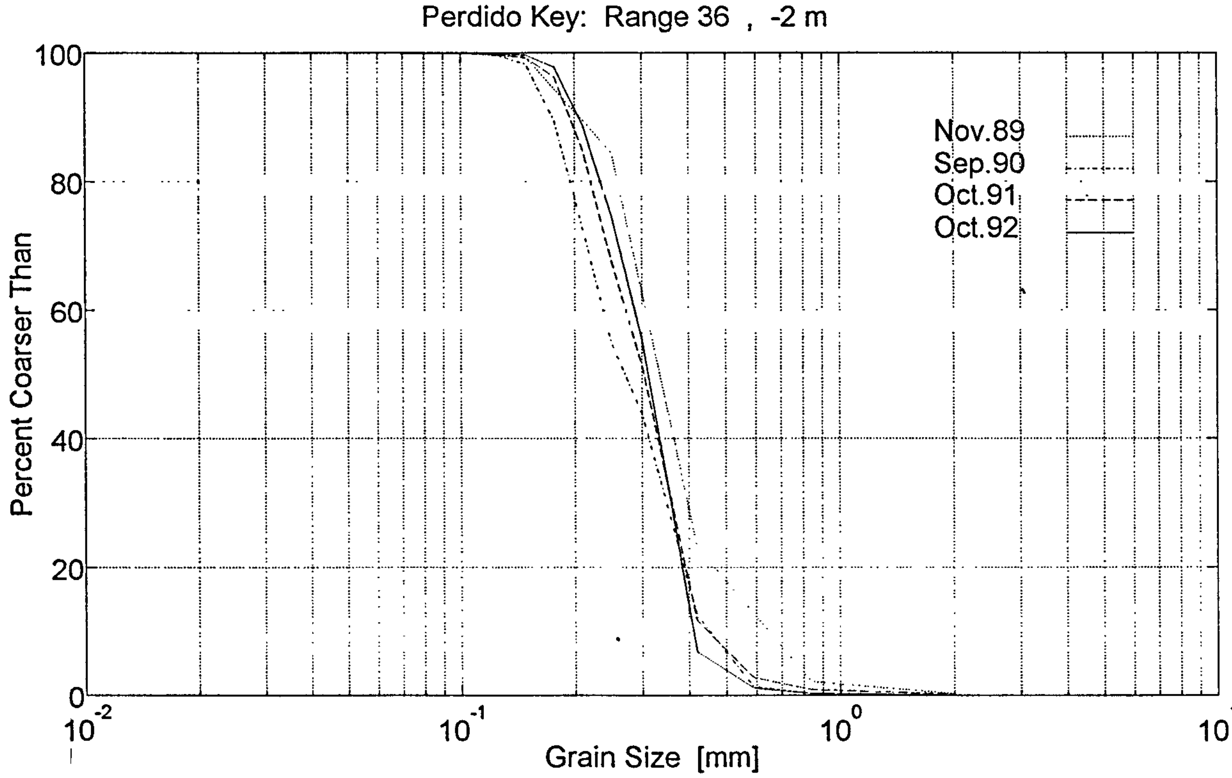
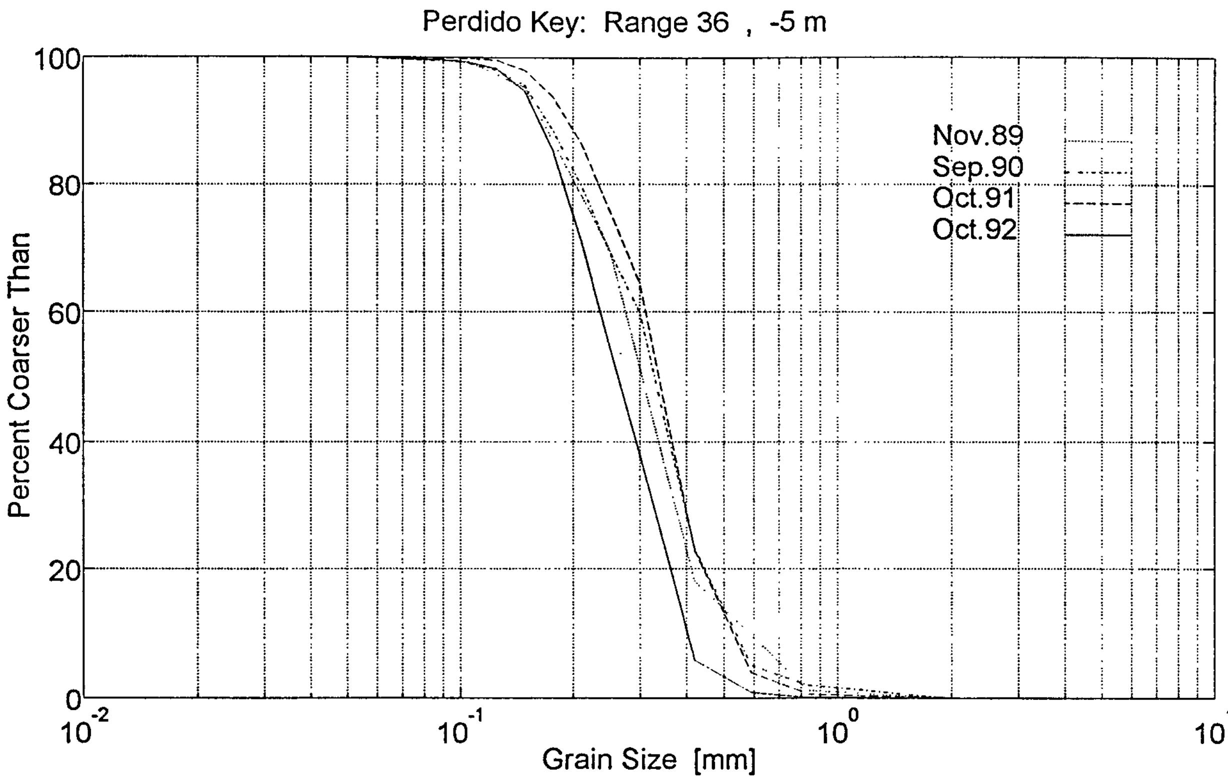


Figure III-15: Grain Size Distributions for Range 36, 1 M Depth and 2 M Depth Positions.



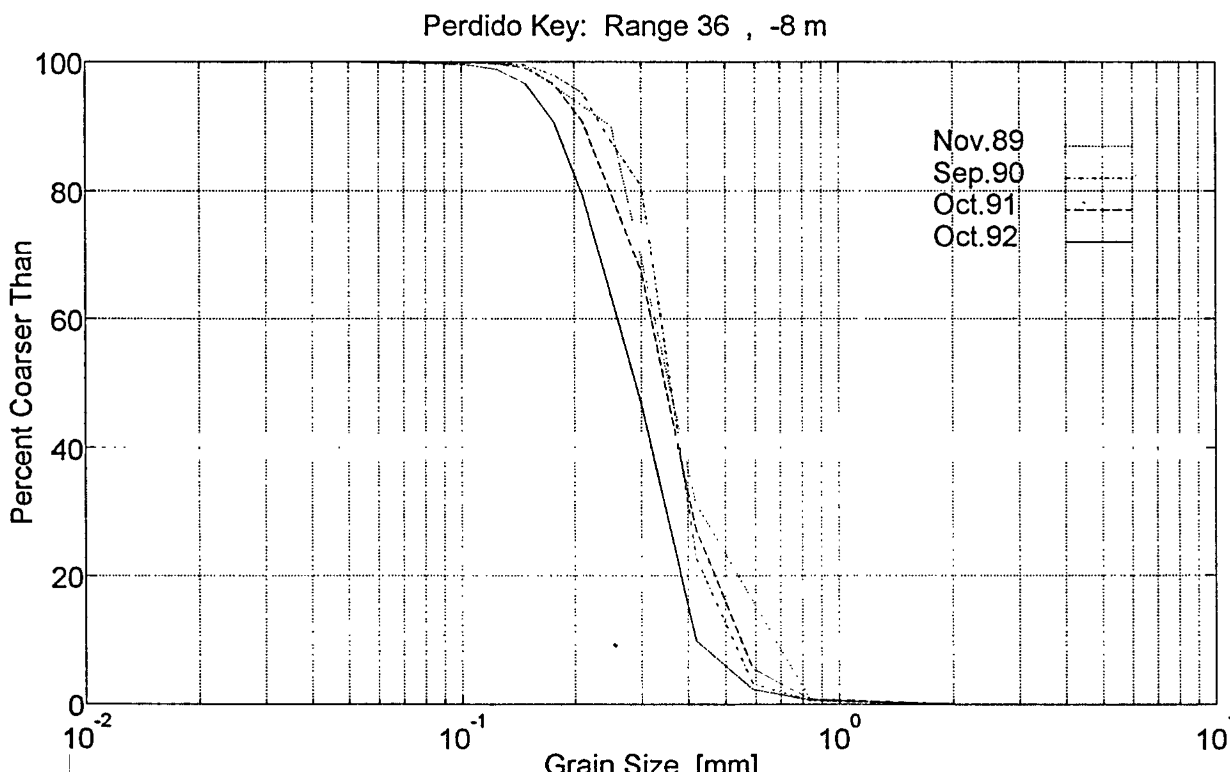
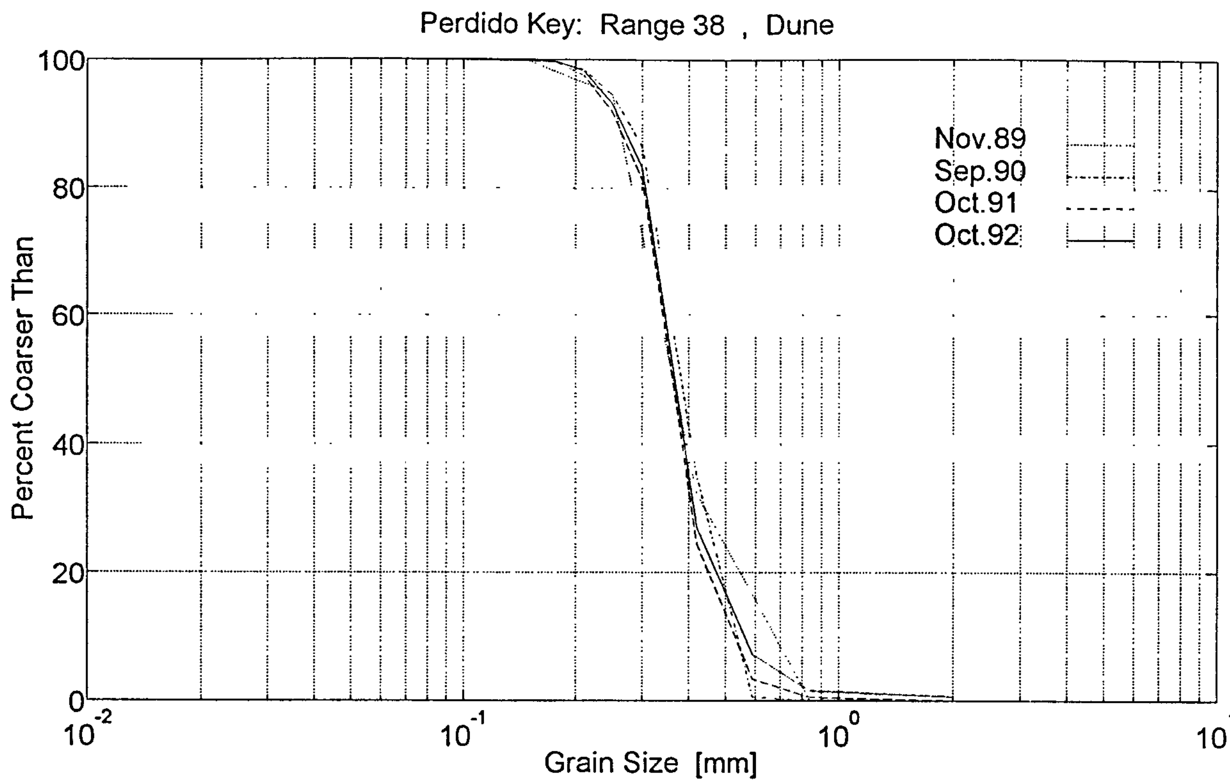


Figure III-16: Grain Size Distributions for Range 36, 5 M Depth and 8 M Depth Positions.



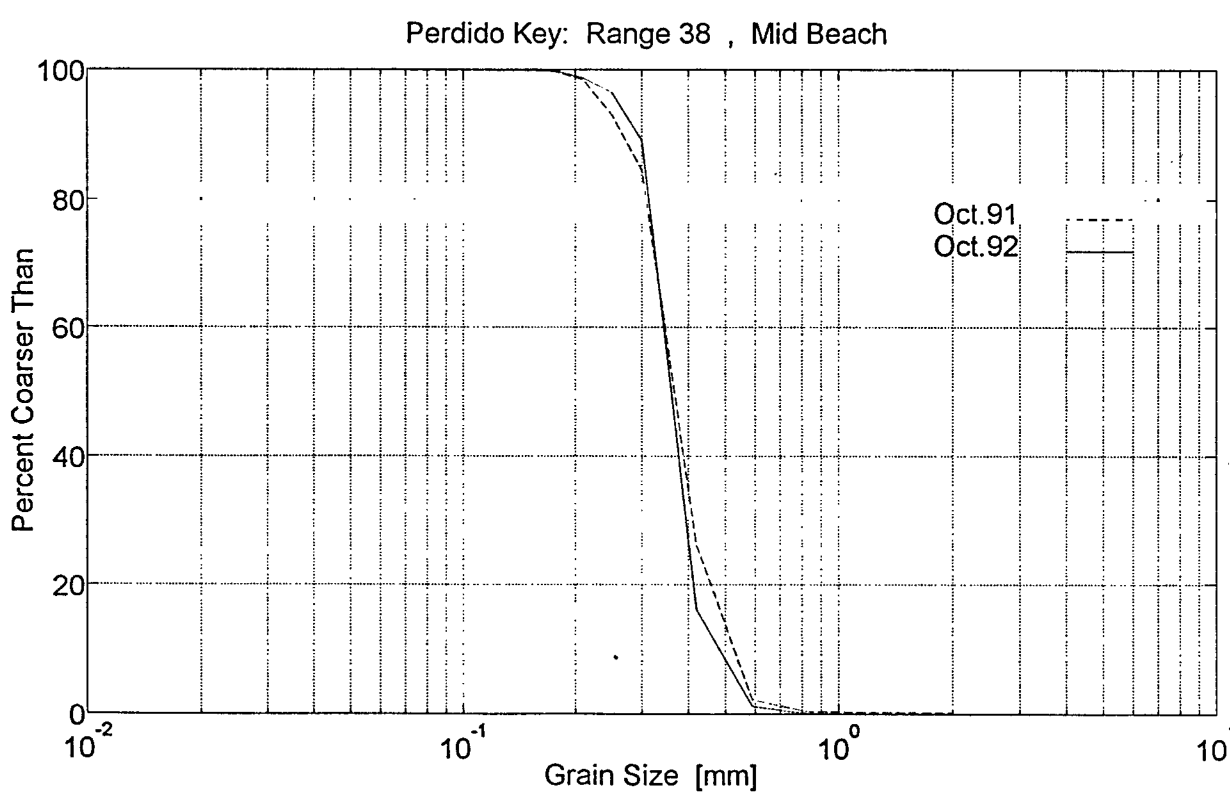
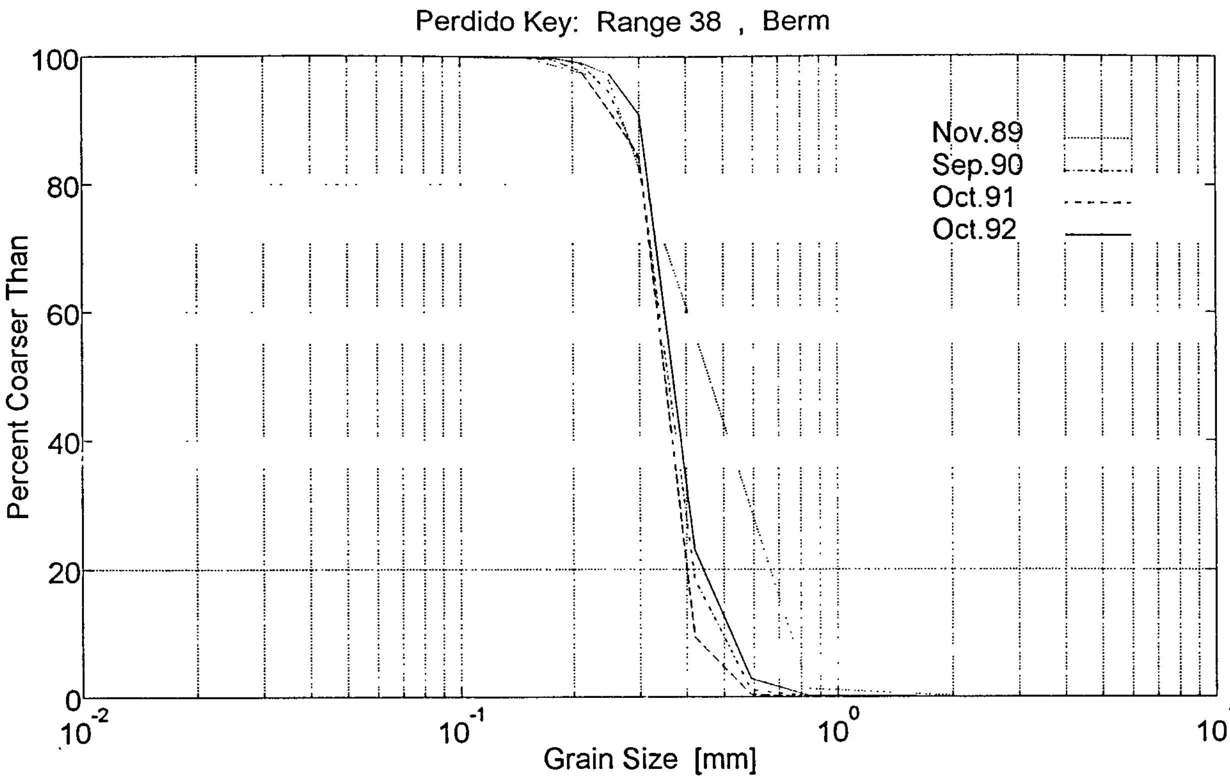


Figure III-17: Grain Size Distributions for Range 38, Dune and Mid-Beach Positions.



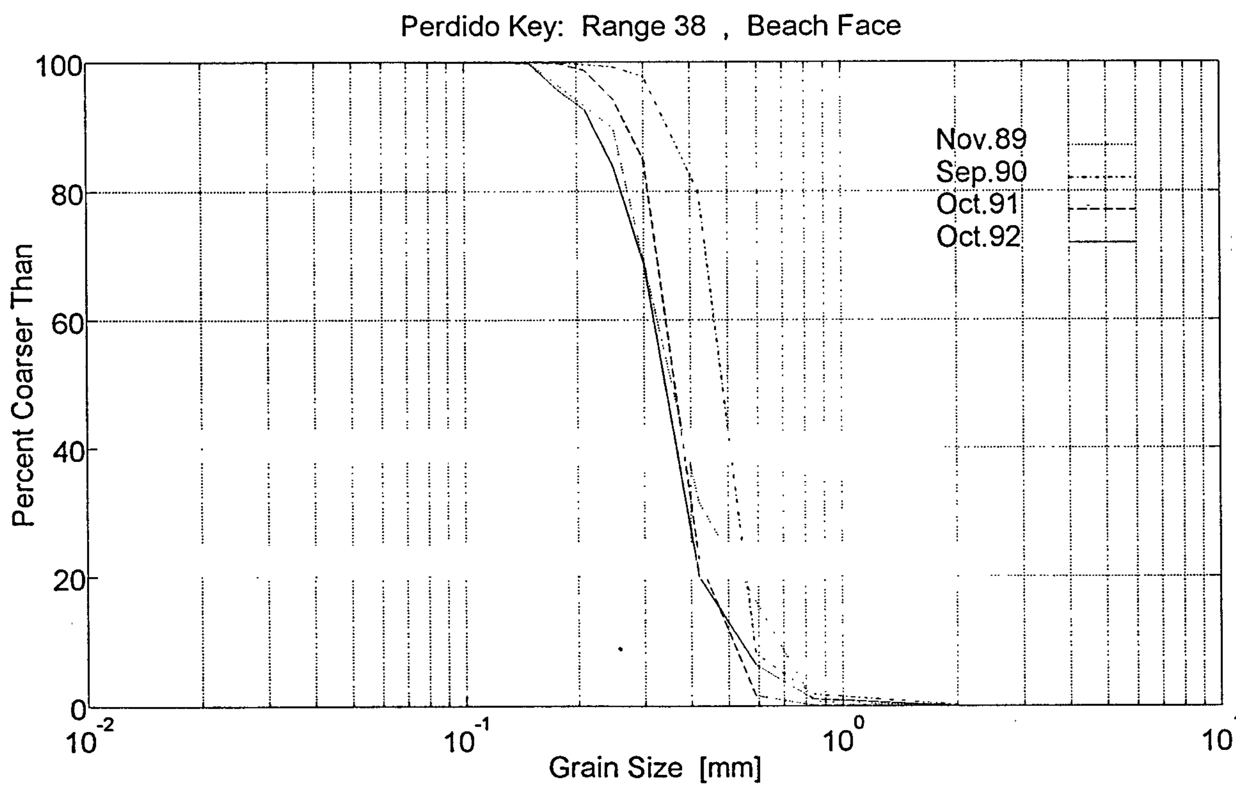
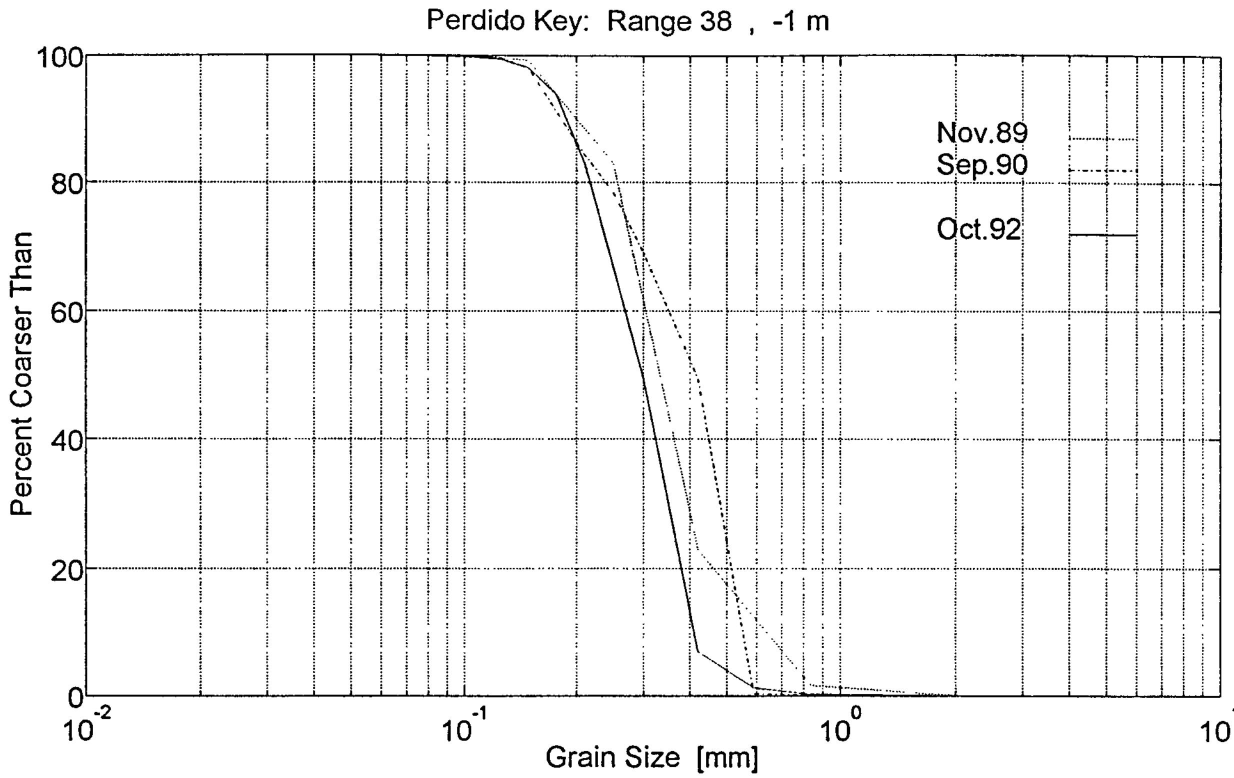


Figure III-18: Grain Size Distributions for Range 38, Berm and Beach Face Positions.



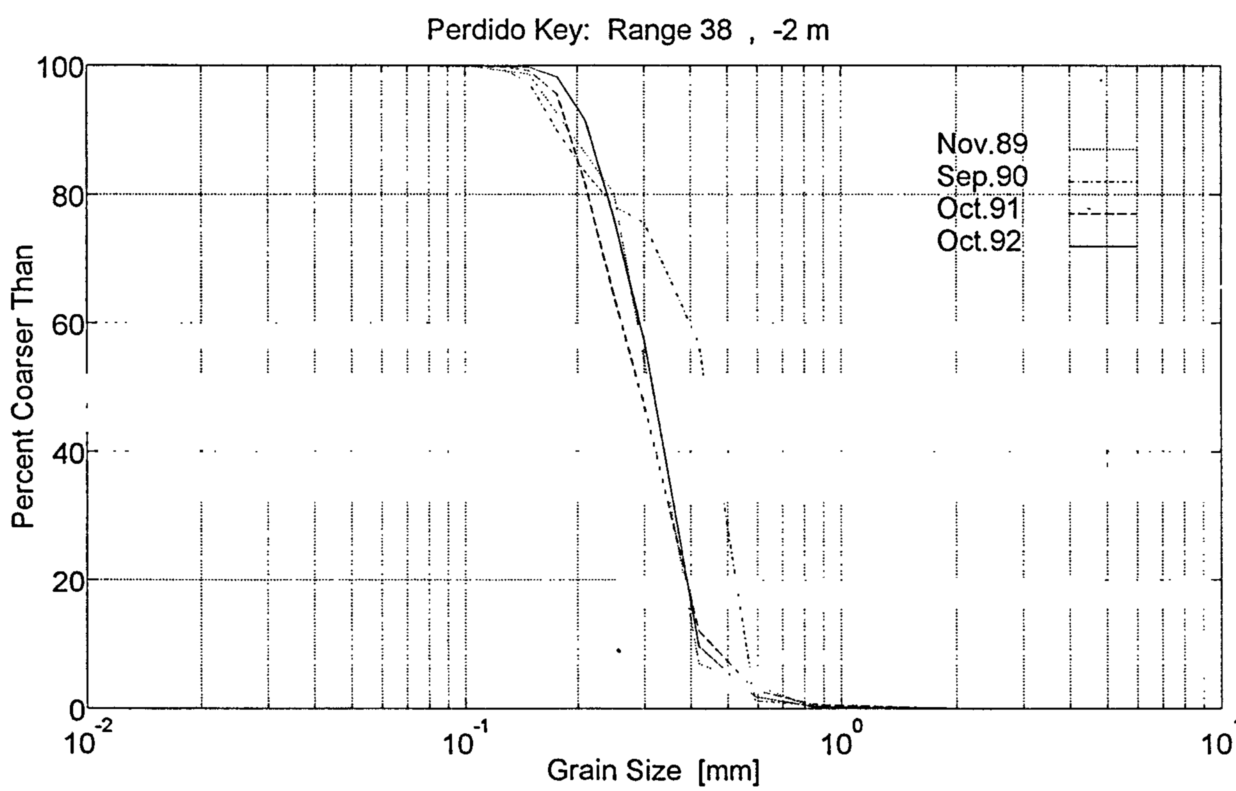
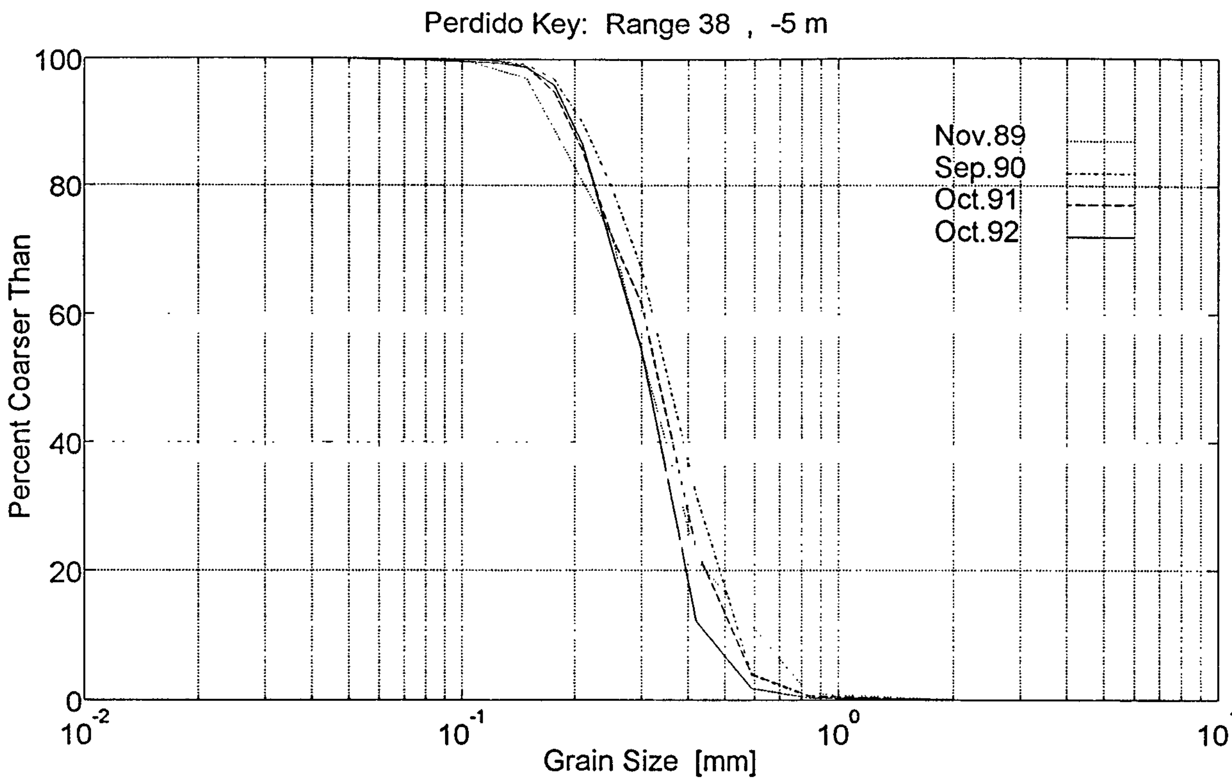


Figure III-19: Grain Size Distributions for Range 38, 1 M Depth and 2 M Depth Positions.



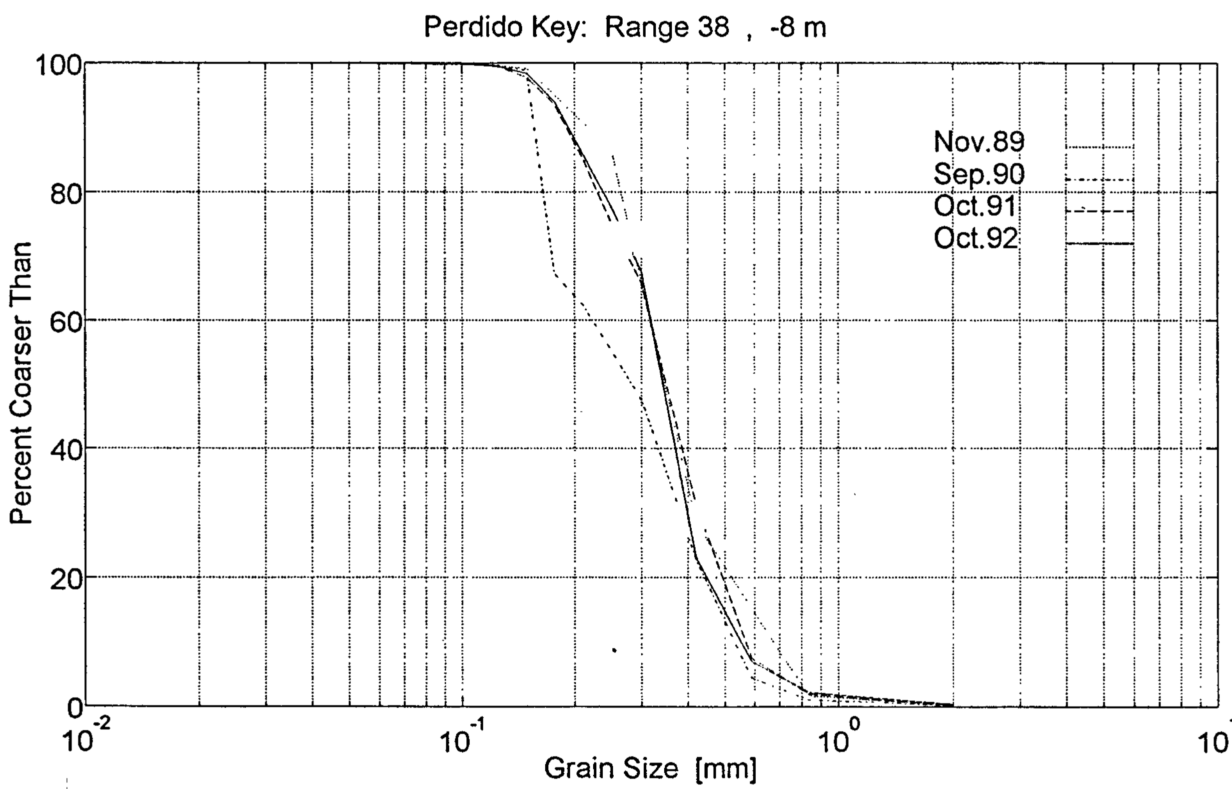
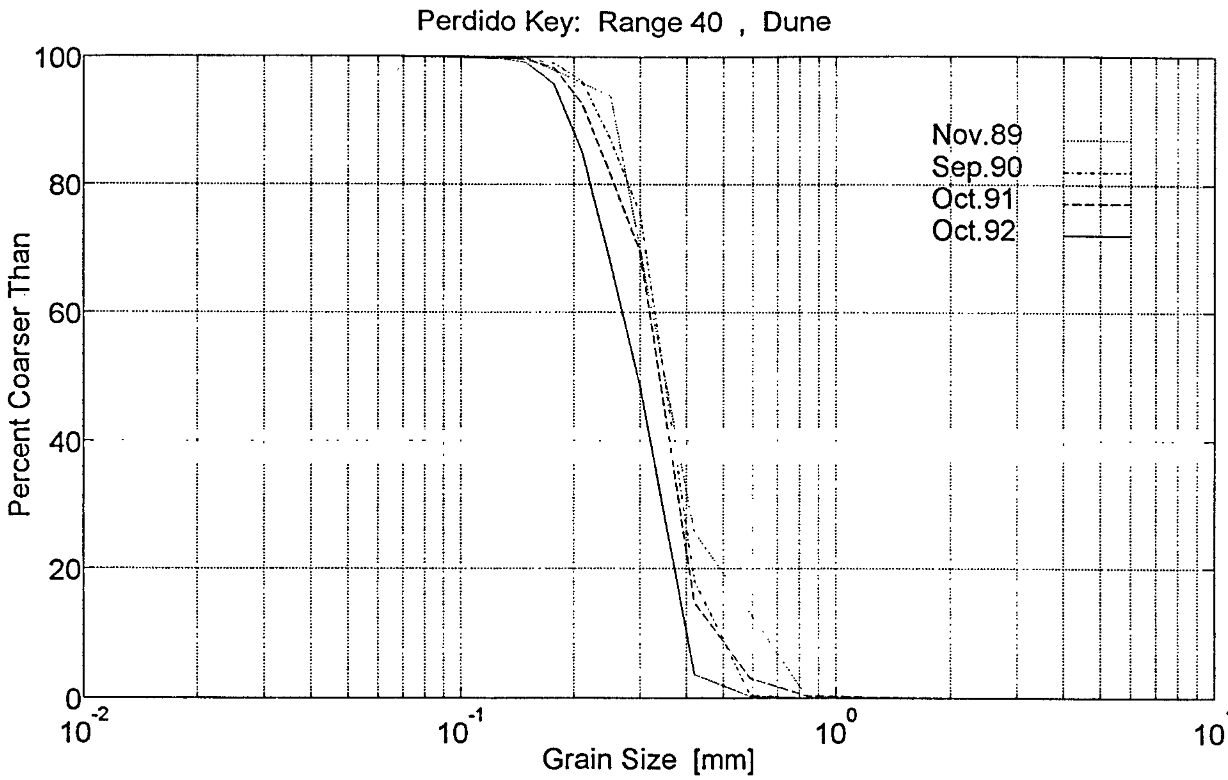


Figure III-20: Grain Size Distributions for Range 38, 5 M Depth and 8 M Depth Positions.



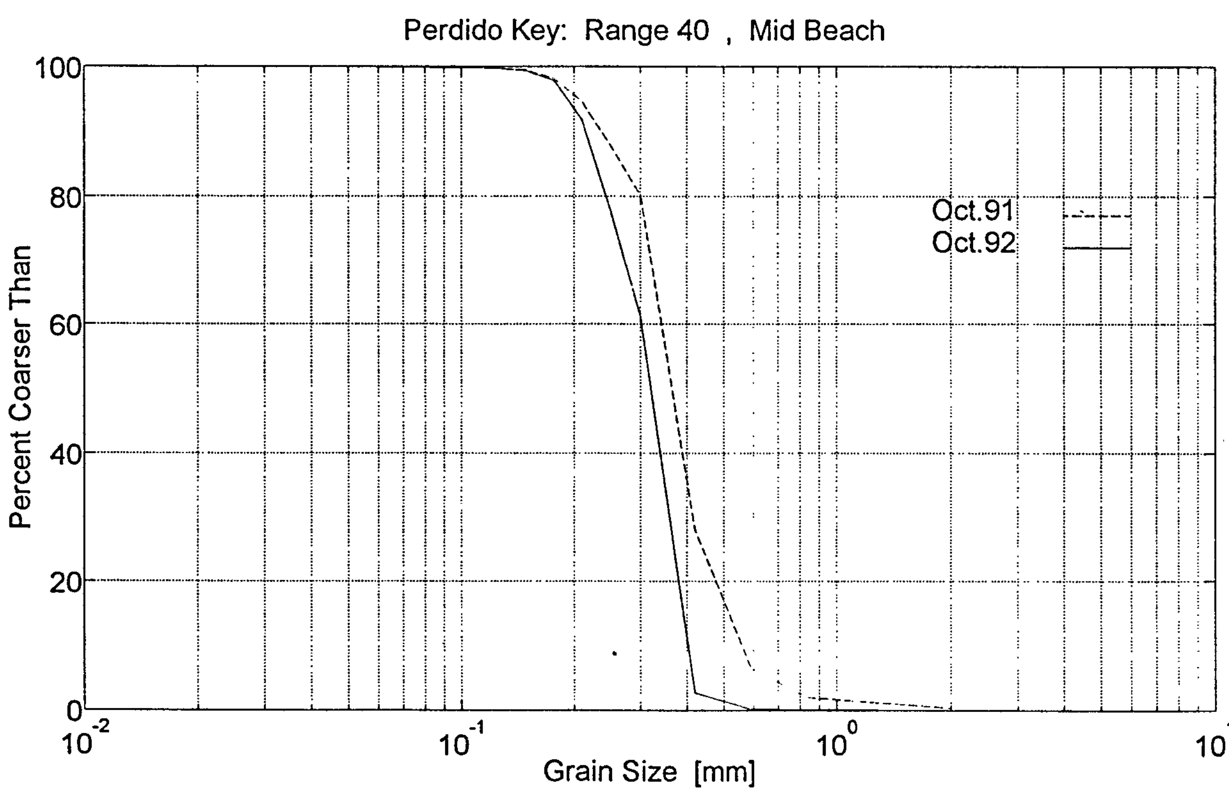
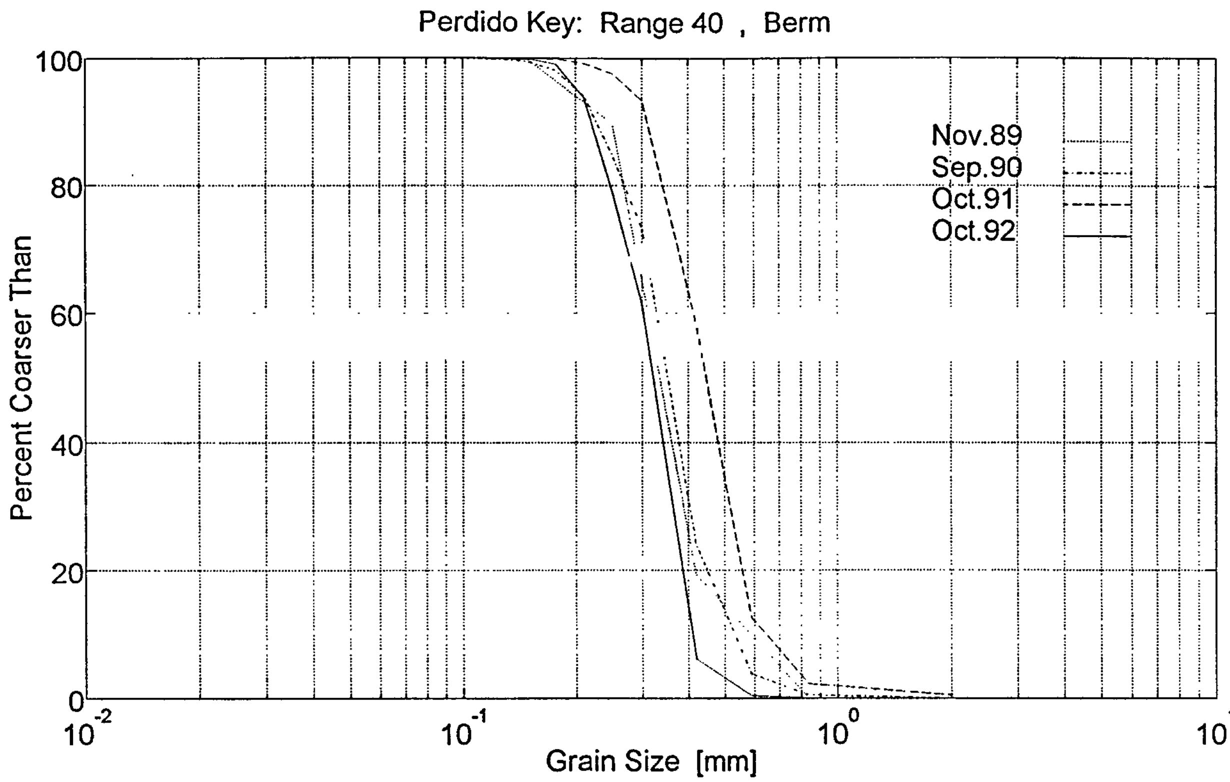


Figure III-21: Grain Size Distributions for Range 40, Dune and Mid-Beach Positions.



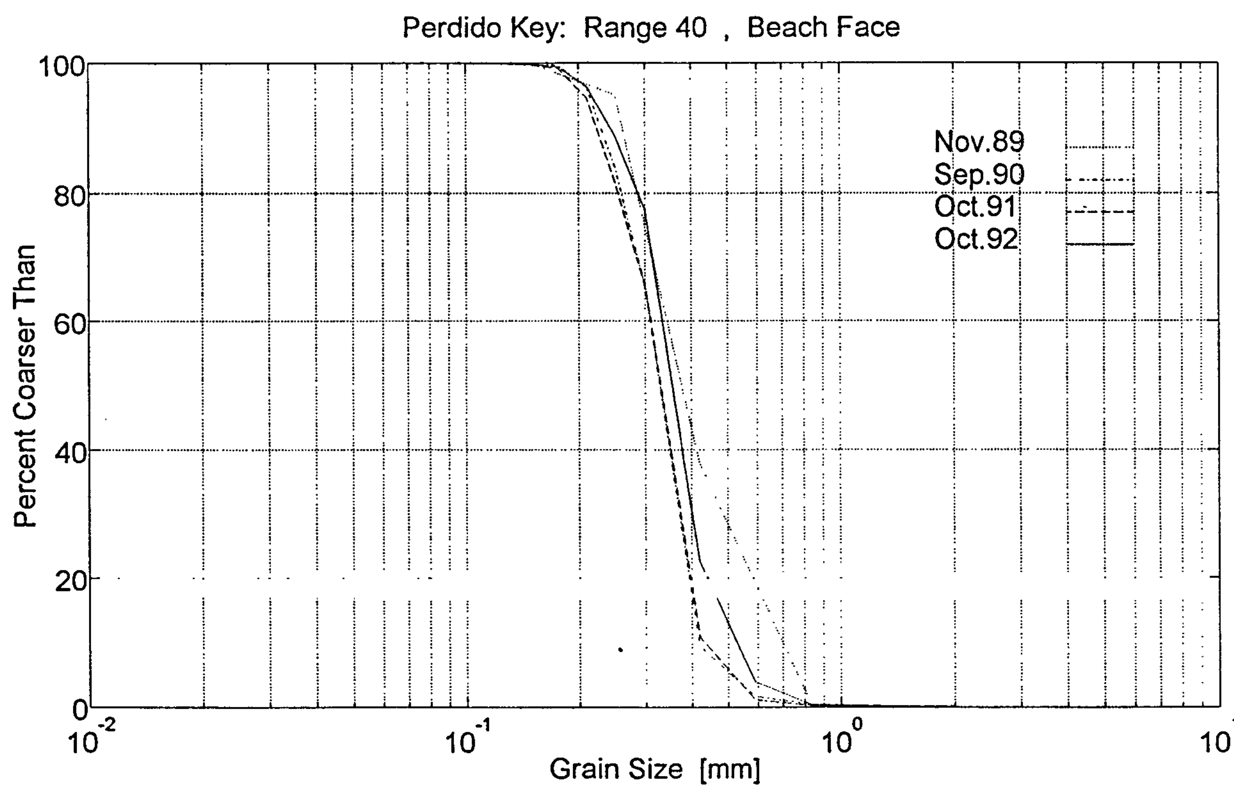
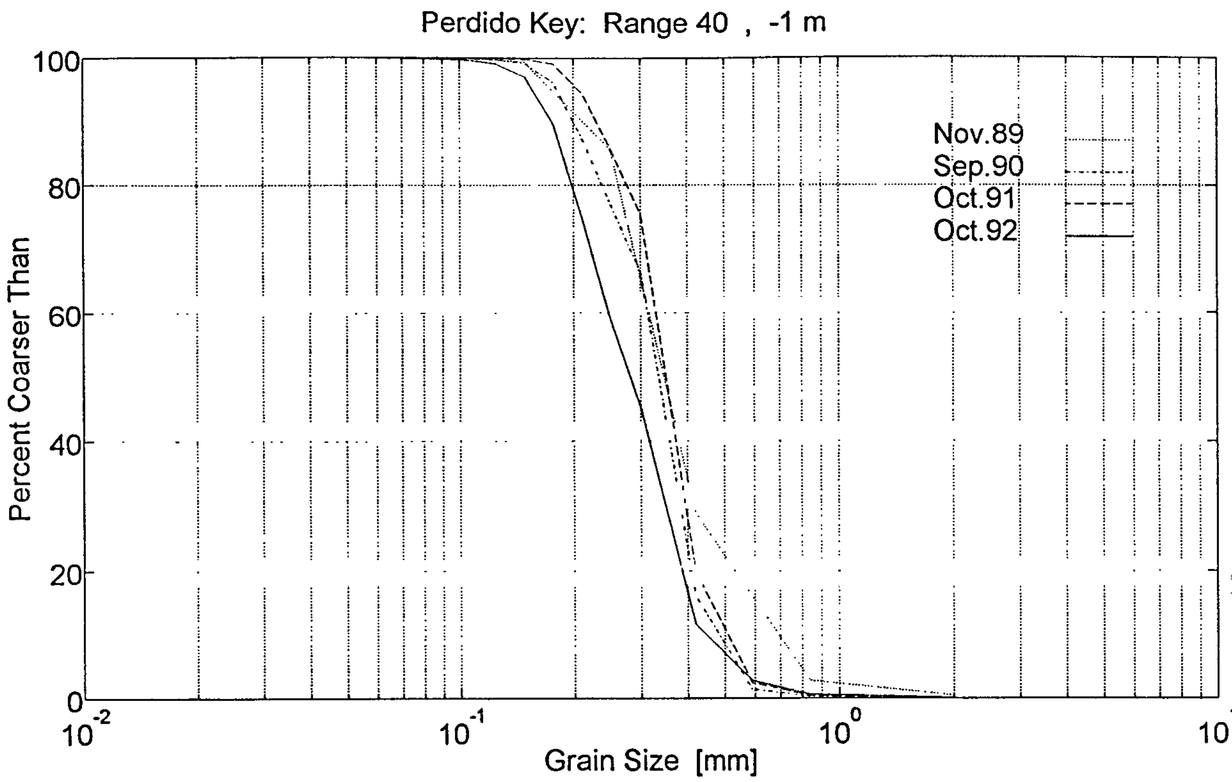


Figure III-22: Grain Size Distributions for Range 40, Berm and Beach Face Positions.



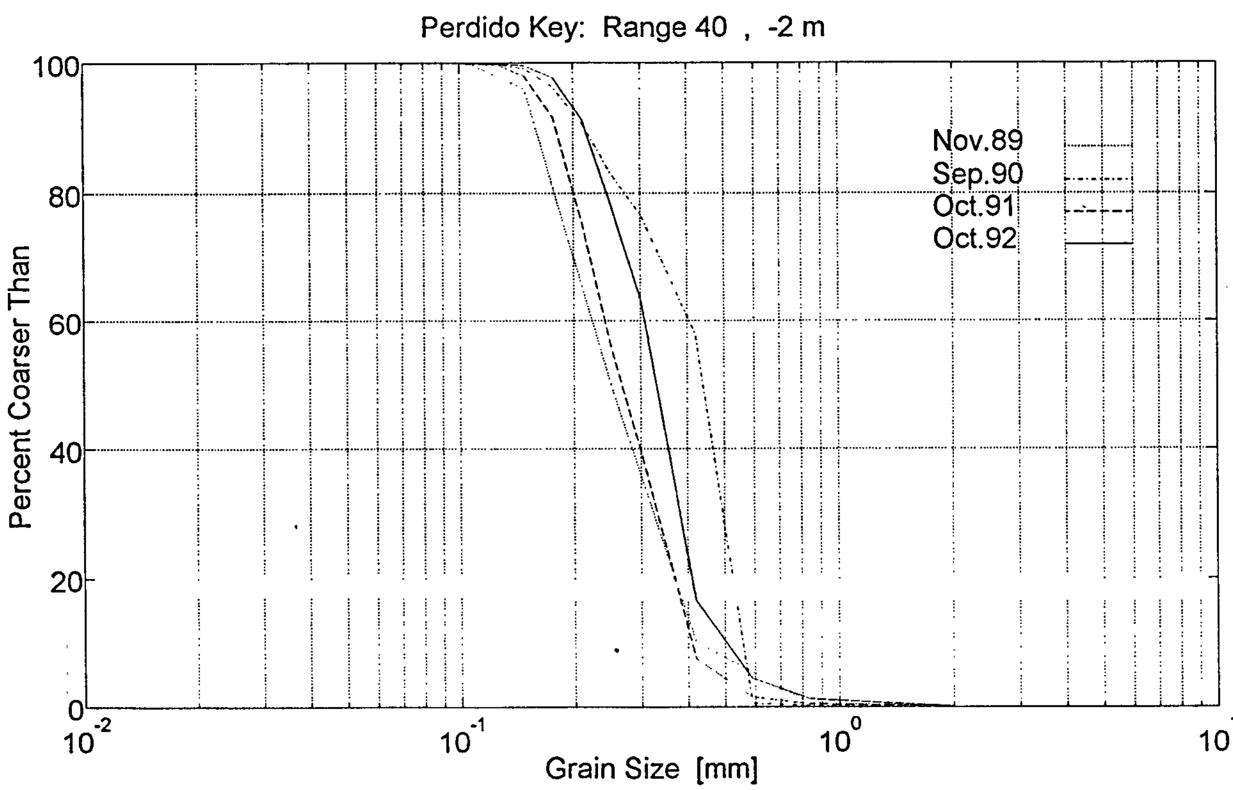
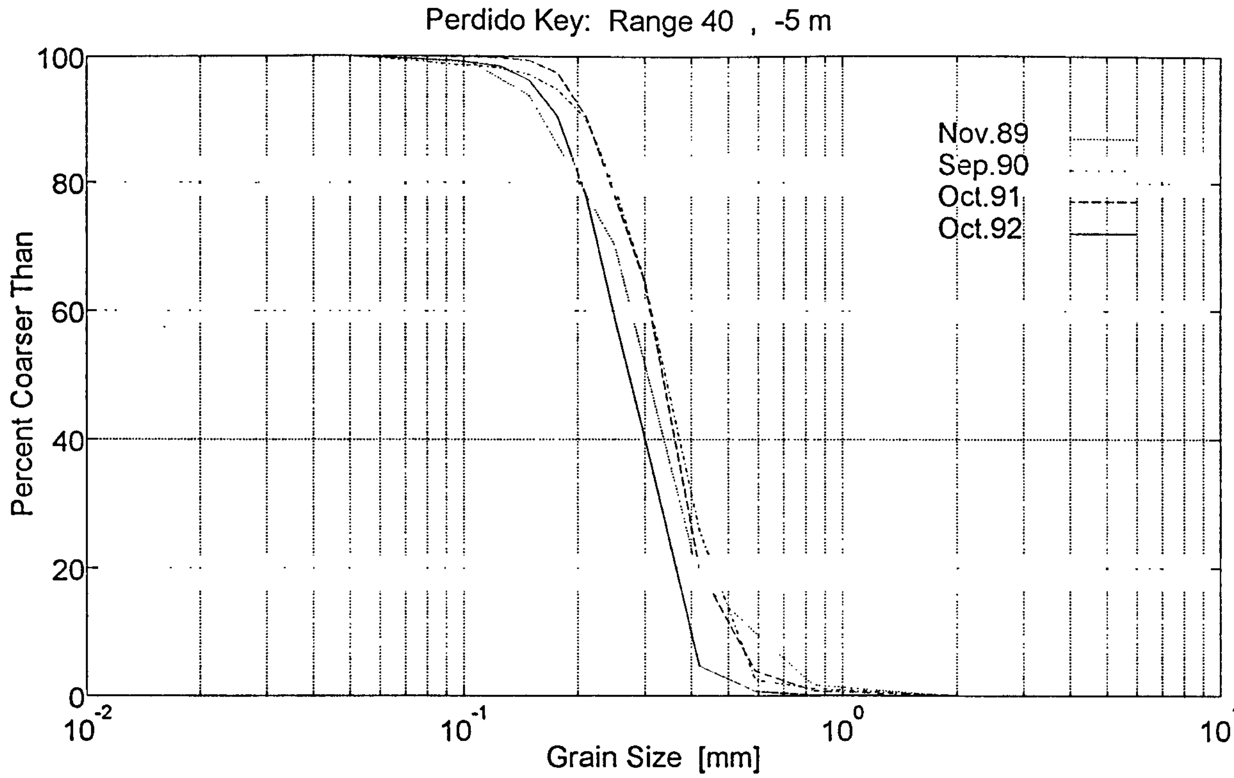


Figure III-23: Grain Size Distributions for Range 40, 1 M Depth and 2 M Depth Positions.



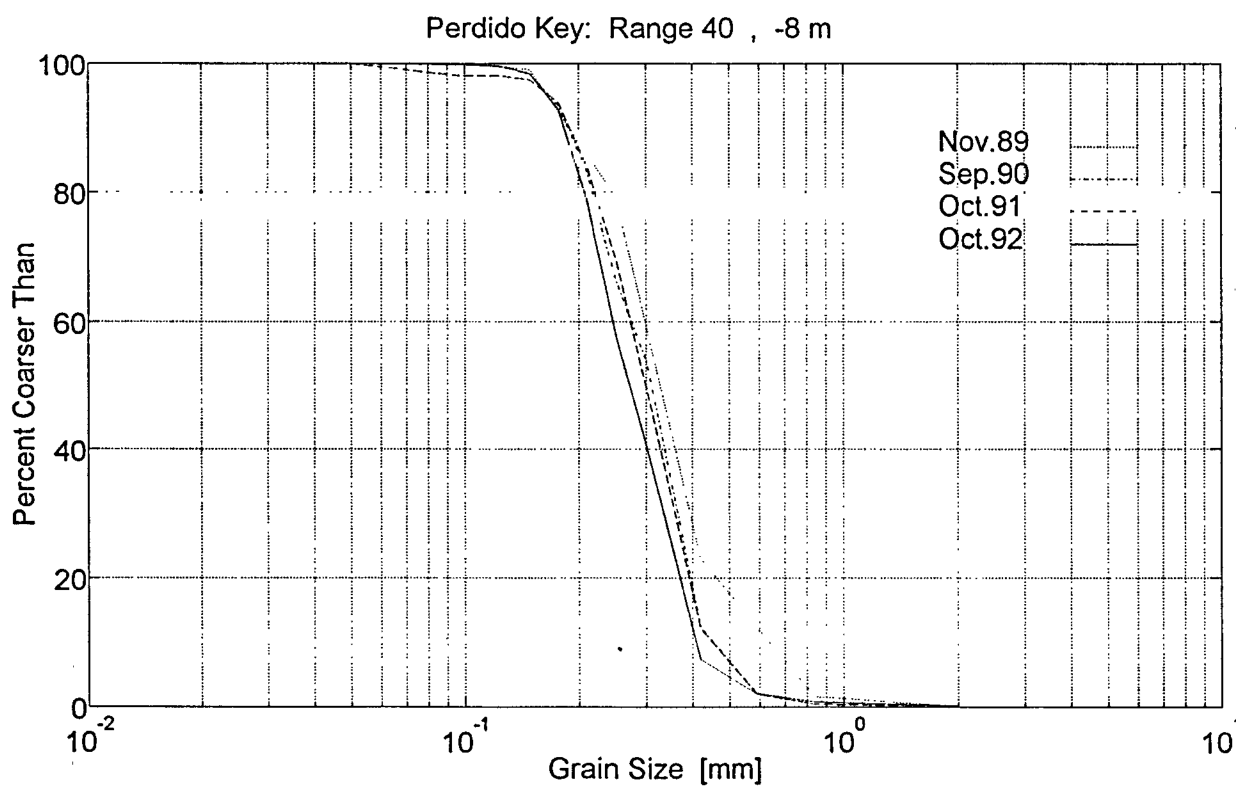


Figure III-24: Grain Size Distributions for Range 40, 5 M Depth and 8 M Depth Positions.

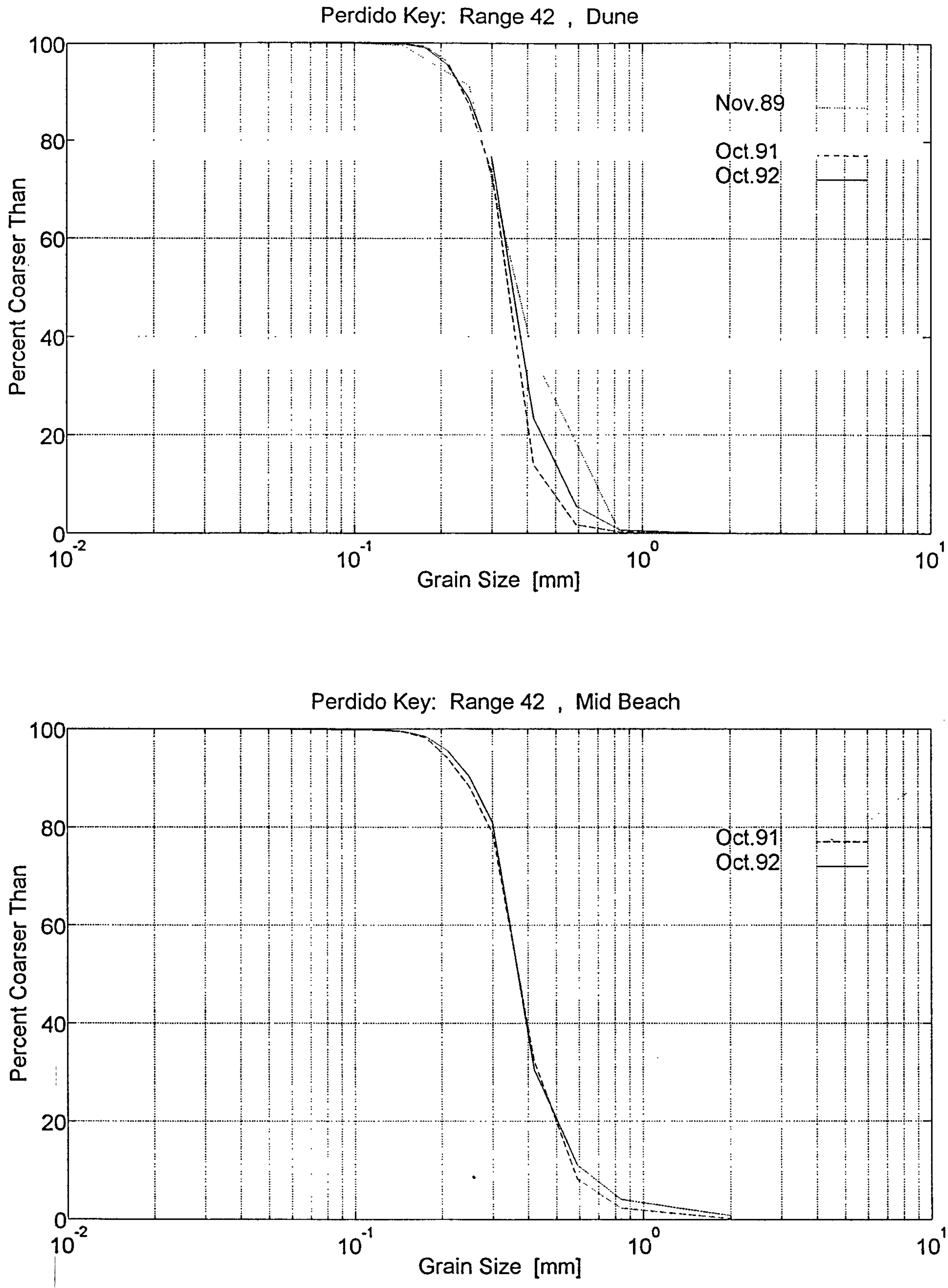
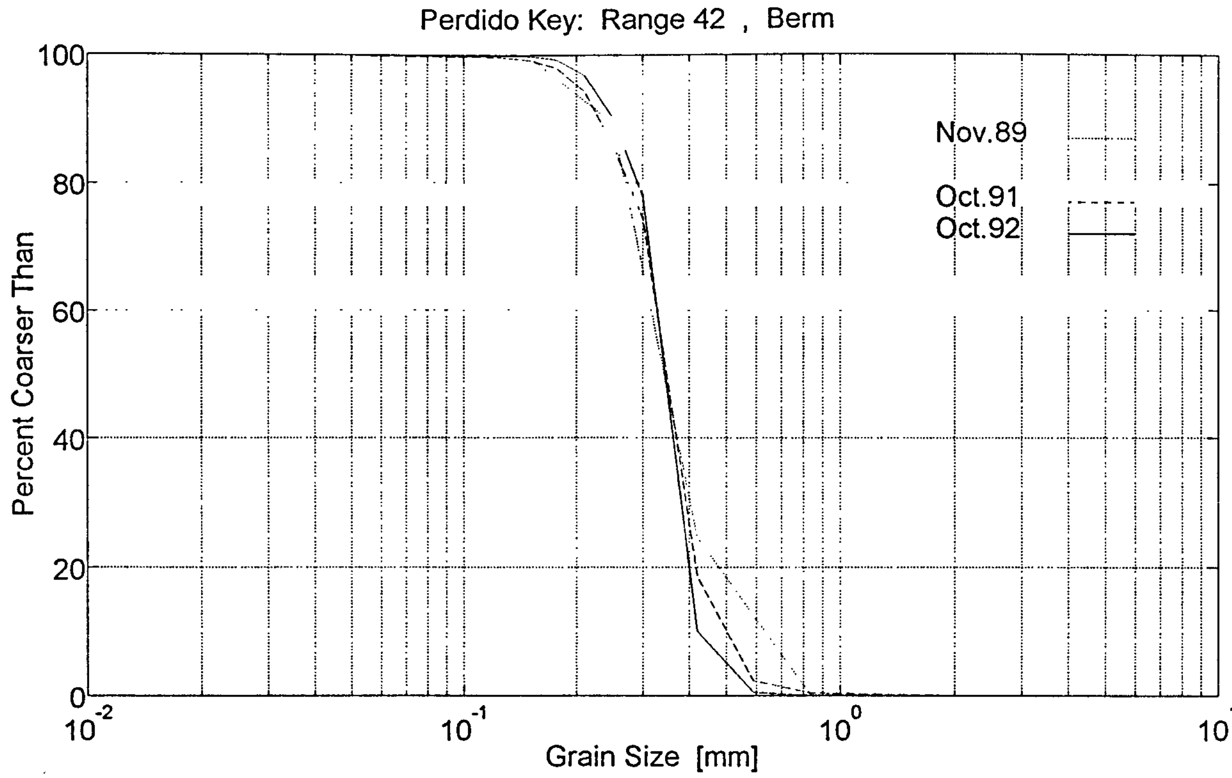


Figure III-25: Grain Size Distributions for Range 42, Dune and Mid-Beach Positions.



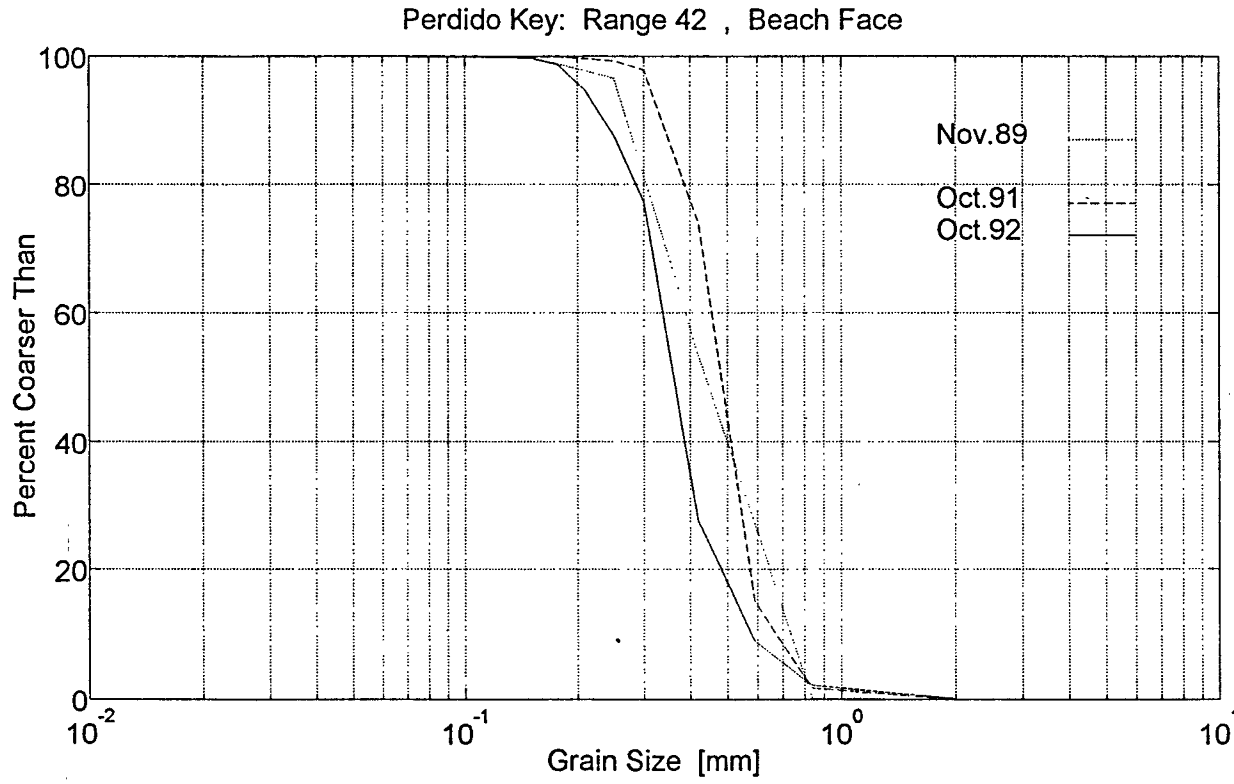
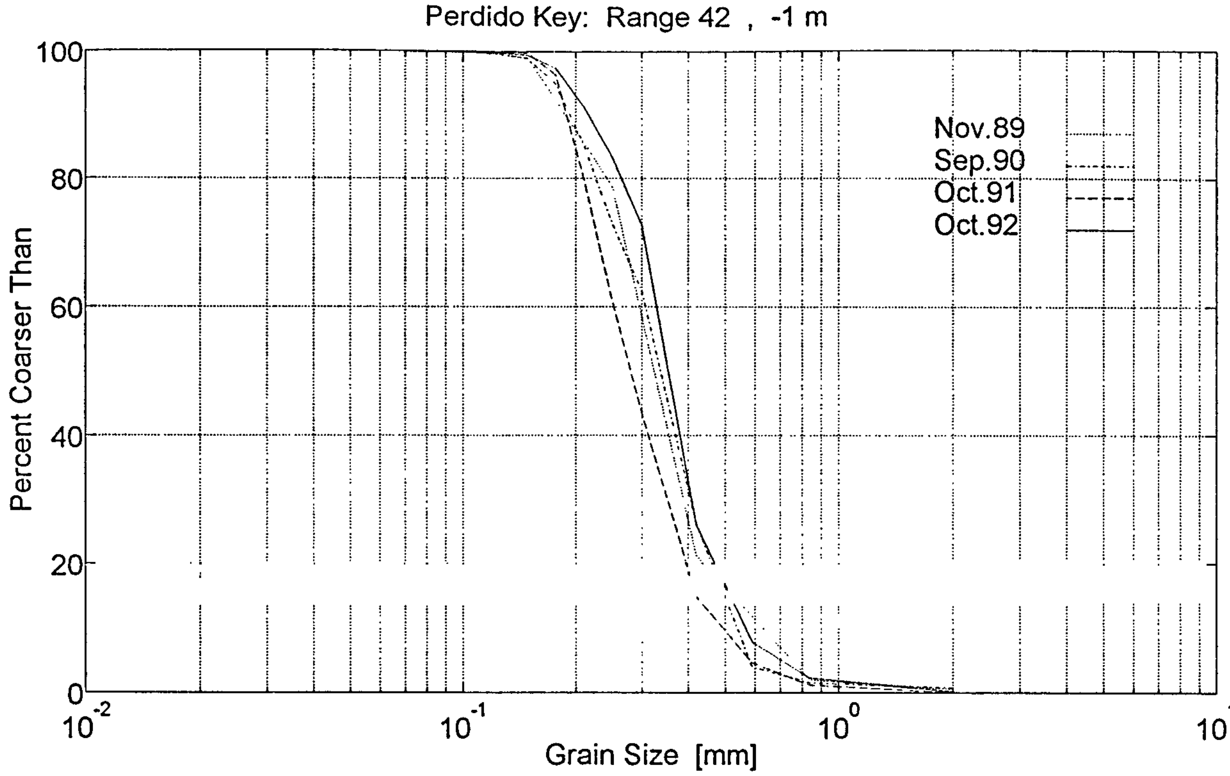


Figure III-26: Grain Size Distributions for Range 42, Berm and Beach Face Positions.



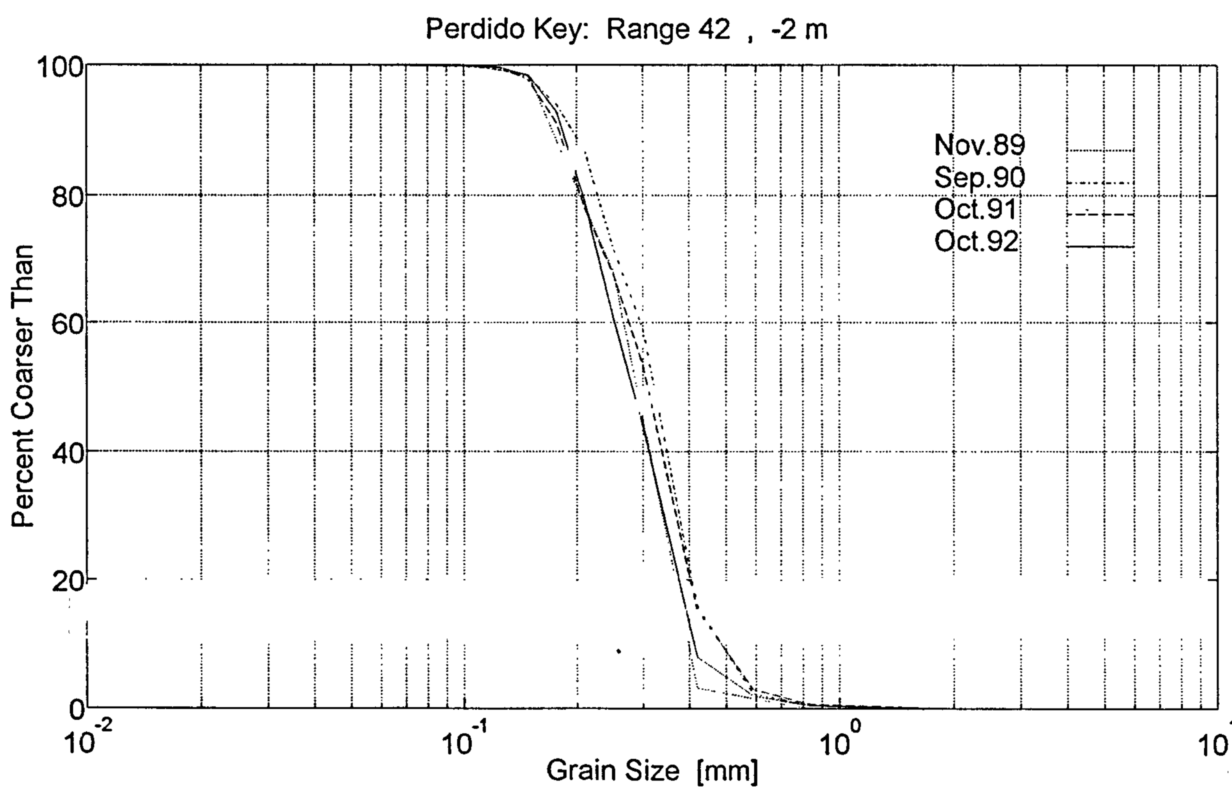
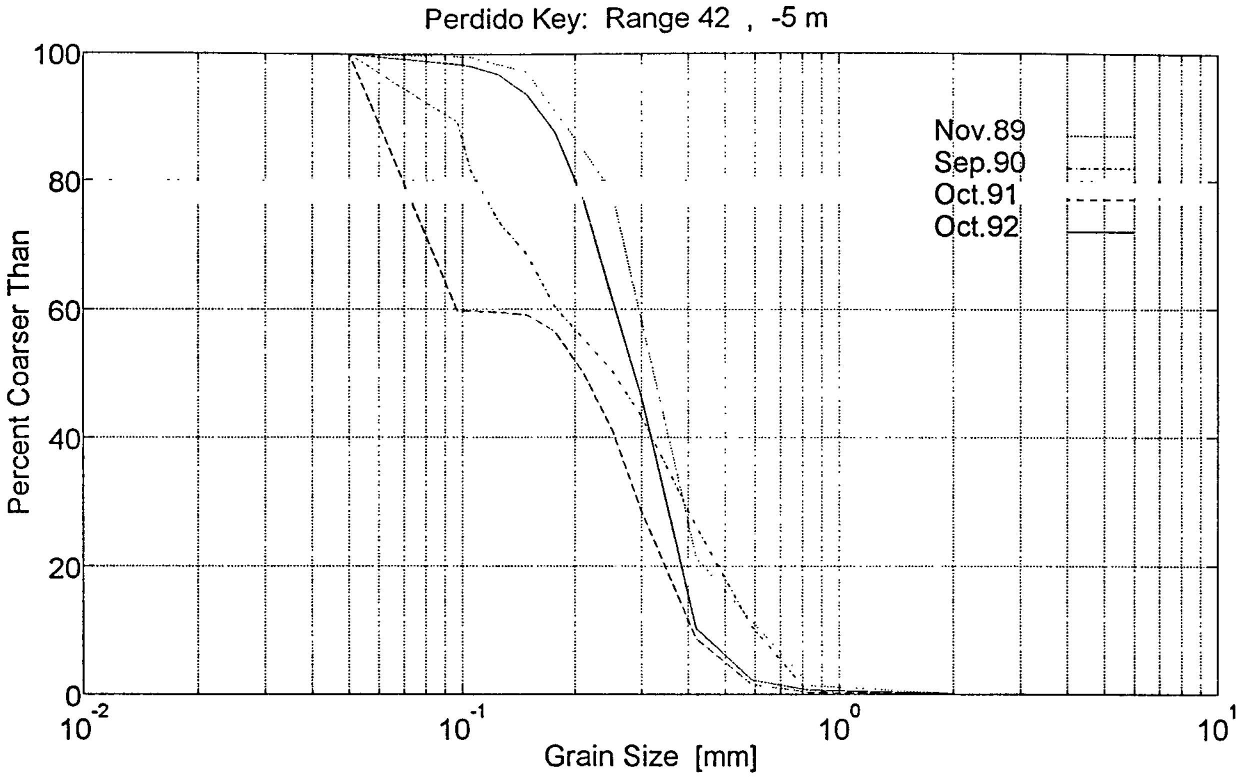


Figure III-27: Grain Size Distributions for Range 42, 1 M Depth and 2 M Depth Positions.



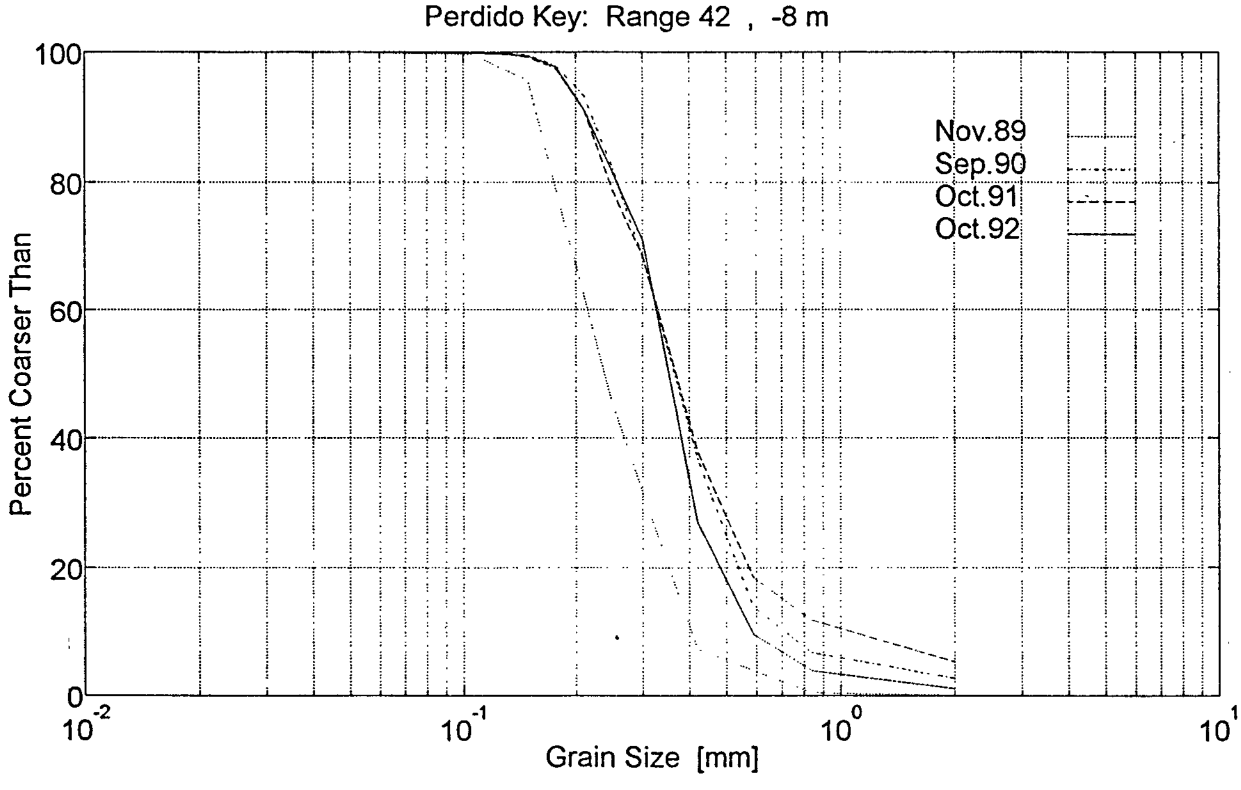


Figure III-28: Grain Size Distributions for Range 42, 5 M Depth and 8 M Depth Positions.

