Shoreline Change Rate Estimates

Escambia and Santa Rosa Counties

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FOREWORD

This report was prepared to provide shoreline change rate estimates to assist in regulatory programs and beach management planning efforts. In particular, there is a need to assist project managers within the Office of Beaches and Coastal Systems in ranking proposed beach management projects for State of Florida funding support. Efforts were made in developing the rate estimates to consider and take into account the influences of coastal structures and sand fill placements on shoreline change. However, these influences can be very complex and extensive analysis and consideration of such influences was beyond the scope of this work.

Shoreline change analyses performed for other specific purposes, such as for establishing 30-year erosion projections pursuant to paragraph 161.053(6), F.S., should be developed in accordance with appropriate and applicable procedures for that specific purpose, although these reports may be relevant in that regard.

This report was prepared by Emmett Foster, P. E., of the Office of Beaches and Coastal Systems and Darren Spurgeon and Jenny Cheng of the Beaches and Shores Resource Center. The shoreline change rate estimates are based on the best available data at the time of report preparation. Updates to the report will be performed as new data becomes available and as staff workload allows.

APPROVED BY

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 EXECUTIVE SUMMARY

This report includes a shoreline change study of both Escambia and Santa Rosa Counties. Escambia County is the westernmost coastal county in Florida. It has a very large inlet, Pensacola Pass, which influences adjacent shorelines. The county contains parts of two barrier islands, Perdido Key on the west and Santa Rosa Island on the east. Large portions of both islands are parkland, primarily Gulf Islands National Seashore. The easternmost portion of the study area is in Santa Rosa County.

Two moderately developed areas exist on Perdido Key between the federal park and the Alabama state line. Pensacola Beach and Navarre Beach are two moderately developed areas on Santa Rosa Island. Development density has been increasing in all the developed zones.

Major renourishment projects occurred on Perdido Key in 1985 and 1989-91. There is no significant coastal armoring in the study area. There are apparently multiple natural hard features (rock and/or peat) in the water and perhaps beneath the beach in some areas which influence coastal changes.

Pre-renourishment erosion rates on Perdido Key were relatively high in the eastern half of the island (R-29 to R-60), -1 to -9 ft/yr. The erosion pattern was progressing westward into the stable to mildly accreting western half. Shoreline change rates on most of Santa Rosa Island were on the order of 0.0 to -1 ft/yr, but increased in the Santa Rosa Island National Seashore (Fort Pickens area) adjacent to the inlet to -3.5 ft/yr. Random, unpredictable large-scale shoreline changes occurred on both sides of Pensacola Pass in the areas immediately adjacent to the inlet (R-60 to R-80).

2 INTRODUCTION

This work is part of an ongoing project to develop up-to-date shoreline erosion rate estimates for the Florida sandy beach coastline. The shoreline referred to is the approximate Mean High water (MHW) elevation contour. The information compiled and analyses conducted are intended to provide quantitative and qualitative information on a county-by-county basis that may be used to assist in beach management planning, coastal regulation, and general shoreline analysis work.

Quantitative erosion information will be focused on providing erosion estimates relative to currently active coastal processes in those places where no renourishment projects exist. Where renourishment or other similar sand fill projects of size exist, erosion rate estimates for the pre-project conditions will be attempted where possible. It is beyond the scope of these reports to analyze renourishment project performance. In such cases, erosion is a combination of initial onshore-offshore adjustments, lateral diffusion, structural interaction, and the "background erosion" process. Because the conditions that affect erosion are being frequently altered (e.g. inlets, shoals, and armoring additions/subtractions), pre-project erosion estimates are useful primarily in a historical sense and in showing what led to the need for the artificial nourishment.

The data used for this analysis is from the Office of Beaches and Coastal Systems Historical Shoreline Database. The database includes beach and offshore profile field surveys, digitized historical shoreline and bathymetric maps, aerial photographs from the Office files, and numerous graphical representations of the data, all within a common set of horizontal and vertical controls. This database was developed and quality controlled by engineers in the Research, Analysis and Policy Section and is continually updated as time and workload allows. Beach profiles were surveyed by the Coastal Data Acquisition Section and, in some cases, by private firms, the latter usually related to the monitoring of coastal erosion control projects.

It is beyond the scope of this report to investigate possible actions that may be necessary to prevent or curb shoreline erosion. Where appropriate, however, recommended actions may be suggested or previous, failed attempts may be pointed out in an effort to help guide the reader towards a better understanding of the dynamics of the coastline and future trends in shoreline change.

3 REGIONAL SETTING

3.1 Study Area

Escambia County is the westernmost county in Florida. Coastal Escambia is bordered on the west by the Alabama state line, and on the east by a small section of Santa Rosa County known as Navarre Beach (Figure 1).

The study area contains parts of two barrier islands, Perdido Key on the west and Santa Rosa Island on the east, separated by Pensacola Pass, a large inlet with an extensive shoal system. Large portions of both islands belong to Gulf Islands National Seashore. The developed areas include two relatively small zones along the western half of Perdido Key, and Pensacola Beach and Navarre Beach on Santa Rosa Island. Perdido Key State Recreation Area separates the two developed areas of the Florida portion of Perdido Key.

There are 214 sequentially numbered DEP survey reference points, generally designated as "R" monuments, spaced approximately 1000 ft (300 m) apart. This report uses these reference points to locate various items within the study area.

3.2 Coastal Setting

3.2.1 Waves and Tides

Tides in the vicinity of Pensacola Bay are predominantly diurnal with a mean tidal range of 1.2 ft (0.4 m) according to the National Ocean Service (1991).

According to Browder and Dean (1999), the average annual significant wave height is approximately 2 ft or less, the mean period averages between 4.3 and 5.0 ft, and the predominant wave direction is from the southeast.

3.2.2 Longshore Transport

Longshore transport is to the west, with the exception of a likely reversal from approximately R-60 eastward to the inlet. Although estimates of the volumes of annual sediment transport vary widely, Browder and Dean (1999) have recently estimated the net westerly sand transport to be between 50,000 and 70,000 yd^3/yr (38,000-54,000 m^3/yr).

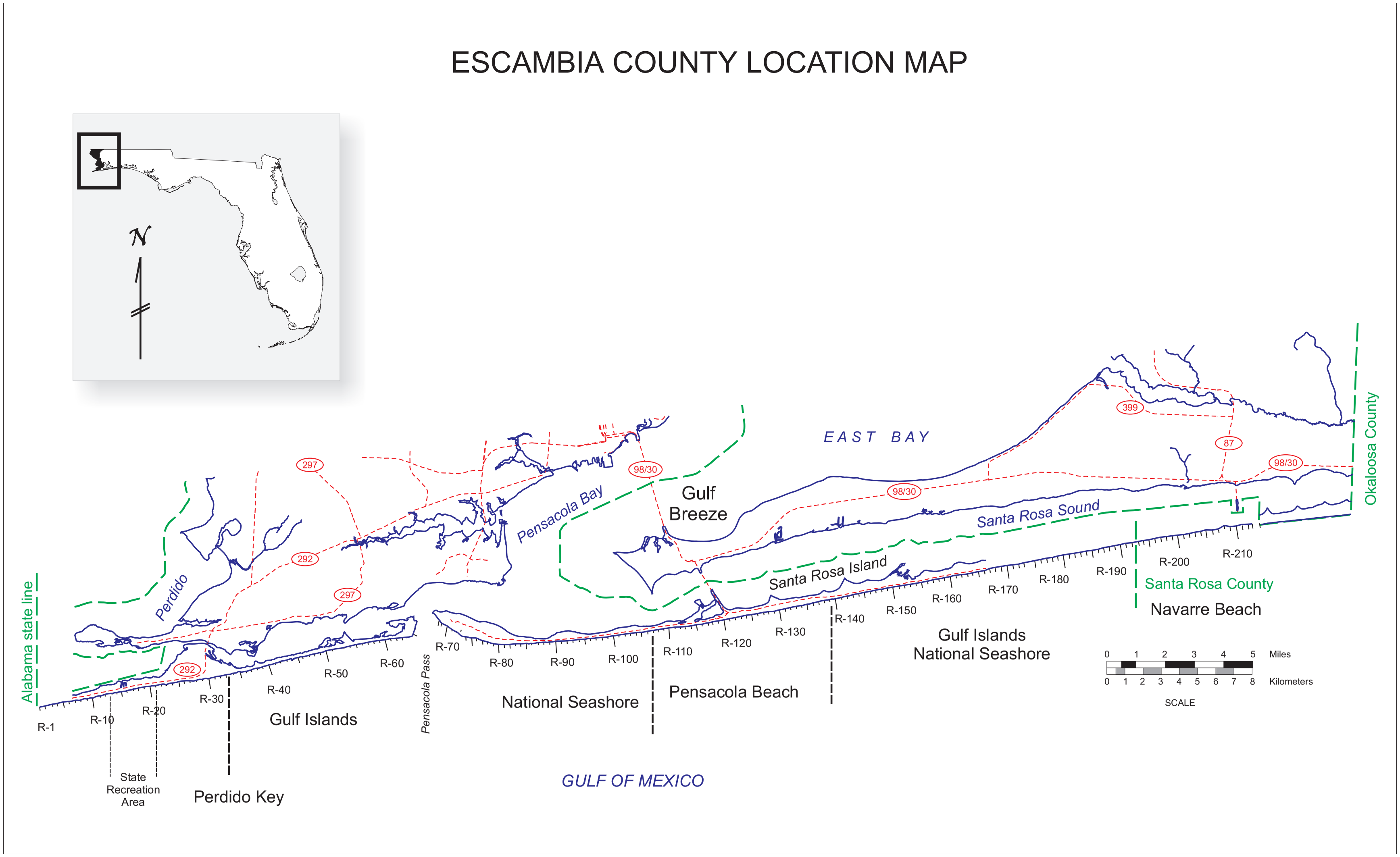

Figure 1. Study area showing Escambia and Santa Rosa Counties, Florida.

Besides the longshore component of littoral transport within the study area, there is also a significant amount of sand transported via overwash during major storms. Numerous large and small overwash deposits are readily observable in DEP aerial photographs and post-storm beach profiles and have been observed in the field by two of the authors (Foster and Spurgeon). Overwash was also noted by Browder and Dean (1999) as a significant impact of Hurricane Opal.

3.2.3 Storms

At least 42 major storms and hurricanes have impacted the study area since 1880 (Browder and Dean, 1999). Hurricane Opal, which made landfall just east of Pensacola Beach in October 1995 (Leadon, 1999), had, by far, the largest impact since Hurricane Fredric in 1979. However, in relation to the study area, Opal primarily affected Santa Rosa Island, whereas Fredric, which made landfall near the Alabama-Mississippi state line, primarily affected Perdido Key.

Hurricanes in this area occur frequently and both the storms and their effects can remain in the area for long periods of time. However, storms are just peaks in the total normal wind and wave climate record. Experience and observations indicate that severe storms can temporarily disrupt or obscure the longer term erosion pattern, perhaps for up to a decade. In some situations, if a major factor such as the sand supply is altered, or if an inlet is significantly changed, coastal processes can be permanently affected by a storm.

It is too soon to tell if the combined impacts of Hurricane Opal and Hurricane Georges (1998) had any significant effect on the long-term erosion pattern of Santa Rosa Island. The erosional effects of Opal were reported to be compounded by impacts from Hurricane Georges in 1998 (Leadon et al.–FDEP, 1999). Opal was a major overtopping event and may have a significant long-term effect on the available sand supply in the region by simply removing a large quantity of sand from the active beach to more landward locations. In addition, substantial volumes of sand were deposited into deep nearshore waters (out to -30 ft NGVD), the fate of which is uncertain. However, this study does not specifically address the hurricane effects. For more information on erosion from Opal, see Leadon (1999) and Leadon et al.–FDEP (1998).

3.3 Pensacola Pass

Modification of Pensacola Pass dates back to 1878 with the authorization of the construction of a 24-foot deep entrance channel. The channel was modified several more times until 1962, when the existing project went into effect, which brought the entrance channel dimensions to a depth of 35 ft and a width of 500 ft (Browder and

Dean, 1999). The U.S. Navy has been very involved in dredging projects, the latest of which in 1991 modified the channel to a depth of 48 ft and a width of 800 feet.

Since dredging began, approximately 45.8 million yd^3 have been removed from the channel, while only 18.6 million yd^3 of that amount were disposed of on or near the adjacent shorelines (Browder and Dean, 1999). The result of this dredging has been a reduction in the volume of the ebb shoals surrounding the inlet and an overall loss of sediment from the littoral system, according to Browder and Dean (1999).

If this is the case, then it can be assumed that there will be, or already have been, significant effects to the beaches adjacent to Pensacola Pass. As with most (if not all) ebb shoal systems, random changes in shoal location, size, shape, elevation, and other characteristics can affect the adjacent beaches by sheltering and exposing different areas to wave attack as well as by altering the sand supply where shoals merge with the shoreline. Channel dredging can often lead to changes in the shoal system.

3.4 Engineering Projects / Hardened Features

There are two small jetties near R-67 on the Perdido Key side of Pensacola Pass, well within the throat of the inlet relative to the ebb shoals.

Beaches along Perdido Key have been nourished twice, once in 1985 and again in 1989-1991. The 1985 nourishment project placed almost 2.5 million yd^3 of sand between DNR monuments R-60 and R-64, a distance of about 4,000 ft (Browder and Dean, 1999).

The latest nourishment project (1989-1991) was much more extensive. Approximately 5.4 million yd^3 of sediment were placed over a one-year period (Fall of 1989 to Fall of 1990) between DNR monuments R-40 and R-64, a distance of about 4.5 miles (Browder and Dean, 1999). More sand, about 3.9 million yd^3, was placed offshore between R-48 and R-60 at a depth of 19-20 feet in 1990-1991 (Browder and Dean, 1999).

The 1985 and 1989-91 beach renourishments on Perdido Key were relatively massive and have been effective in controlling the pre-renourishment erosion pattern, as will be discussed later in this report.

There are persistent offshore features, some of which are apparently hard (possibly rock), observable in the historic bathymetry (Figure 2) that correlate with shoreline orientation and changes (see Section 5). For Perdido Key, there is a small nearshore feature between R-7 and R-11, which correlates with a minor protrusion of the shoreline. In the vicinity of R-1 to R-4, near the Alabama state line, there is another similar nearshore feature, the effects of which are uncertain due to the lack of information about the adjacent area to the west. In the vicinity of R-26 to R-28, there is also a similar nearshore feature, but it is within a much larger headland zone so the effects are obscured. There is a large and somewhat rectangular seaward extension of the -24 ft contour between about R-26 and R-44, which correlates with a significant headland on the coast. There is an adjacent indenture in the -24 ft contour between about R-44 and R-50, which correlates with irregularities in shoreline orientation and change rates in that area. It is also observed that the ebb shoals of Pensacola Pass begin at about R-60, affecting shoreline changes on both sides of that location. In general, the bathymetry offshore of Perdido Key is highly irregular as compared with Santa Rosa Island.

For Santa Rosa Island, significant nearshore hard features apparently exist in the vicinity of R-80 to R-88 and R-114 to R-117, with smaller features in between. The former feature acts as the eastern boundary for the ebb shoals and as a pivot or anchor point for a distinct change in shoreline curvature. The latter also acts as a pivot or anchor point for a distinct change in shoreline curvature. Peat exposures exist between R-107 and R-108. There may also be a subsurface and/or nearshore feature helping to stabilize the area between R-144 and R-189, though this is not readily identifiable in the historic bathymetry and is not shown in Figure 2. Peat exposures also exist along the central part of Navarre Beach.

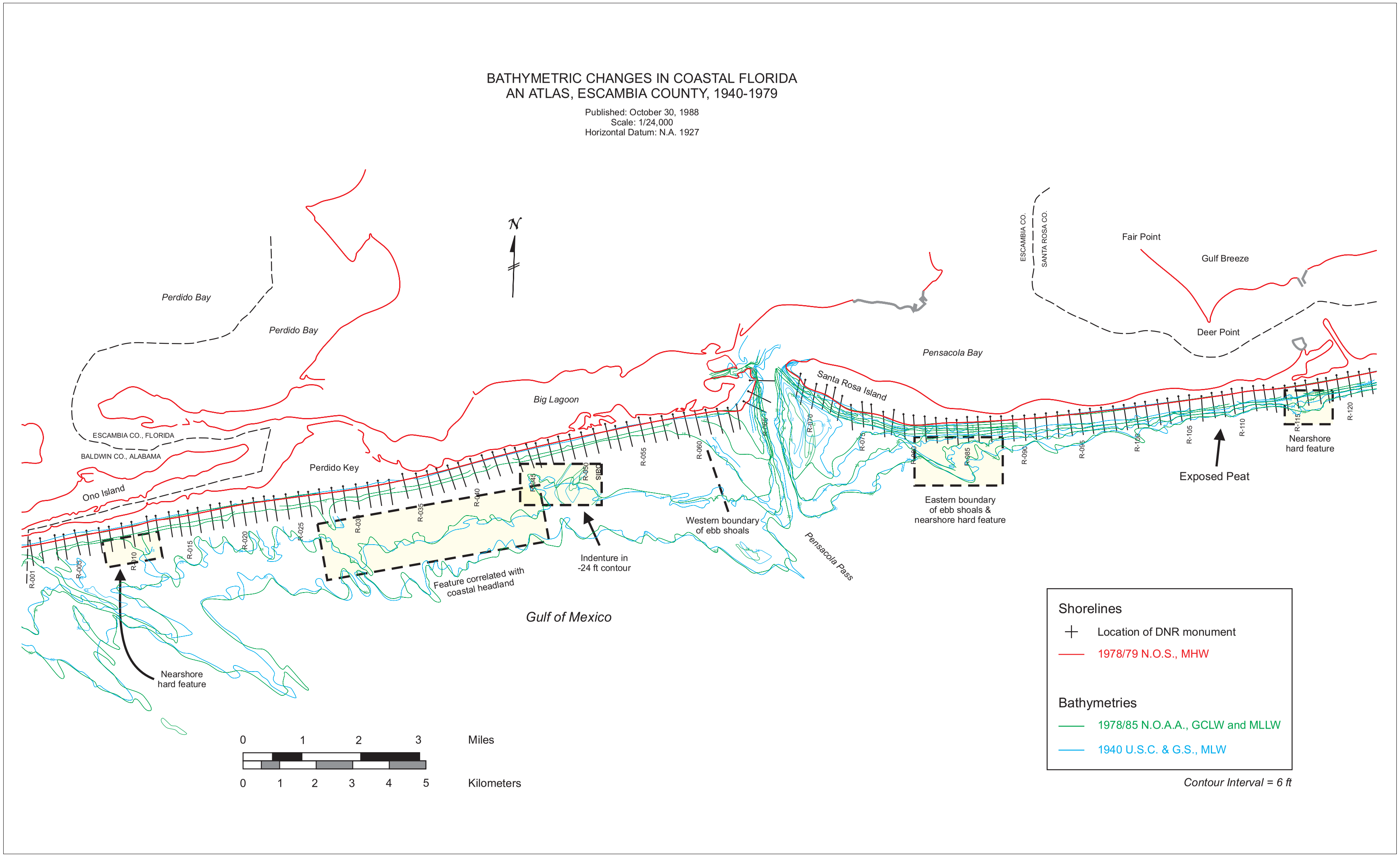

Figure 2. Historic bathymetric map of Escambia County, Florida.

4 METHODS

A shoreline change analysis to satisfy the report objectives was performed using the methodology initially developed by Foster and Savage (1989) and Foster (1992). In brief, within the often nonlinear record of shoreline change versus time by reference points, segments are identified, consistent with observed coastal processes, in which the erosion is relatively constant or can reasonably be approximated as such. Three different rate calculation methods are applied to these approximately linear shoreline change versus time segments: the rate averaging, least squares, and end-point methods. These results are first averaged alongshore and then averaged across the three calculation methods to achieve a consensus average, not dependent on any single rate calculation method. This is because each calculation method has relative advantages and disadvantages. If time segments are selected reasonably well, the differences between rate methods will be minimal. In certain simplified situations it may be better to use a single rate calculation method, such as the end-point method, as necessity and reason dictate. If the averaging is done properly it will achieve results representative of the unaveraged data but will not be overly affected by individual point variability.

In many cases rates from longer and shorter time periods are calculated for comparison purposes (e.g., to show possible progression of an erosion pattern over time or to show that the use of more recent data, which is generally of higher accuracy, yields essentially the same results as the data in a comparative longer time period).

Visual tools used for analysis generally include plan views of shorelines oriented and scaled to emphasize shoreline width changes as well as sometimes subtle but important shoreline orientation differences or geologic features within a county or reach. This analysis is also dependent on the shoreline location versus time plots with overlapping axes, known as "stack plots" because several data plots are stacked in sequence to better see a pattern in the data (Appendix B). There are also representative beach profile plots (Appendix C).

Note that all post-storm surveys have been excluded from the data set used for rate calculations. These are 9/1979 post-Frederic, 9-10/1985 post-Elena, 8/1995 post-Erin, and 11/1995 through 10/1998 post-Opal surveys. Post-storm data sets are useful for studies of temporary storm effects and recovery but are not considered to be useful indicators of longer-term erosion patterns. Experience suggests that this type of data often tends to obscure or hide the longer-term erosion patterns that are eventually reestablished in an area. It may take as long as a decade after a major storm for the pre-storm erosion pattern to again become clearly evident.

5 SHORELINE CHANGE RESULTS

5.1 Perdido Key

In the pre-nourishment era, prior to 1985, a similar erosion pattern exists between the 1890,95 vs. 1974 and 1974 vs. 1984 shorelines (Figures 3 and 4), the notable differences in the latter being the much shorter time period and the fact that erosion has spread further westward to about R-26. These historic shorelines were selected as being the most helpful in showing the shoreline change patterns occurring on the island.

There were apparently three coastal processes dominating in the Perdido Key study area. The most important of these was a westward spreading, progressively worsening erosion pattern, caused by a deficiency in the sand supply originating at the inlet and predominant wave energy from the southeast. Similar erosion patterns have been described theoretically and specifically for Florida inlets (Foster, 1995). This pattern was modified by a second process: apparent random changes in the sand supply and wave sheltering via inlet shoal changes near Pensacola Pass. These in turn were probably affected by the many dredging projects over time. The third process was a progressively eastward spreading accretion pattern assumed to originate at the inlet structures at Perdido Pass in Alabama. Because there is no data for the last ten percent of the island, which is in Alabama, the exact nature of the accretion pattern is not certain, but accretion updrift of the inlet structures is very likely. As of 1984, the end of the pre-nourishment era, the westward spreading erosion pattern had intersected with the eastward speading accretion pattern in the vicinity of R-26/R-27.

Geomorphic influences other than the Pensacola Pass inlet system have been previously noted (see section 3.4 and Figure 2). There are persistent bathymetric features that either cause or contribute to the presence of a significant headland feature between approximately R-26 and R-42, and a minor seaward bulging feature between about R-9 and R-11 (Figure 2). The discussed erosion and accretion patterns act upon an overall island shape strongly related to these geomorphic features. Some of the shoreline irregularities observable in plan view (Figures 3 and 4) may be attributed to these features and the exceptionally rough offshore bathymetry in general.

Erosion rates relative to the latest approximately linear time segment in the pre-renourishment data (1974-1984) have been selected as most representative of pre-renourishment conditions. A longer time segment was not selected because of the non-linear fluctuations in the time history (refer to the distance vs. time "stack plots" of Appendix B) and the need to account for the last westward progression of the erosion pattern. Erosion rate estimates are given in Table A-1 of Appendix A and

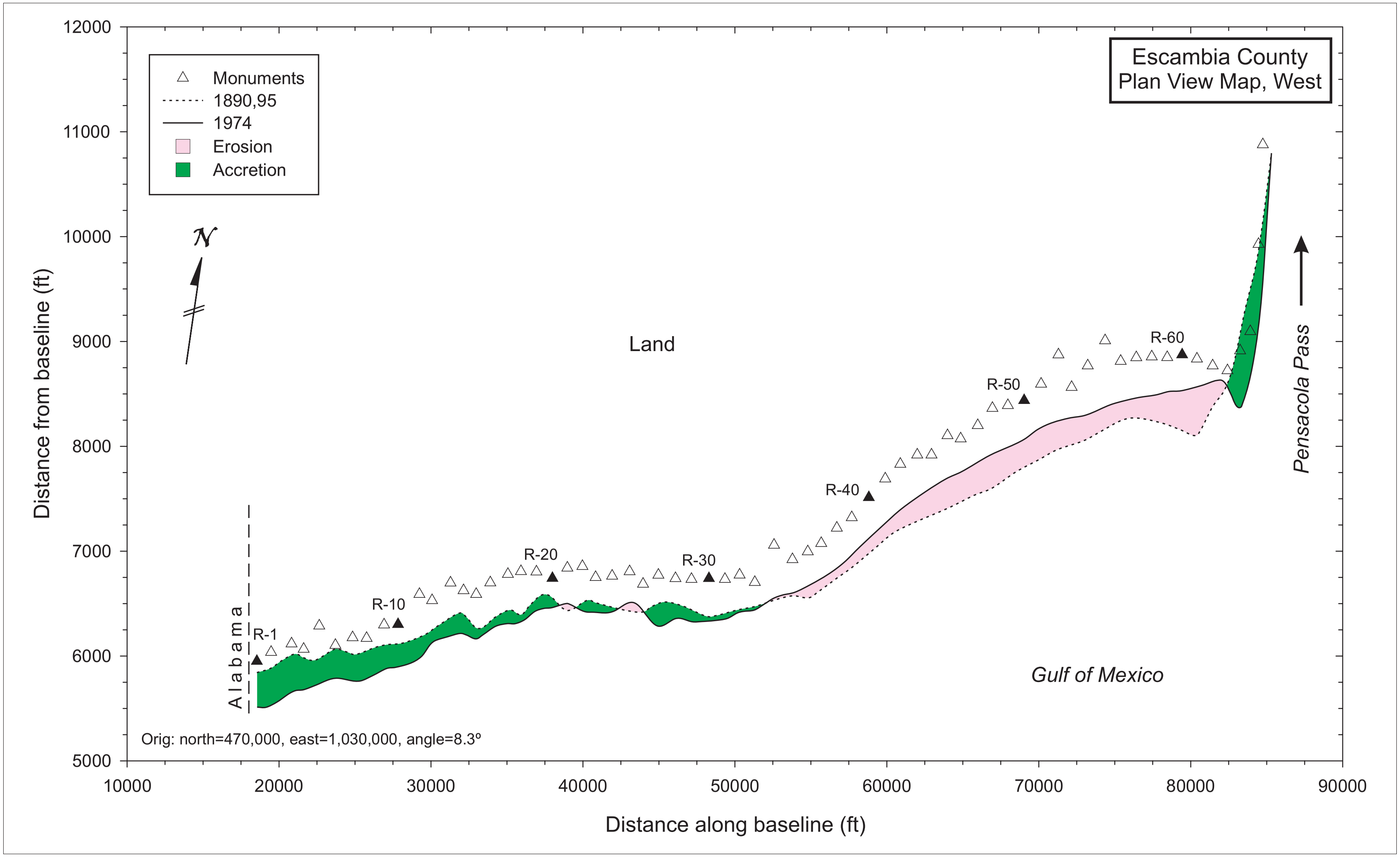

Figure 3. Plan view map of Perdido Key, Escambia County, Florida, 1890,95 to 1974.