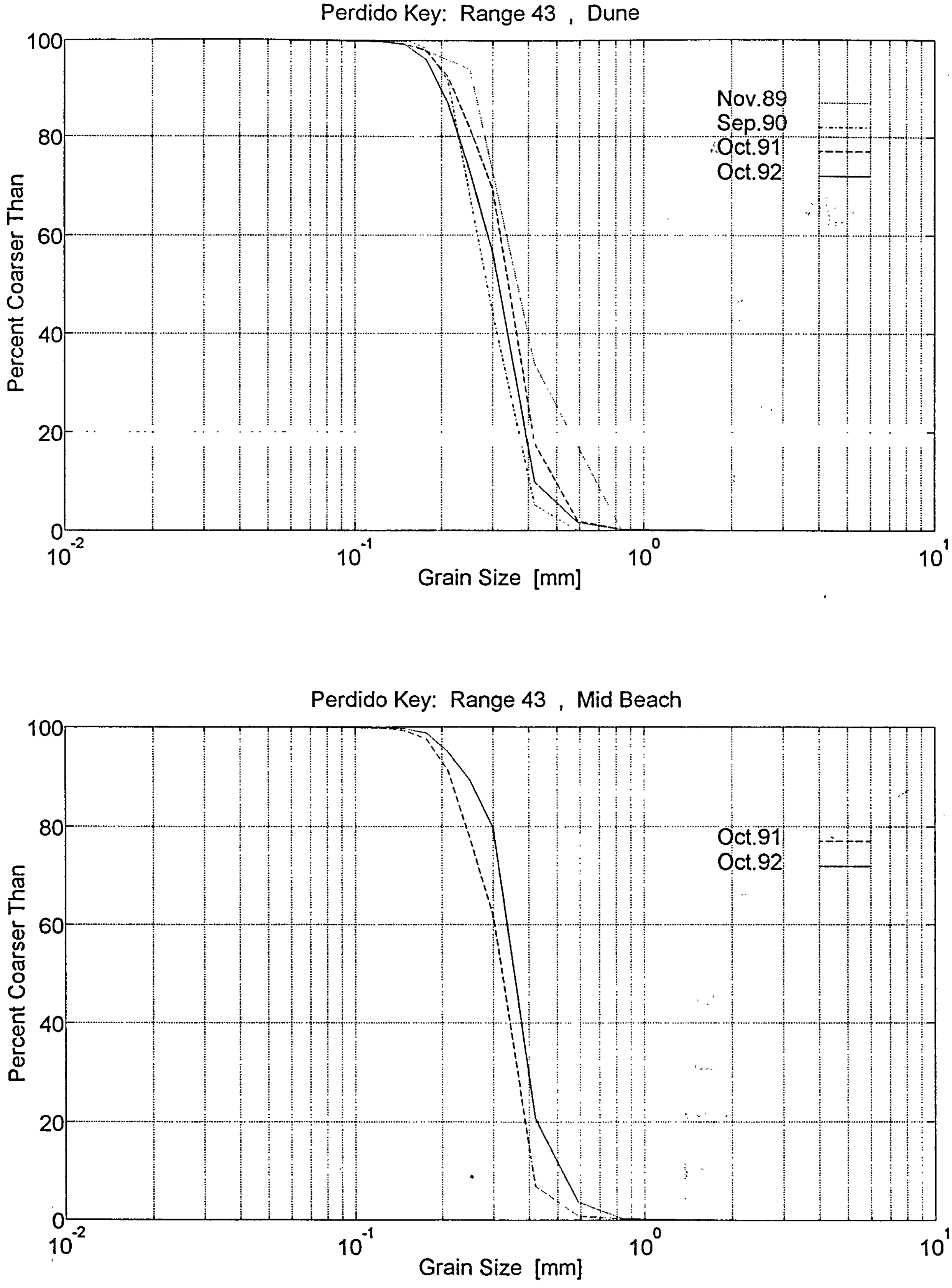
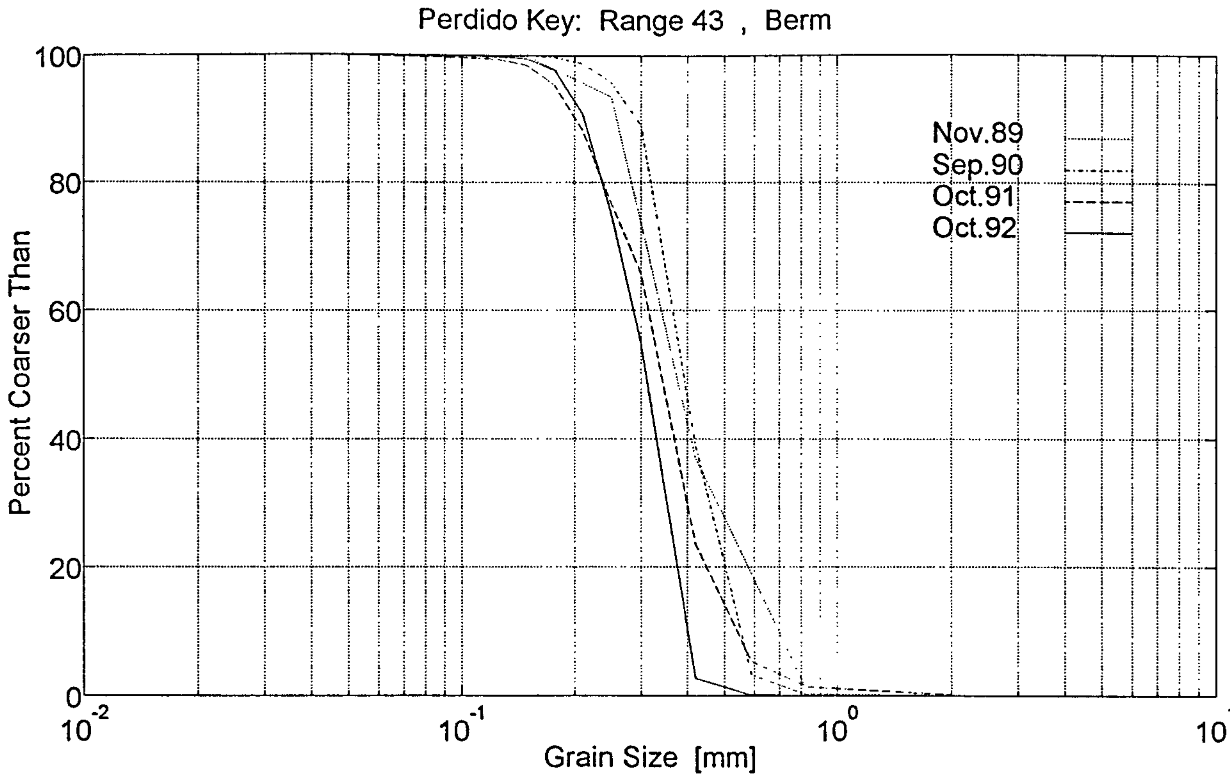


Figure III-29: Grain Size Distributions for Range 43, Dune and Mid-Beach Positions.



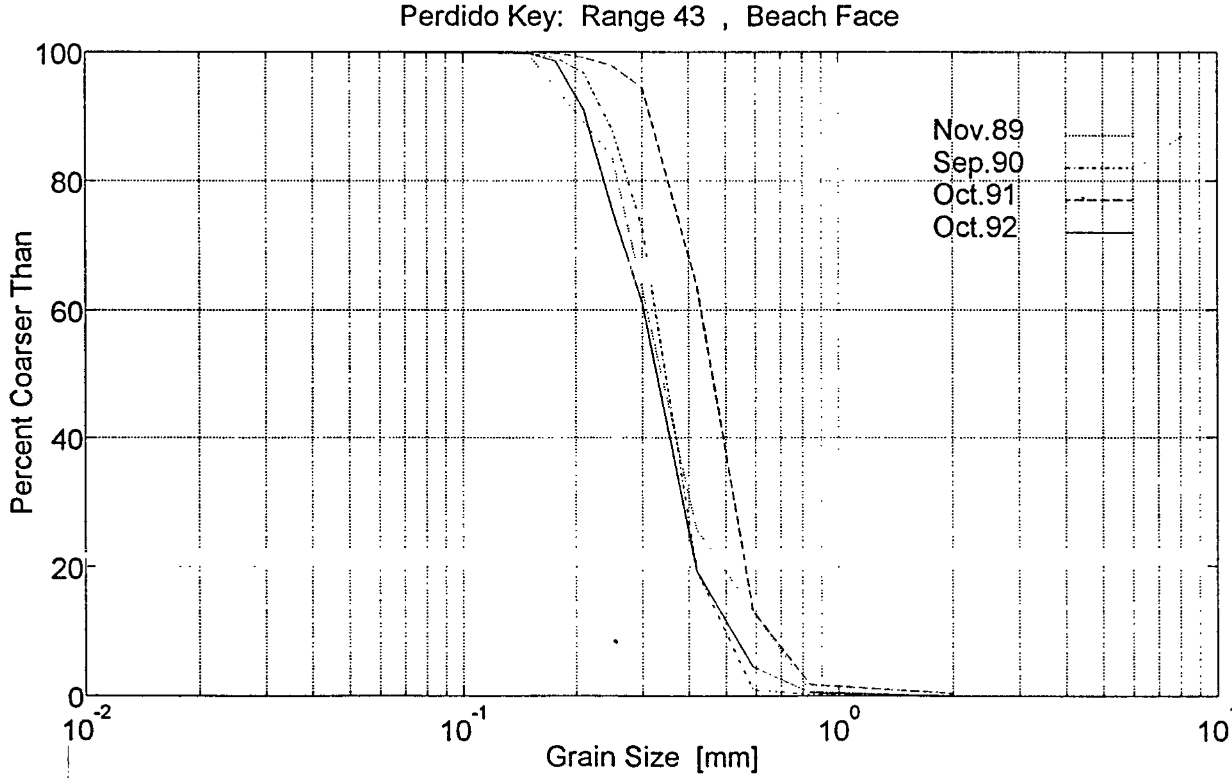
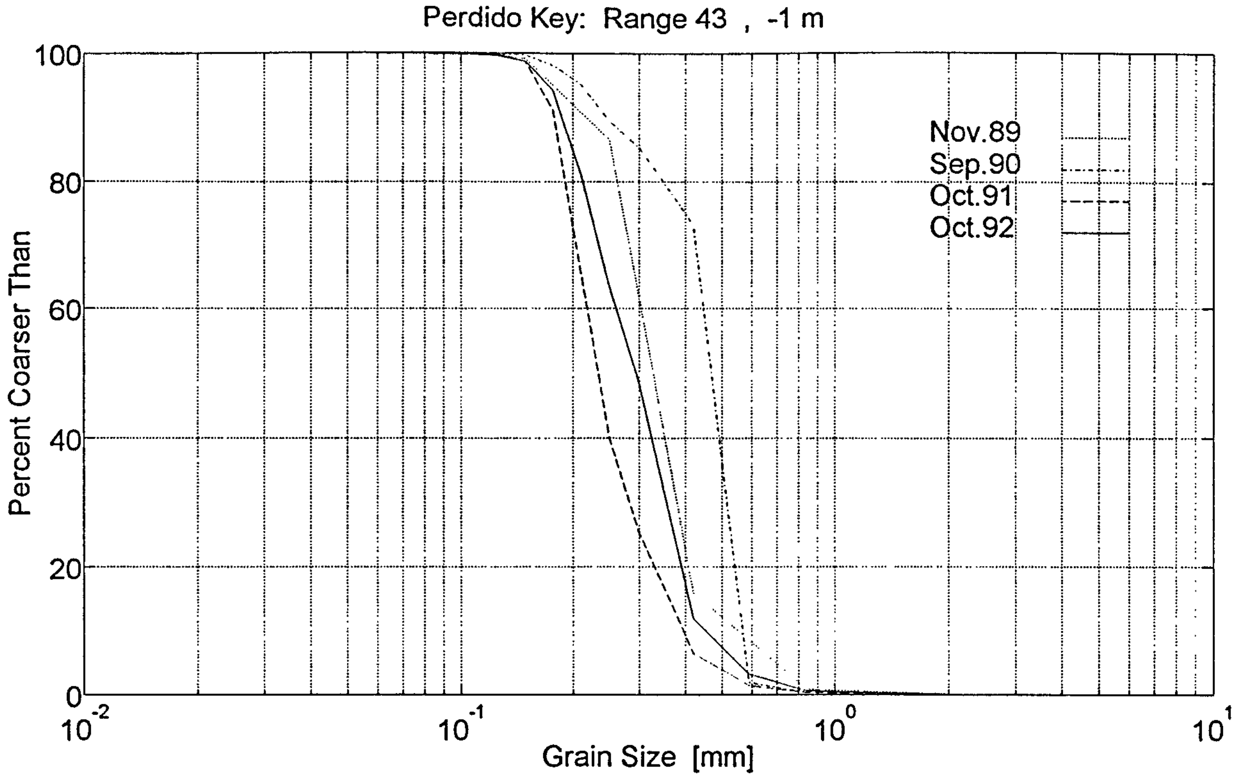


Figure III-30: Grain Size Distributions for Range 43, Berm and Beach Face Positions.



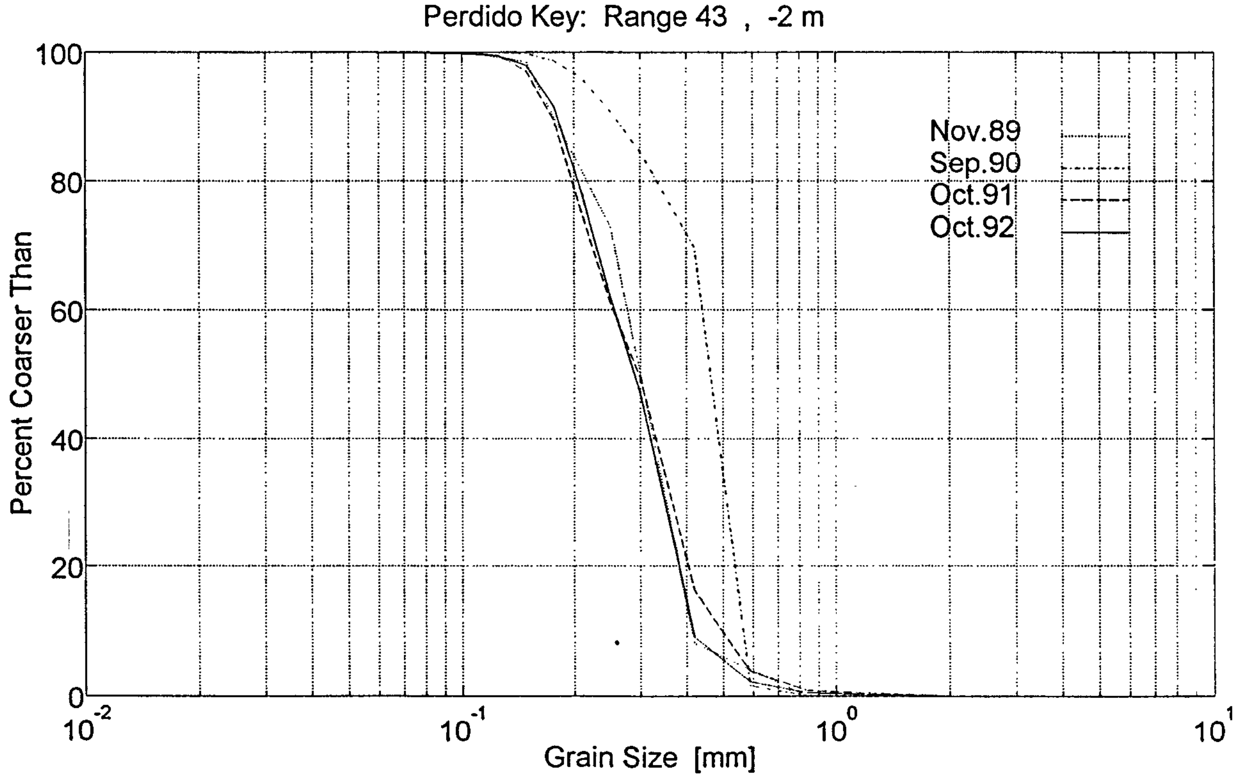


Figure III-31: Grain Size Distributions for Range 43, 1 M Depth and 2 M Depth Positions.

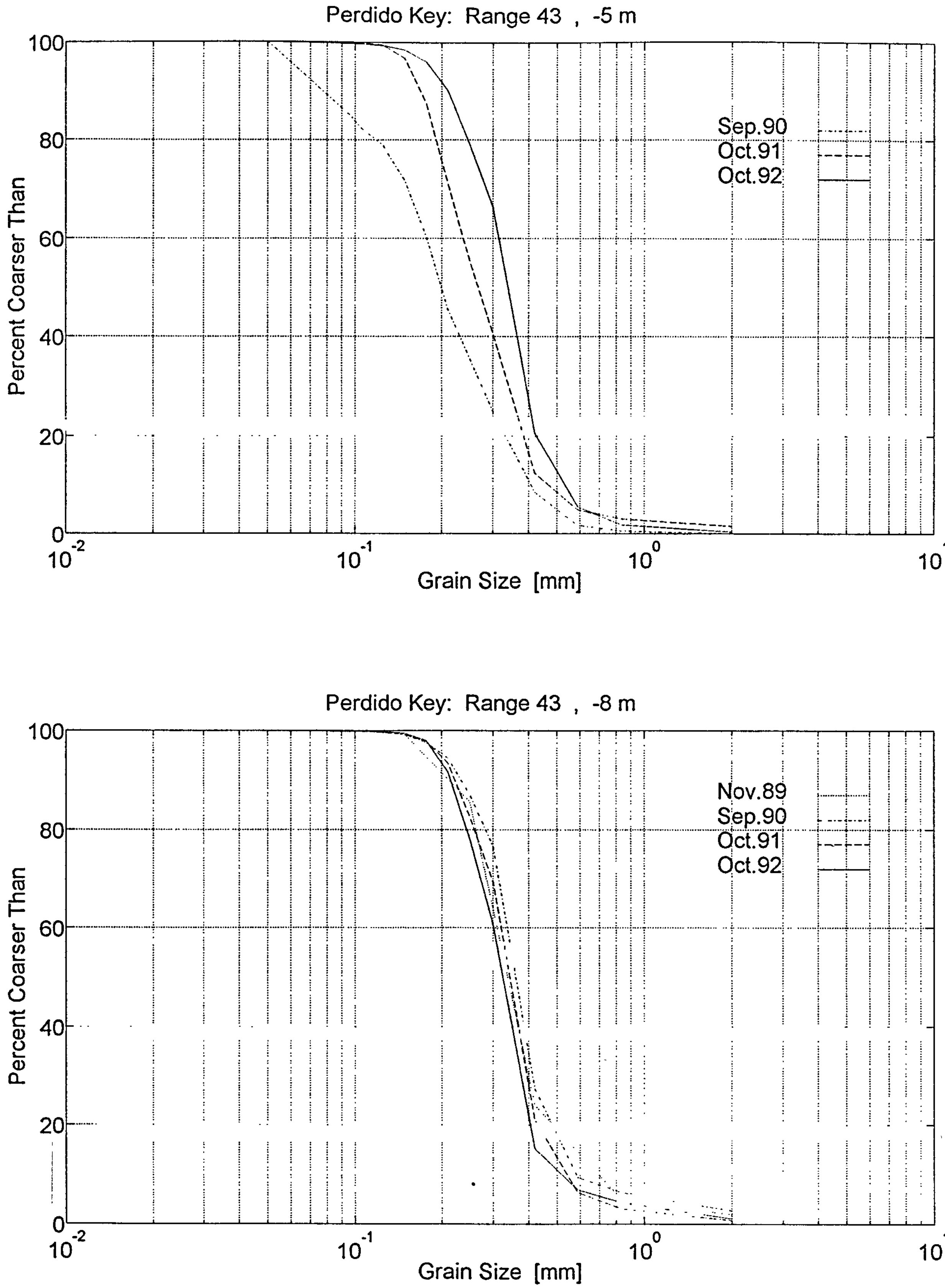
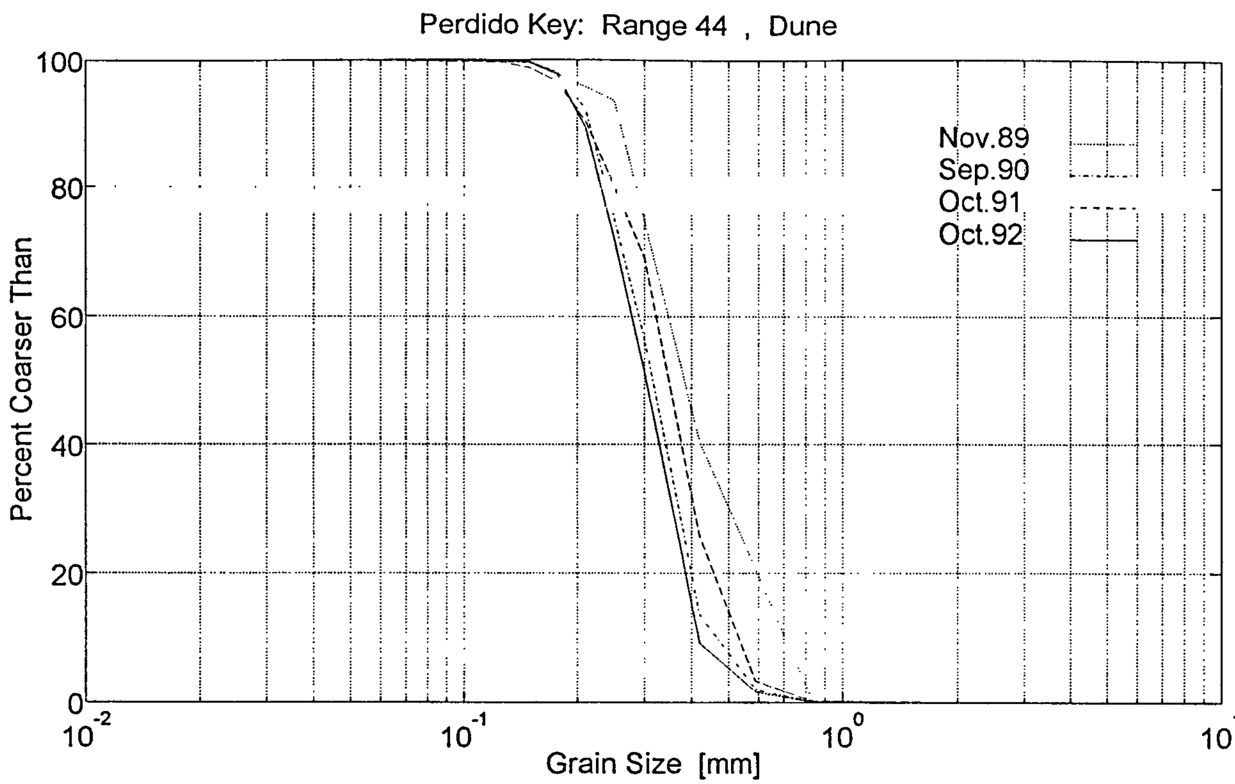


Figure III-32: Grain Size Distributions for Range 43, 5 M Depth and 8 M Depth Positions.



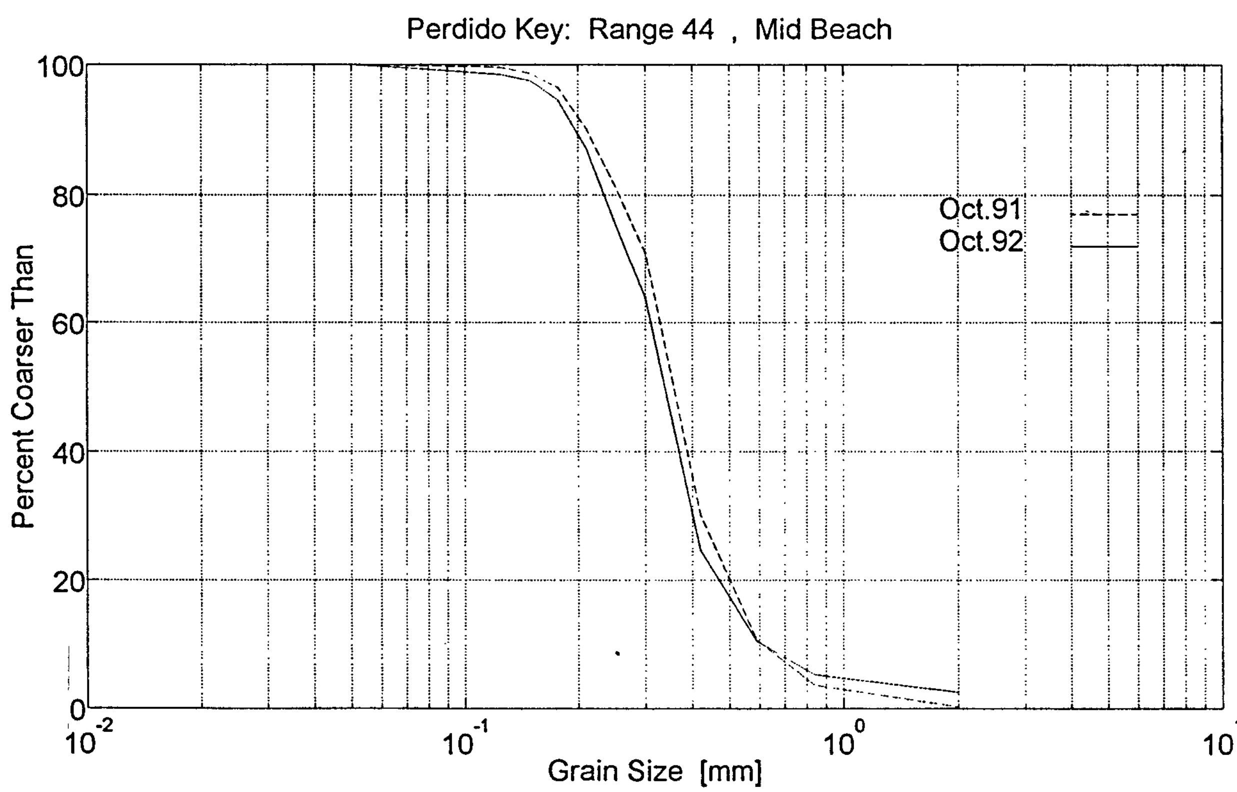
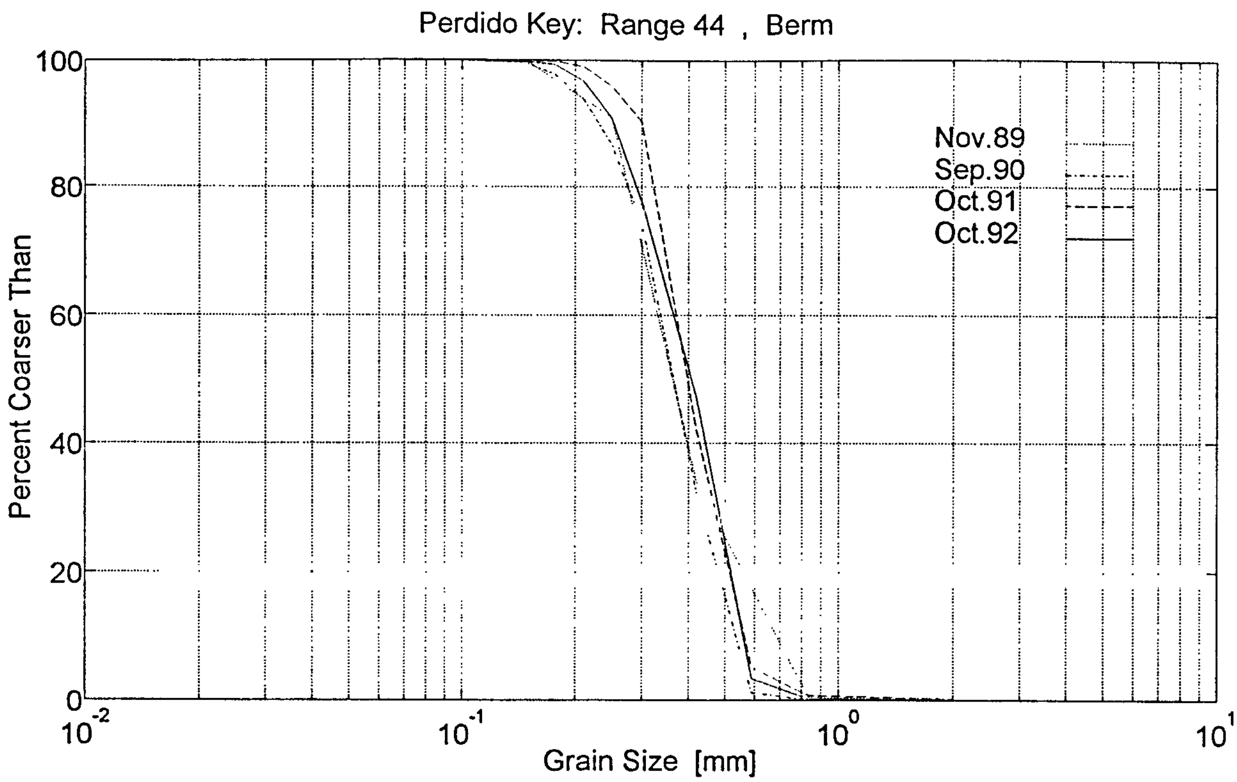


Figure III-33: Grain Size Distributions for Range 44, Dune and Mid-Beach Positions.



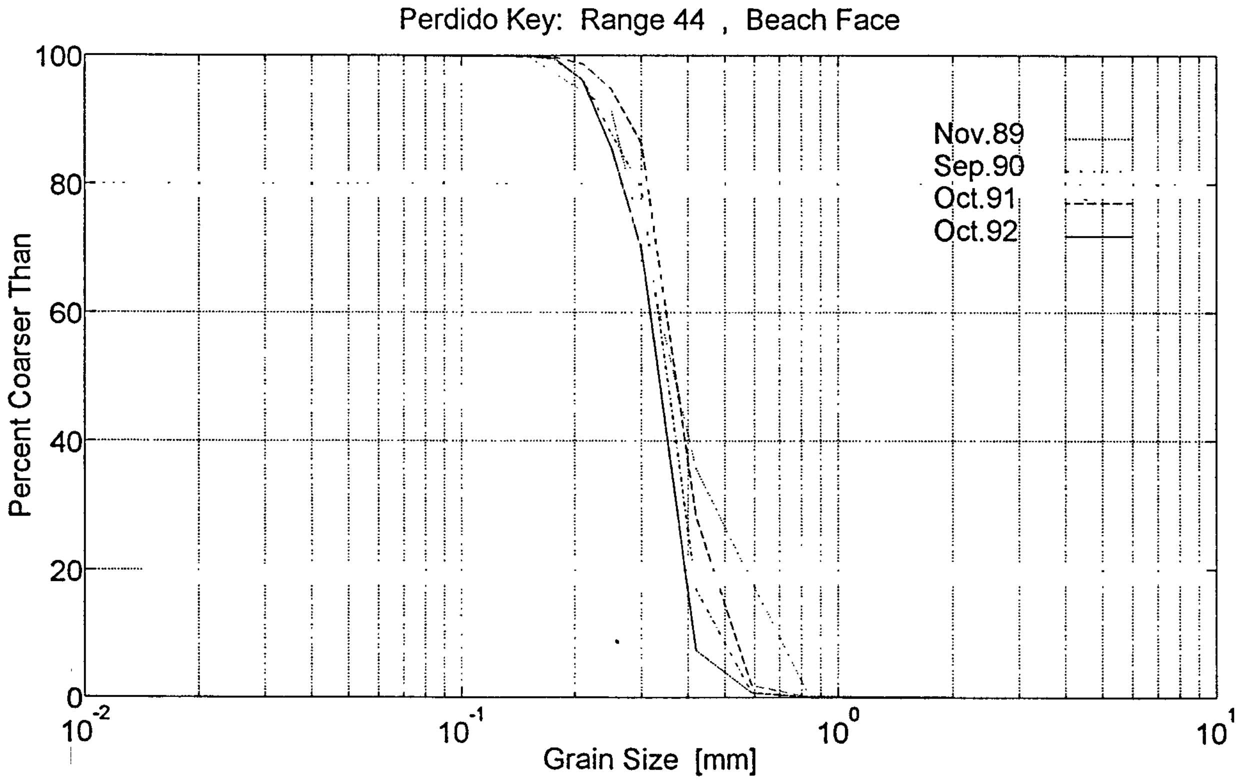
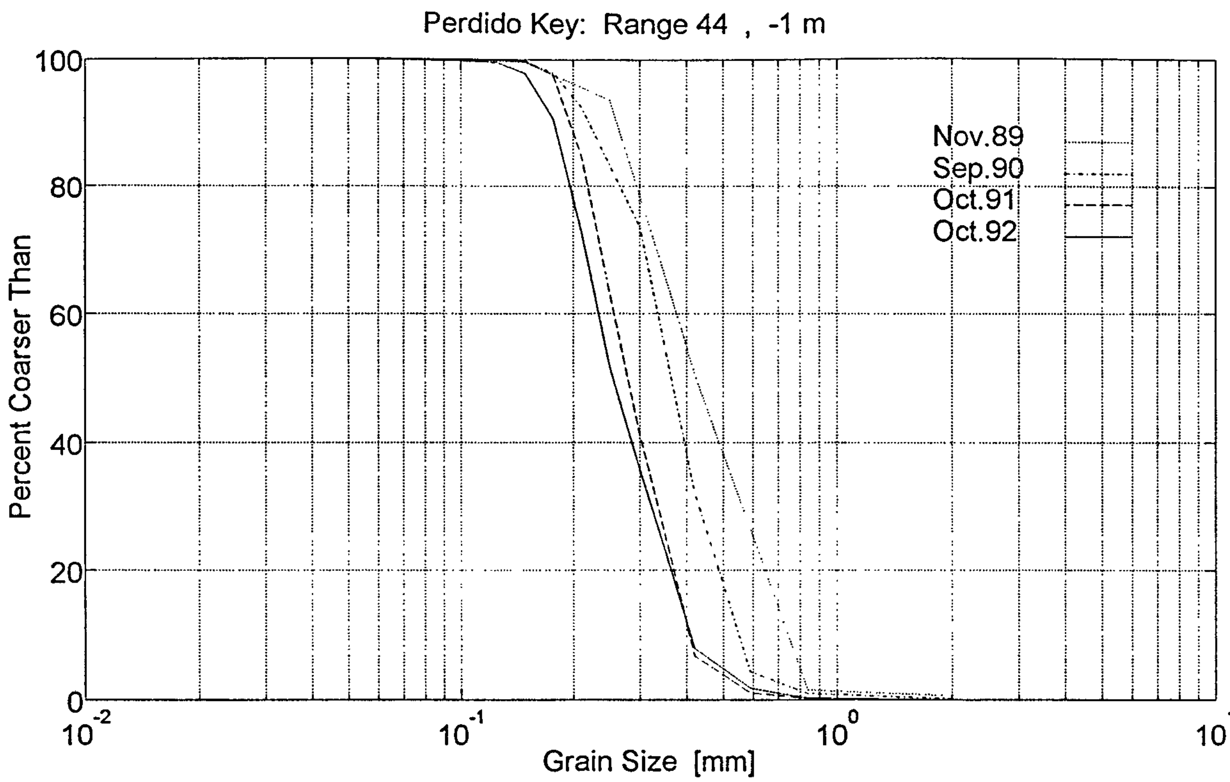


Figure III-34: Grain Size Distributions for Range 44, Berm and Beach Face Positions.



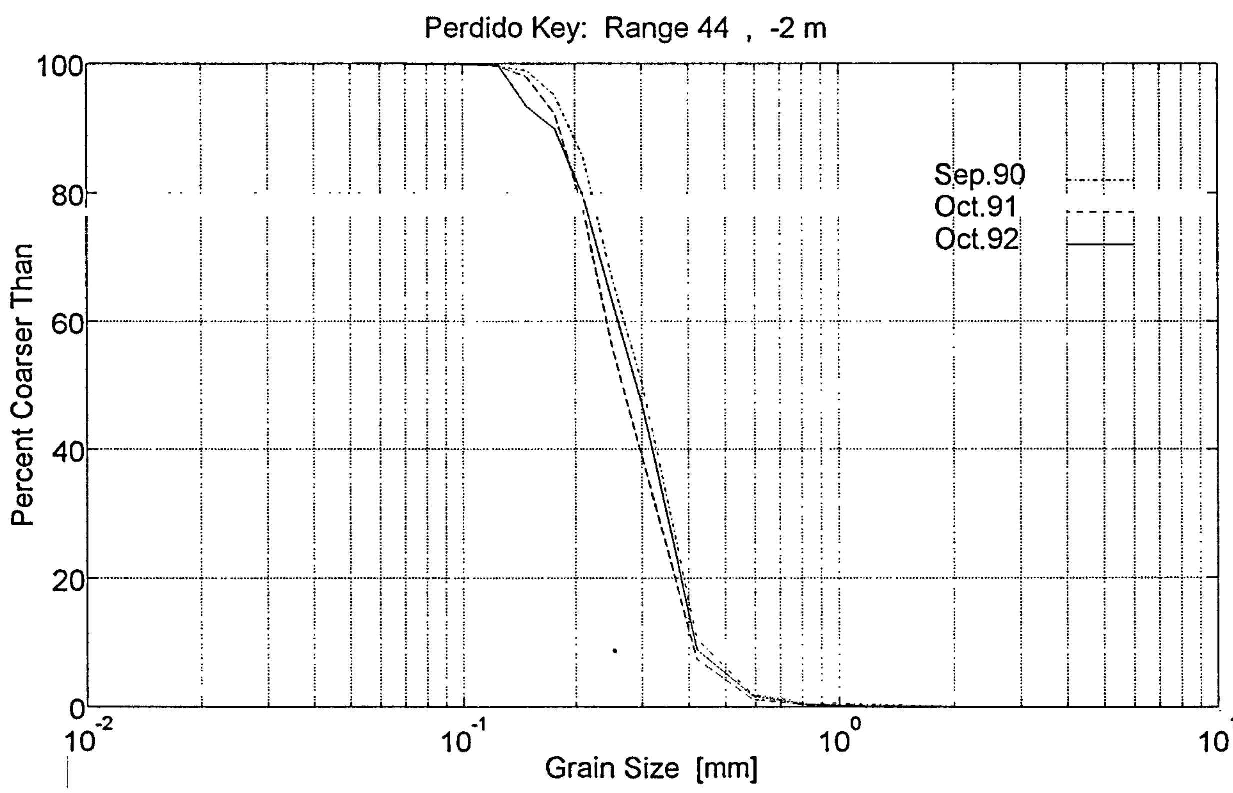
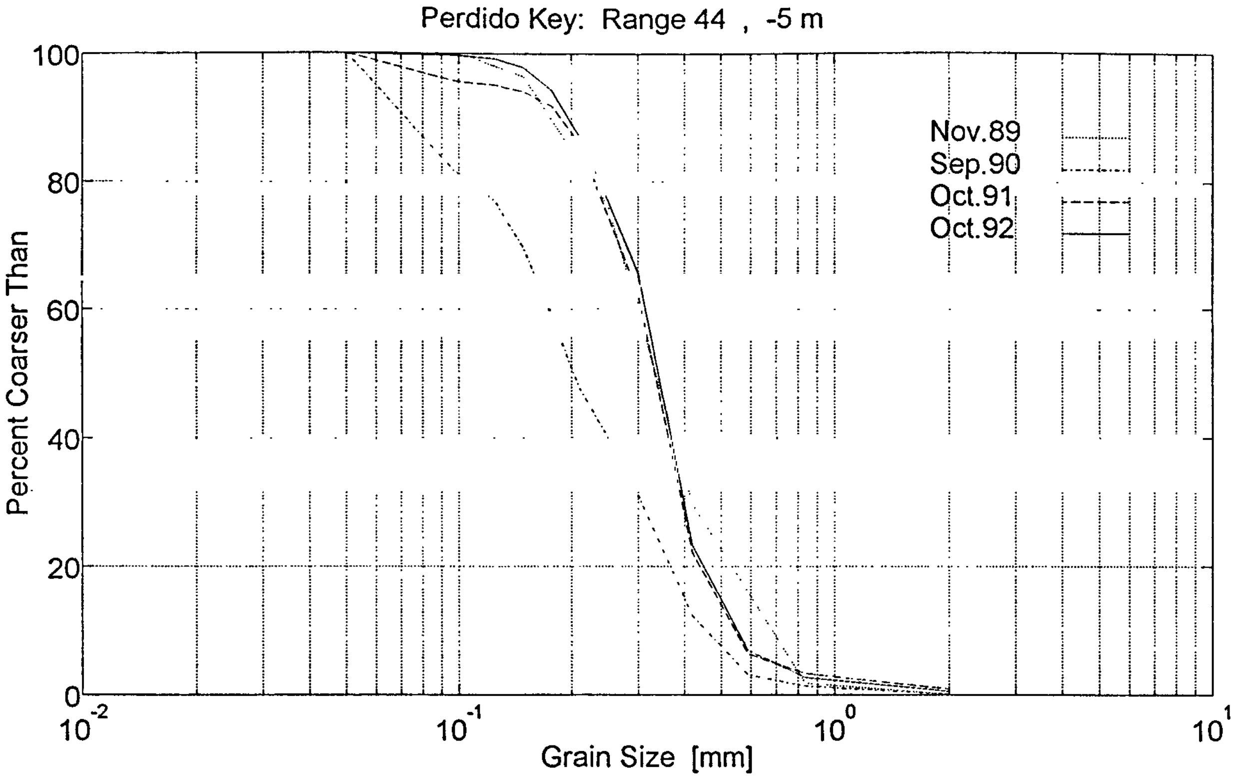


Figure III-35: Grain Size Distributions for Range 44, 1 M Depth and 2 M Depth Positions.



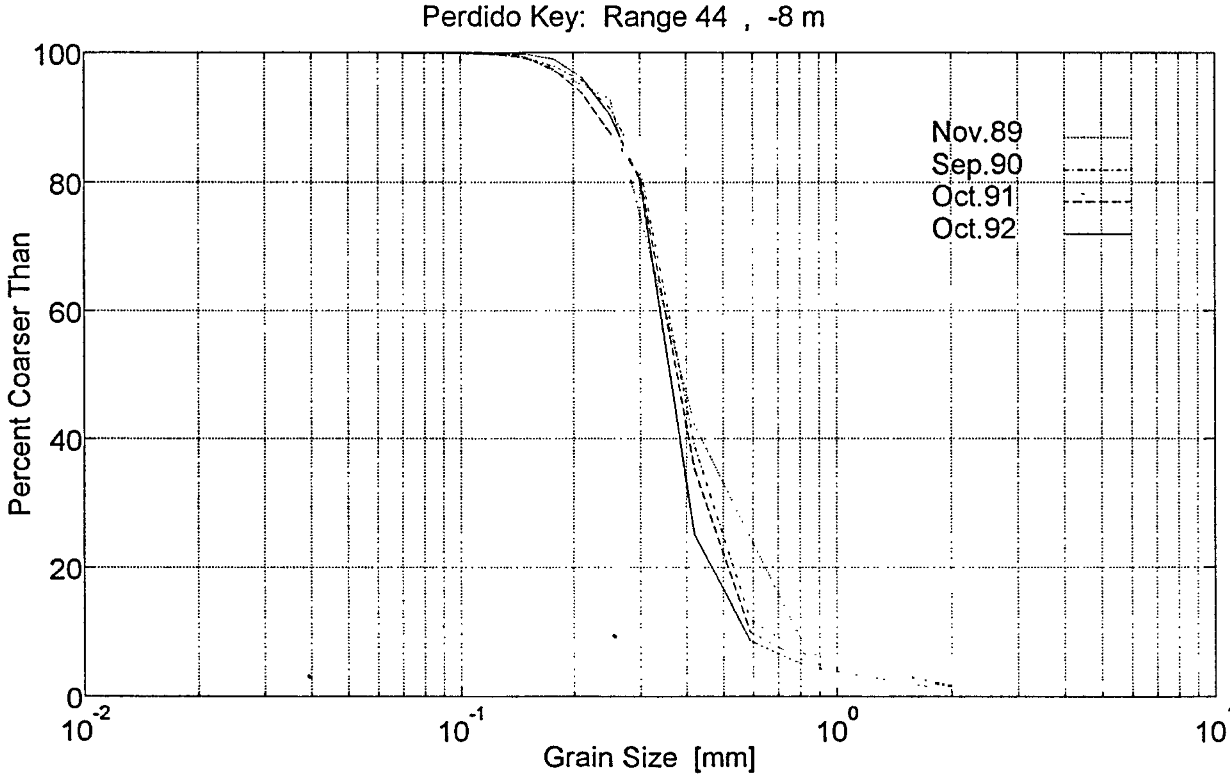
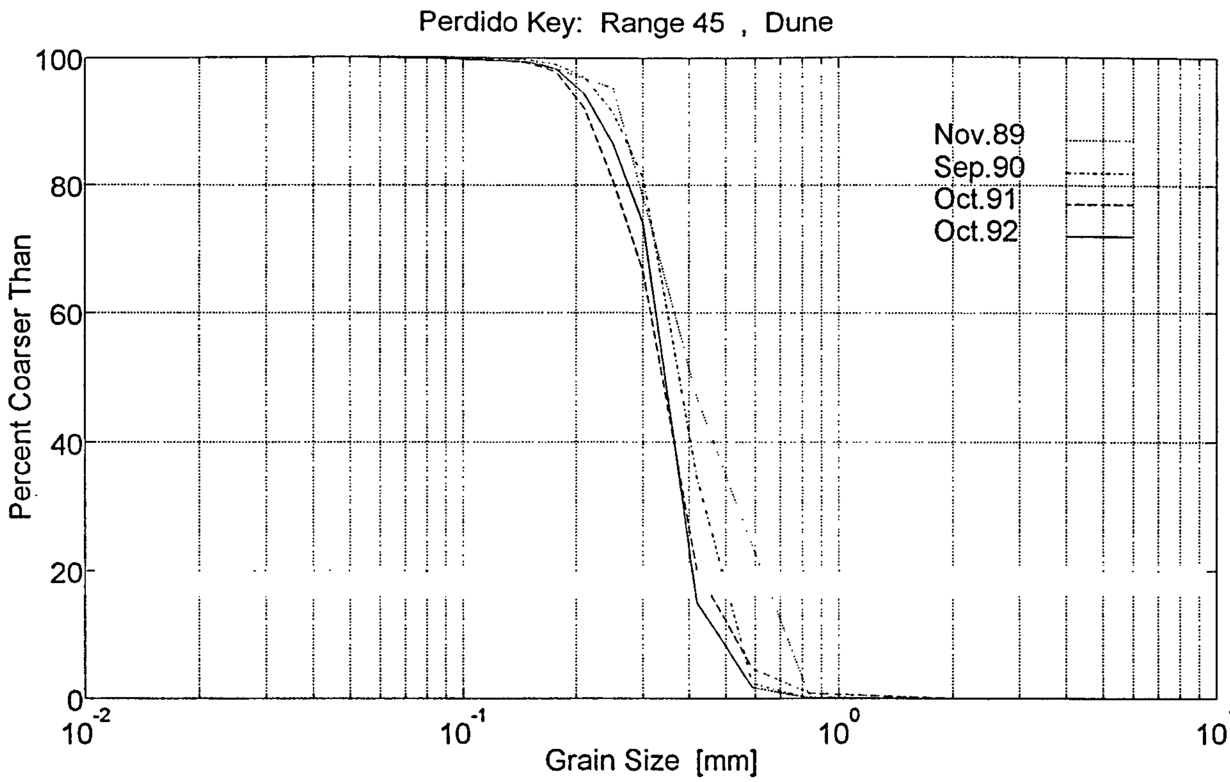


Figure III-36: Grain Size Distributions for Range 44, 5 M Depth and 8 M Depth Positions.



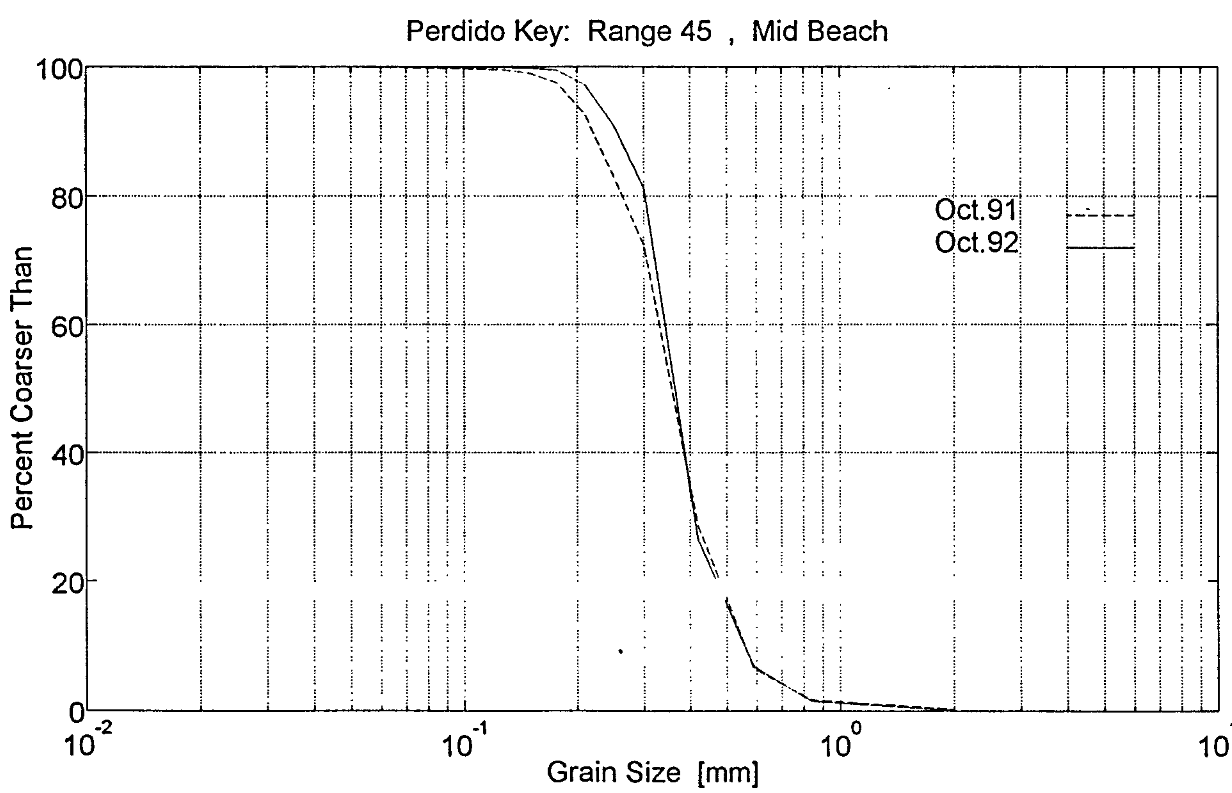
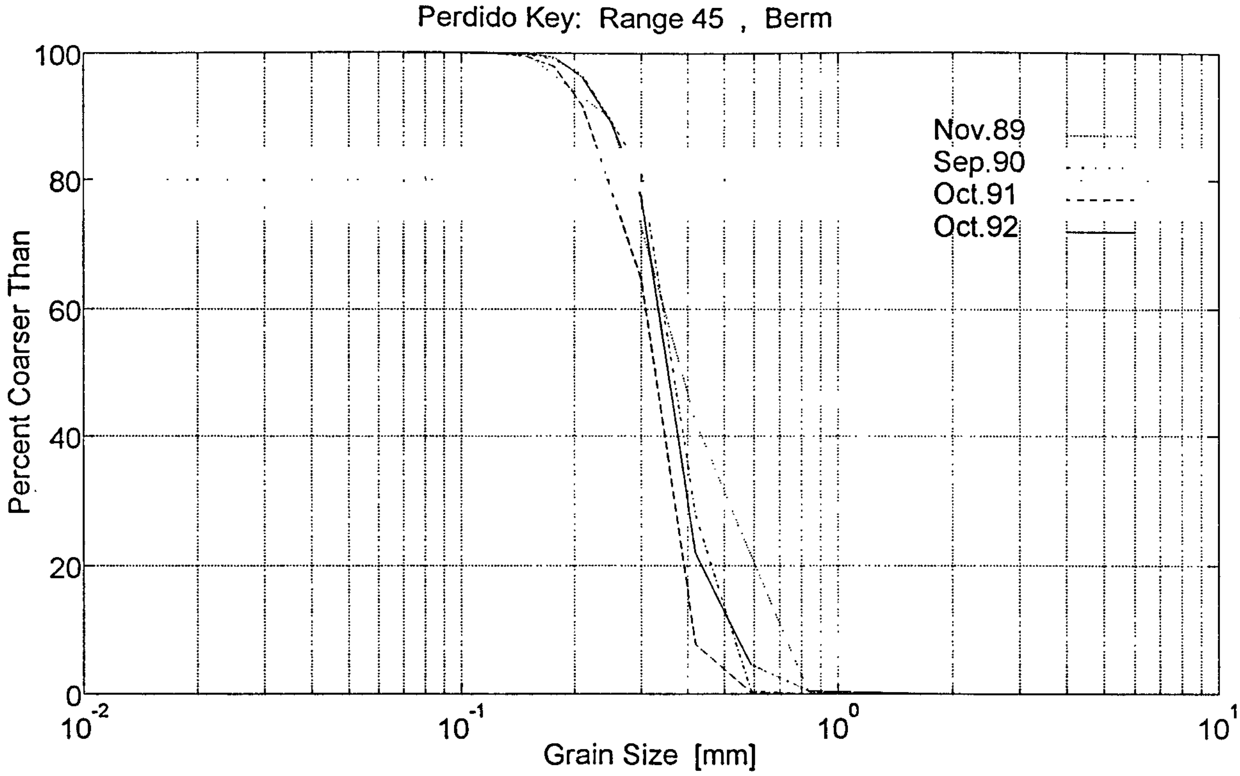


Figure III-37: Grain Size Distributions for Range 45, Dune and Mid-Beach Positions.



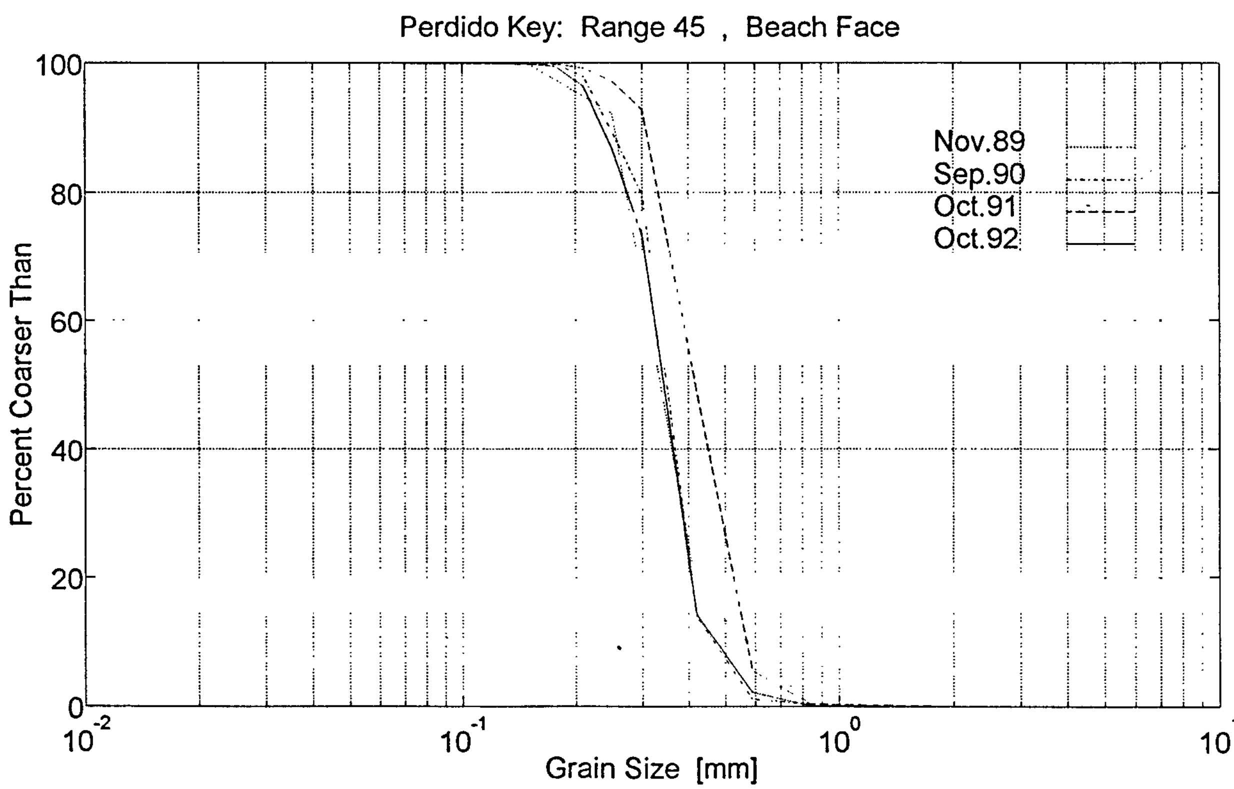
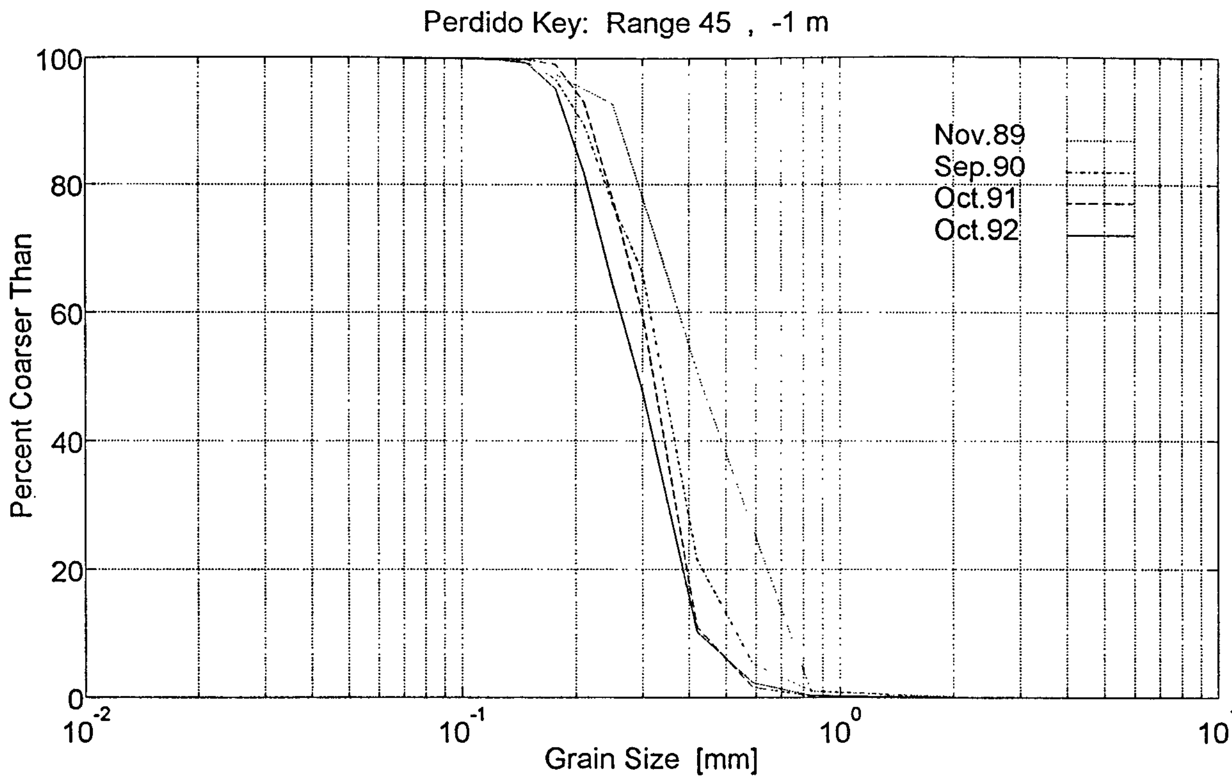


Figure III-38: Grain Size Distributions for Range 45, Berm and Beach Face Positions.



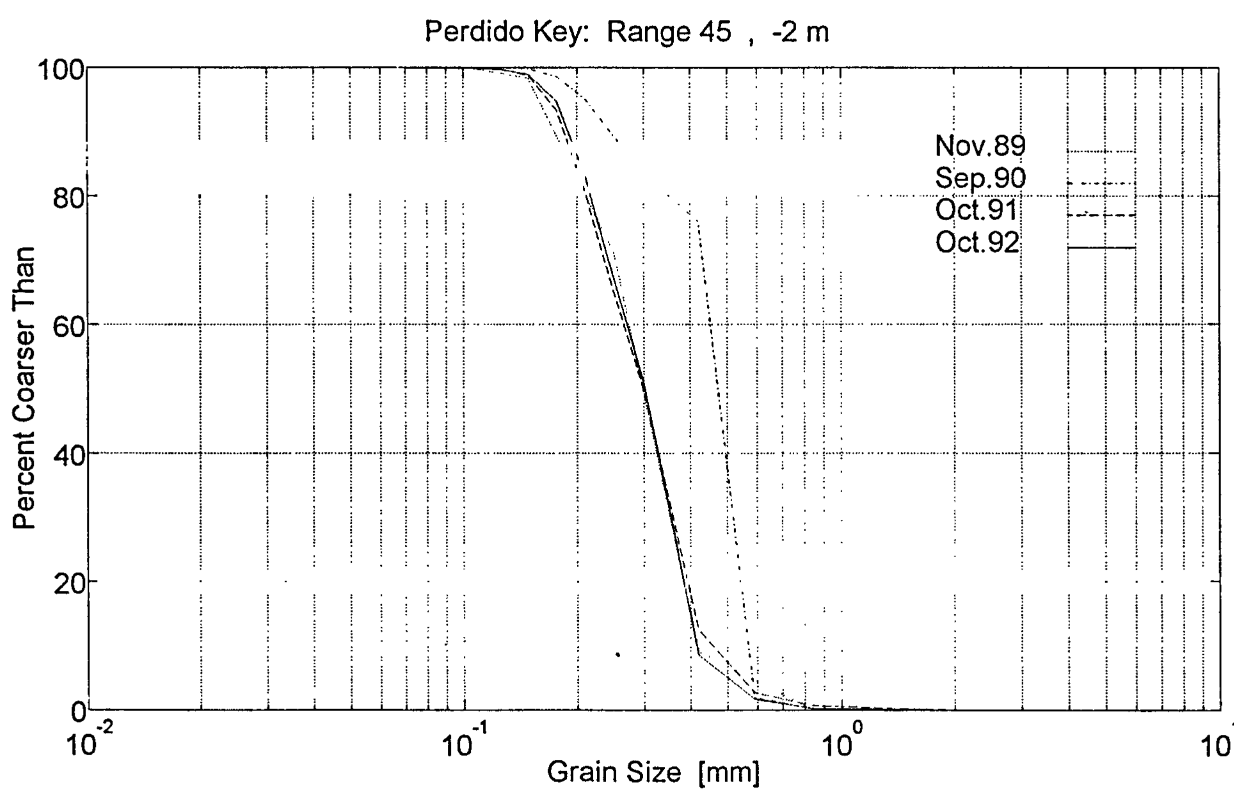


Figure III-39: Grain Size Distributions for Range 45, 1 M Depth and 2 M Depth Positions.

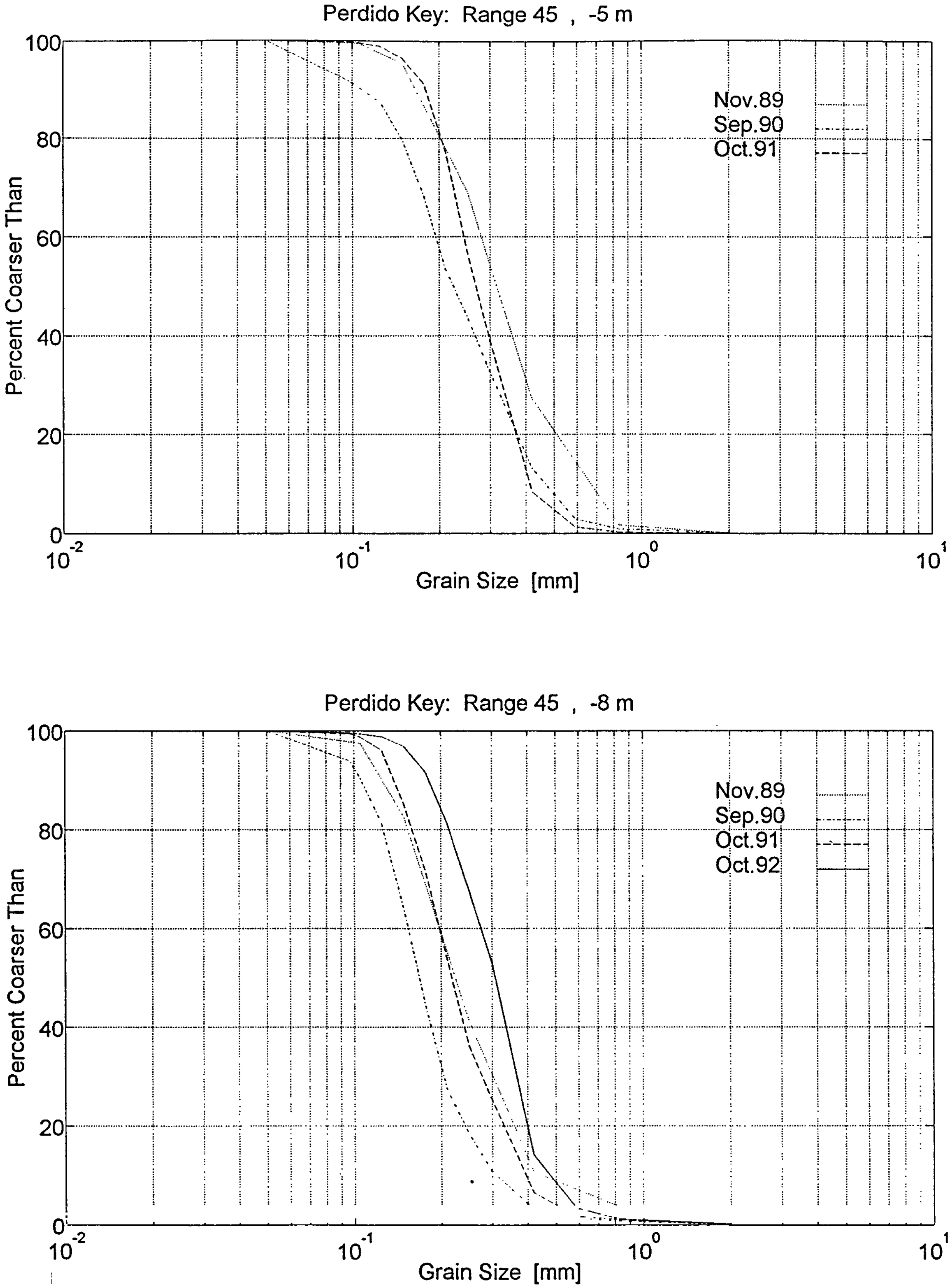
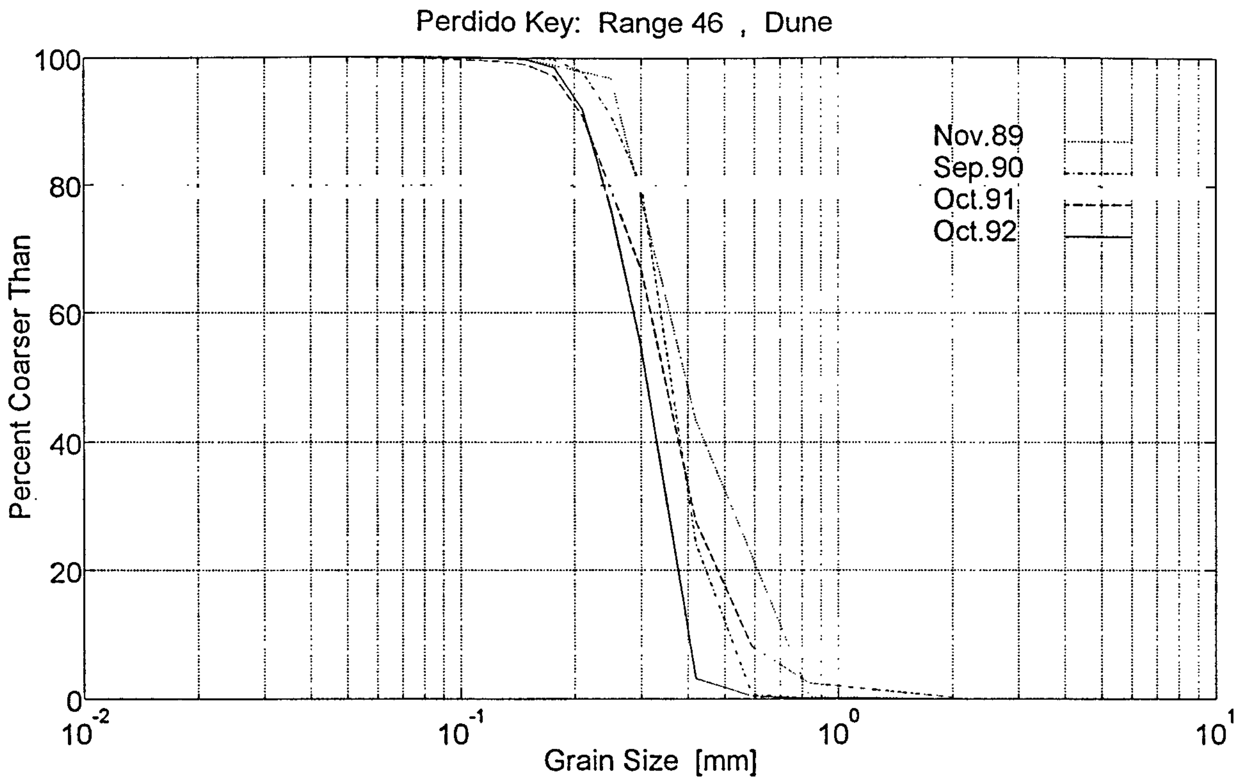


Figure III-40: Grain Size Distributions for Range 45, 5 M Depth and 8 M Depth Positions.



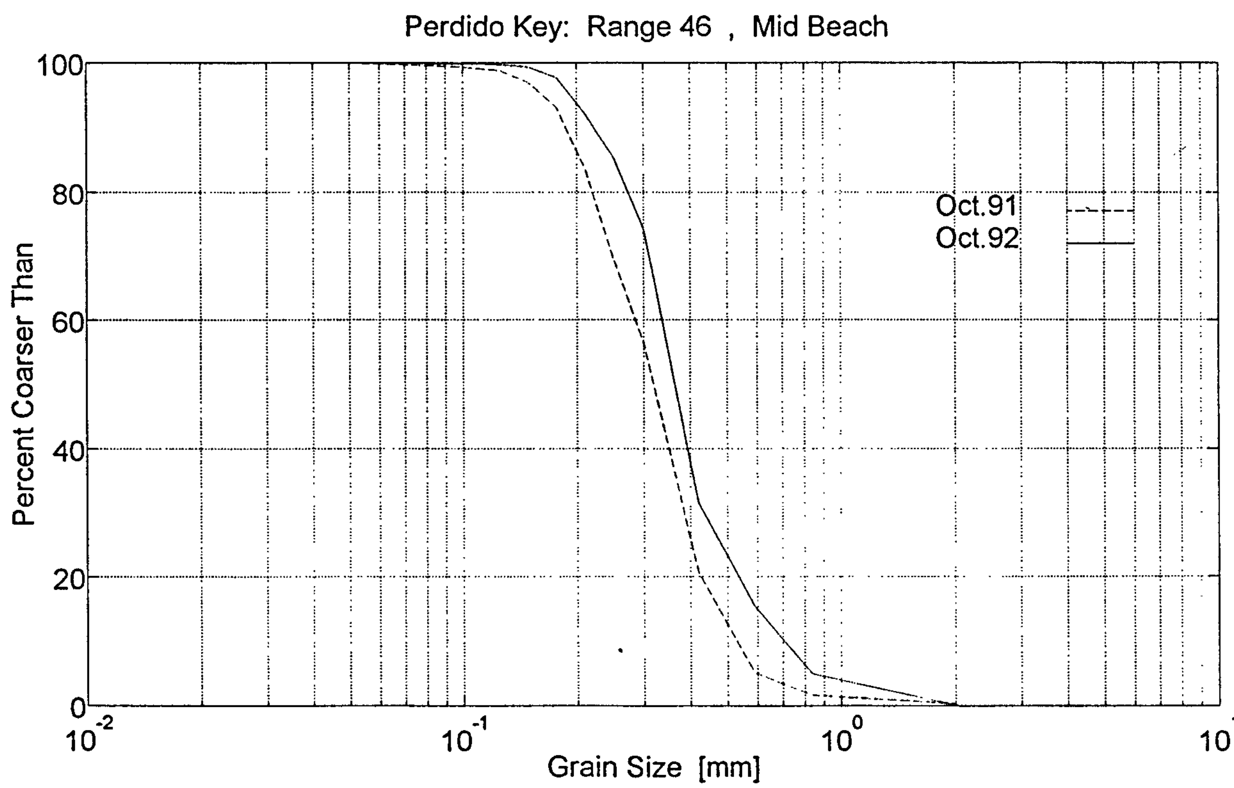
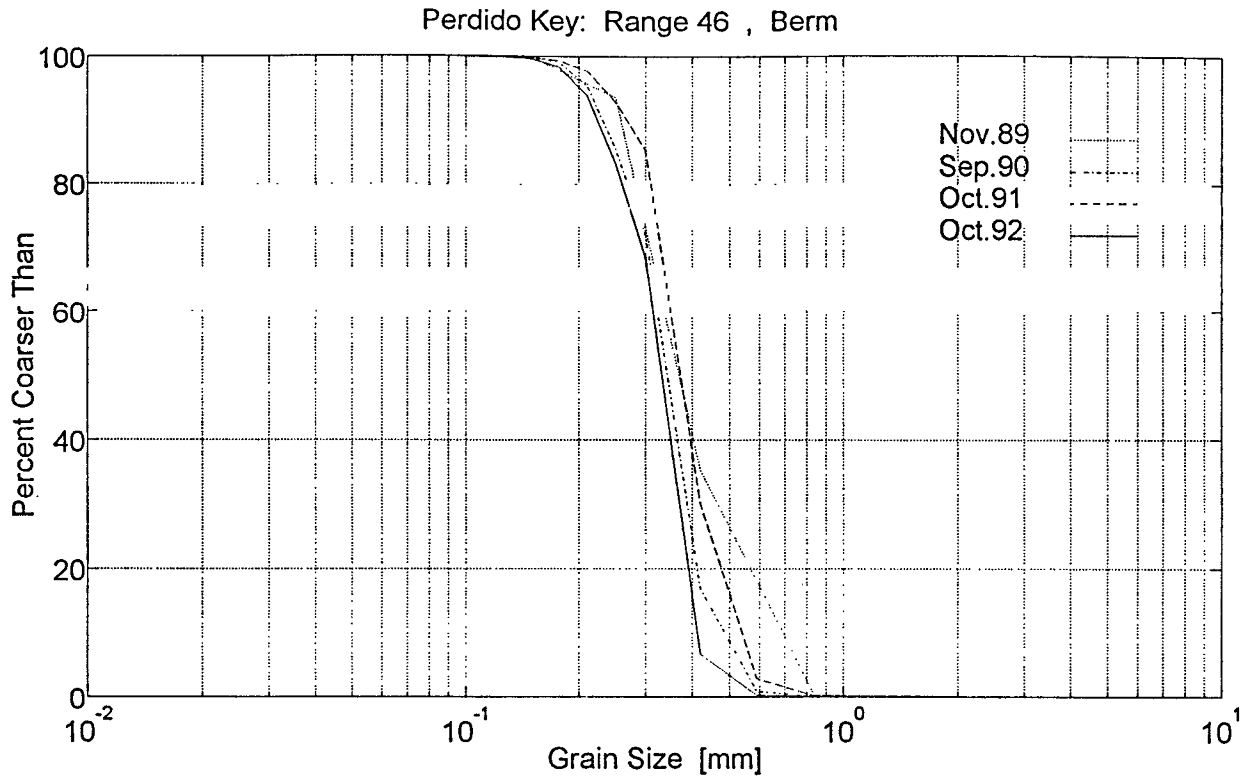


Figure III-41: Grain Size Distributions for Range 46, Dune and Mid-Beach Positions.



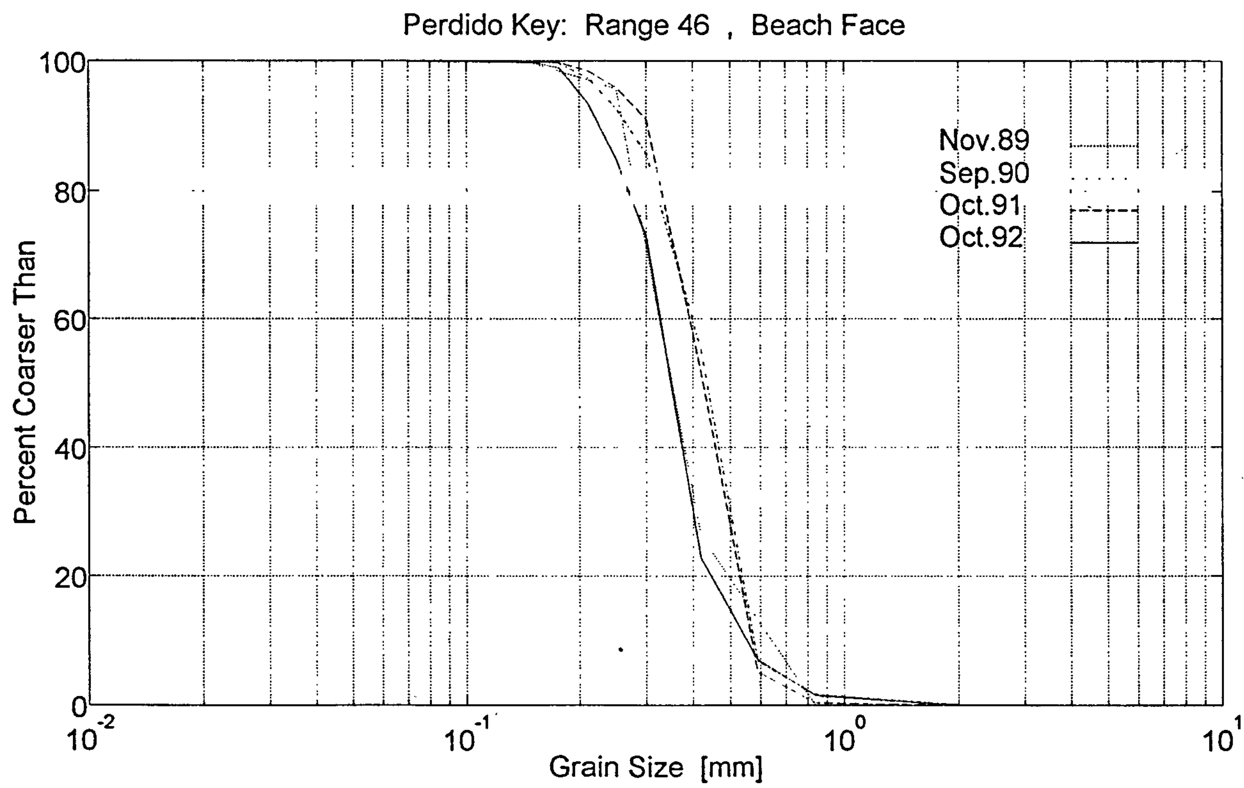
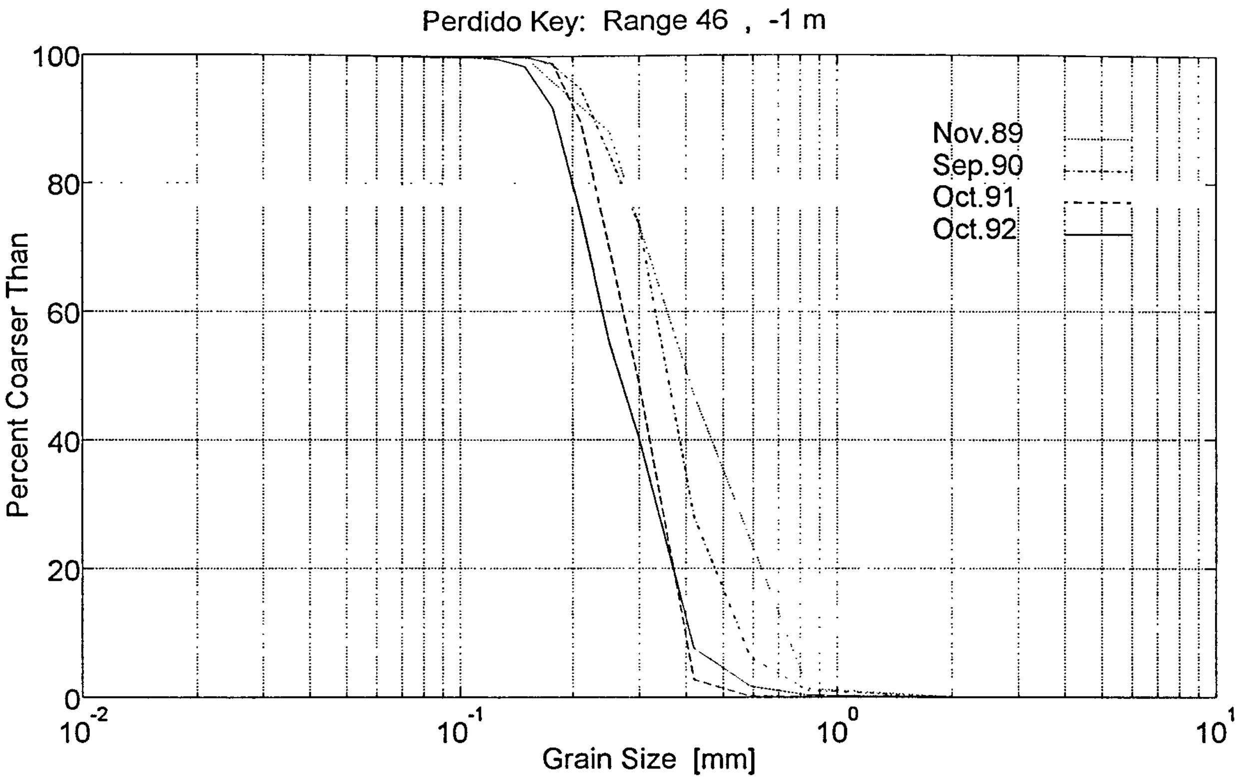


Figure III-42: Grain Size Distributions for Range 46, Berm and Beach Face Positions.



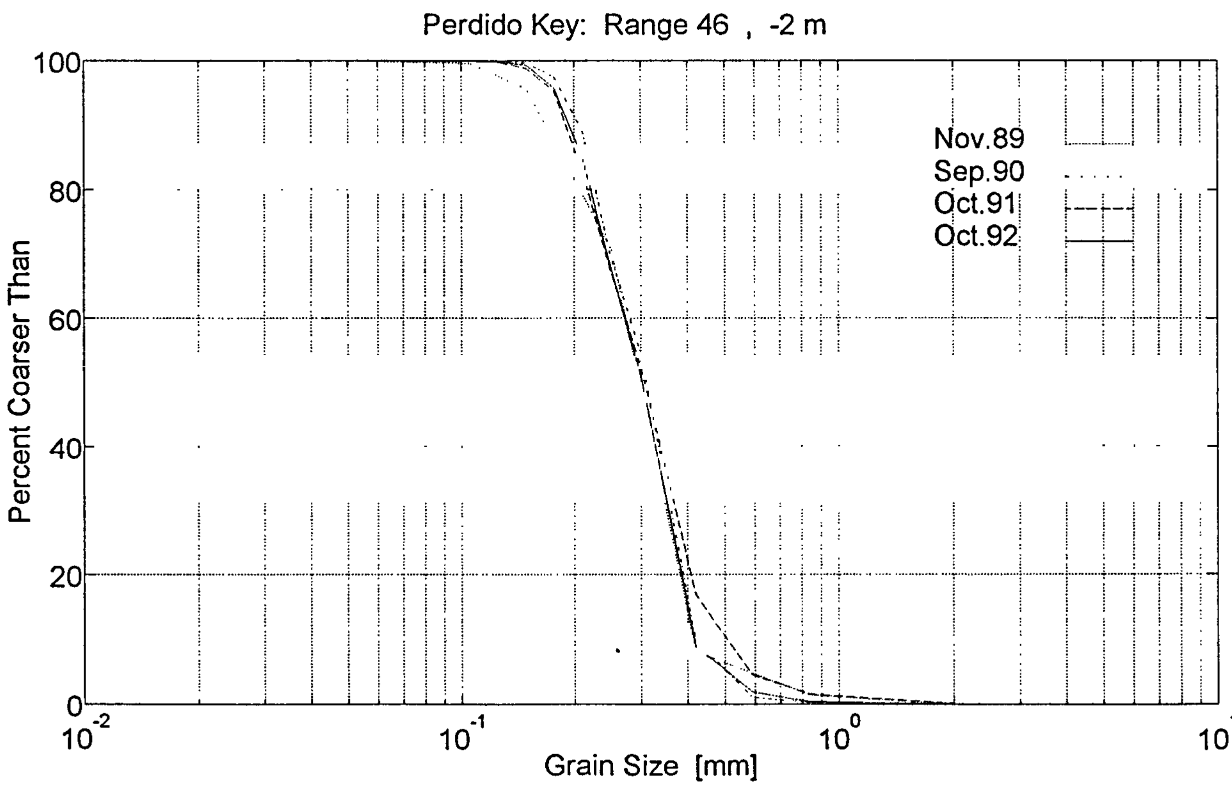
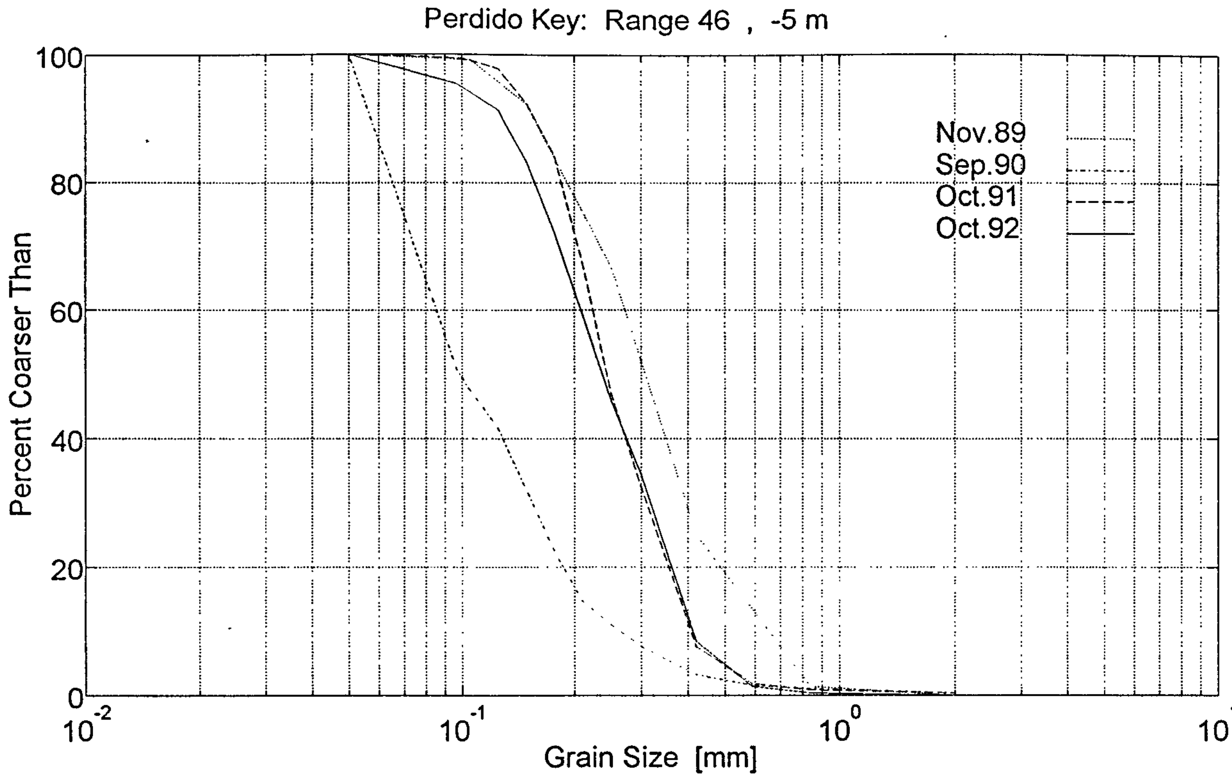


Figure III-43: Grain Size Distributions for Range 46, 1 M Depth and 2 M Depth Positions.



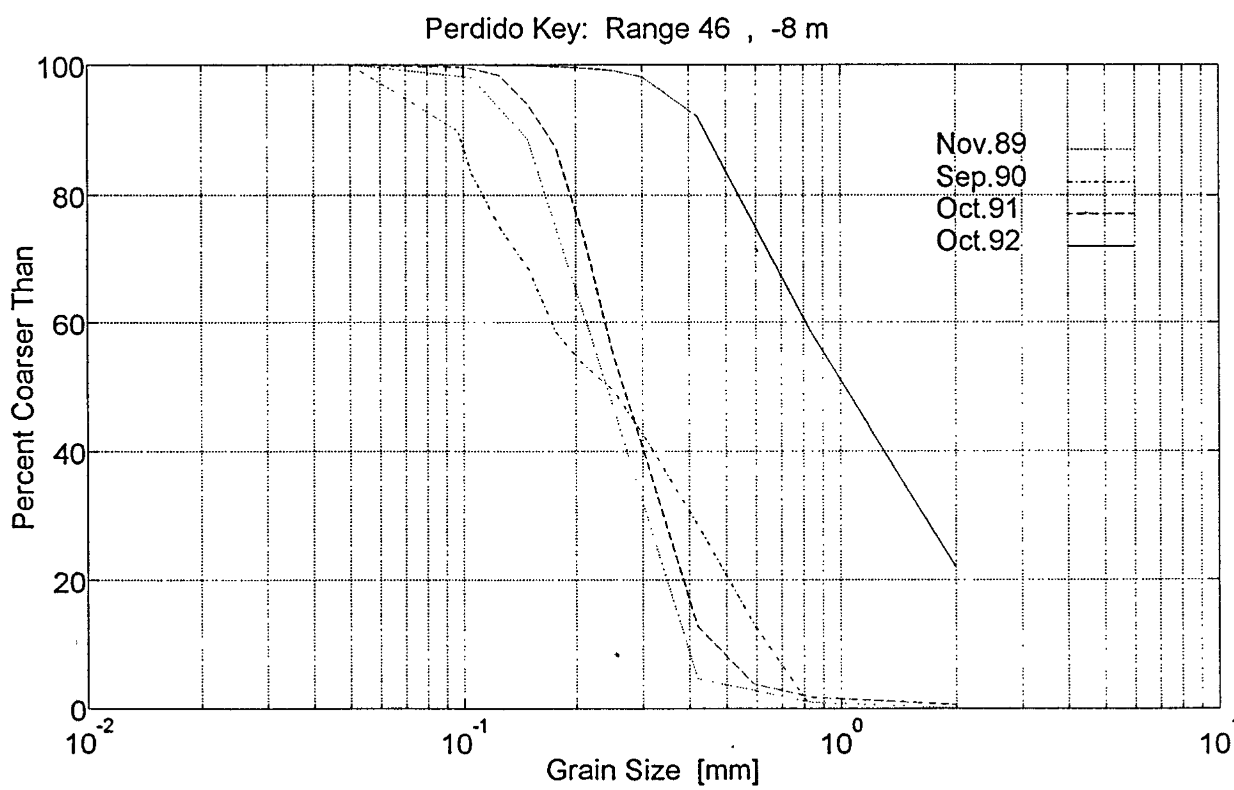
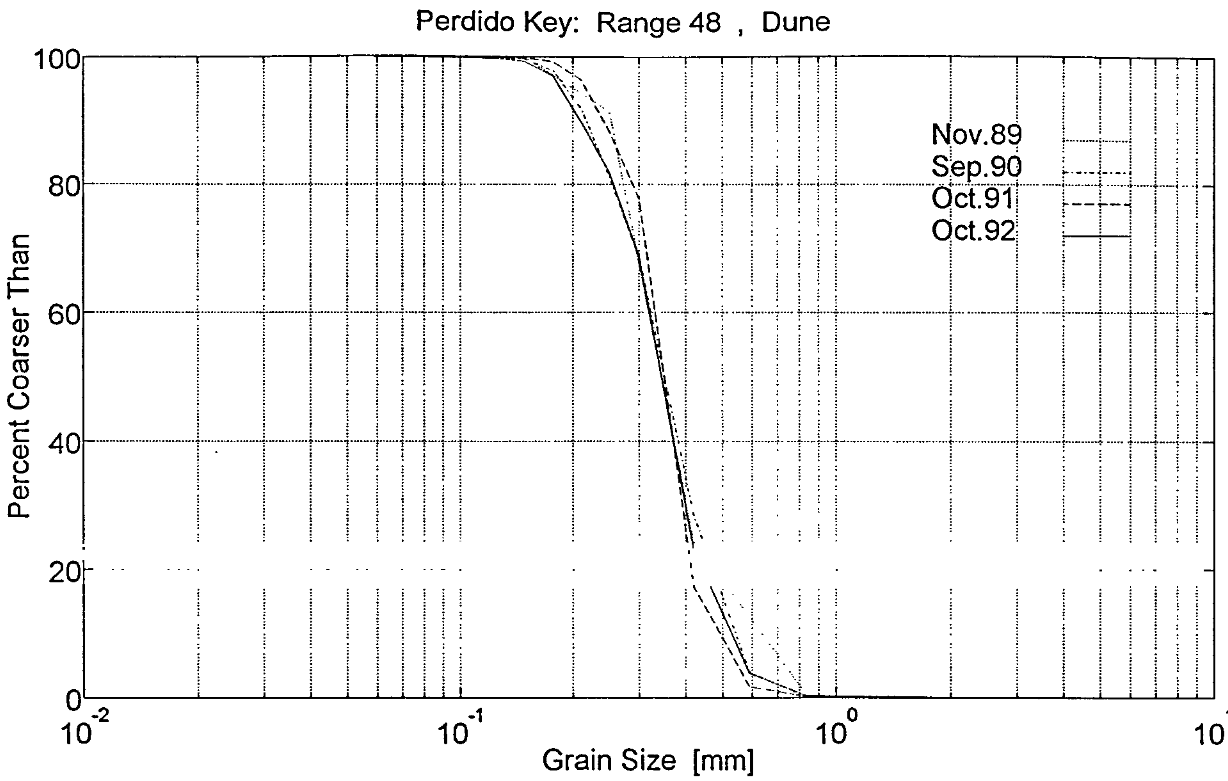


Figure III-44: Grain Size Distributions for Range 46, 5 M Depth and 8 M Depth Positions.



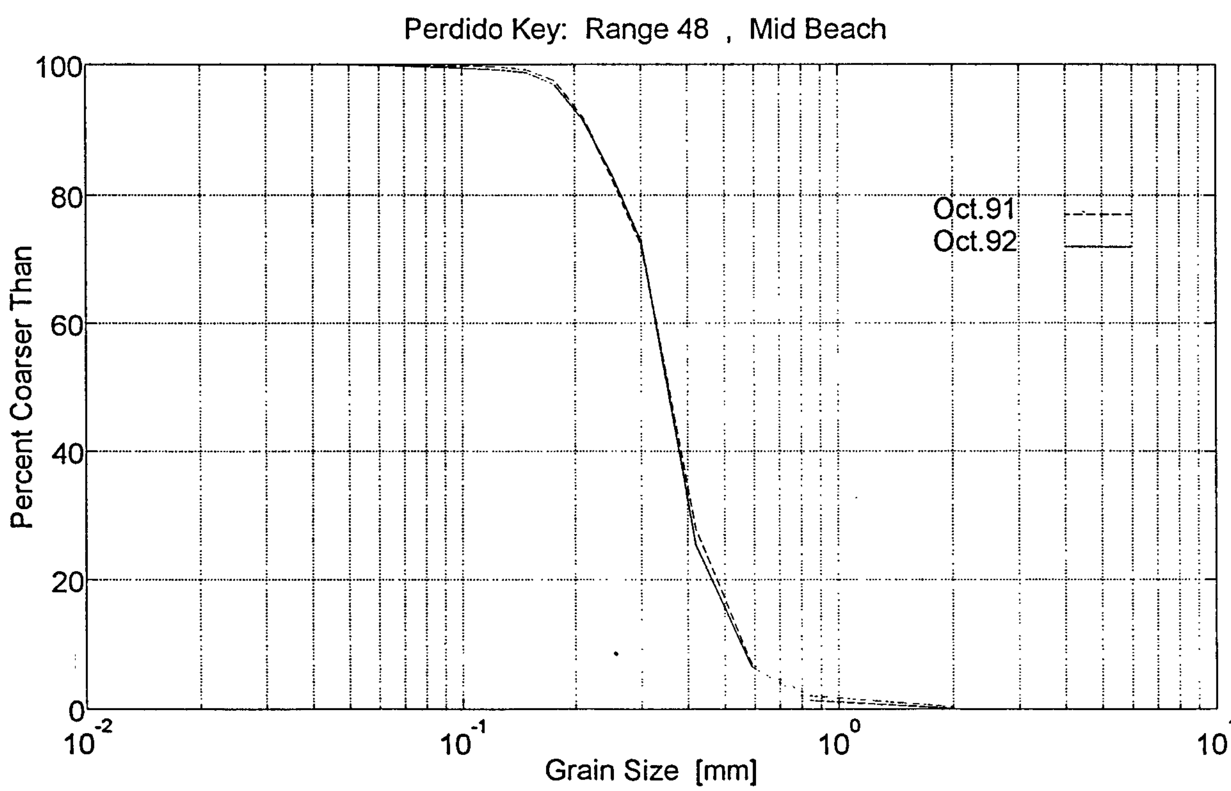
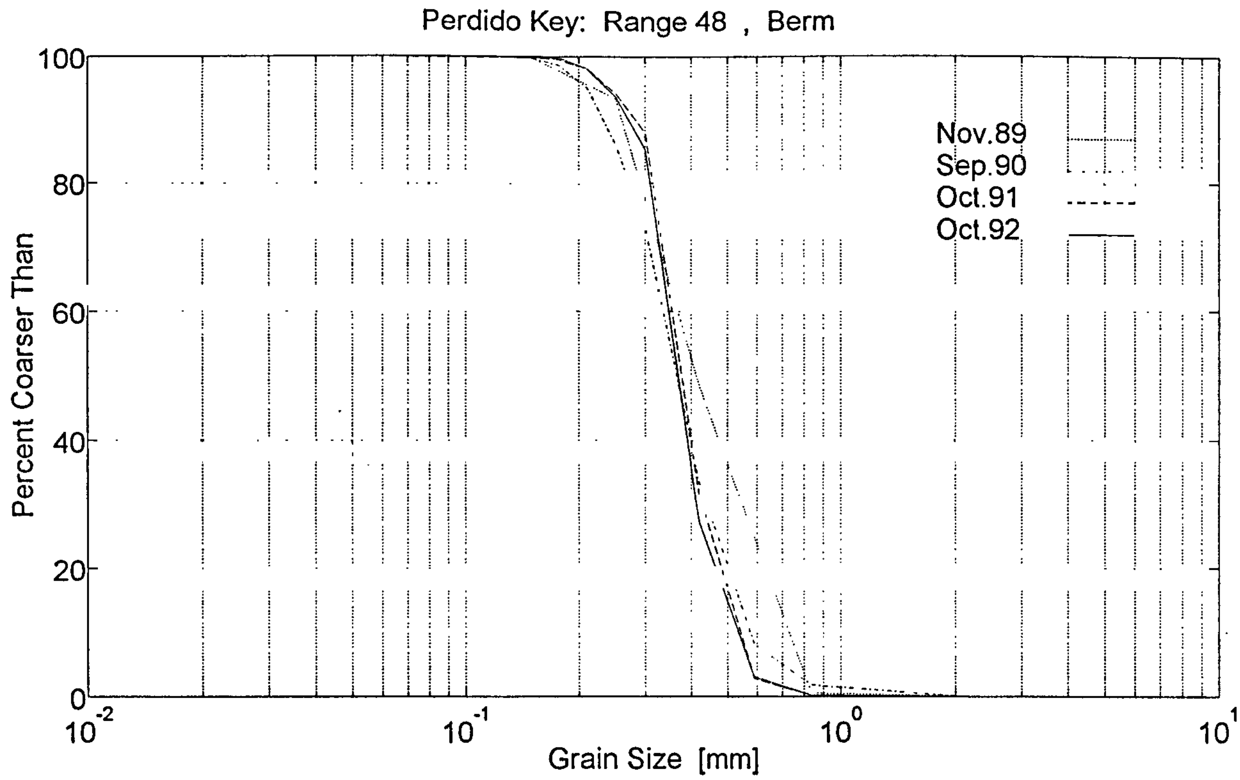


Figure III-45: Grain Size Distributions for Range 48, Dune and Mid-Beach Positions.



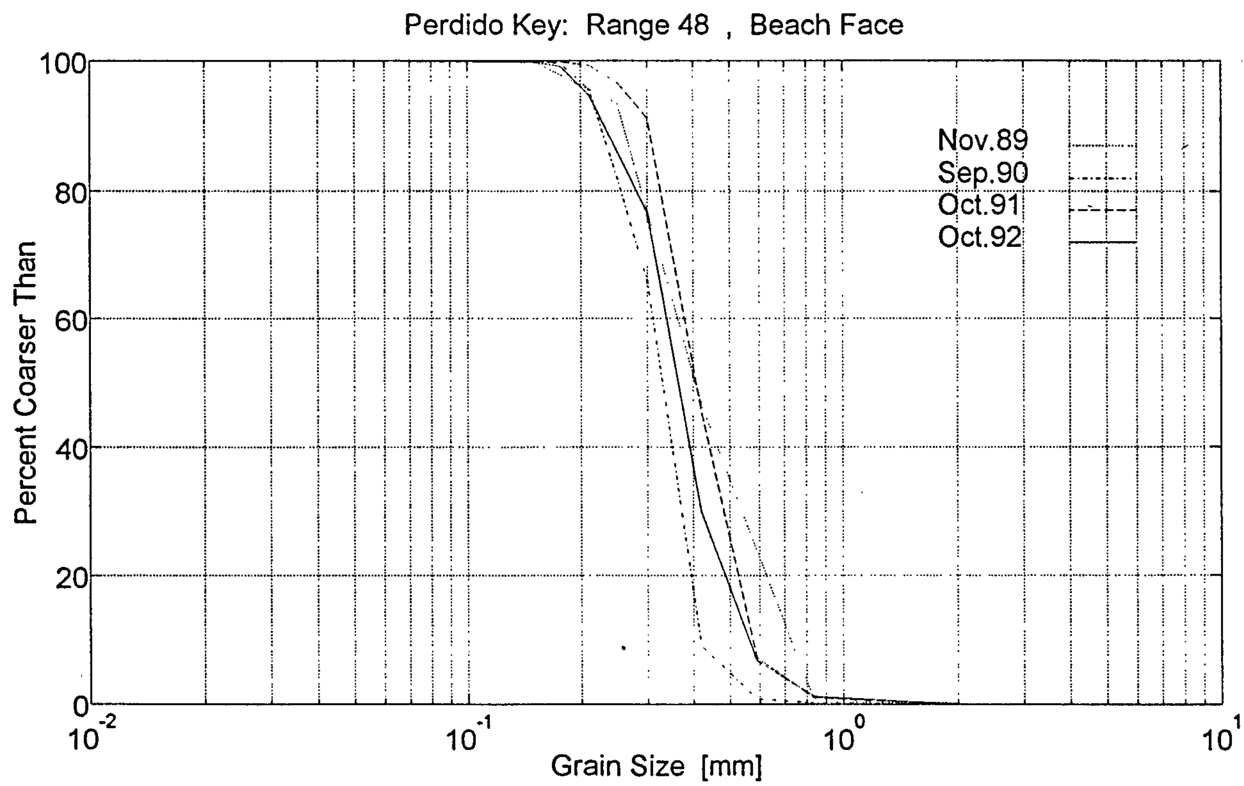
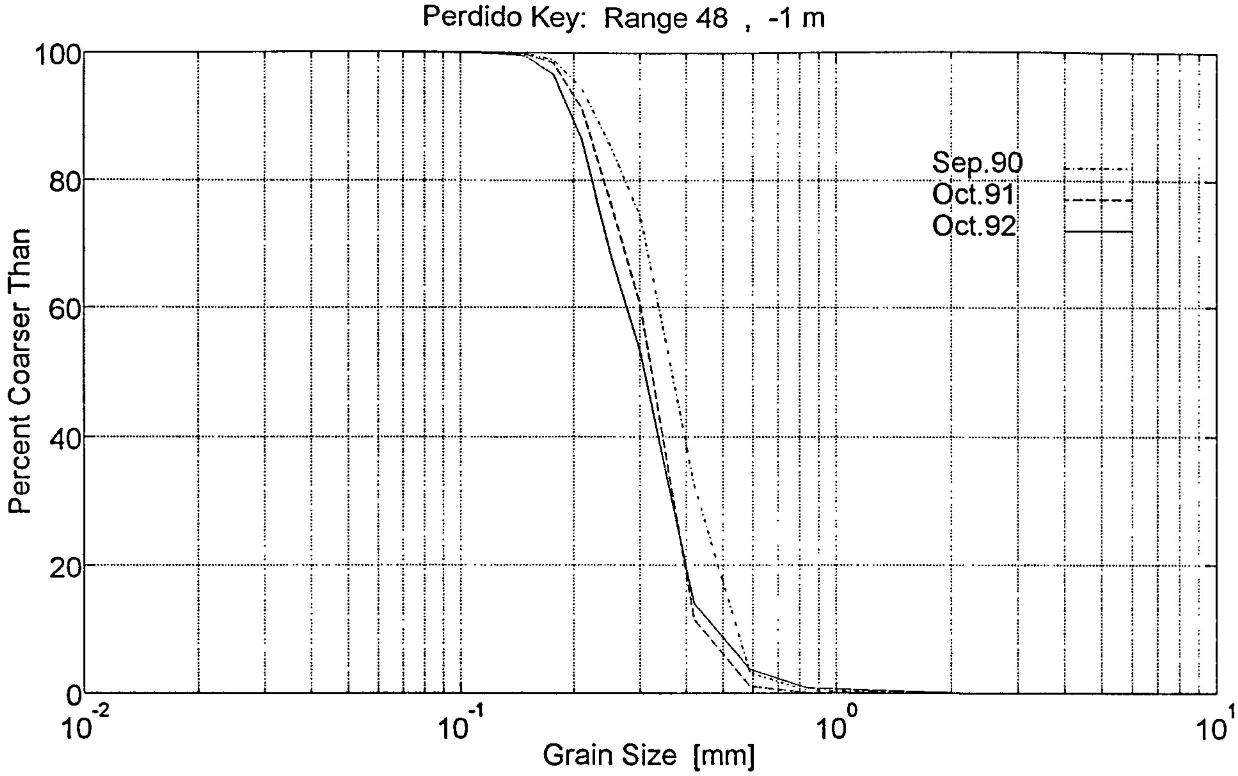


Figure III-46: Grain Size Distributions for Range 48, Berm and Beach Face Positions.



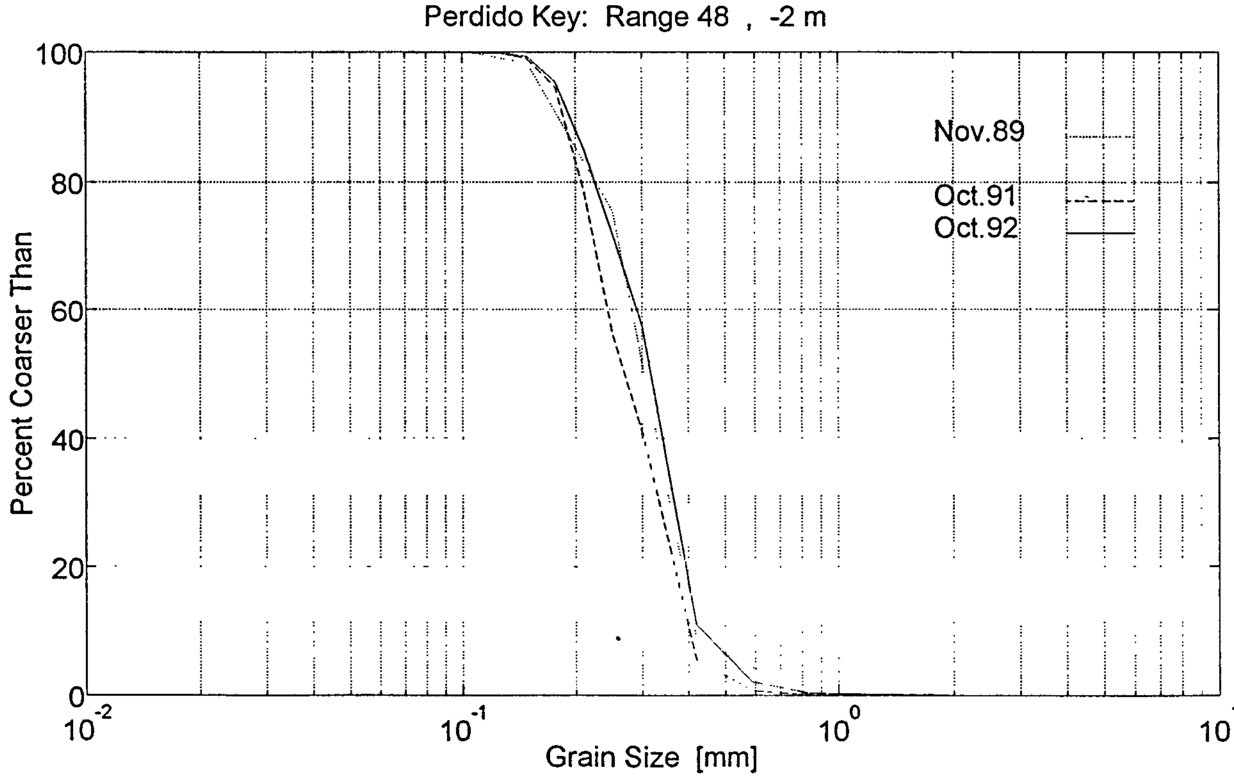
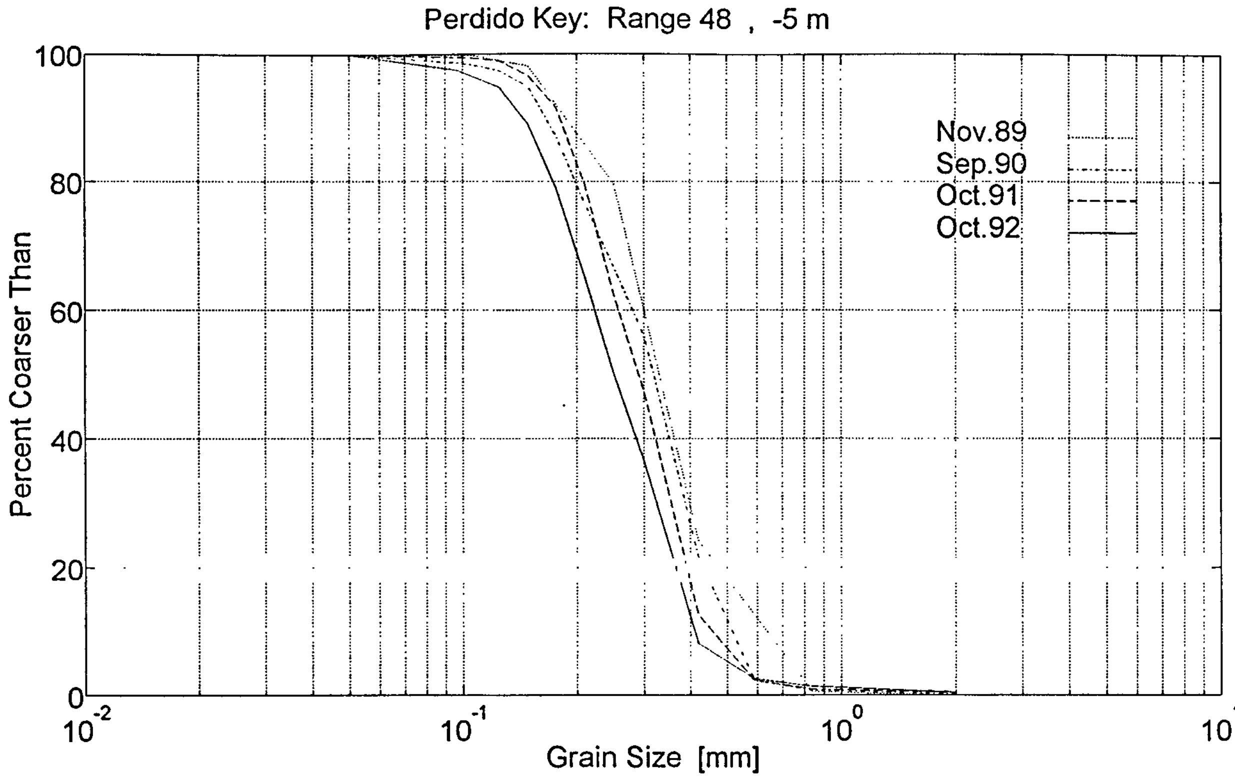


Figure III-47: Grain Size Distributions for Range 48, 1 M Depth and 2 M Depth Positions.



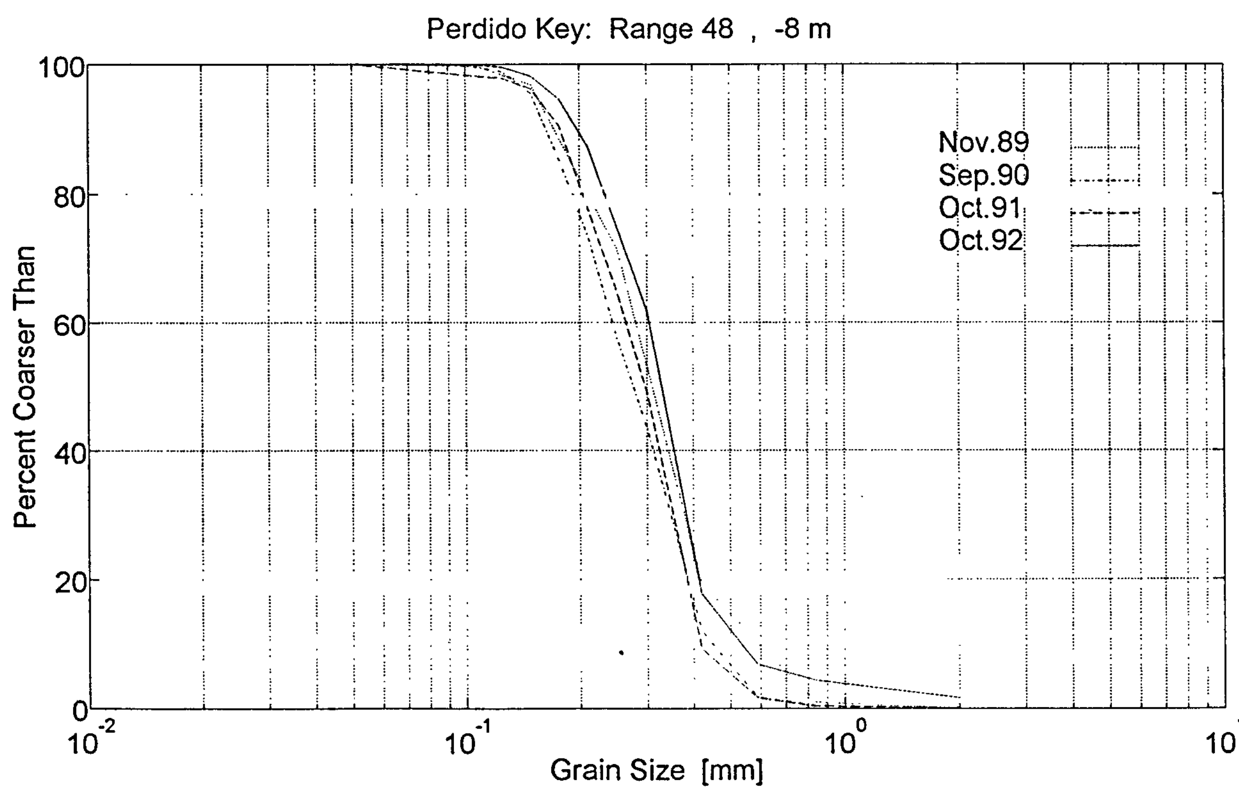
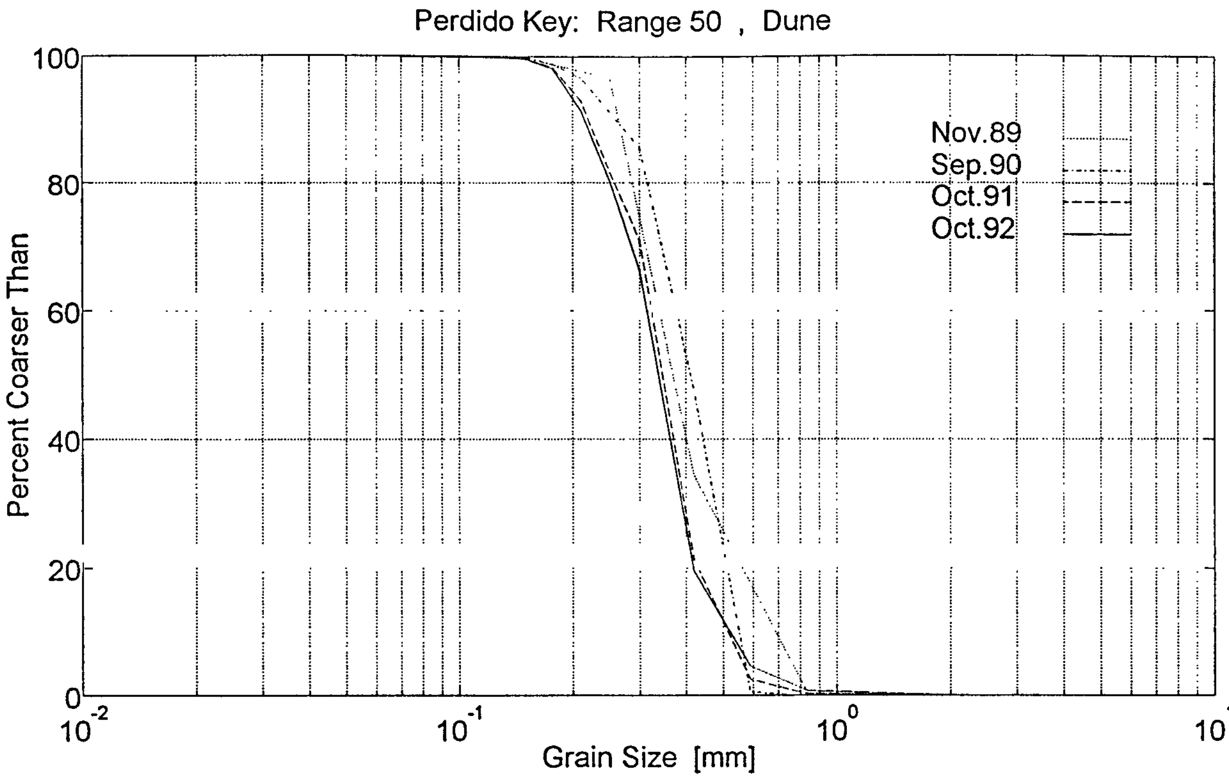


Figure III-48: Grain Size Distributions for Range 48, 5 M Depth and 8 M Depth Positions.



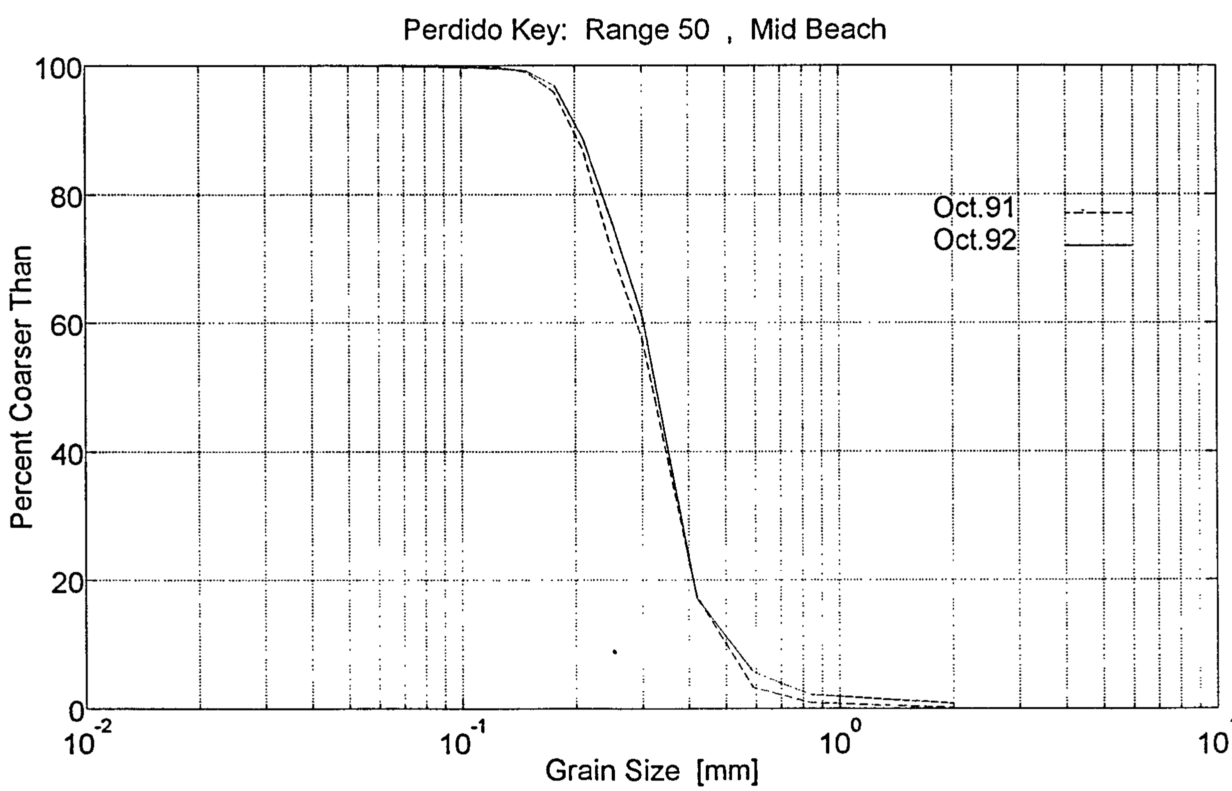
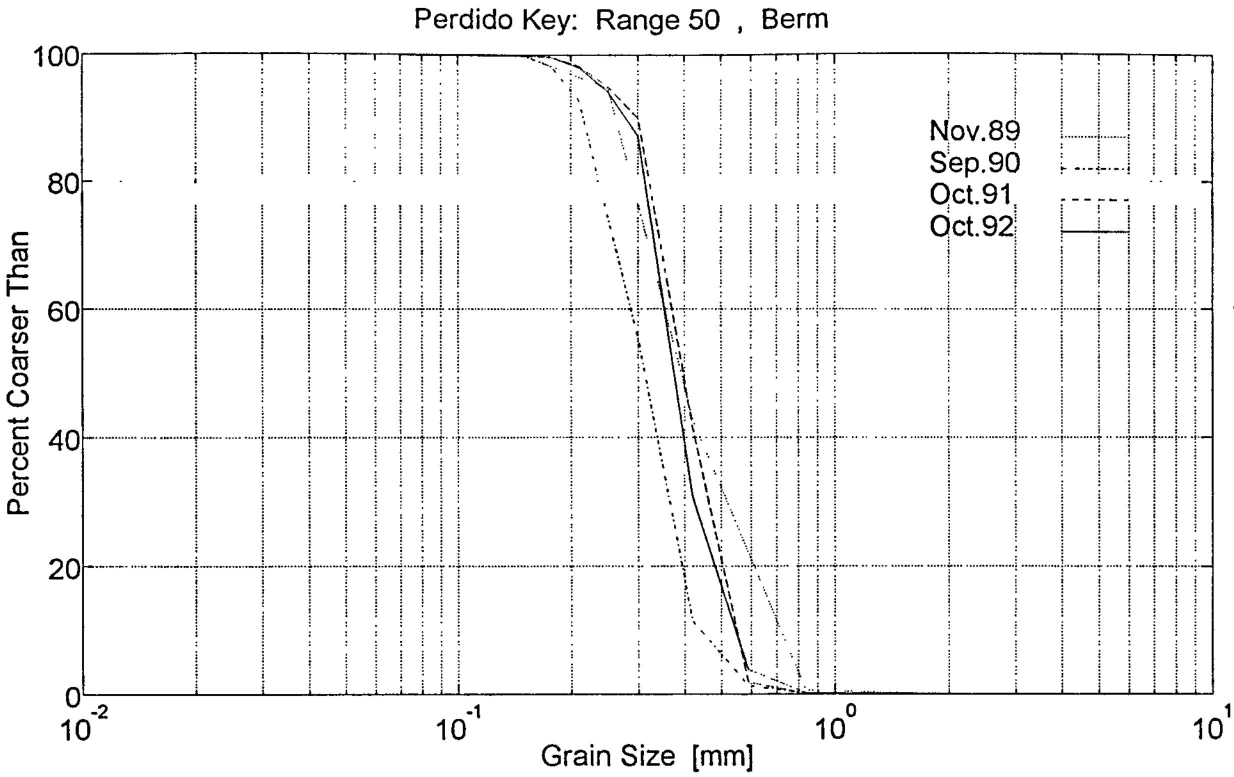


Figure III-49: Grain Size Distributions for Range 50, Dune and Mid-Beach Positions.



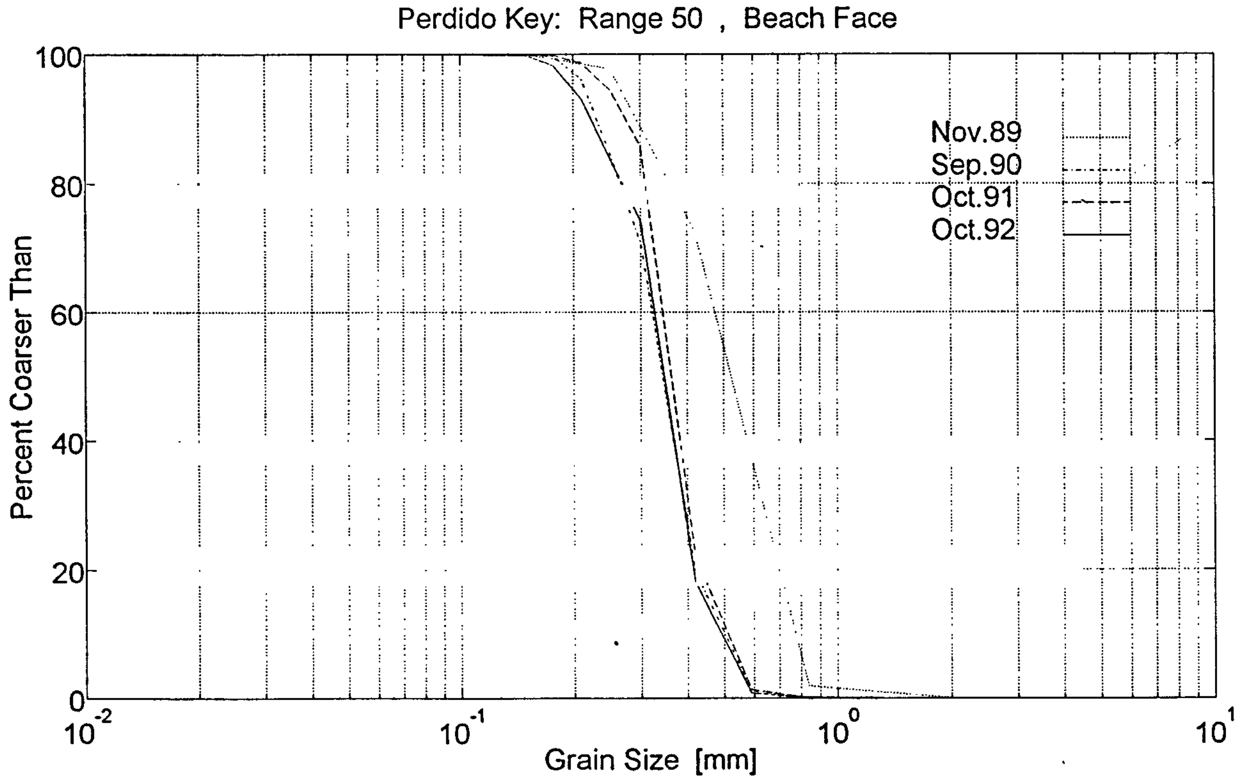
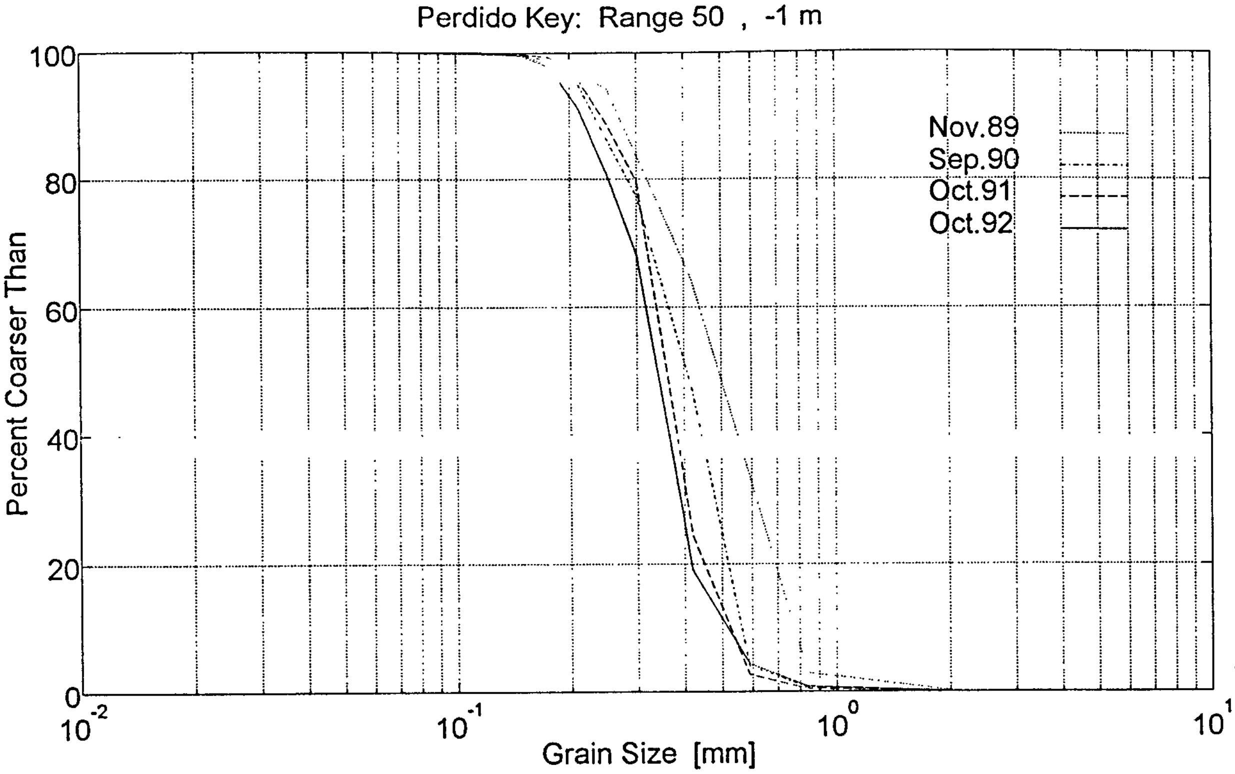


Figure III-50: Grain Size Distributions for Range 50, Berm and Beach Face Positions.



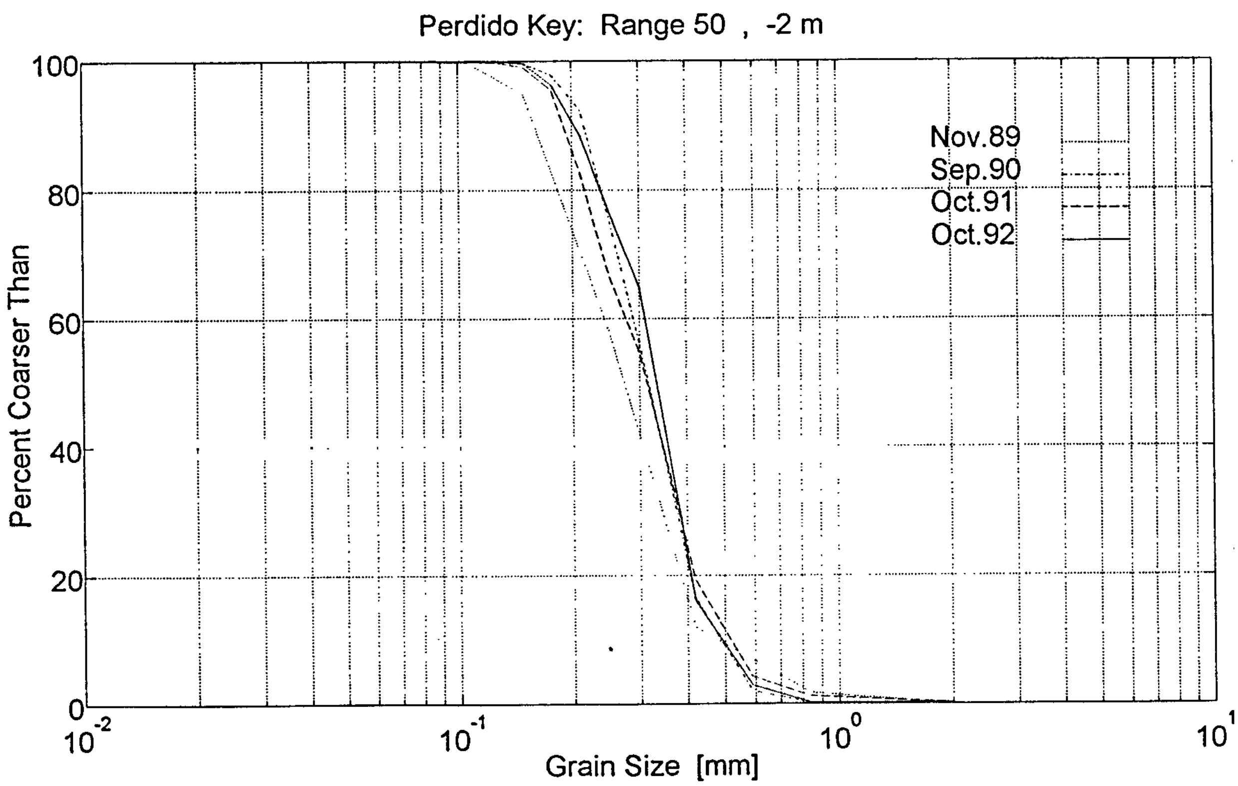
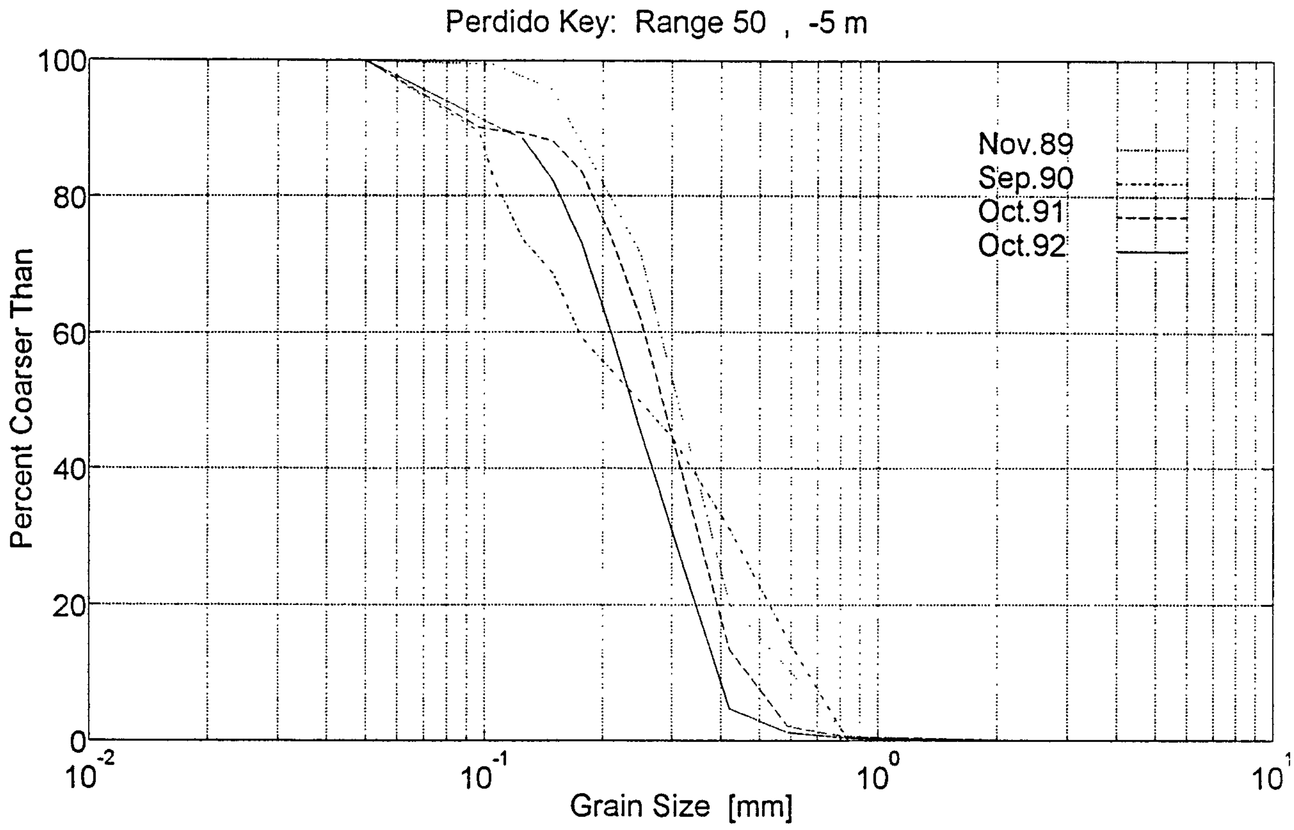


Figure III-51: Grain Size Distributions for Range 50, 1 M Depth and 2 M Depth Positions.



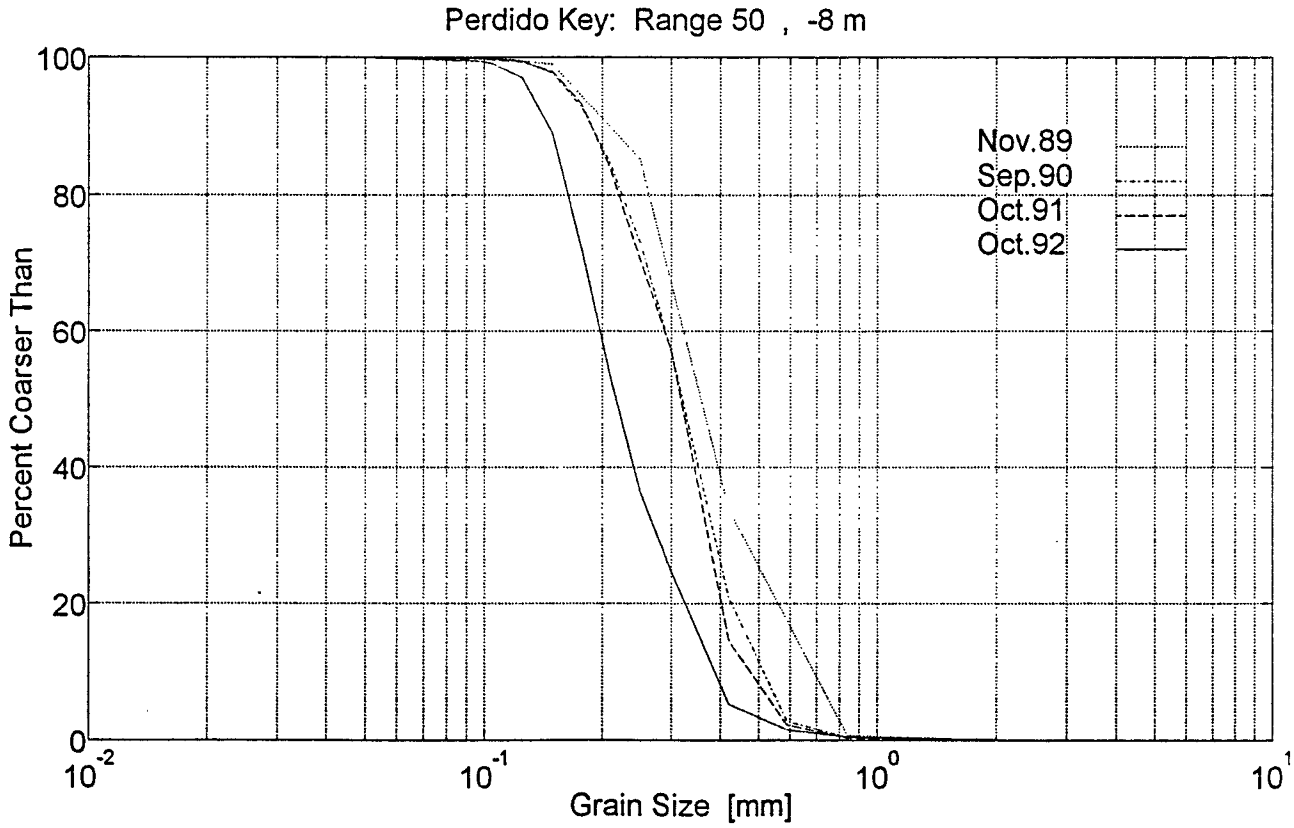
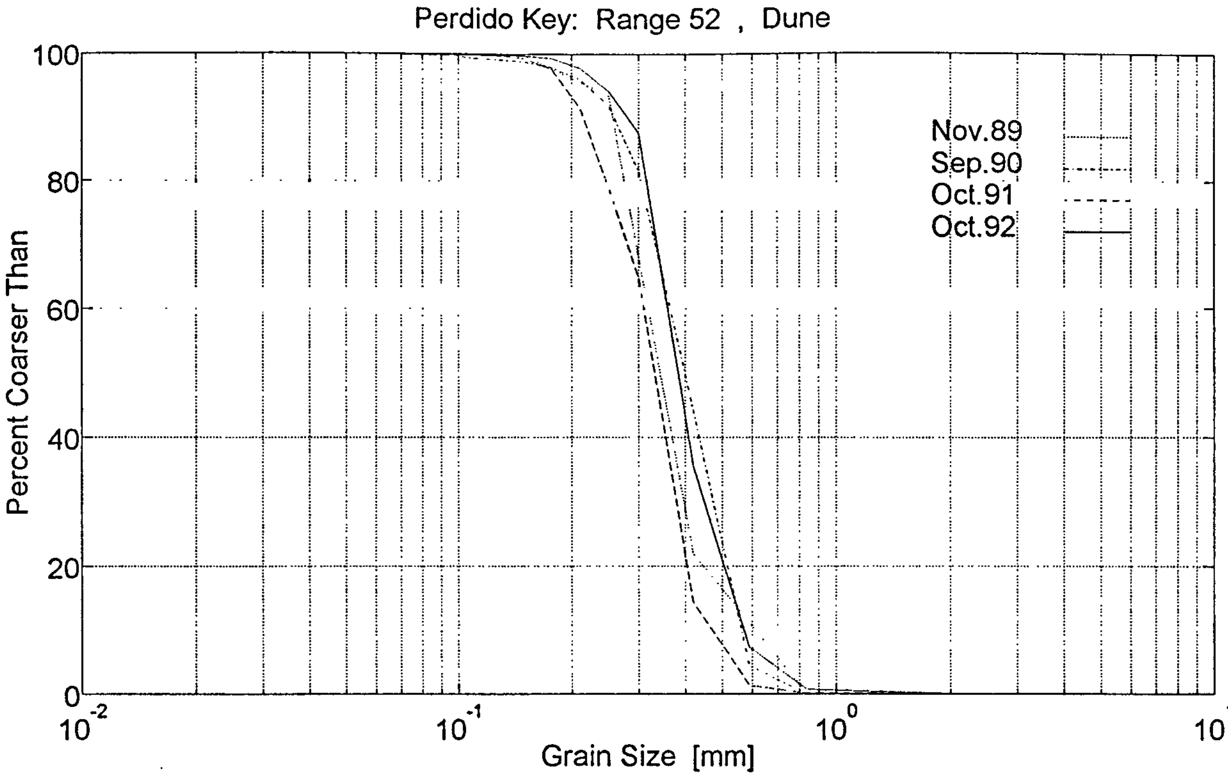


Figure III-52: Grain Size Distributions for Range 50, 5 M Depth and 8 M Depth Positions.



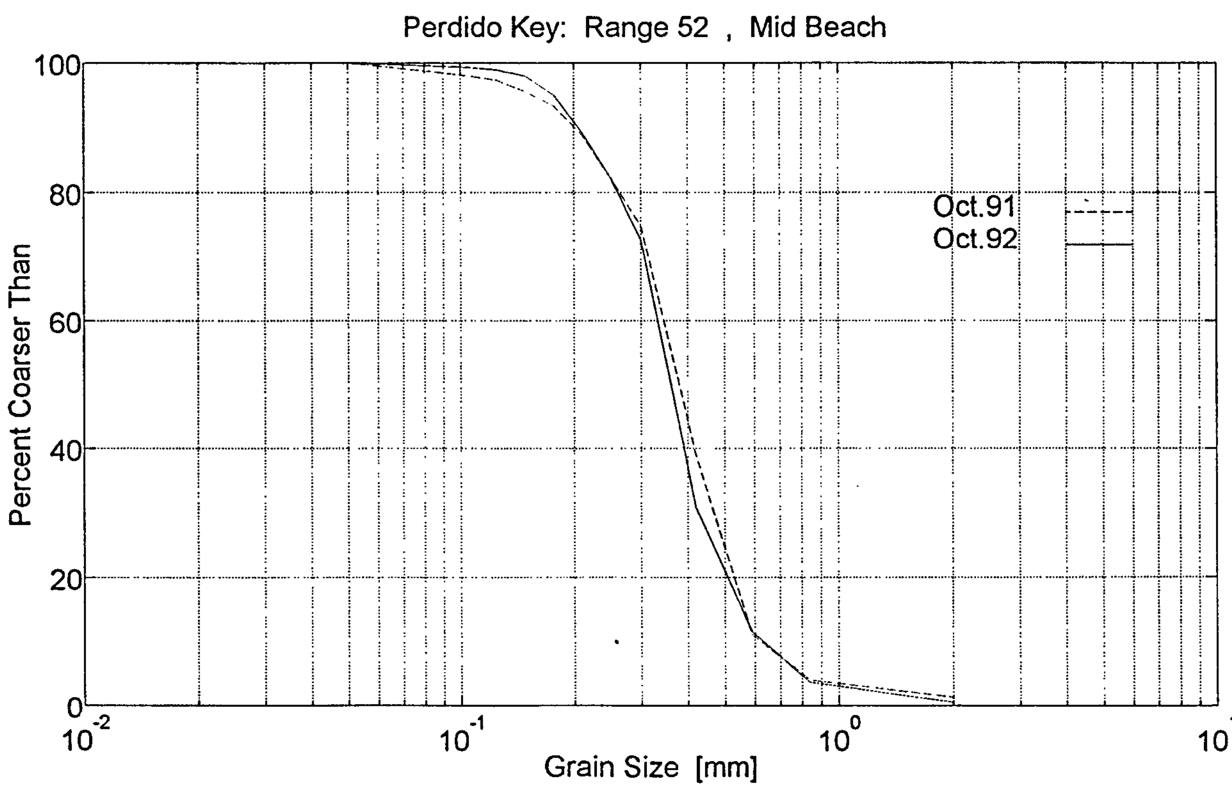
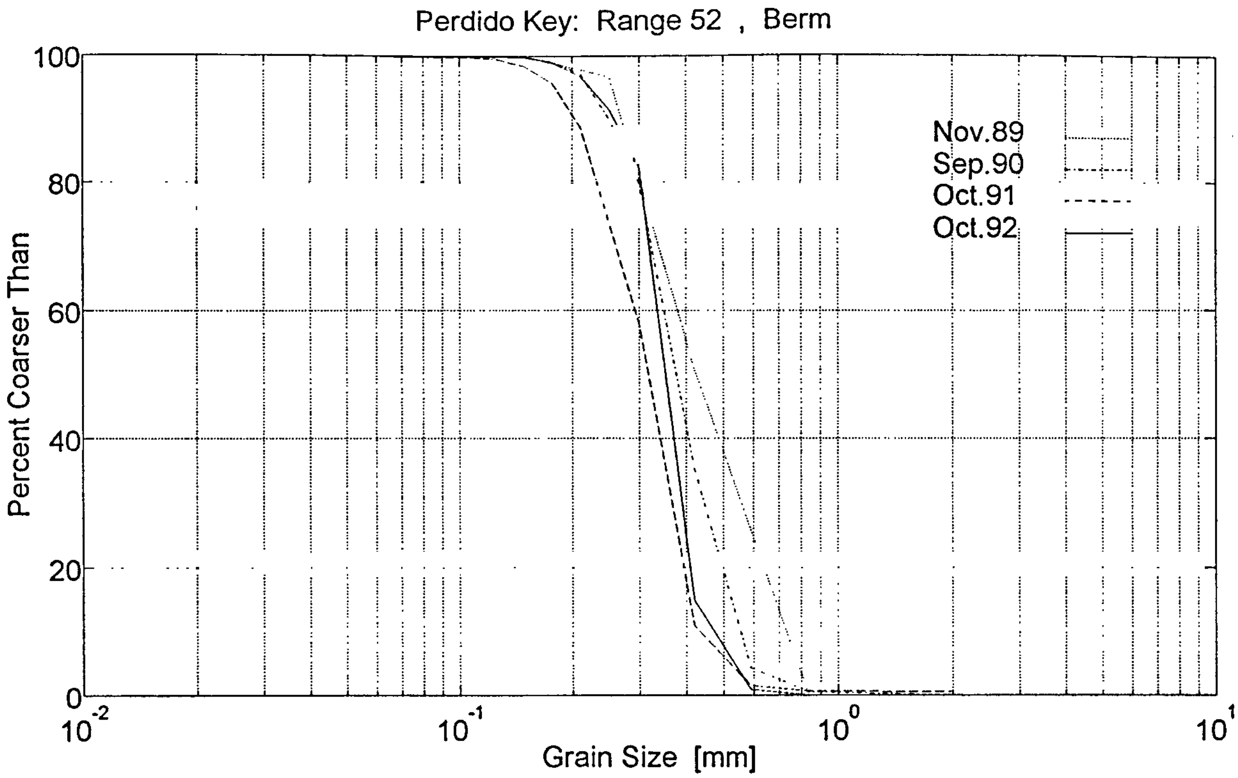


Figure III-53: Grain Size Distributions for Range 52, Dune and Mid-Beach Positions.



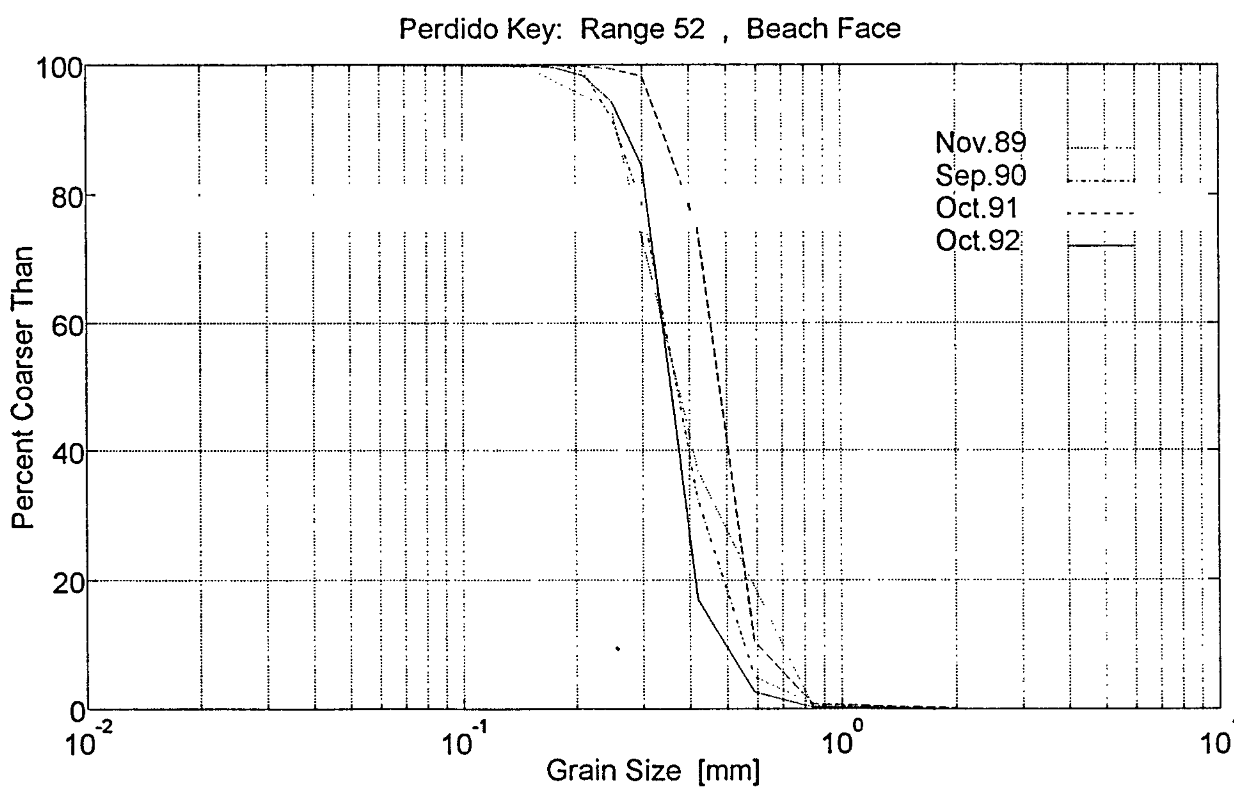
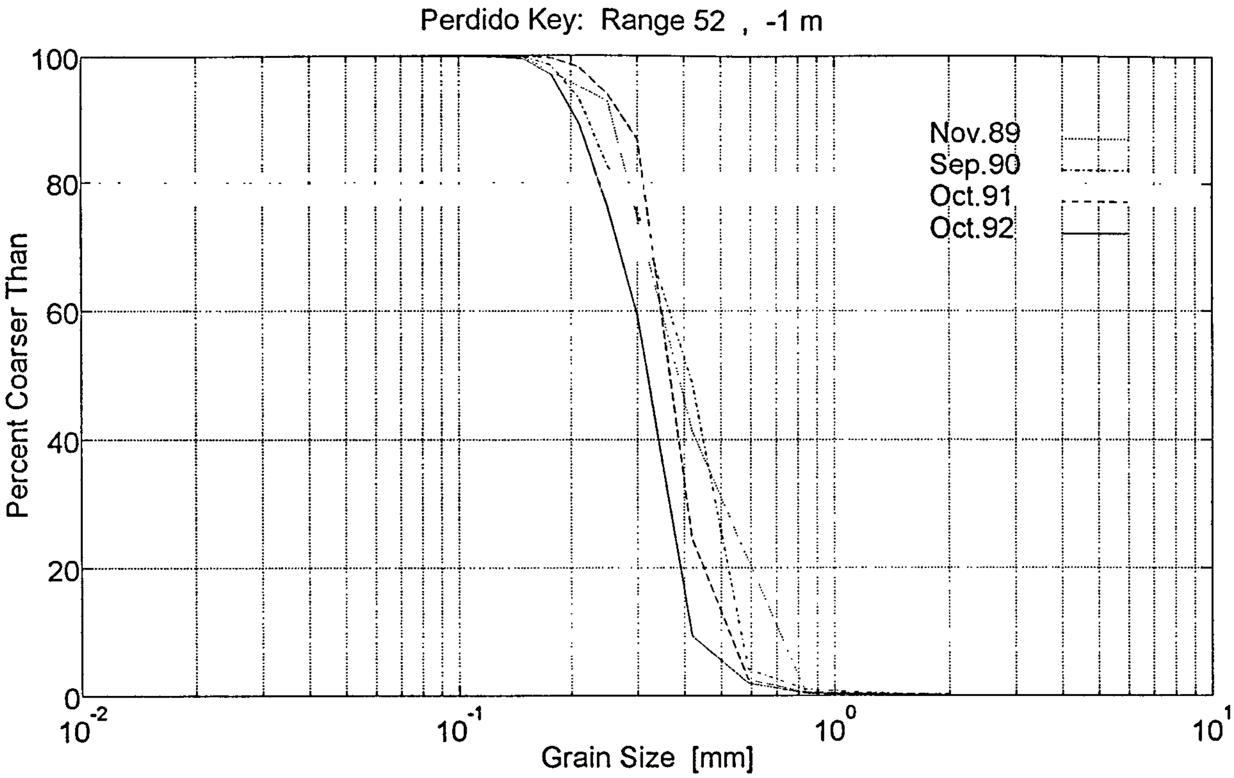


Figure III-54: Grain Size Distributions for Range 52, Berm and Beach Face Positions.