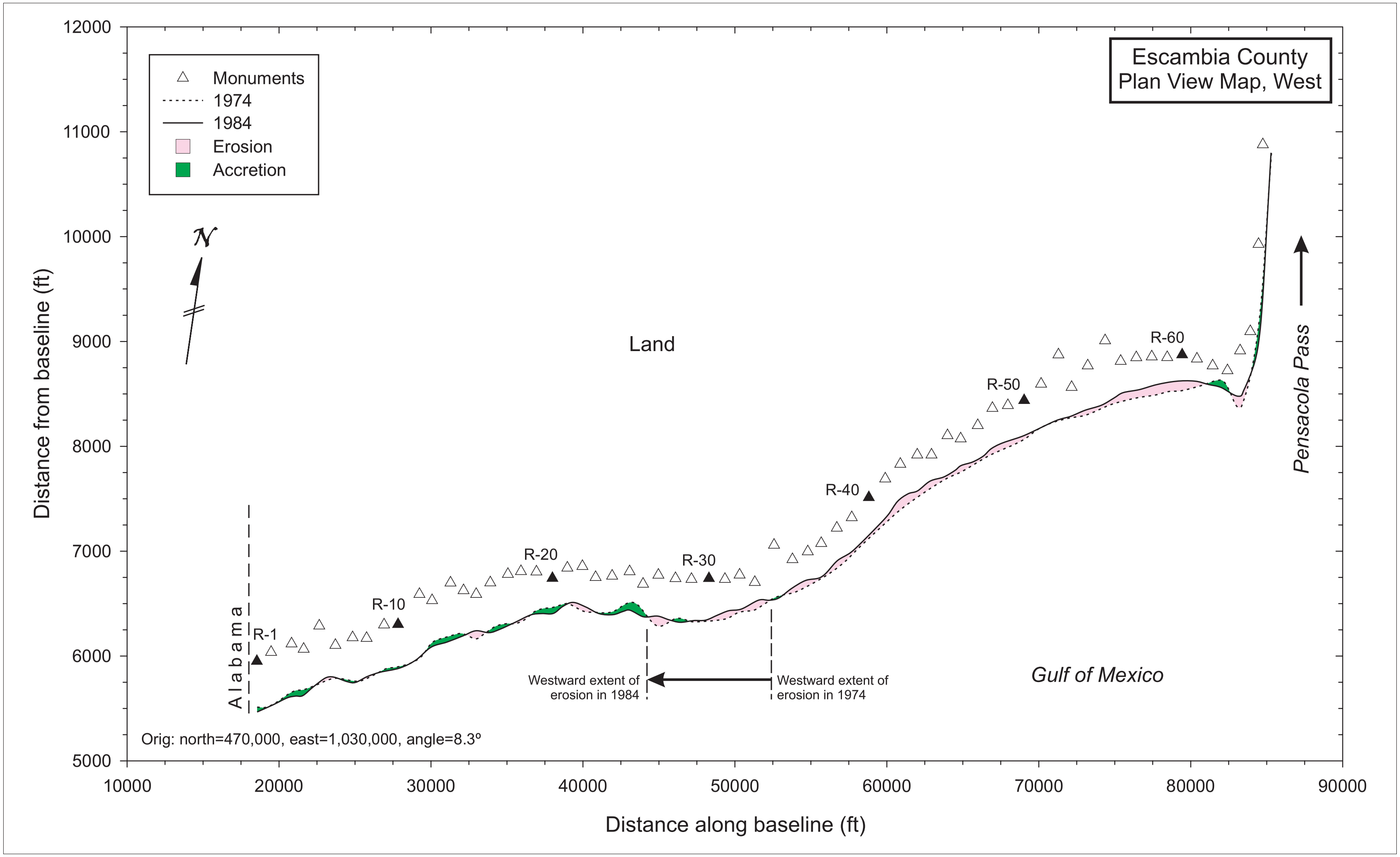

Figure 4. Plan view map of Perdido Key, Escambia County, Florida, 1974 to 1984.

are shown graphically in Figure 5. The rates of accretion shown nearest the Alabama state line in the west (R-1 to R-3) may be deceptively high or misleading because there were no data points in Alabama to include in the averaging.

The ranges at the eastern end of the island, closest to Pensacola Pass (R-61 through R-67) are treated in a special manner because they are within a zone of high random fluctuations over relatively short distances, caused by the inlet ebb shoal system and tidal currents. In this area it appears to make little sense to average across multiple ranges. Also in this area, the rates represent estimates relative only to a particular snapshot in time. The rates changed frequently and randomly over time in this area (see Appendix B). Therefore, these rates would not be expected to be at all predictive, or helpful in hindcast.

In the heart of the Perdido Key study area (R-4 through R-60), rates of change average about +1 ft/yr for R-4 to R-25 and -1 to -9 ft/yr for R-26 to R-60 (Figure 5; Table A-1). A polynomial curve fit was also applied to the rates for this zone to visually clarify the pattern (Figure 5). The average rates do not plot smoothly for two probable reasons: (1) rates were rounded to the nearest 0.5 ft/yr; and (2) there is large-scale rhythmic topography (Komar, 1976), sometimes called large-scale beach cusps, on the order of 100-150 feet in amplitude and up to several thousand feet in length, observed in the field to be related to nearshore bars merging back onto shore.

Averaging does not remove all the effects of the frequently observed large-scale beach cusps. This phenomenon is at least partly responsible for the roughness seen in plan view graphs for this entire study area. Large-scale beach cusps have been observed by one of the authors (Foster) on many other northwest Florida beaches. Measurements taken at unevenly spaced reference points along a coastline where large-scale beach cusps exist can produce rough plots.

There are irregularities in shoreline orientation and erosion rates between about R-44 and R-50 (Figures 3-5). Correlated with these irregularities is an indenture in the -24 foot bathymetric contour between R-44 and R-50 (Figure 2). These observed irregularities probably result from wave refraction and diffraction effects.

The renourishments of 1985 and 1989-91 added a large quantity of sand supply to the system in the area of highest erosion (see section 3.4). The fill has been sufficient in controlling net erosion through 1996 relative to pre-fill conditions (Figure 6). When the fill eventually dissipates, the pre-fill erosion pattern is expected to once again become evident.

5.2 Santa Rosa Island

The most complete 1800s and 1920 USCGS shorelines were plotted against the 1993 DEP shoreline in Figure 7. Scale and baseline choices have been made to highlight

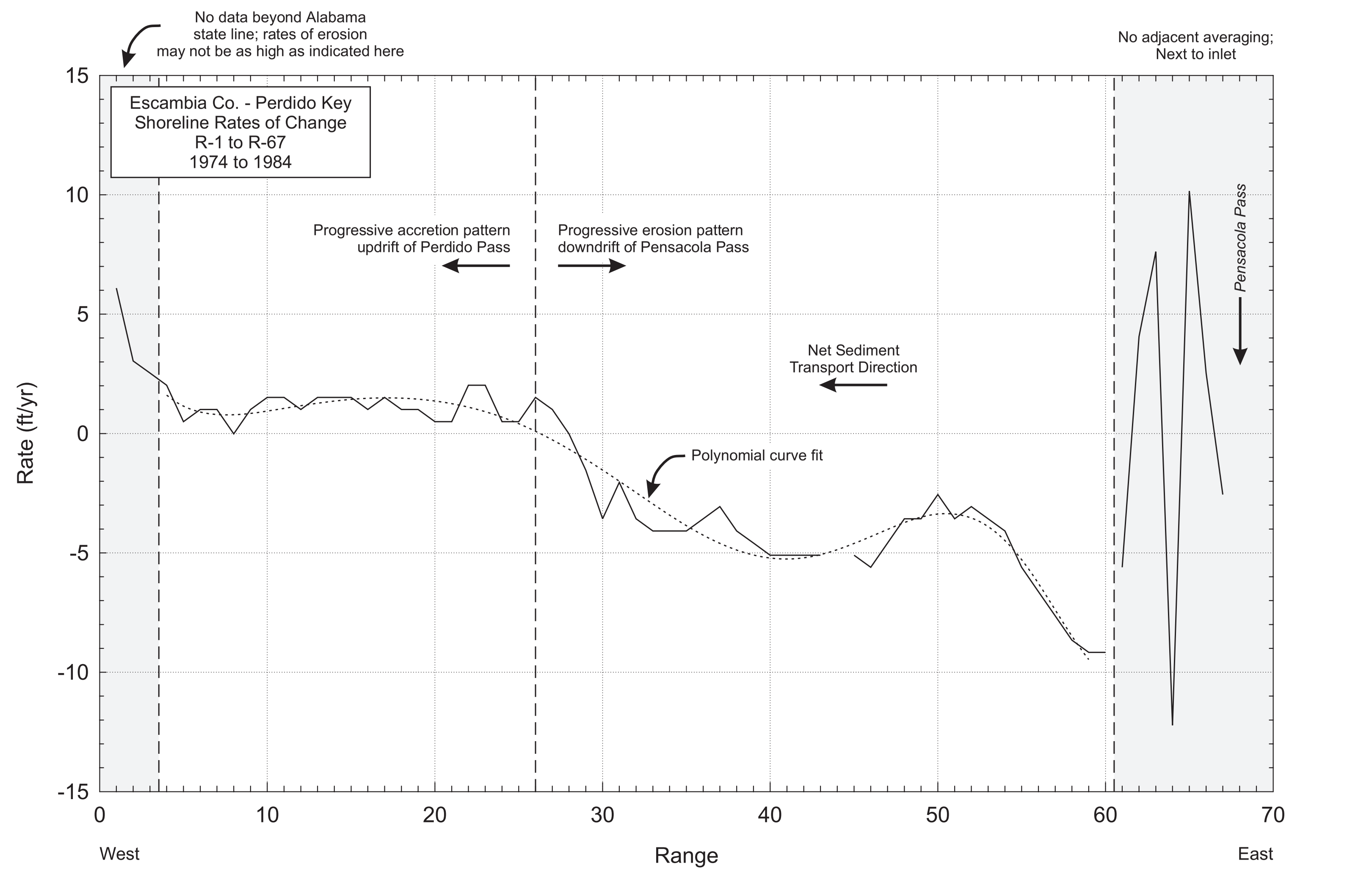

Figure 5. Shoreline rates of change for Perdido Key, Escambia County, Florida.

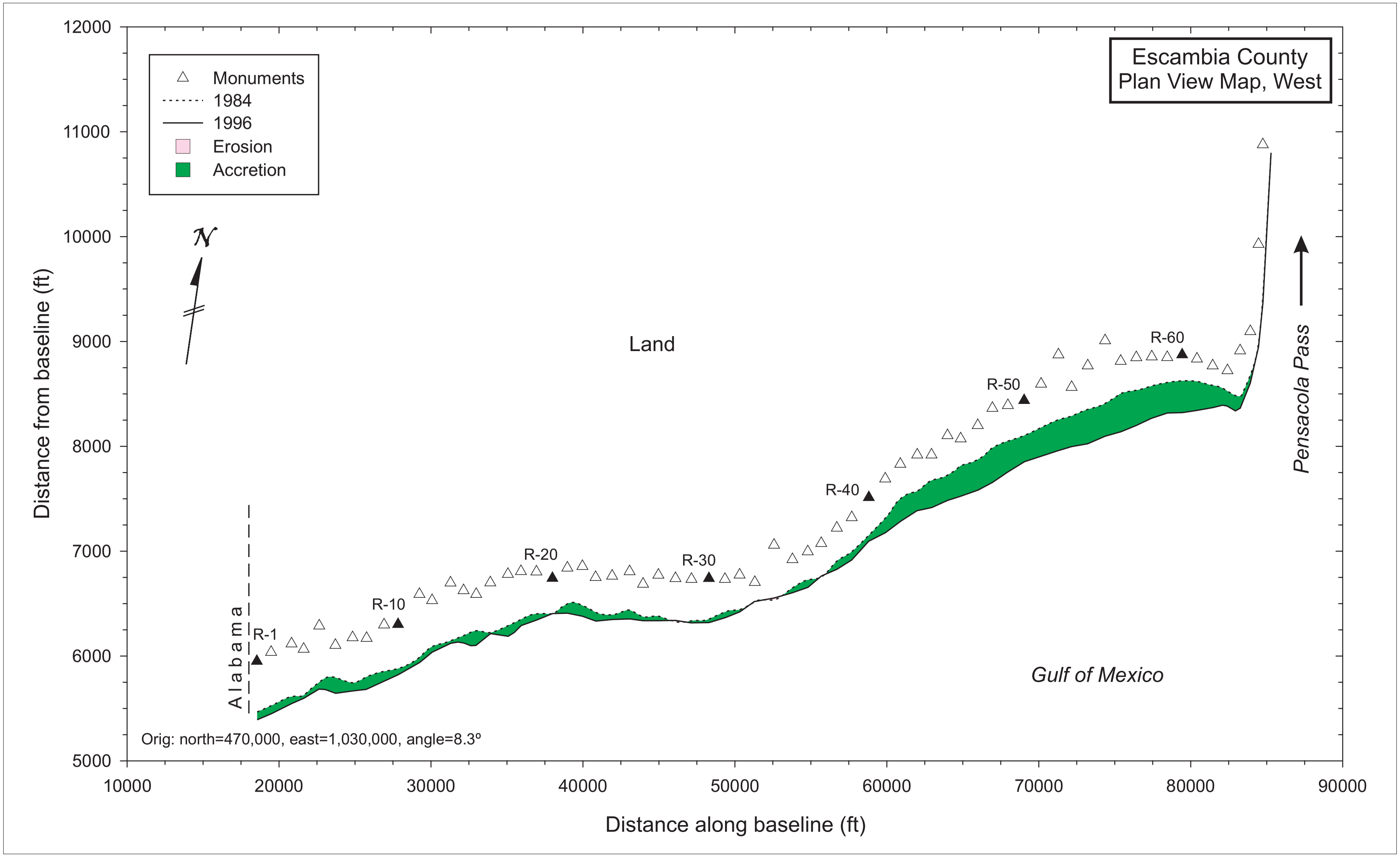

Figure 6. Plan view map of Perdido Key, Escambia County, Florida, 1984/85 to 1996.

beach width changes along the major portion of this study area. The 1993 DEP survey was the more complete, latest available pre-Hurricane Opal survey (a pre- vs. post-storm comparison is shown in Figure 8), but was only a partial survey accounting for approximately every third range. There were also partial 1988 and 1994 DEP surveys, and a complete 1985 DEP survey, all of which were included in the rate calculations.

From R-81 eastward to R-143, the 1920 shoreline may be considered the first modern shoreline, linearly comparable and related to all later shorelines (Figure 7). From R-144 eastward to R-214 the 1867,71 shoreline appears directly comparable with all the later shorelines. In the area closest to the inlet, R-68 to R-80, again there is a need for special treatment due to the random shoreline fluctuations associated with the inlet shoals.

Peat exposures have been observed by one of the authors (Foster) along the beachface between R-107 and R-108. More importantly, there are significant and persistent nearshore features between R-80 and R-88, and R-114 to R-117 (Figure 2). The R-80 to R-88 feature appears to act as a boundary on the inlet's east ebb shoals and as a pivot point about which the shoreline curves. The R-114 to R-117 feature and, to a lesser extent, the R-107 to R-108 peat feature, also appear to act as pivot points for the shoreline as it bends landward towards the inlet throat area. There are apparently other smaller, nearshore features between R-88 and R-107 which perform similar but less significant roles. It is suspected that there may be underlying hard features between R-144 and R-189 because of the historic stability and the mild seaward protrusion of that zone, though the available historic bathymetry neither confirms nor rules out this possibility.

Erosion rate estimates are listed in Table A-1 in Appendix A and shown graphically in Figure 9. Erosion increases towards the inlet (R-100 to R-81) from about 0 to -3.5 ft/yr. Very near the inlet (R-80 to R-68) there have been large fluctuations in the shoreline. The time period for the rates in this area was chosen only to be consistent with those of the adjacent area. Because of the non-linearity of changes in this adjacent to the inlet area (refer to the distance vs. time "stack" plots in Appendix B), it is inappropriate to use the Rate Averaging (RA) calculation method here because it is applicable only to approximately linear time segments (Foster and Savage, 1989). Instead these rates may more accurately be considered as erosional "trends" over the selected time period as calculated with the Least Squares (LS) and End Point (EP) formulas. Because large changes occur over small distances, it again was not meaningful to average alongshore in this area. The difference in procedure on this side of the inlet versus the Perdido side lies in the exclusion of the RA method rate calculations due to too much non-linearity in the selected time segment. The calculated erosional trends here are not necessarily likely to be helpful in either prediction or hindcast.

In the heart of the Santa Rosa Island study area (R-100 to R-214, which includes the developed Pensacola Beach area R-107 to R-139, and developed Navarre Beach

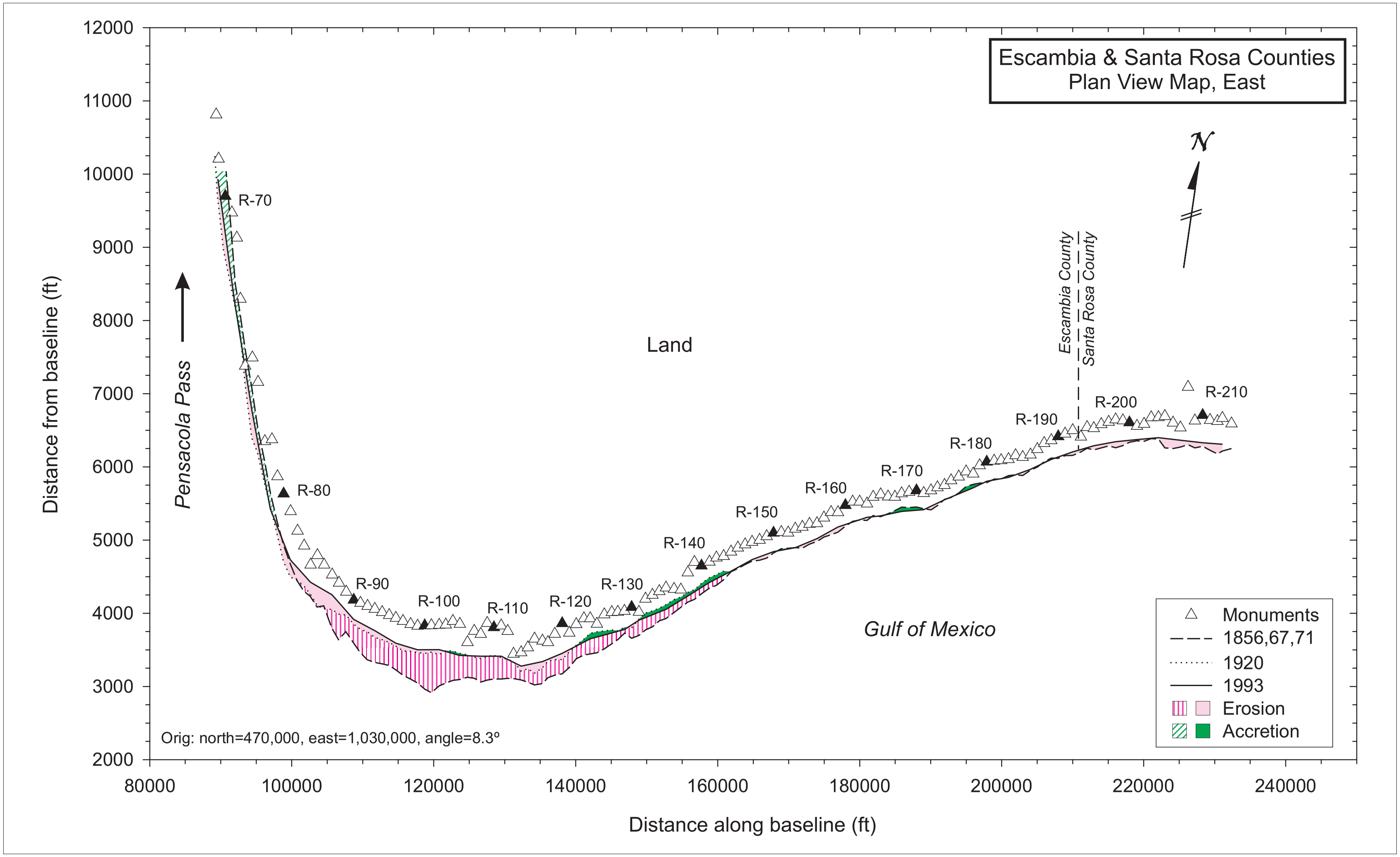

Figure 7. Plan view map of Santa Rosa Island, Escambia and Santa Rosa Counties, Florida, 1856,67,71 to 1993.

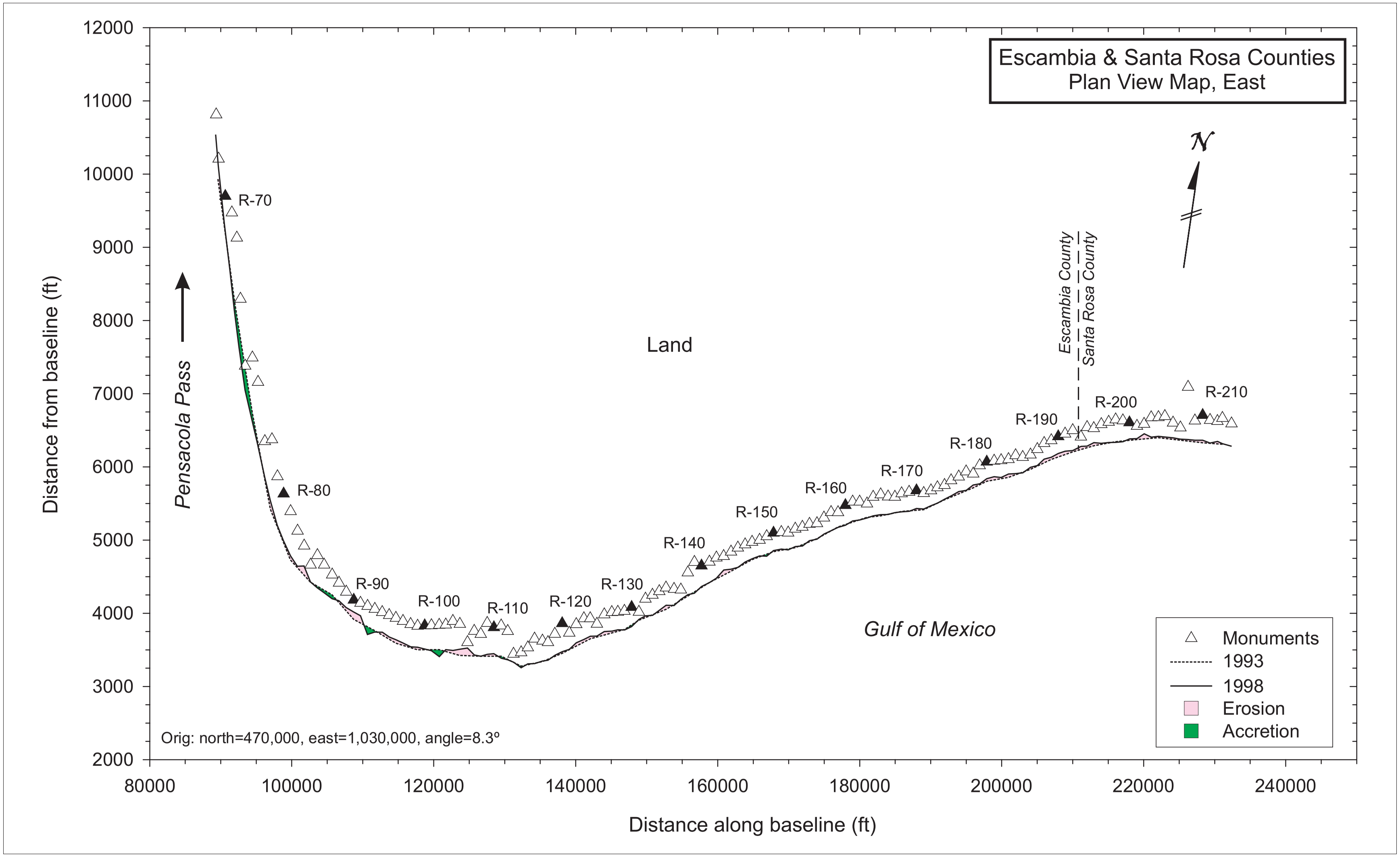

Figure 8. Plan view map of Santa Rosa Island, Escambia and Santa Rosa Counties, Florida, 1993 to 1998.

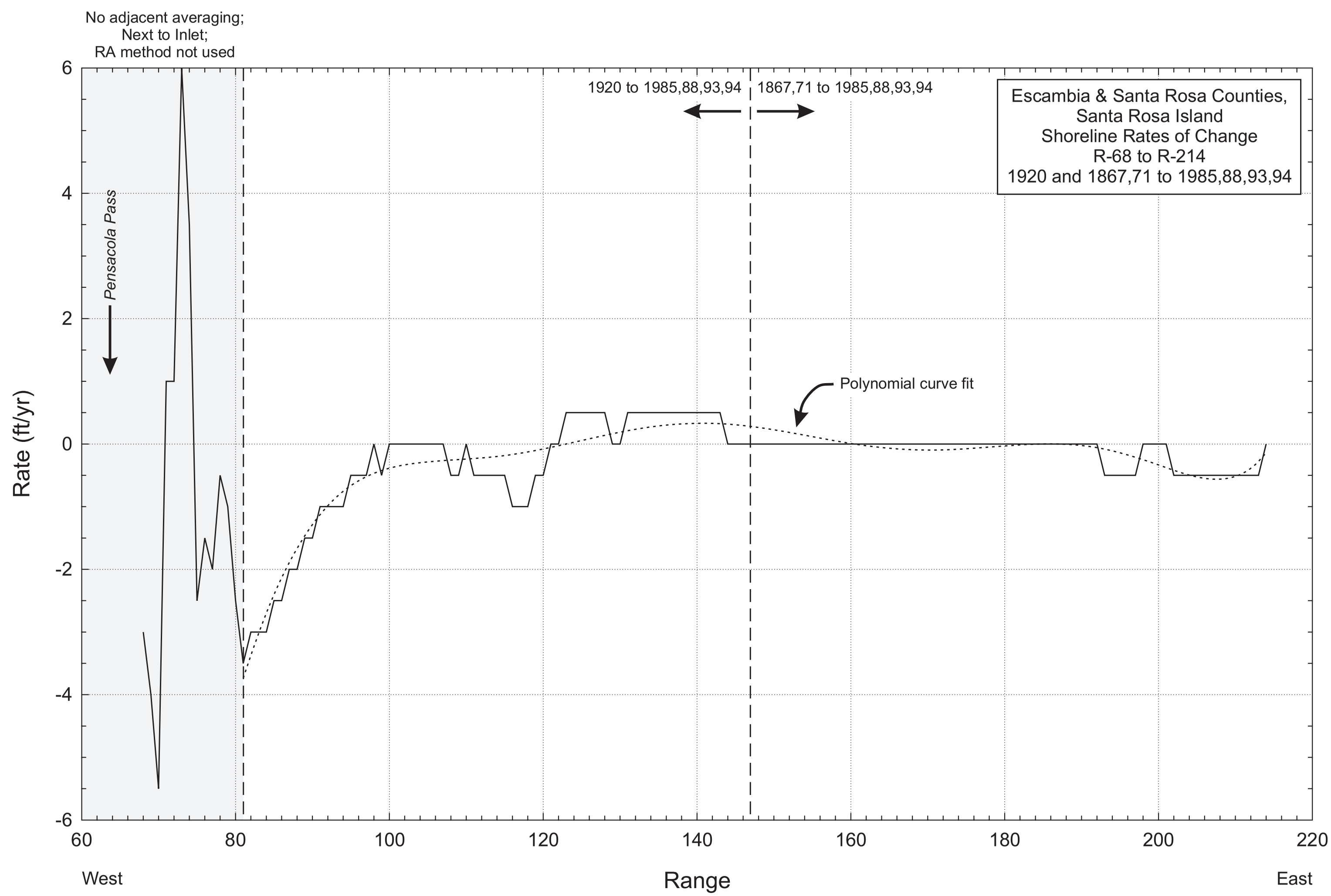

Figure 9. Shoreline rates of change for Santa Rosa Island, Escambia and Santa Rosa Counties, Florida.

R-200 to R-214), there are some mild but interesting changes in the rates (Figure 9). One interpretation is that the slightly higher erosion of about -1 ft/yr in the vicinity of R-115 reflects a gradual wearing down of the pivot point in that area associated with the nearshore hard feature. One interpretation of the slight amount of accretion (about +0.5 ft/yr) found between R-120 and R-143 is that this represents a slight filling in of a pocket between two harder features. As noted previously, the 0 ft/yr estimate across R-144 to R-189 suggests some type of subsurface and/or nearshore hard feature. A small pocket of erosion on the order of -0.5 ft/yr begins east of R-189 and extends through Navarre Beach to at least R-214. The existence of such an erosional pocket is consistent with the theory that there is an erosion resistant area between R-144 and R-189.