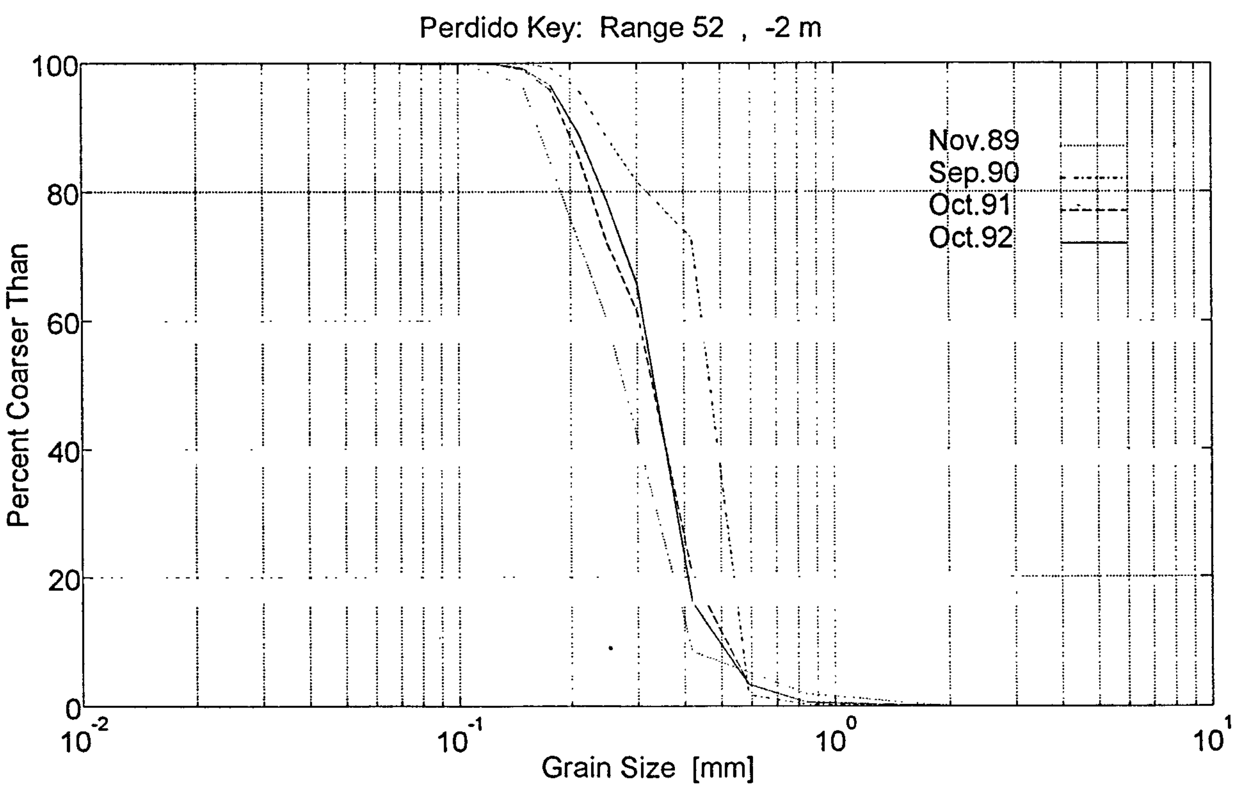
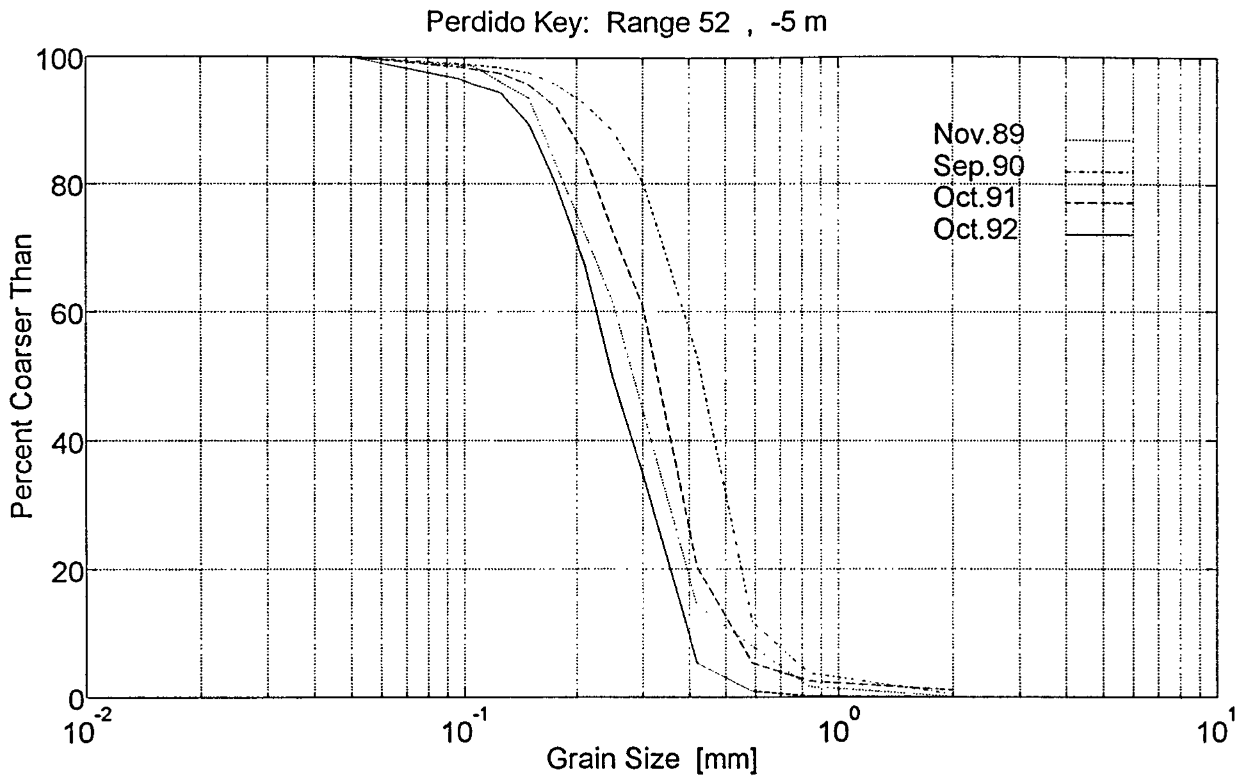


Figure III-55: Grain Size Distributions for Range 52, 1 M Depth and 2 M Depth Positions.



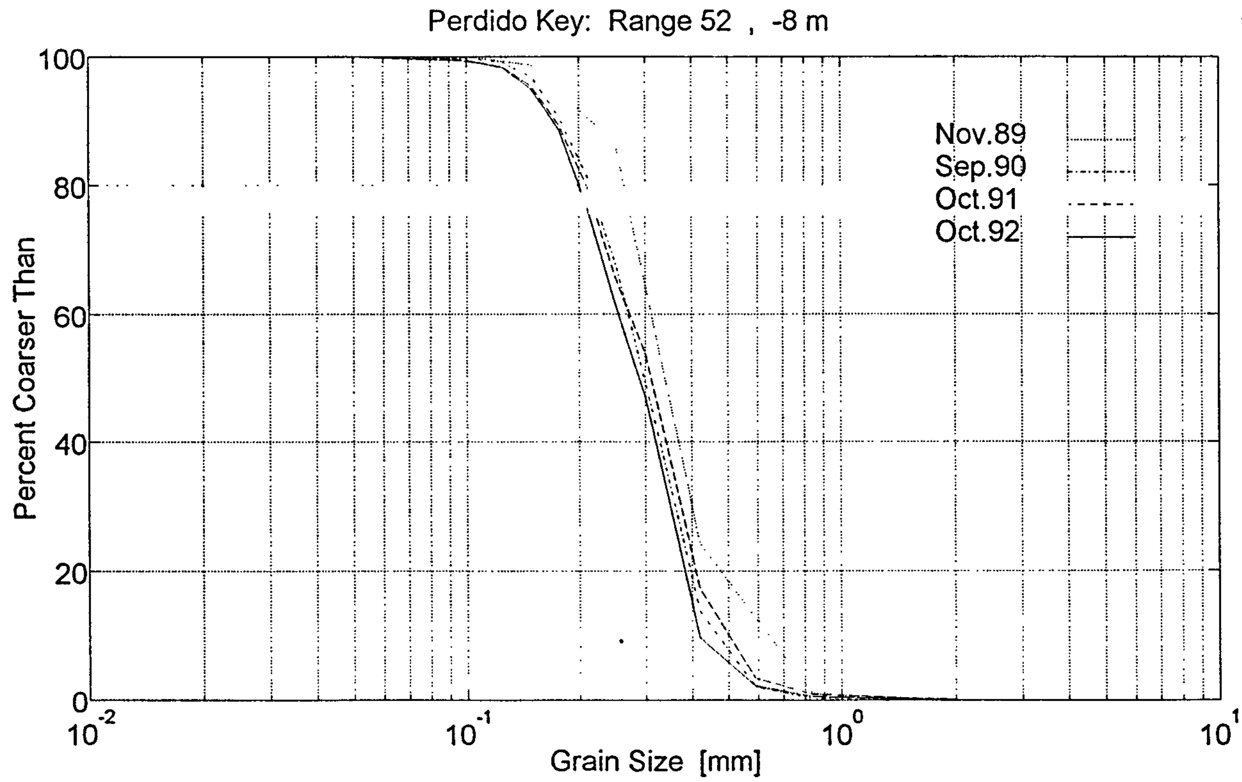
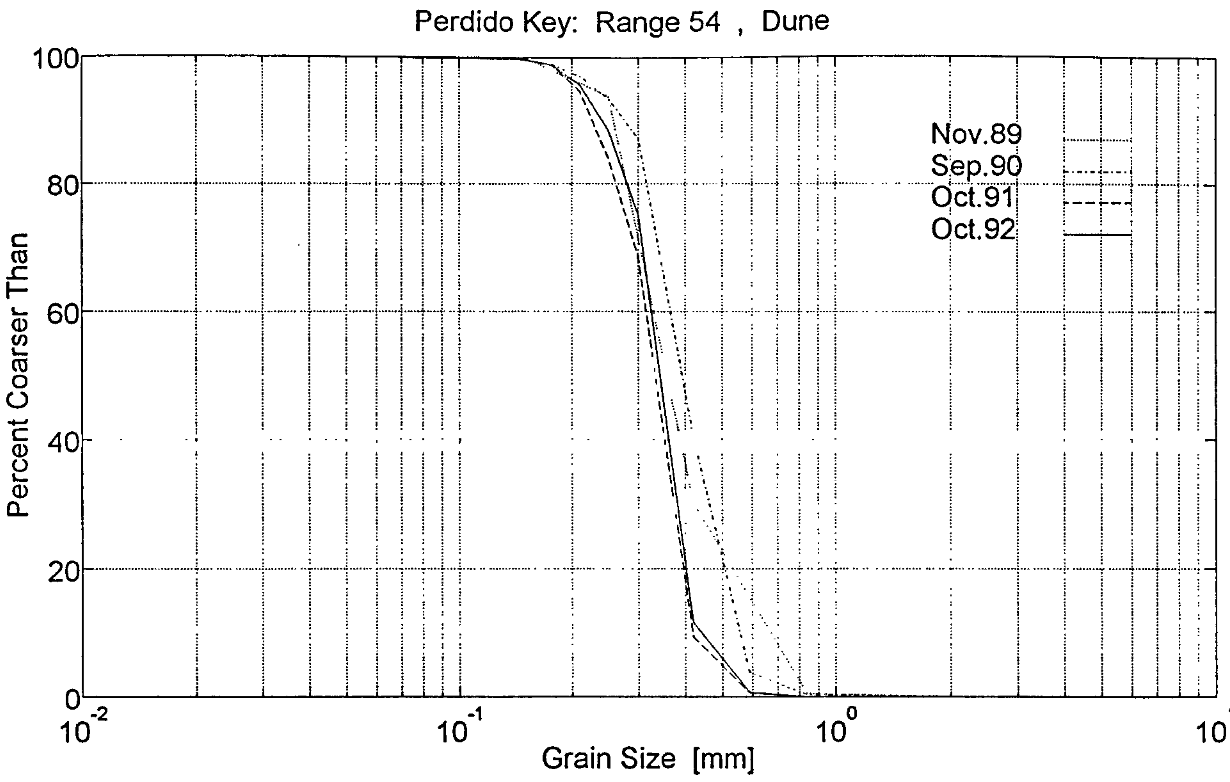


Figure III-56: Grain Size Distributions for Range 52, 5 M Depth and 8 M Depth Positions.



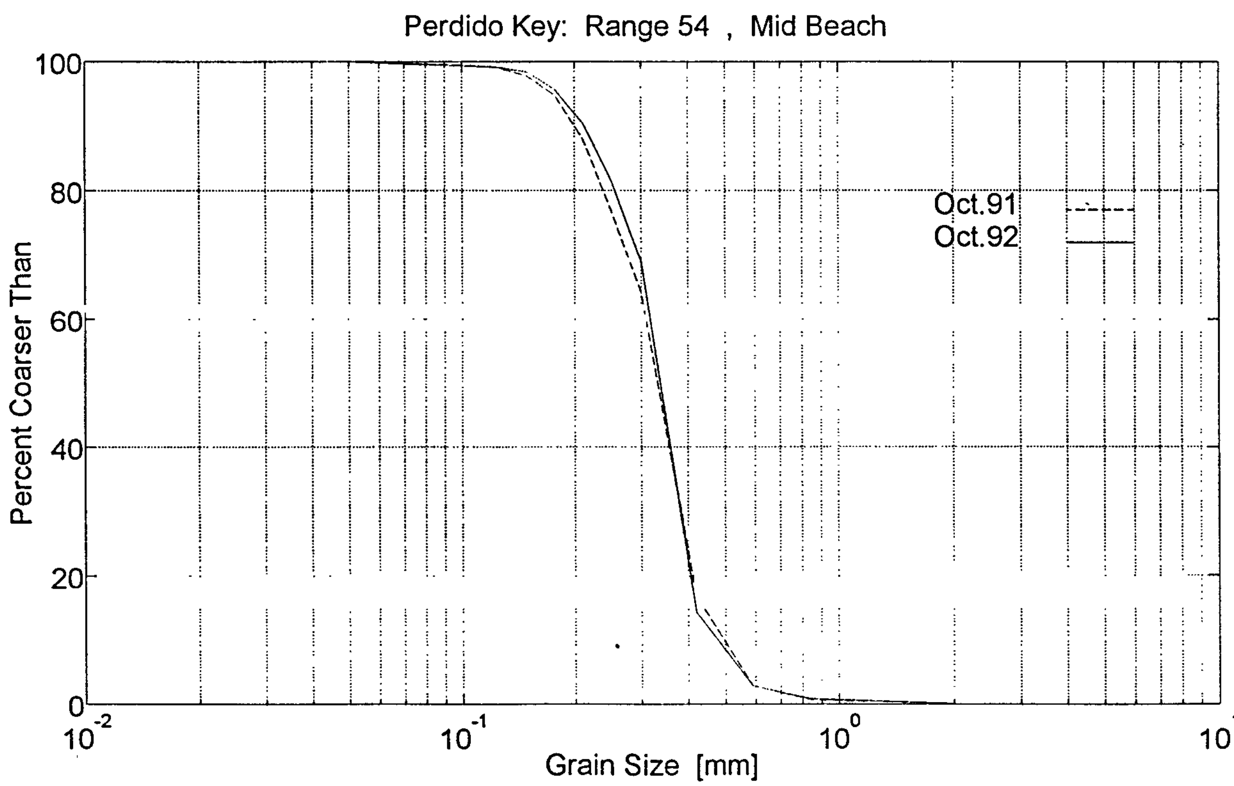
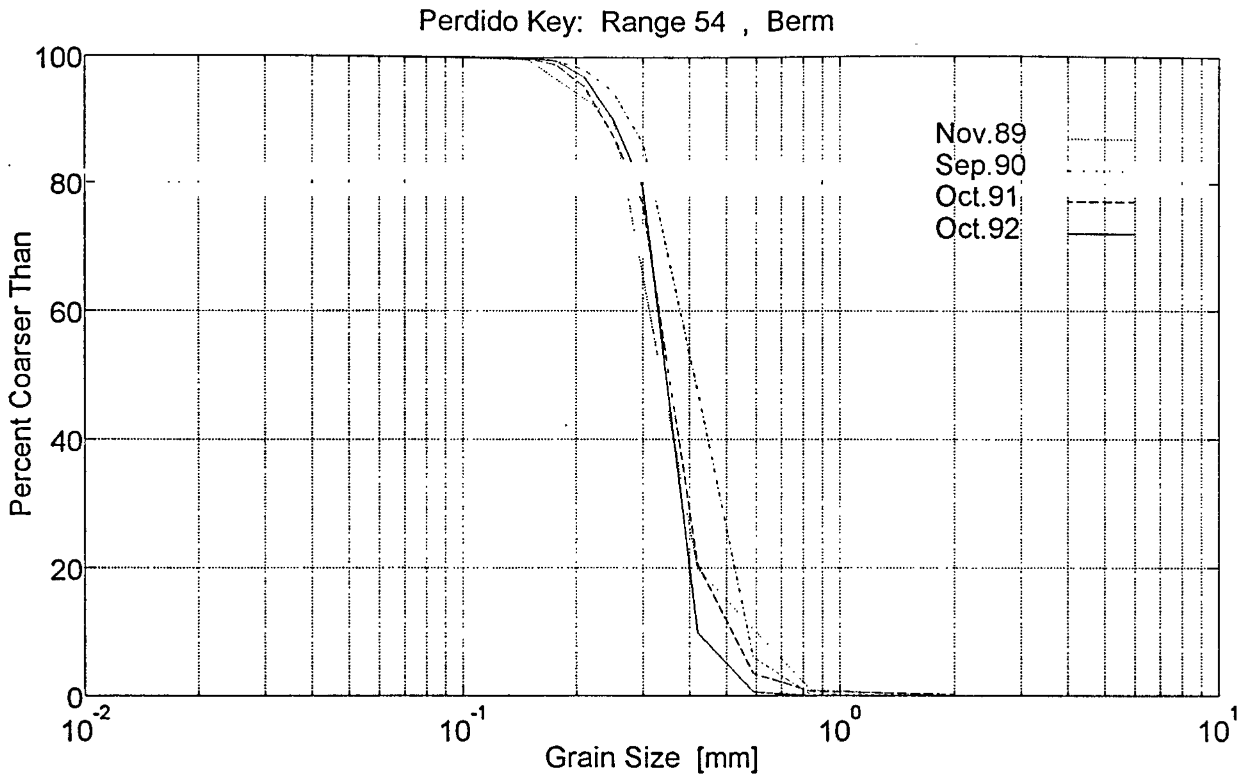


Figure III-57: Grain Size Distributions for Range 54, Dune and Mid-Beach Positions.



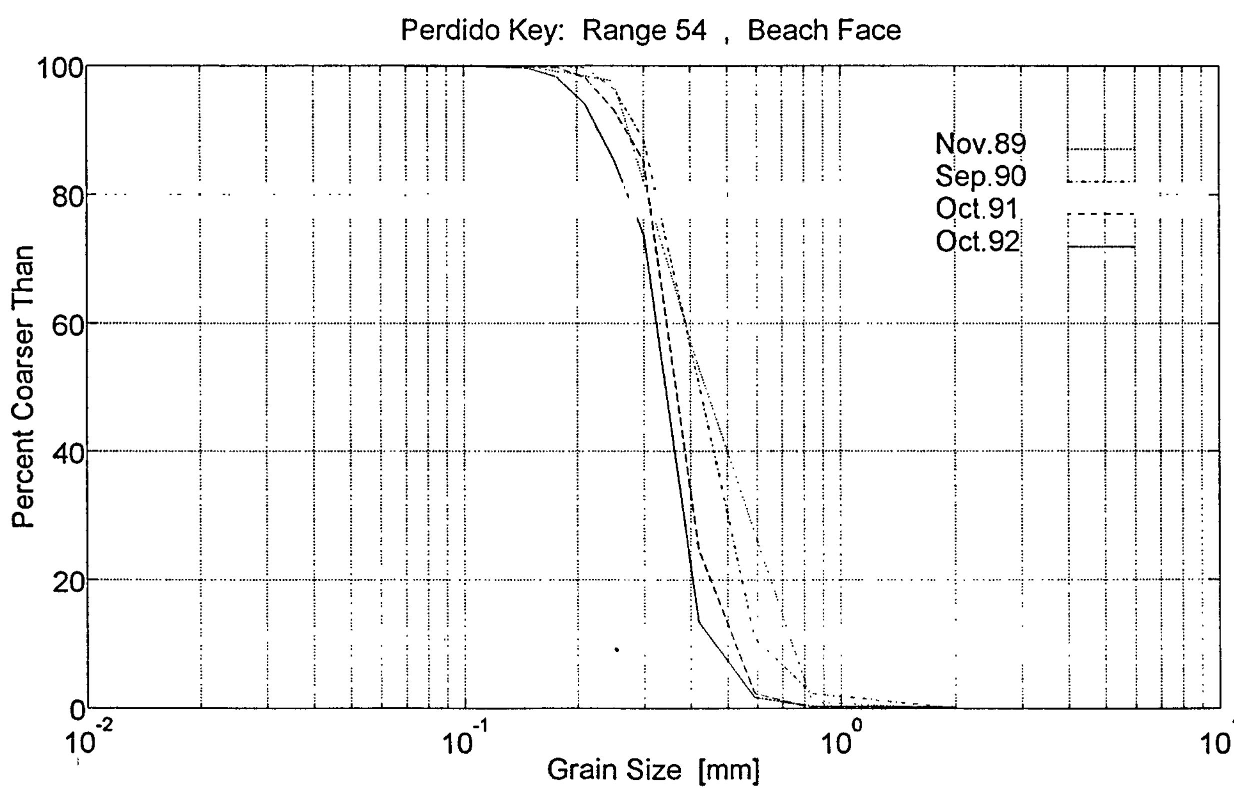
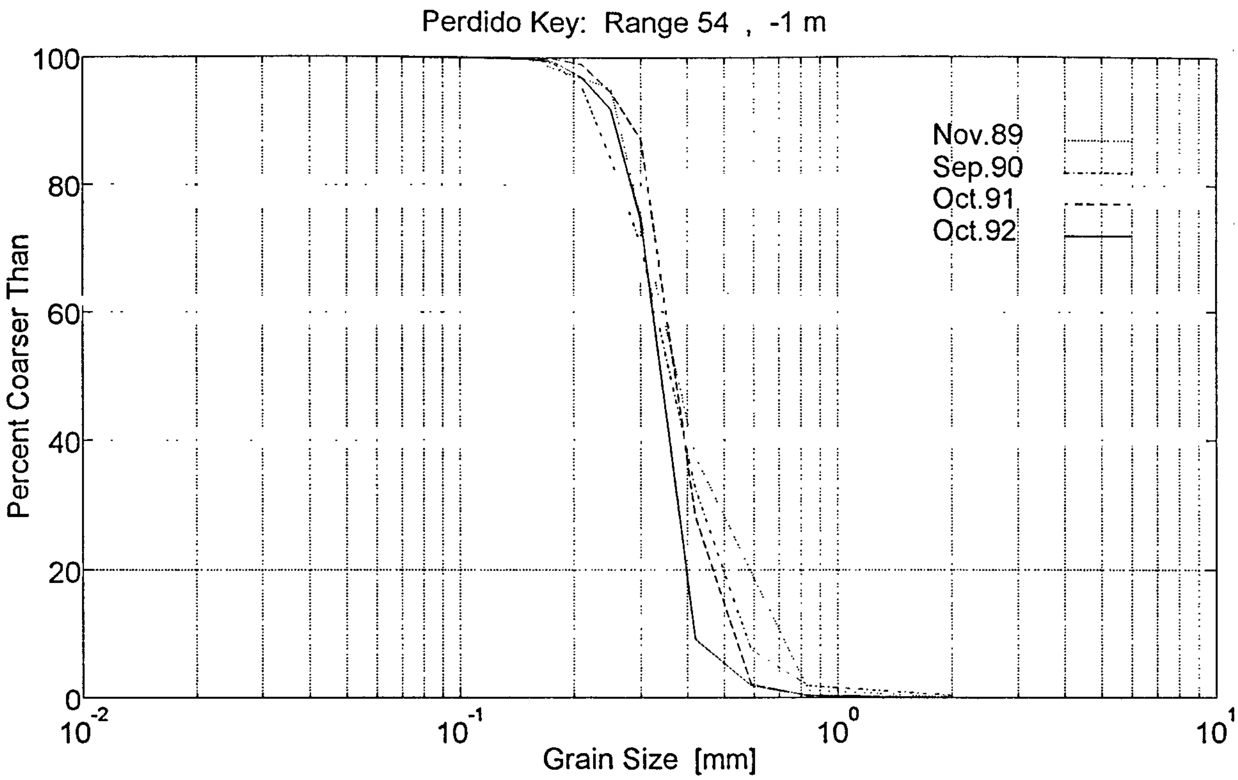


Figure III-58: Grain Size Distributions for Range 54, Berm and Beach Face Positions.



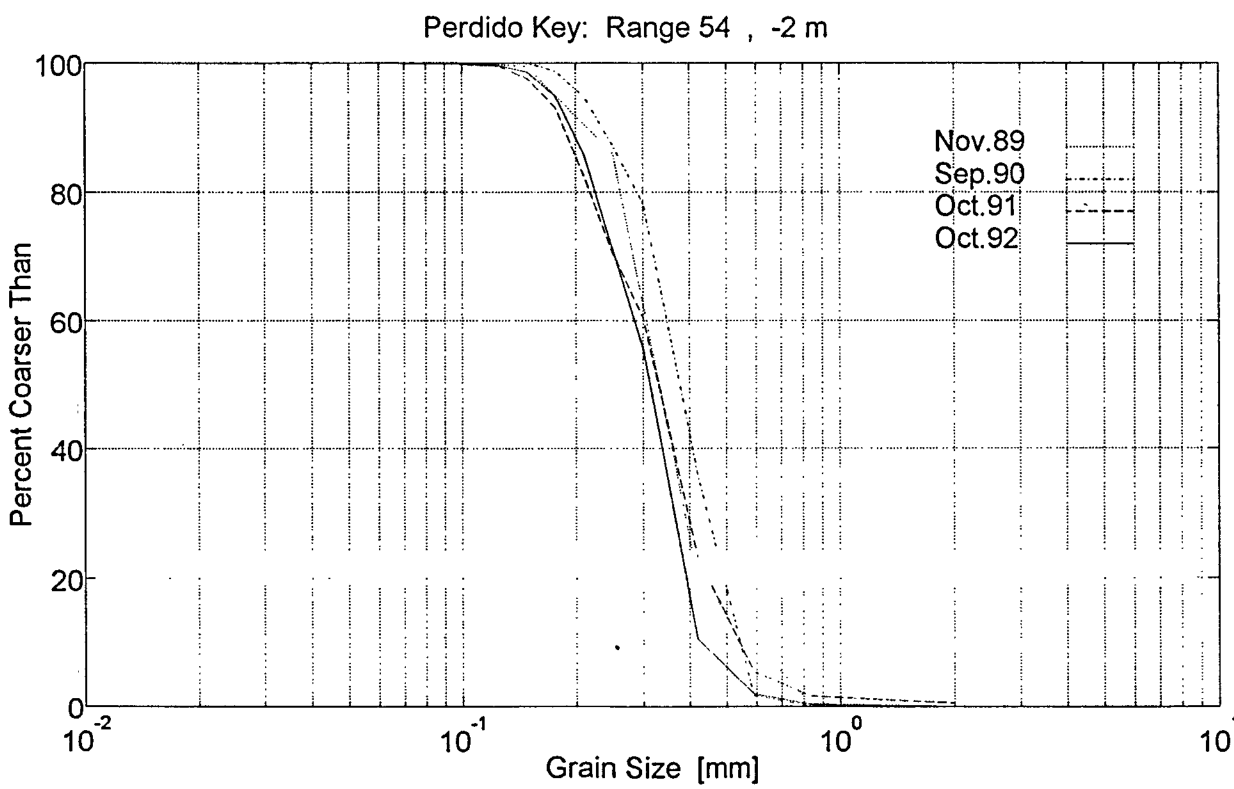
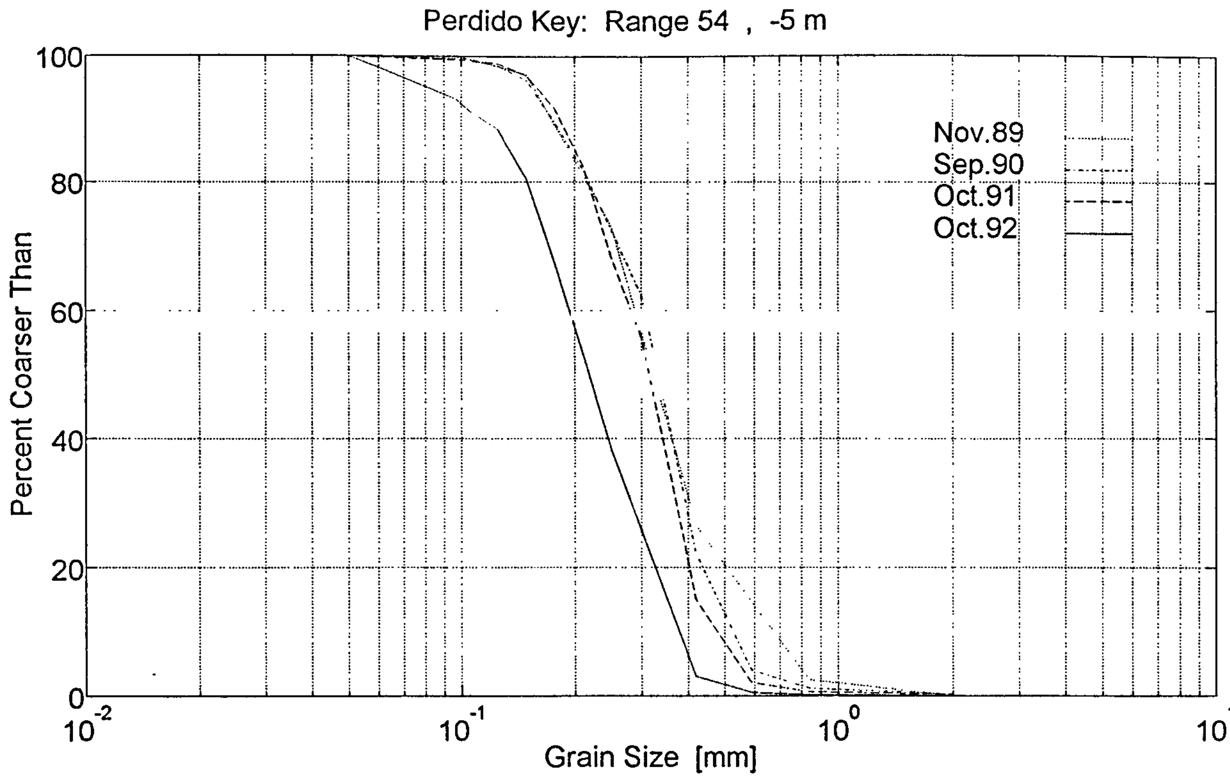


Figure III-59: Grain Size Distributions for Range 54, 1 M Depth and 2 M Depth Positions.



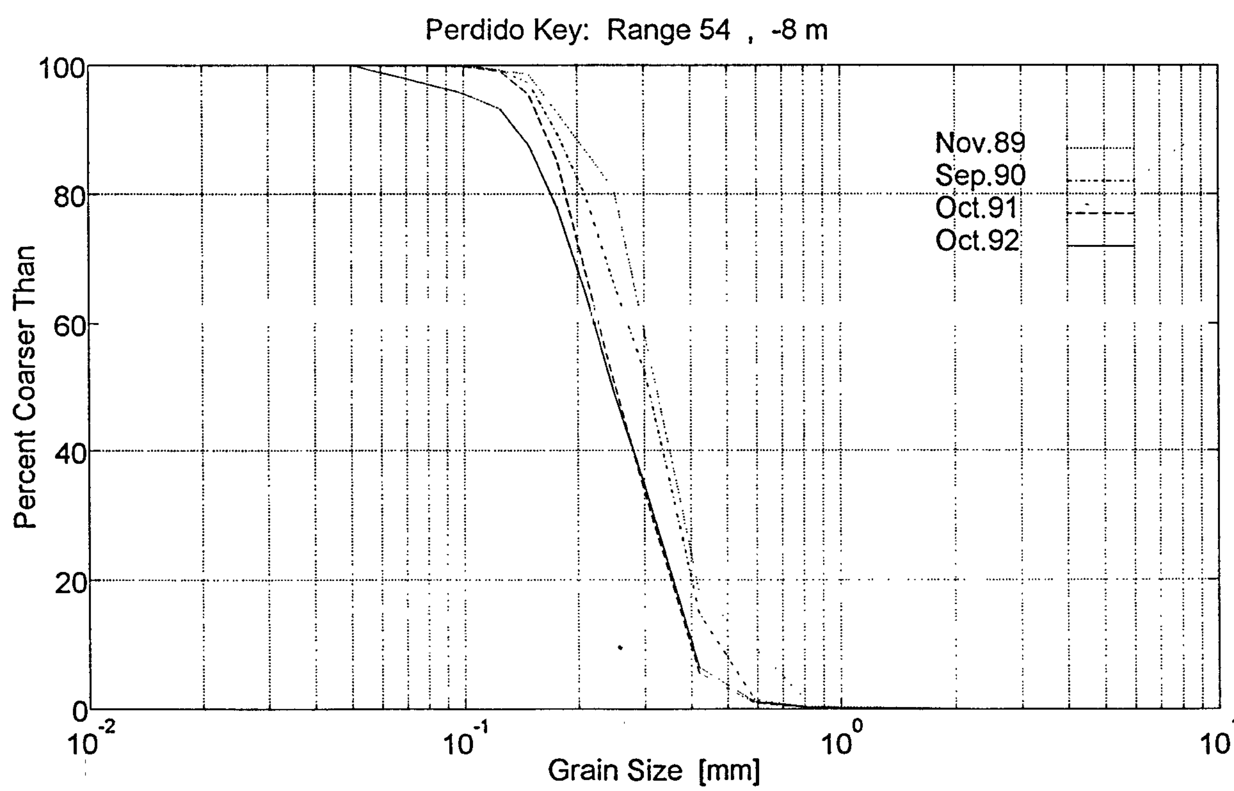


Figure III-60: Grain Size Distributions for Range 54, 5 M Depth and 8 M Depth Positions.

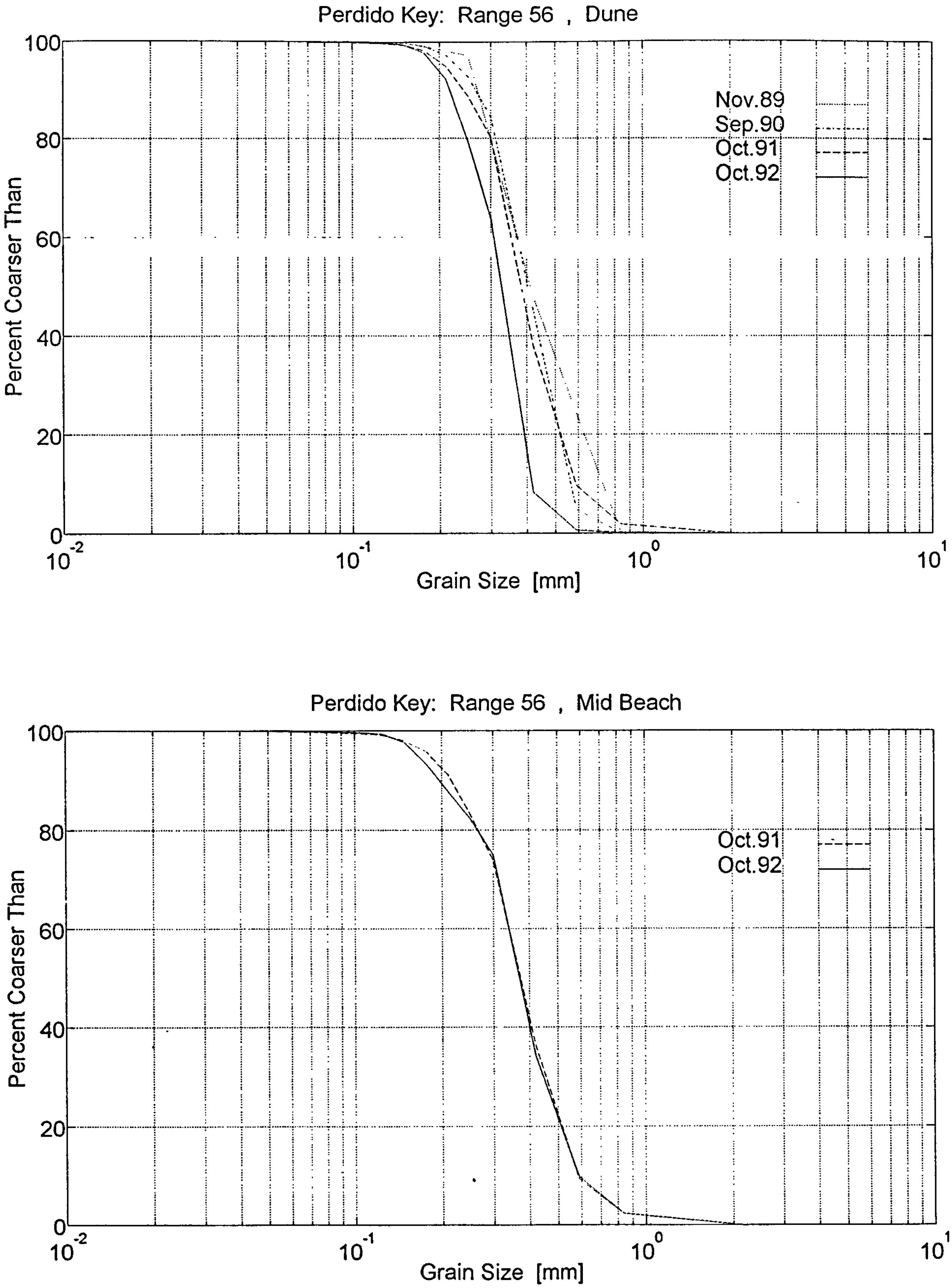
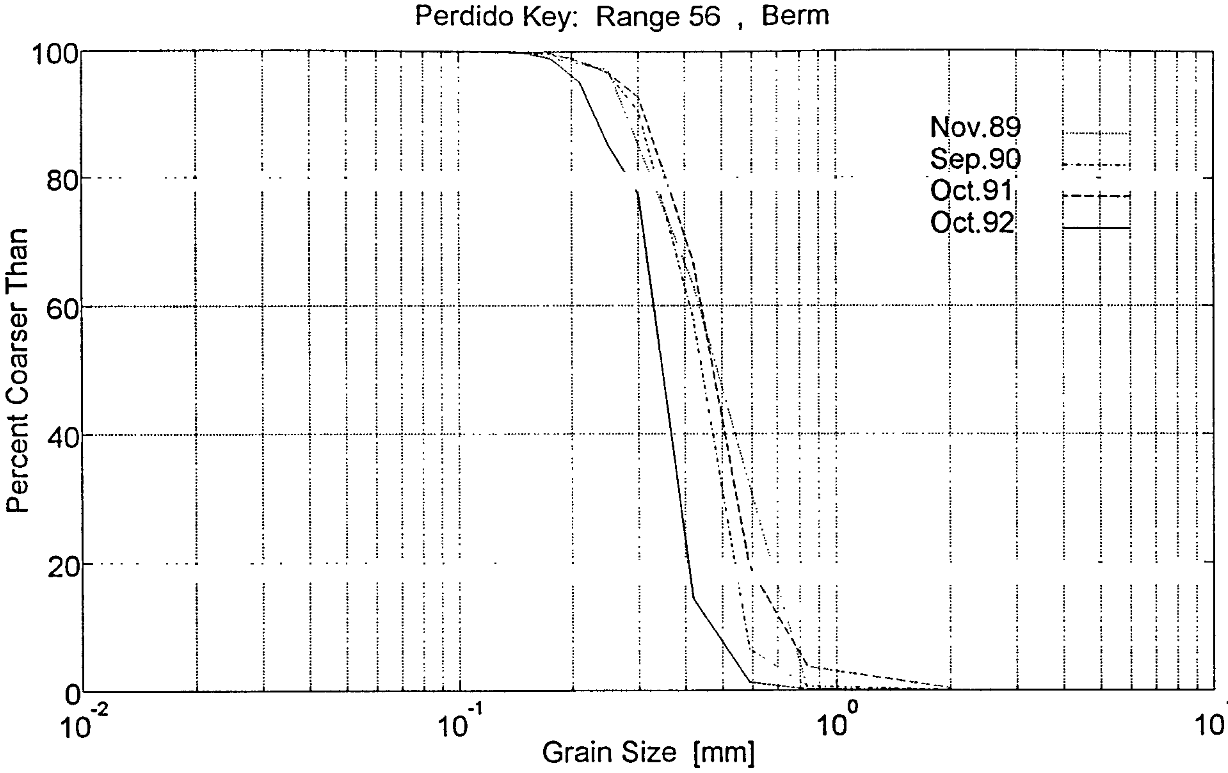


Figure III-61: Grain Size Distributions for Range 56, Dune and Mid-Beach Positions.



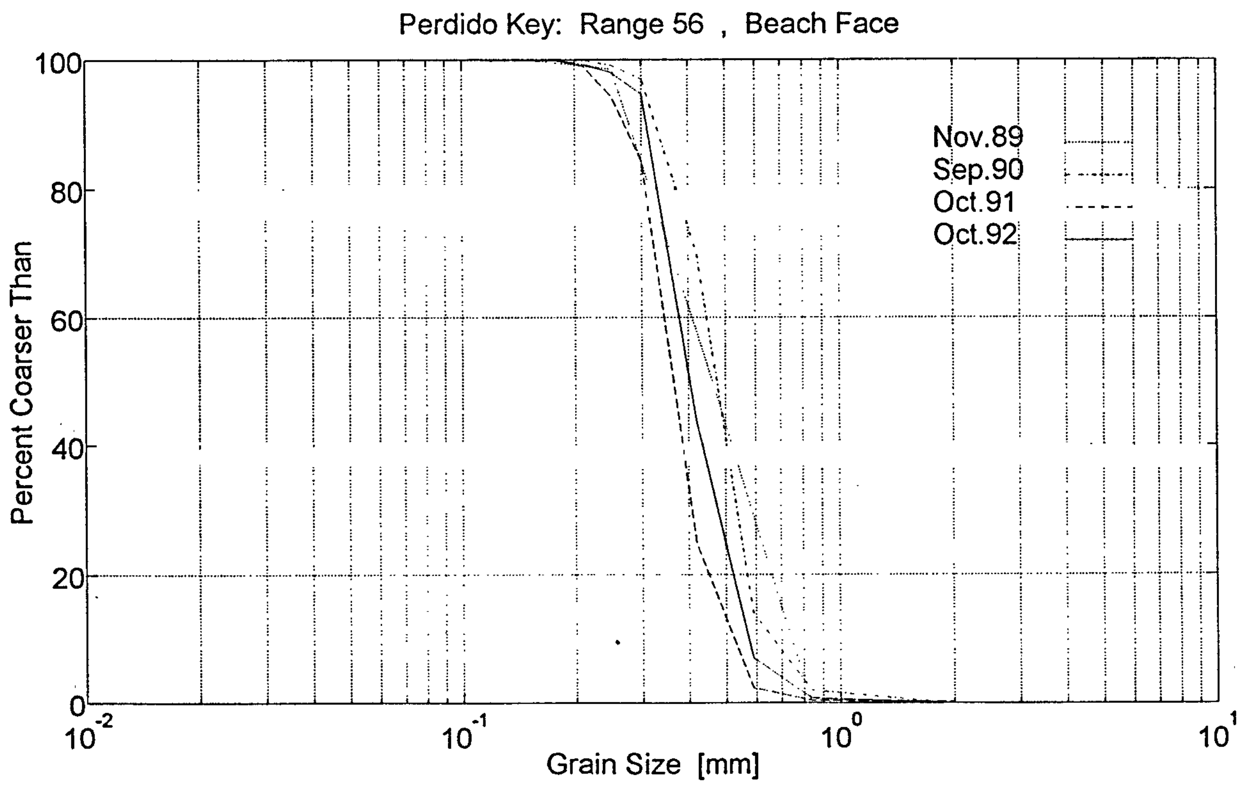
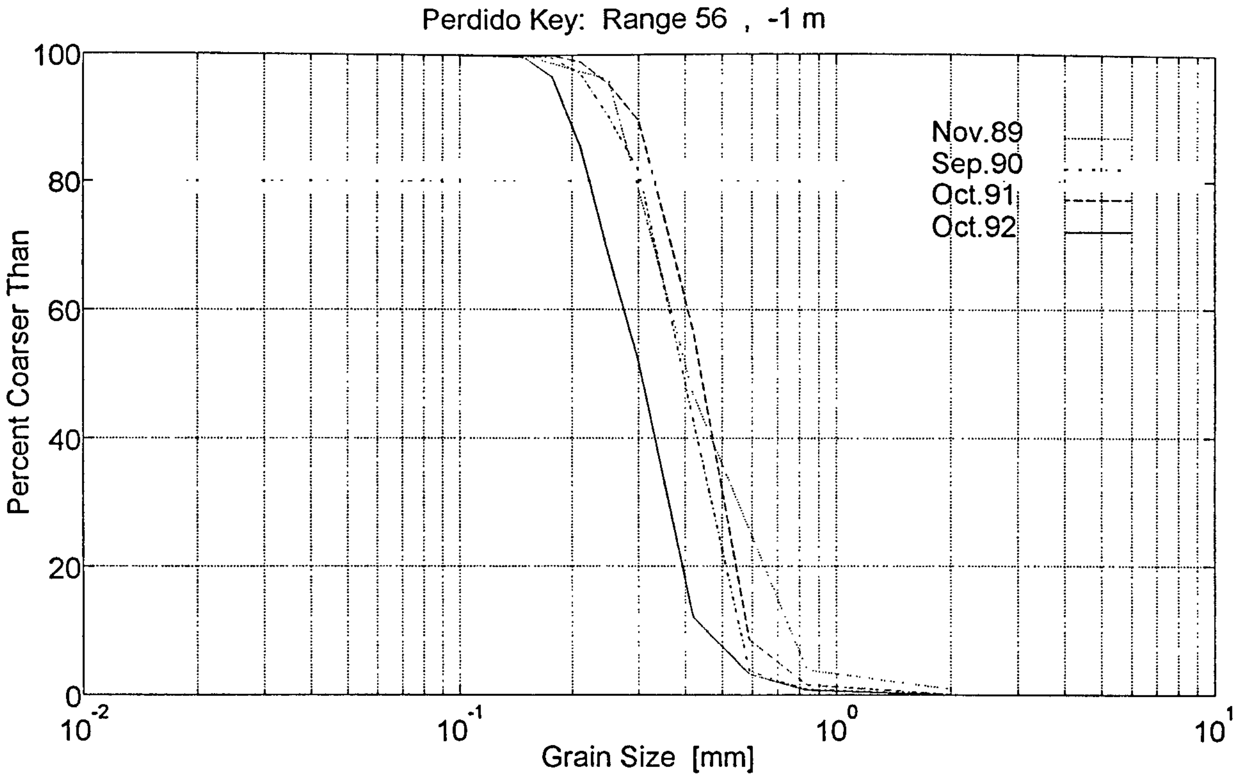


Figure III-62: Grain Size Distributions for Range 56, Berm and Beach Face Positions.



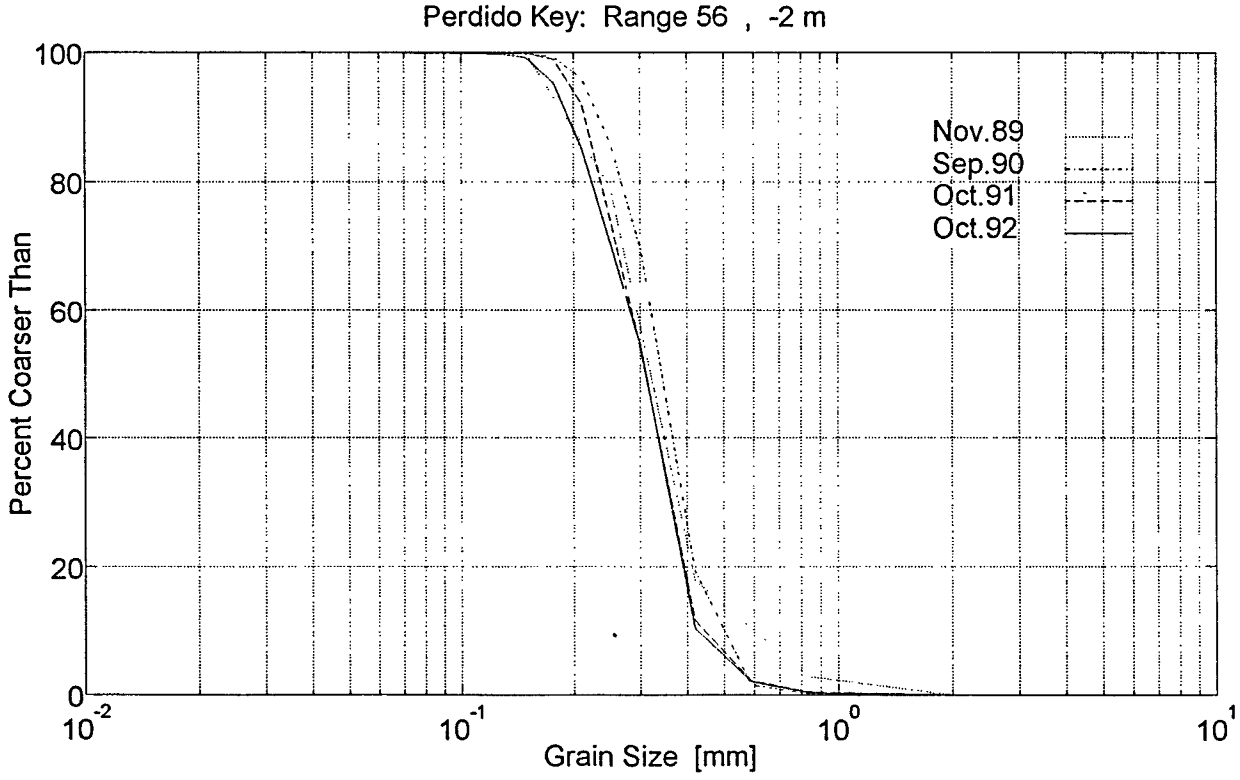
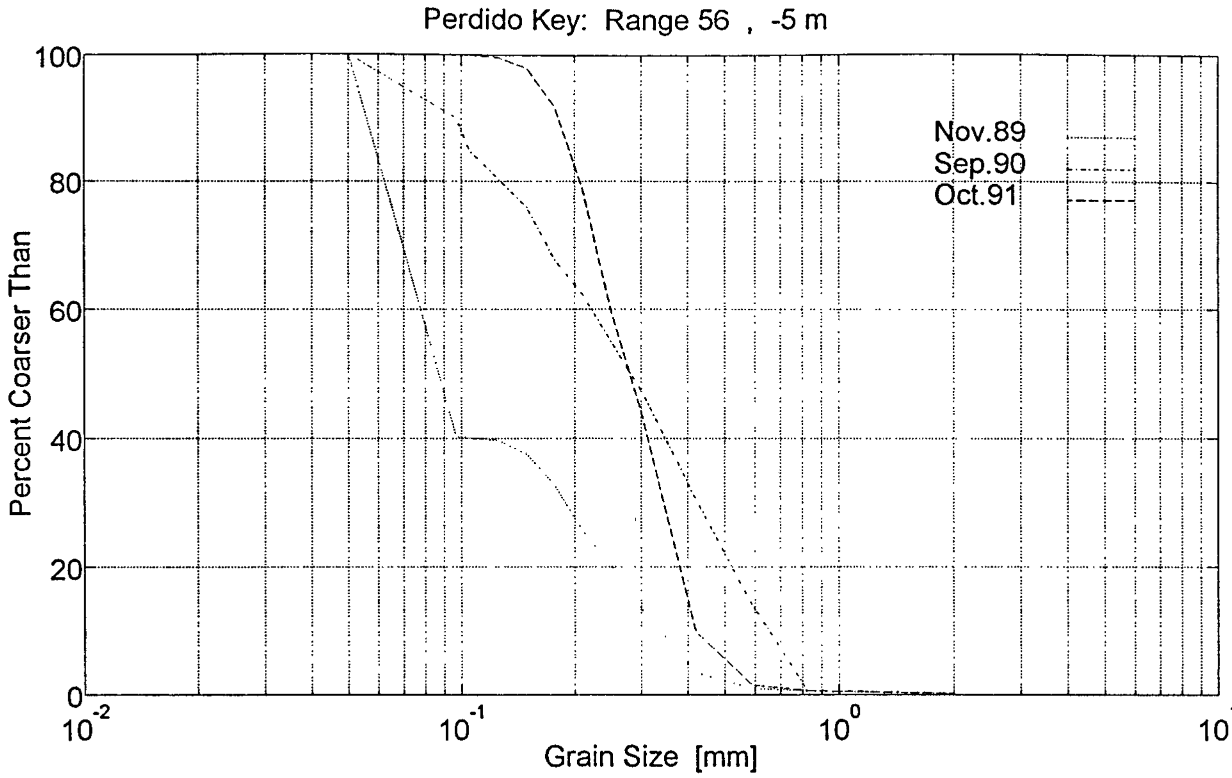


Figure III-63: Grain Size Distributions for Range 56, 1 M Depth and 2 M Depth Positions.



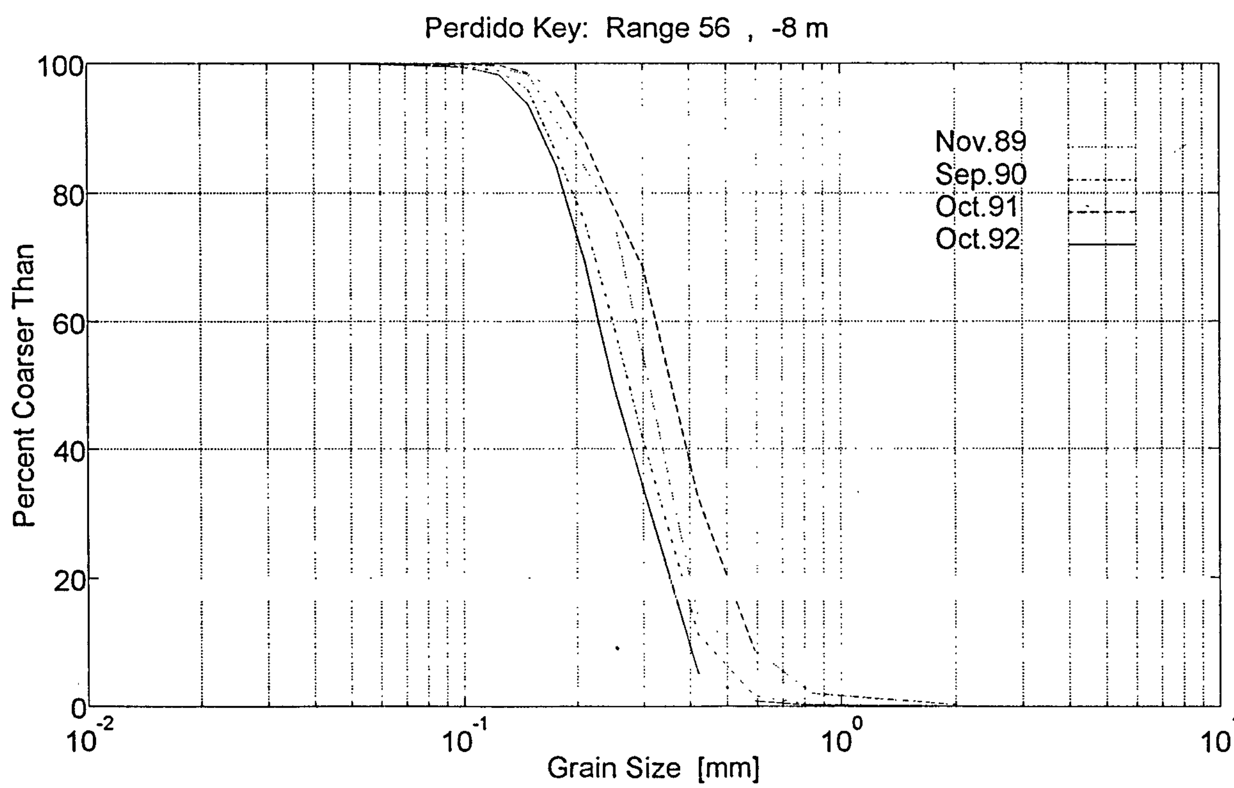
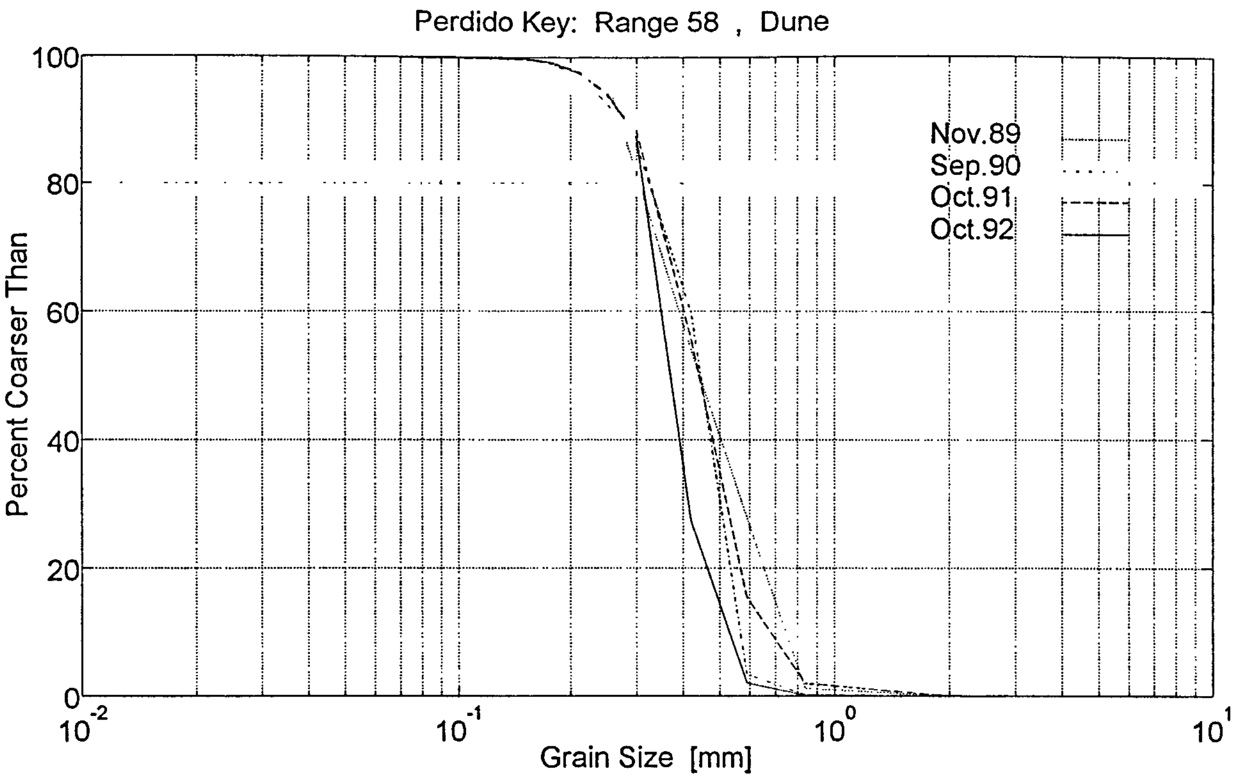


Figure III-64: Grain Size Distributions for Range 56, 5 M Depth and 8 M Depth Positions.



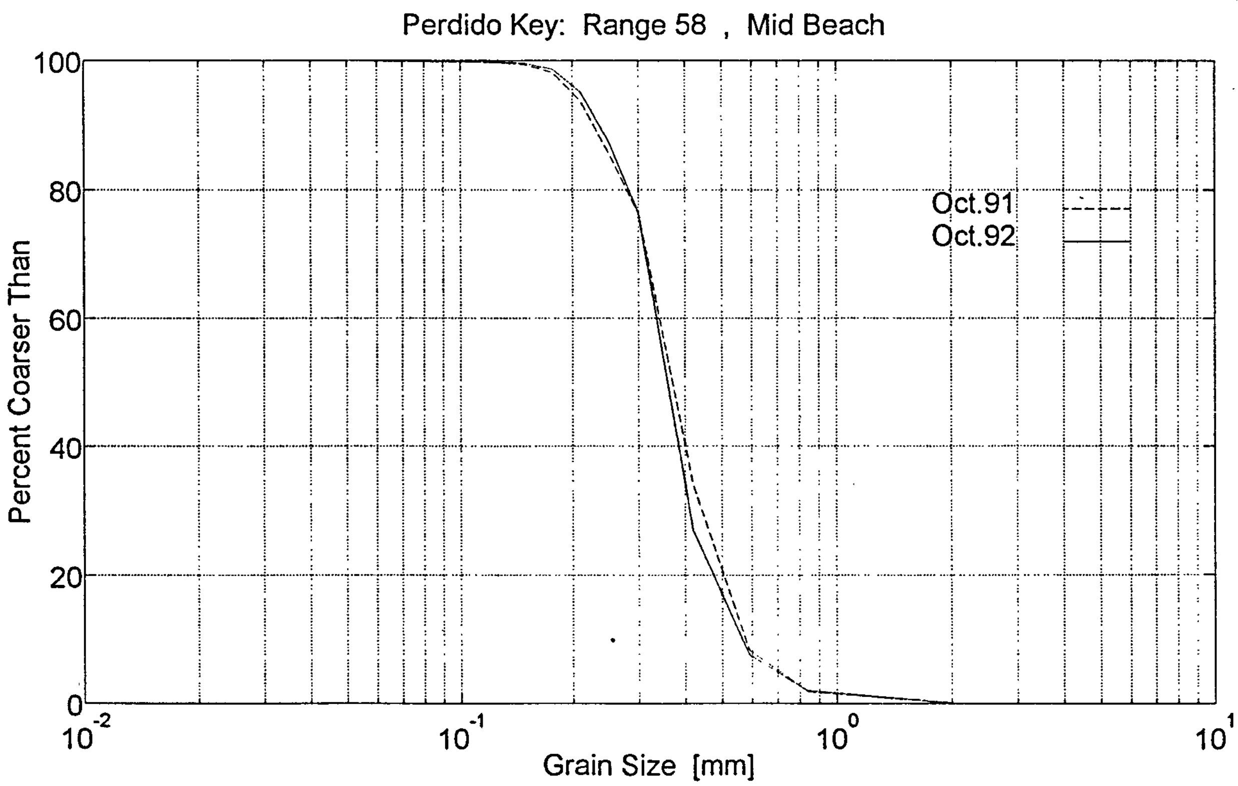
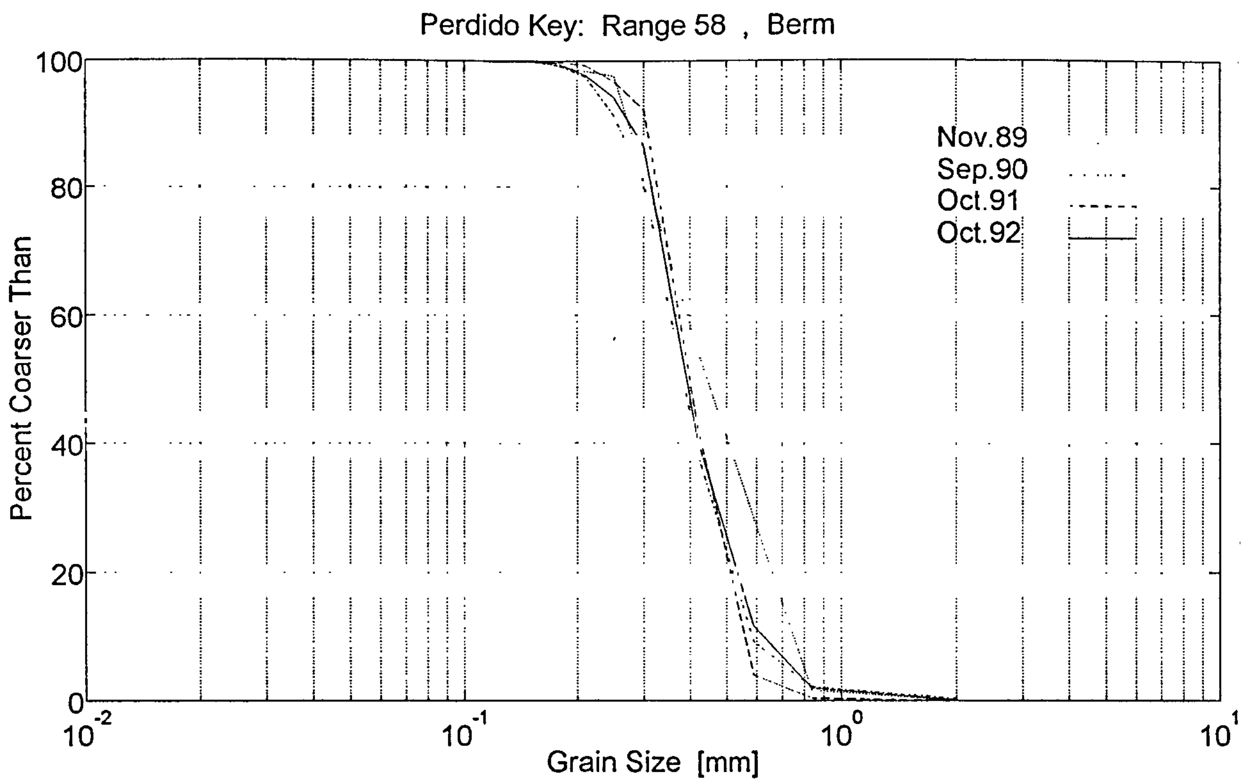


Figure III-65: Grain Size Distributions for Range 58, Dune and Mid-Beach Positions.



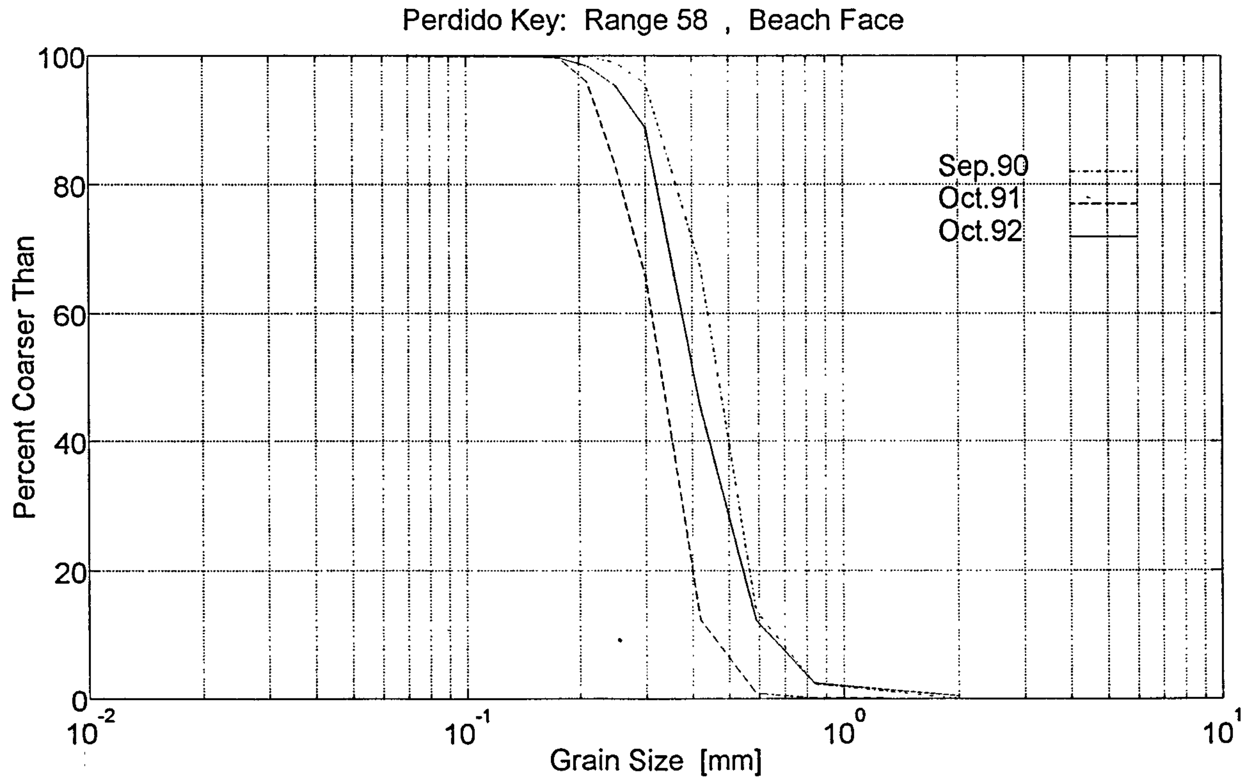
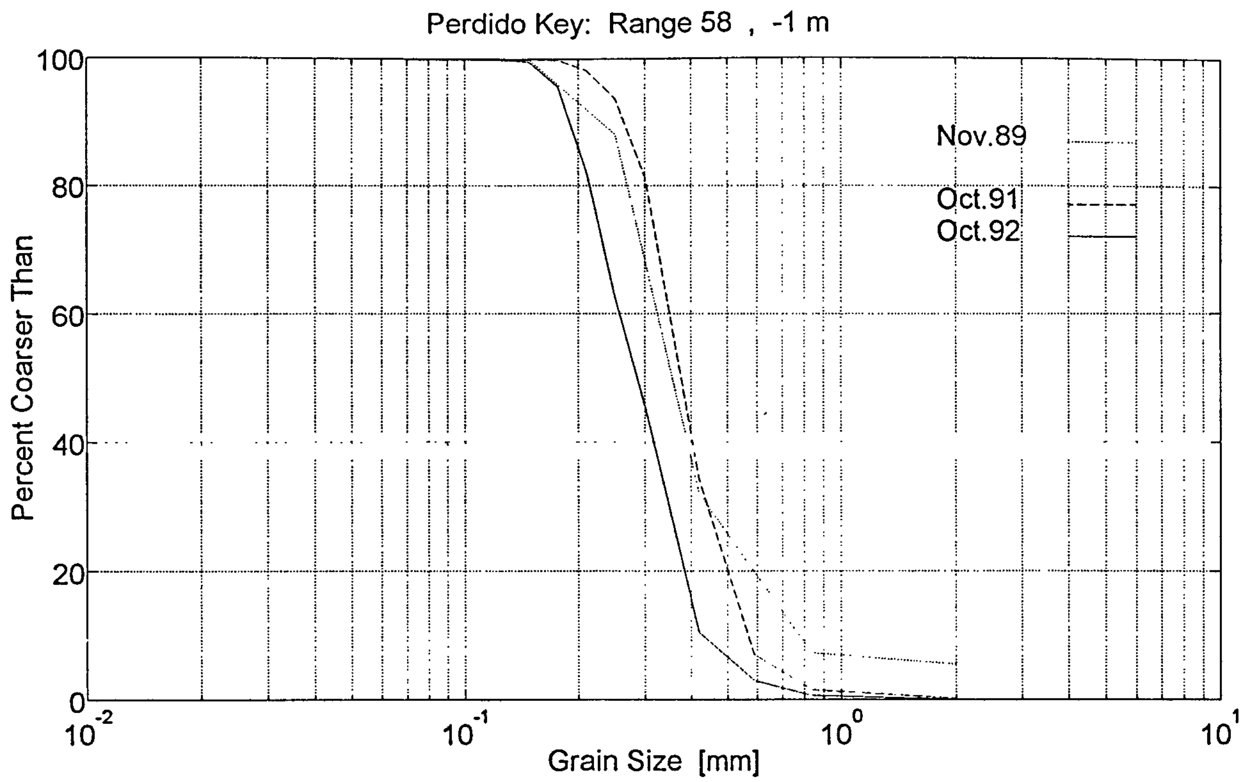


Figure III-66: Grain Size Distributions for Range 58, Berm and Beach Face Positions.



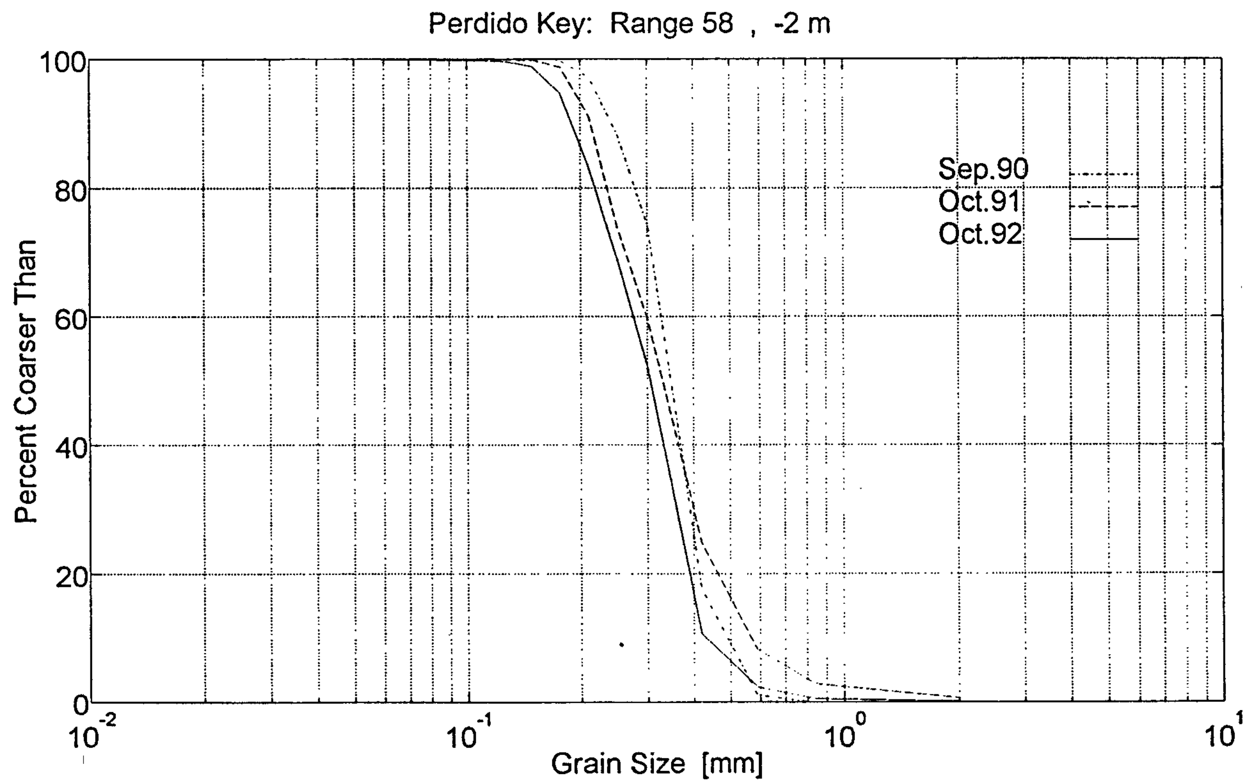
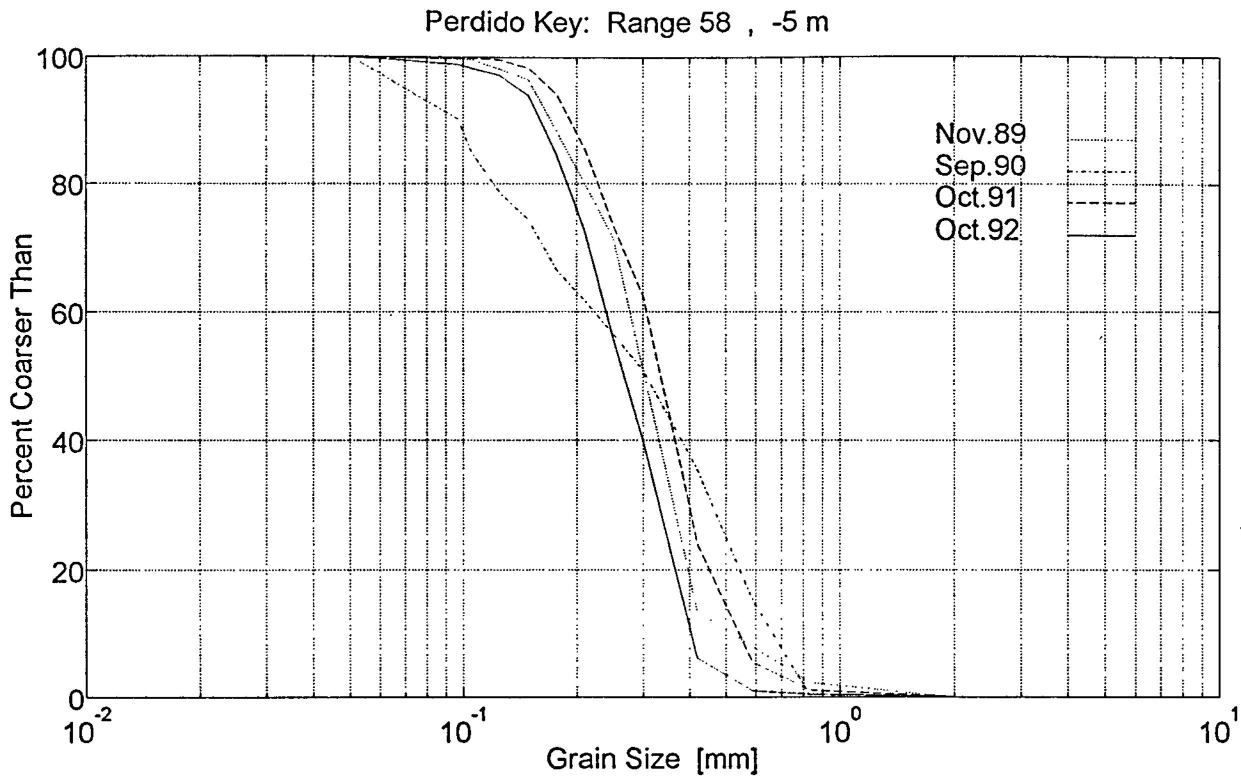


Figure III-67: Grain Size Distributions for Range 58, 1 M Depth and 2 M Depth Positions.



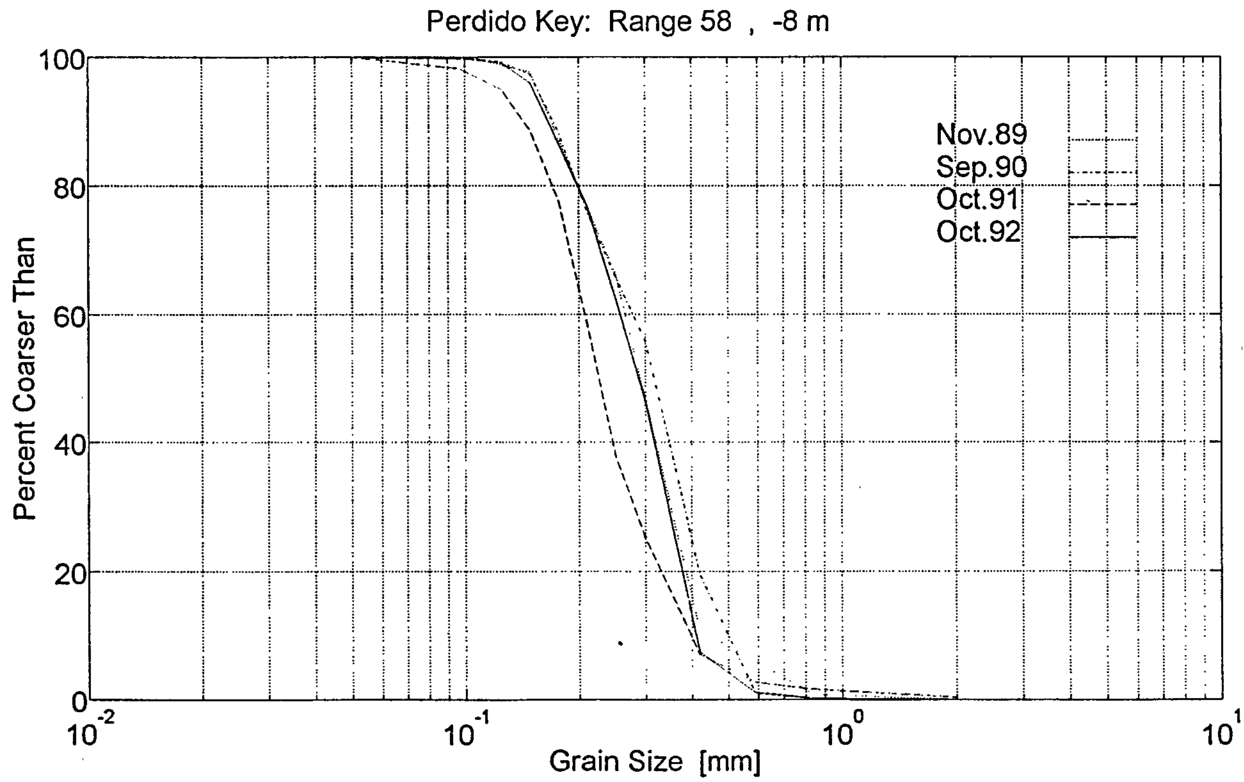
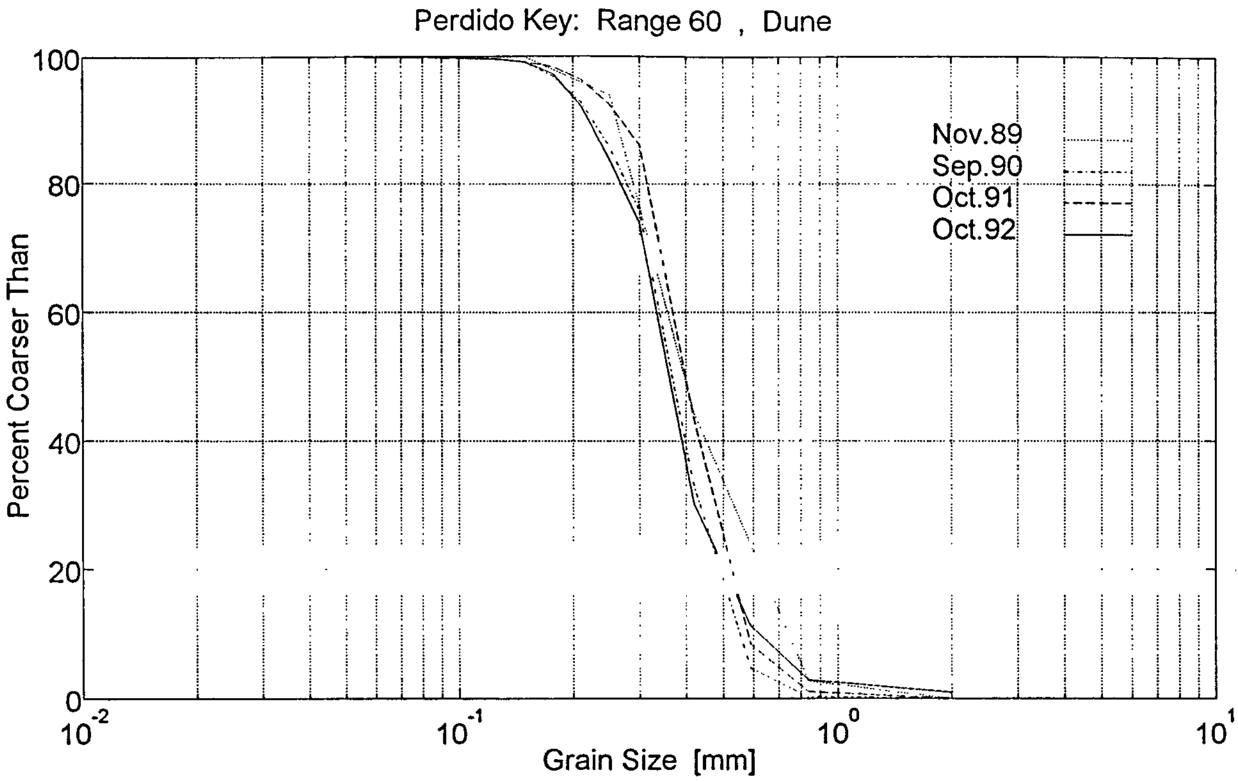


Figure III-68: Grain Size Distributions for Range 58, 5 M Depth and 8 M Depth Positions.



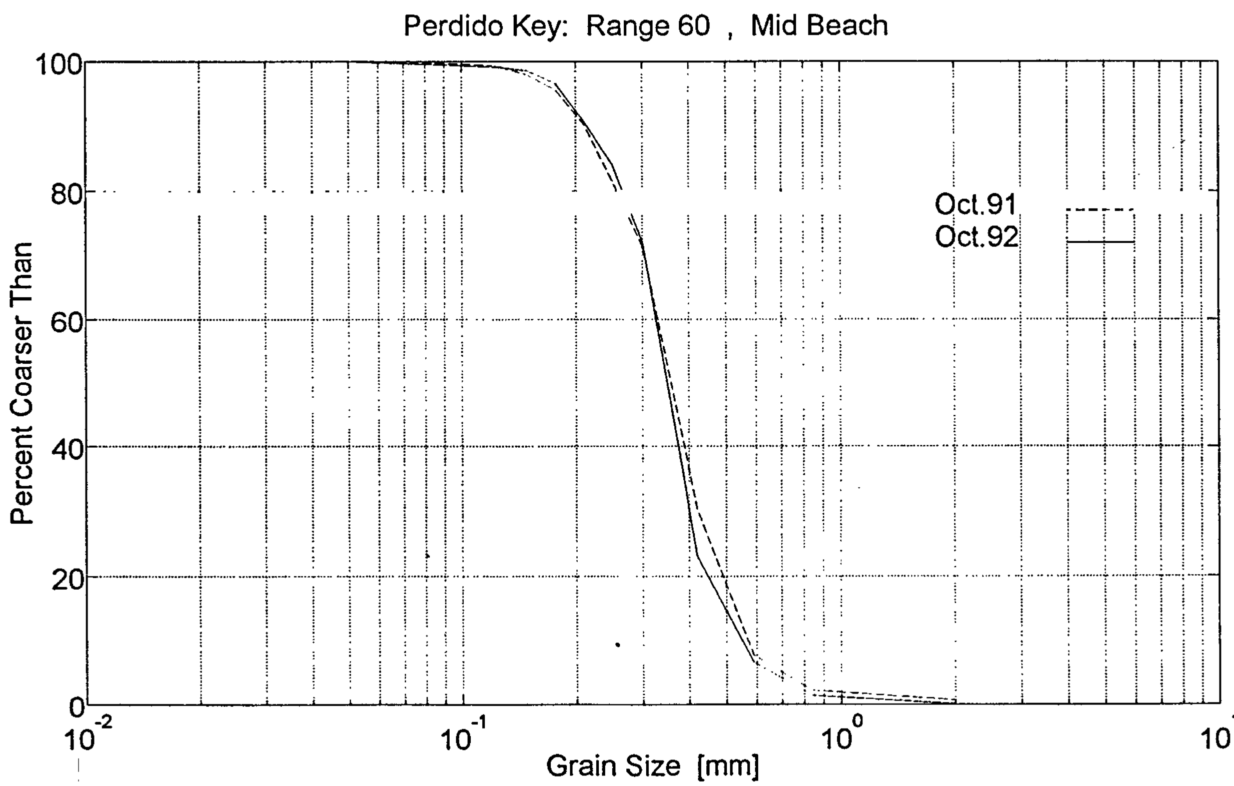
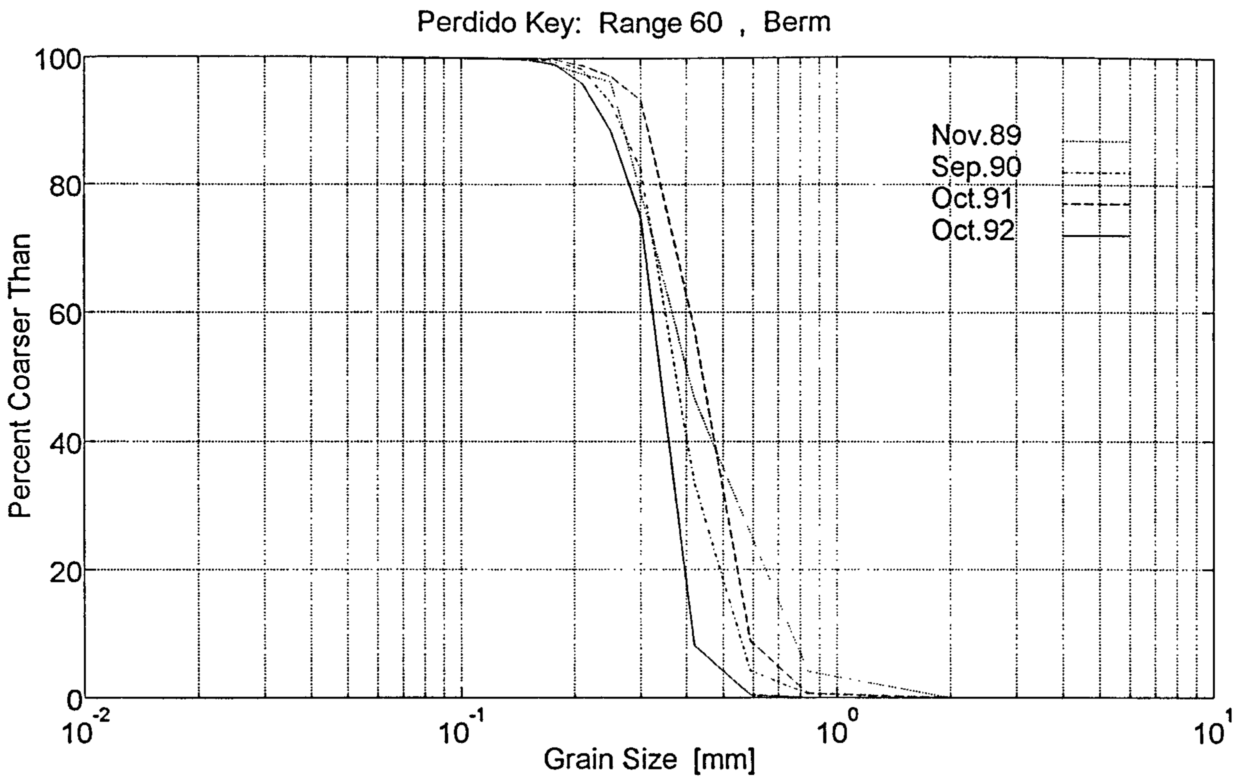


Figure III-69: Grain Size Distributions for Range 60, Dune and Mid-Beach Positions.



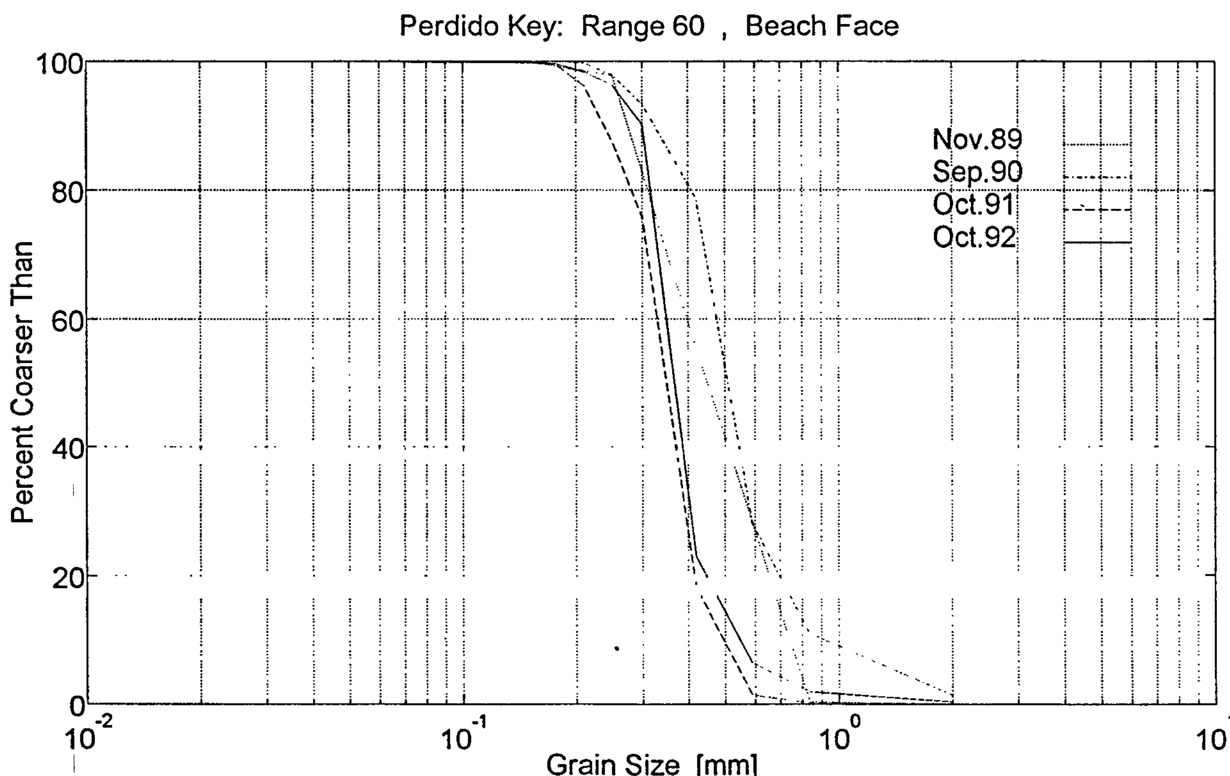
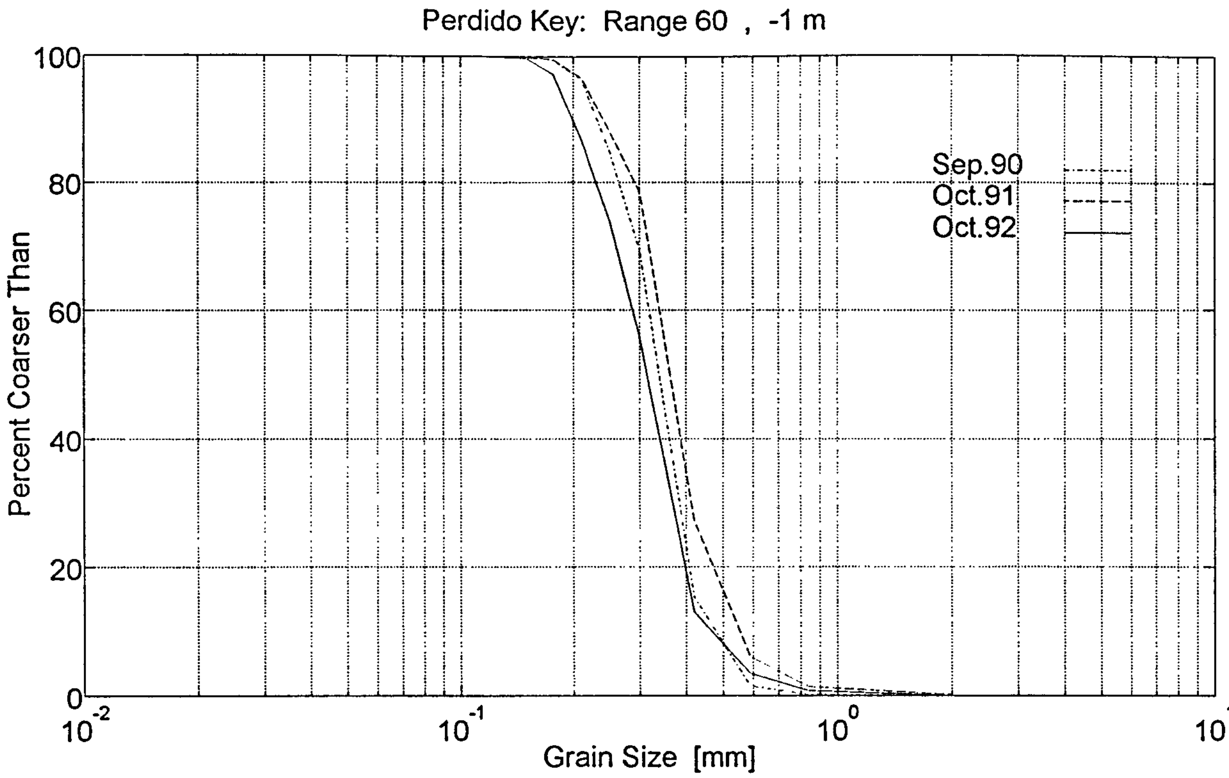


Figure III-70: Grain Size Distributions for Range 60, Berm and Beach Face Positions.



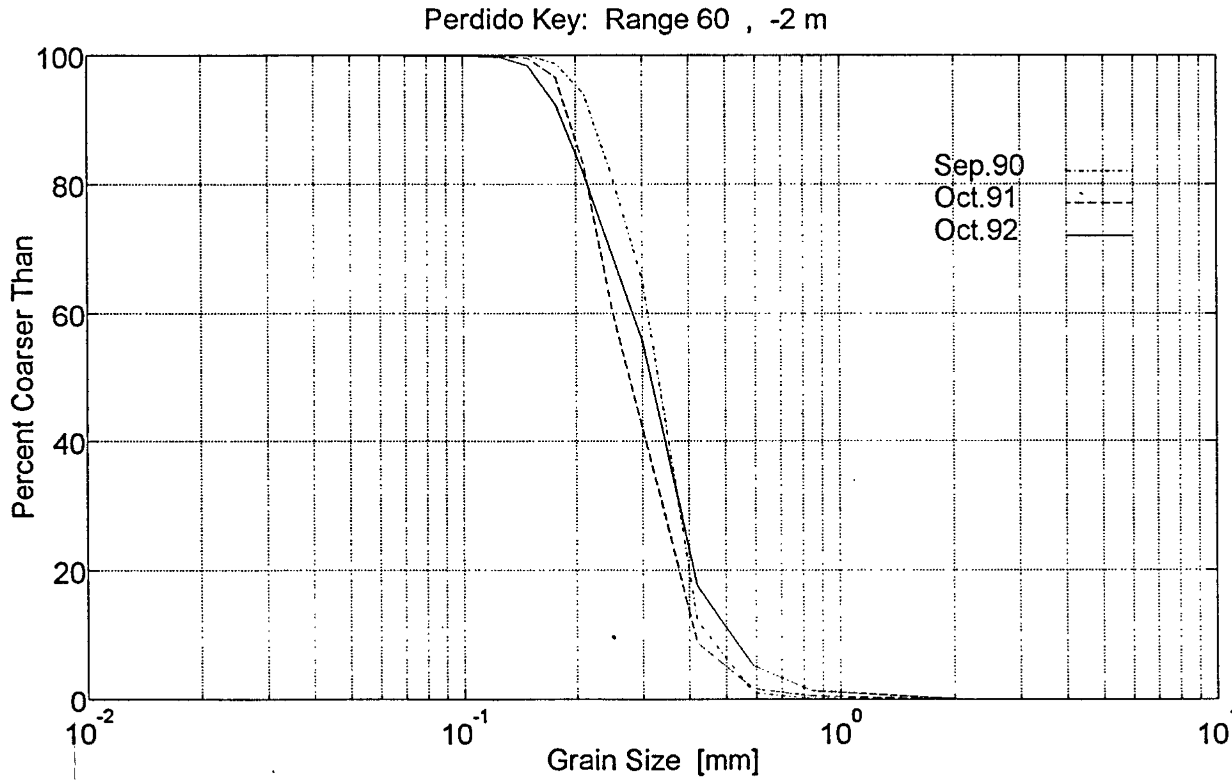
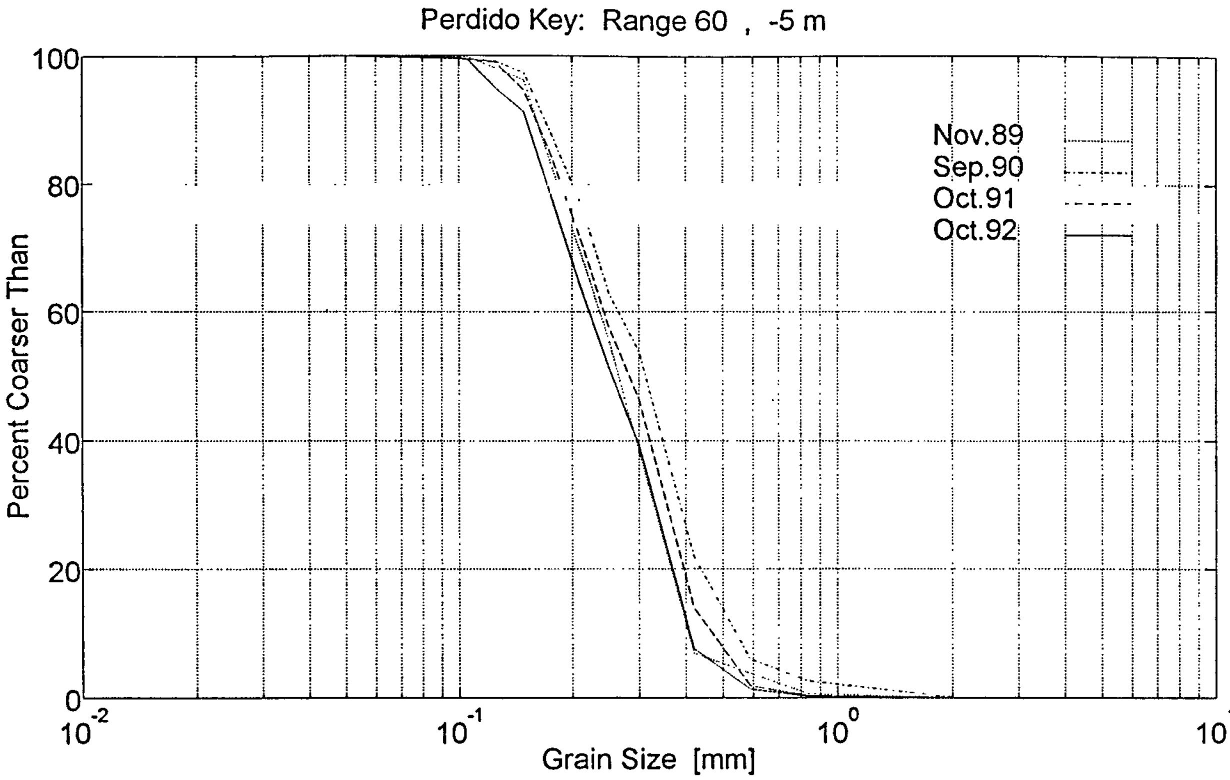


Figure III-71: Grain Size Distributions for Range 60, 1 M Depth and 2 M Depth Positions.



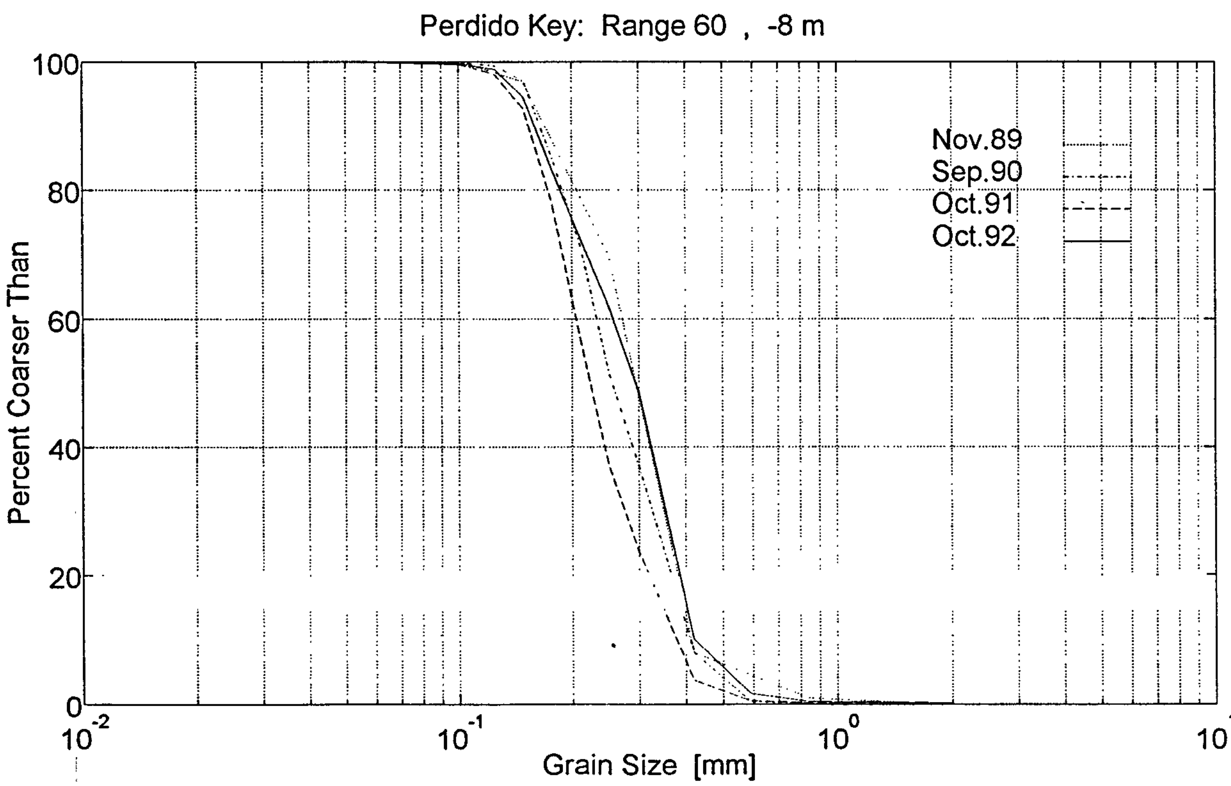
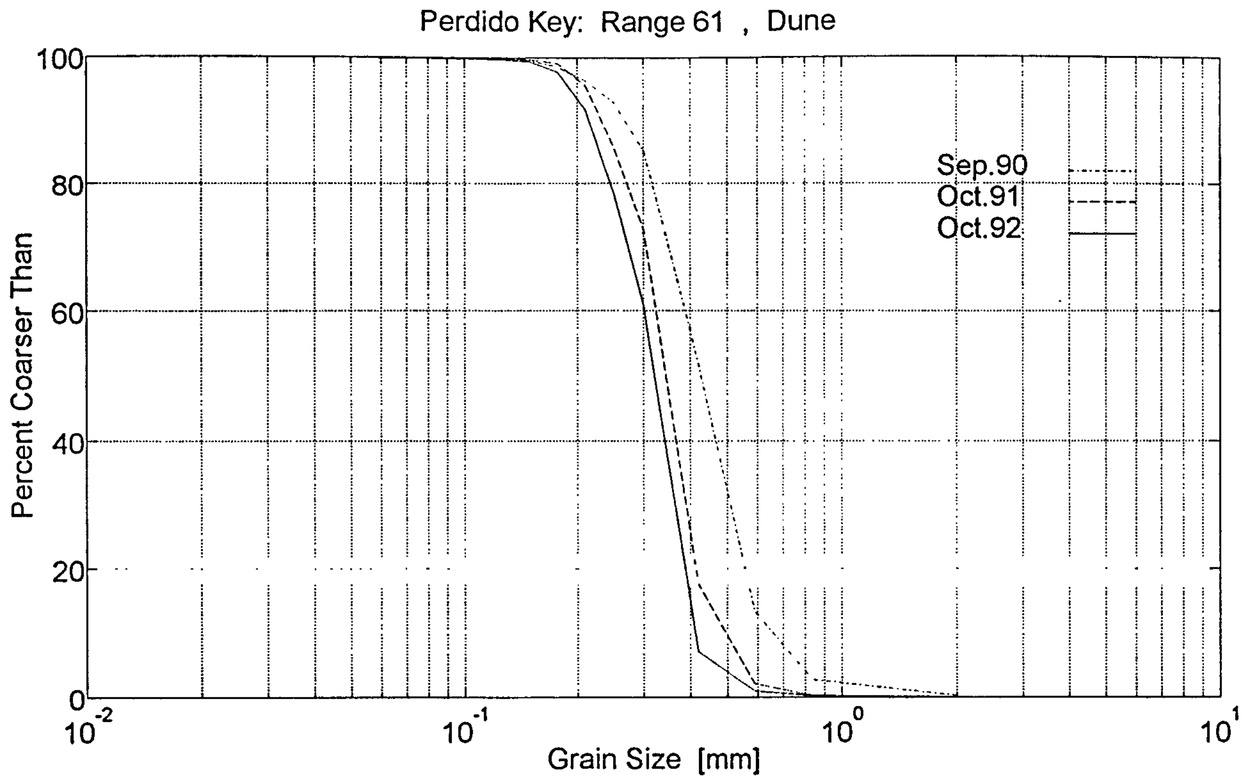


Figure III-72: Grain Size Distributions for Range 60, 5 M Depth and 8 M Depth Positions.



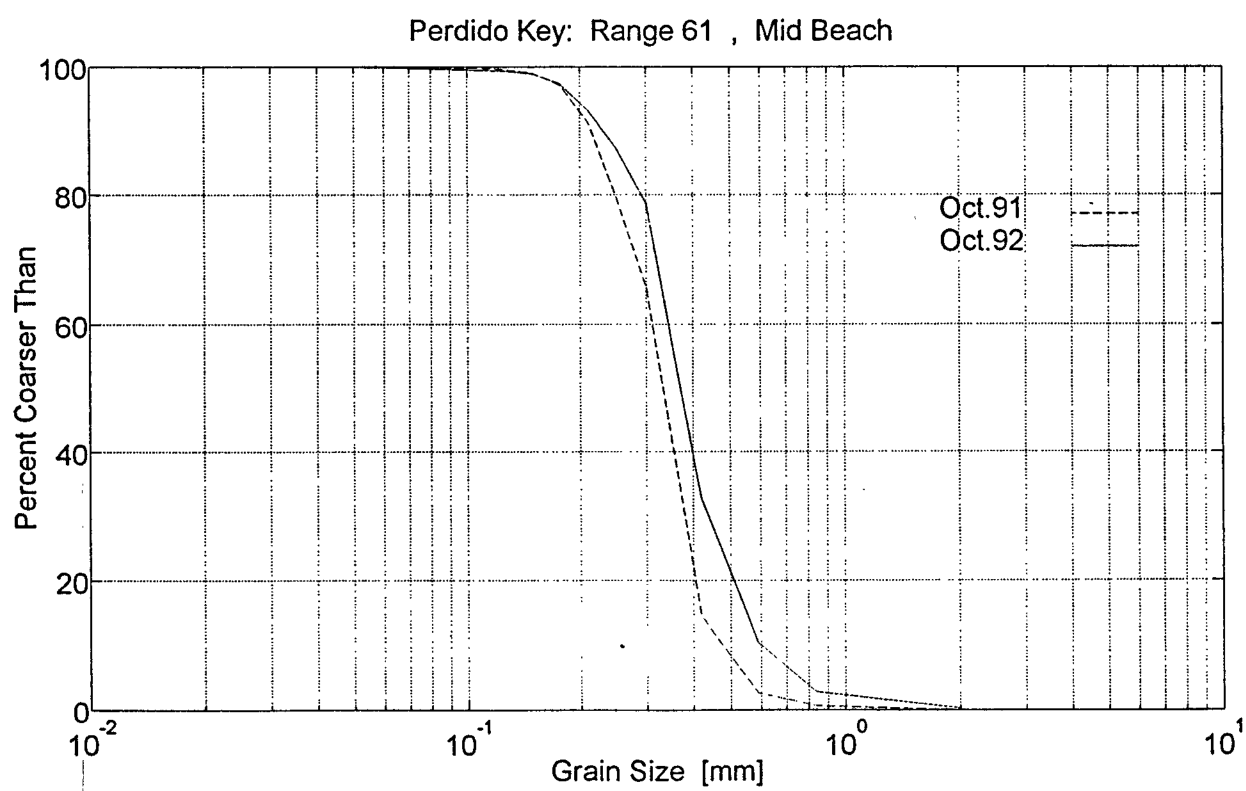
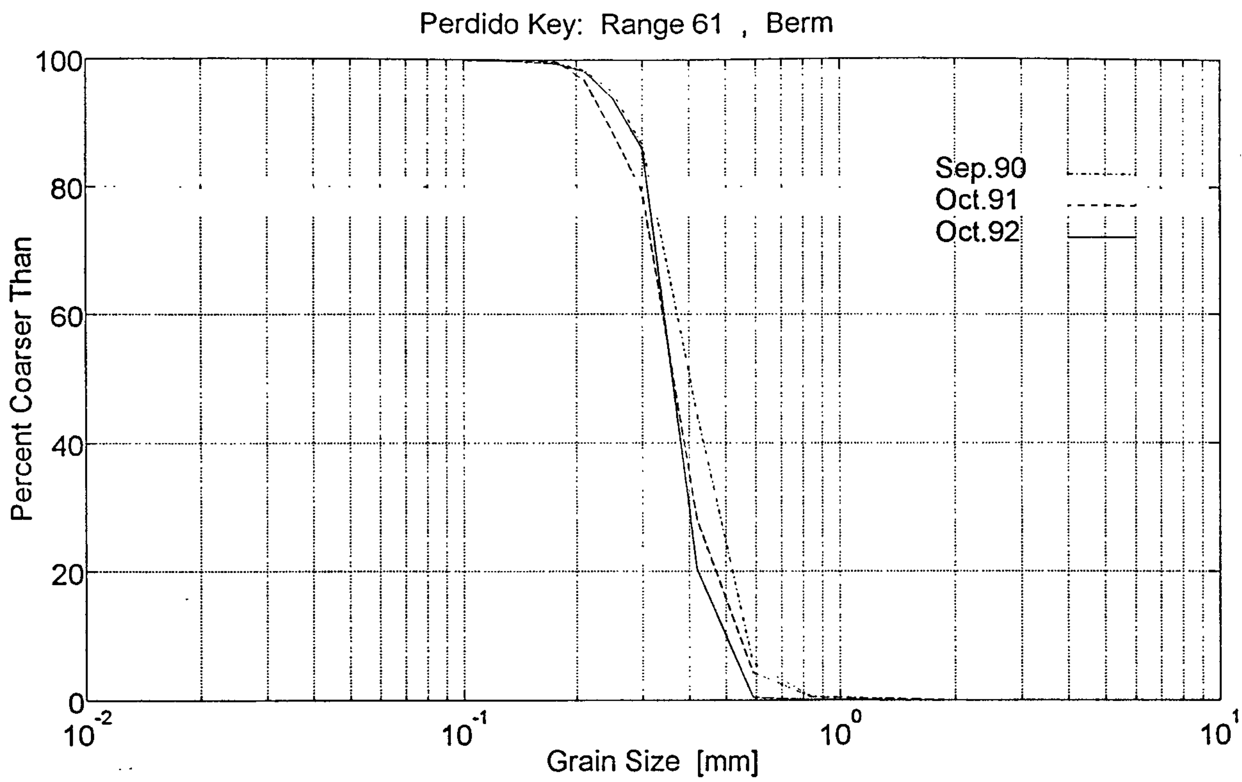


Figure III-73: Grain Size Distributions for Range 61, Dune and Mid-Beach Positions.



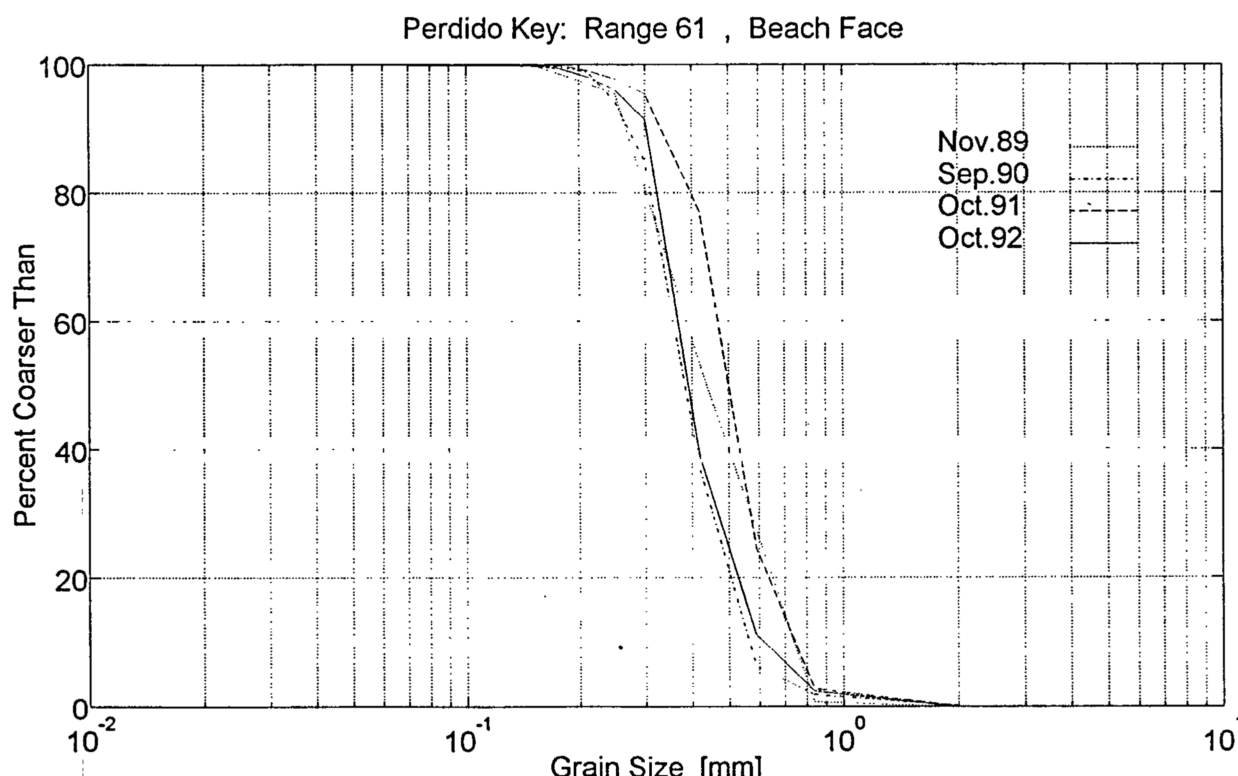
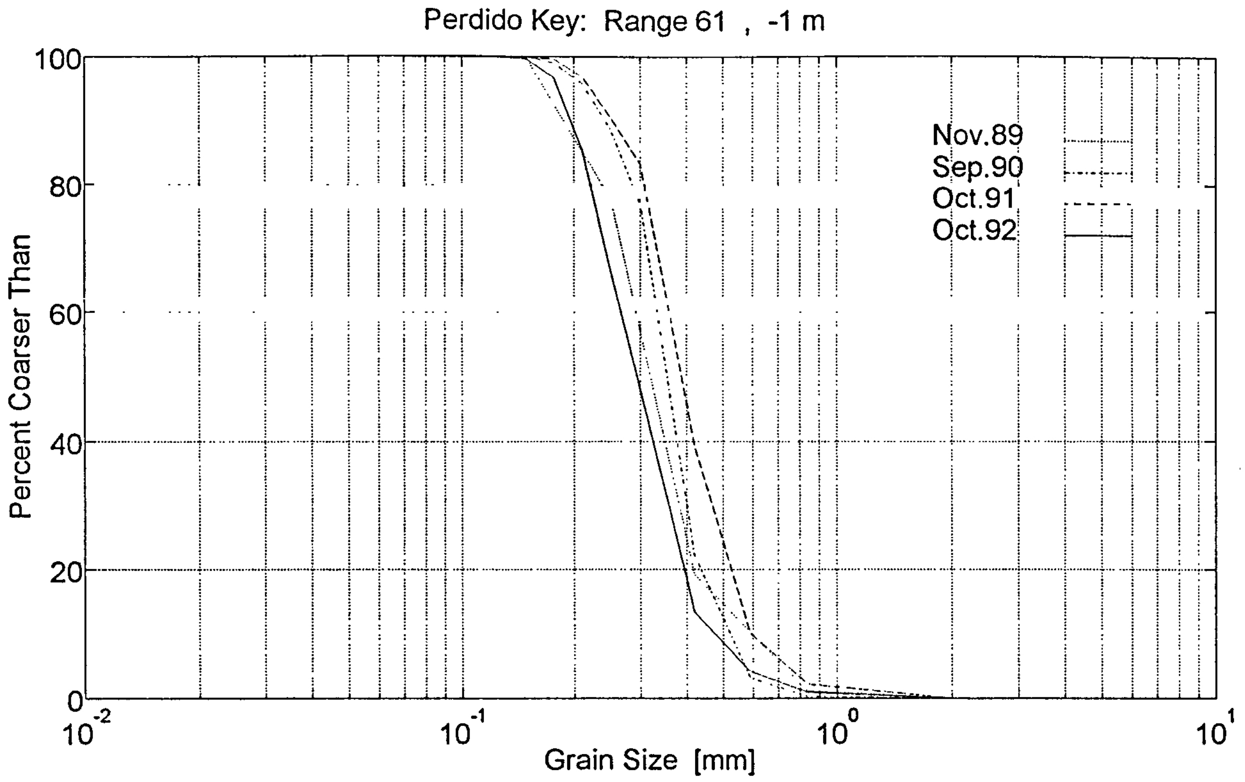


Figure III-74: Grain Size Distributions for Range 61, Berm and Beach Face Positions.



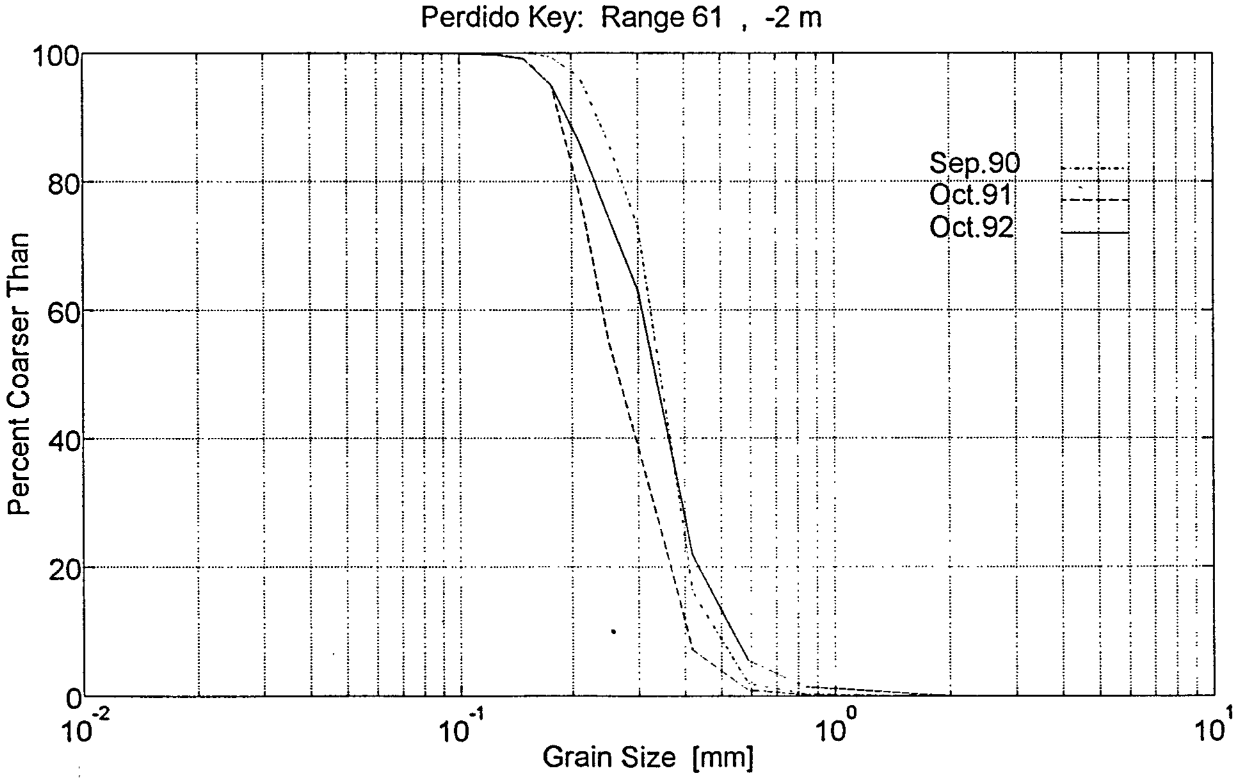


Figure III-75: Grain Size Distributions for Range 61, 1 M Depth and 2 M Depth Positions.

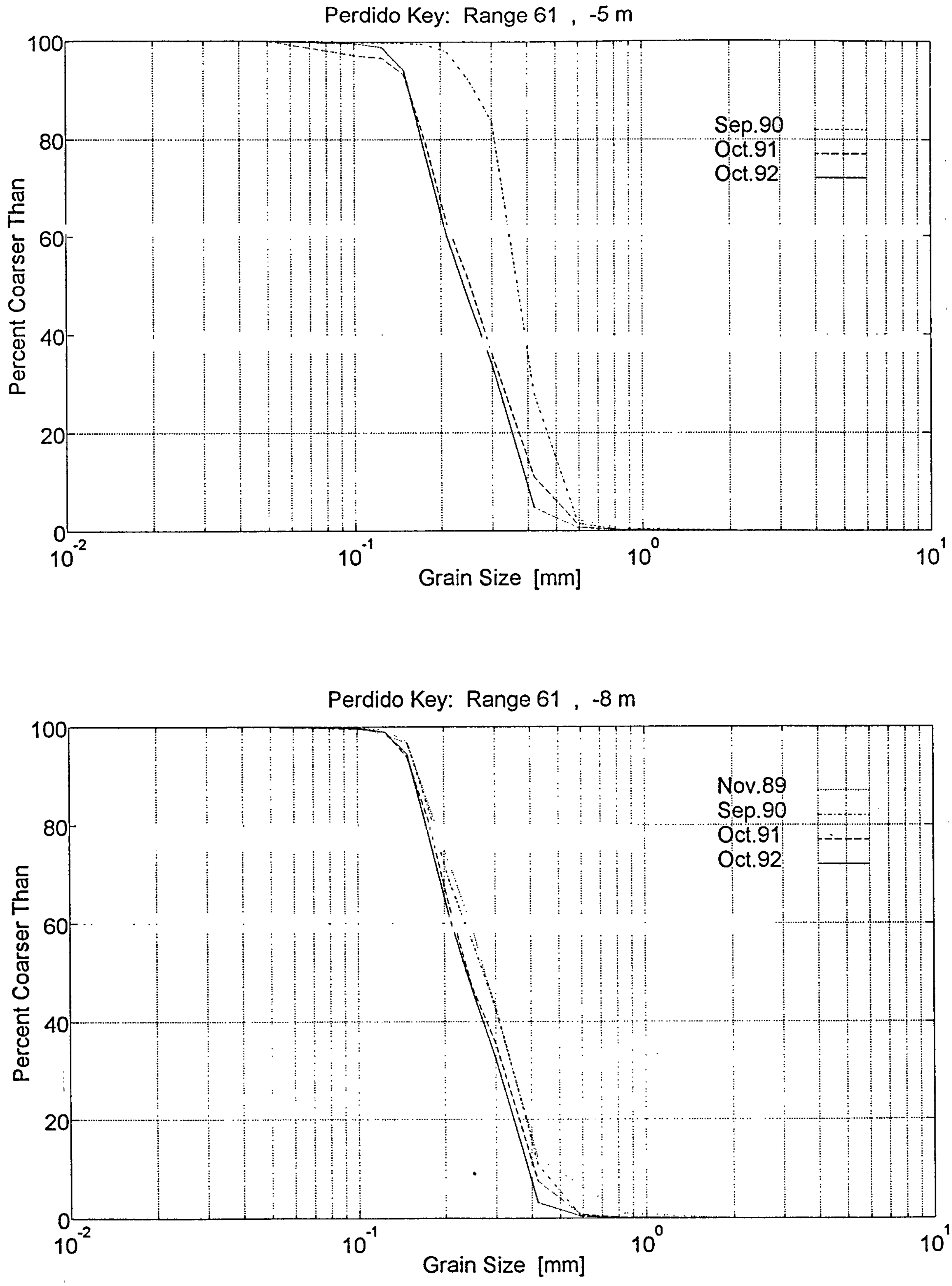
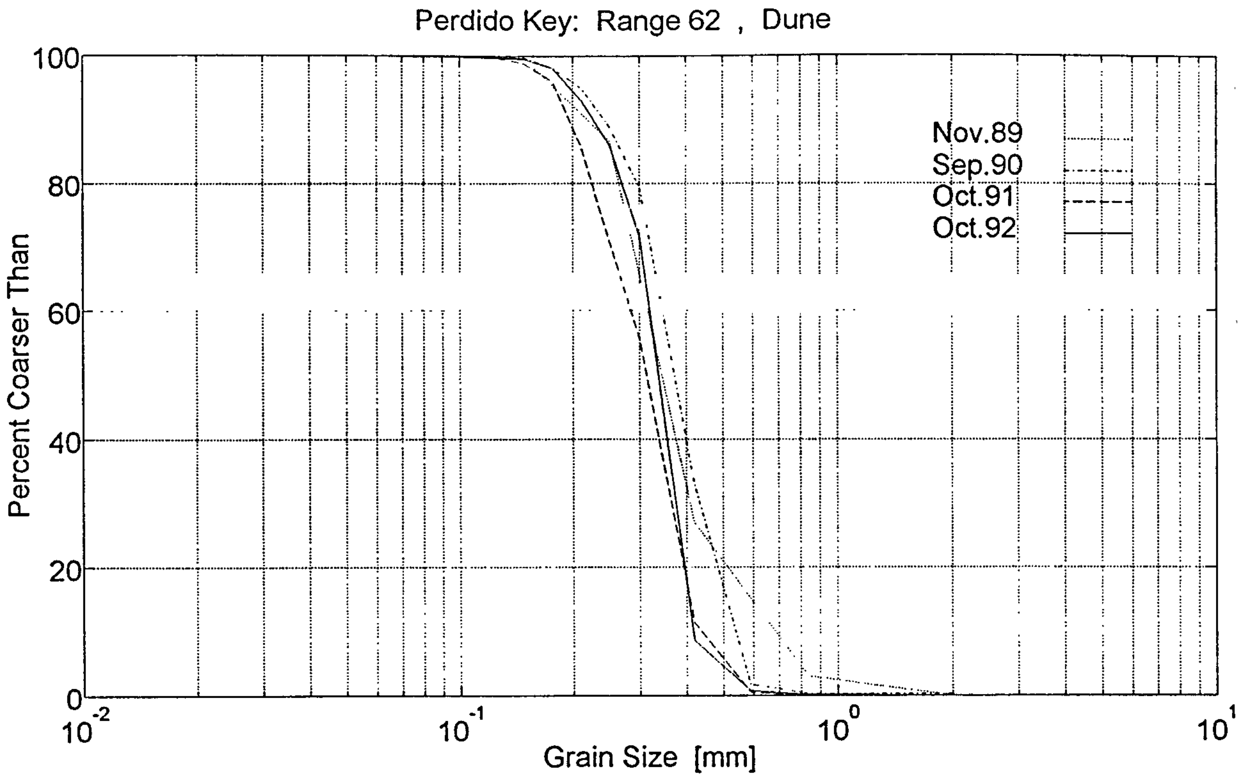


Figure III-76: Grain Size Distributions for Range 61, 5 M Depth and 8 M Depth Positions.



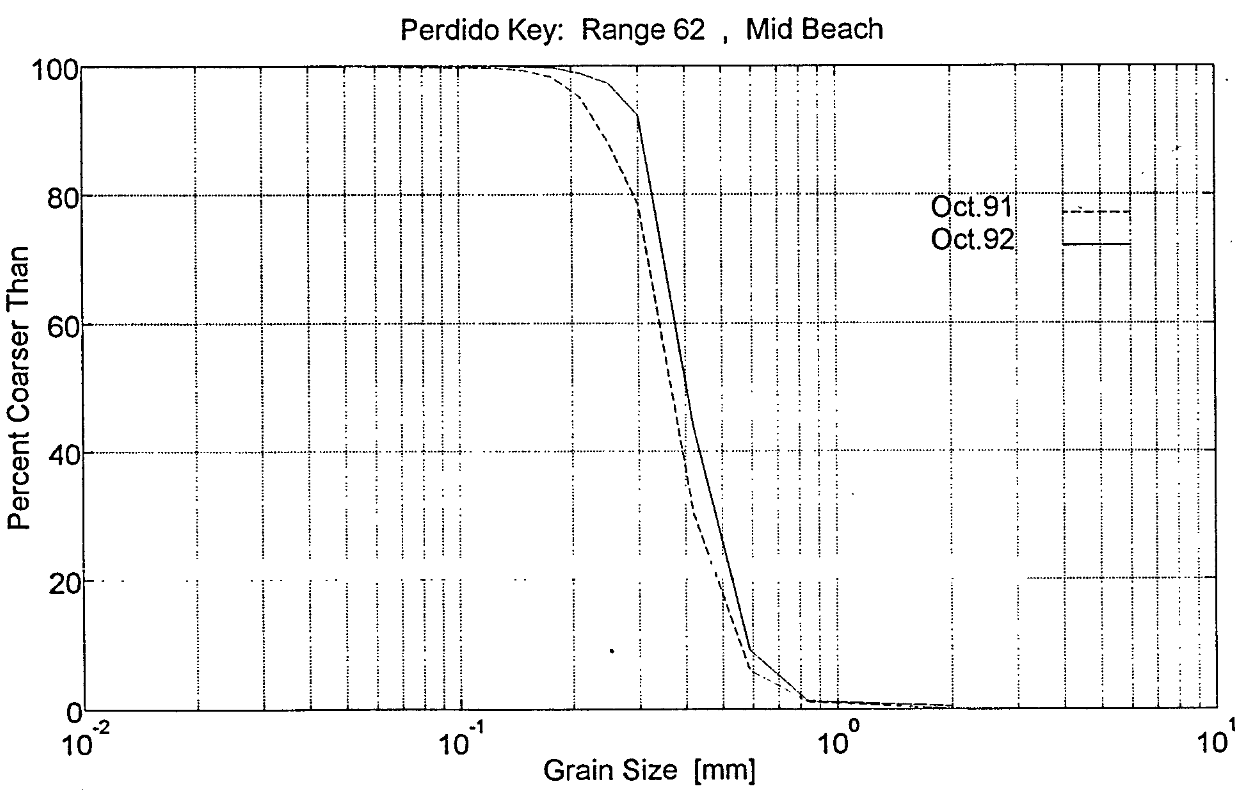
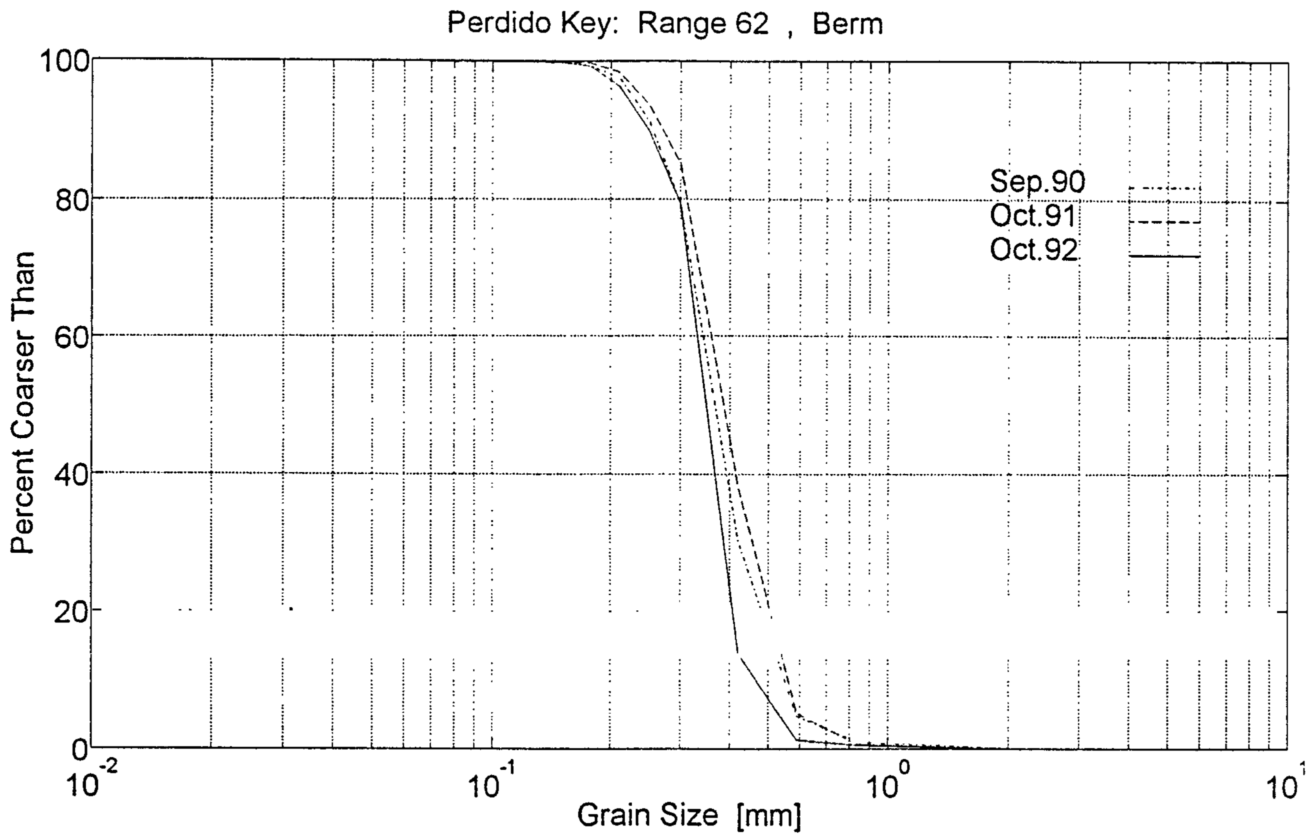


Figure III-77: Grain Size Distributions for Range 62, Dune and Mid-Beach Positions.



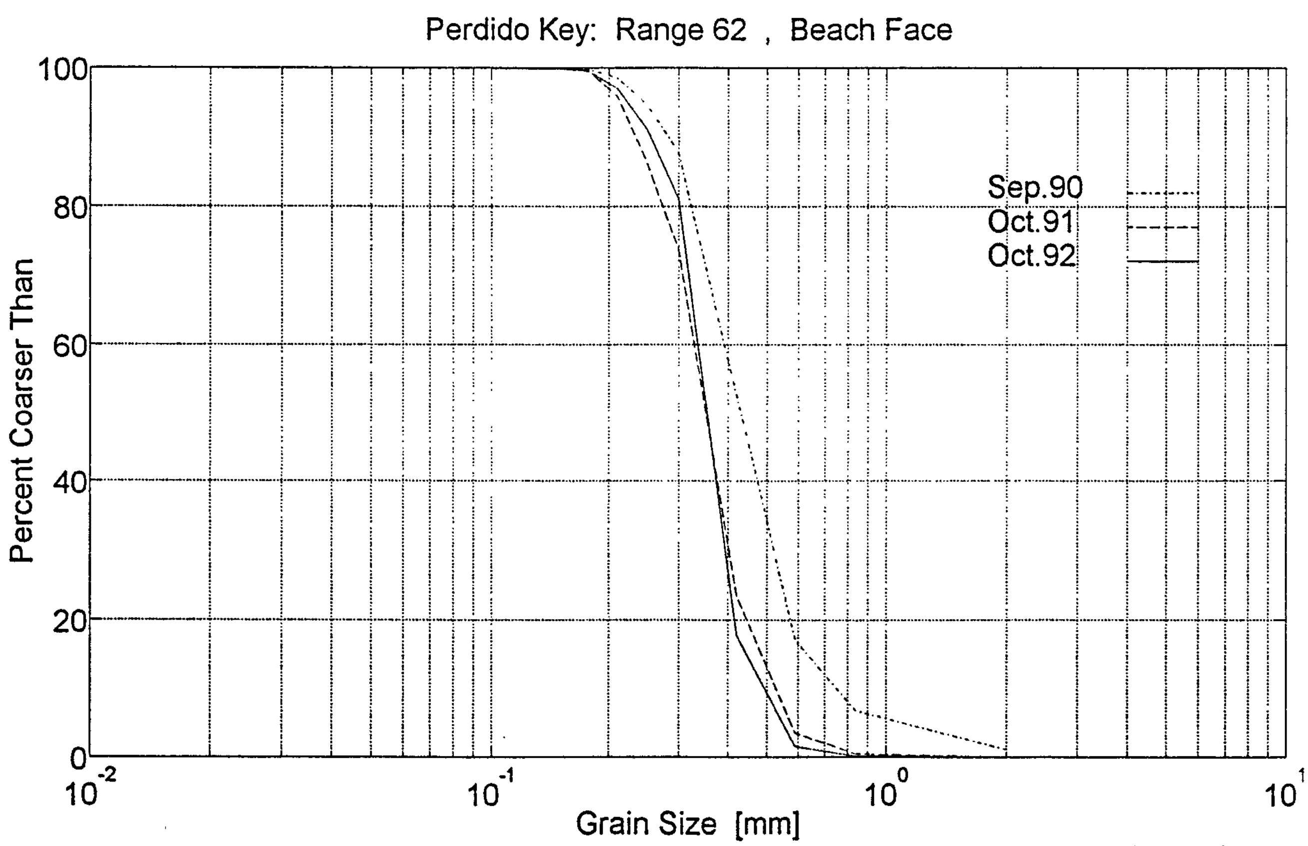
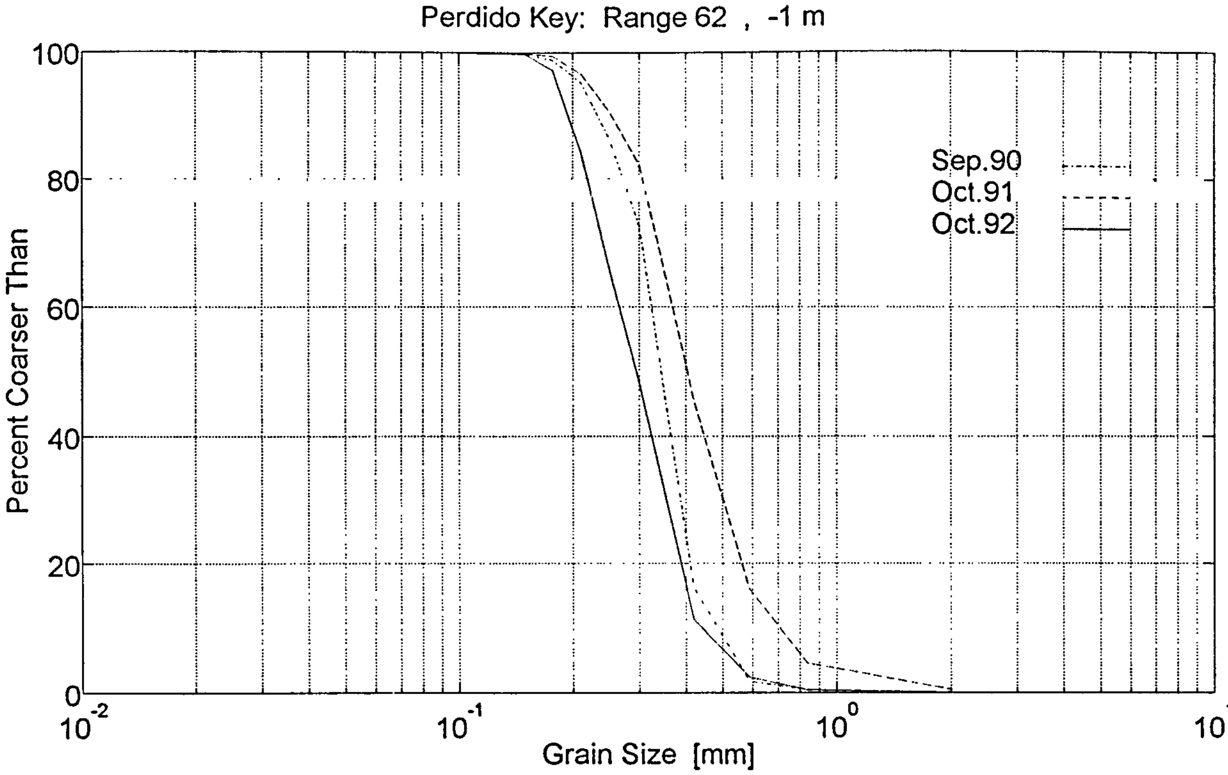


Figure III-78: Grain Size Distributions for Range 62, Berm and Beach Face Positions.



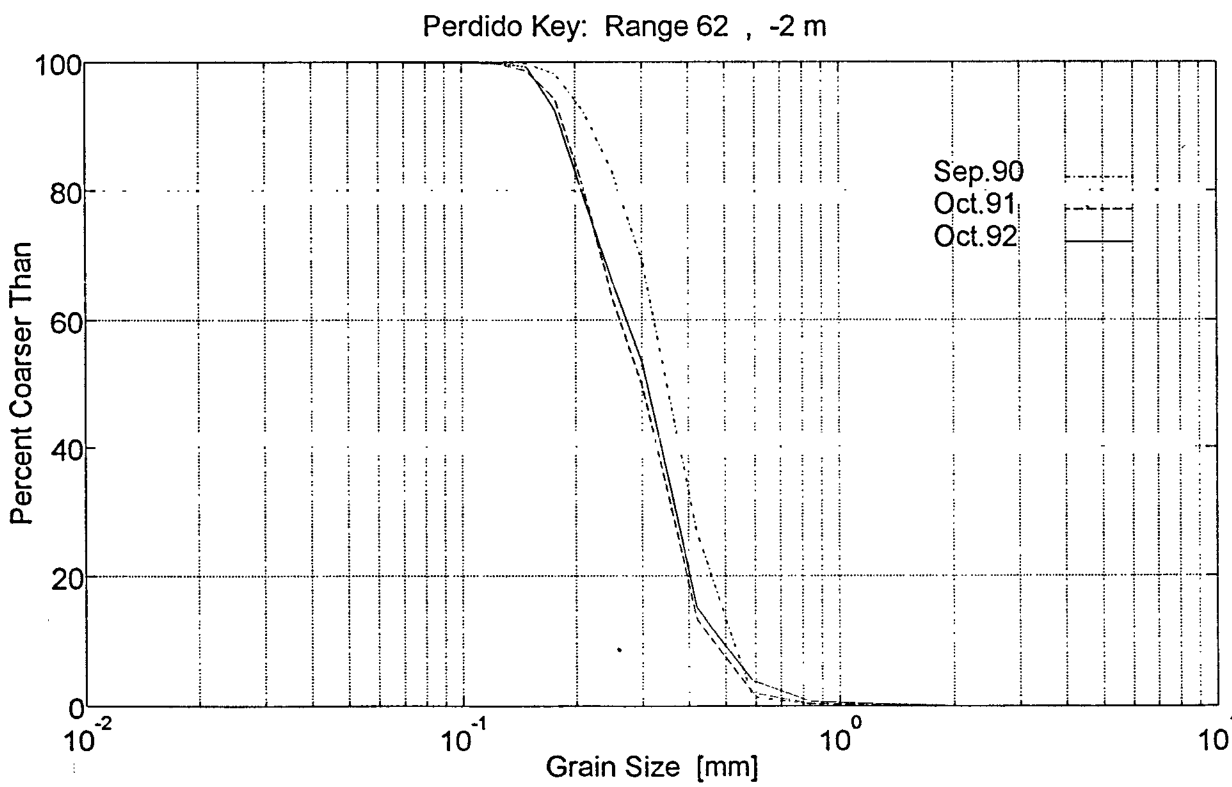
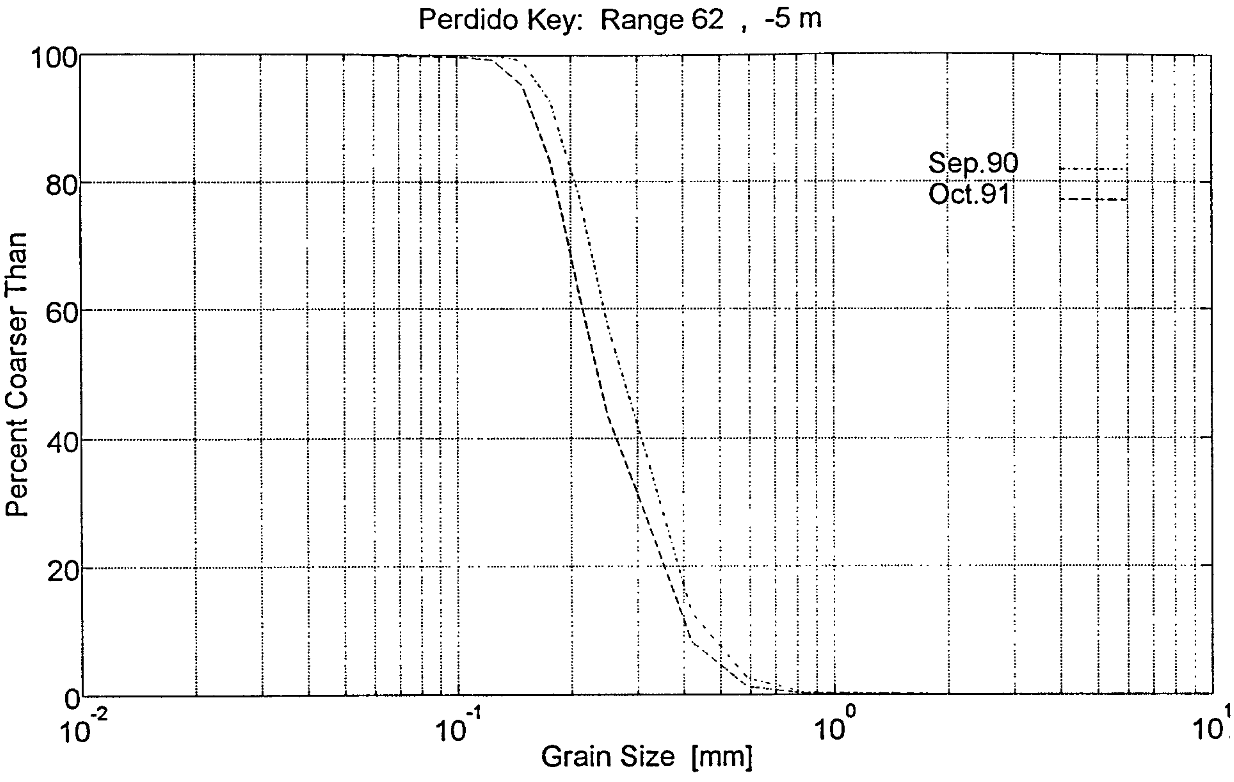


Figure III-79: Grain Size Distributions for Range 62, 1 M Depth and 2 M Depth Positions.



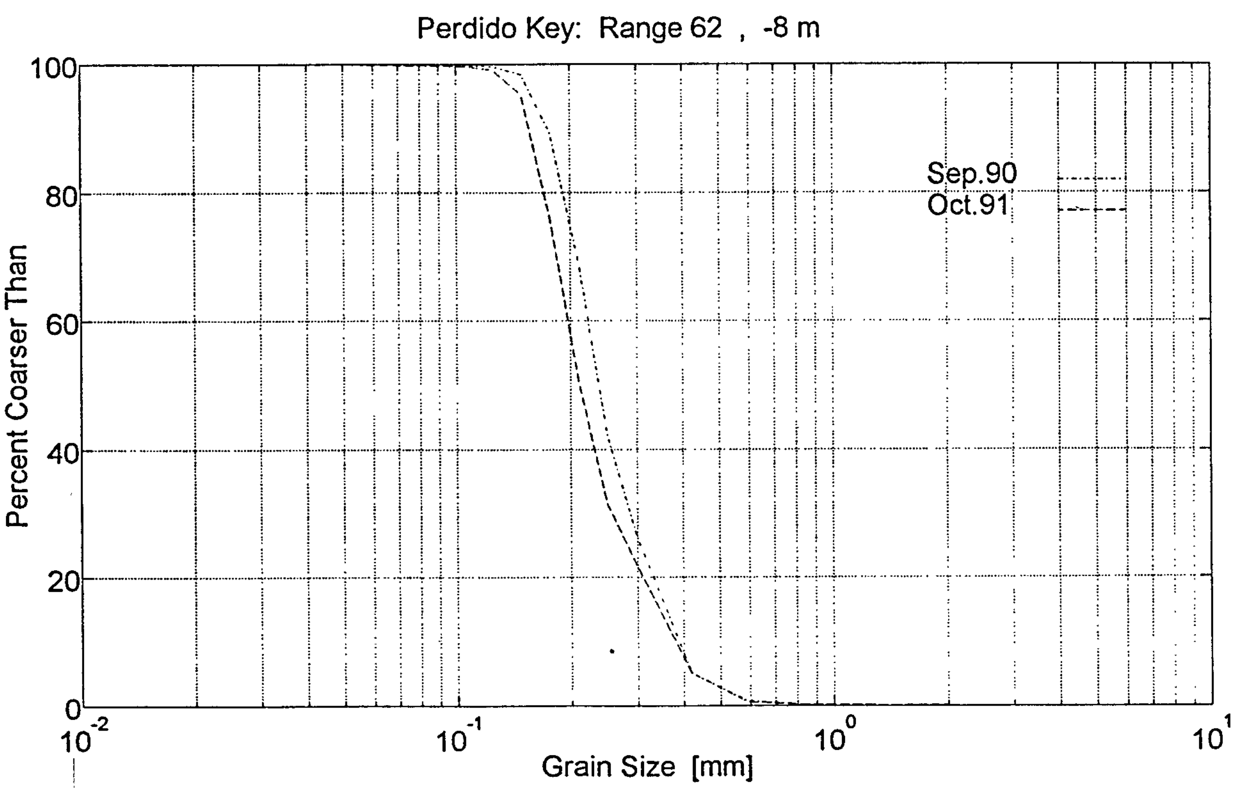
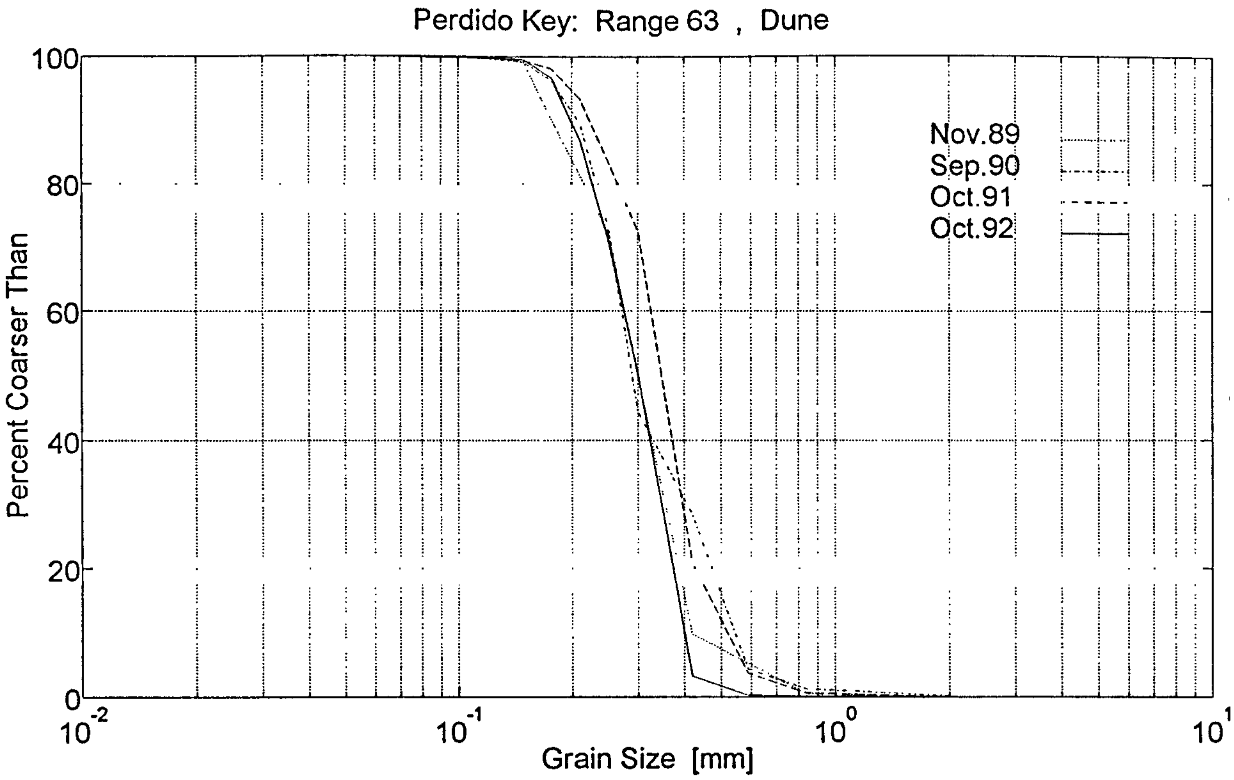


Figure III-80: Grain Size Distributions for Range 62, 5 M Depth and 8 M Depth Positions.



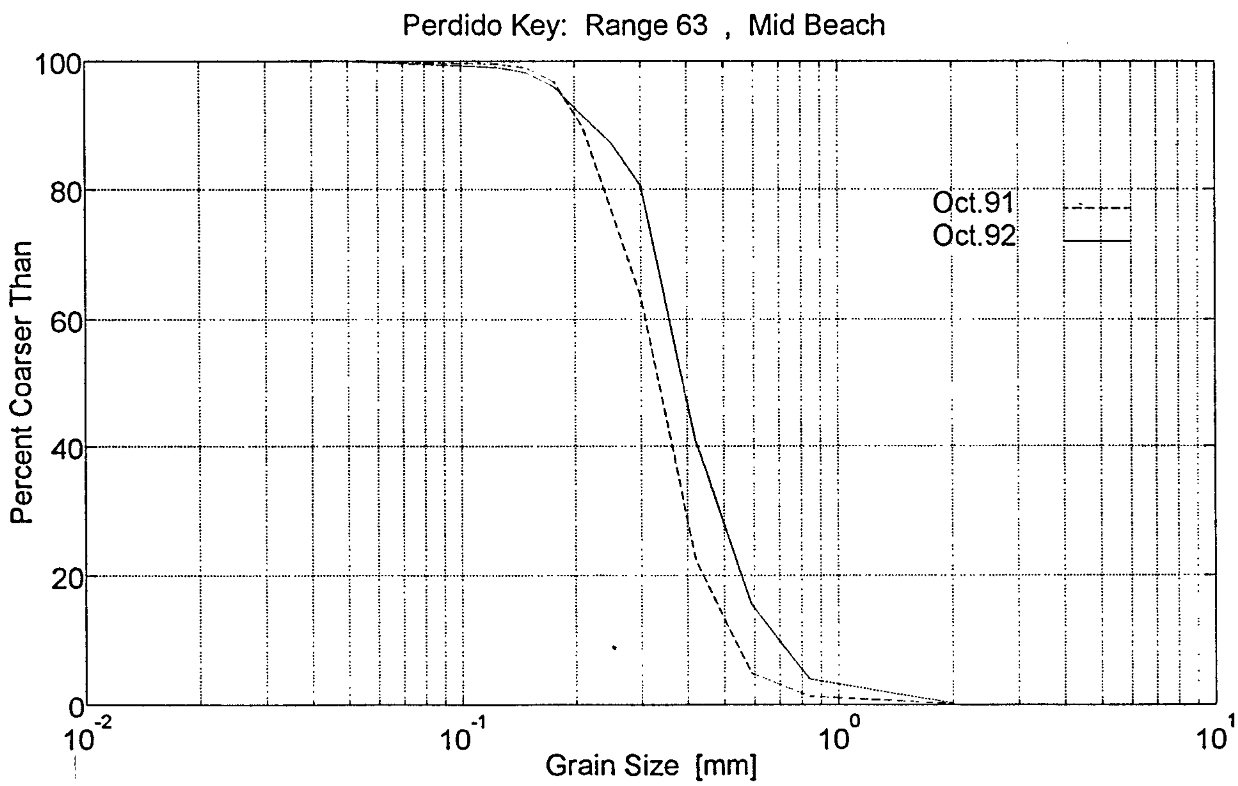
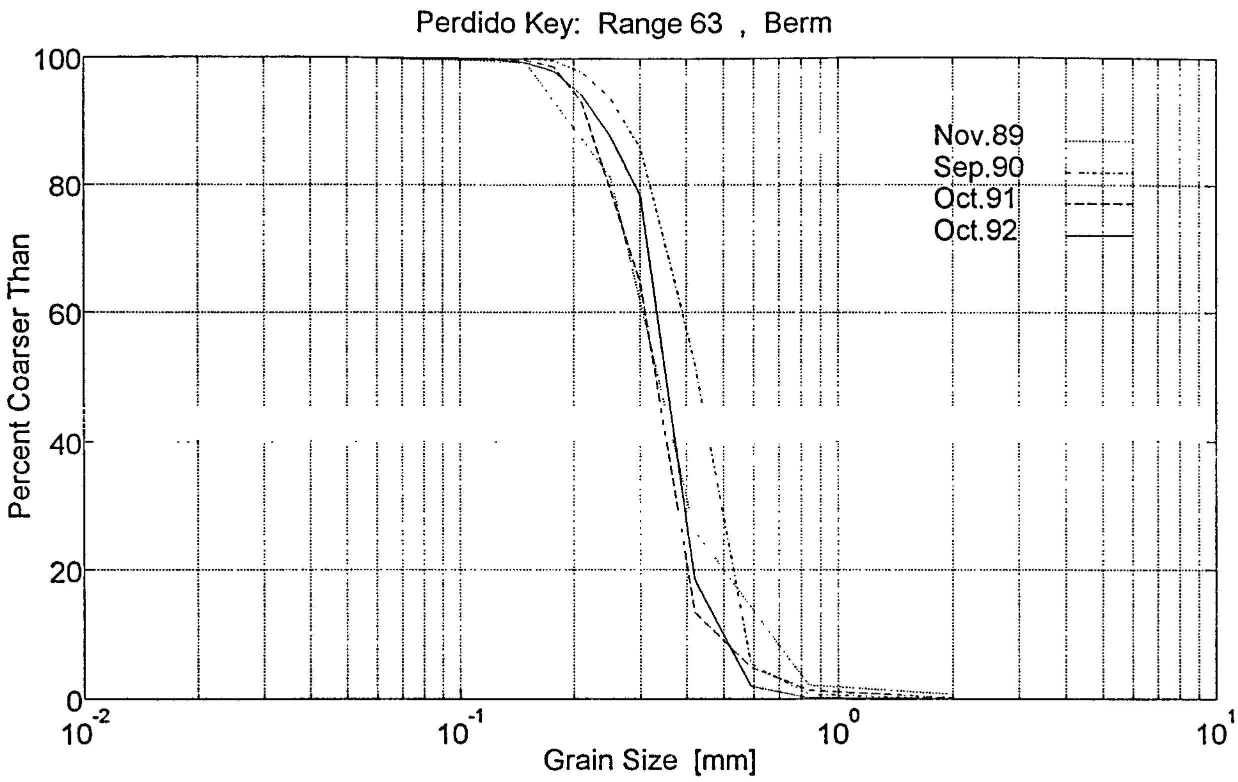


Figure III-81: Grain Size Distributions for Range 63, Dune and Mid-Beach Positions.