Hurricane Opal could have had some permanent effects on Santa Rosa Island, although it is really too soon to tell. For example, the observed large loss of beach sand to overwash could have been significant enough to eventually register as a unilateral loss of beach width. Also, the pivot points near R-80, R-107, and R-114 could have been worn down significantly enough to allow more erosion in these and adjacent areas. On the other hand, in the long term there certainly have been other hurricanes of Opal's magnitude and perhaps these extreme events are just peaks on an otherwise fairly low wave energy record. If so, they would be expected to average out in effect over enough time towards the rates estimated in this study.

Beach cusps occur on Santa Rosa Island similar to the ones found on Perdido Key. Again, these are observed to be associated with nearshore bars merging back onto the beach following higher wave energy events.

5.3 Concluding Remarks

Because of the uncertainties involved with future climatic conditions such as sea level rise and major storm impacts, it is not recommended to plan for less erosion than -1 ft/yr at any location with zero, positive, or -0.5 ft/yr rate estimates. Also, there is uncertainty regarding erosion adjacent to the pivot points near R-80, R-107, and R-114 due to possible Opal erosion effects not yet evident. Based on experience with other major storms, probably another 5 to 6 years must pass without another major storm for the normal erosion pattern to become clearly evident again.

On Perdido Key the recent past has been entirely dependent on beach renourishments. If these are not continued the progressve erosion pattern of the pre-fill era will likely be re-established and will spread into the developed area once again.

6 SUMMARY

There are significantly different erosional patterns on Perdido Key and Santa Rosa Island. On Perdido Key, a progressive erosion pattern of concern was spreading westward from the inlet. This has since been controlled by beach renourishments in 1985 and 1989-91. On Santa Rosa Island, apparently due in part to some historically erosion-resistant pivot points and zones along the study area, and also due to the study area being far from the next eastward inlet, there has been very little net erosion in the developed areas, on the order of -1 ft/yr or less erosion. However, there are uncertainties as to whether Hurricane Opal may have altered the status quo on Santa Rosa Island. It may be several years before these uncertainties are resolved.

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8 APPENDICES

8.1 Appendix A: Shoreline Change Rates

Table A-1: This table provides rates based on the method described in Section 4.

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
1	RA	6.6			6.0	original
	LS	6.1				no averaging
	EP	4.6				
2	RA	0.2			3.0	3 pt average
	LS	0.5				
	EP	0.2				
3	RA	2.2			2.5	5 pt average
	LS	1.7				
	EP	4.1				
4	RA	4.8			2.0	7 pt average ↓
	LS	5.3				
	EP	5.2				
5	RA	-2.3			0.5	
	LS	-1.8				
	EP	-2.3				
6	RA	-0.9			1.0	
	LS	-0.9				
	EP	-0.9				
7	RA	1.9			1.0	
	LS	1.9				
	EP	1.9				
8	RA	-2.0			0.0	
	LS	-2.0				
	EP	-2.0				
9	RA	1.9			1.0	
	LS	1.5				
	EP	2.0				
10	RA	1.7			1.5	
	LS	1.7				
	EP	1.7				
11	RA	-0.6			1.5	
	LS	-0.6				
	EP	-0.6				
12	RA	3.5			1.0	
	LS	3.4				
	EP	3.9				
13	RA	4.9			1.5	
	LS	4.9				
	EP	4.9				
14	RA	1.7			1.5	
	LS	1.7				
	EP	1.7				

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
15	RA	-5.3			1.5	
	LS	-4.1				
	EP	-7.7				
16	RA	3.6			1.0	
	LS	3.6				
	EP	3.6				
17	RA	1.7			1.5	
	LS	1.7				
	EP	1.7				
18	RA	0.1			1.0	
	LS	-0.6				
	EP	-2.2				
19	RA	2.8			1.0	
	LS	2.8				
	EP	2.8				
20	RA	5.8			0.5	
	LS	5.8				
	EP	5.8				
21	RA	-0.4			0.5	
	LS	1.1				
	EP	-0.4				
22	RA	-5.5			2.0	
	LS	-5.5				
	EP	-5.5				
23	RA	0.0			2.0	
	LS	0.0				
	EP	0.0				
24	RA	1.9			0.5	
	LS	1.6				
	EP	2.8				
25	RA	7.4			0.5	
	LS	7.4				
	EP	7.4				
26	RA	5.7			1.5	
	LS	5.7				
	EP	5.7				
27	RA	-7.1			1.0	
	LS	-7.8				
	EP	-9.6				
28	RA	3.5			0.0	
	LS	3.5				
	EP	3.5				

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
29	RA	-1.1			-1.5	
	LS	-1.1				
	EP	-1.1				
30	RA	-1.1			-3.5	
	LS	-0.1				
	EP	-1.1				
31	RA	-7.7			-2.0	
	LS	-7.6				
	EP	-7.7				
32	RA	-2.0			-3.5	
	LS	-2.0				
	EP	-2.0				
33	RA	-8.4			-4.0	
	LS	-7.8				
	EP	-8.8				
34	RA	2.1			-4.0	
	LS	2.1				
	EP	2.1				
35	RA	-5.2			-4.0	
	LS	-5.2				
	EP	-5.2				
36	RA	-2.9			-3.5	
	LS	-4.5				
	EP	-5.8				
37	RA	-1.7			-3.0	
	LS	-1.7				
	EP	-1.7				
38	RA	-7.3			-4.0	
	LS	-7.3				
	EP	-7.3				
39	RA	0.3			-4.5	
	LS	-0.7				
	EP	-2.5				
40	RA	-3.7			-5.0	
	LS	-3.7				
	EP	-3.7				
41	RA	-4.5			-5.0	
	LS	-4.5				
	EP	-4.5				
42	RA	-11.2			-5.0	
	LS	-9.8				
	EP	-11.2				

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
43	RA	-5.7			-5.0	
	LS	-5.7				
	EP	-5.7				
45	RA	-2.4			-5.0	
	LS	-3.2				
	EP	-1.8				
46	RA	-6.1			-5.5	
	LS	-6.1				
	EP	-6.1				
47	RA	-1.7			-4.5	
	LS	-1.7				
	EP	-1.7				
48	RA	-3.5			-3.5	
	LS	-4.7				
	EP	-6.2				
49	RA	-5.7			-3.5	
	LS	-5.7				
	EP	-5.7				
50	RA	-3.4			-2.5	
	LS	-3.4				
	EP	-3.4				
51	RA	0.5			-3.5	
	LS	-2.1				
	EP	0.5				
52	RA	-1.2			-3.0	
	LS	-1.2				
	EP	-1.2				
53	RA	-1.5			-3.5	
	LS	-1.5				
	EP	-1.5				
54	RA	-6.3			-4.0	
	LS	-6.7				
	EP	-5.2				
55	RA	-2.8			-5.5	
	LS	-2.8				
	EP	-2.8				
56	RA	-7.9			-6.5	
	LS	-7.9				
	EP	-7.9				
57	RA	-7.9			-7.5	↑
	LS	-9.0				7 pt average
	EP	-7.4				

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
58	RA	-9.6			-8.5	5 pt average
	LS	-9.6				
	EP	-9.6				
59	RA	-9.1			-9.0	3 pt average
	LS	-9.1				
	EP	-9.1				
60	RA	-9.1			-9.0	original ↓
	LS	-8.6				
	EP	-9.3				
61	RA	-5.3			-5.5	inlet shoal area ↓
	LS	-5.3				
	EP	-5.3				
62	RA	4.1			4.0	
	LS	4.1				
	EP	4.1				
63	RA	9.7			7.5	
	LS	8.2				
	EP	4.2				
64	RA	-11.8			-12.0	
	LS	-11.8				
	EP	-11.8				
65	RA	9.8			10.0	
	LS	9.8				
	EP	9.8				
66	RA	0.7			2.5	
	LS	1.7				
	EP	4.7				
67	RA	-2.6			-2.5	
	LS	-2.6				
	EP	-2.6				
Pensacola Inlet						
68	RA		n/a		-3.0	only LS & EP methods used ↓
	LS		-1.2			
	EP		-4.3			
69	RA		n/a		-4.0	
	LS		-5.0			
	EP		-3.4			
70	RA		n/a		-5.5	
	LS		-4.9			
	EP		-5.6			
71	RA		n/a		1.0	
	LS		0.8			

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
	EP		1.1			
72	RA		n/a		1.0	
	LS		0.4			
	EP		1.2			
73	RA		n/a		6.0	
	LS		5.5			
	EP		6.8			
74	RA		n/a		3.5	
	LS		3.7			
	EP		3.1			
75	RA		n/a		-2.5	
	LS		-2.8			
	EP		-2.6			
76	RA		n/a		-1.5	
	LS		-1.2			
	EP		-2.1			
77	RA		n/a		-2.0	
	LS		-2.1			
	EP		-2.1			
78	RA		n/a		-0.5	
	LS		-1.0			
	EP		0.3			
79	RA		n/a		-1.0	
	LS		-1.3			
	EP		-0.7			
80	RA		n/a		-2.5	↑
	LS		-2.6			only LS & EP
	EP		-2.5			methods used
81	RA		-3.6		-3.5	original
	LS		-3.4			
	EP		-2.8			
82	RA		-3.2		-3.0	3 pt average
	LS		-3.0			
	EP		-2.6			
83	RA		-2.9		-3.0	5 pt average
	LS		-2.5			
	EP		-2.4			
84	RA		-2.7		-3.0	7 pt average
	LS		-2.4			↓
	EP		-2.4			
85	RA		-3.2		-2.5	
	LS		-3.3			

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
	EP		-3.1			
86	RA		-2.9		-2.5	
	LS		-2.8			
	EP		-3.0			
87	RA		-2.9		-2.0	
	LS		-2.3			
	EP		-2.1			
88	RA		-1.3		-2.0	
	LS		-1.5			
	EP		-1.8			
89	RA		-0.6		-1.5	
	LS		-0.6			
	EP		-0.6			
90	RA		-1.4		-1.5	
	LS		-1.3			
	EP		-0.8			
91	RA		-1.7		-1.0	
	LS		-1.3			
	EP		-1.7			
92	RA		-1.3		-1.0	
	LS		-1.2			
	EP		-1.1			
93	RA		-1.0		-1.0	
	LS		-1.2			
	EP		-0.9			
94	RA		-0.5		-1.0	
	LS		-0.5			
	EP		-0.7			
95	RA		-0.3		-0.5	
	LS		-0.3			
	EP		-0.7			
96	RA		-0.5		-0.5	
	LS		-0.8			
	EP		-0.4			
97	RA		-0.2		-0.5	
	LS		-0.4			
	EP		-1.2			
98	RA		0.3		0.0	
	LS		0.1			
	EP		-0.8			
99	RA		-0.1		-0.5	
	LS		0.1			

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
	EP		-0.1			
100	RA		-0.2		0.0	
	LS		0.1			
	EP		-0.2			
101	RA		0.3		0.0	
	LS		0.1			
	EP		0.3			
102	RA		-0.8		0.0	
	LS		-0.7			
	EP		-0.6			
103	RA		0.2		0.0	
	LS		0.3			
	EP		0.2			
104	RA		0.4		0.0	
	LS		0.5			
	EP		0.4			
105	RA		0.3		0.0	
	LS		0.0			
	EP		0.3			
106	RA		-0.1		0.0	
	LS		-0.4			
	EP		-0.6			
107	RA		-0.2		0.0	
	LS		-0.5			
	EP		-0.2			
108	RA		-0.4		-0.5	
	LS		-0.5			
	EP		-0.4			
109	RA		-0.8		-0.5	
	LS		-0.8			
	EP		-0.9			
110	RA		-0.2		0.0	
	LS		-0.2			
	EP		-0.2			
111	RA		-0.2		-0.5	
	LS		-0.7			
	EP		-0.2			
112	RA		0.0		-0.5	
	LS		-0.3			
	EP		0.0			
113	RA		0.2		-0.5	
	LS		0.4			

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
	EP		1.0			
114	RA		-0.7		-0.5	
	LS		-1.0			
	EP		-0.8			
115	RA		-1.1		-0.5	
	LS		-0.9			
	EP		-0.8			
116	RA		-1.5		-1.0	
	LS		-1.6			
	EP		-2.1			
117	RA		-1.4		-1.0	
	LS		-1.5			
	EP		-1.2			
118	RA		-0.7		-1.0	
	LS		-0.6			
	EP		-1.0			
119	RA		-0.2		-0.5	
	LS		-0.1			
	EP		-0.2			
120	RA		-0.8		-0.5	
	LS		-0.9			
	EP		-0.9			
121	RA		-0.4		0.0	
	LS		-0.2			
	EP		-0.4			
122	RA		0.3		0.0	
	LS		0.3			
	EP		0.3			
123	RA		0.1		0.5	
	LS		0.1			
	EP		0.1			
124	RA		1.1		0.5	
	LS		1.3			
	EP		1.5			
125	RA		1.5		0.5	
	LS		1.5			
	EP		1.1			
126	RA		1.2		0.5	
	LS		0.8			
	EP		1.0			
127	RA		-0.3		0.5	
	LS		0.6			

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
	EP		-0.3			
128	RA		-0.3		0.5	
	LS		0.4			
	EP		-0.3			
129	RA		0.2		0.0	
	LS		0.3			
	EP		0.5			
130	RA		-0.3		0.0	
	LS		-0.3			
	EP		-0.9			
131	RA		0.2		0.5	
	LS		0.4			
	EP		0.2			
132	RA		0.2		0.5	
	LS		0.9			
	EP		0.2			
133	RA		0.0		0.5	
	LS		0.5			
	EP		0.0			
134	RA		1.3		0.5	
	LS		1.3			
	EP		0.9			
135	RA		0.7		0.5	
	LS		0.6			
	EP		0.9			
136	RA		0.1		0.5	
	LS		0.7			
	EP		0.1			
137	RA		0.6		0.5	
	LS		1.0			
	EP		0.6			
138	RA		0.8		0.5	
	LS		0.6			
	EP		0.8			
139	RA		-0.1		0.5	
	LS		0.7			
	EP		-0.1			
140	RA		1.4		0.5	
	LS		1.4			
	EP		1.0			
141	RA		1.1		0.5	
	LS		0.8			

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
	EP		1.0			
142	RA		-0.2		0.5	
	LS		0.5			
	EP		-0.2			
143	RA		0.8		0.5	
	LS		1.2			
	EP		0.7			
144	RA			-0.1	0.0	
	LS			0.1		
	EP			-0.1		
145	RA			0.0	0.0	
	LS			0.0		
	EP			-0.9		
146	RA			-0.2	0.0	
	LS			0.2		
	EP			-0.4		
147	RA			-0.2	0.0	
	LS			0.2		
	EP			-0.2		
148	RA			-0.3	0.0	
	LS			-0.2		
	EP			-0.7		
149	RA			-0.2	0.0	
	LS			-0.1		
	EP			-0.6		
150	RA			-0.1	0.0	
	LS			0.0		
	EP			-0.1		
151	RA			0.1	0.0	
	LS			0.5		
	EP			0.1		
152	RA			0.0	0.0	
	LS			0.5		
	EP			0.0		
153	RA			0.0	0.0	
	LS			0.2		
	EP			0.0		
154	RA			-0.1	0.0	
	LS			-0.1		
	EP			-0.6		
155	RA			-0.3	0.0	
	LS			0.2		

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
	EP			-0.4		
156	RA			-0.2	0.0	
	LS			0.1		
	EP			-0.2		
157	RA			-0.2	0.0	
	LS			-0.2		
	EP			-0.6		
158	RA			-0.5	0.0	
	LS			0.0		
	EP			-0.3		
159	RA			-0.2	0.0	
	LS			-0.3		
	EP			-0.5		
160	RA			-0.2	0.0	
	LS			0.0		
	EP			-0.5		
161	RA			-0.3	0.0	
	LS			0.2		
	EP			-0.3		
162	RA			0.1	0.0	
	LS			0.0		
	EP			-0.6		
163	RA			-0.2	0.0	
	LS			0.1		
	EP			-0.2		
164	RA			0.0	0.0	
	LS			0.4		
	EP			0.0		
165	RA			-0.1	0.0	
	LS			0.1		
	EP			-0.1		
166	RA			-0.4	0.0	
	LS			0.0		
	EP			-0.3		
167	RA			0.1	0.0	
	LS			0.2		
	EP			0.1		
168	RA			0.4	0.0	
	LS			0.4		
	EP			0.6		
169	RA			0.4	0.0	
	LS			0.4		

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
	EP			0.4		
170	RA			-0.1	0.0	
	LS			0.2		
	EP			-0.1		
171	RA			0.1	0.0	
	LS			0.1		
	EP			0.1		
172	RA			-0.5	0.0	
	LS			-0.4		
	EP			-0.8		
173	RA			-0.4	0.0	
	LS			-0.3		
	EP			-0.7		
174	RA			0.1	0.0	
	LS			0.0		
	EP			0.1		
175	RA			0.0	0.0	
	LS			0.1		
	EP			0.0		
176	RA			-0.7	0.0	
	LS			-0.4		
	EP			-0.6		
177	RA			0.0	0.0	
	LS			0.3		
	EP			0.0		
178	RA			0.2	0.0	
	LS			0.4		
	EP			0.3		
179	RA			0.0	0.0	
	LS			0.0		
	EP			0.0		
180	RA			-0.2	0.0	
	LS			-0.2		
	EP			-0.2		
181	RA			-0.3	0.0	
	LS			-0.3		
	EP			-0.5		
182	RA			-0.2	0.0	
	LS			-0.1		
	EP			-0.2		
183	RA			0.2	0.0	
	LS			0.0		

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
	EP			0.2		
184	RA			-0.1	0.0	
	LS			0.0		
	EP			-0.1		
185	RA			-0.2	0.0	
	LS			-0.3		
	EP			-0.7		
186	RA			-0.1	0.0	
	LS			0.2		
	EP			-0.1		
187	RA			-0.3	0.0	
	LS			0.0		
	EP			-0.3		
188	RA			-0.2	0.0	
	LS			0.1		
	EP			-0.2		
189	RA			0.1	0.0	
	LS			0.3		
	EP			0.1		
190	RA			-0.2	0.0	
	LS			-0.3		
	EP			-0.5		
191	RA			-0.2	0.0	
	LS			0.0		
	EP			-0.2		
192	RA			-0.3	0.0	
	LS			-0.1		
	EP			-0.5		
193	RA			-0.2	-0.5	
	LS			-0.3		
	EP			-0.7		
194	RA			-0.2	-0.5	
	LS			0.1		
	EP			-0.2		
195	RA			-0.7	-0.5	
	LS			0.0		
	EP			-0.4		
196	RA			-0.2	-0.5	
	LS			-0.4		
	EP			-0.7		
197	RA			-0.3	-0.5	
	LS			0.1		

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

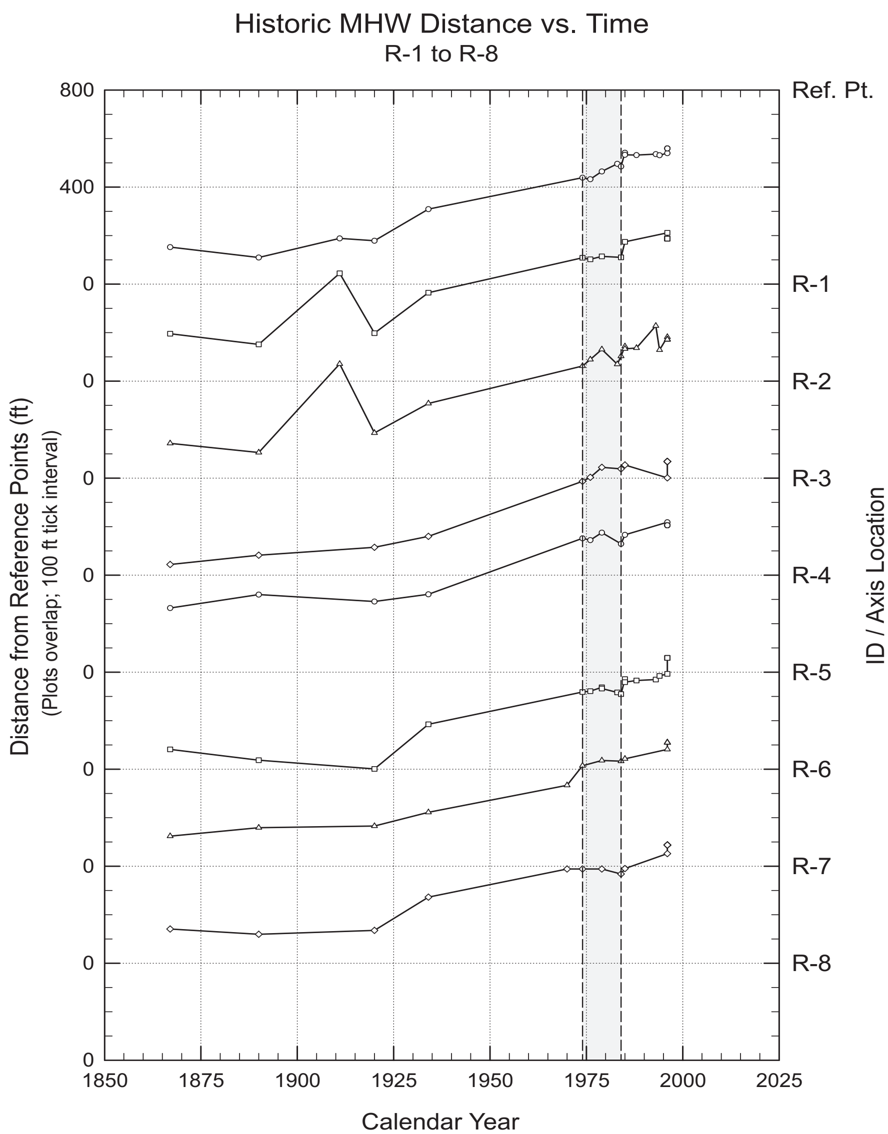
Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
	EP			-0.3		
198	RA			-0.8	0.0	
	LS			-0.1		
	EP			-0.4		
199	RA			-0.5	0.0	
	LS			-0.1		
	EP			-0.4		
200	RA			-0.1	0.0	
	LS			0.2		
	EP			-0.1		
201	RA			0.0	0.0	
	LS			0.2		
	EP			0.0		
202	RA			-0.5	-0.5	
	LS			-0.3		
	EP			-0.5		
203	RA			-0.3	-0.5	
	LS			-0.2		
	EP			-0.3		
204	RA			-0.2	-0.5	
	LS			-0.1		
	EP			-0.2		
205	RA			-0.3	-0.5	
	LS			-1.1		
	EP			-1.4		
206	RA			-0.4	-0.5	
	LS			-1.1		
	EP			-1.3		
207	RA			0.2	-0.5	
	LS			-0.4		
	EP			-0.8		
208	RA			-0.4	-0.5	
	LS			0.1		
	EP			-0.5		
209	RA			-0.2	-0.5	
	LS			-0.6		
	EP			-1.0		
210	RA			-0.6	-0.5	
	LS			0.1		
	EP			-0.4		
211	RA			0.3	-0.5	↑
	LS			-0.3		7 pt average

Table A-1. Rates of shoreline change for Escambia and Santa Rosa Counties, Florida.

Range	Method	Original Rate Estimates (ft/yr)			Consensus Rate Average Estimates	
		1974 to 1984	1920 to 1985,93,94	1867,71 to 1985,93,94	Rate (ft/yr)	Comments
	EP			-0.6		
212	RA			0.3	-0.5	5 pt average
	LS			-0.6		
	EP			-1.3		
213	RA			-0.7	-0.5	3 pt average
	LS			0.0		
	EP			-0.4		
214	RA			-0.5	0.0	original
	LS			0.2		no averaging
	EP			-0.4		

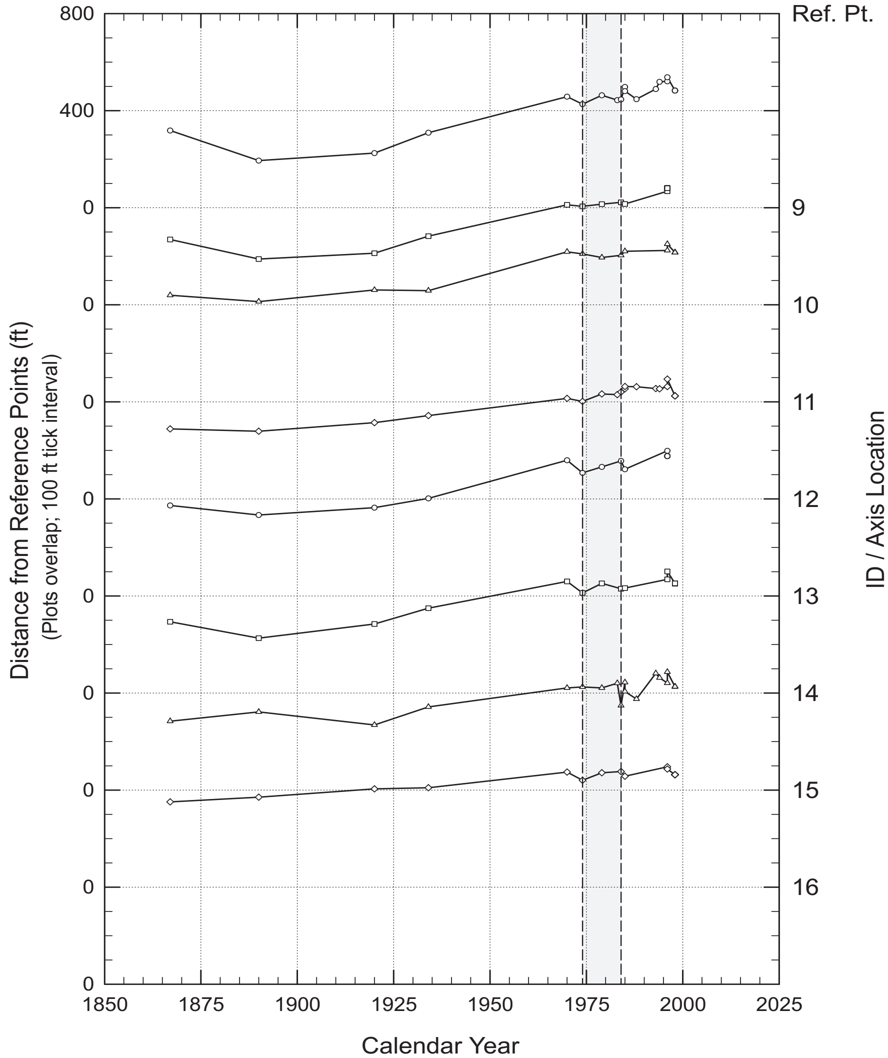
8.2 Appendix B: Stack Plots

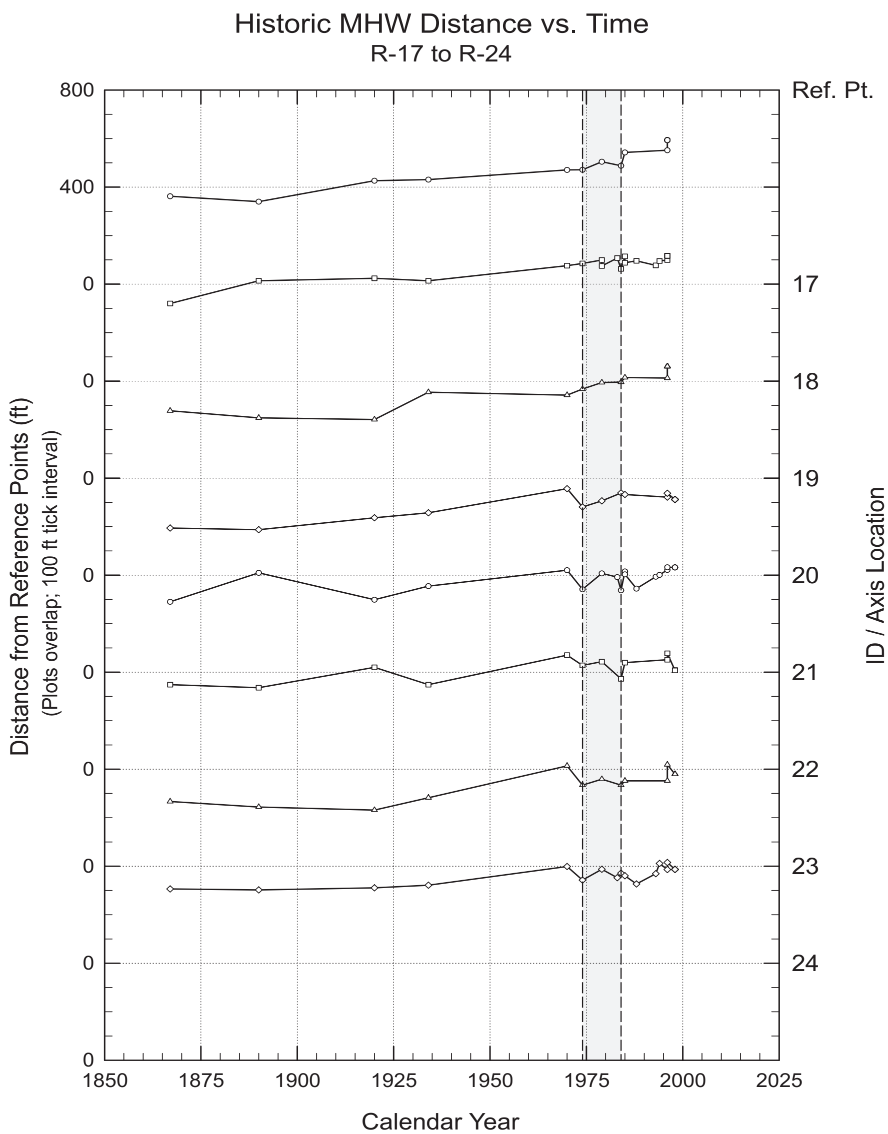
Stack plots from Historic Shoreline Database, Florida Department of Environmental Protection, Bureau of Beaches and Coastal Systems; slightly modified by authors.

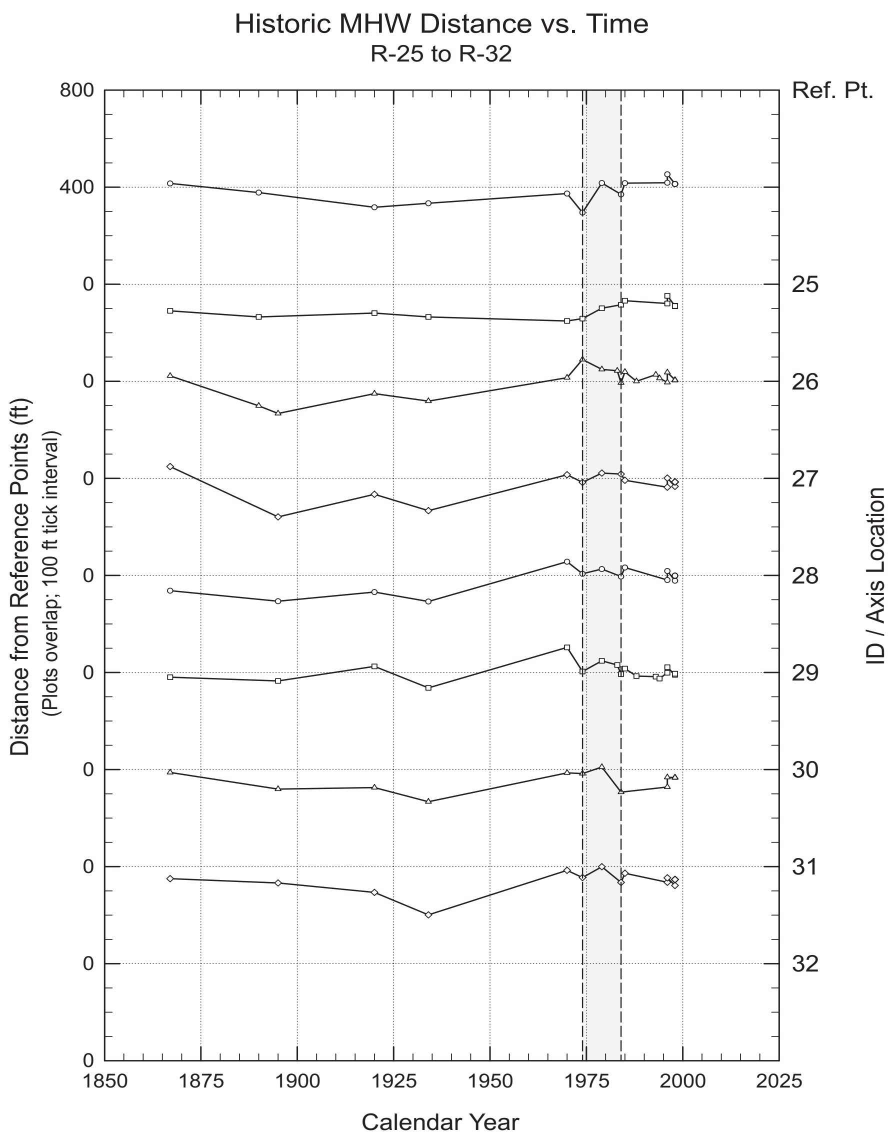

Historic MHW Distance vs. Time
R-1 to R-8
800
400
0
0
0
0
0
0
0
0
0
Ref. Pt.
R-1
R-2
R-3
R-4
R-5
R-6
R-7
R-8
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

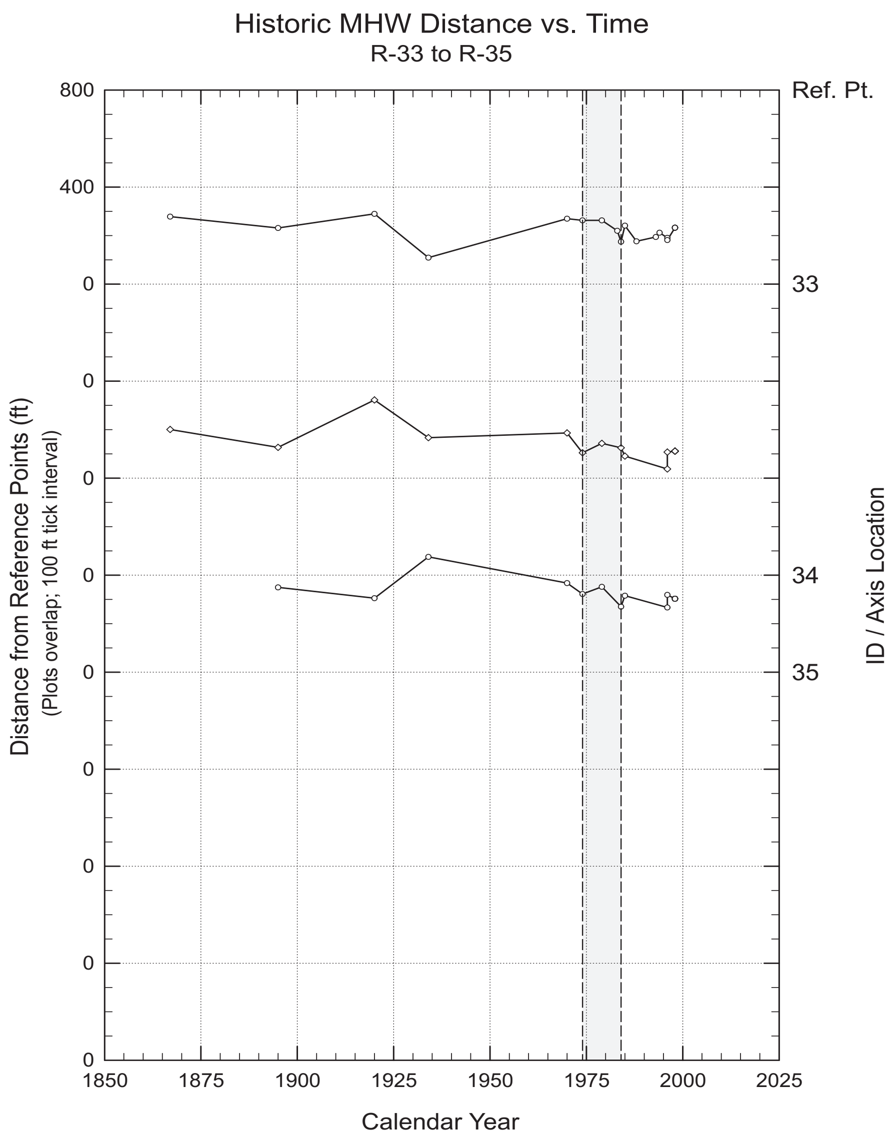
Historic MHW Distance vs. Time

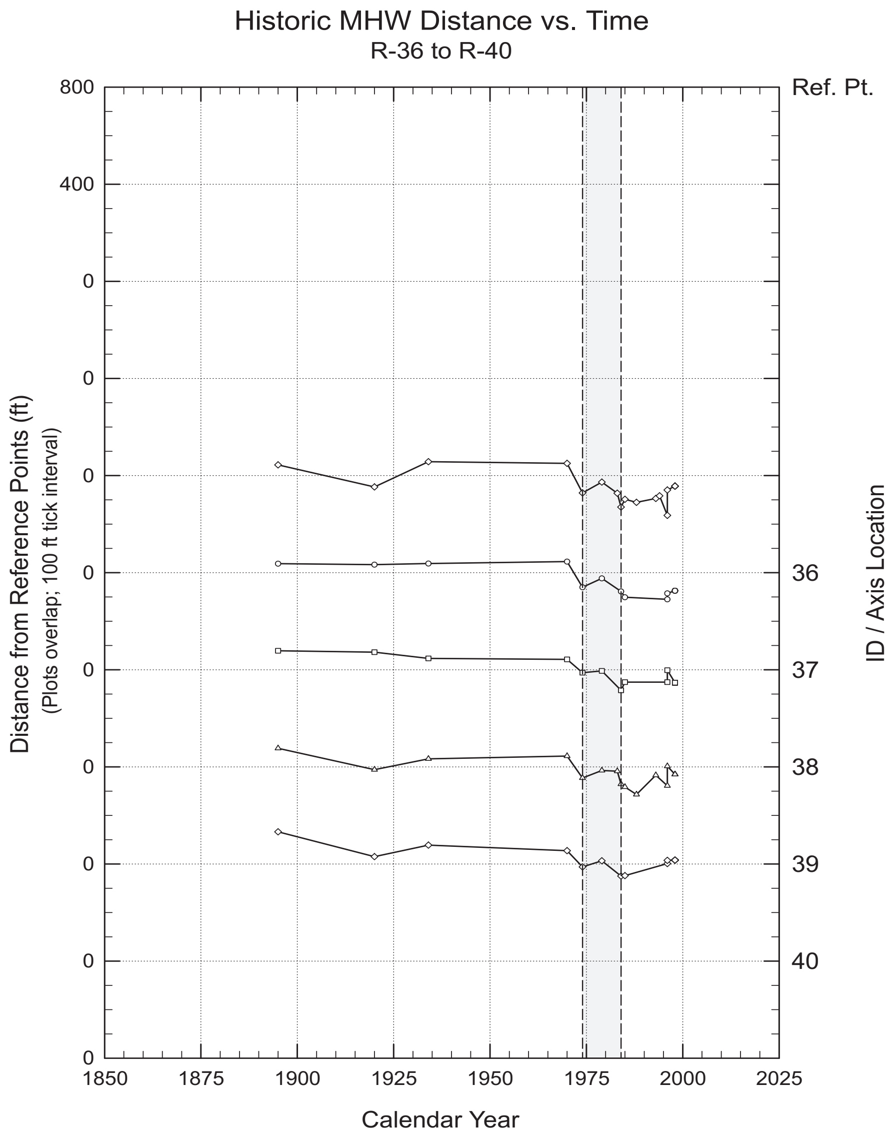
R-9 to R-16



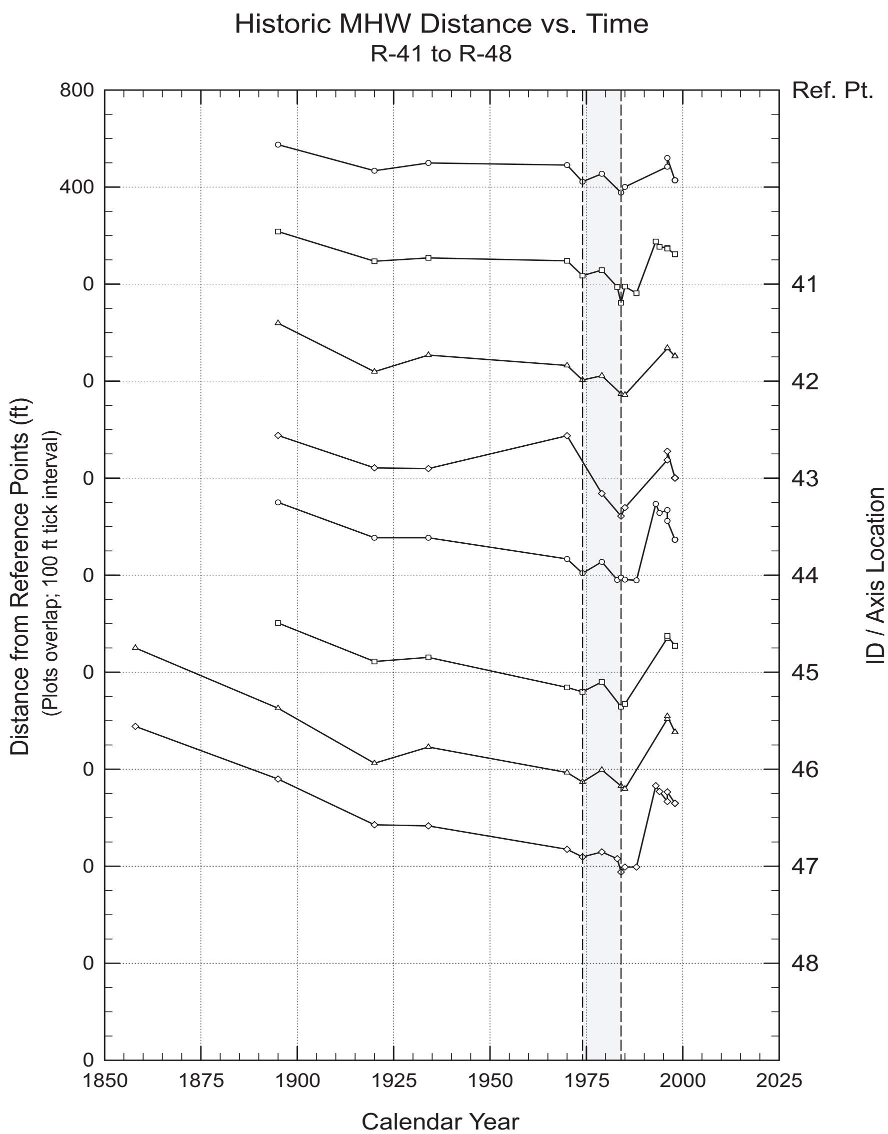

Historic MHW Distance vs. Time
R-17 to R-24
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
Ref. Pt.
17
18
19
20
21
22
23
24
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year


Historic MHW Distance vs. Time
R-25 to R-32
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
0
Ref. Pt.
25
26
27
28
29
30
31
32
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

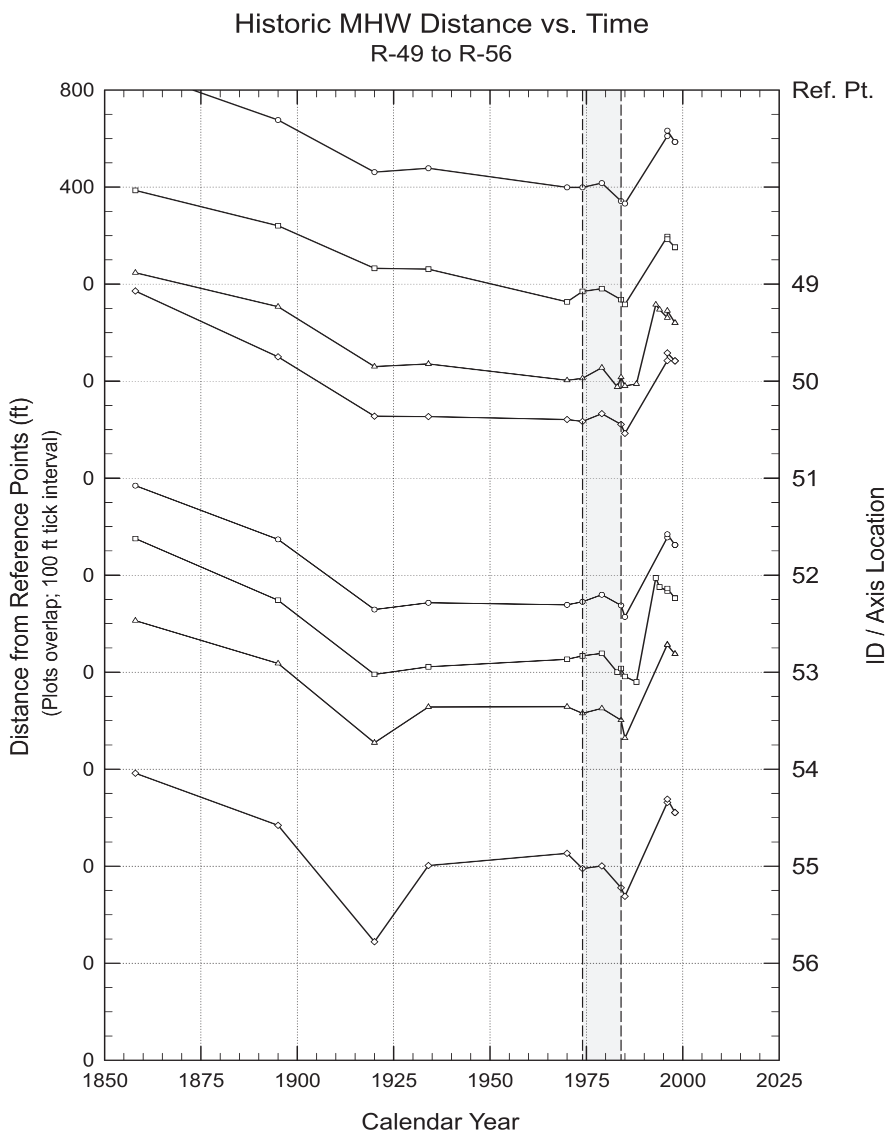

Historic MHW Distance vs. Time
R-33 to R-35
800
400
0
0
0
0
0
0
0
0
0
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Ref. Pt.
33
34
35
ID / Axis Location



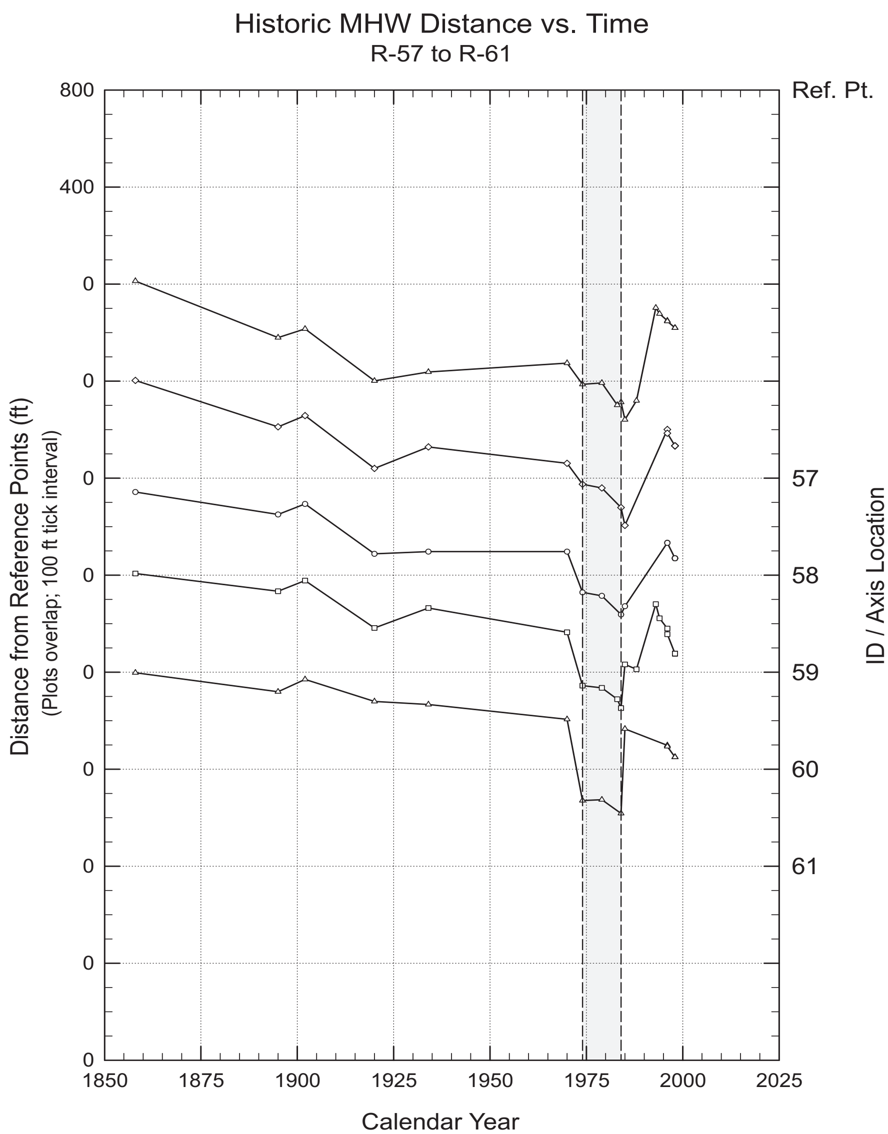
Historic MHW Distance vs. Time
R-36 to R-40
800
400
0
0
0
0
0
0
0
0
0
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Ref. Pt.
36
37
38
39
40
ID / Axis Location



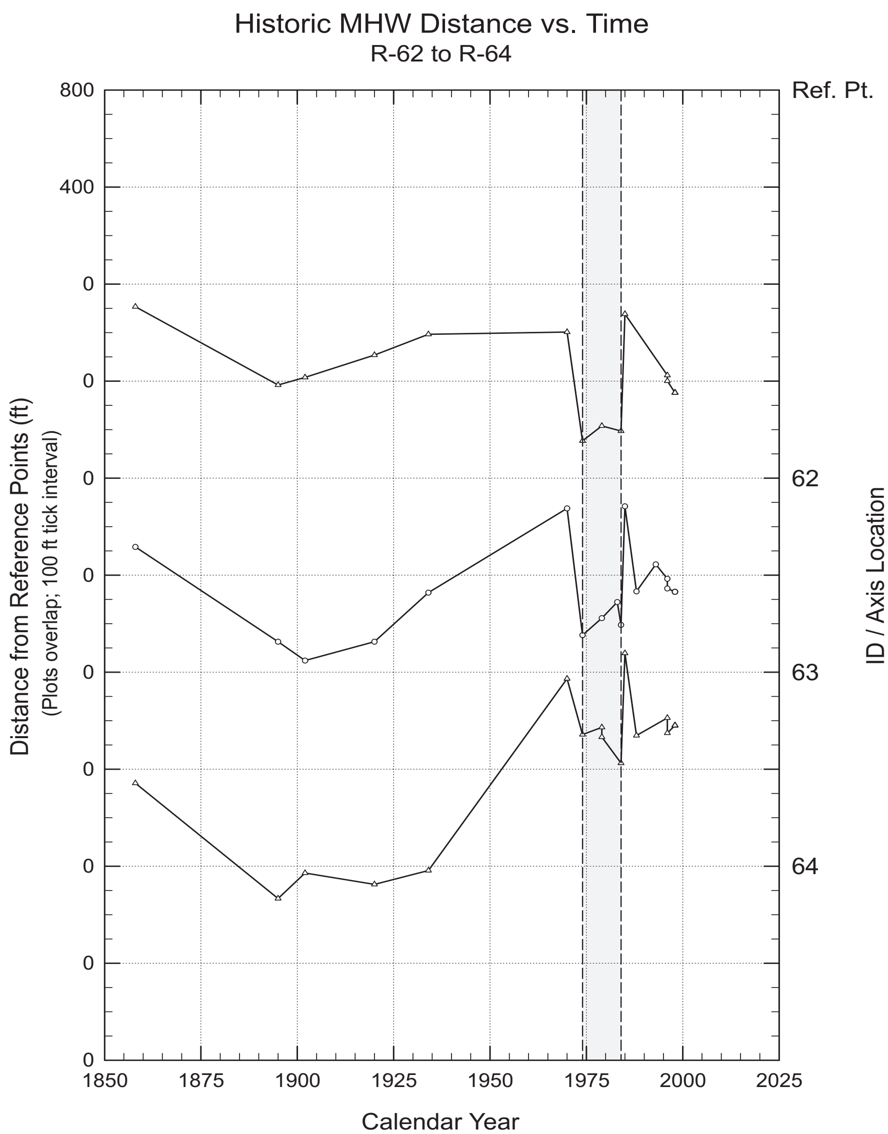
Historic MHW Distance vs. Time
R-41 to R-48
Ref. Pt.
800
400
0
41
42
43
44
45
46
47
48
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

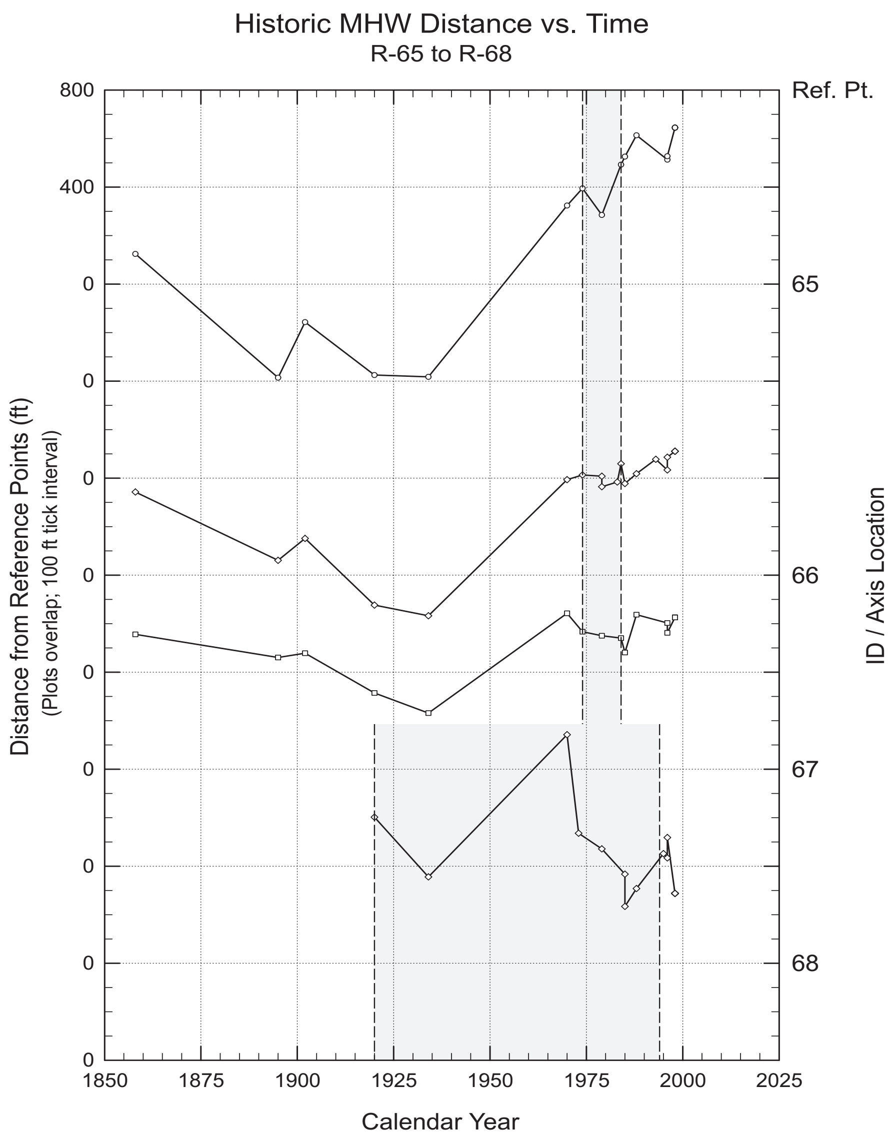


Historic MHW Distance vs. Time
R-49 to R-56
800
400
0
0
0
0
0
0
0
0
0
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
Ref. Pt.
49
50
51
52
53
54
55
56
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