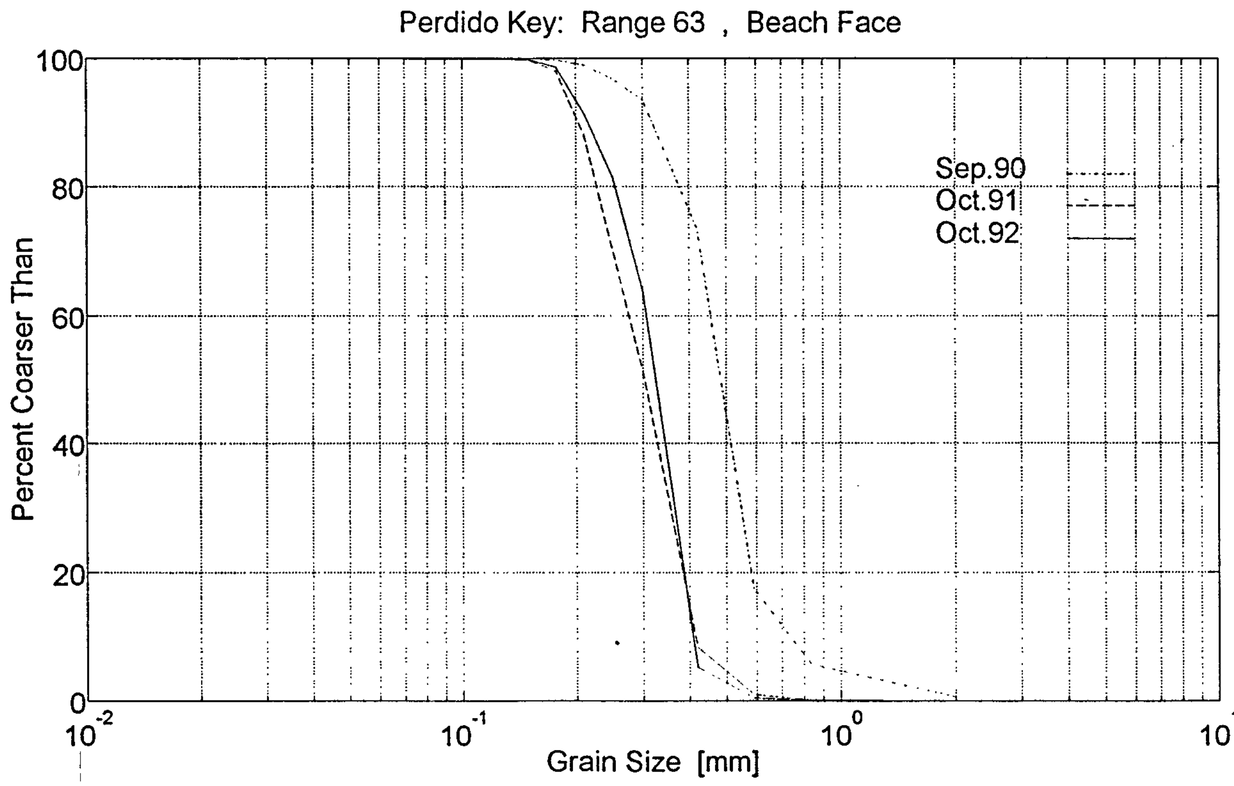
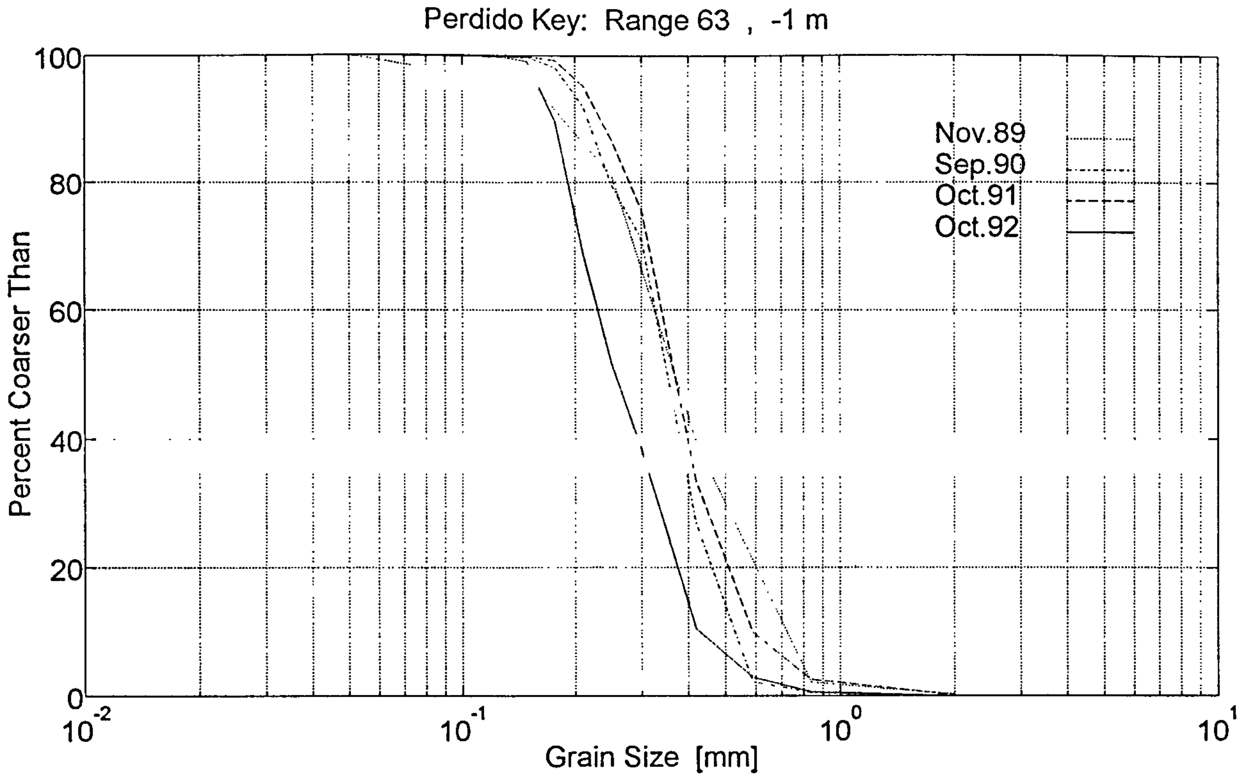


Figure III-82: Grain Size Distributions for Range 63, Berm and Beach Face Positions.



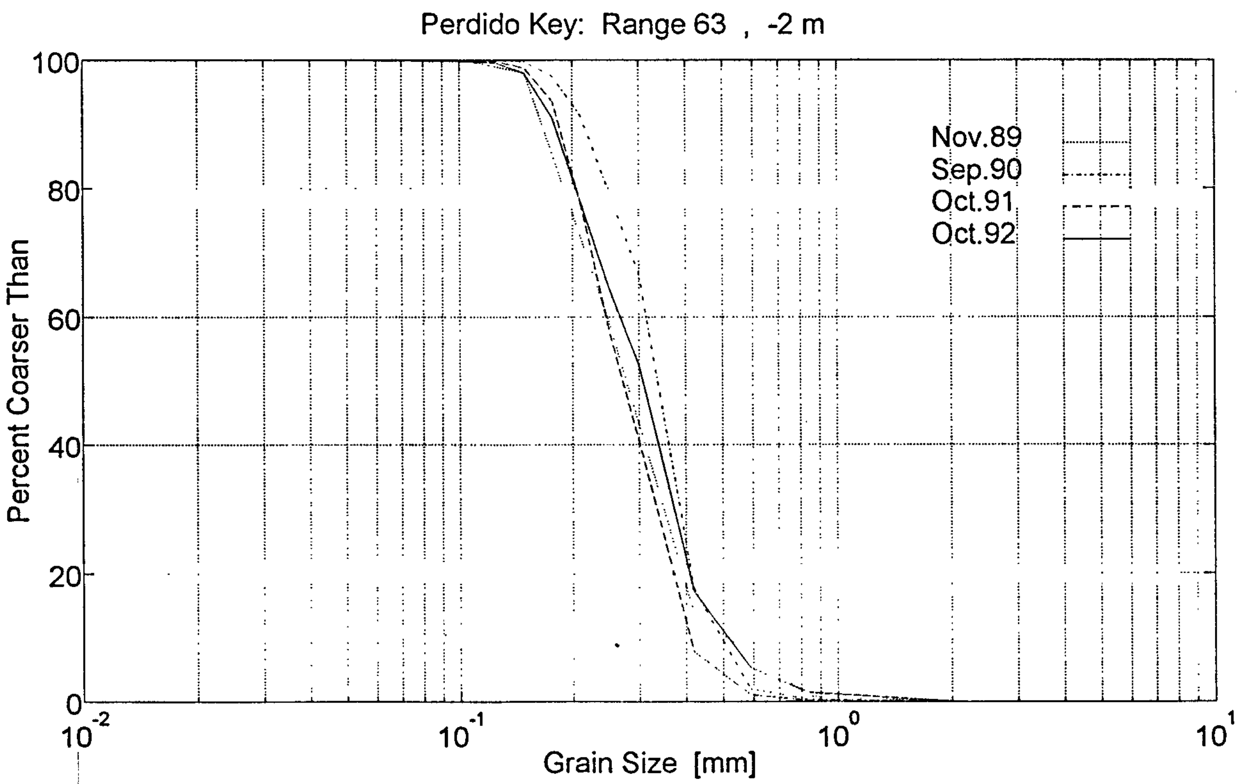
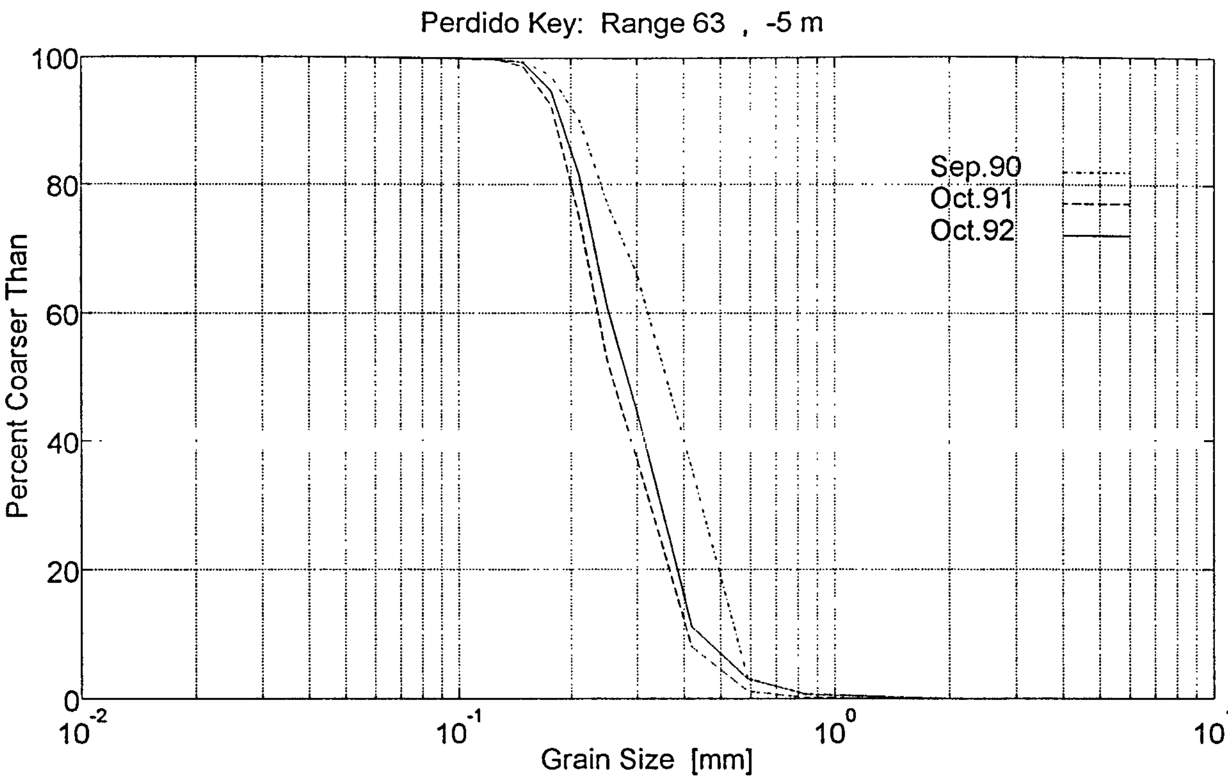


Figure III-83: Grain Size Distributions for Range 63, 1 M Depth and 2 M Depth Positions.



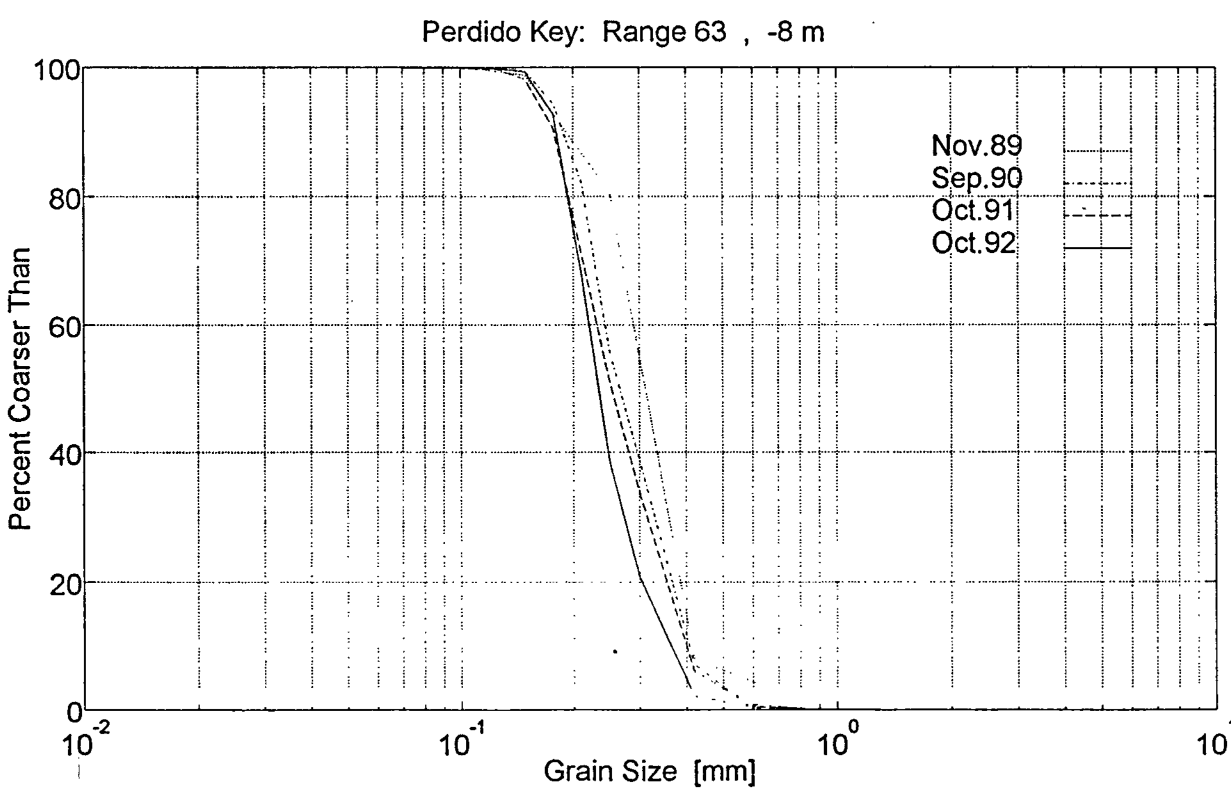


Figure III-84: Grain Size Distributions for Range 63, 5 M Depth and 8 M Depth Positions.

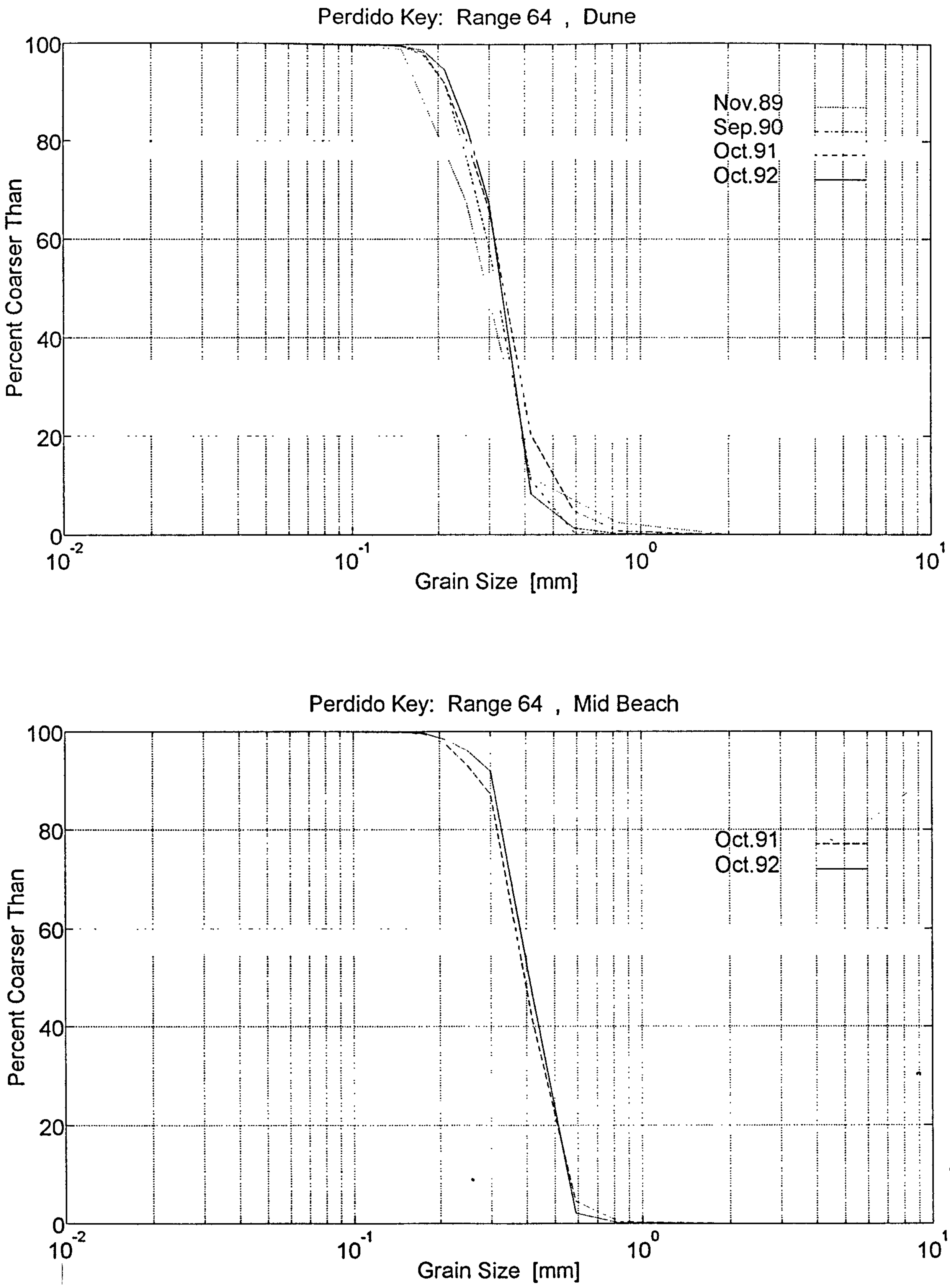
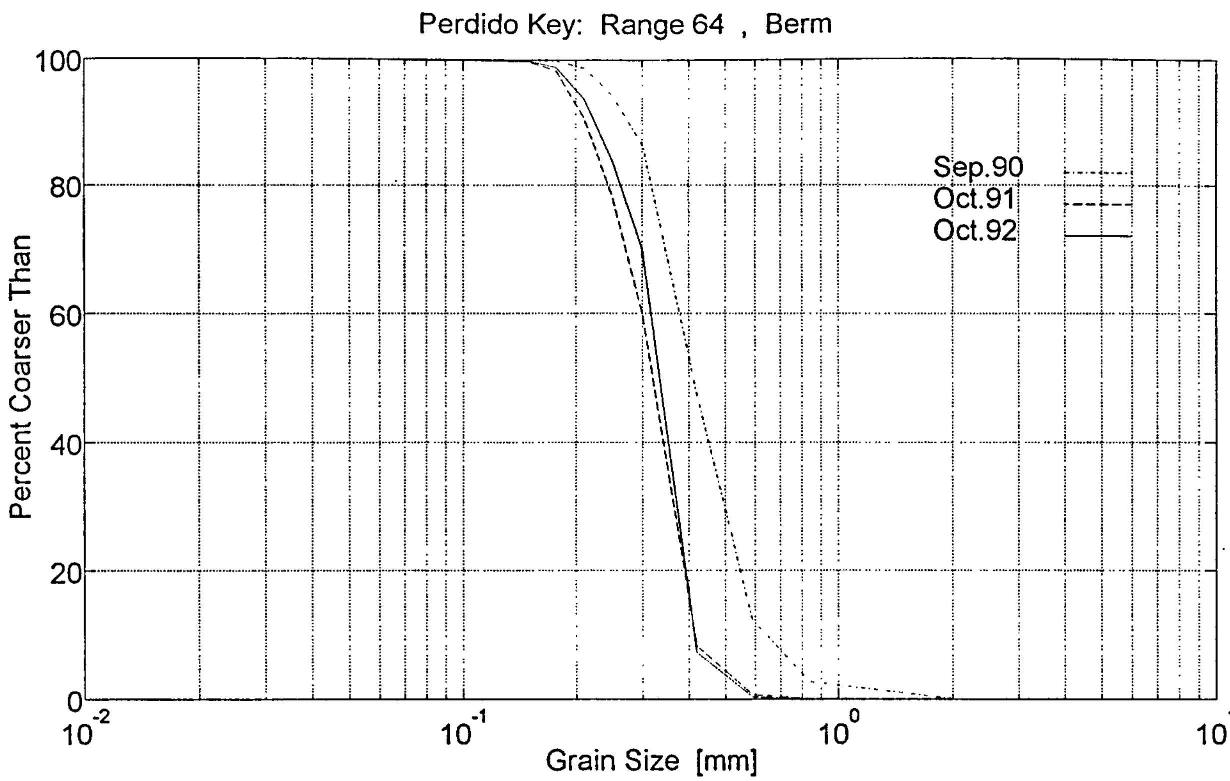


Figure III-85: Grain Size Distributions for Range 64, Dune and Mid-Beach Positions.



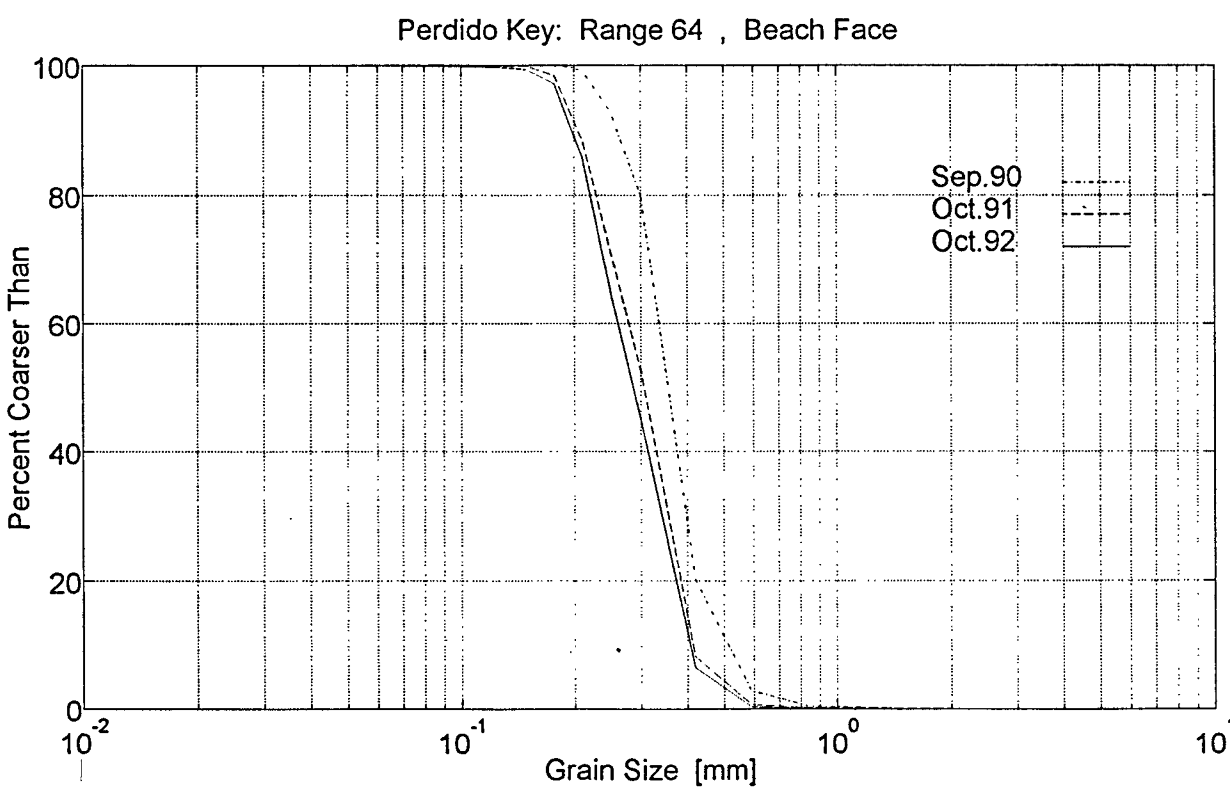
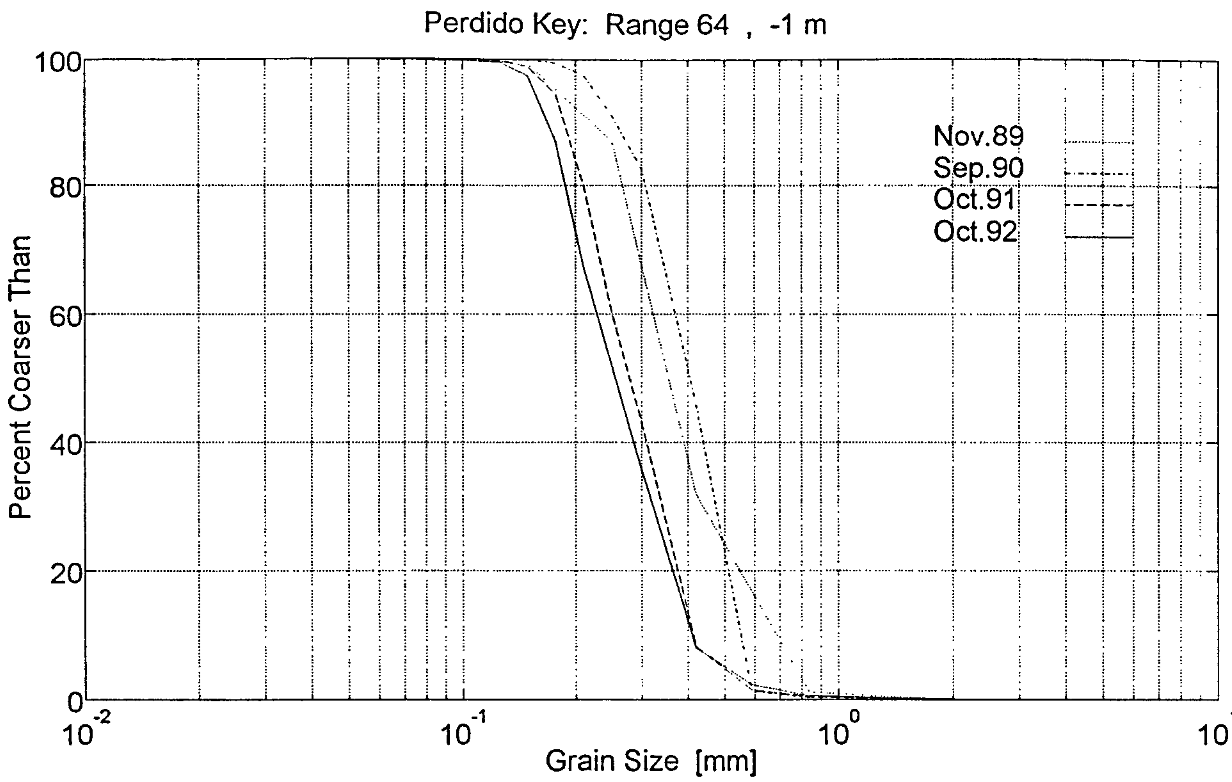


Figure III-86: Grain Size Distributions for Range 64, Berm and Beach Face Positions.



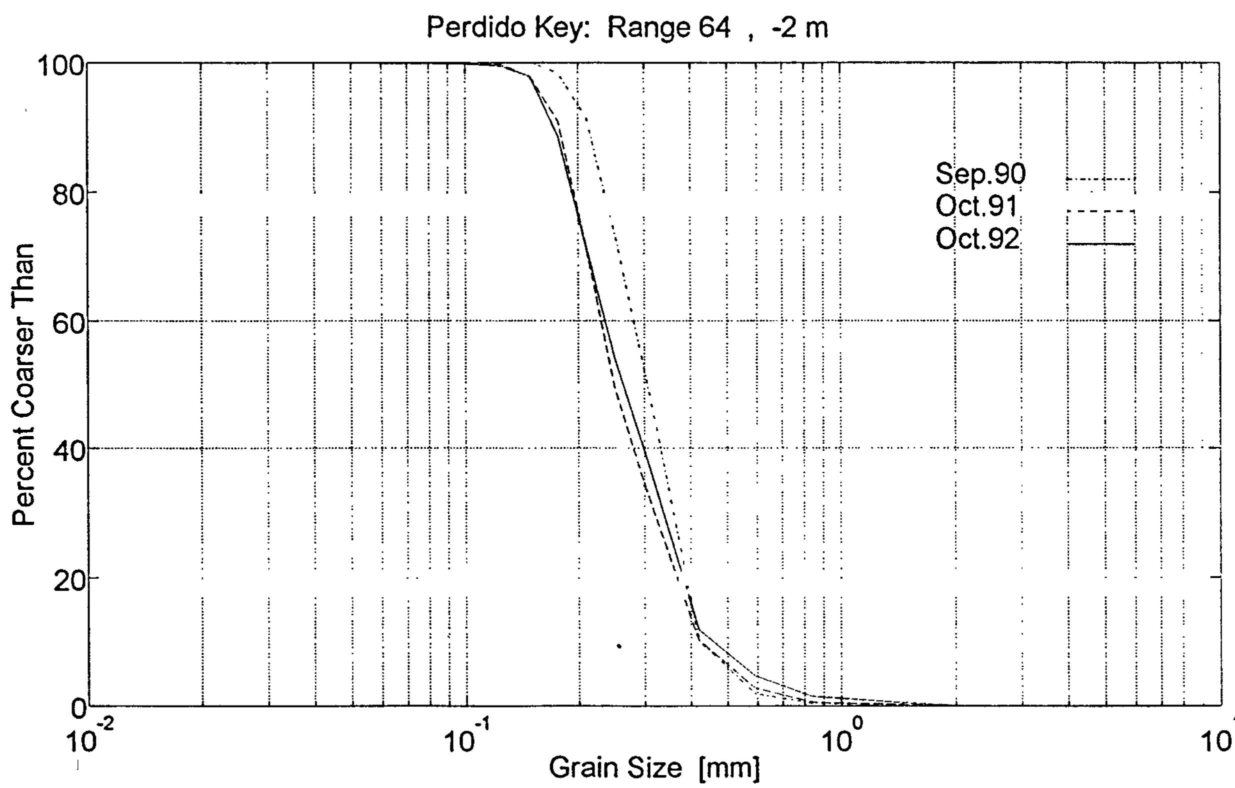
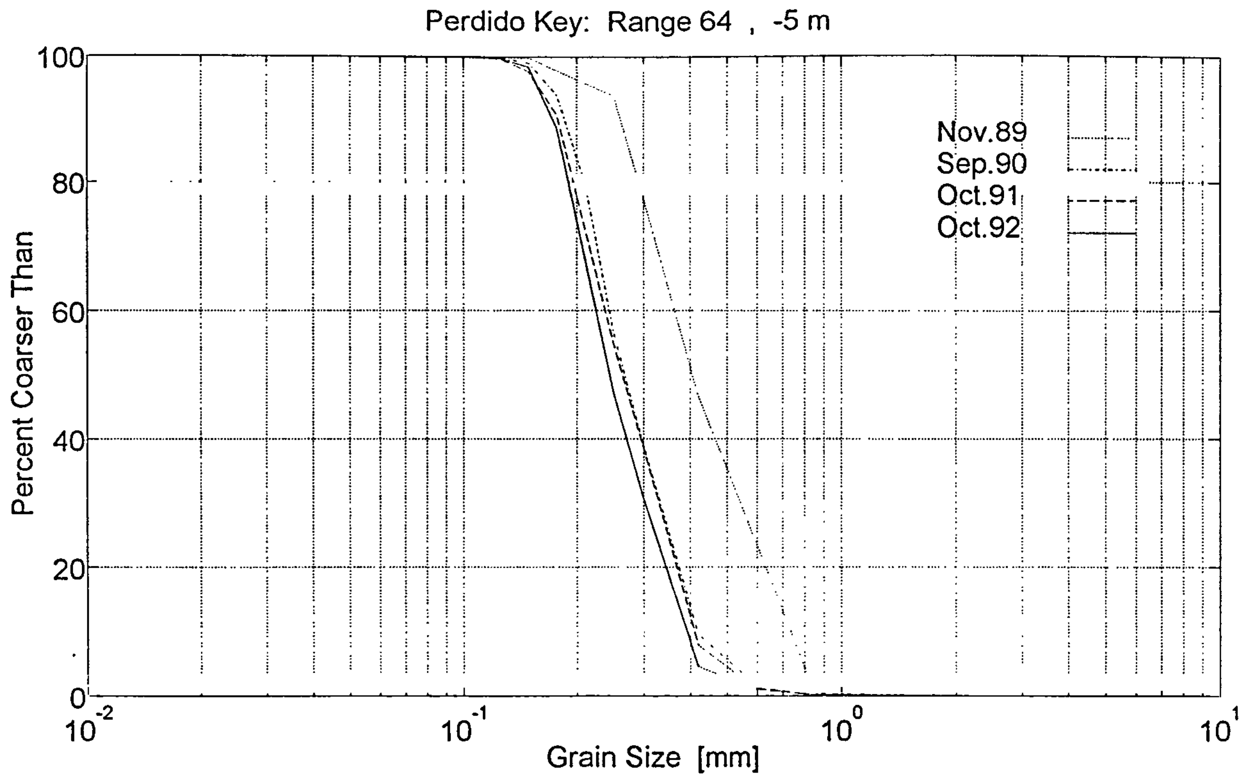


Figure III-87: Grain Size Distributions for Range 64, 1 M Depth and 2 M Depth Positions.



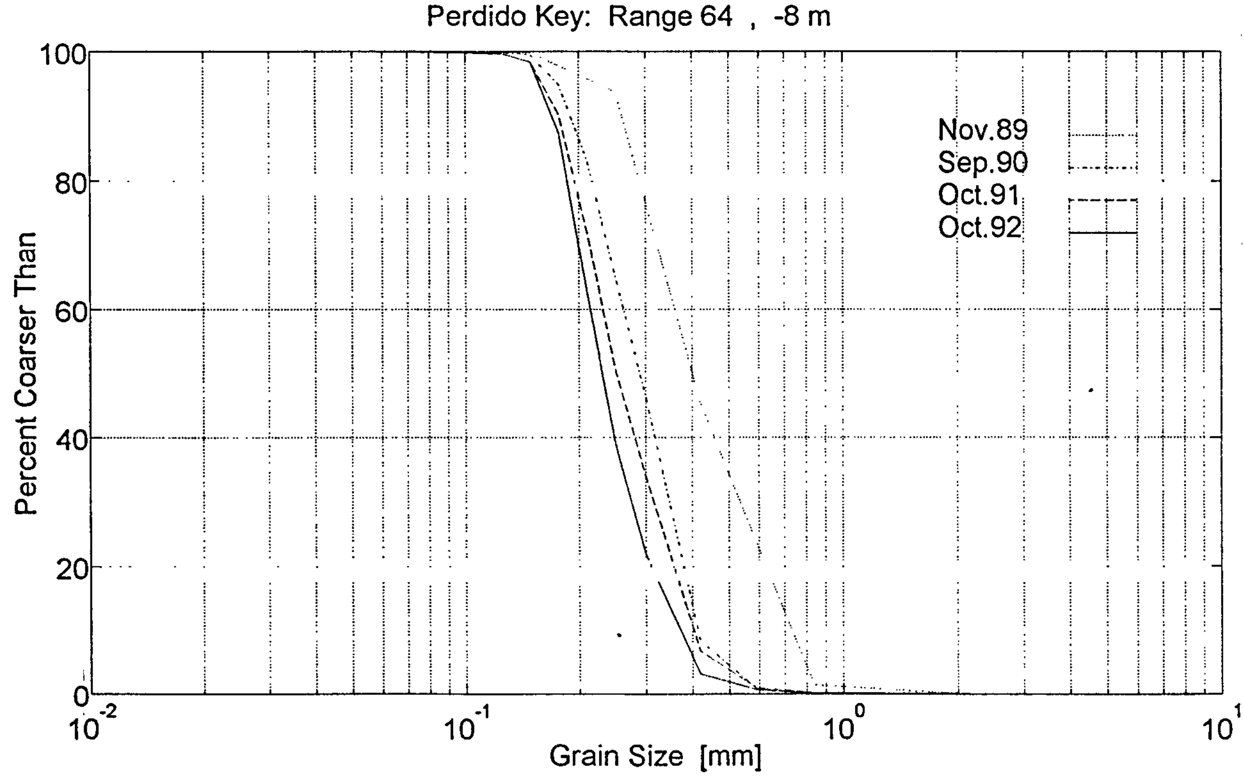
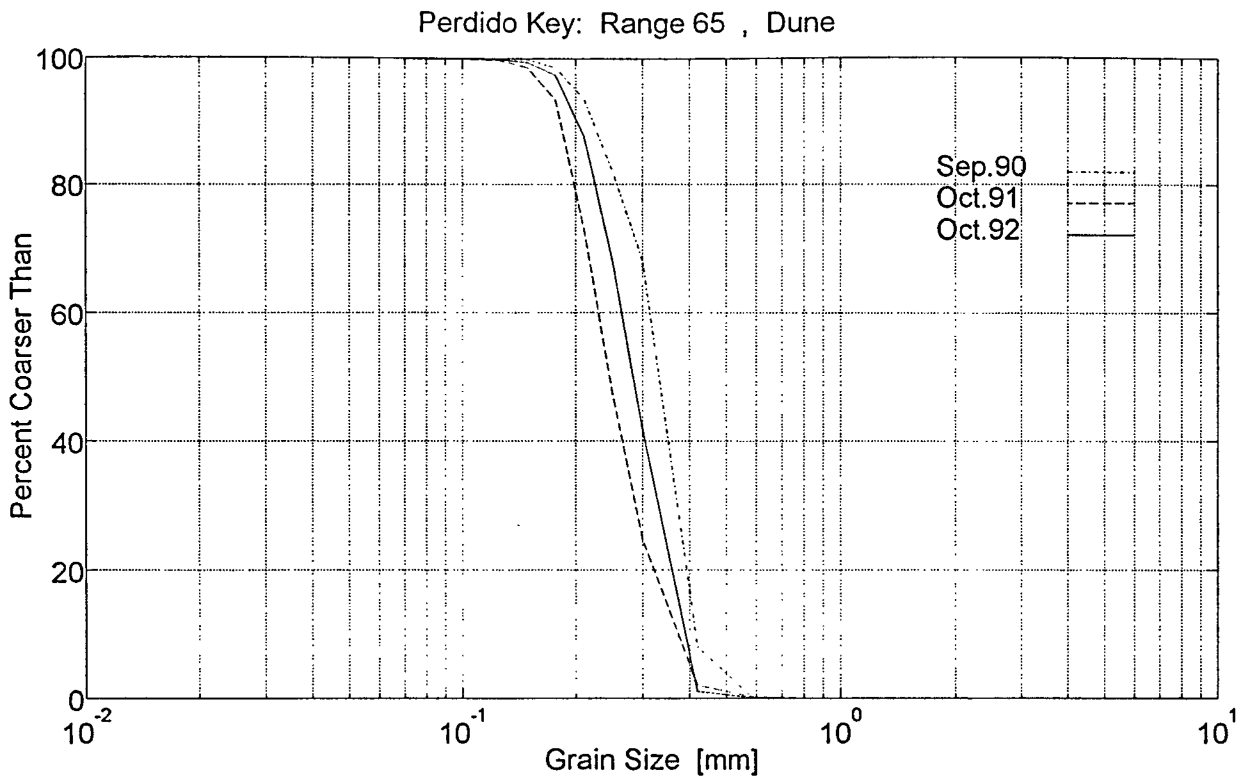


Figure III-88: Grain Size Distributions for Range 64, 5 M Depth and 8 M Depth Positions.



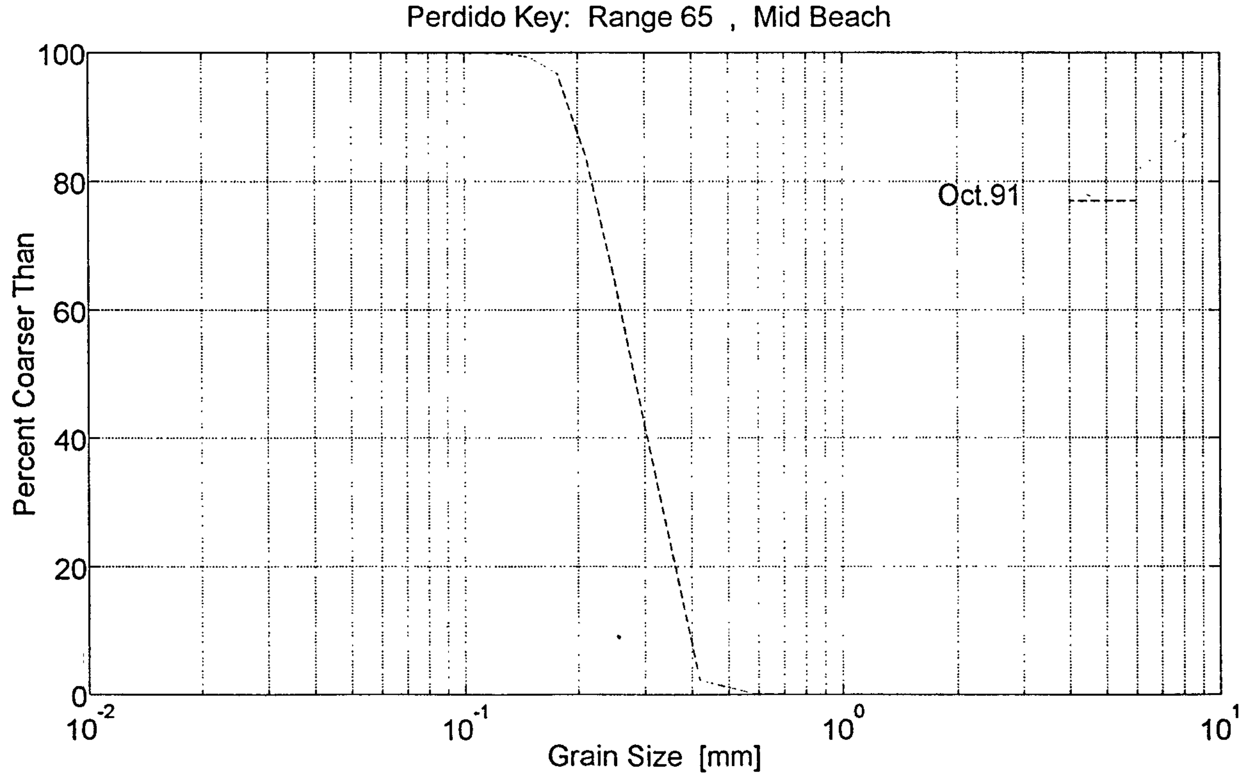
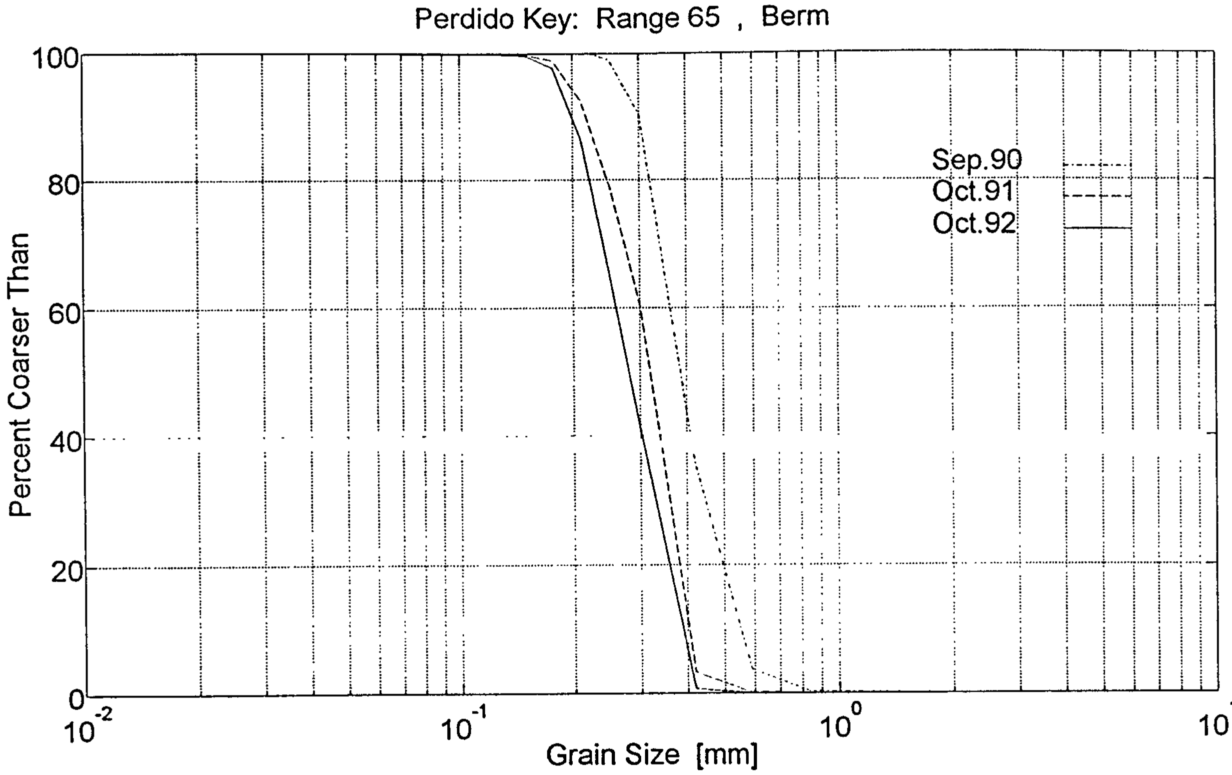


Figure III-89: Grain Size Distributions for Range 65, Dune and Mid-Beach Positions.



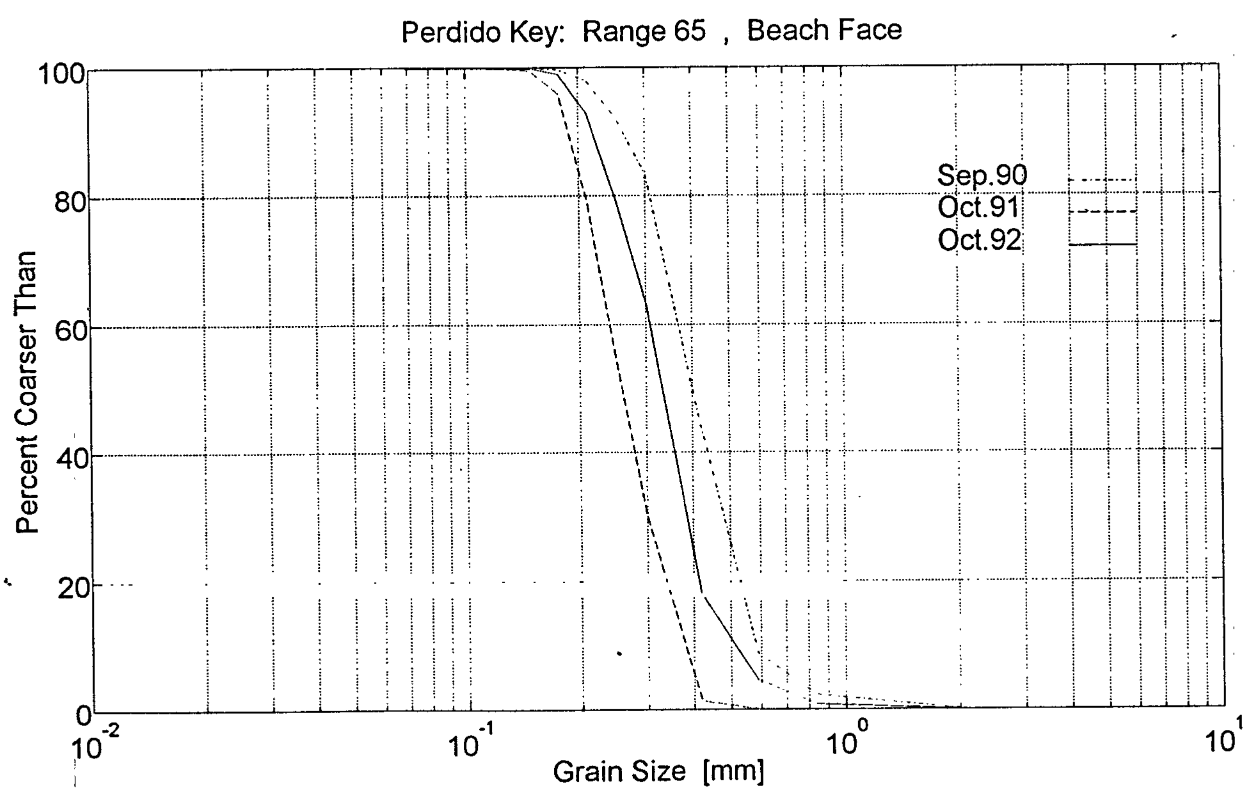
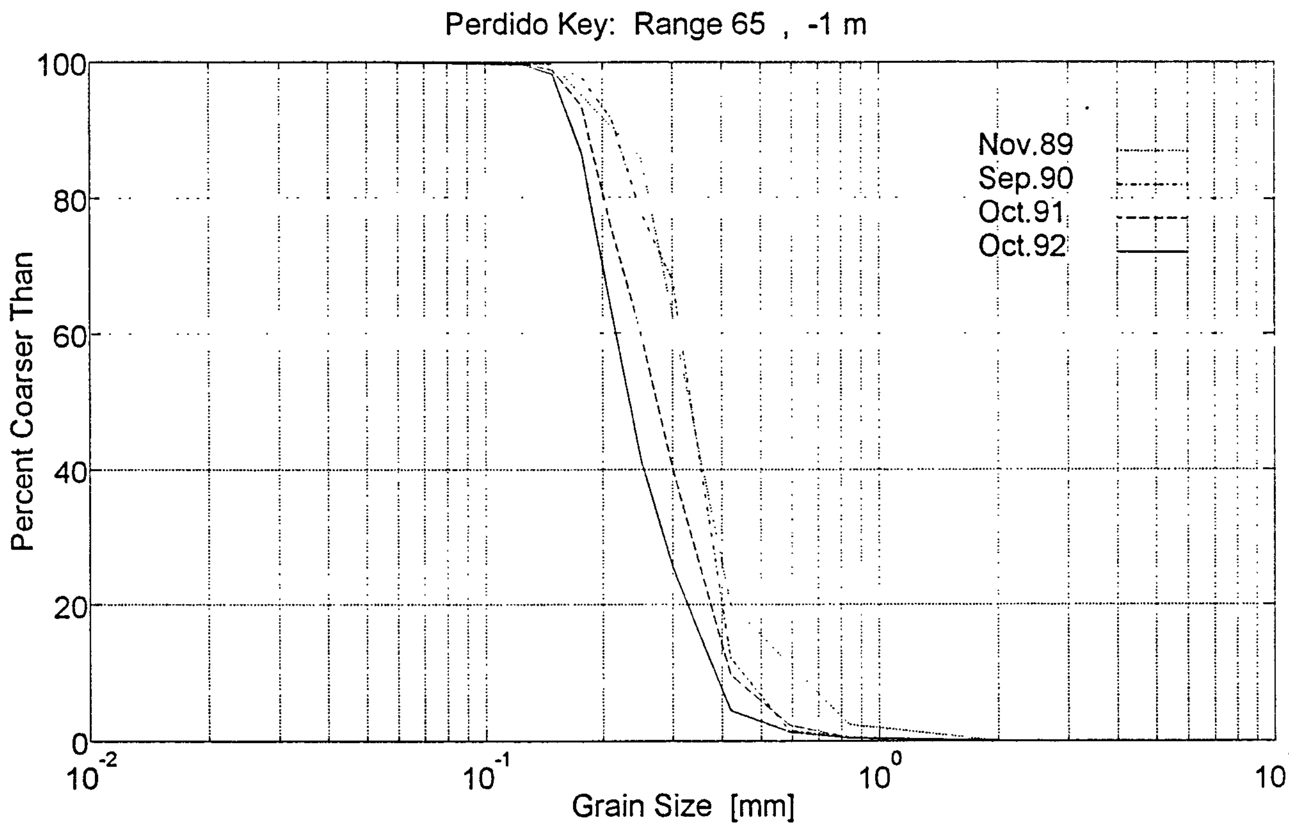


Figure III-90: Grain Size Distributions for Range 65, Berm and Beach Face Positions.



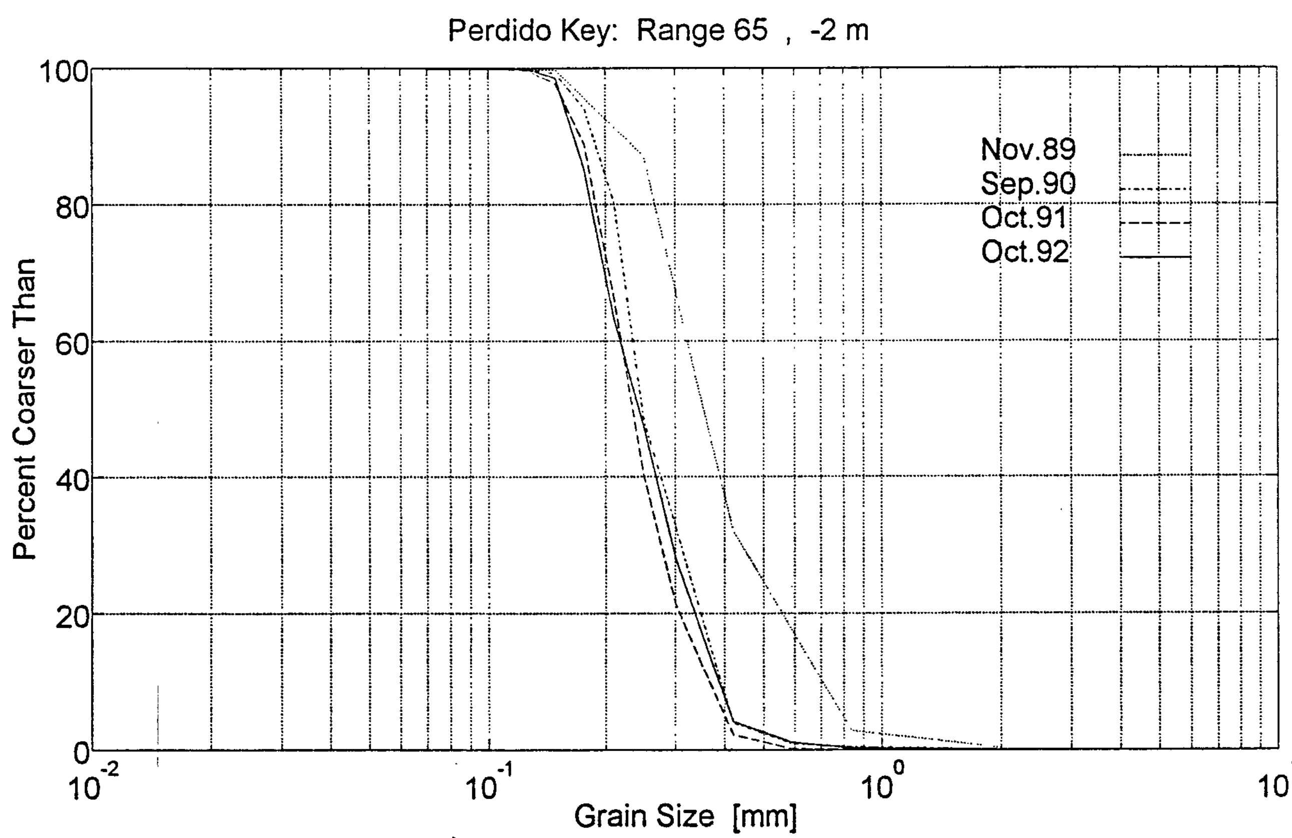
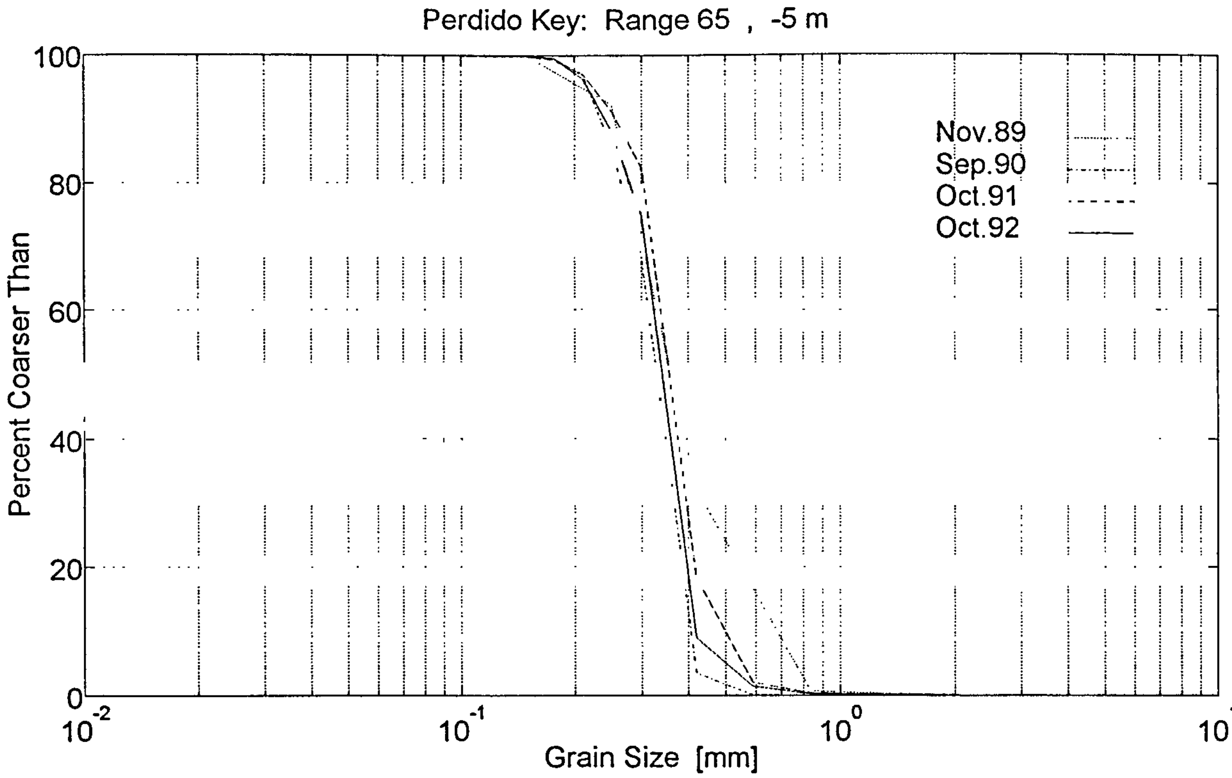


Figure III-91: Grain Size Distributions for Range 65, 1 M Depth and 2 M Depth Positions.



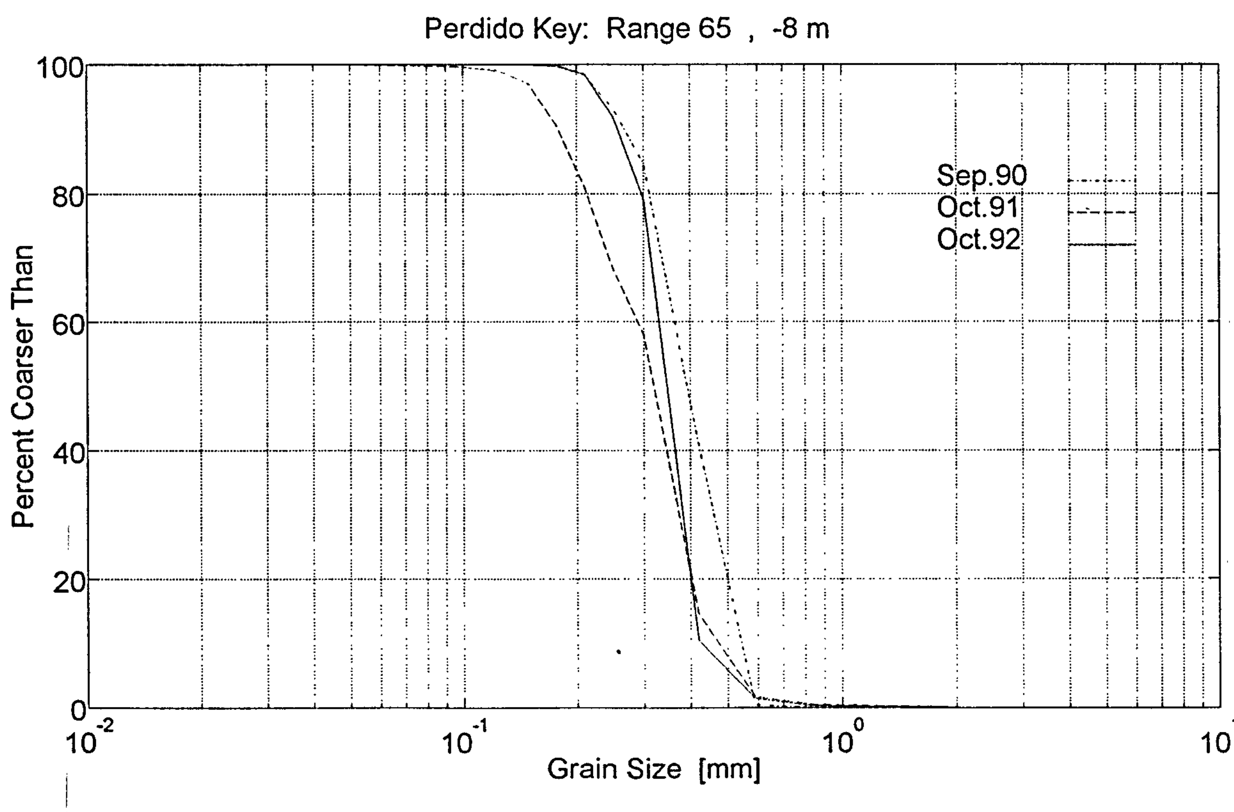
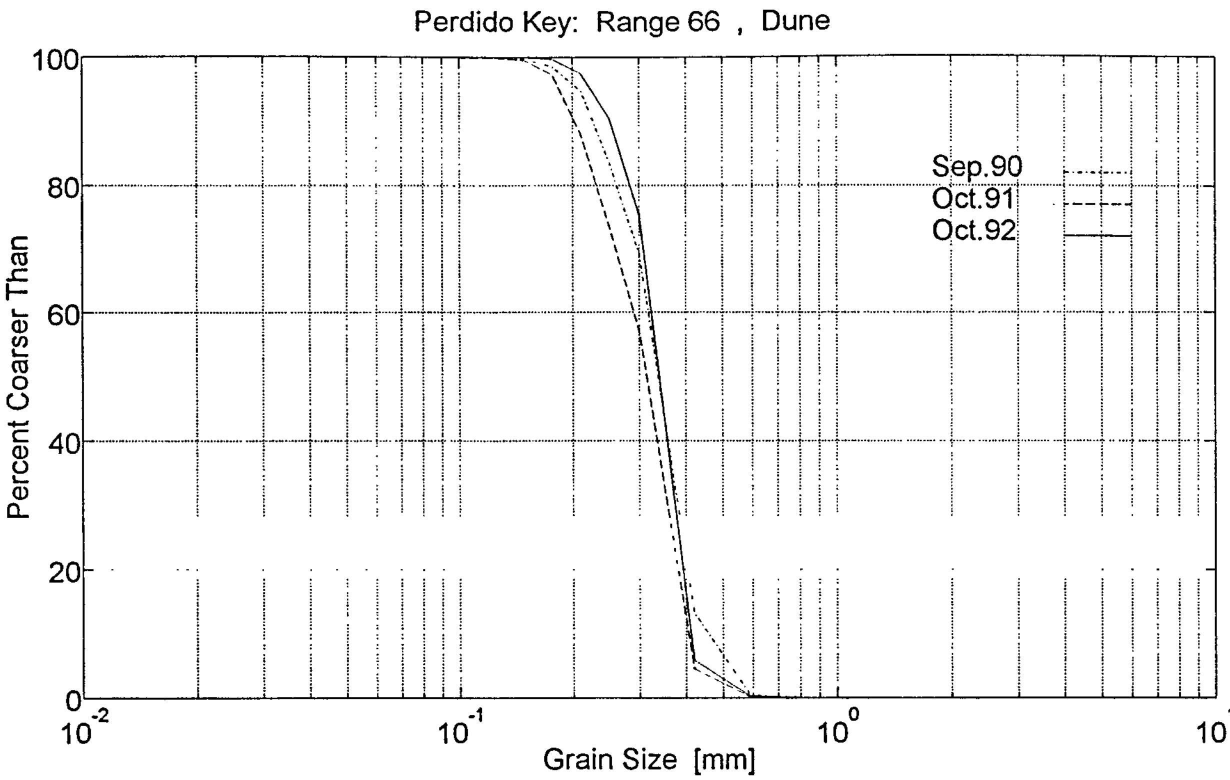


Figure III-92: Grain Size Distributions for Range 65, 5 M Depth and 8 M Depth Positions.



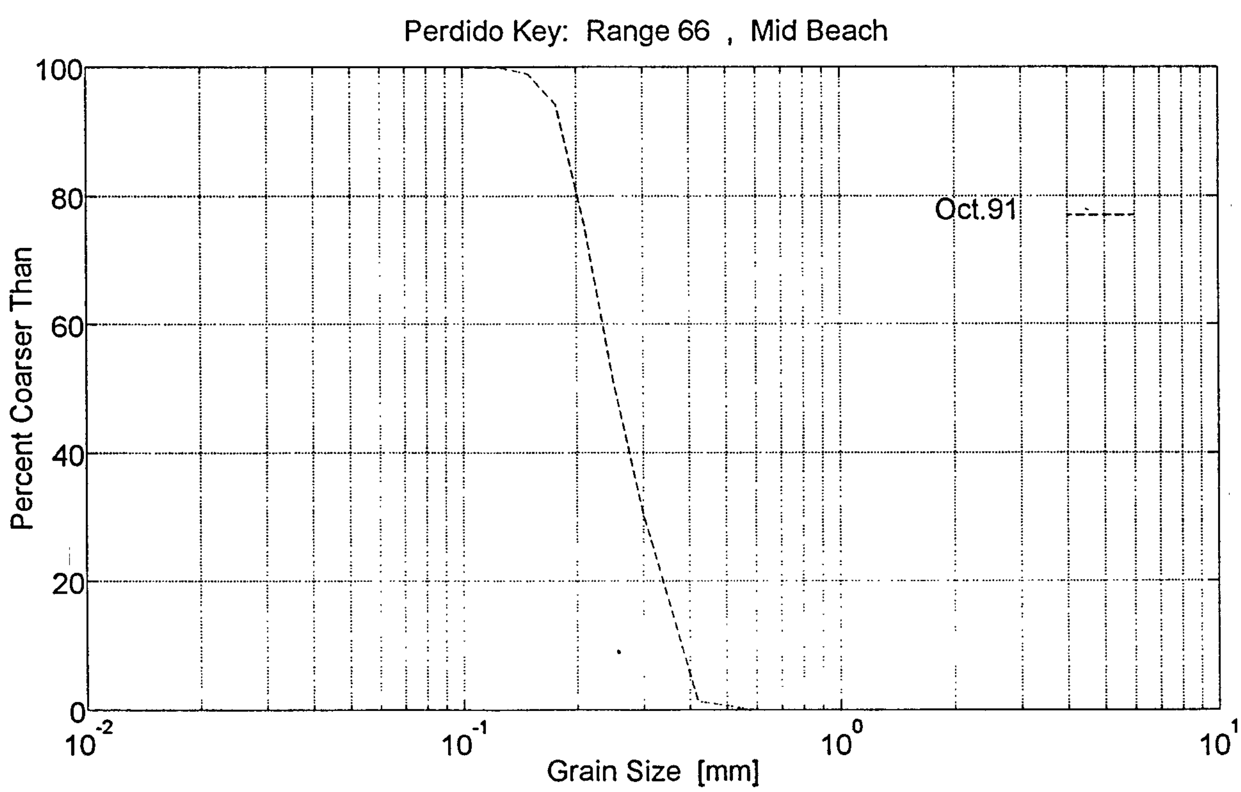
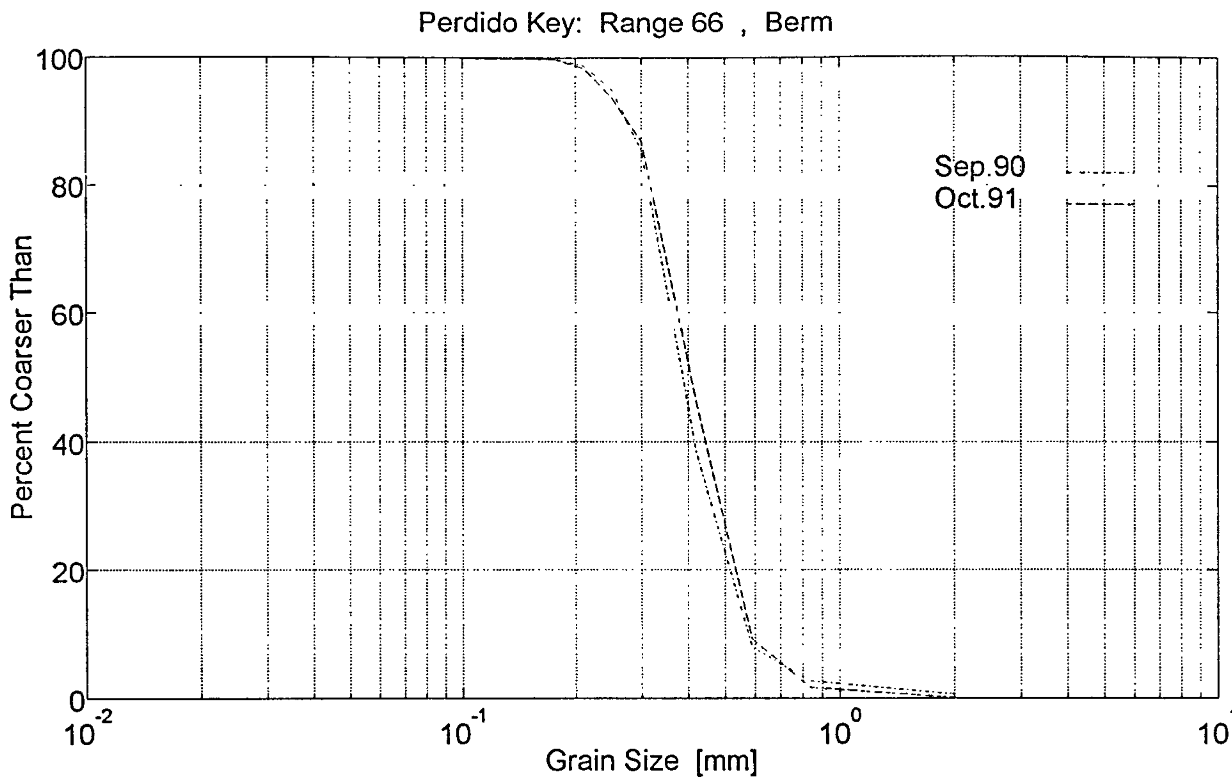


Figure III-93: Grain Size Distributions for Range 66, Dune and Mid-Beach Positions.



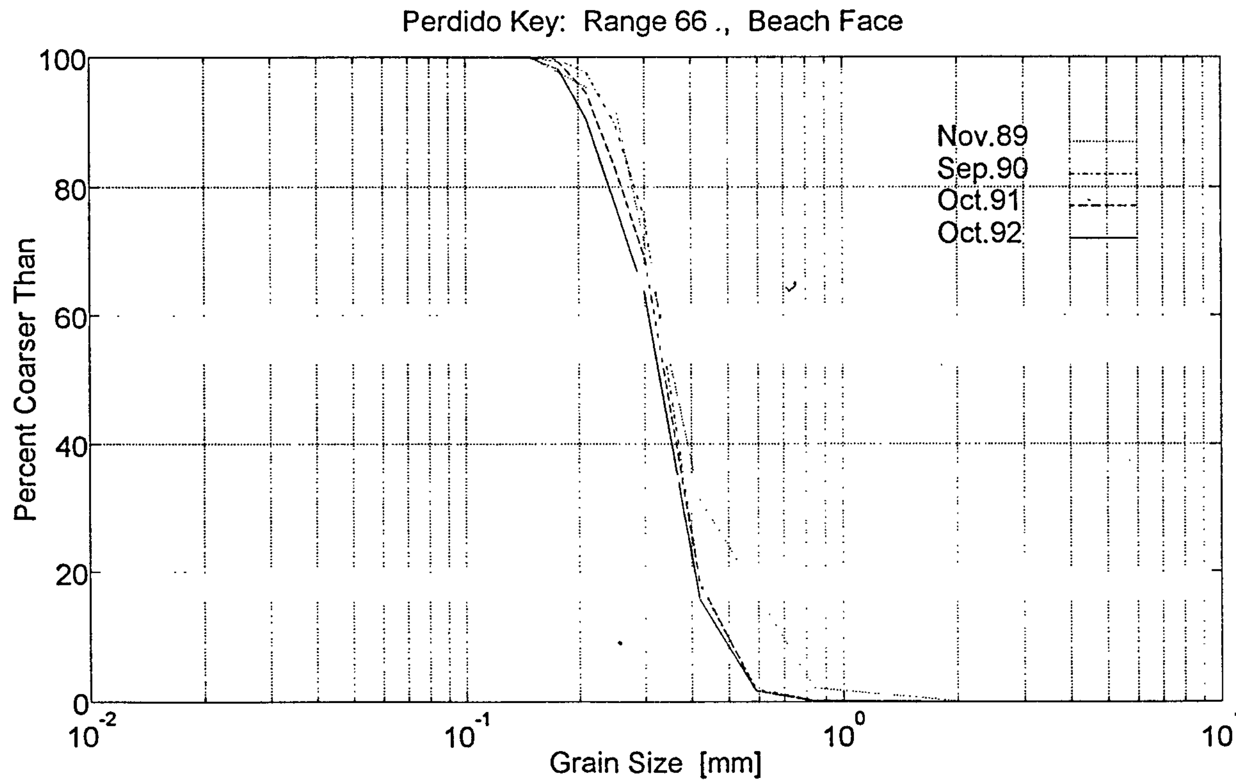
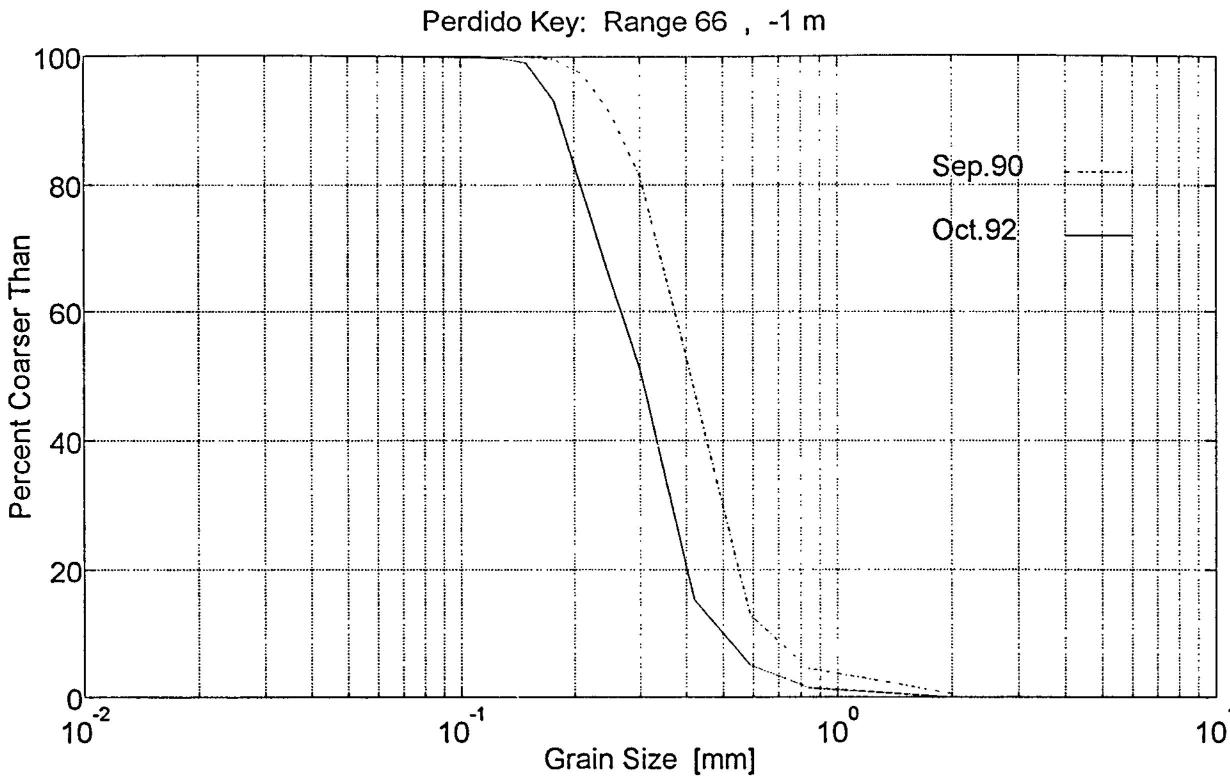


Figure III-94: Grain Size Distributions for Range 66, Berm and Beach Face Positions.