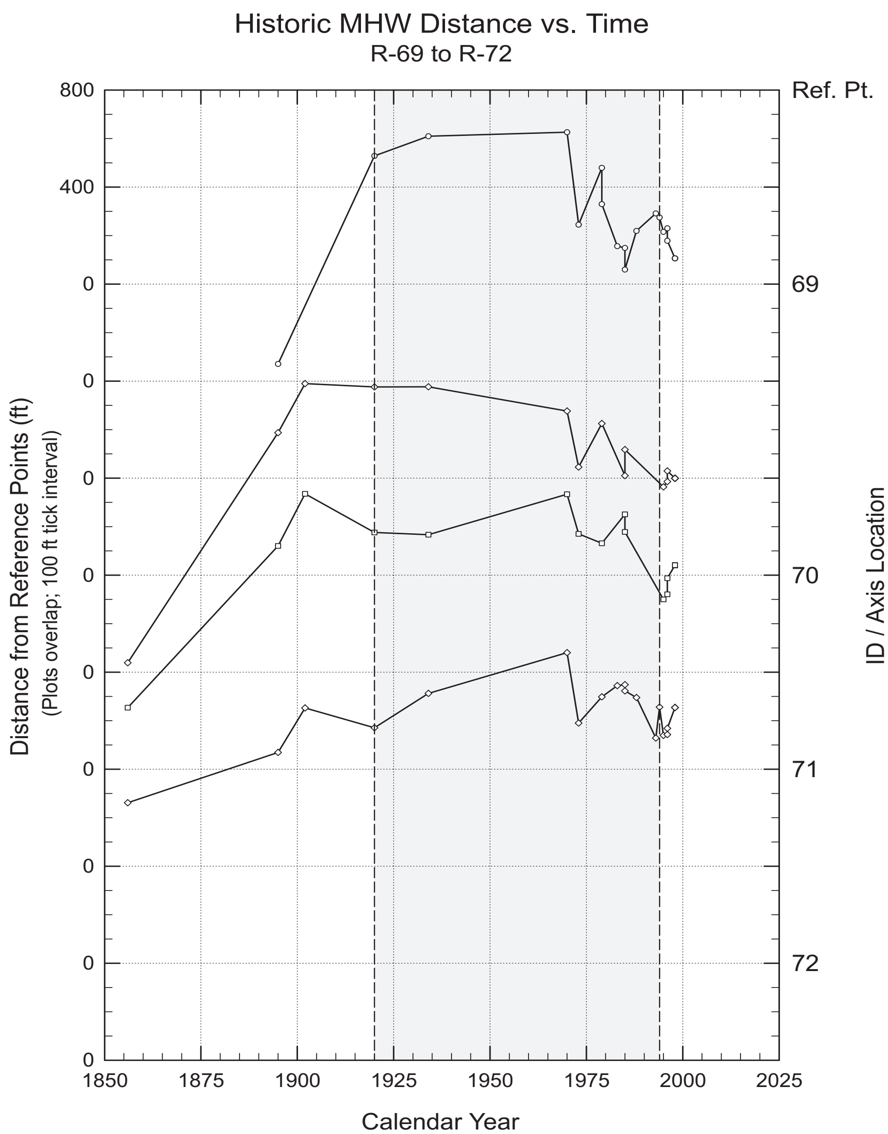


Historic MHW Distance vs. Time
R-57 to R-61
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
Ref. Pt.
57
58
59
60
61
ID / Axis Location


Historic MHW Distance vs. Time
R-62 to R-64
800
400
0
0
0
0
0
0
0
0
0
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Ref. Pt.
62
63
64
ID / Axis Location

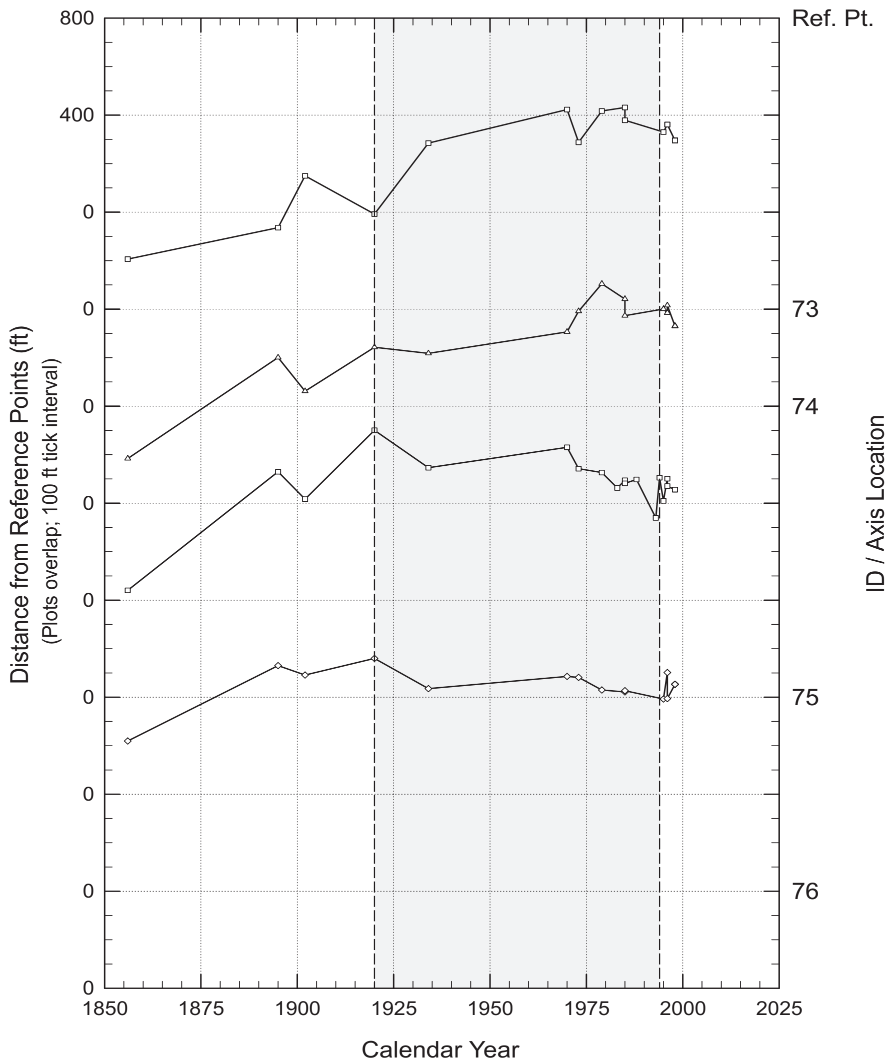


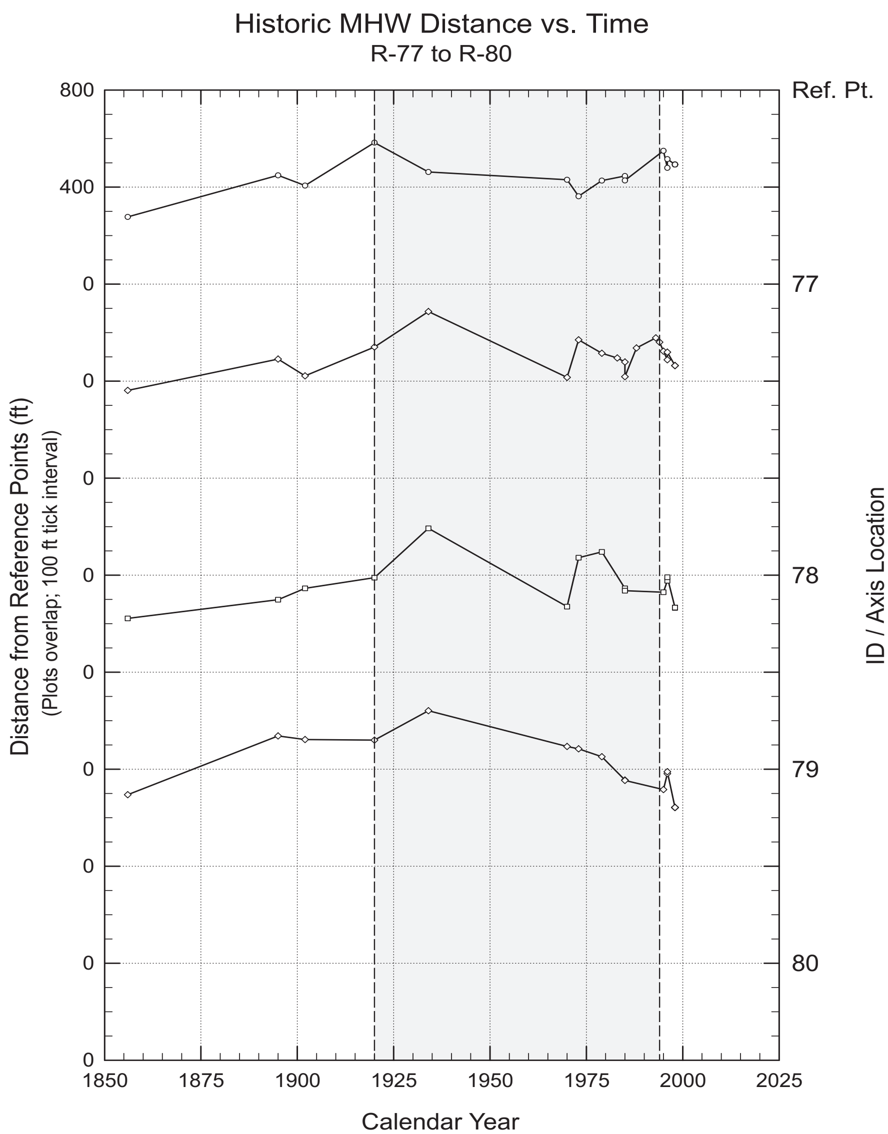
Historic MHW Distance vs. Time
R-65 to R-68
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
Ref. Pt.
65
66
67
68
ID / Axis Location



Historic MHW Distance vs. Time
R-69 to R-72
800
400
0
0
0
0
0
0
0
0
0
Ref. Pt.
69
70
71
72
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location

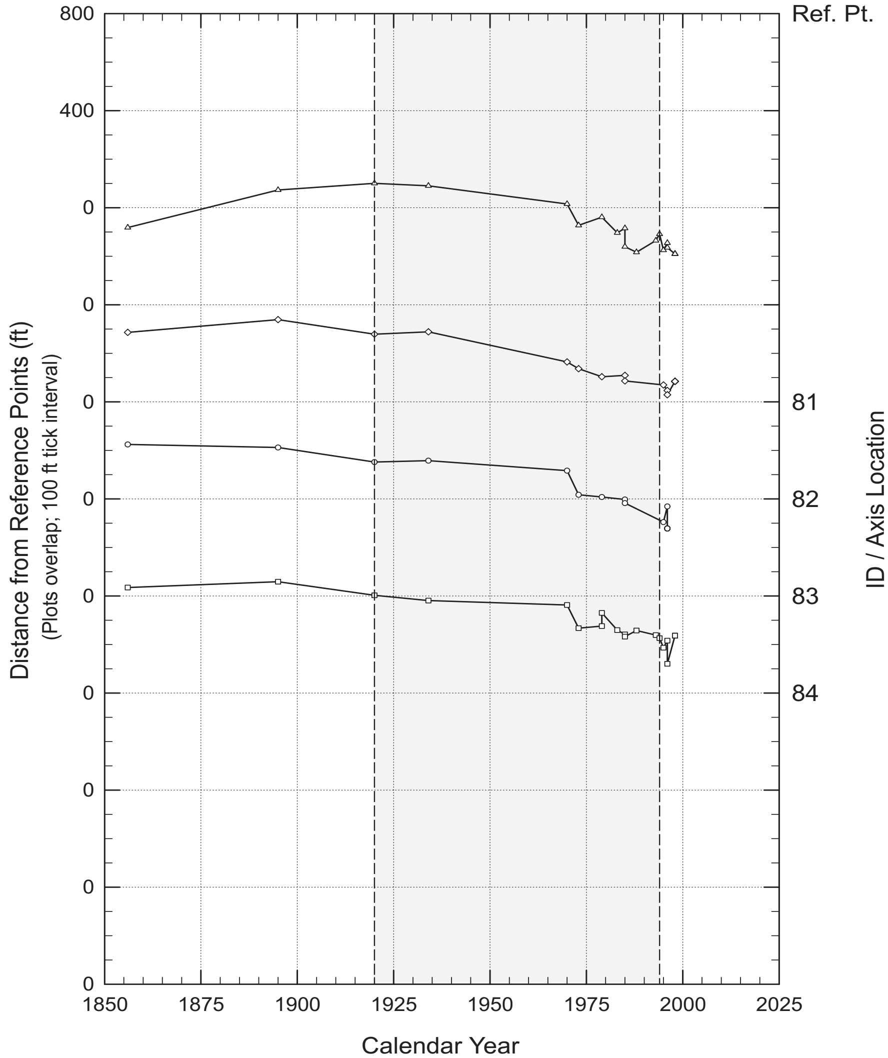
Historic MHW Distance vs. Time
R-73 to R-76



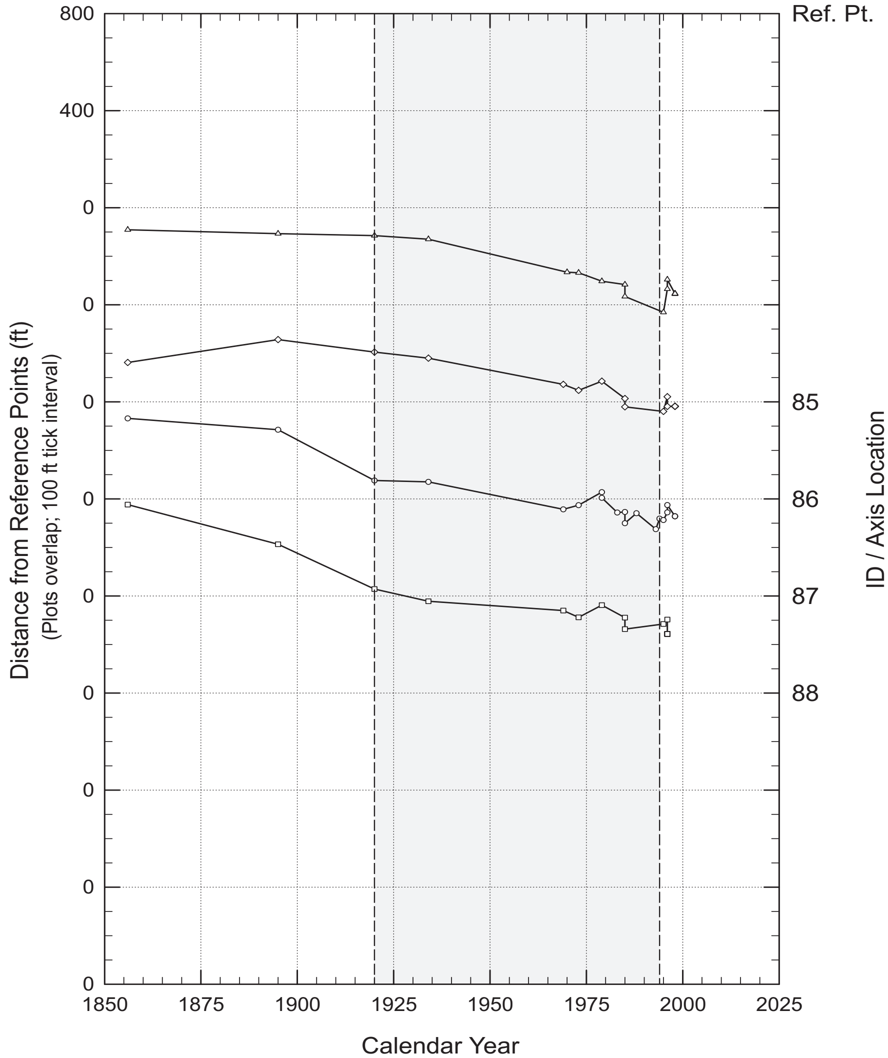

Historic MHW Distance vs. Time
R-77 to R-80
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Ref. Pt.
77
78
79
80
ID / Axis Location

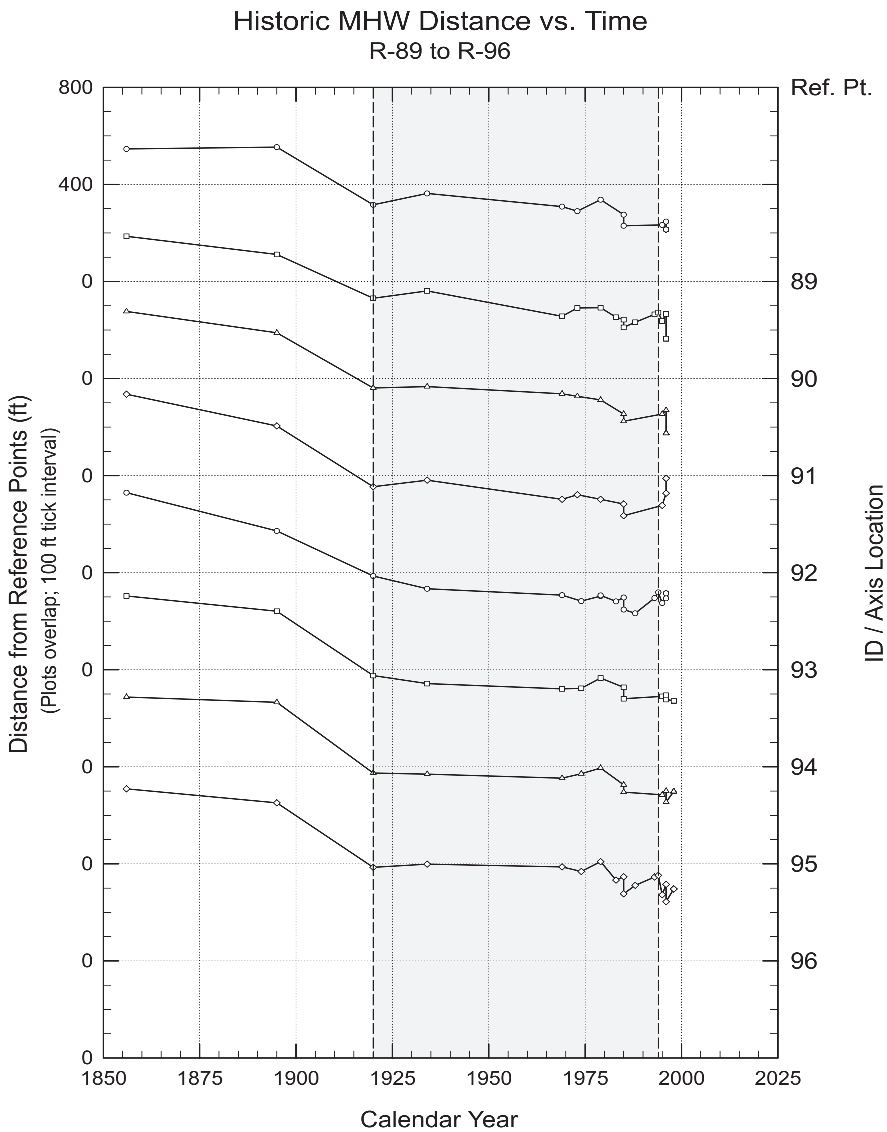
Historic MHW Distance vs. Time

R-81 to R-84



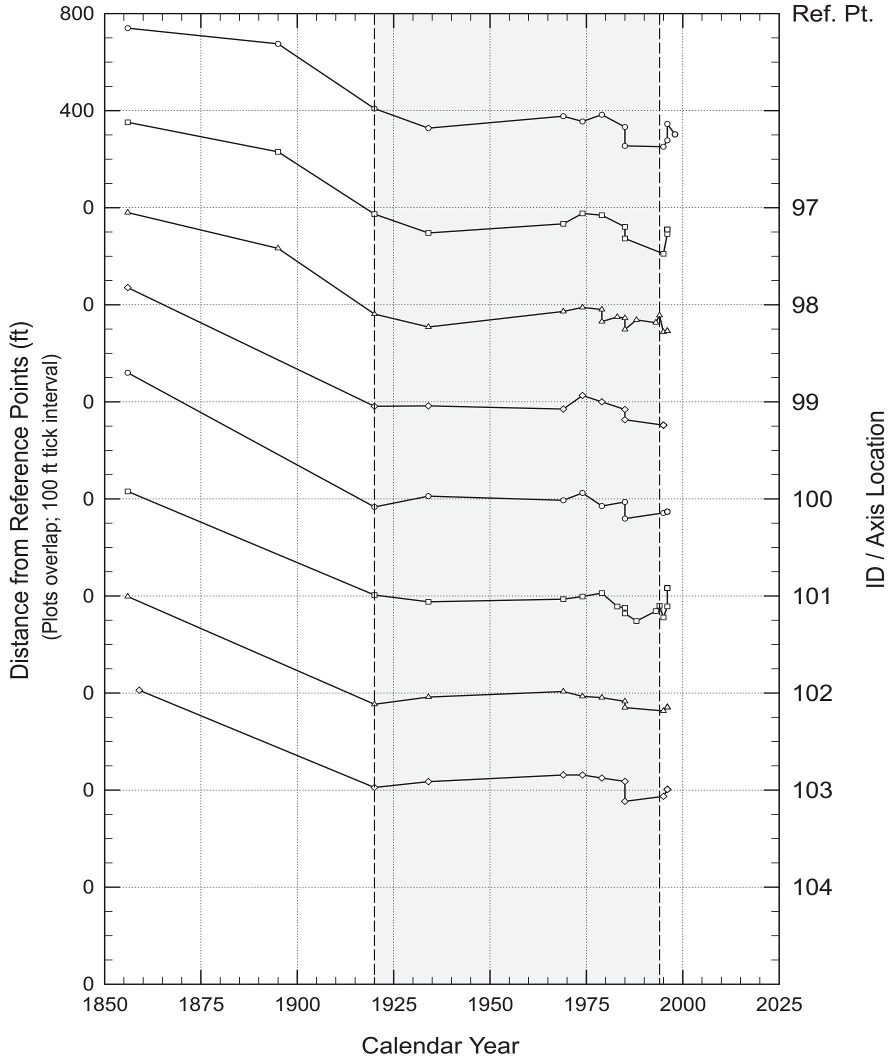
Historic MHW Distance vs. Time
R-85 to R-88

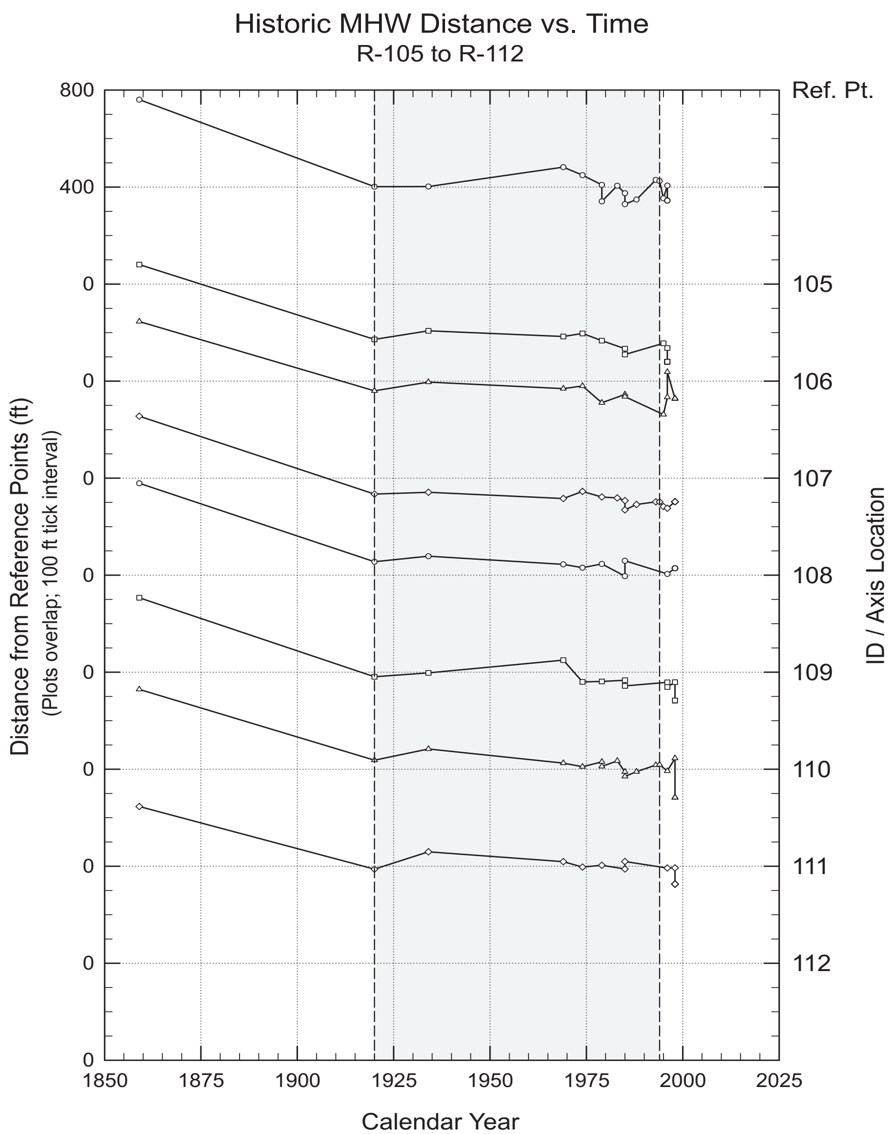


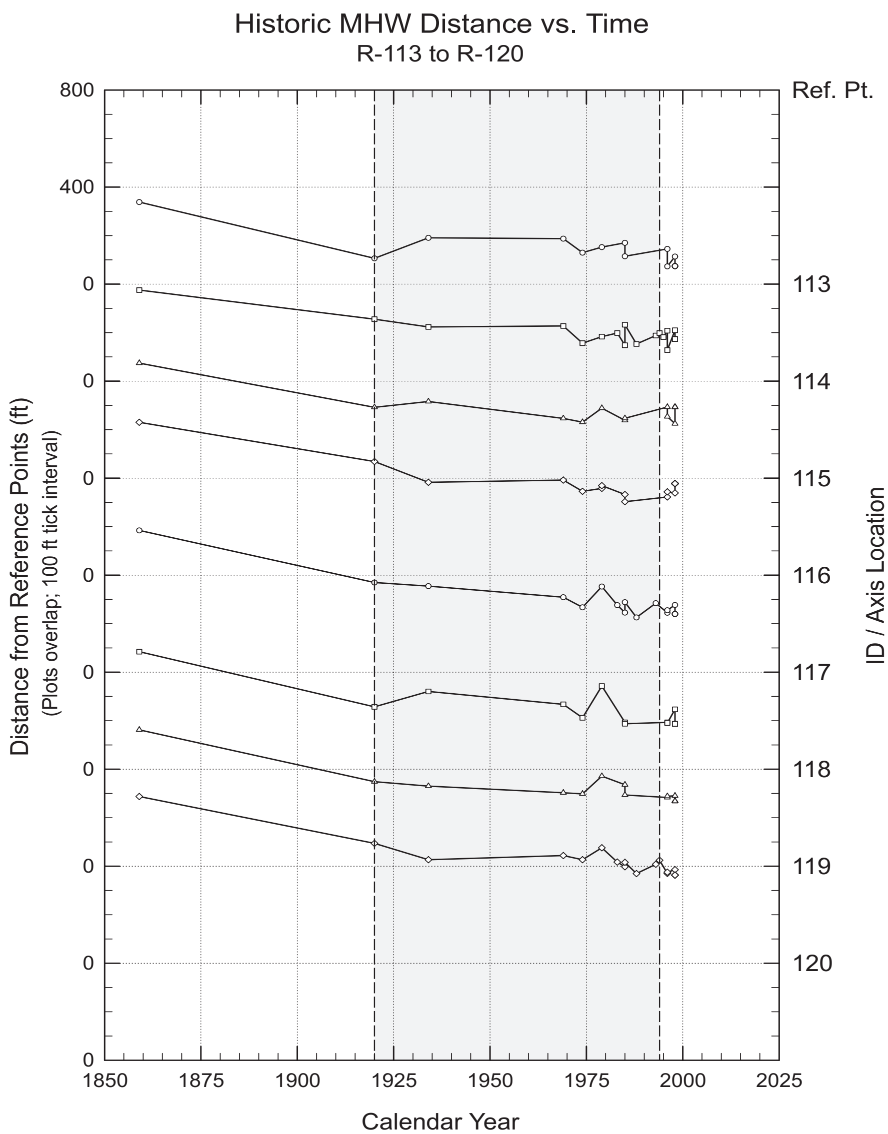

Historic MHW Distance vs. Time
R-89 to R-96
800
400
0
0
0
0
0
0
0
0
0
Ref. Pt.
89
90
91
92
93
94
95
96
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

Historic MHW Distance vs. Time

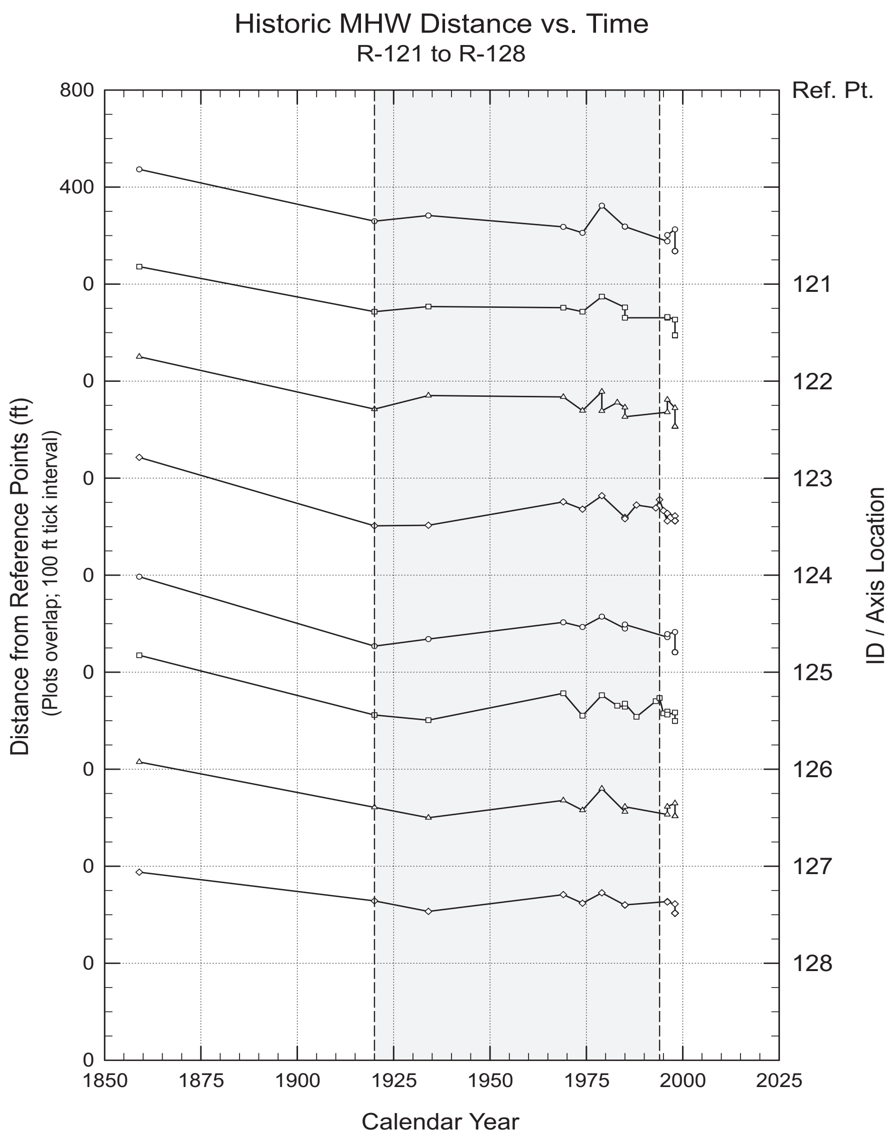
R-97 to R-104

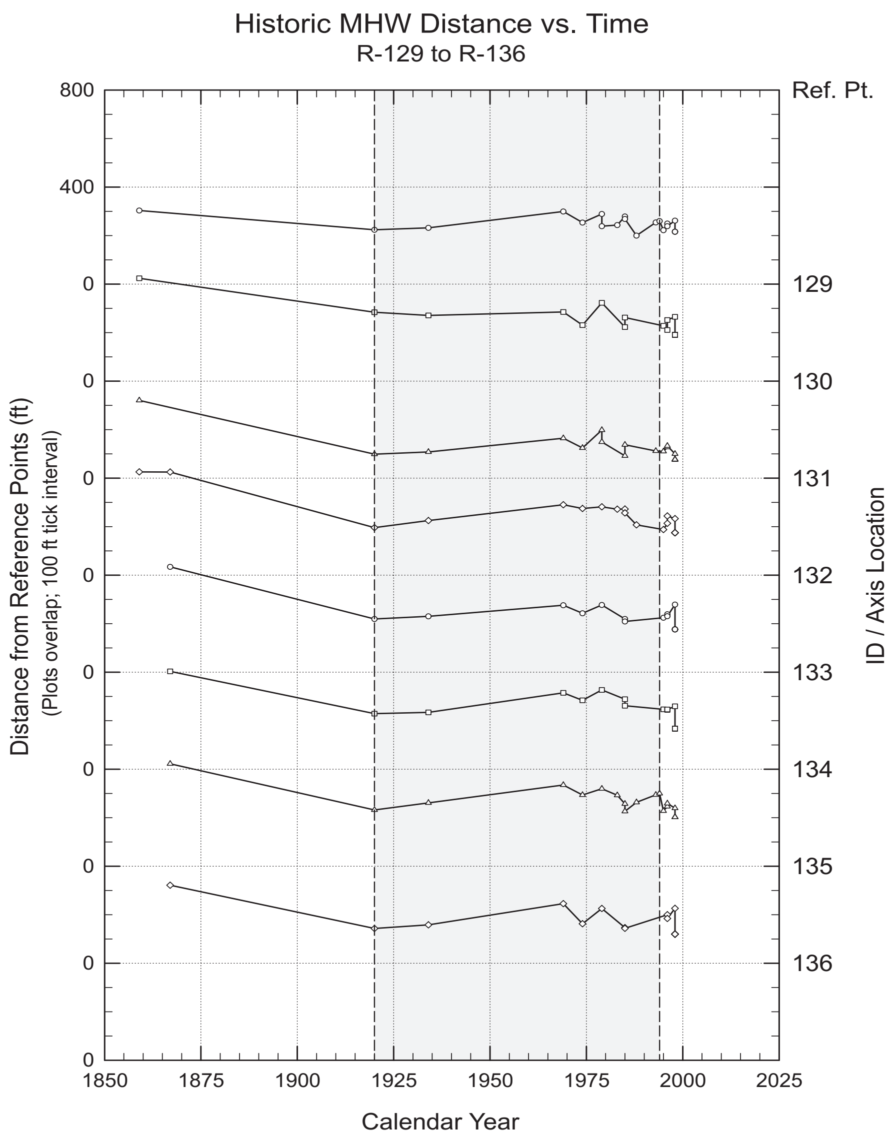



Historic MHW Distance vs. Time
R-105 to R-112
800
400
0
0
0
0
0
0
0
0
0
Ref. Pt.
105
106
107
108
109
110
111
112
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

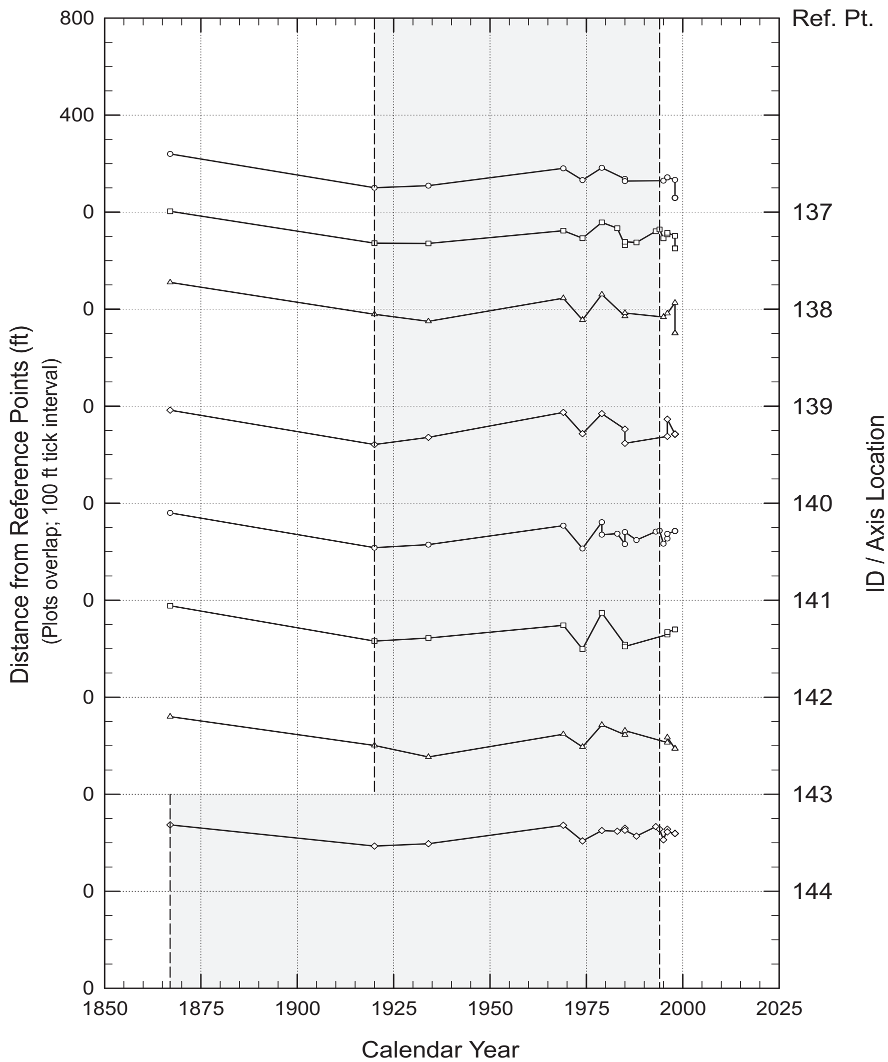


Historic MHW Distance vs. Time
R-113 to R-120
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
Ref. Pt.
113
114
115
116
117
118
119
120
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

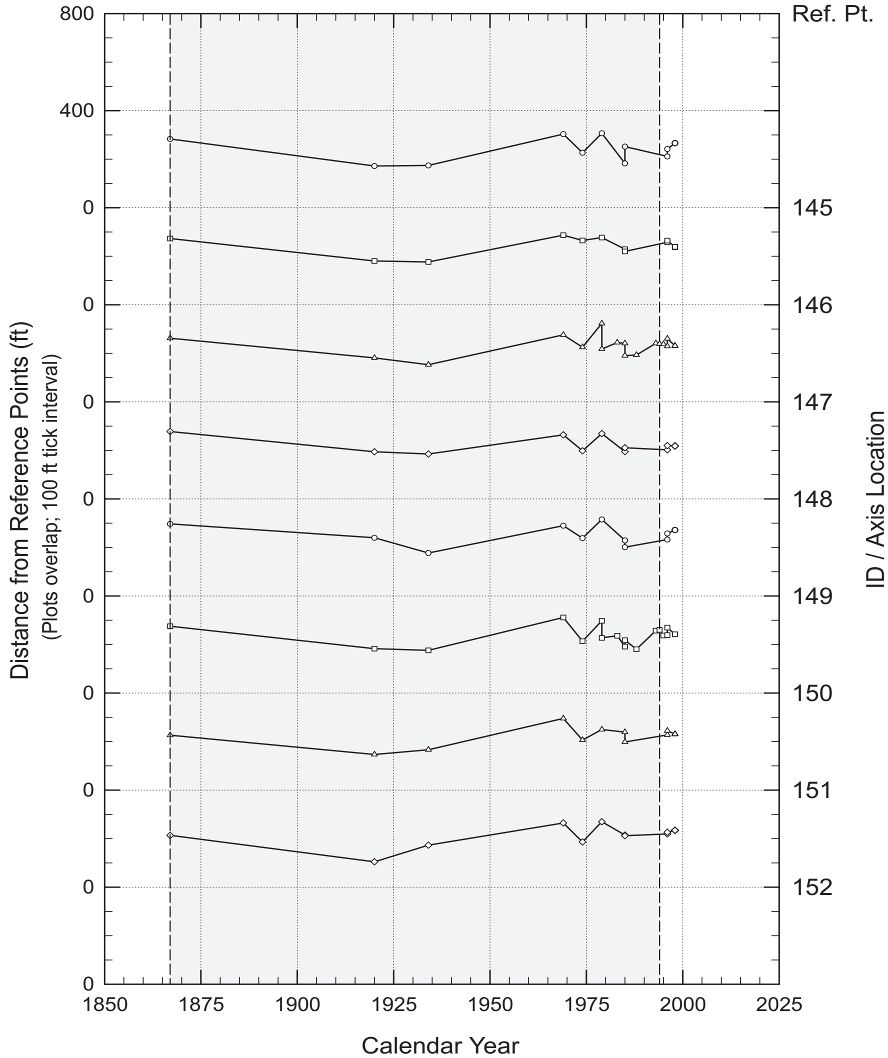

Historic MHW Distance vs. Time
R-121 to R-128
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Ref. Pt.
121
122
123
124
125
126
127
128
ID / Axis Location

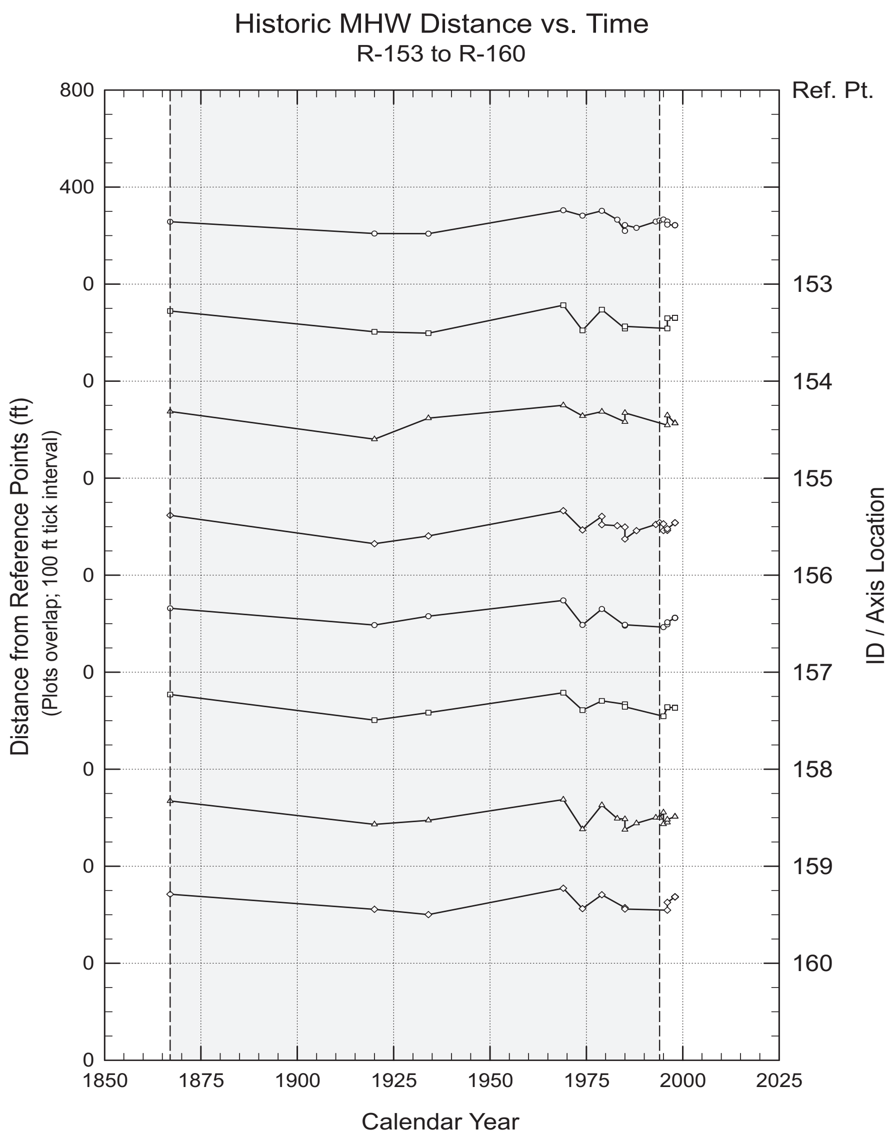

Historic MHW Distance vs. Time
R-129 to R-136
Ref. Pt.
800
400
0
129
130
131
132
133
134
135
136
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

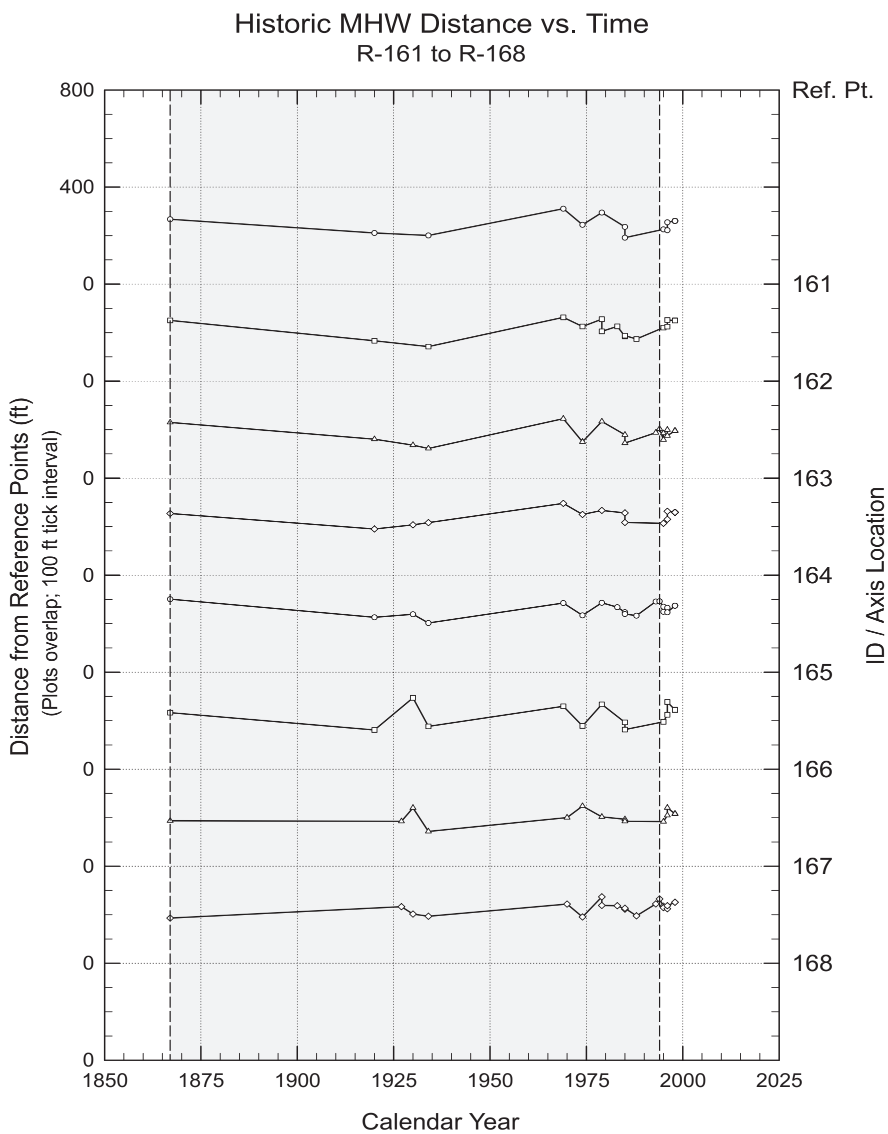
Historic MHW Distance vs. Time
R-137 to R-144



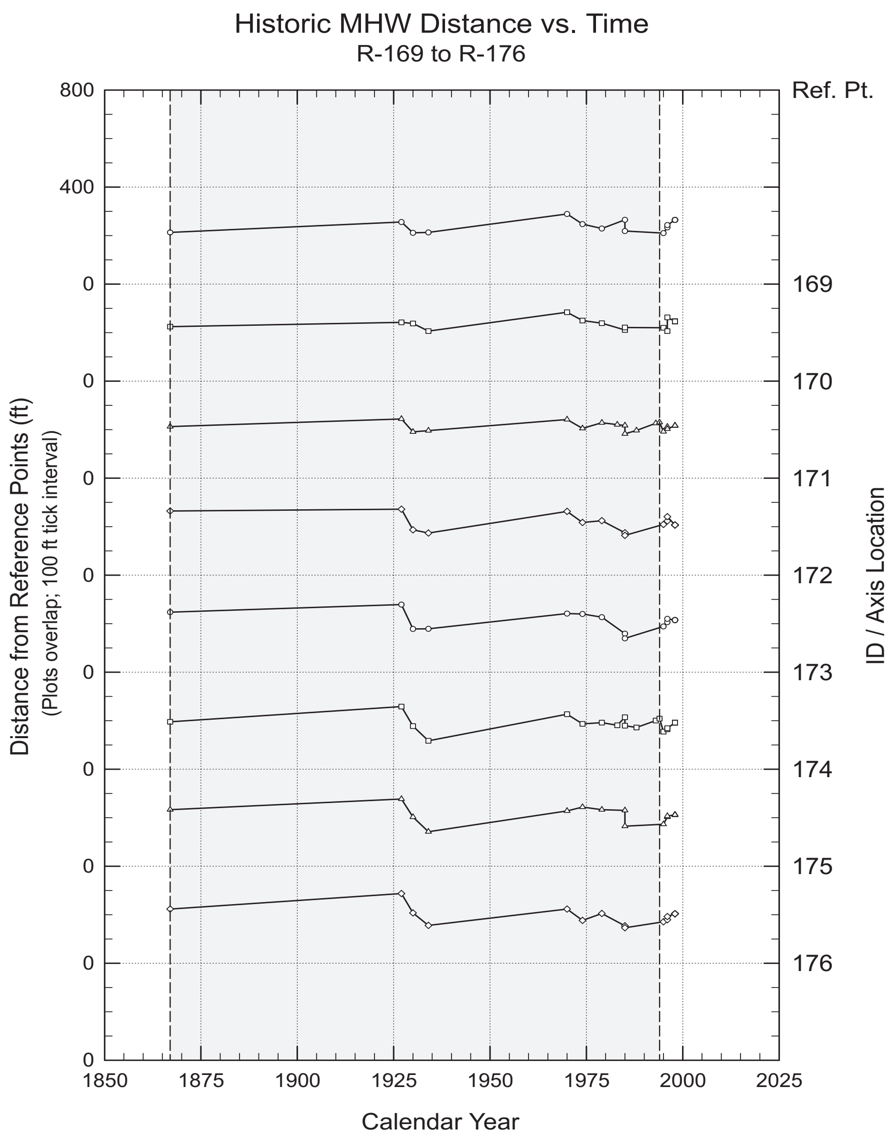
Historic MHW Distance vs. Time
R-145 to R-152

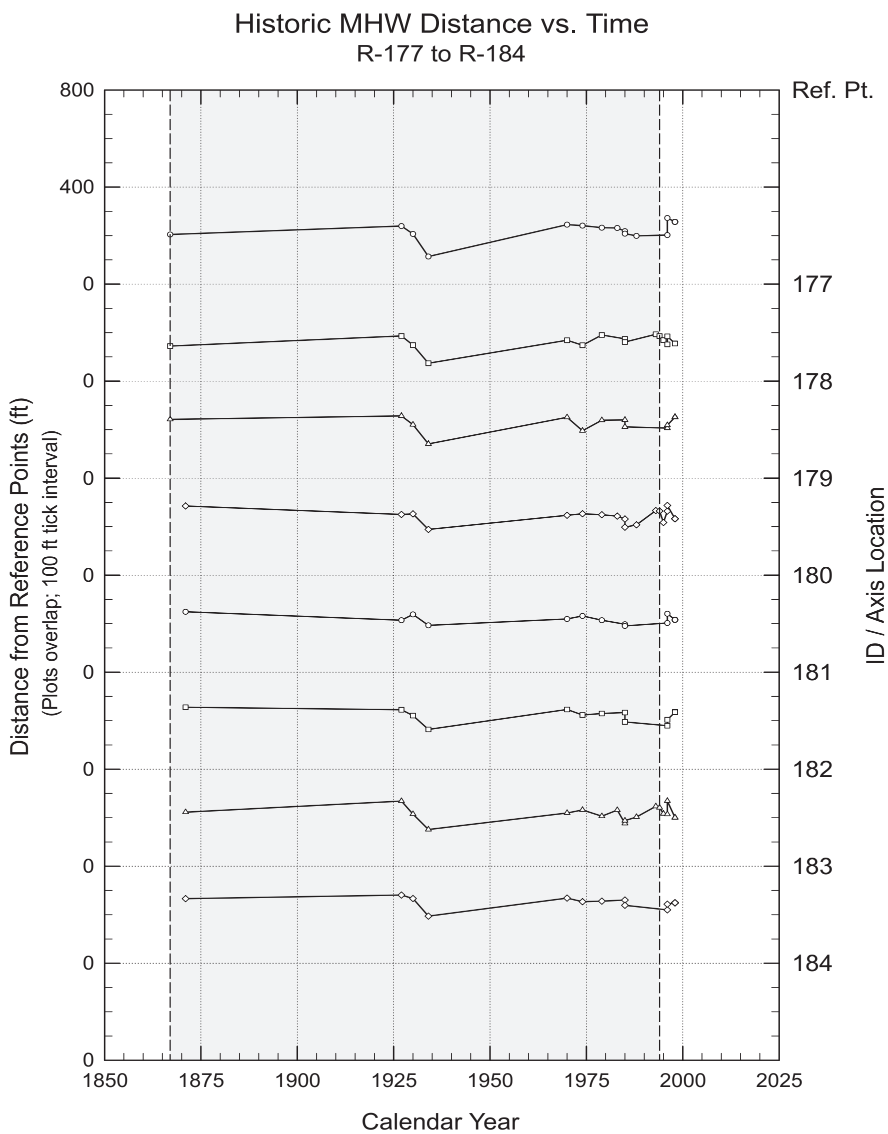


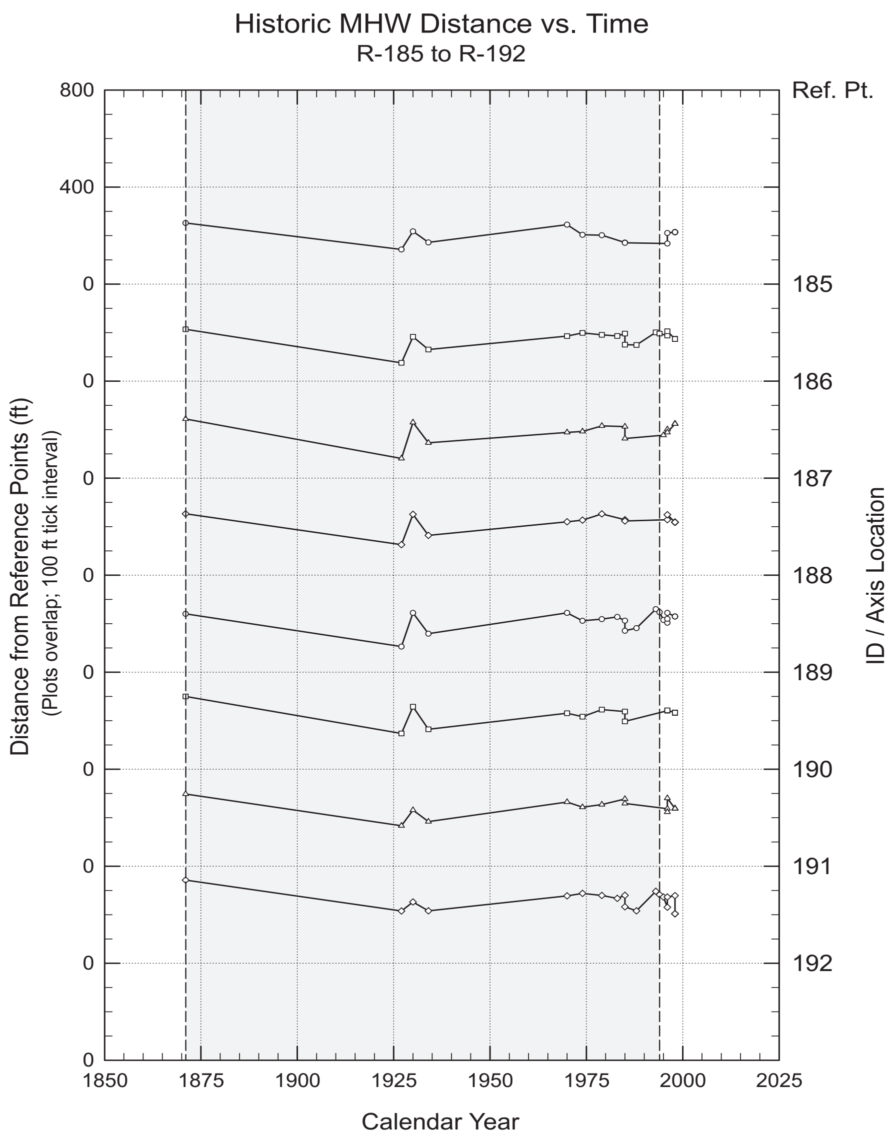

Historic MHW Distance vs. Time
R-153 to R-160
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Ref. Pt.
153
154
155
156
157
158
159
160
ID / Axis Location