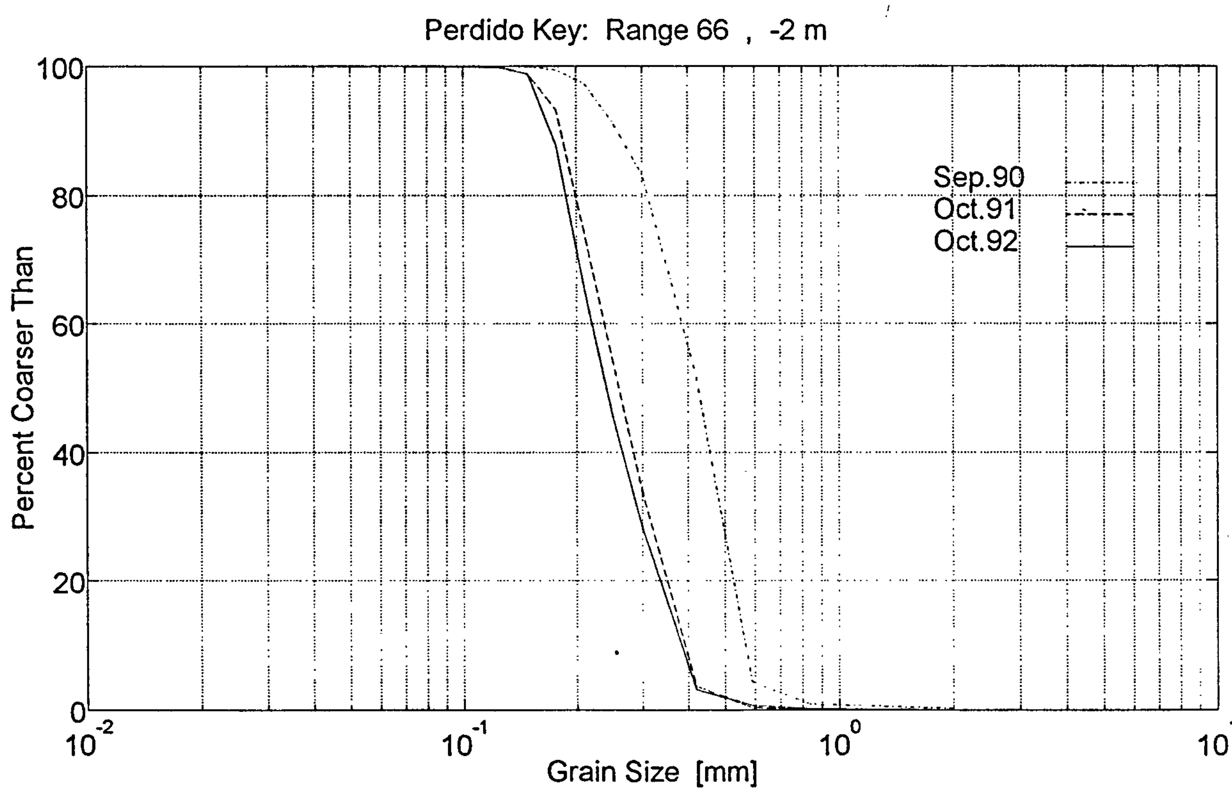
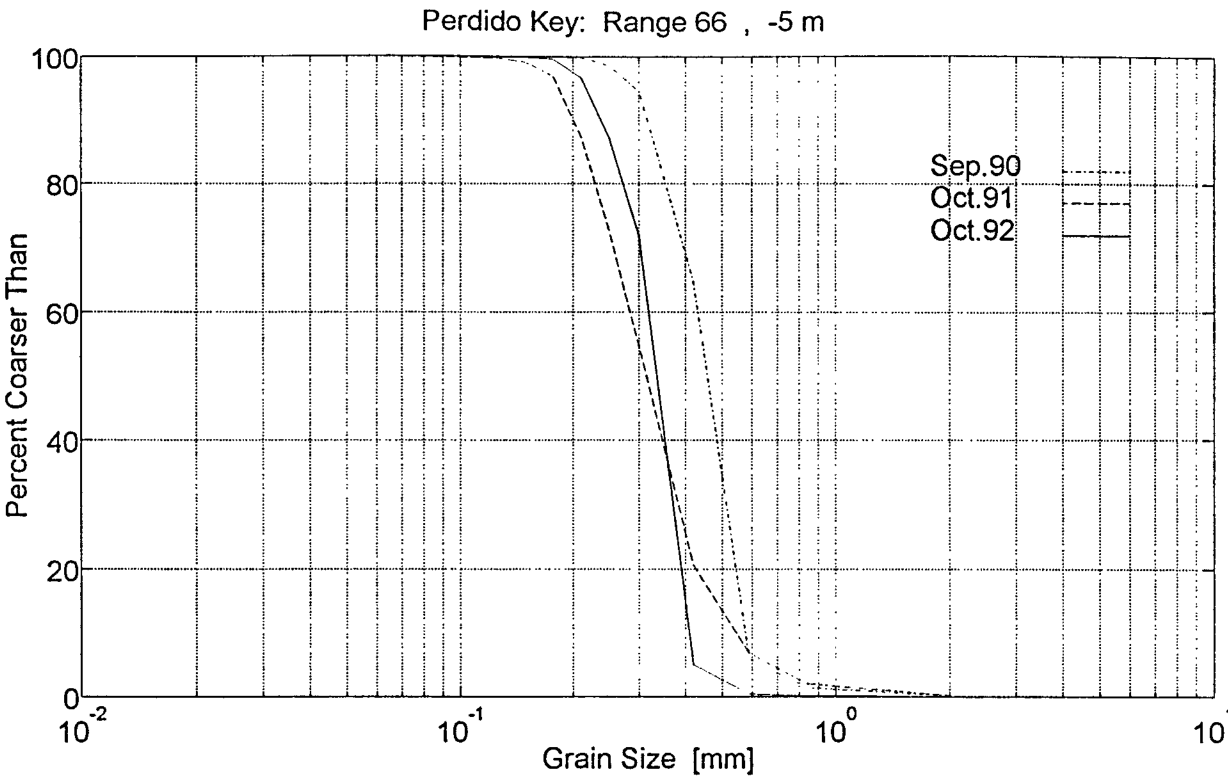


Figure III-95: Grain Size Distributions for Range 66, 1 M Depth and 2 M Depth Positions.



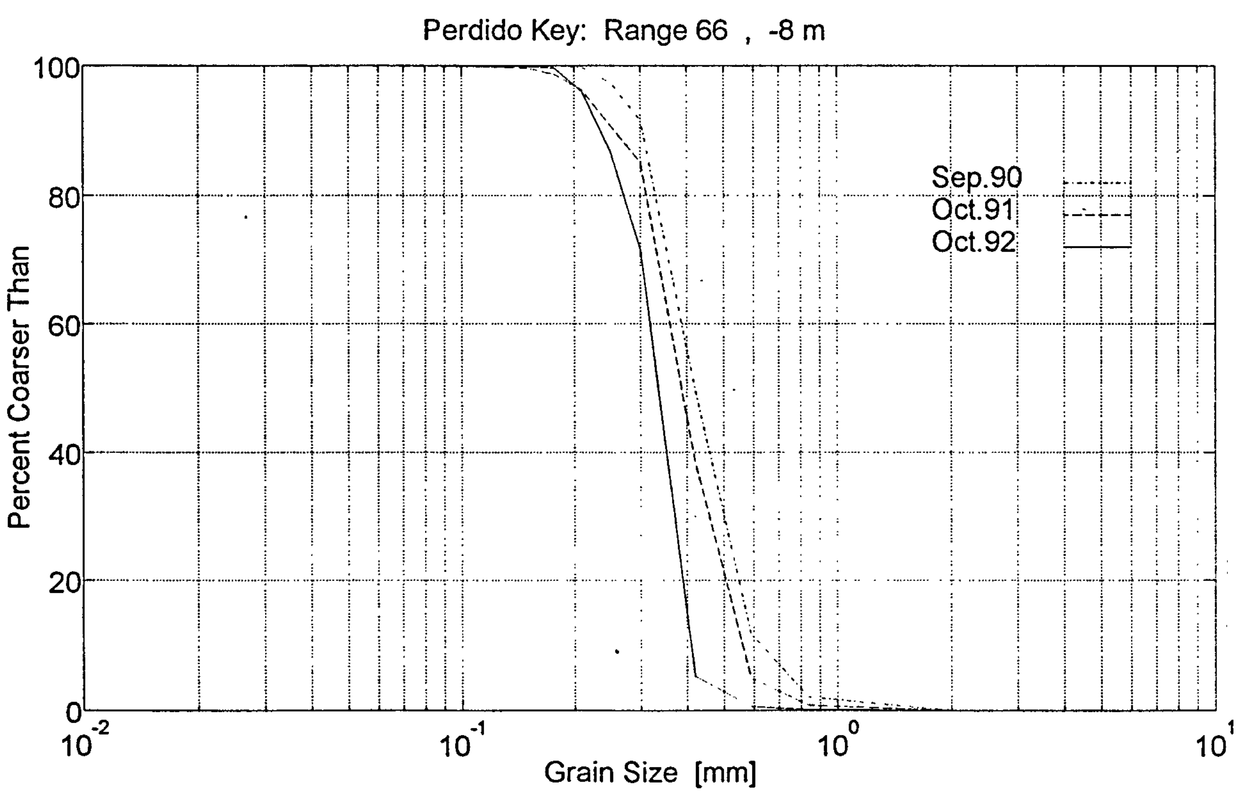
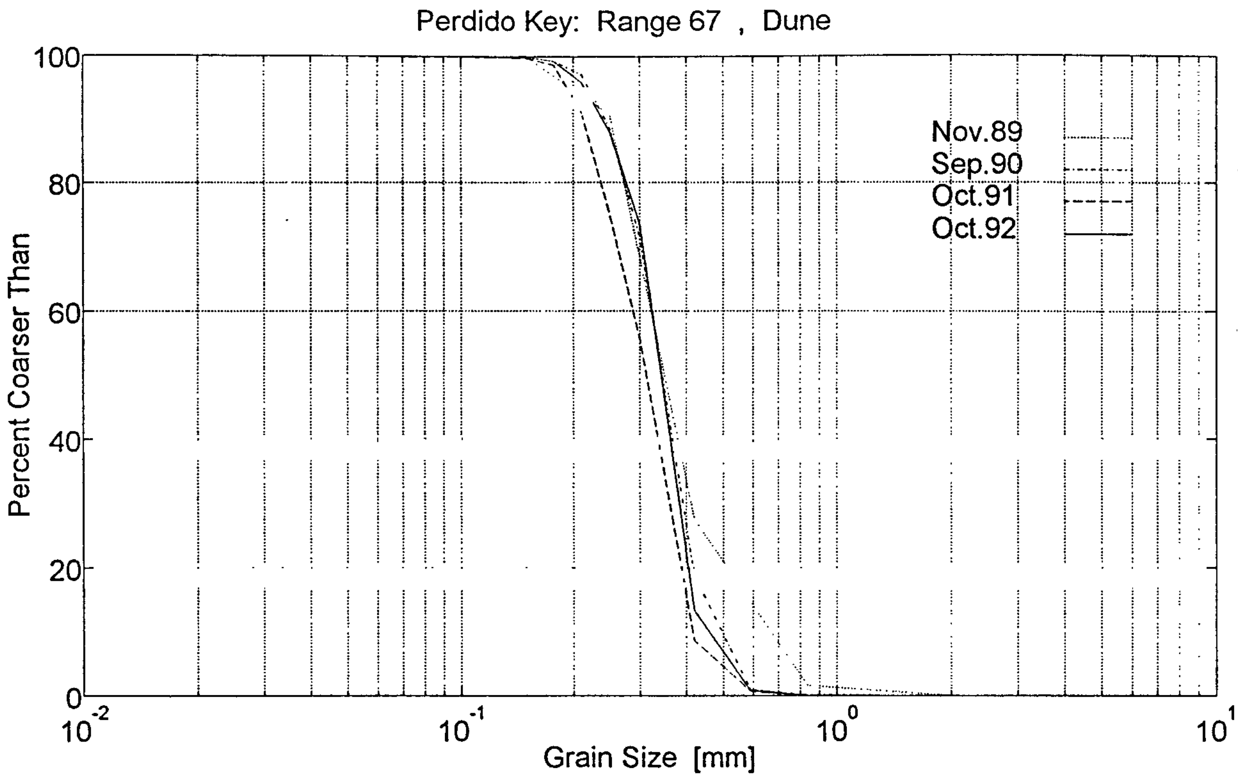


Figure III-96: Grain Size Distributions for Range 66, 5 M Depth and 8 M Depth Positions.



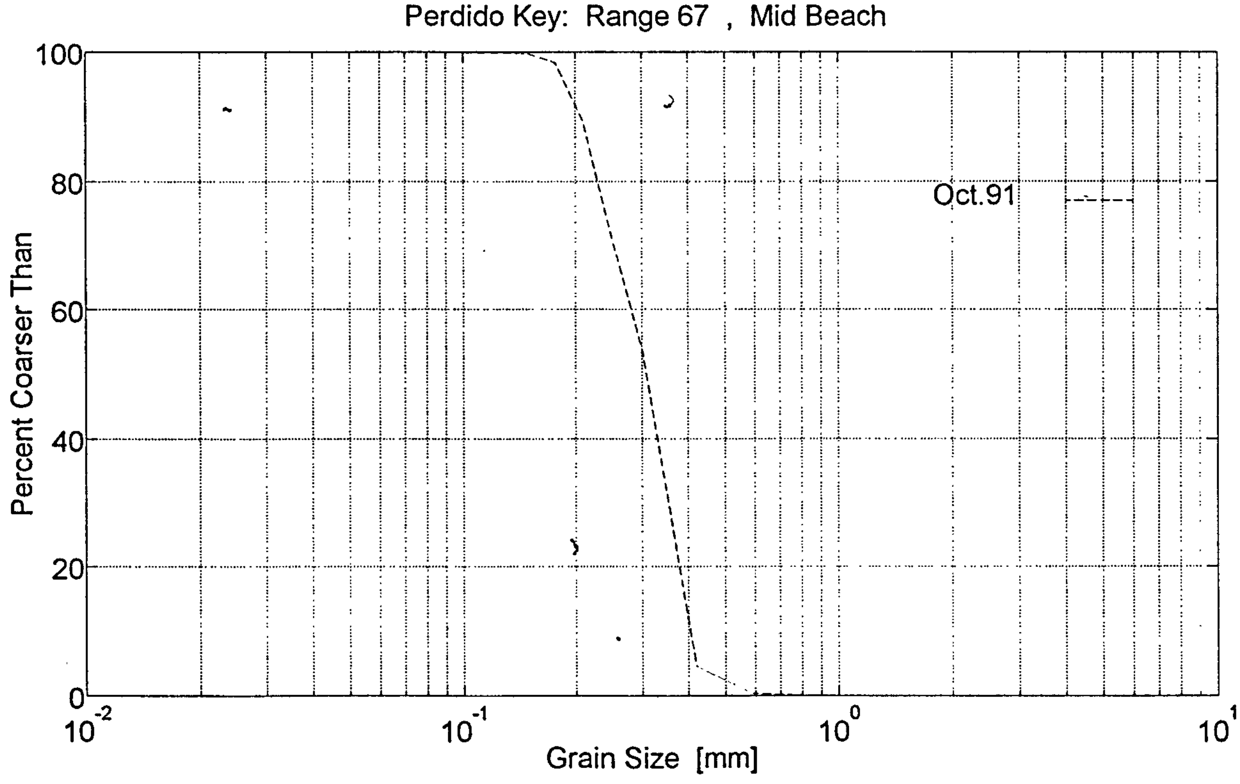
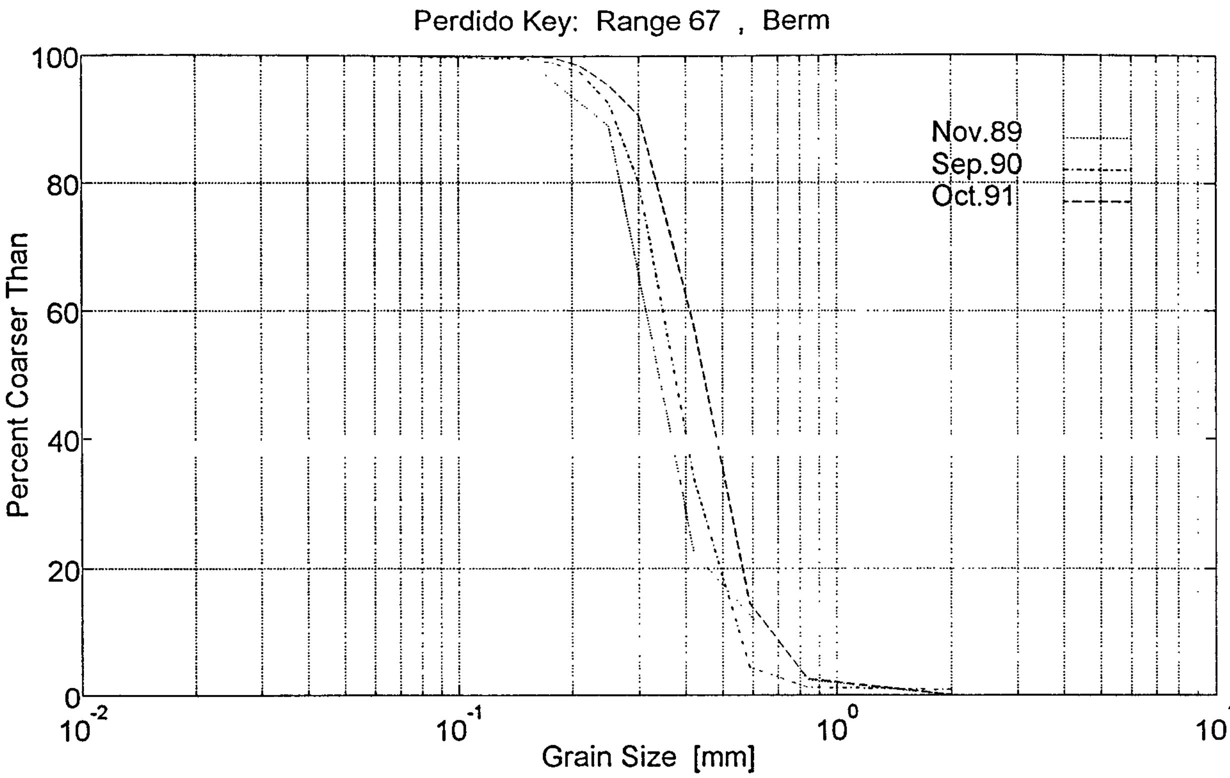


Figure III-97: Grain Size Distributions for Range 67, Dune and Mid-Beach Positions.



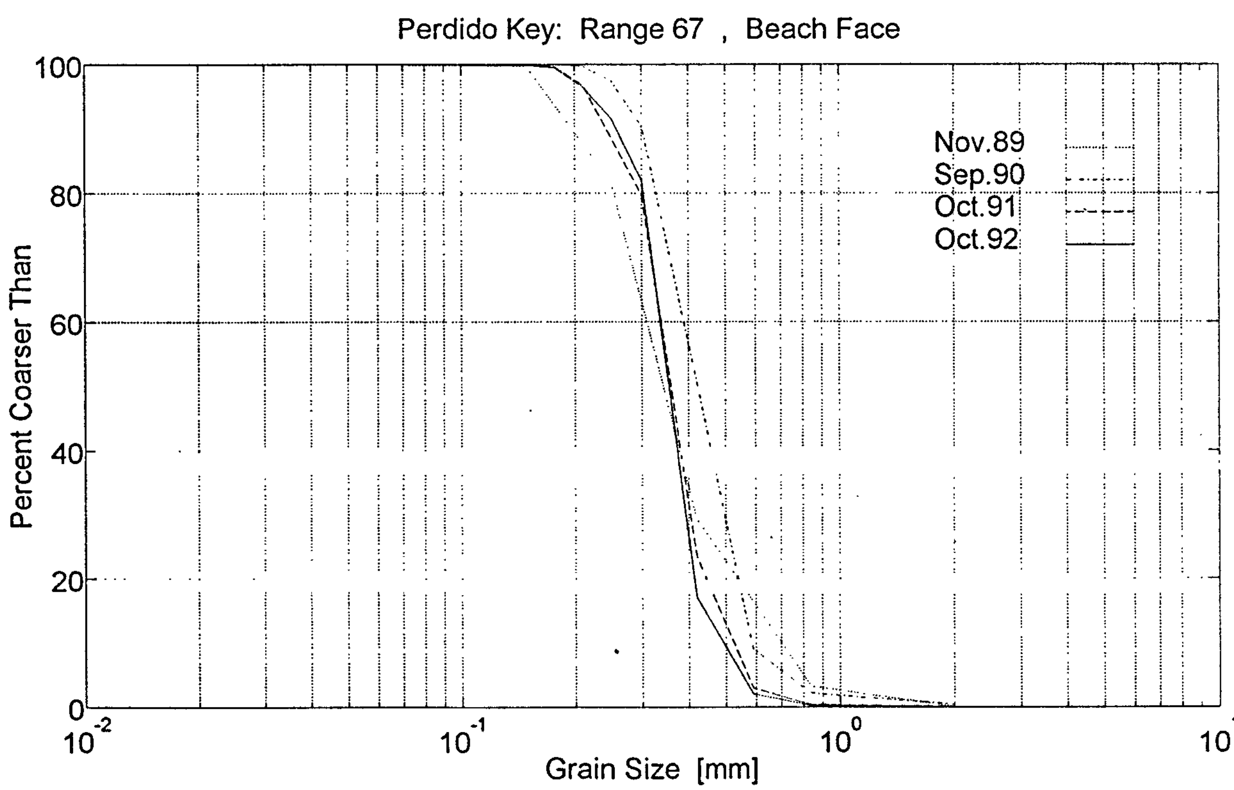
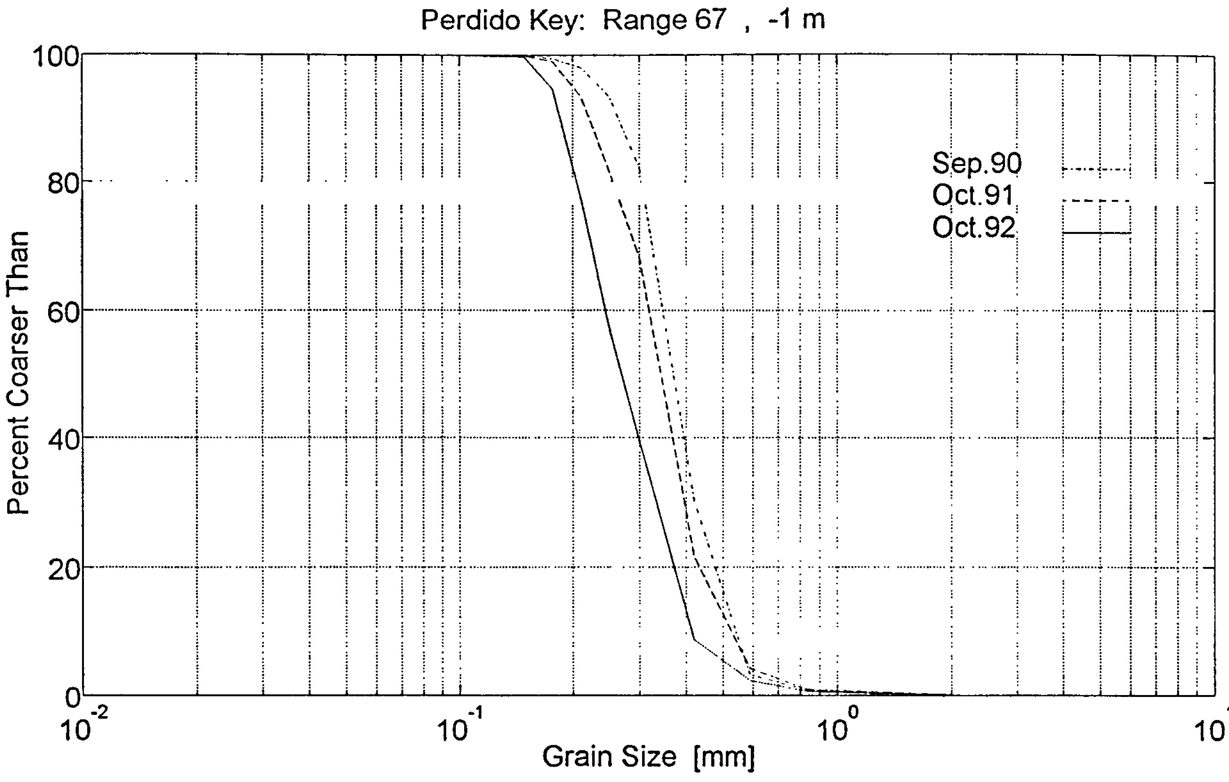


Figure III-98: Grain Size Distributions for Range 67, Berm and Beach Face Positions.



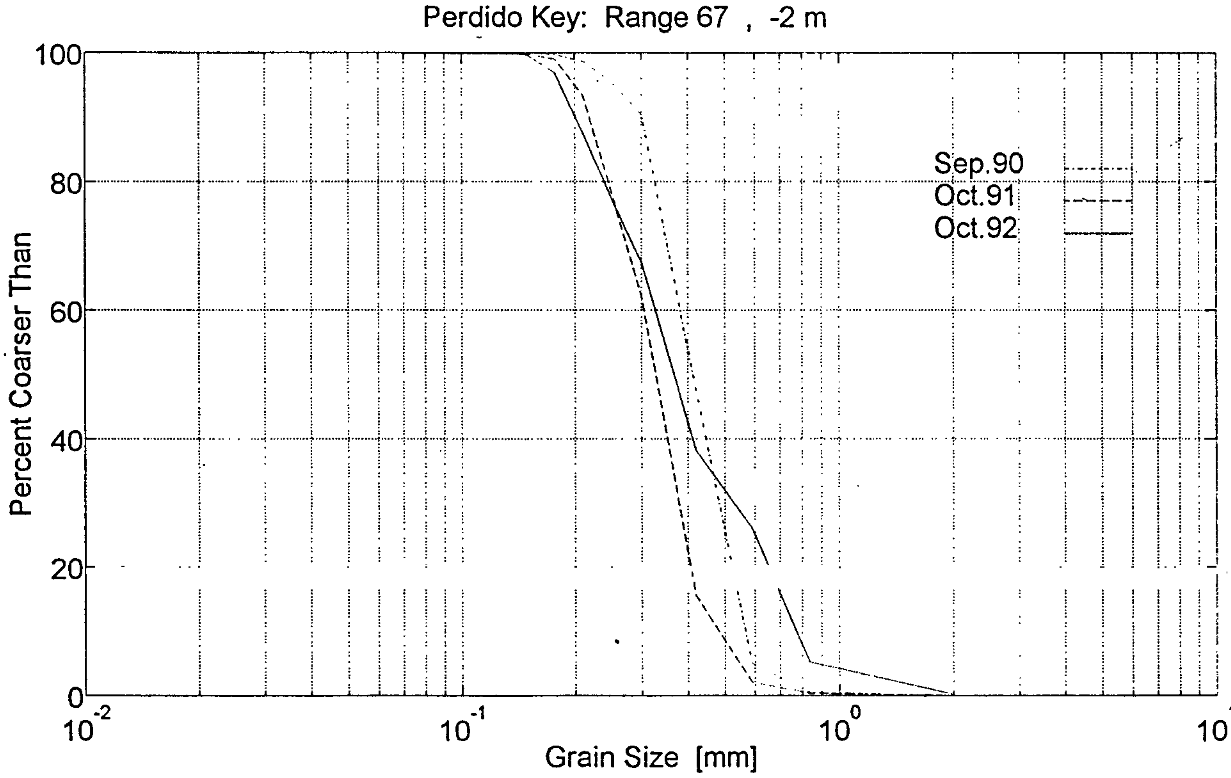
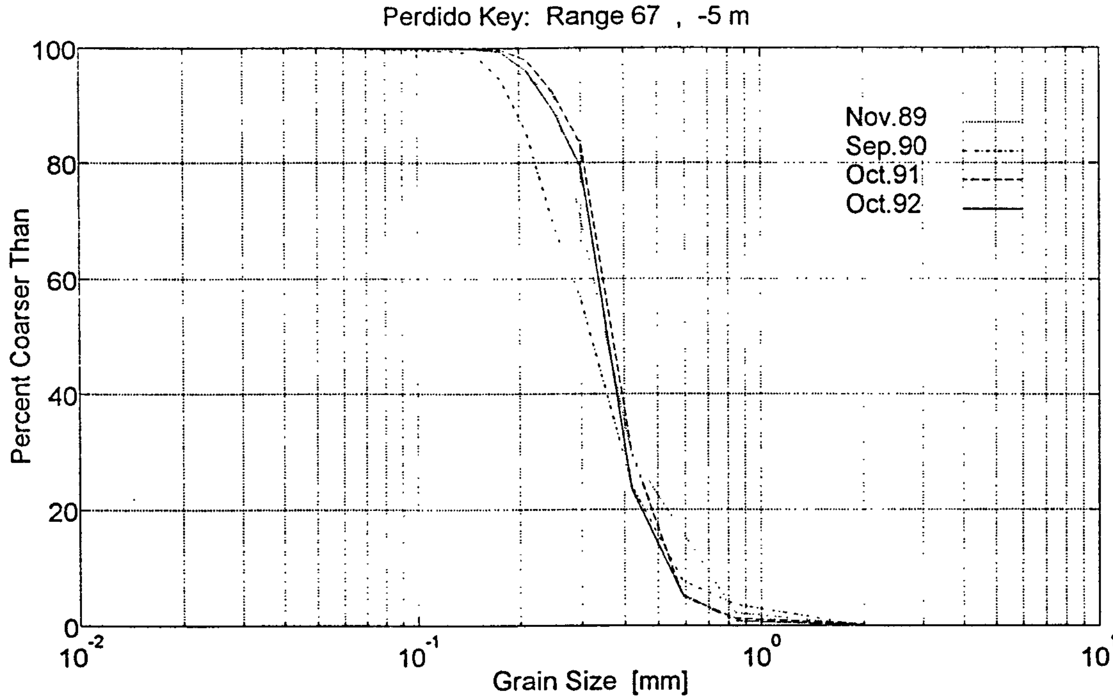


Figure III-99: Grain Size Distributions for Range 67, 1 M Depth and 2 M Depth Positions.



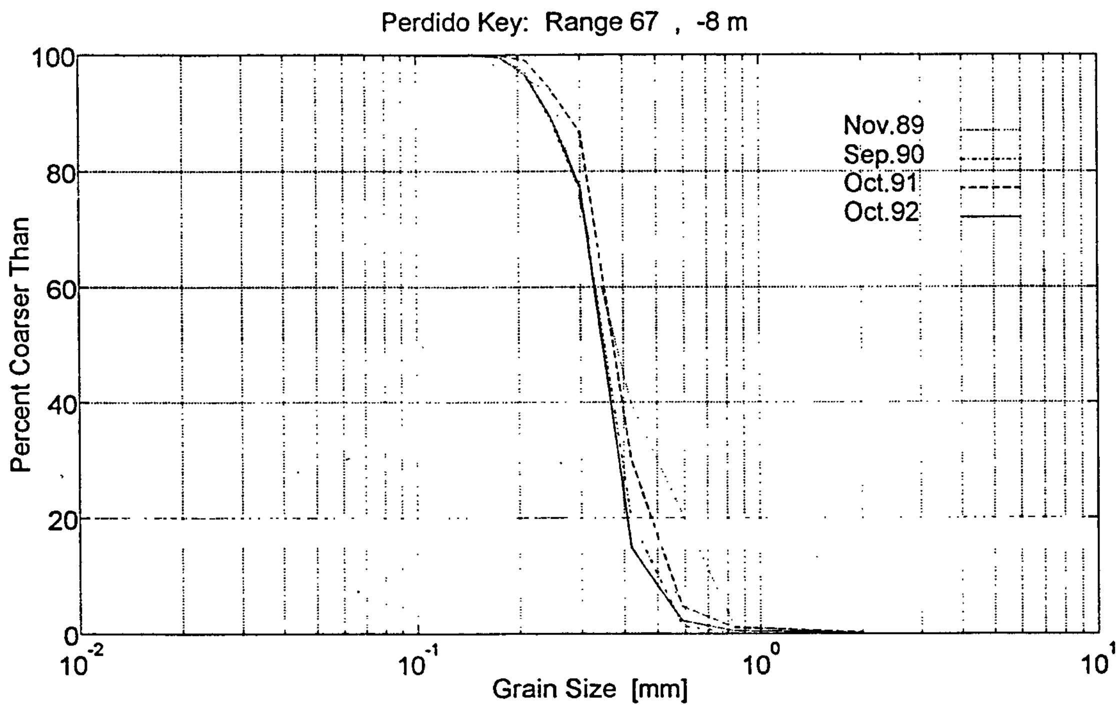


Figure III-100: Grain Size Distributions for Range 67, 5 M Depth and 8 M Depth Positions.

APPENDIX IV

METEOROLOGICAL DATA

from Weather Station located at Ranger Station

January, 1992 - December, 1992

- Stick diagramm showing wind speed and wind direction
- Wind Speed
- Wind Direction

- Air Temperature
- Rainfall

Notes: 1) Horizontal axis is given in days; i.e. Day=7 denotes the end of the 7th day of the month.

2) Wind direction is the direction from which the wind is blowing. It is measured clockwise from magnetic north.

3) In the stick diagram open end of the wind arrow shows the direction that the wind is heading.

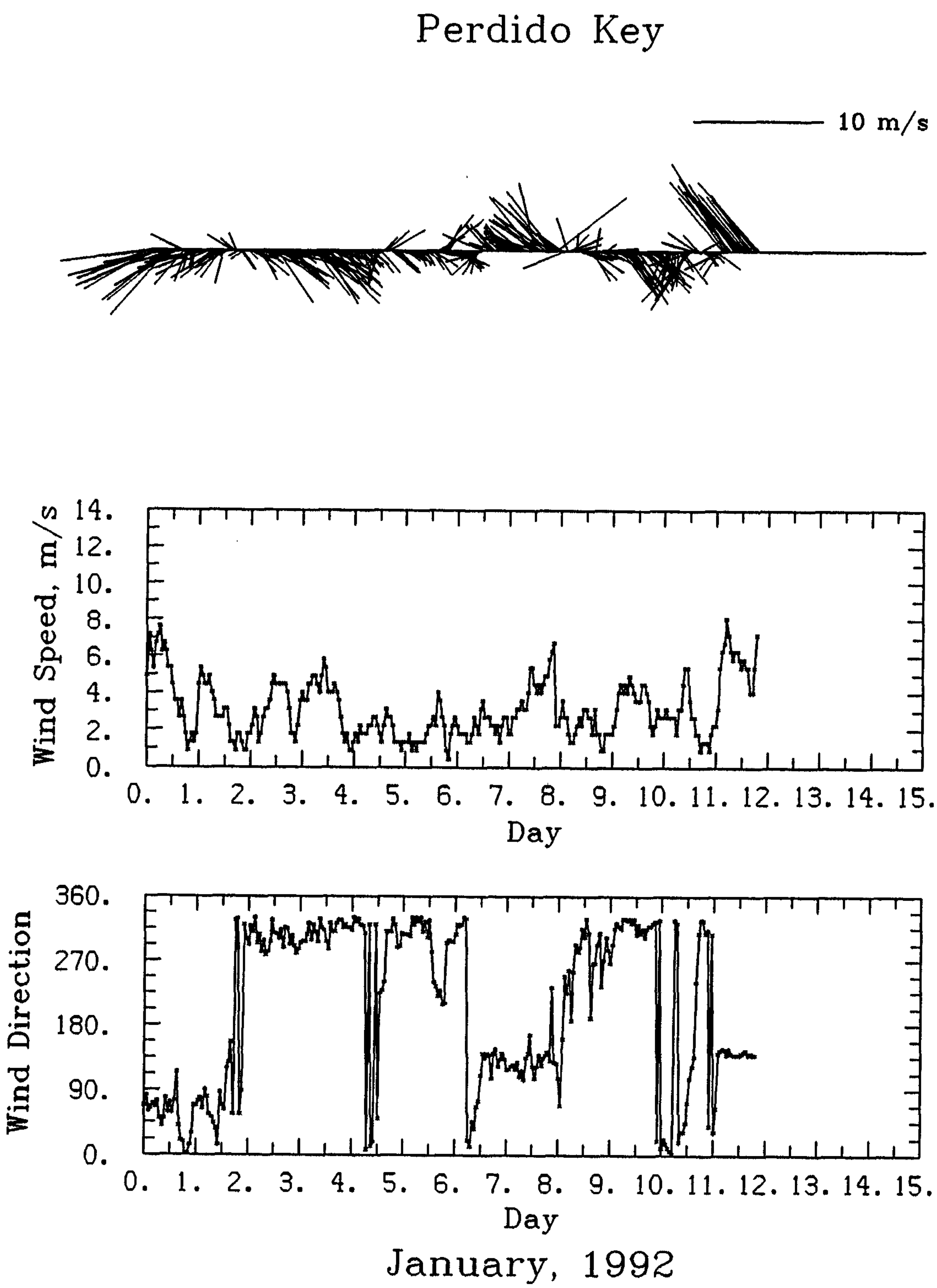
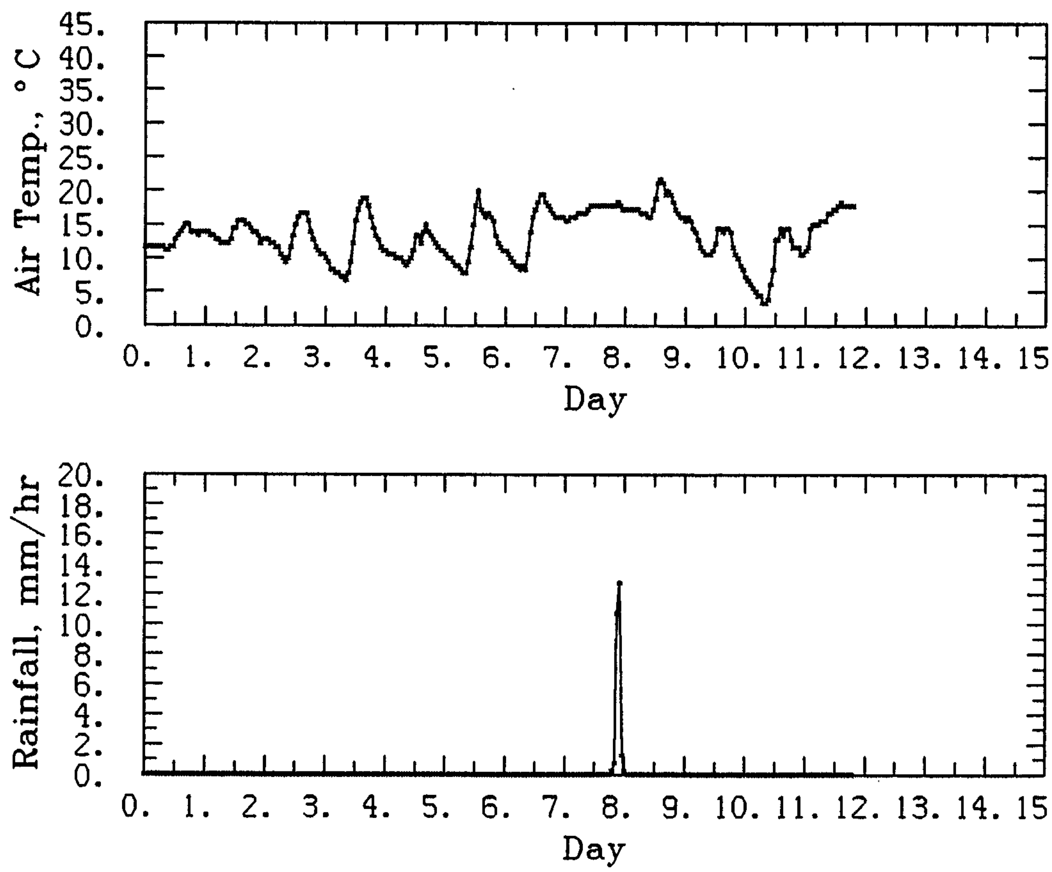


Figure IV-1: Wind Speed and Direction, January 1-15, 1992.

Perdido Key



January, 1992

Figure IV-2: Air Temperature and Rainfall, January 1-15, 1992.

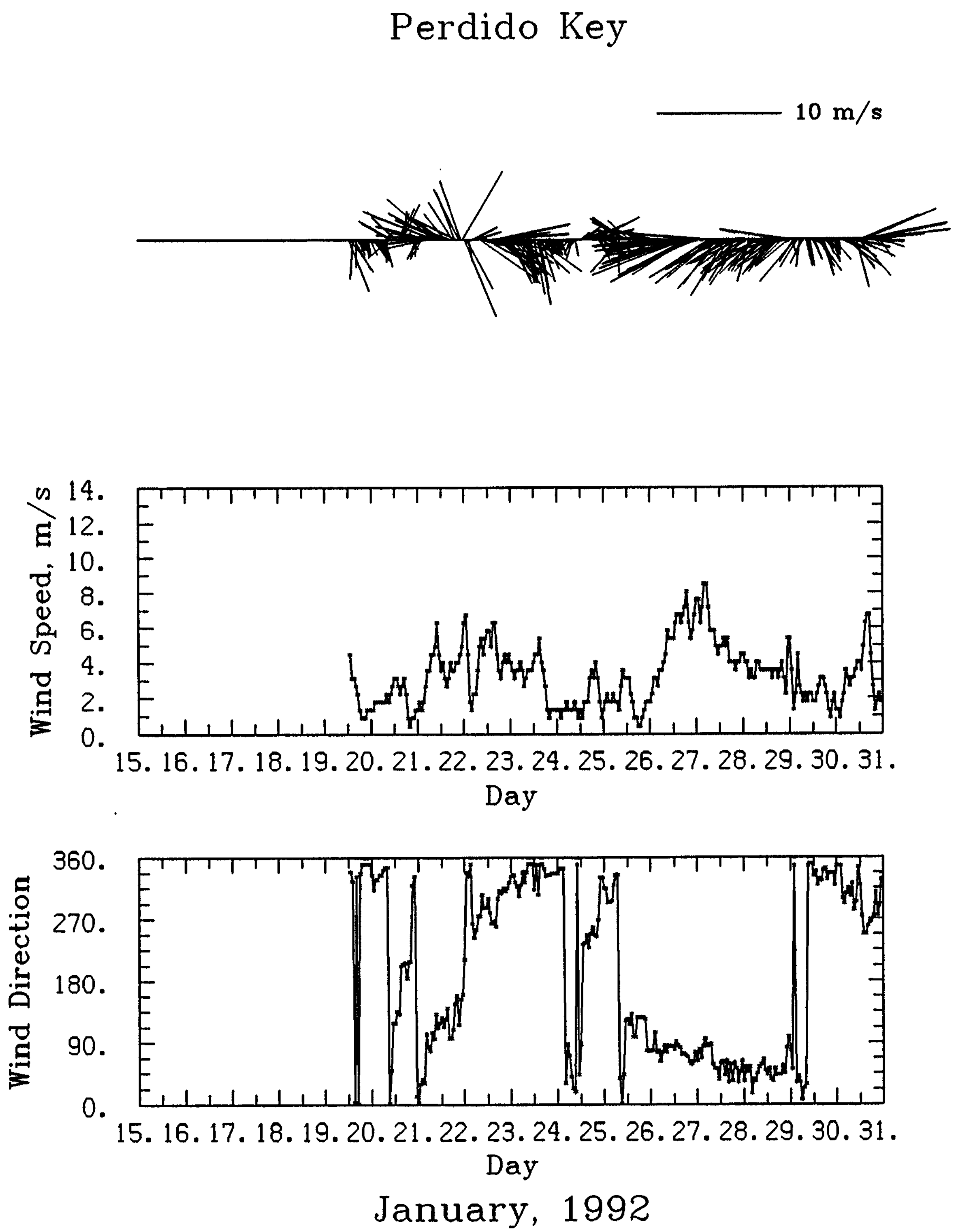


Figure IV-3: Wind Speed and Direction, January 16-31, 1992.

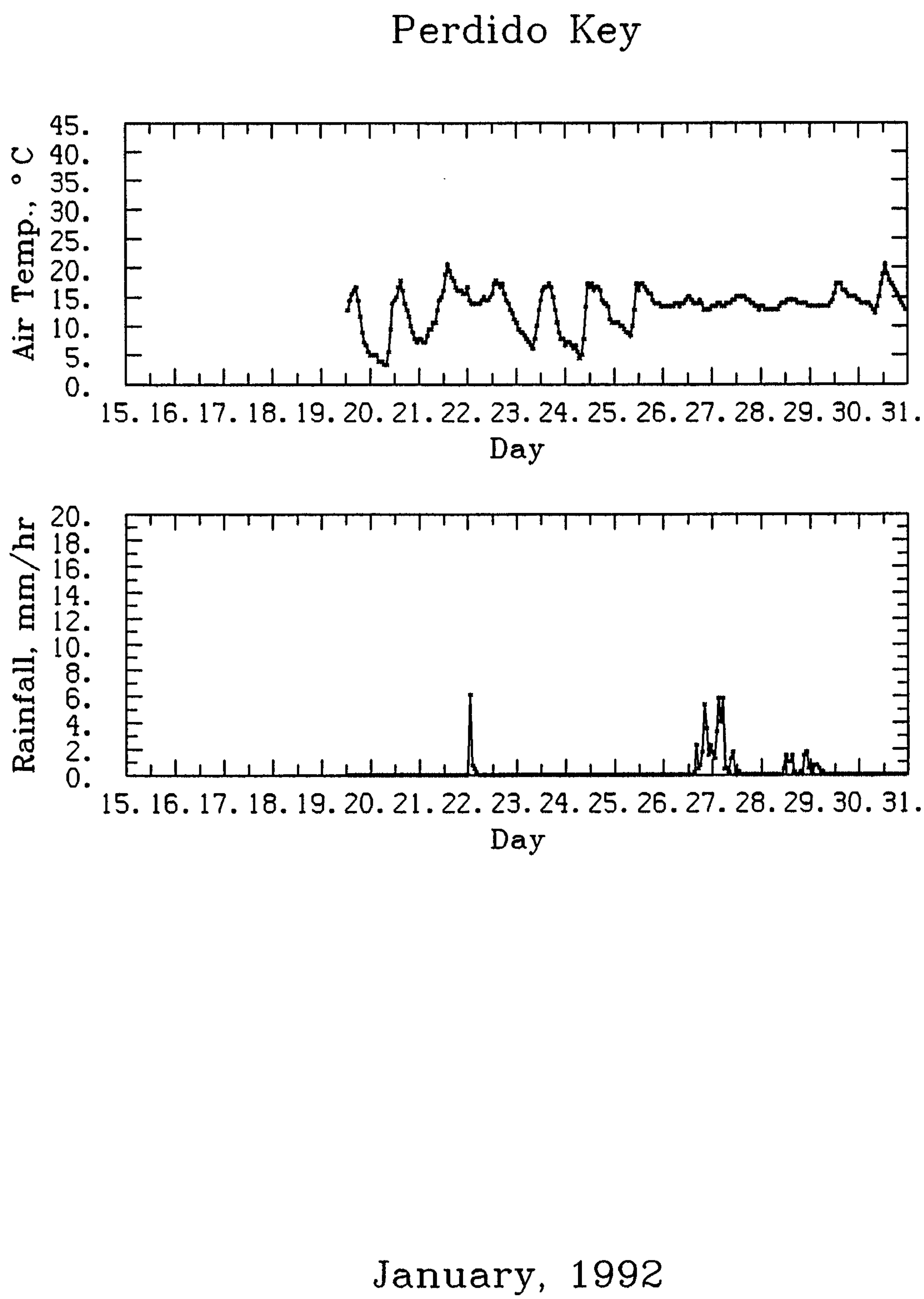


Figure IV-4: Air Temperature and Rainfall, January 16-31, 1992.

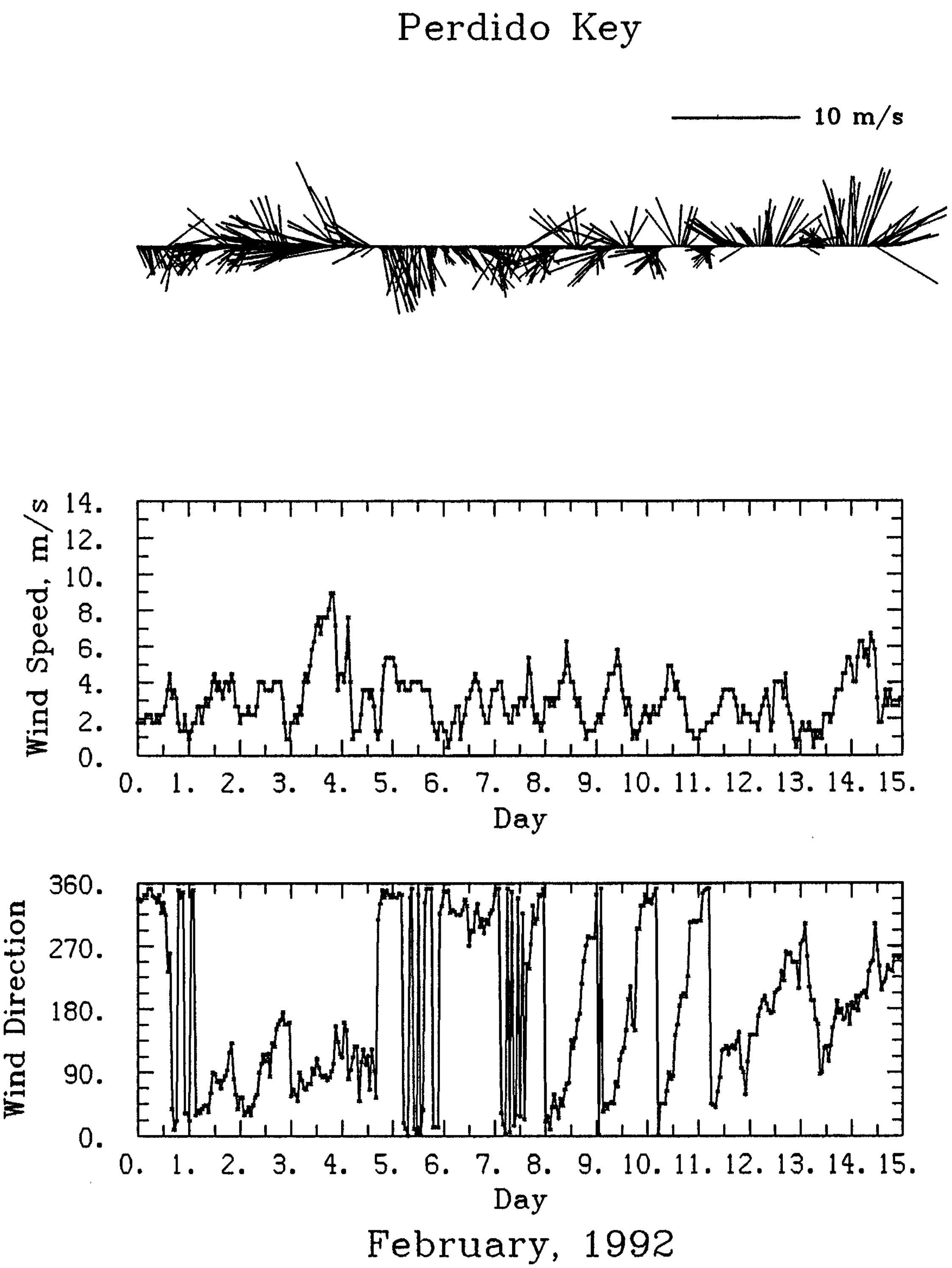
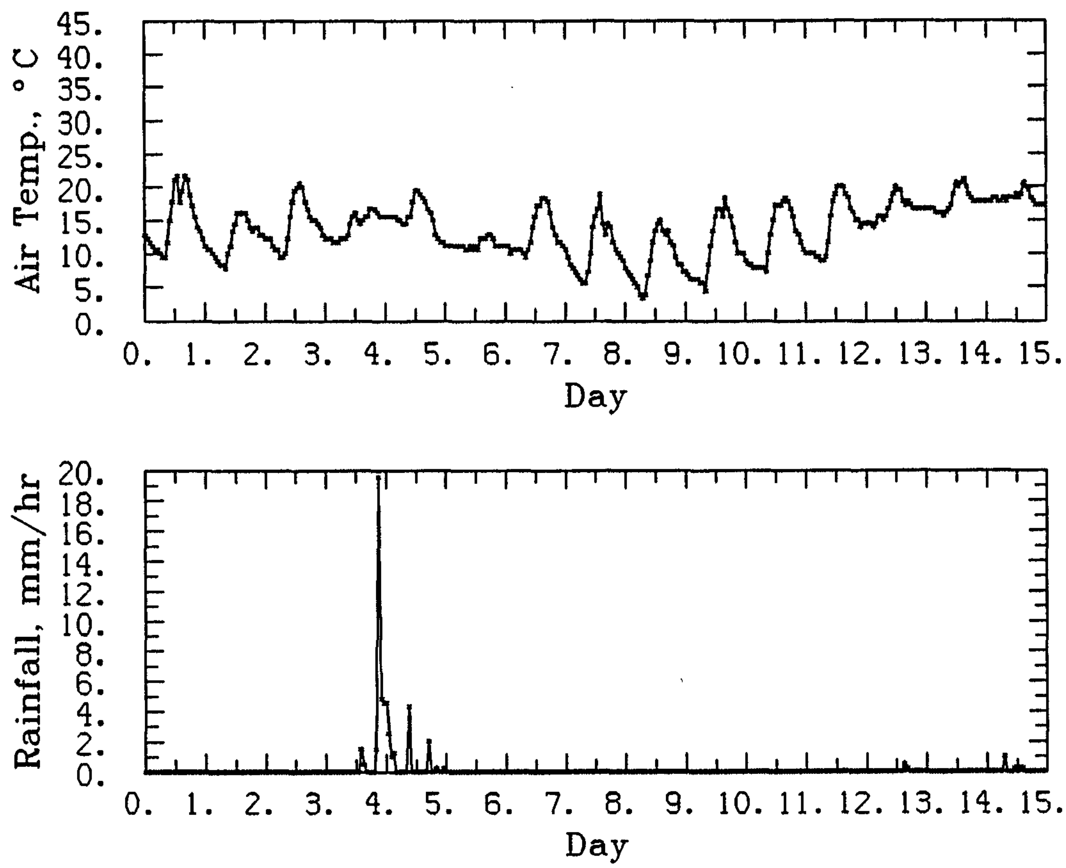


Figure IV-5: Wind Speed and Direction, February 1-15, 1992.

Perdido Key



February, 1992

Figure IV-6: Air Temperature and Rainfall, February 1-15, 1992.

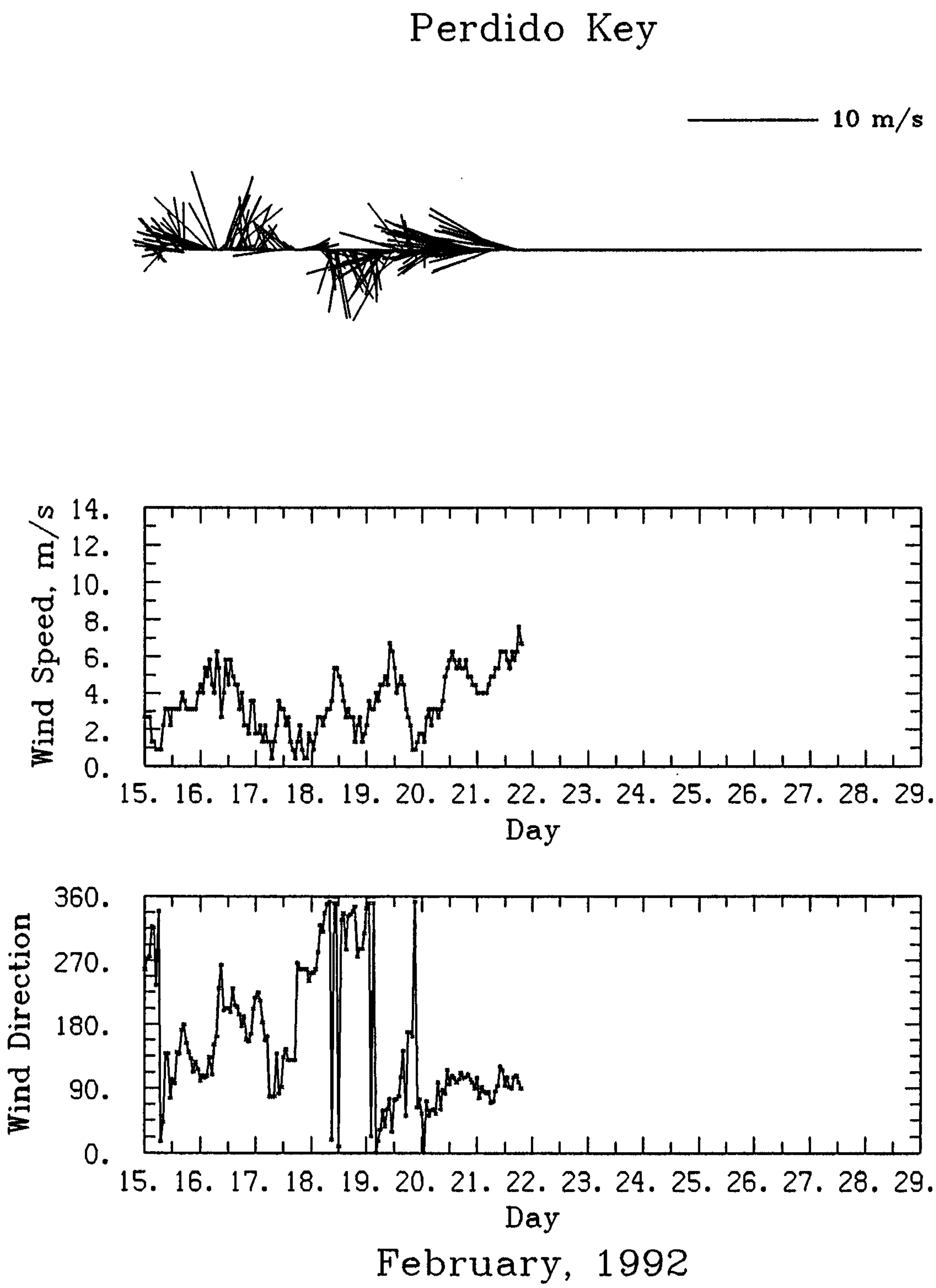
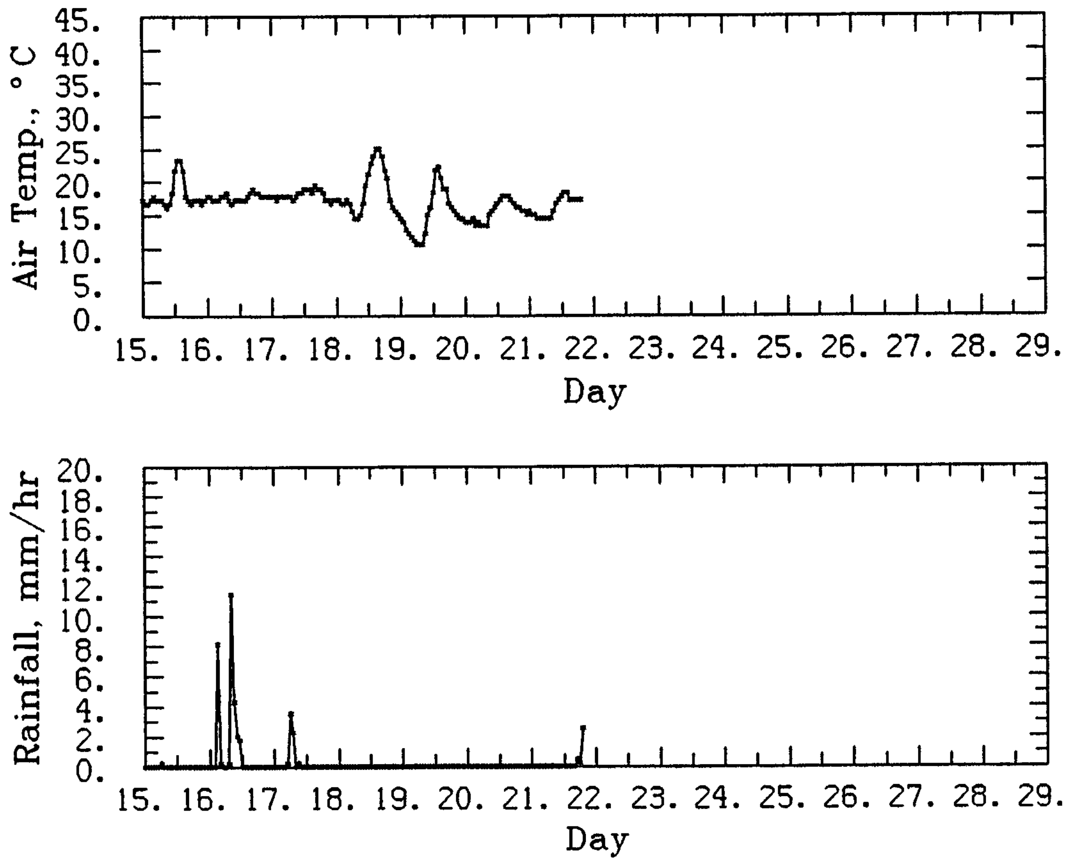


Figure IV-7: Wind Speed and Direction, February 16-29, 1992.

Perdido Key



February, 1992

Figure IV-8: Air Temperature and Rainfall, February 16-29, 1992.

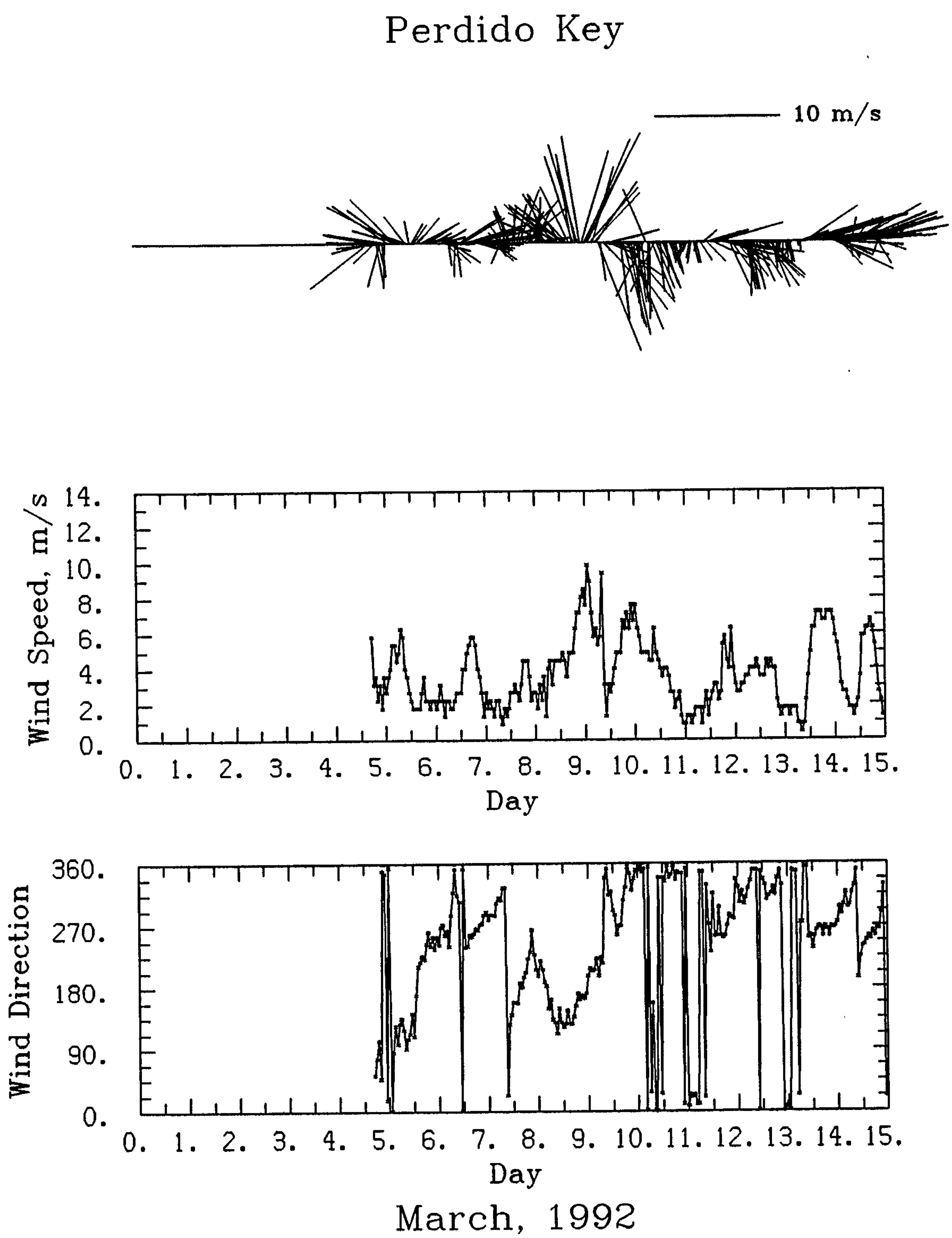
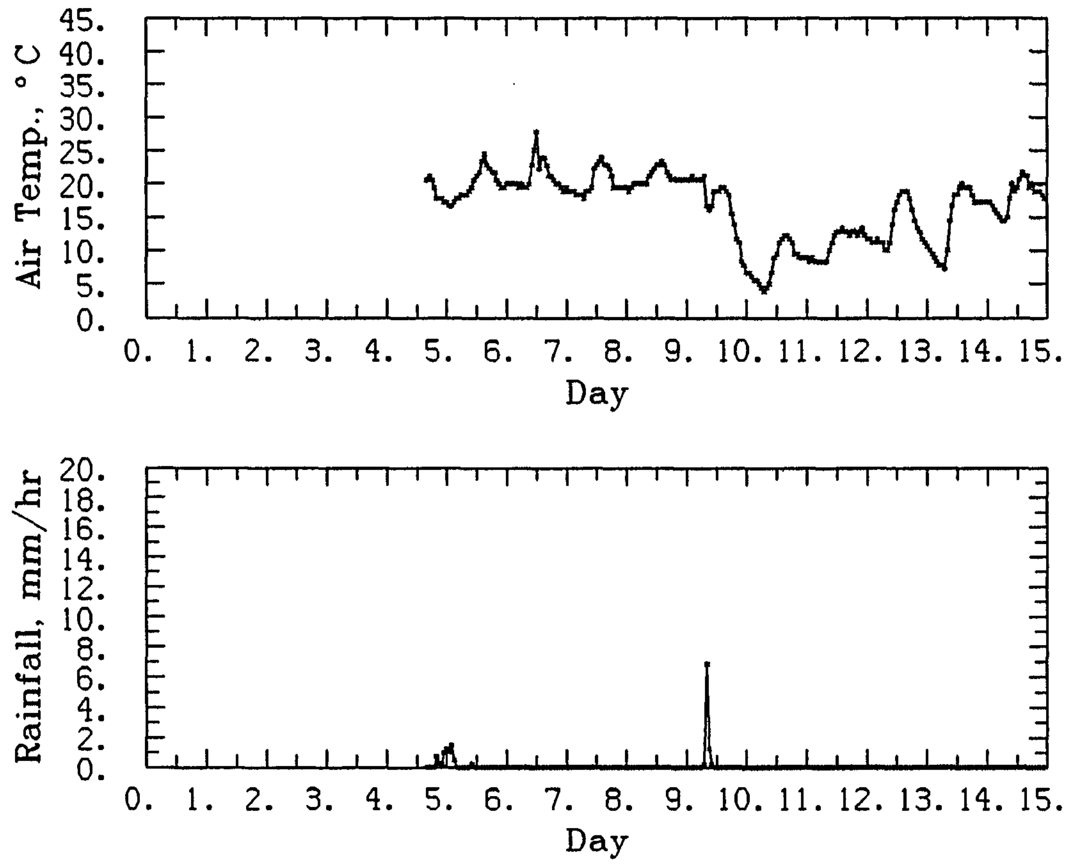


Figure IV-9: Wind Speed and Direction, March 1-15, 1992.

Perdido Key



March, 1992

Figure IV-10: Air Temperature and Rainfall, March 1-15, 1992.

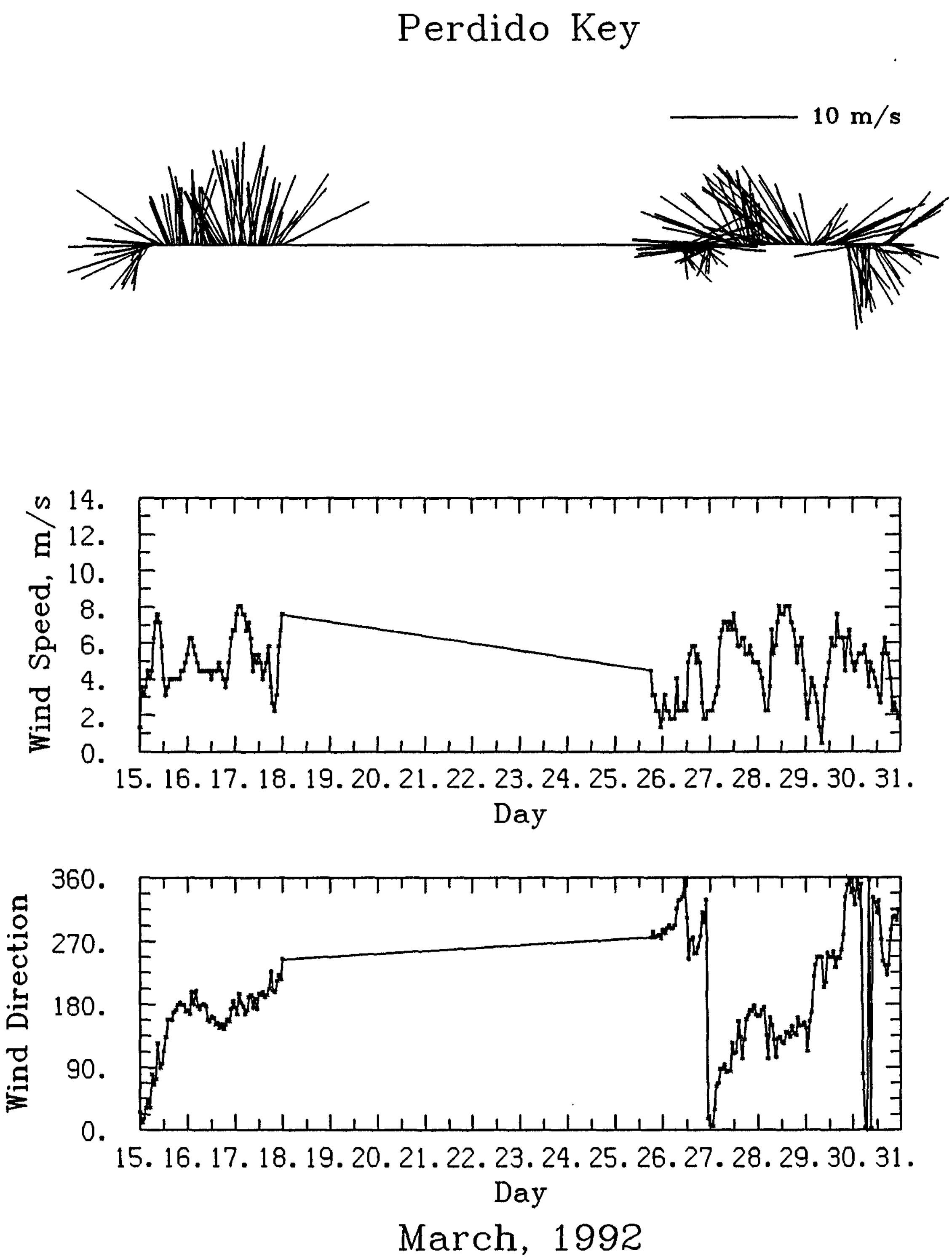
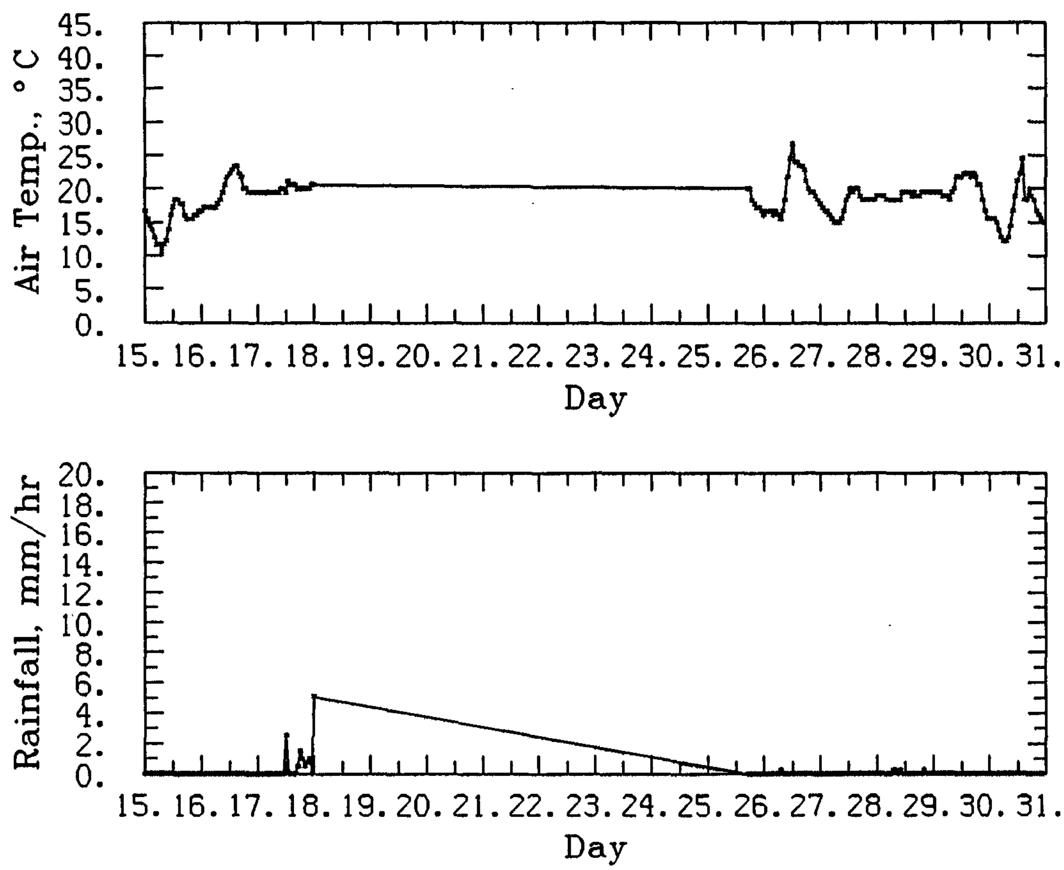


Figure IV-11: Wind Speed and Direction, March 16-31, 1992.

Perdido Key



March, 1992

Figure IV-12: Air Temperature and Rainfall, March 16-31, 1992.

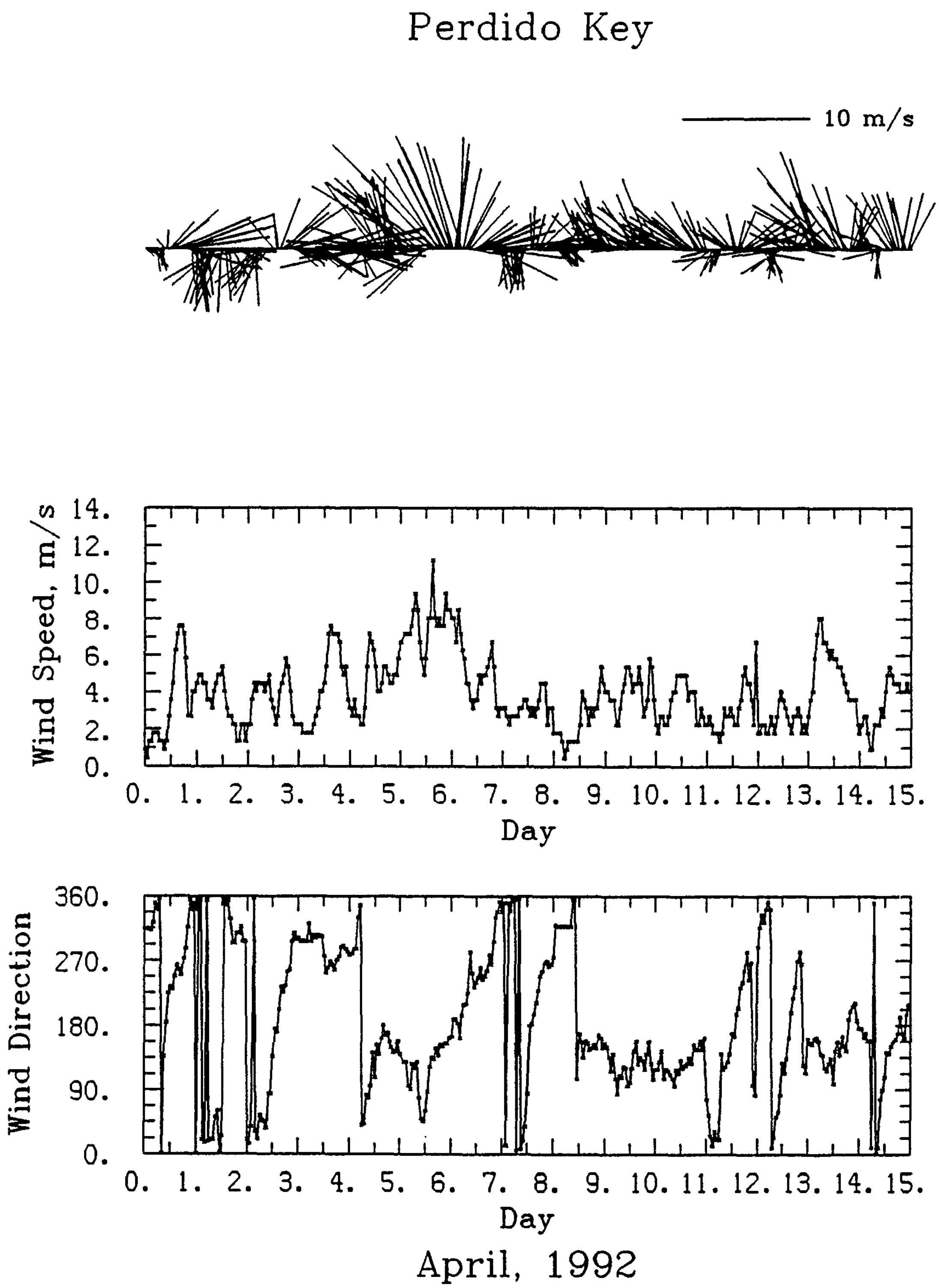


Figure IV-13: Wind Speed and Direction, April 1-15, 1992.

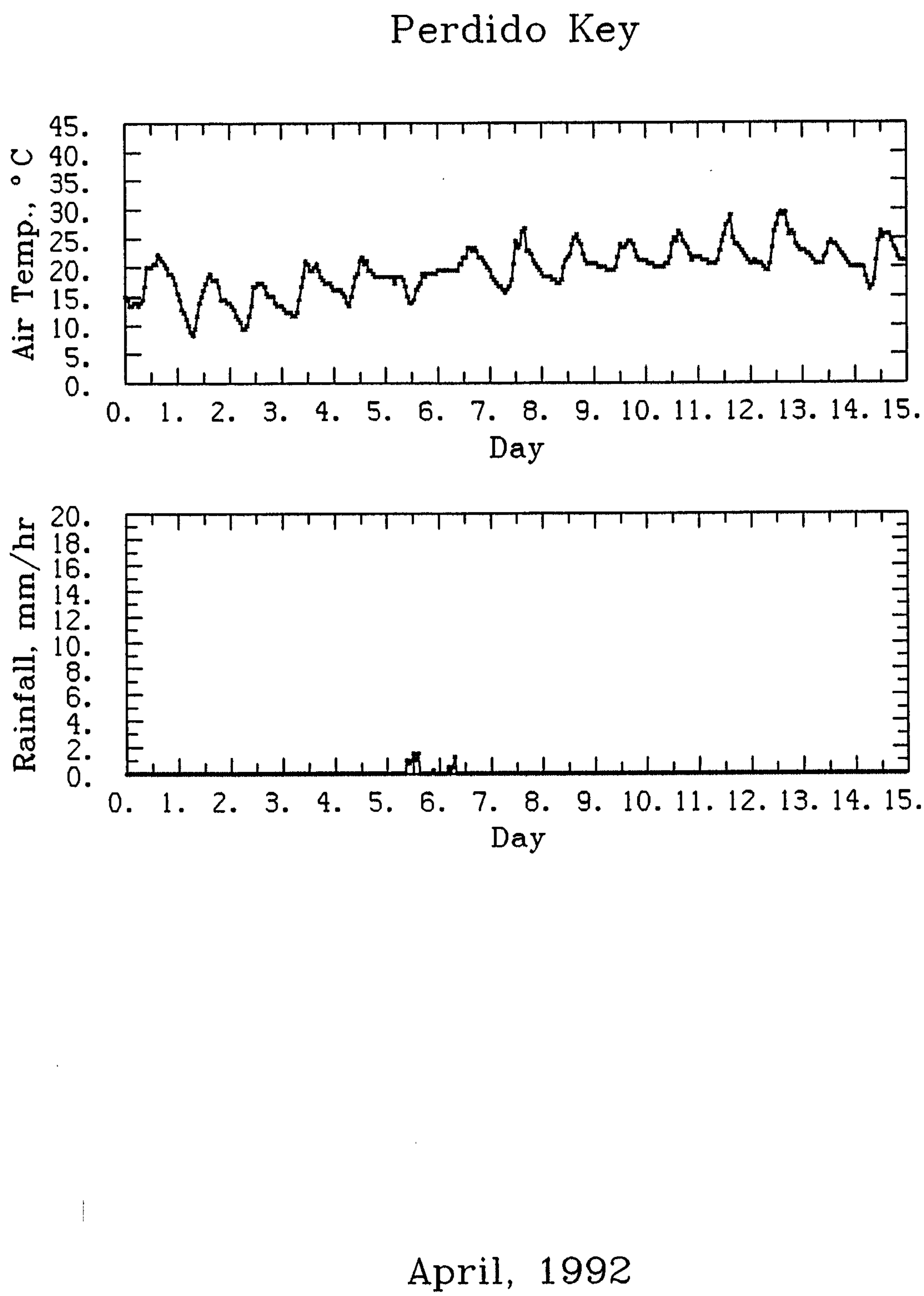


Figure IV-14: Air Temperature and Rainfall, April 1-15, 1992.