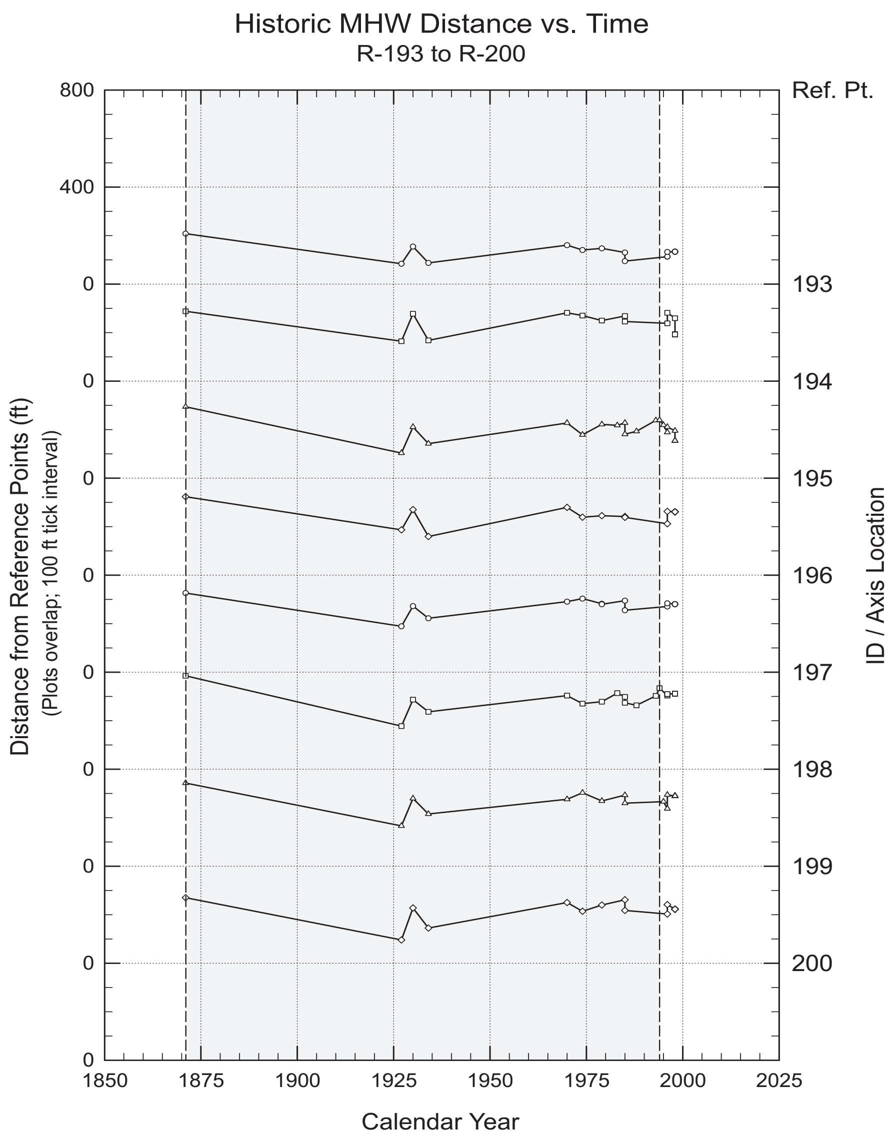
Historic MHW Distance vs. Time
R-161 to R-168
800
400
0
0
0
0
0
0
0
0
0
Ref. Pt.
161
162
163
164
165
166
167
168
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

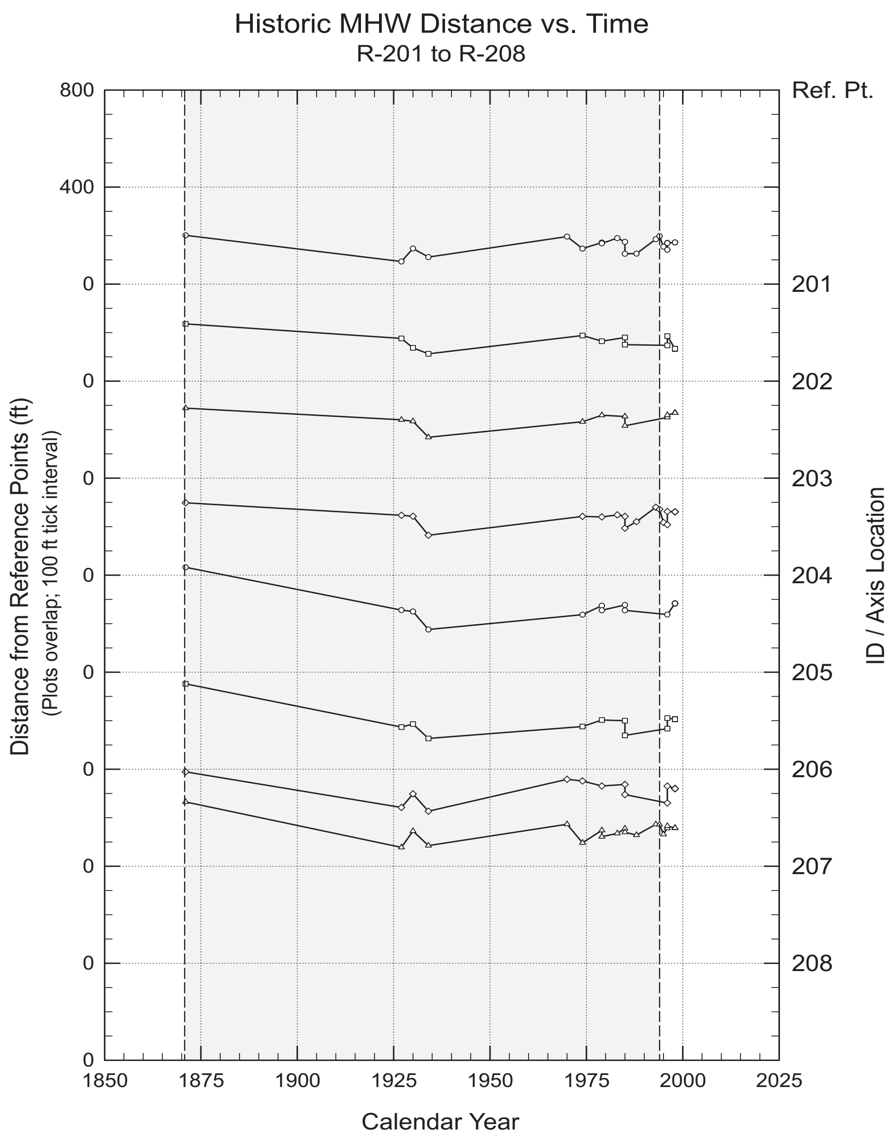

Historic MHW Distance vs. Time
R-169 to R-176
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
0
Ref. Pt.
169
170
171
172
173
174
175
176
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year


Historic MHW Distance vs. Time
R-177 to R-184
800
400
0
0
0
0
0
0
0
0
0
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Ref. Pt.
177
178
179
180
181
182
183
184
ID / Axis Location

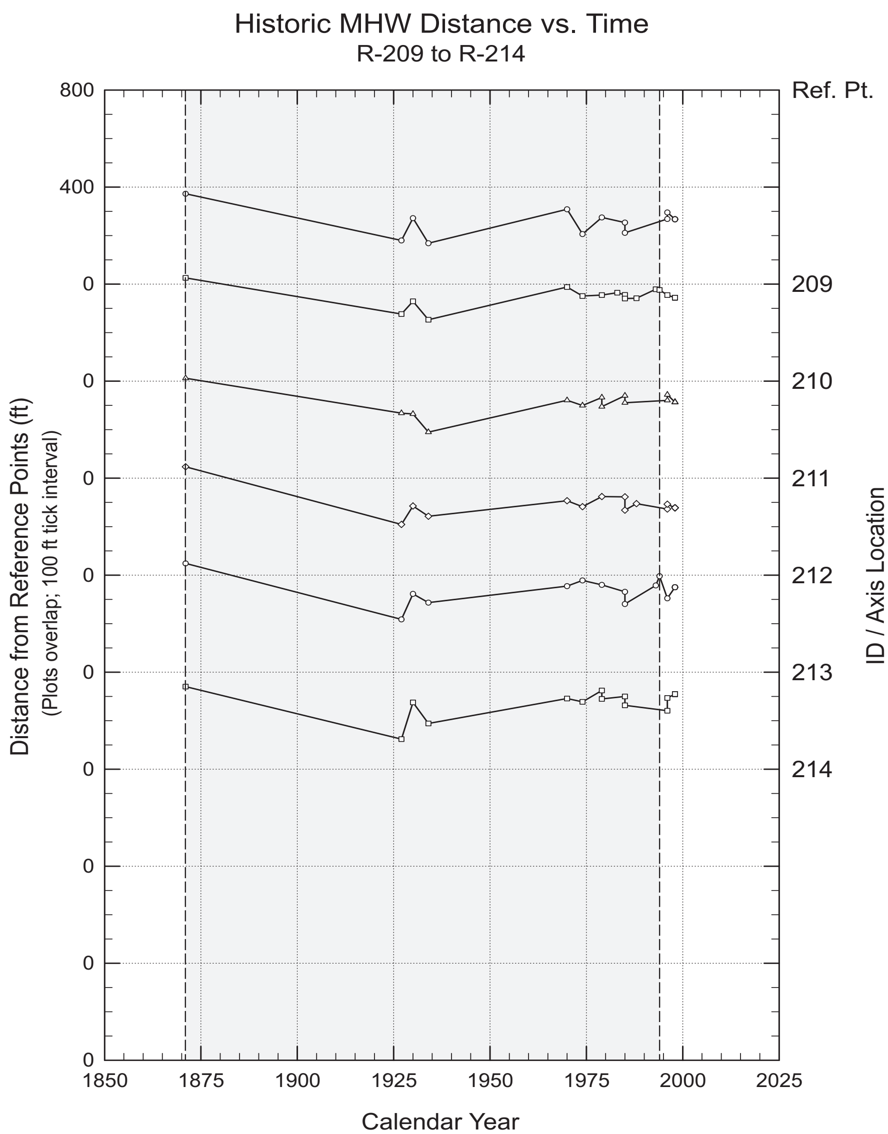


Historic MHW Distance vs. Time
R-185 to R-192
800
400
0
0
0
0
0
0
0
0
0
Ref. Pt.
185
186
187
188
189
190
191
192
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year


Historic MHW Distance vs. Time
R-193 to R-200
800
400
0
0
0
0
0
0
0
0
0
Ref. Pt.
193
194
195
196
197
198
199
200
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

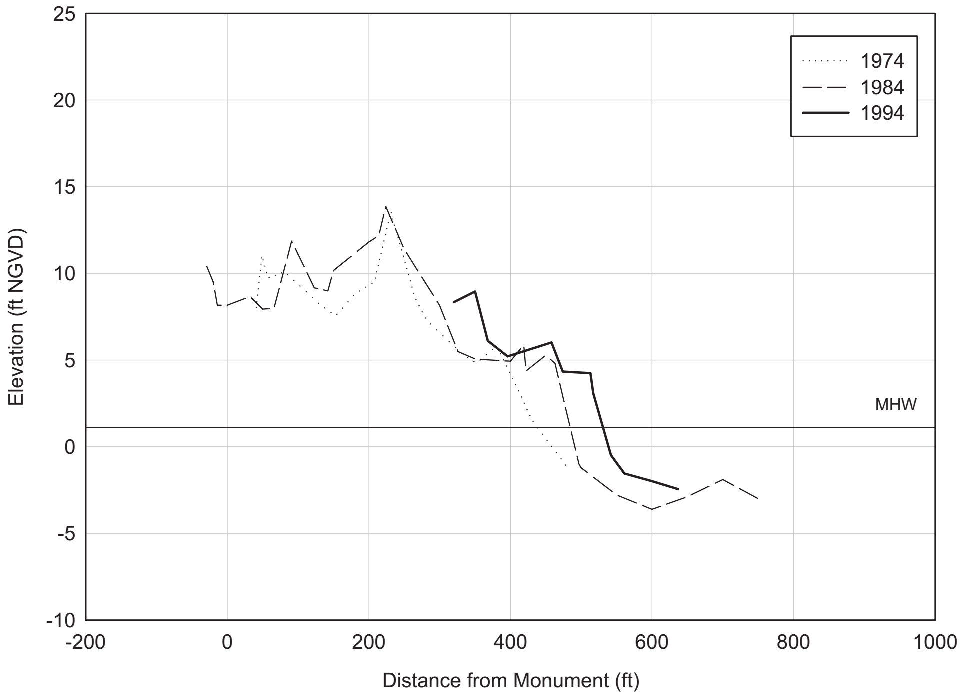


Historic MHW Distance vs. Time
R-201 to R-208
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Ref. Pt.
201
202
203
204
205
206
207
208
ID / Axis Location

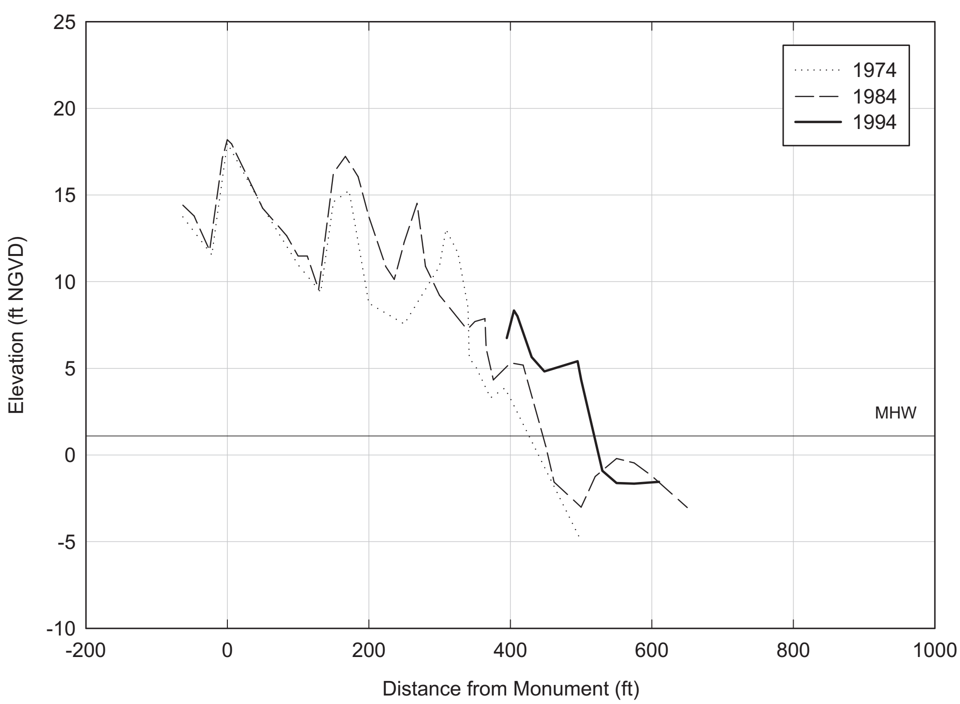

Historic MHW Distance vs. Time
R-209 to R-214
Ref. Pt.
800
400
0
209
210
211
212
213
214
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

8.3 Appendix C: Profile Plots

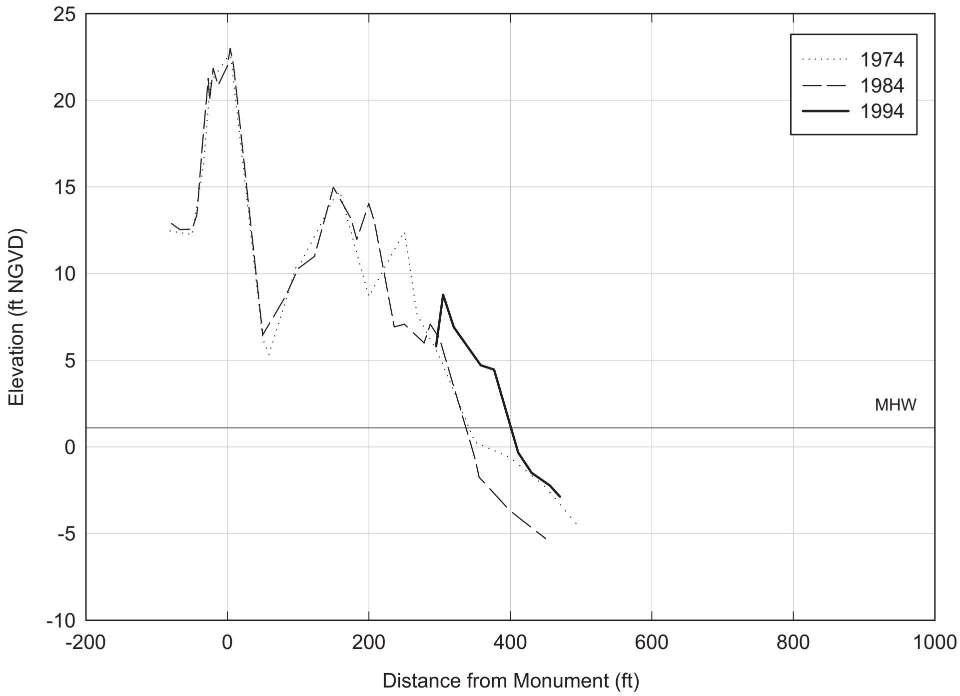
Escambia County
R-1



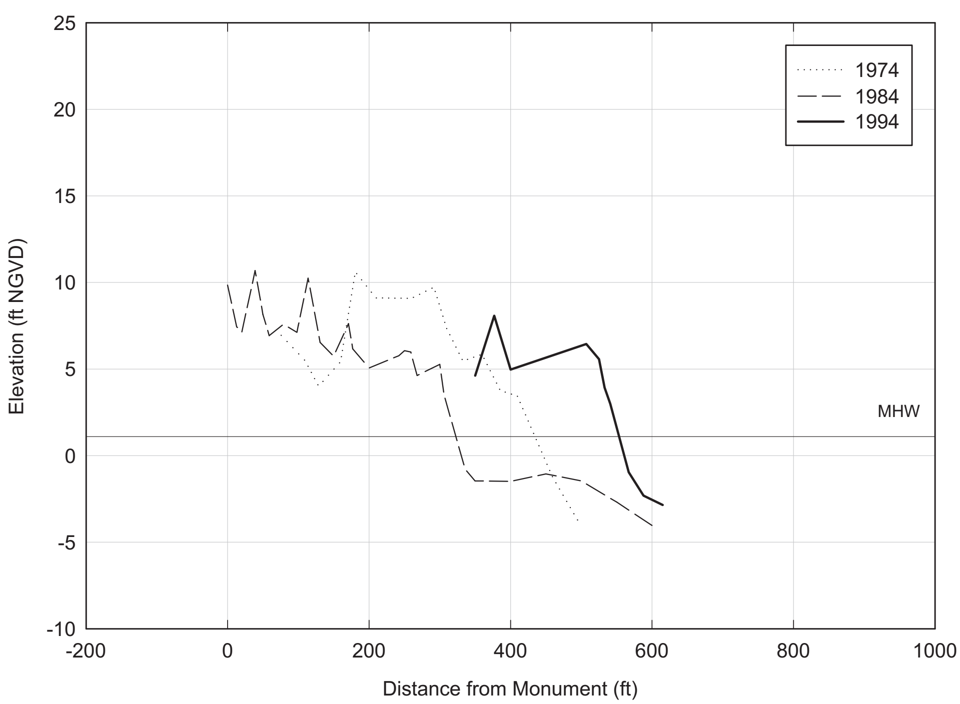
Escambia County
R-9



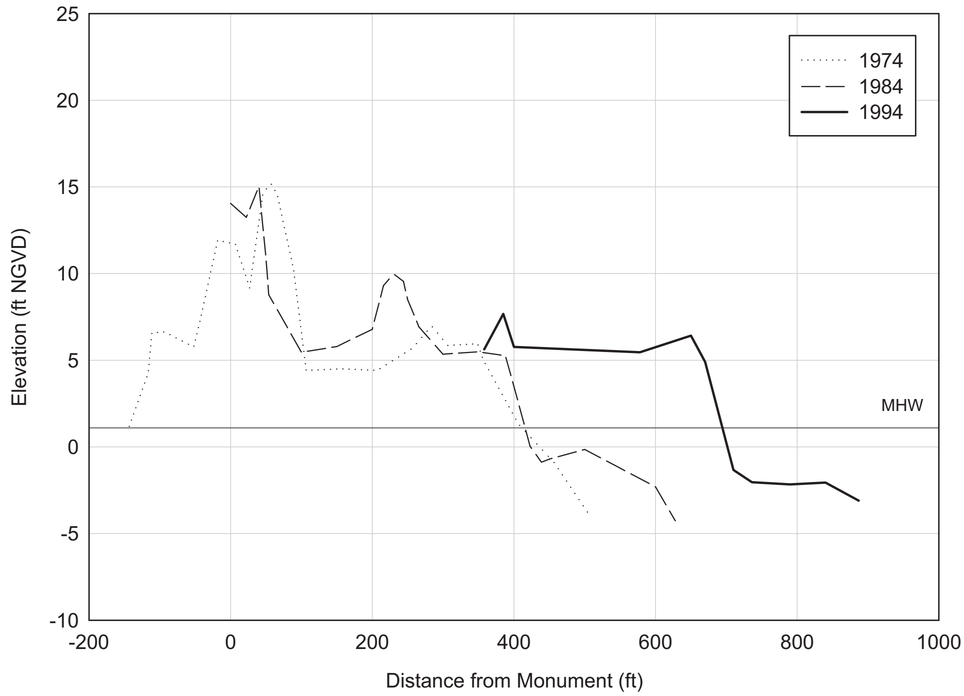
Escambia County
R-21



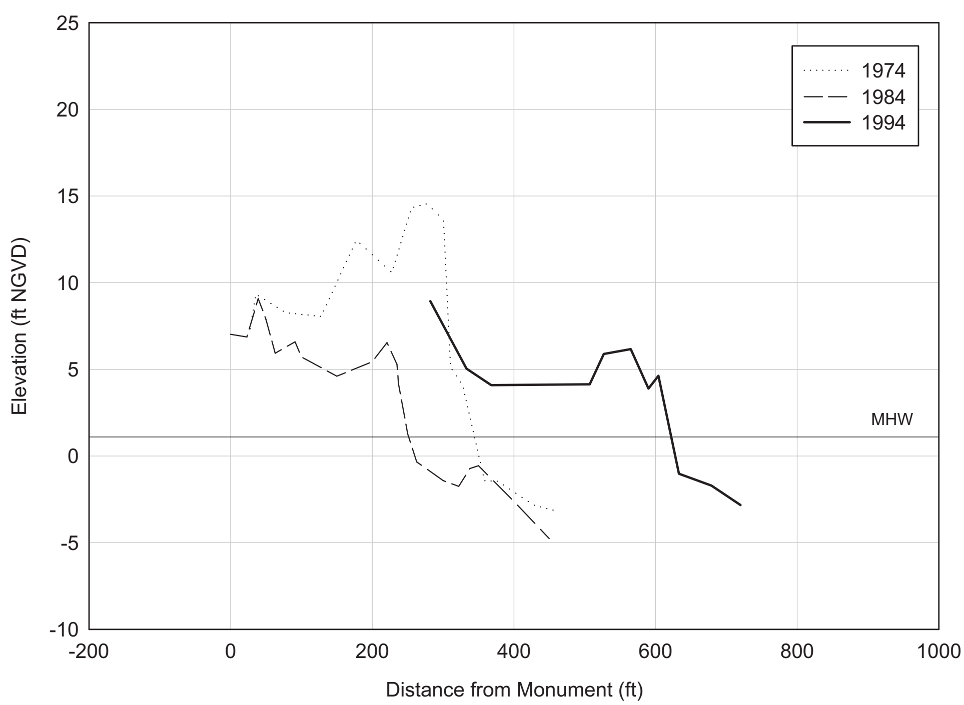
Escambia County
R-42



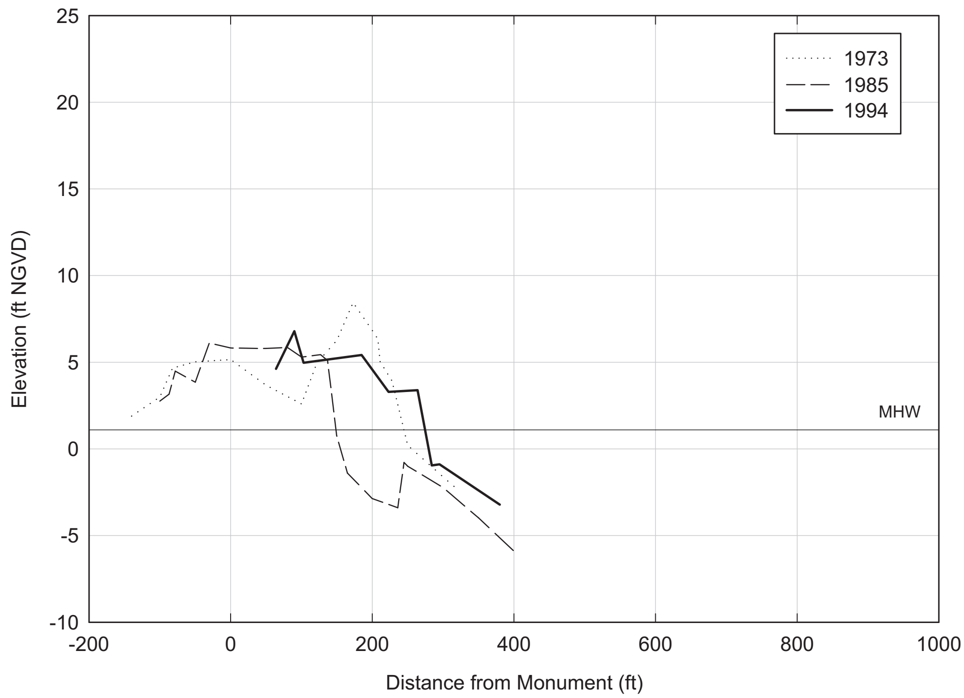
Escambia County
R-51



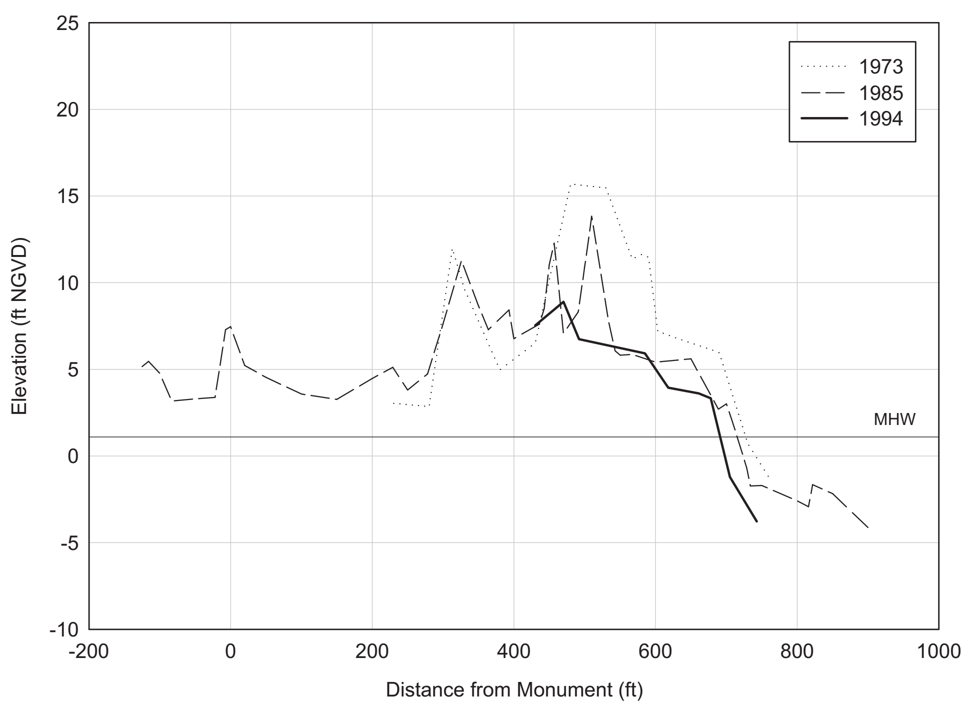
Escambia County
R-60



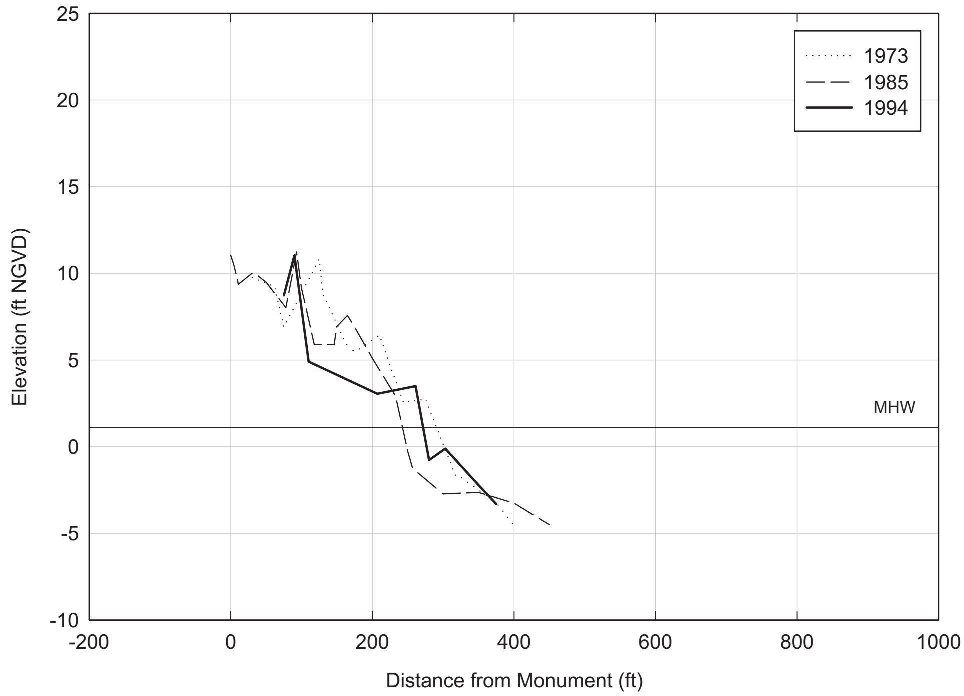
Escambia County
R-69



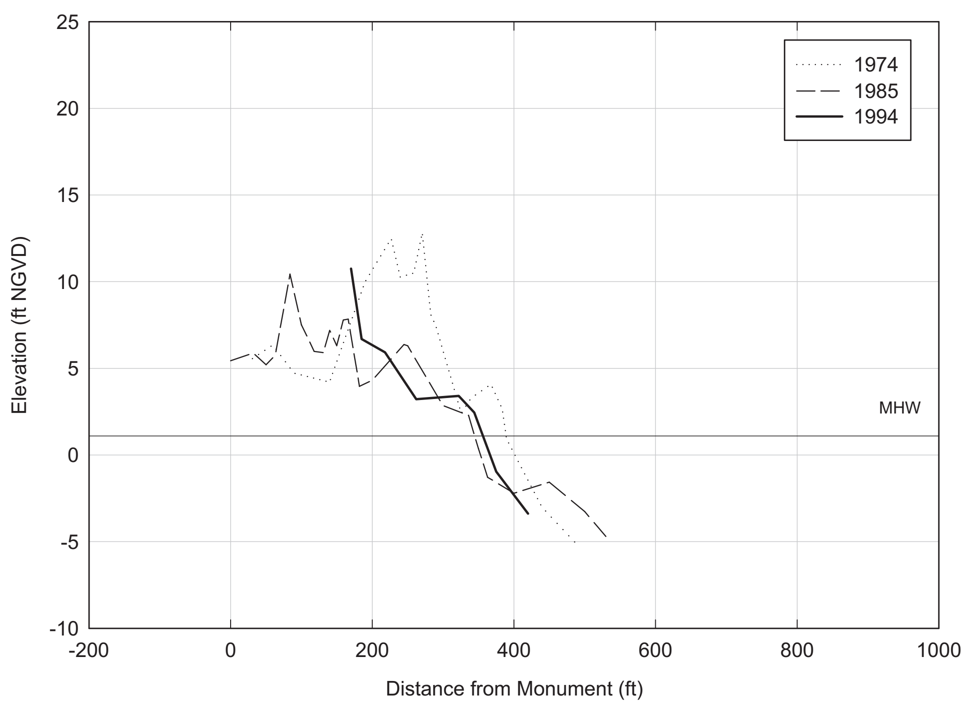
Escambia County
R-81



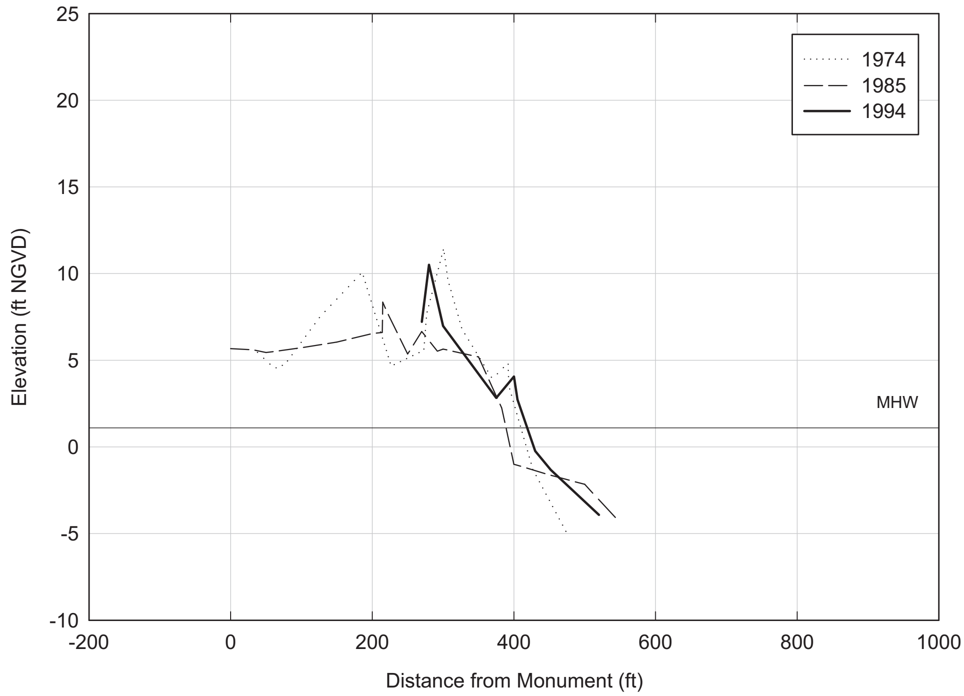
Escambia County
R-90



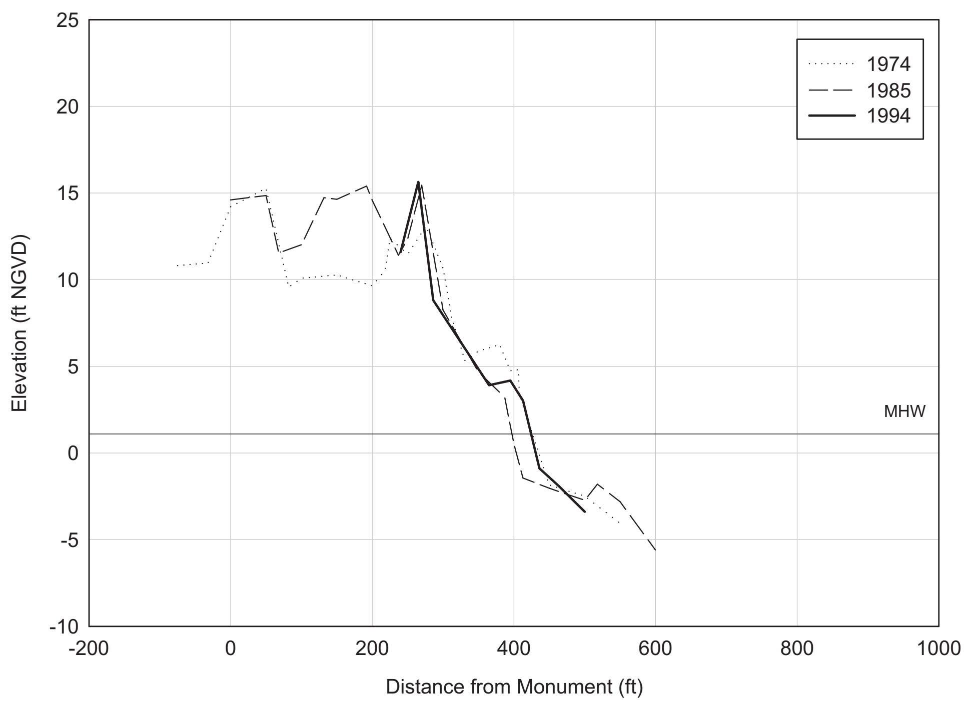
Escambia County
R-99



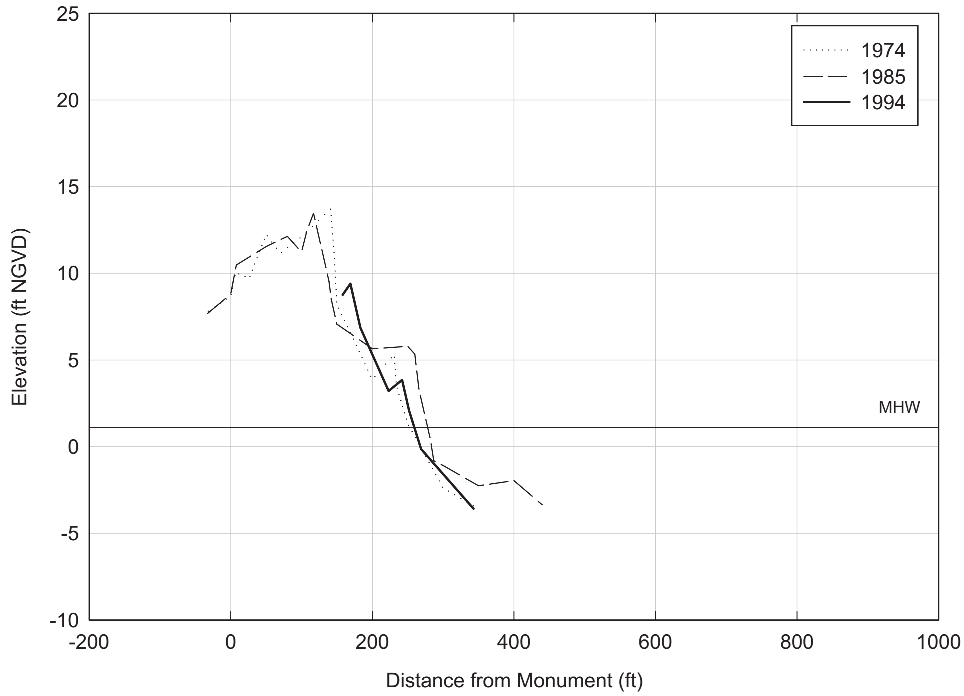
Escambia County
R-111



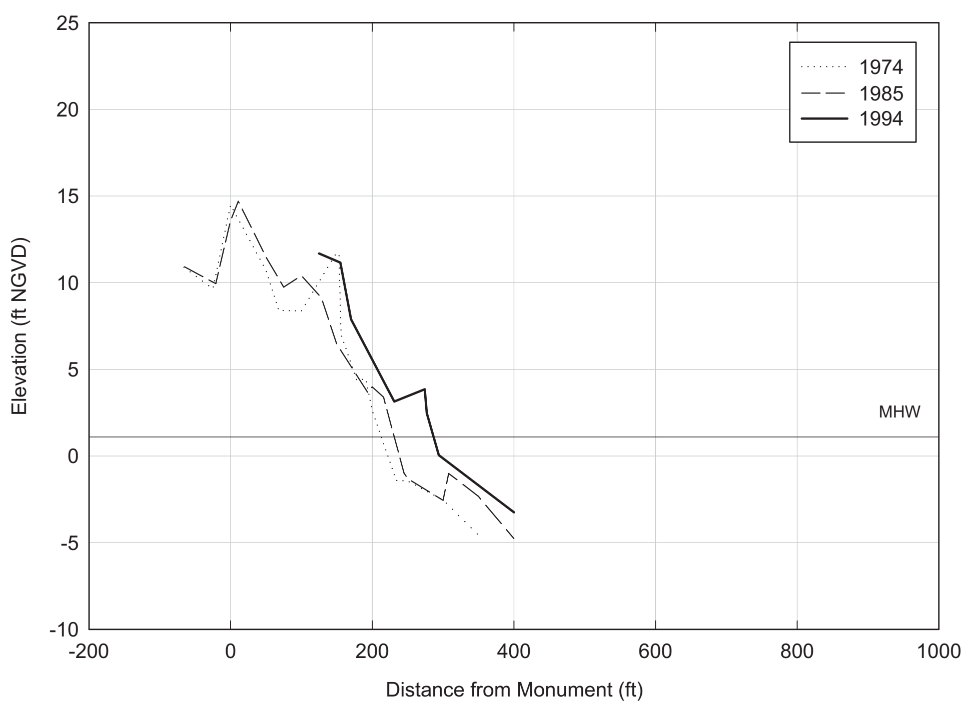
Escambia County
R-120



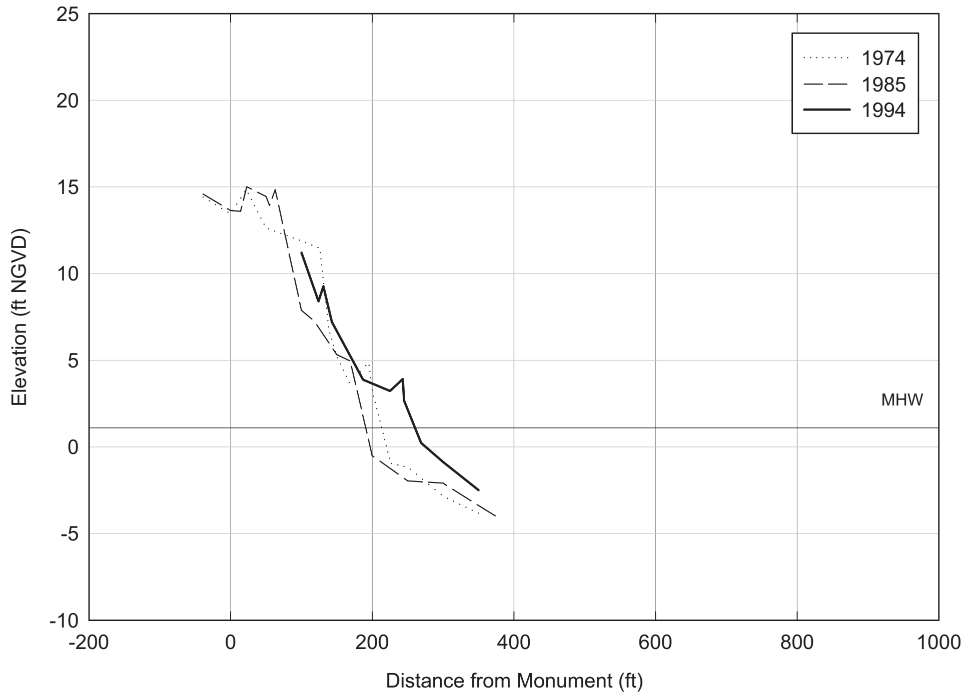
Escambia County
R-129



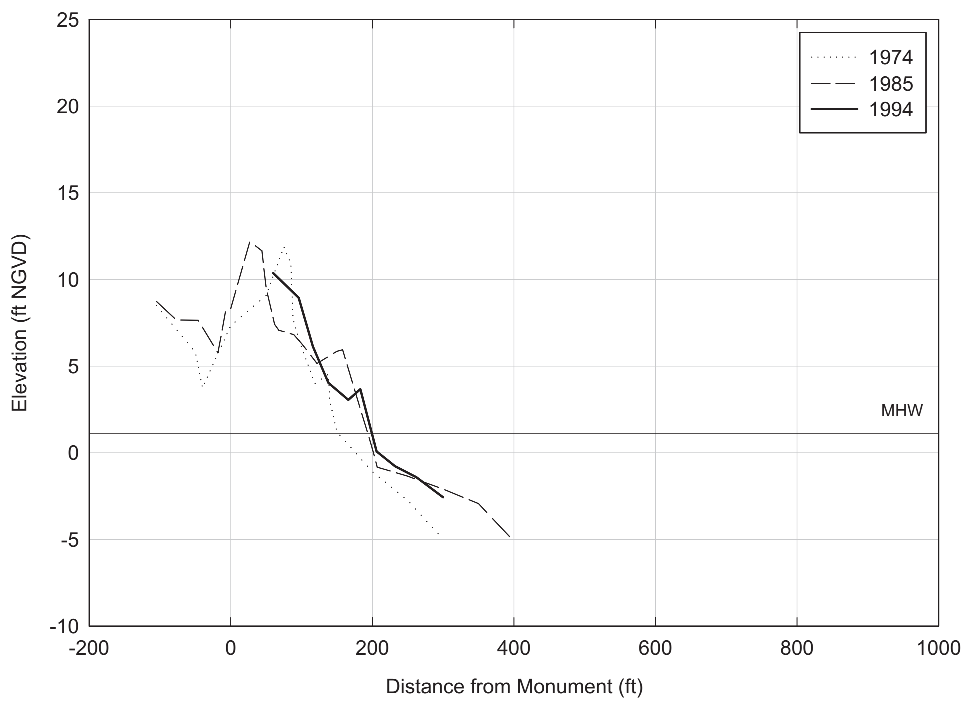
Escambia County
R-141



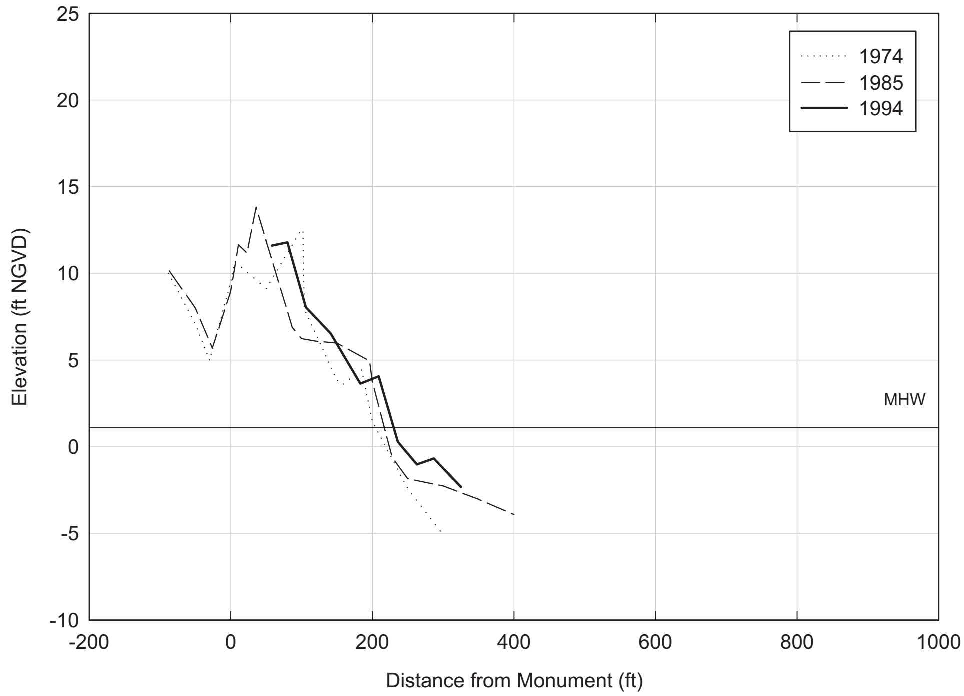
Escambia County
R-150



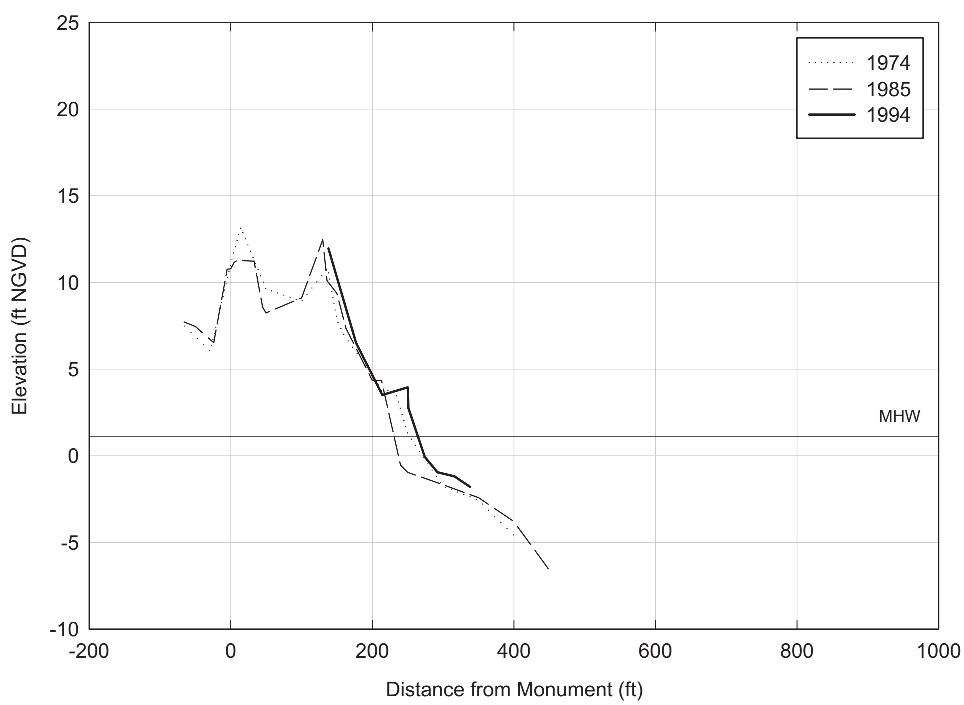
Escambia County
R-159



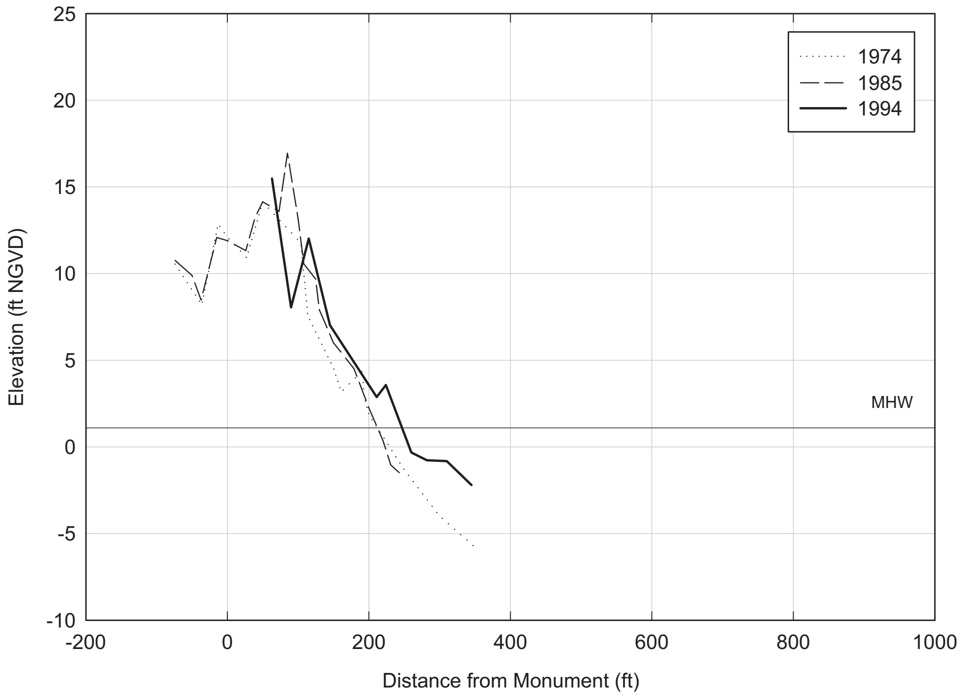
Escambia County
R-171



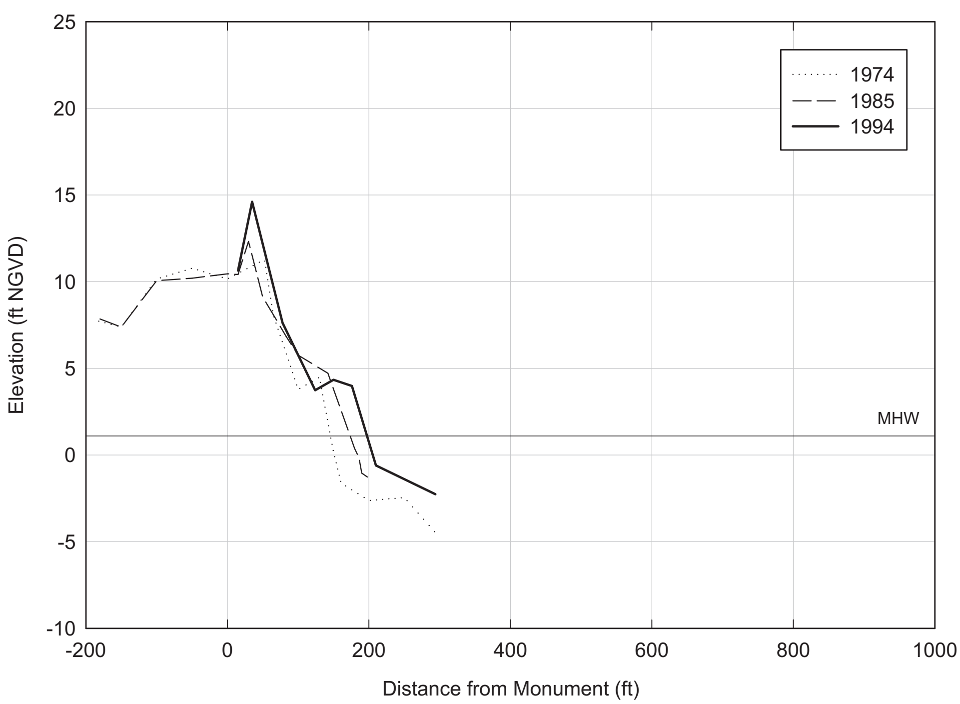
Escambia County
R-180



Escambia County
R-189



Escambia County
R-201



Escambia County
R-210