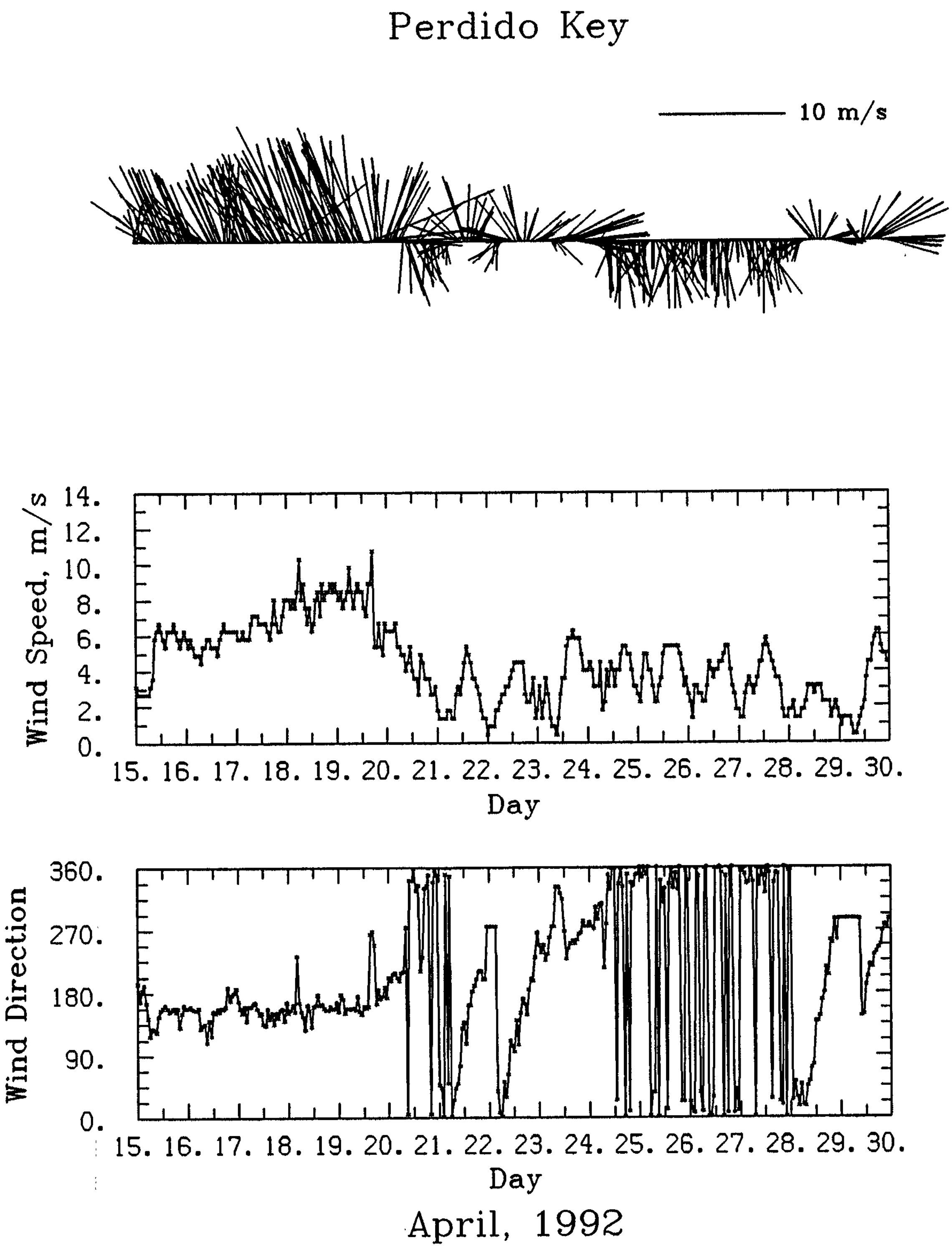
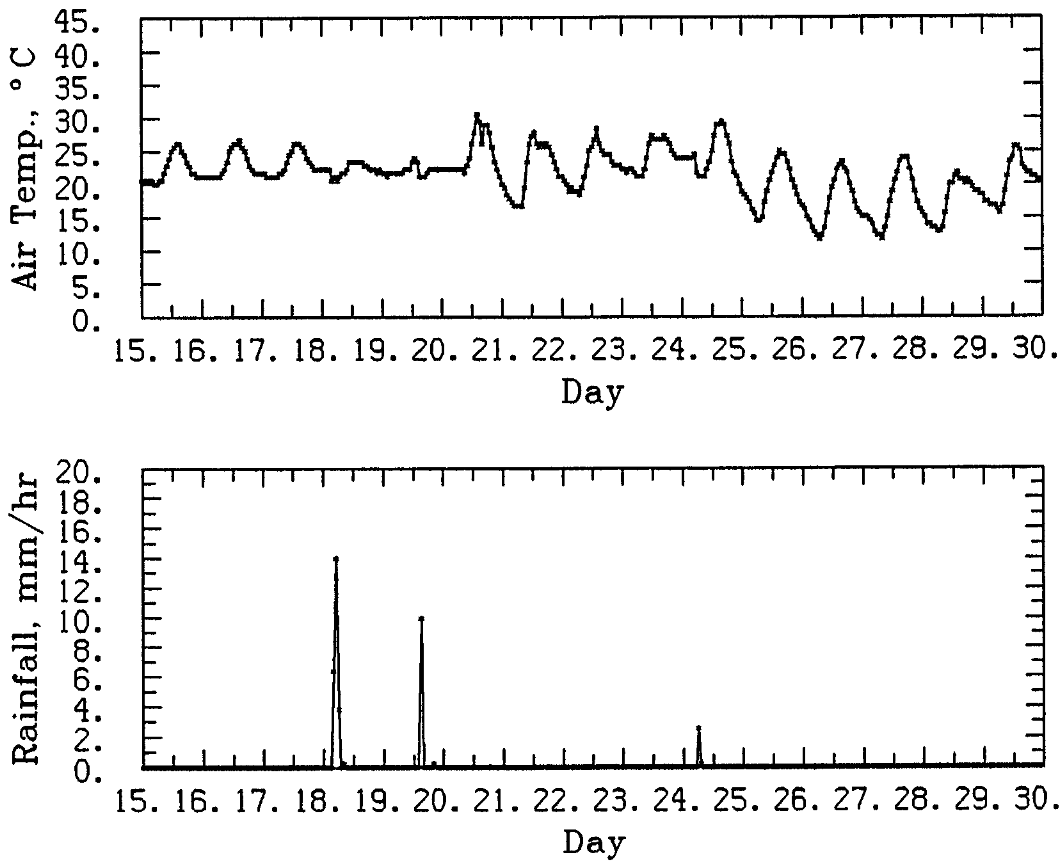


Figure IV-15: Wind Speed and Direction, April 16-30, 1992.

Perdido Key



April, 1992

Figure IV-16: Air Temperature and Rainfall, April 16-30, 1992.

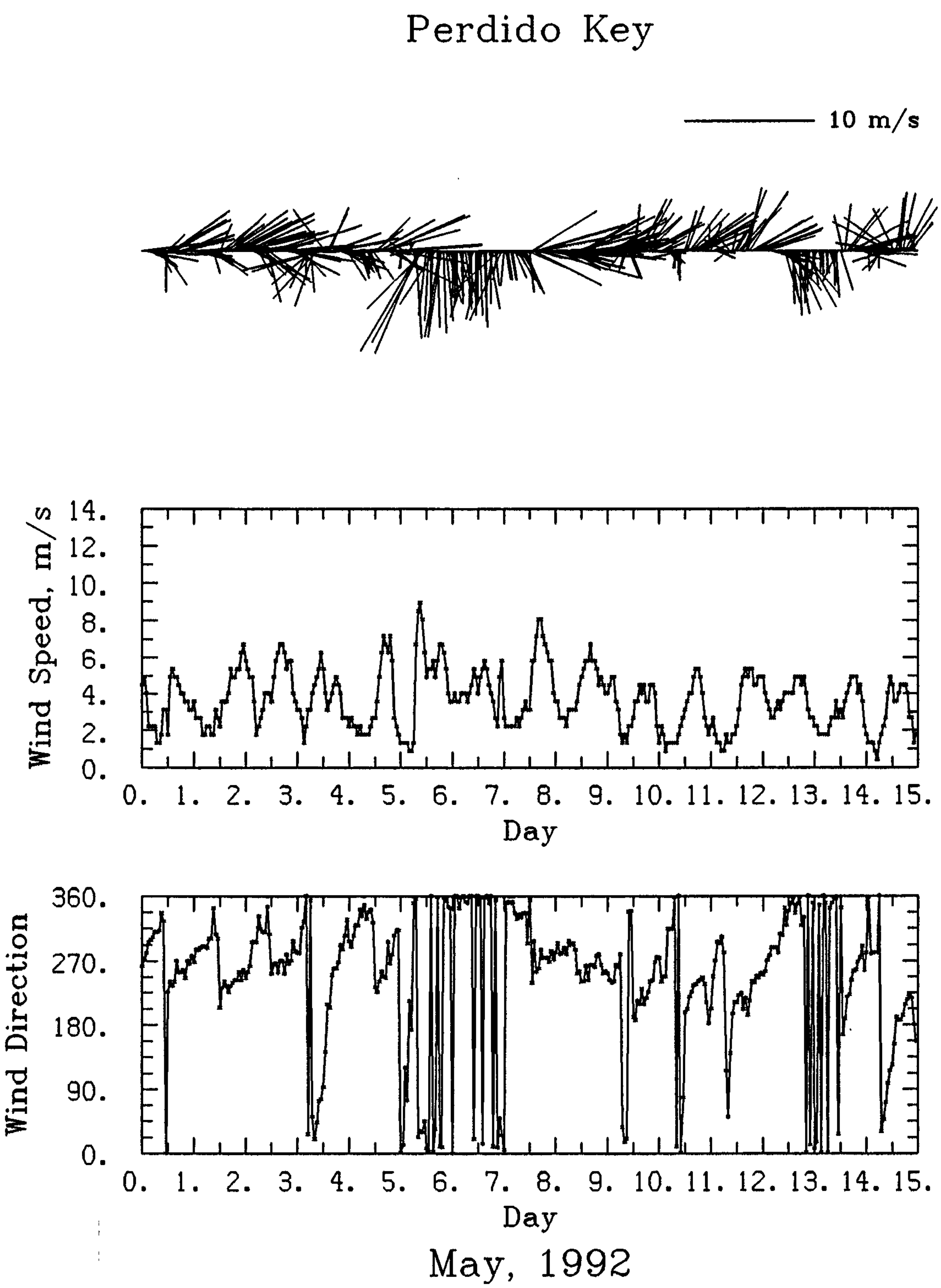


Figure IV-17: Wind Speed and Direction, May 1-15, 1992.

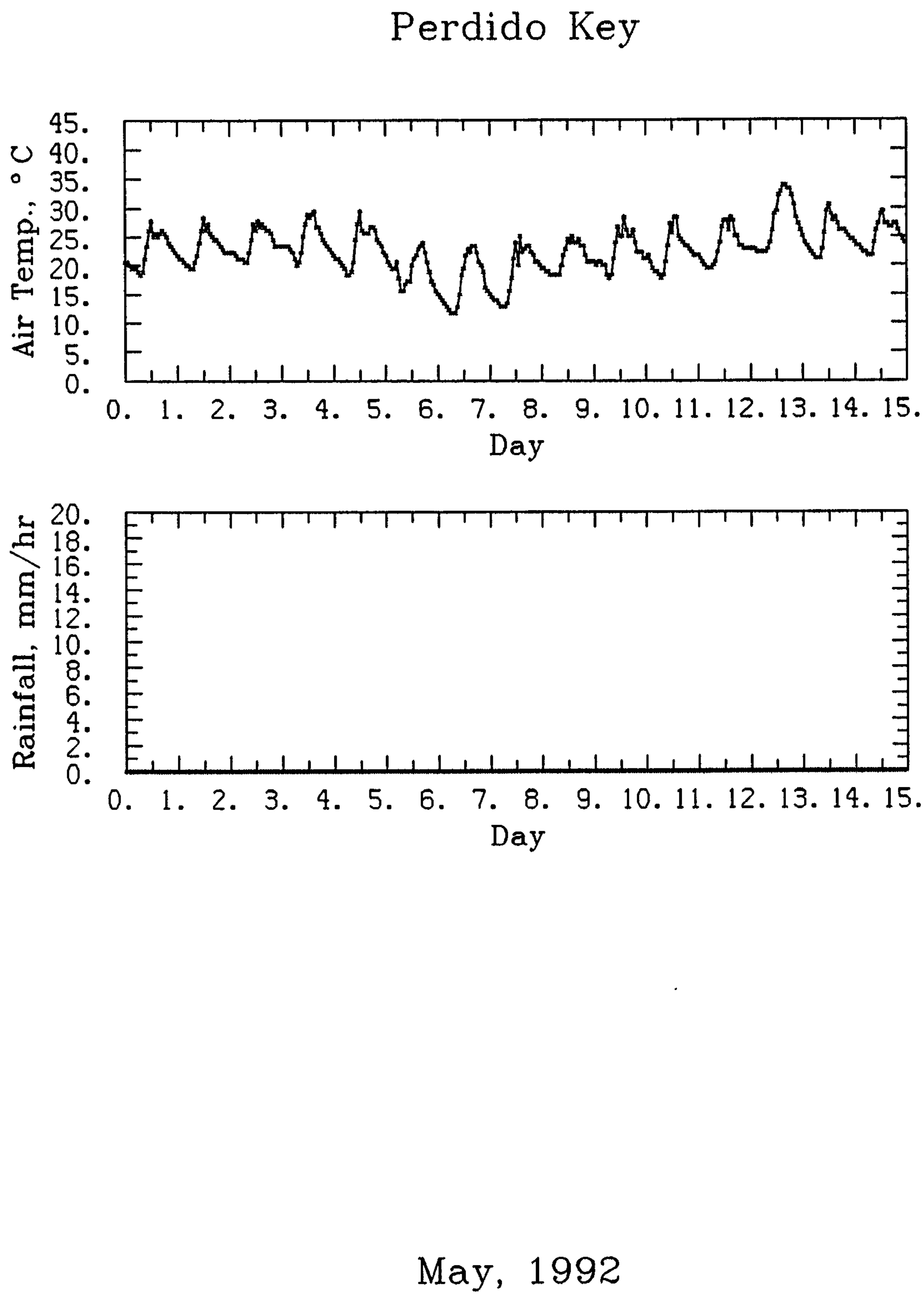


Figure IV-18: Air Temperature and Rainfall, May 1-15, 1992.

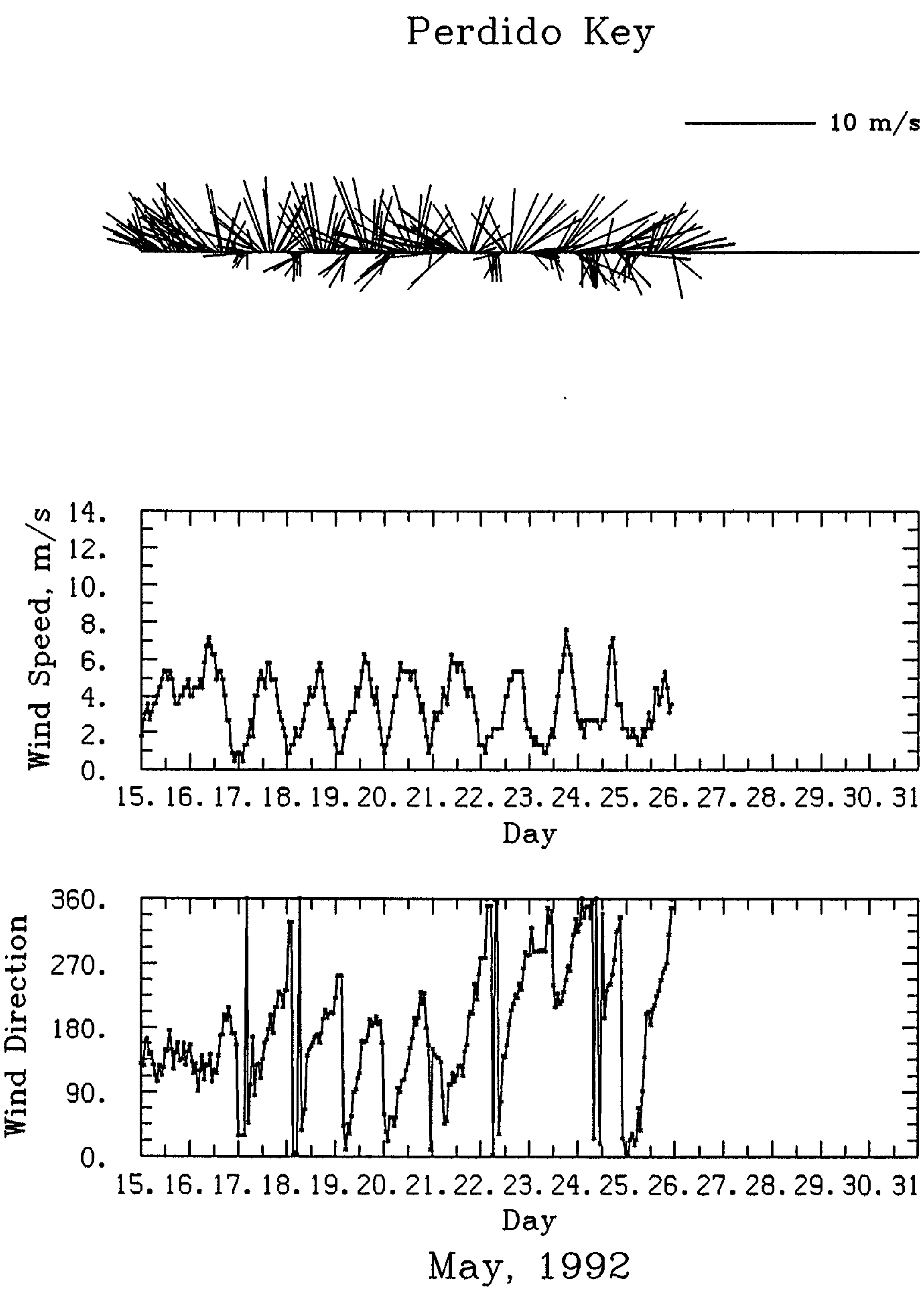


Figure IV-19: Wind Speed and Direction, May 16-31, 1992.

Perdido Key

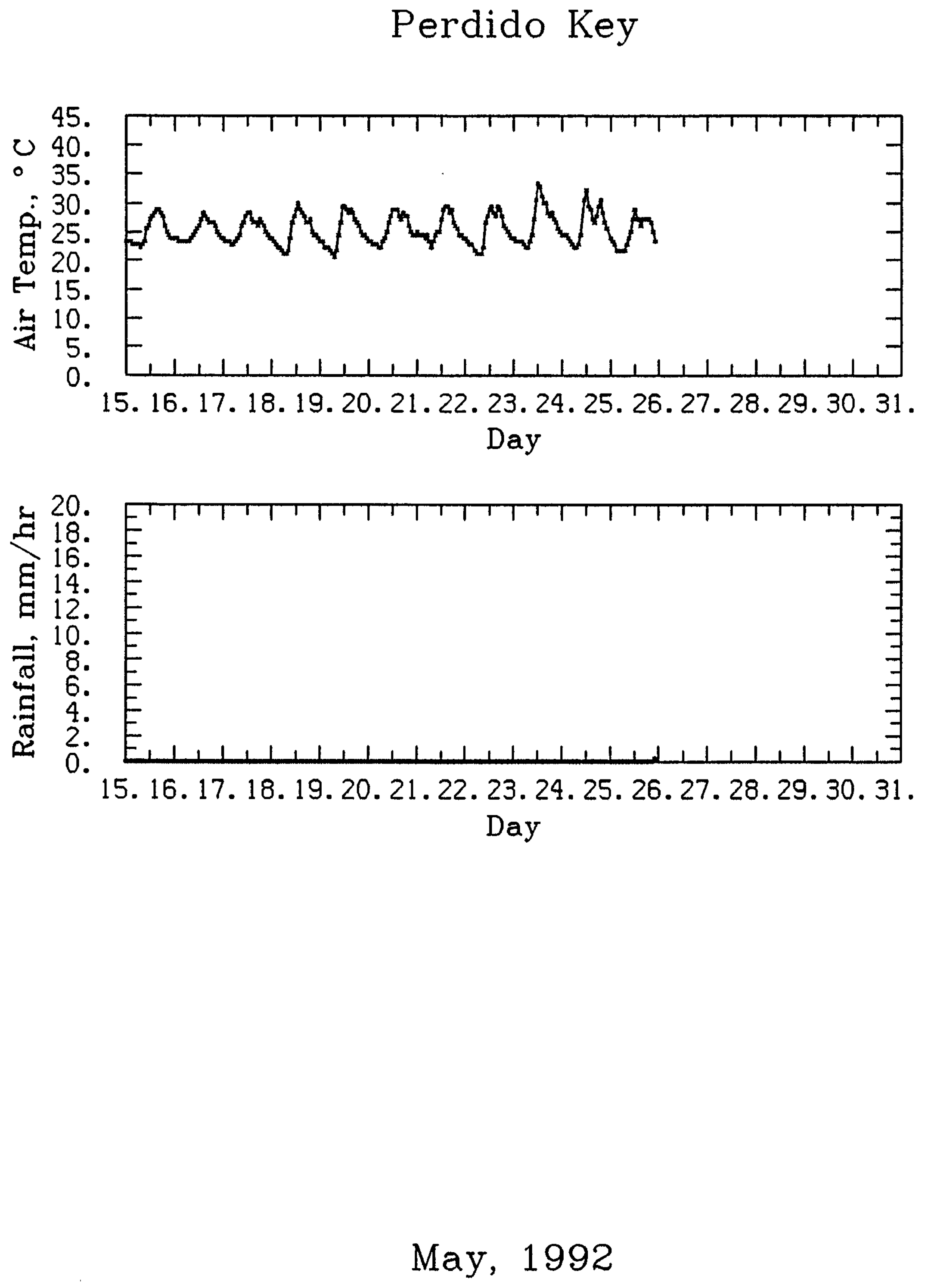


Figure IV-20: Air Temperature and Rainfall, May 16-31, 1992.

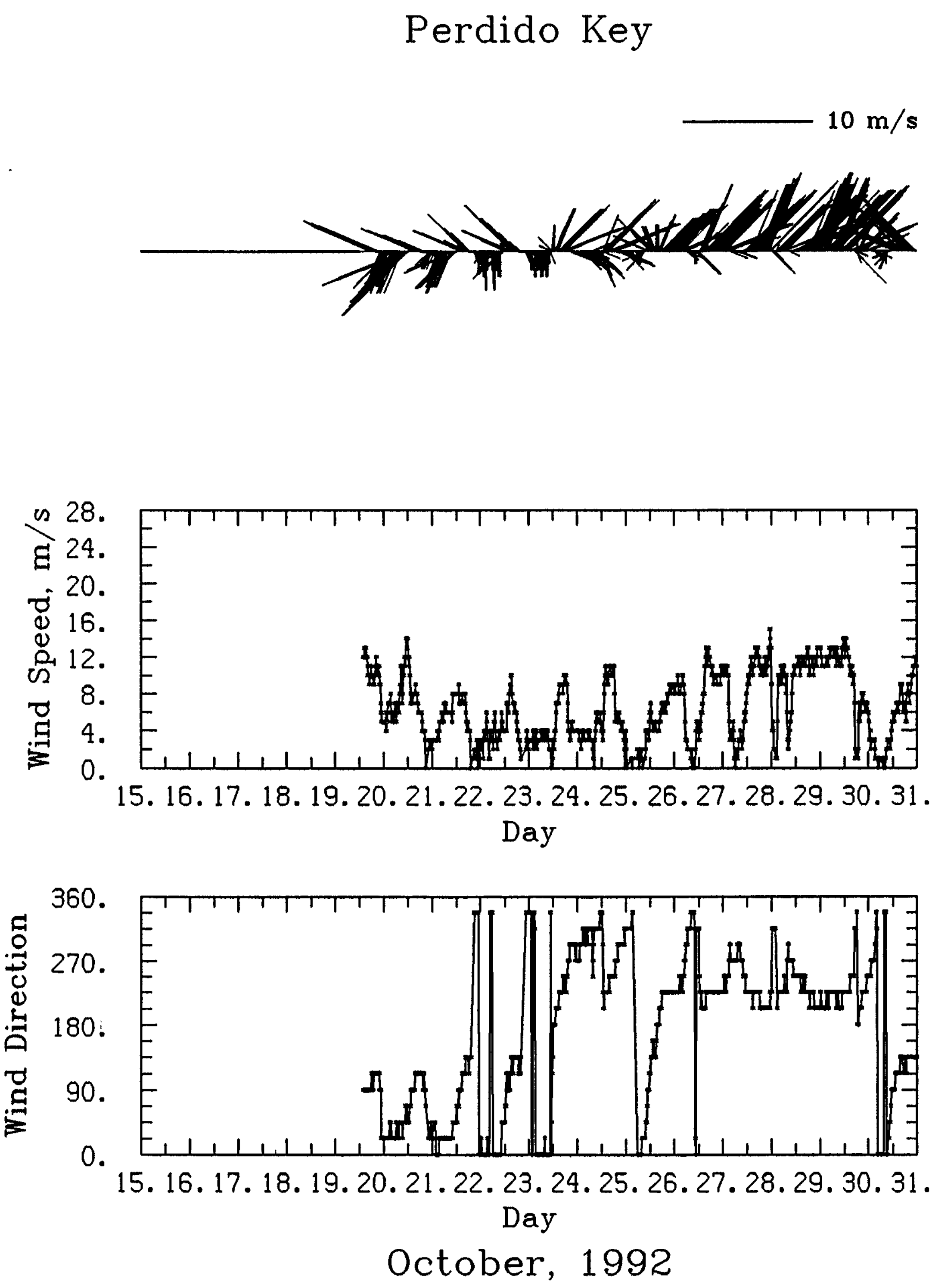
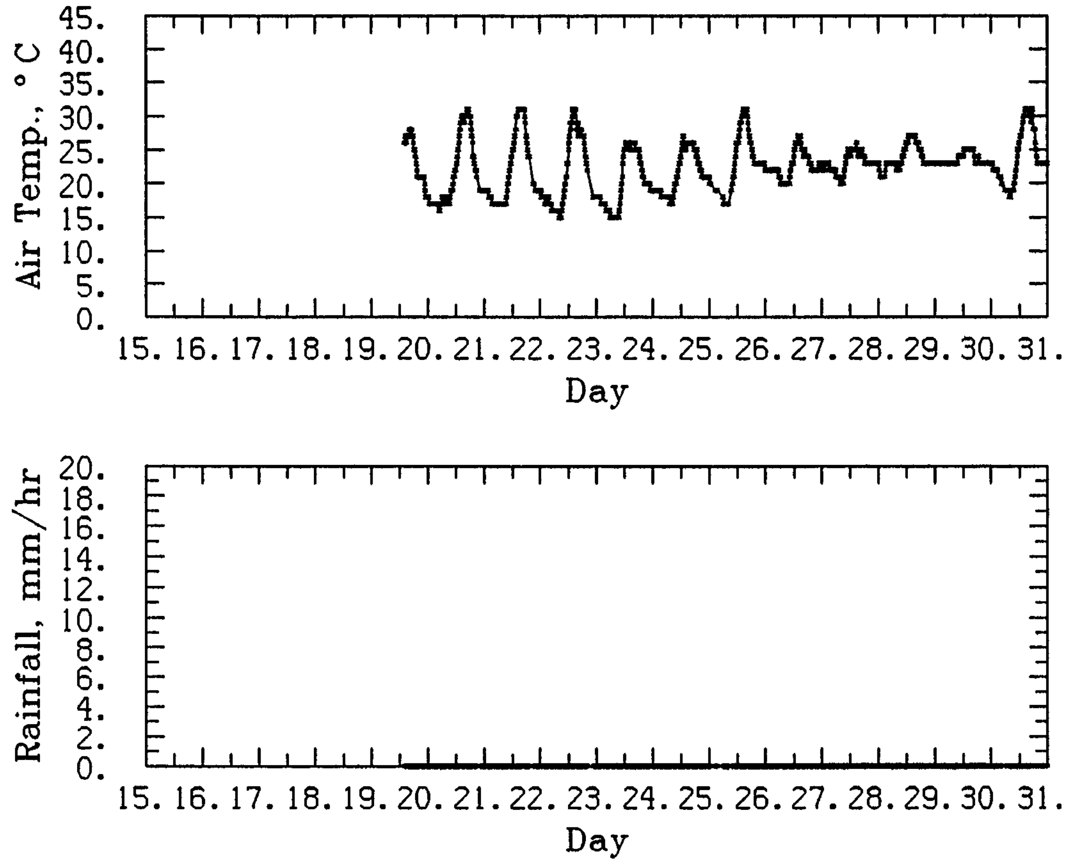


Figure IV-21: Wind Speed and Direction, October 16-31, 1992.

Perdido Key



October, 1992

Figure IV-22: Air Temperature and Rainfall, October 16-31, 1992.

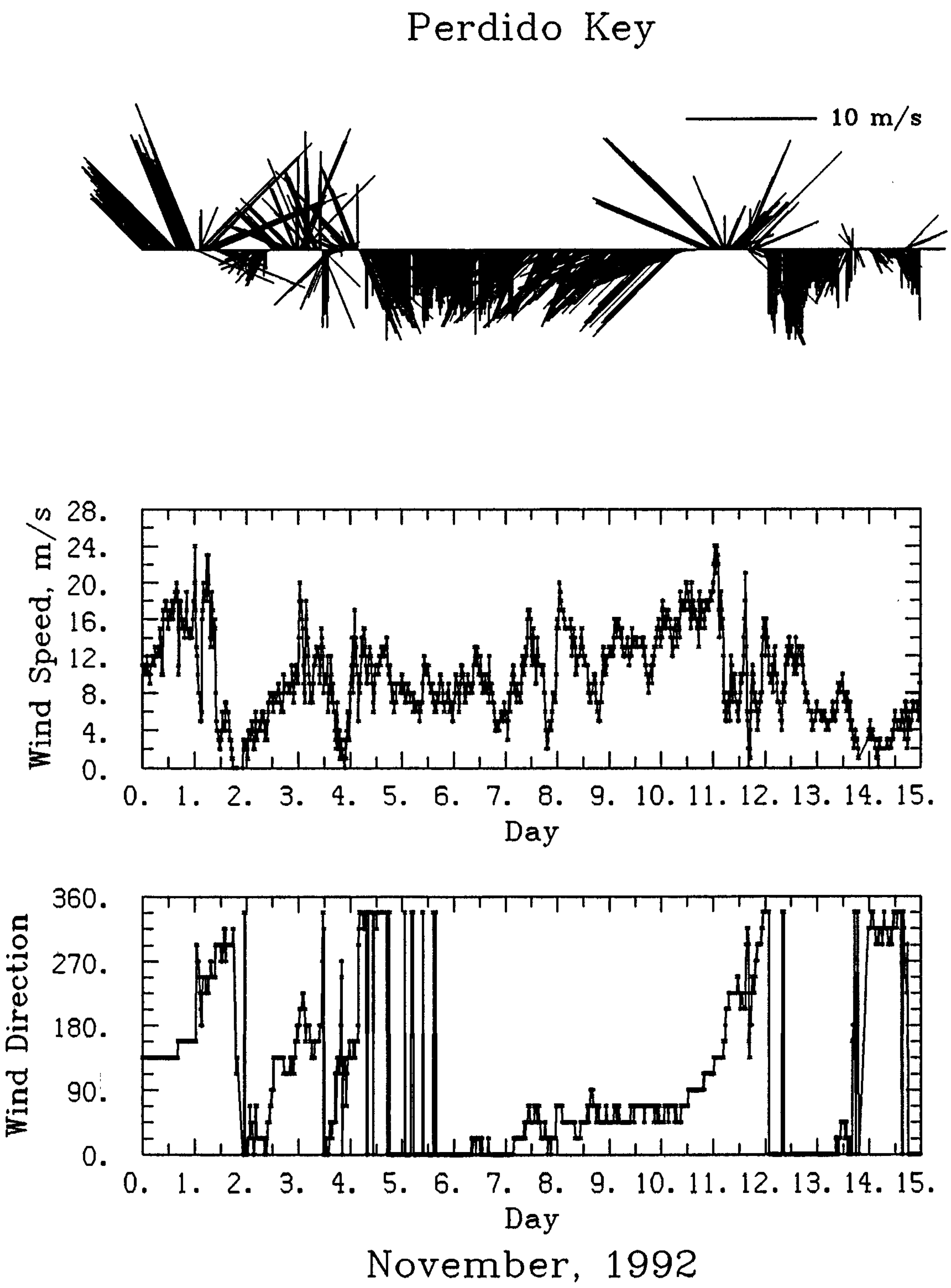


Figure IV-23: Wind Speed and Direction, November 1-15, 1992.

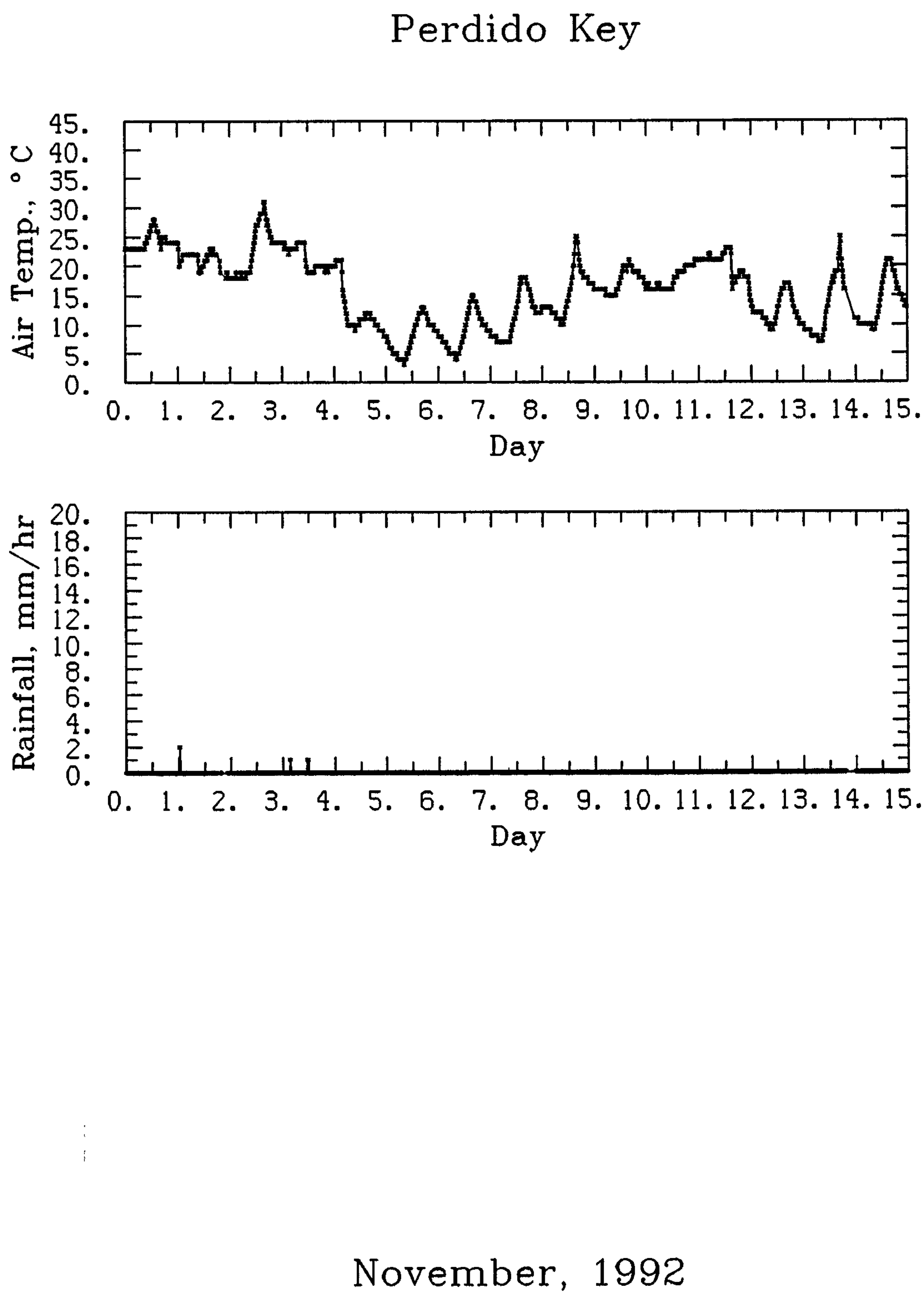


Figure IV-24: Air Temperature and Rainfall, November 1-15, 1992.

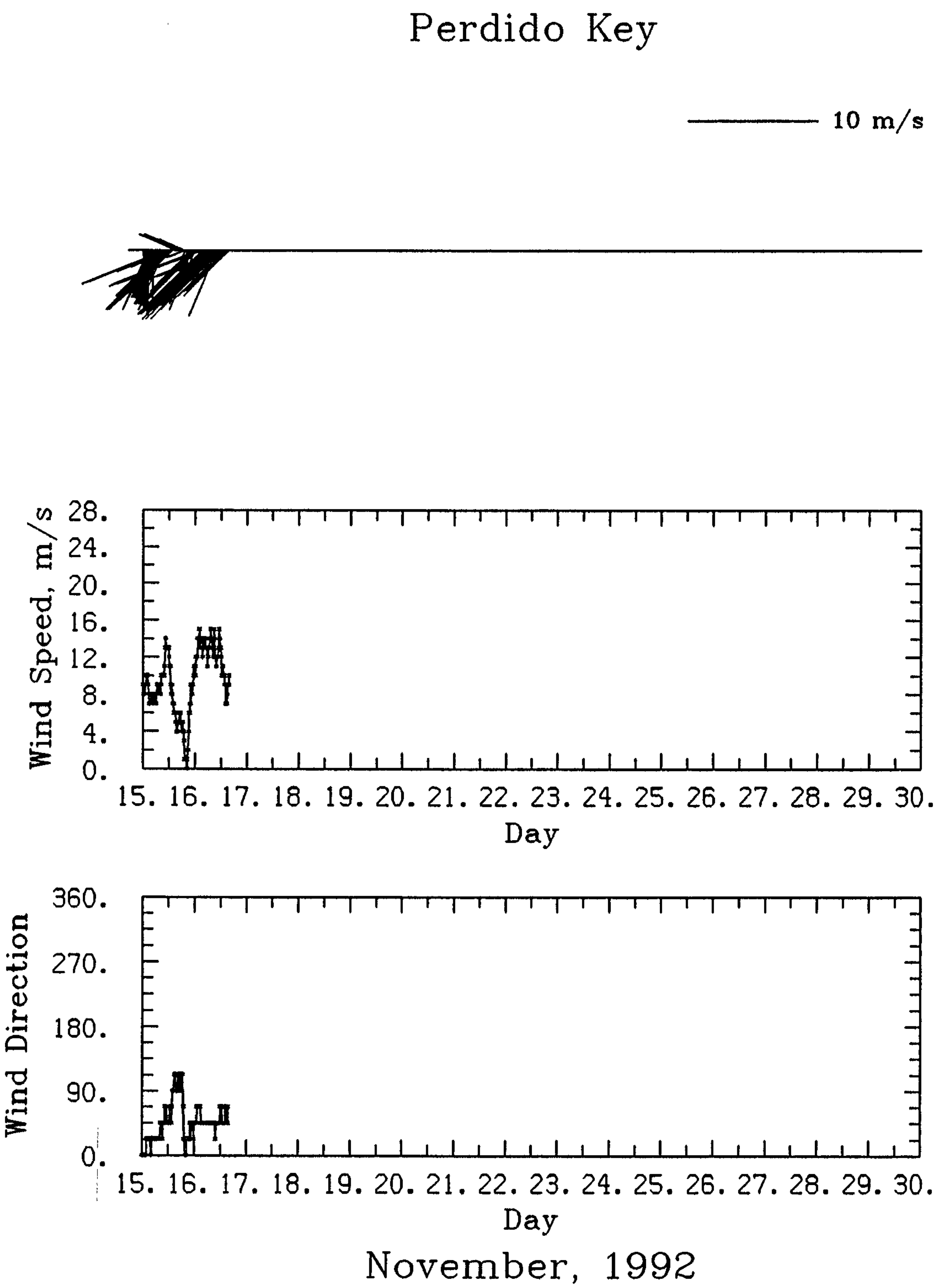
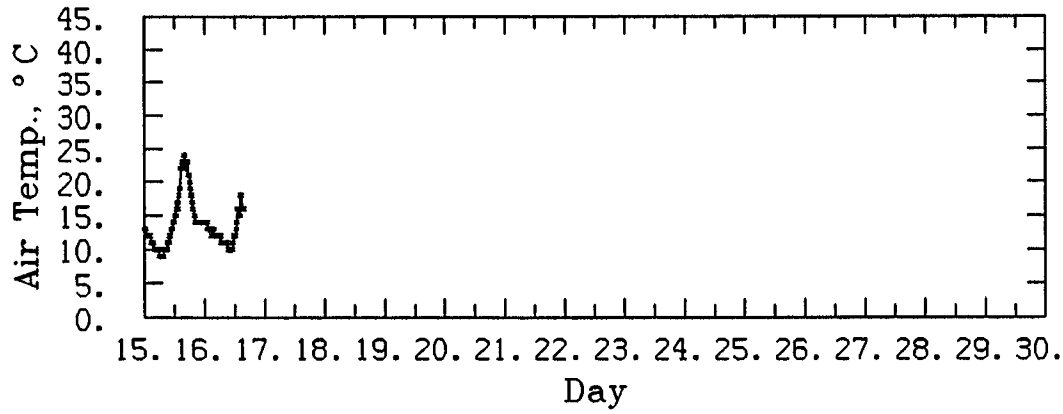
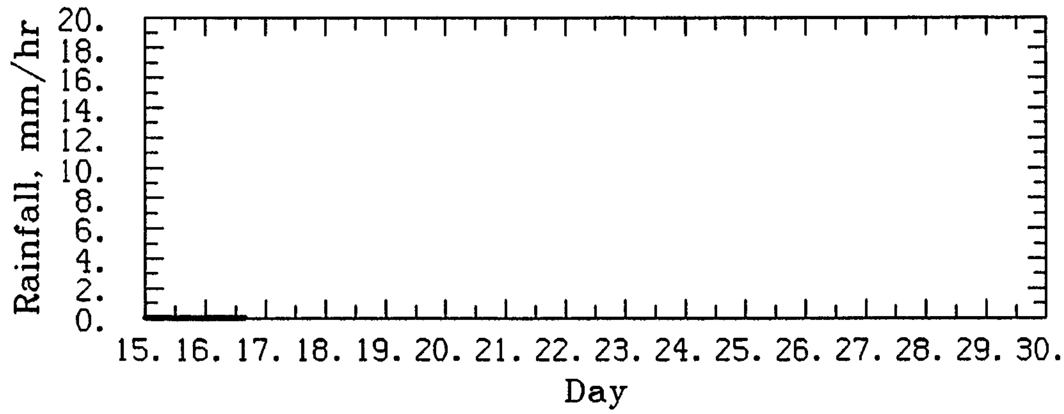


Figure IV-25: Wind Speed and Direction, November 16-30, 1992.

Perdido Key





November, 1992

Figure IV-26: Air Temperature and Rainfall, November 16-30, 1992.

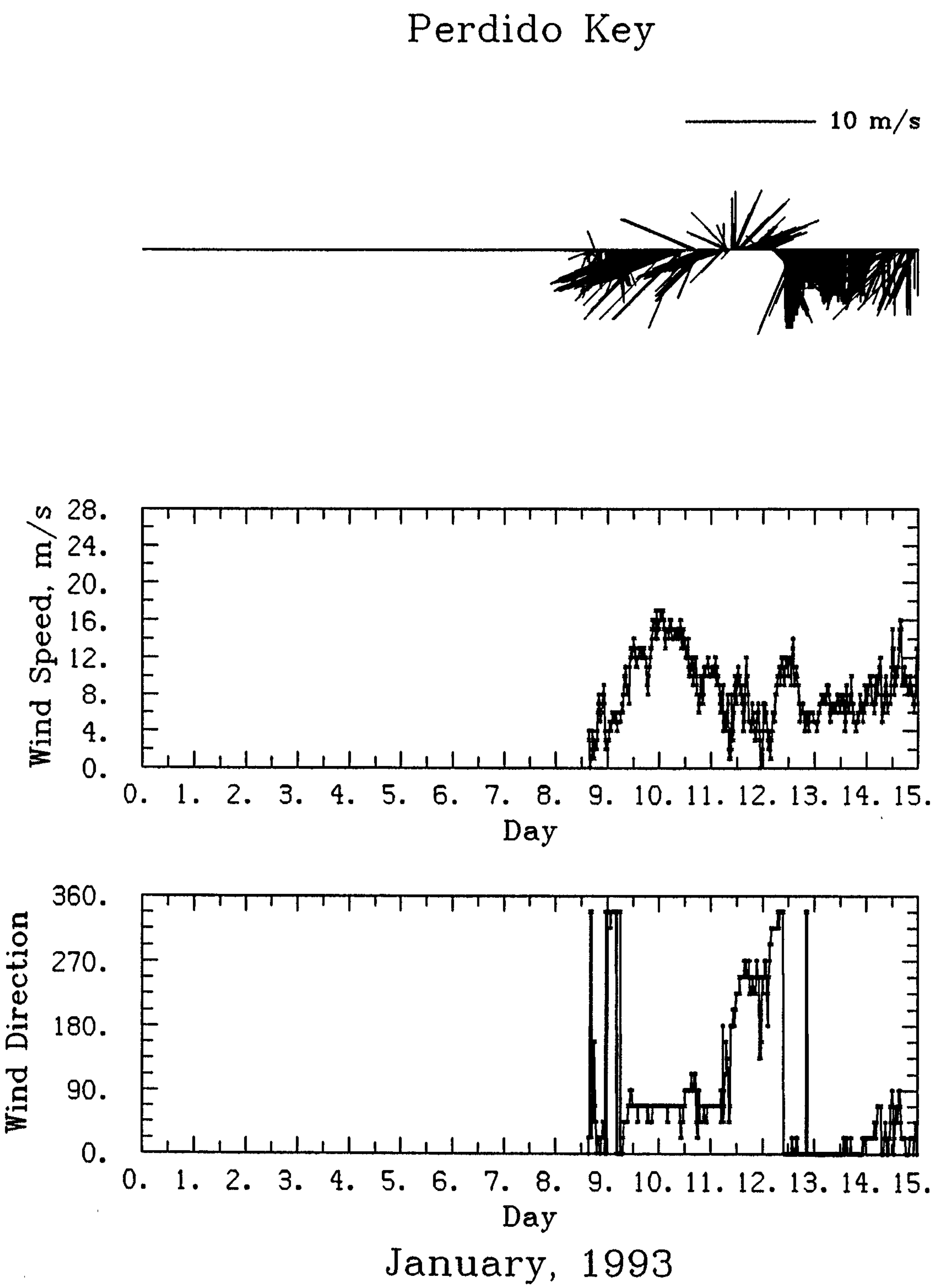
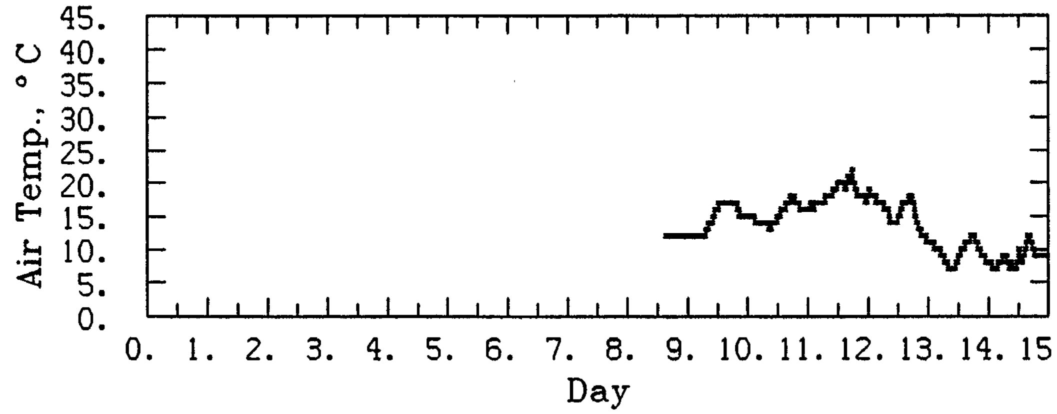
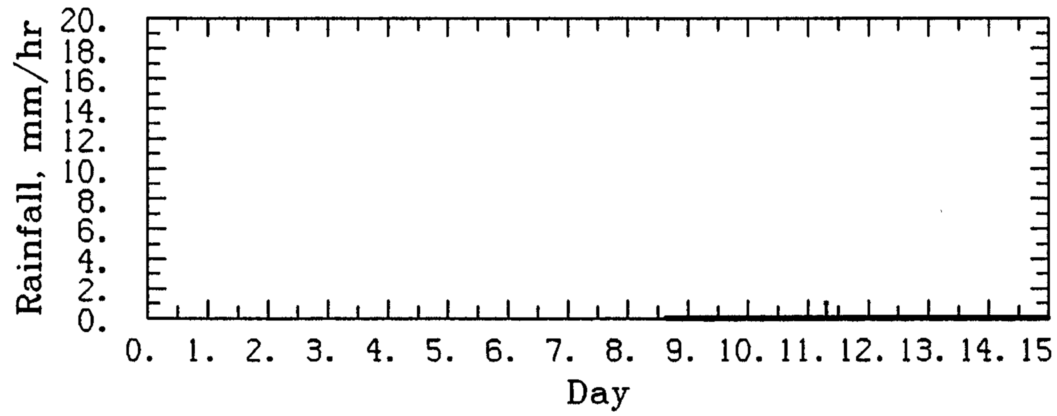


Figure IV-27: Wind Speed and Direction, January 1-15, 1993.

Perdido Key





January, 1993

Figure IV-28: Air Temperature and Rainfall, January 1-15, 1993.

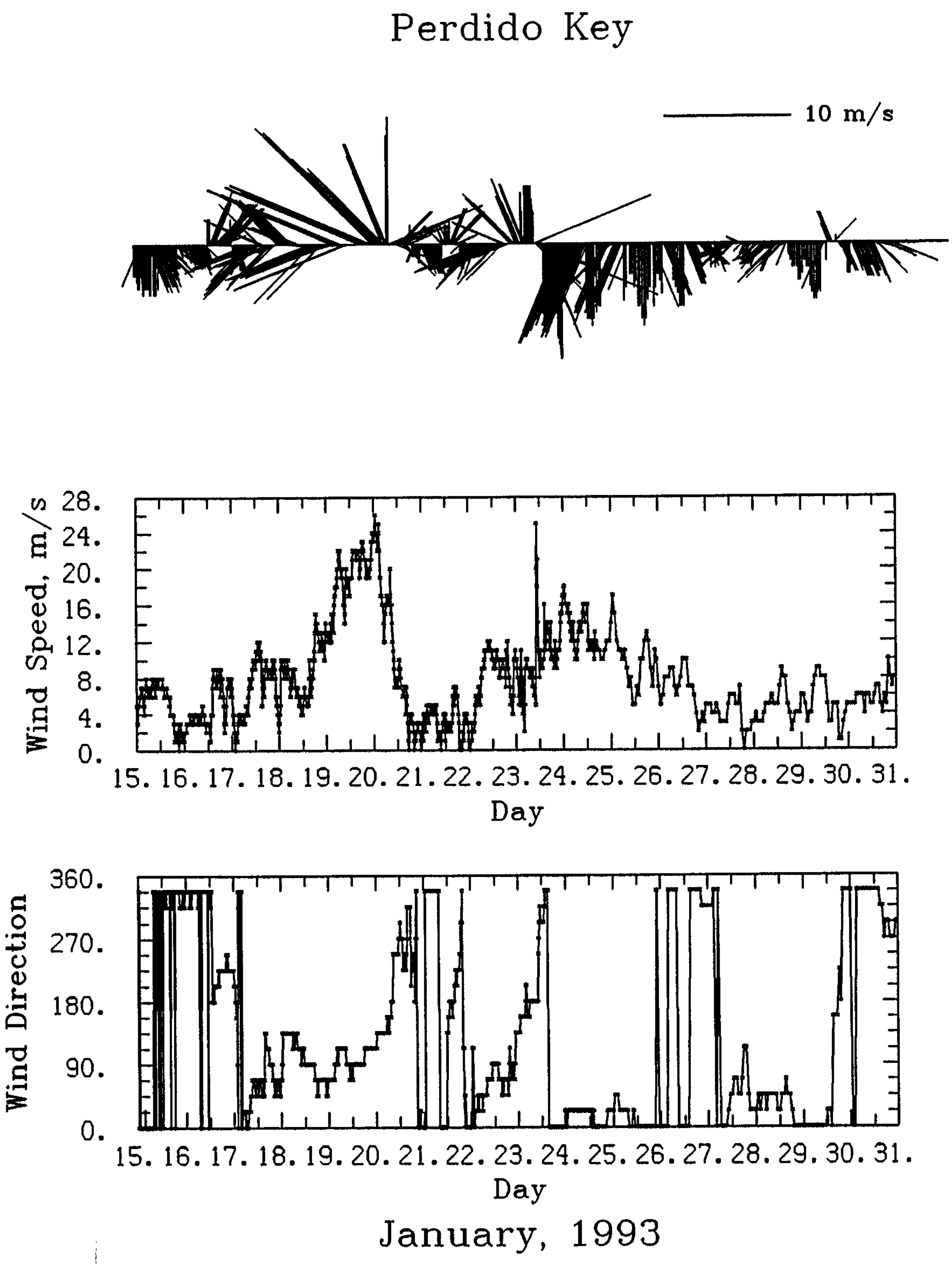


Figure IV-29: Wind Speed and Direction, January 16-31, 1993.

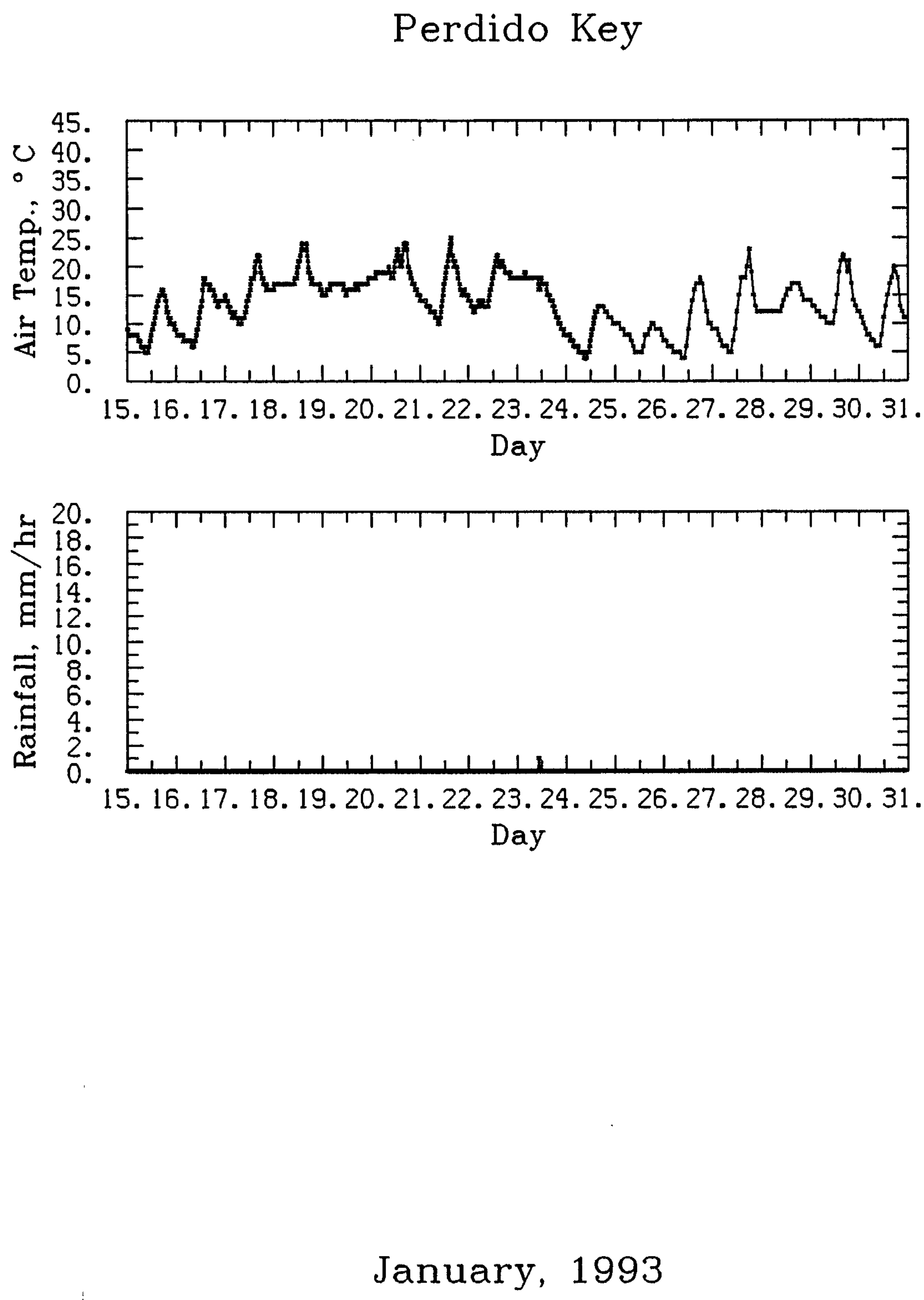


Figure IV-30: Air Temperature and Rainfall, January 16-31, 1993.

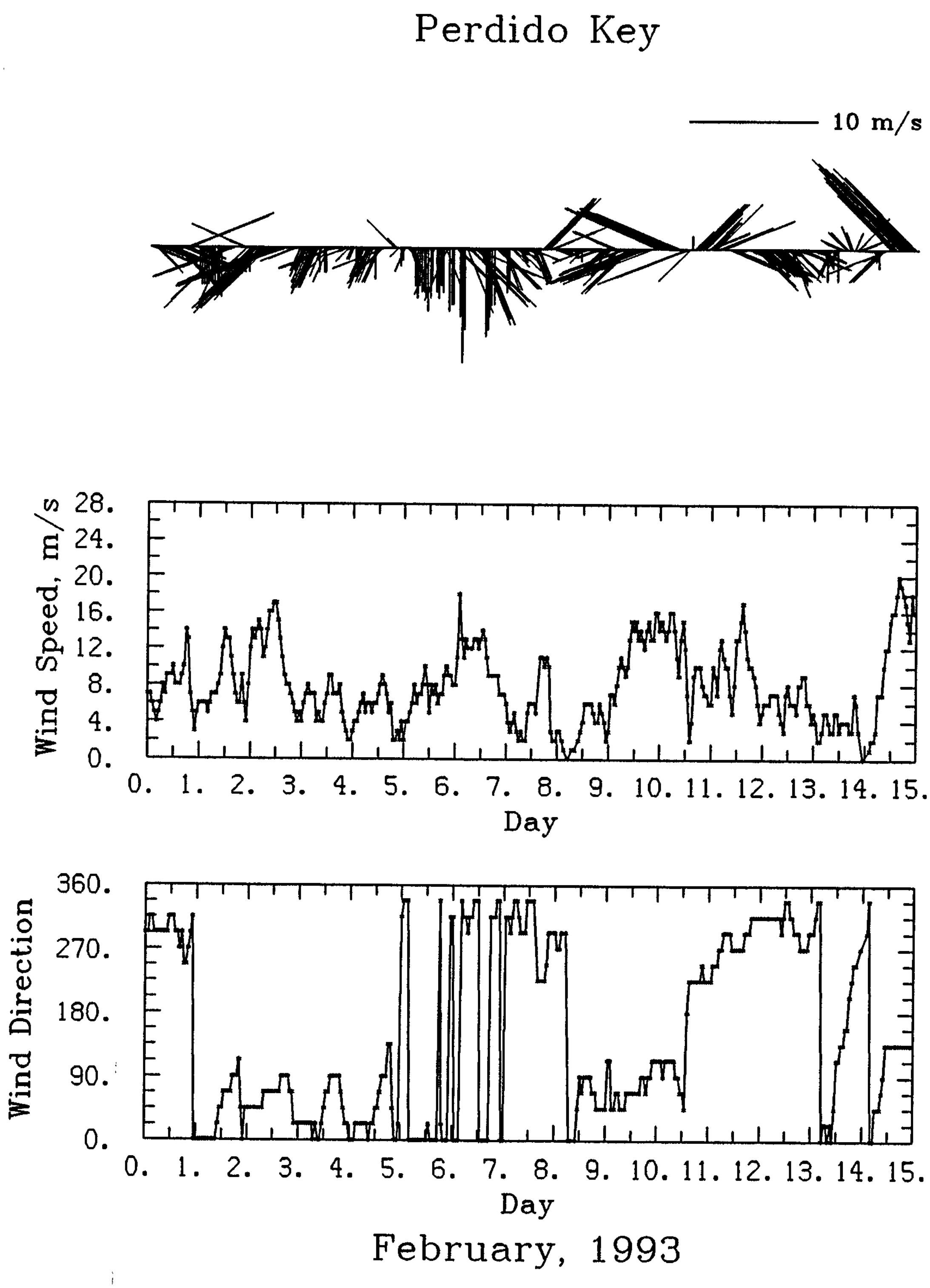


Figure IV-31: Wind Speed and Direction, February 1-15, 1993.

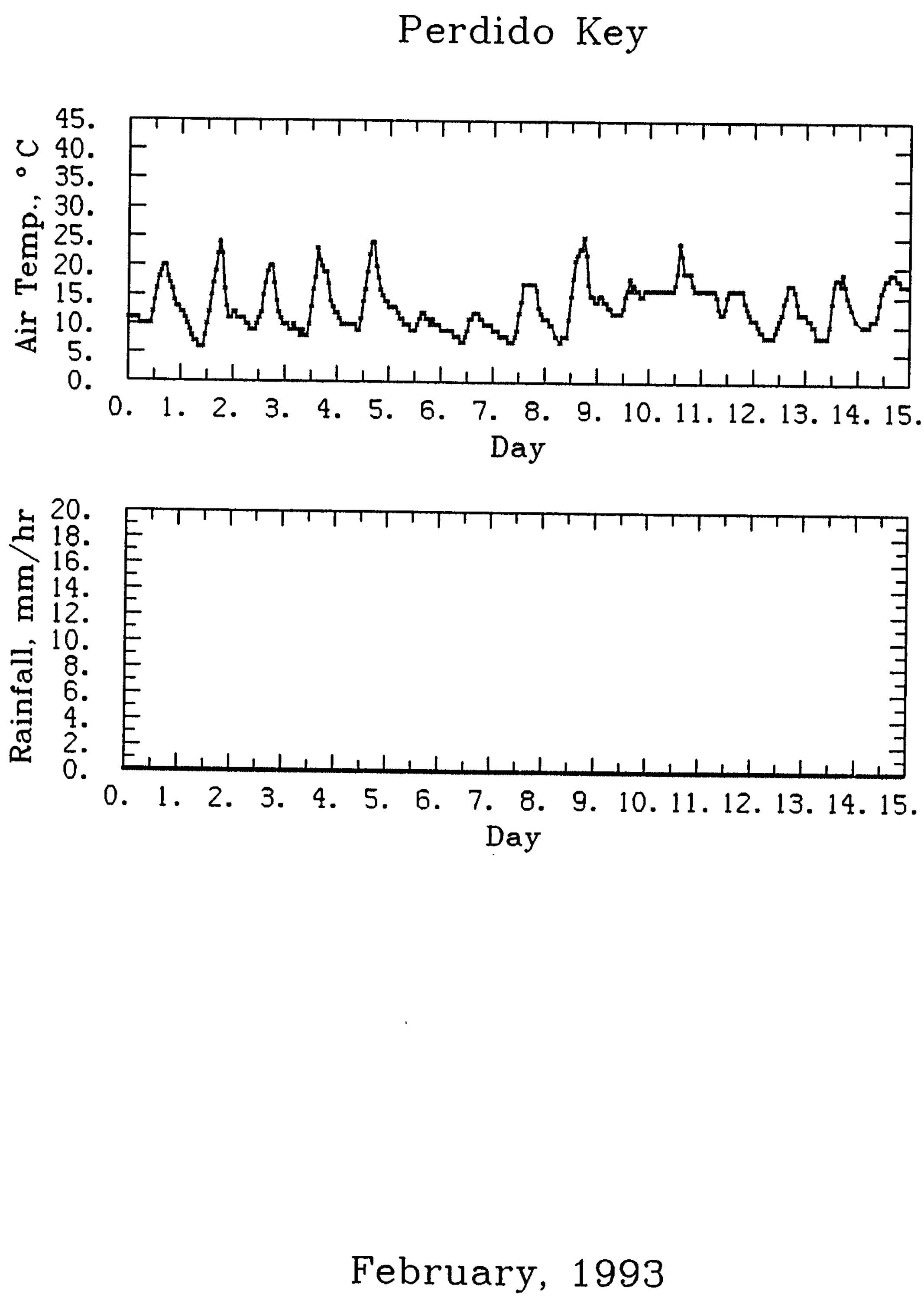


Figure IV-32: Air Temperature and Rainfall, February 1-15, 1993.

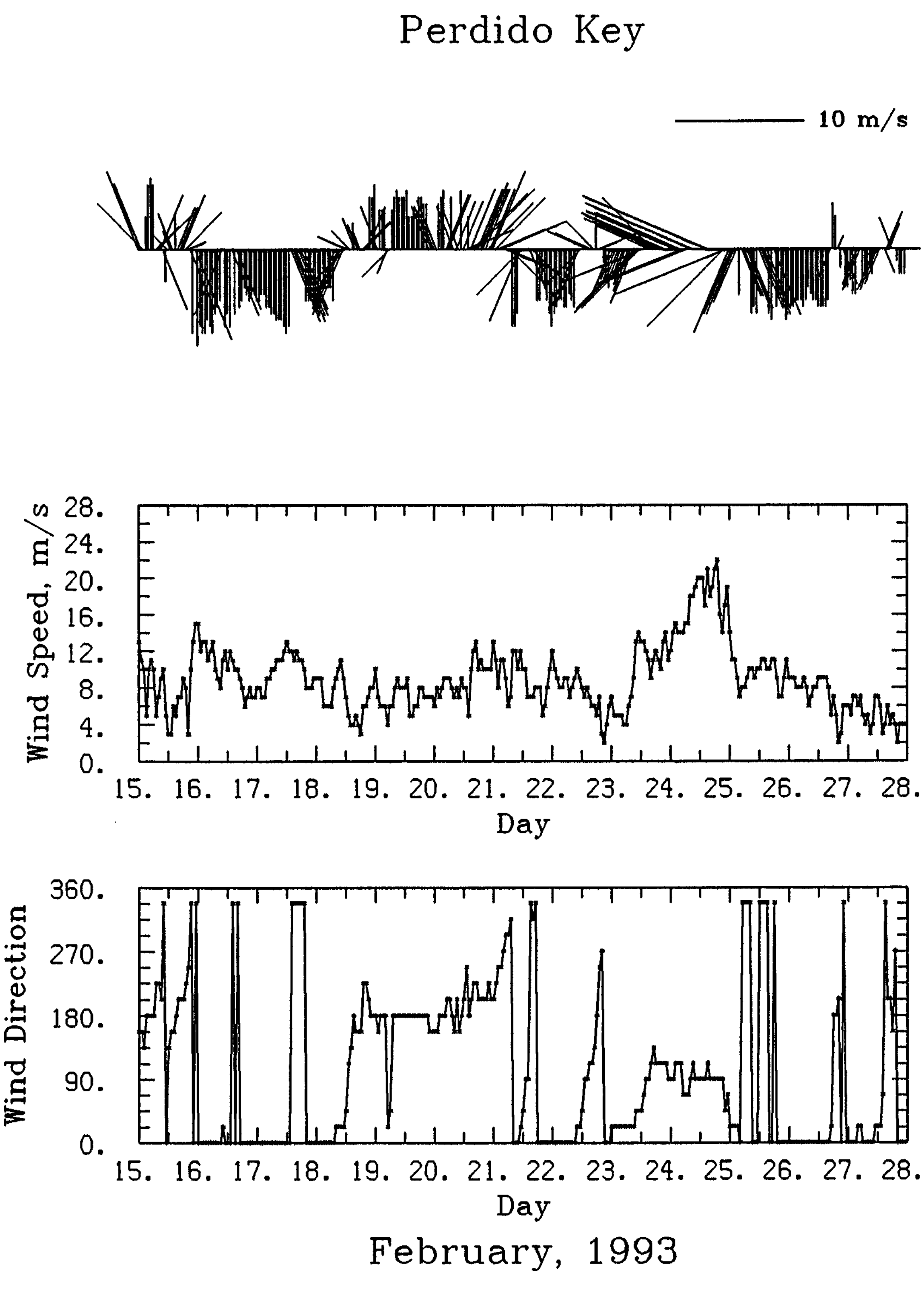


Figure IV-33: Wind Speed and Direction, February 16-28, 1993.

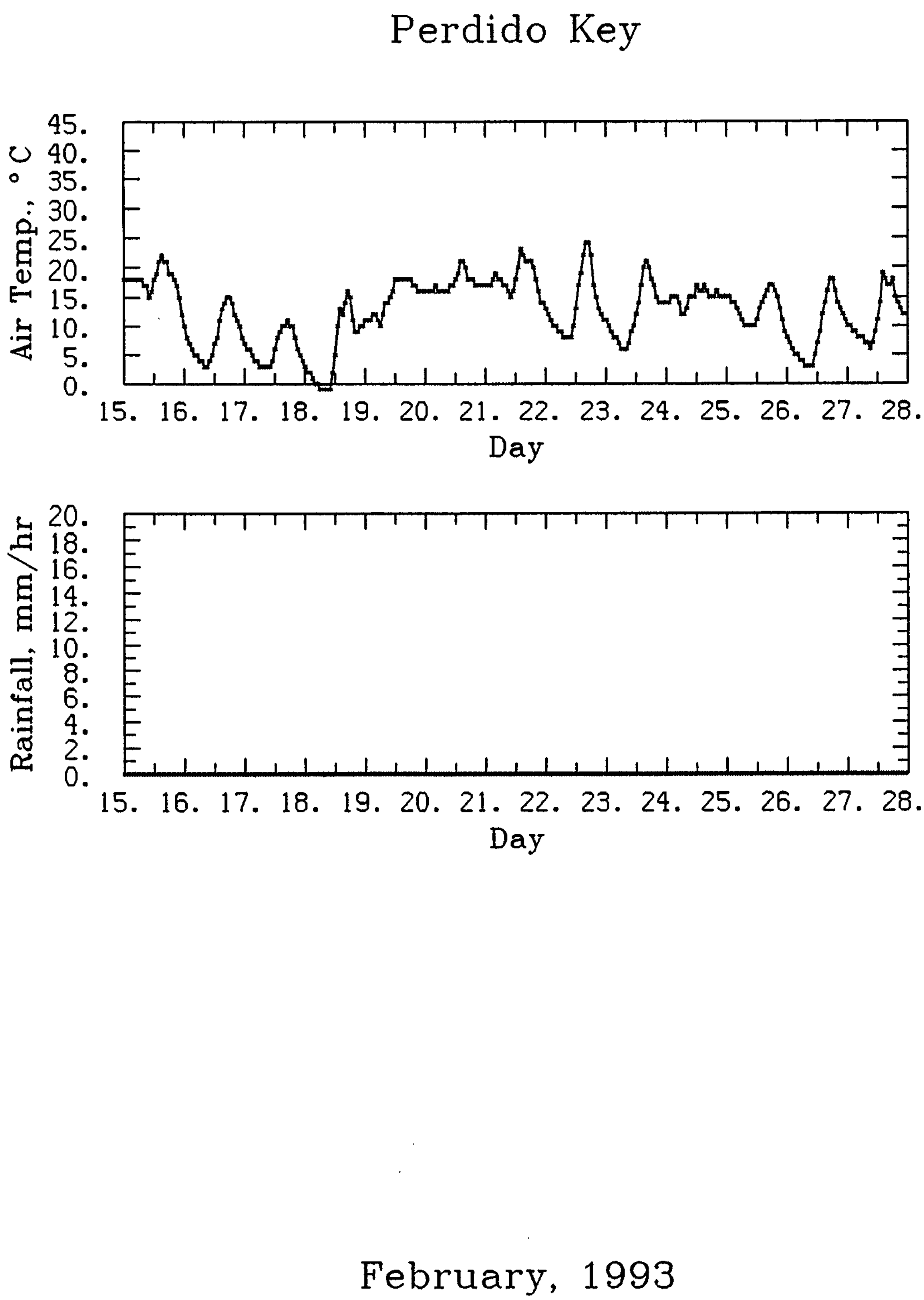


Figure IV-34: Air Temperature and Rainfall, February 16-28, 1993.

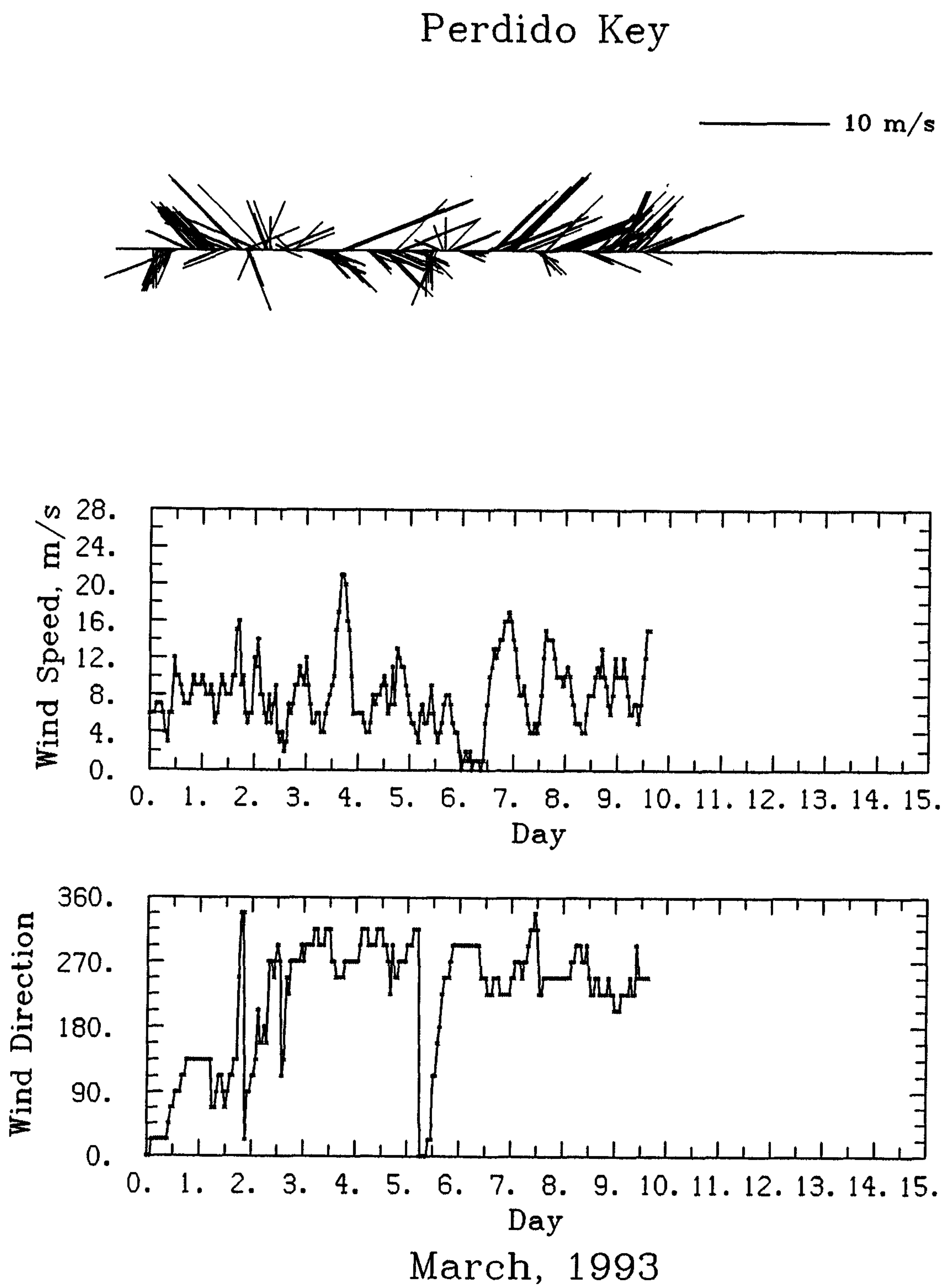
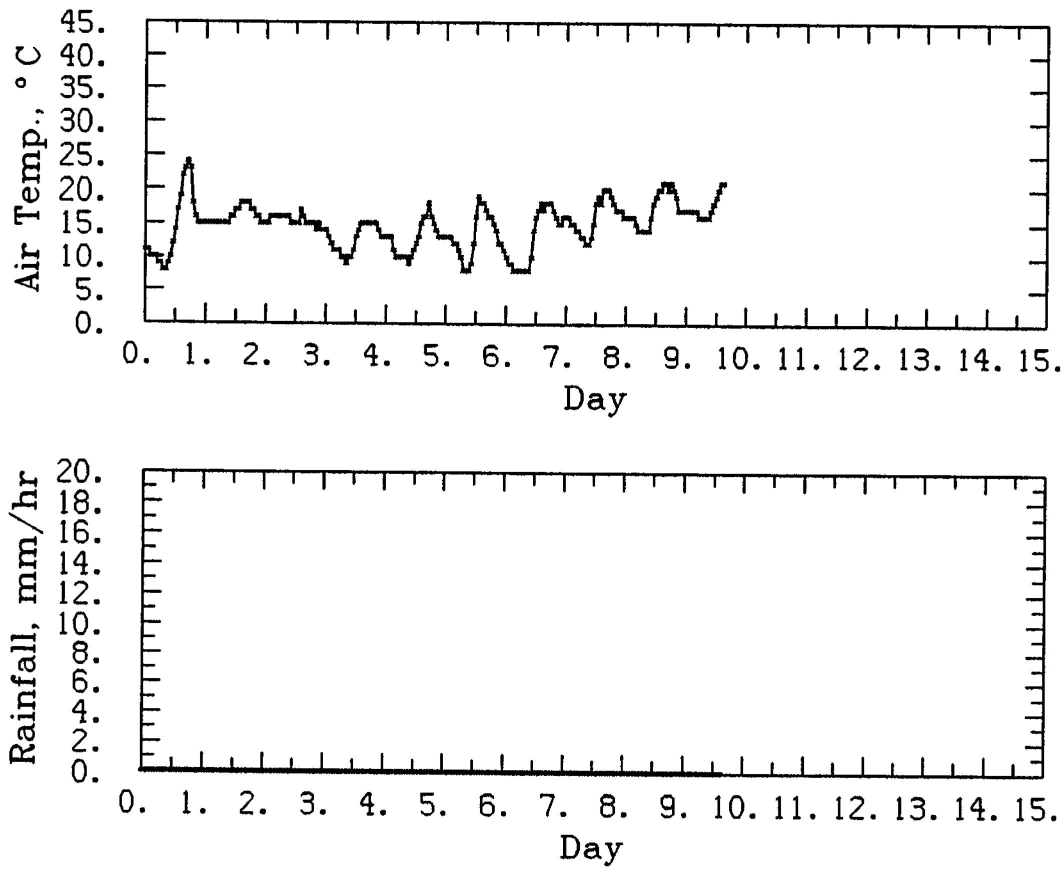


Figure IV-35: Wind Speed and Direction, March 1-15, 1993.

Perdido Key



March, 1993

Figure IV-36: Air Temperature and Rainfall, March 1-15, 1993.