Shoreline Change Rate Estimates

Walton County

April 2000

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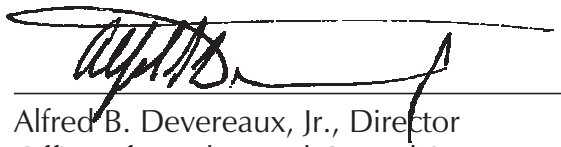
FOREWORD

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



Alfred B. Devereaux, Jr., Director
Office of Beaches and Coastal Systems

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1 EXECUTIVE SUMMARY

An analysis of the Walton County historic shoreline data shows a very mildly eroding shoreline, between +0.5 and -0.5 ft/yr throughout. It is conservatively recommended that a rate of -1.0 ft/yr be used county-wide for planning purposes.

A very low magnitude of shoreline change was found regardless of the time period selected or the impacts of storms, especially Hurricane Opal, during the 1990s. It was necessary to use the longest time periods where data was available in order to obtain negative shoreline changes. Shorter term data tends to show beach width fluctuations both positive and negative, which may be misleading.

The future for Walton County appears favorable in that no major shoreline orientation adjustments appear likely and adequate sand supply continuation is likely to continue from the Panama City Renourishment Project to the east. The main concern, with regards to erosion, remains the instability of the bluff escarpment during storms in those places where buildings are sited close to the edge of the bluff.

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 Historic 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, unsuccessful 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

Walton County is located in the Panhandle of west Florida (Figure 1), approximately 70 miles (113 km) east of the Alabama-Florida state line. The length of the ocean shoreline is a little over 25 miles (40 km). There are no inlets or natural embayments in this county. However, a number of seasonal fresh-water lake outlets cut across the dunes in several areas.

There are both dune and bluff areas. High elevations along the coast range from 15 to 40 ft NGVD. In some of the areas, notably in the vicinity of R-90 to R-91 and R-112 to R-114, peat deposits have been observed by one of the authors (Foster) within the bluff and on the beach after being temporarily uncovered by Hurricane Opal in 1995. DEP post-Opal (10/1995) aerial photography suggests there are likely several other areas with shallow peat deposits. Such deposits are probably helpful in absorbing wave energy during storms, and may have subtle influences on the shoreline configuration.

There are 127 sequentially numbered DEP survey reference points, generally referred to as "R" monuments, spaced approximately 1,000 ft (300 m) apart. This report uses these reference points to locate various items within the study area.

The level of development is moderate but increasing rapidly. Much of the development has occurred within the last 15 years. The primary state park parcels are Topsail Beach (R-24 to R-40), Grayton Beach (R-73 to R-78), and Deer Lake (R-99 to R-104). This coast is known for its emerald green water color and white sand beaches.

3.2 Coastal Setting

3.2.1 Waves and Tides

Tides for Panama City, the nearest oceanside tidal station located 10 miles (16 km) east of Walton County, are predominantly diurnal with a mean tidal range of 1.3 ft (0.38 m) and a spring tidal range of 1.4 ft (0.42 m) (NOS, 1988).

According to the Wave Information Study (WIS) of the Waterways Experiment Station, U.S. Army Corps of Engineers, the mean significant wave height for offshore

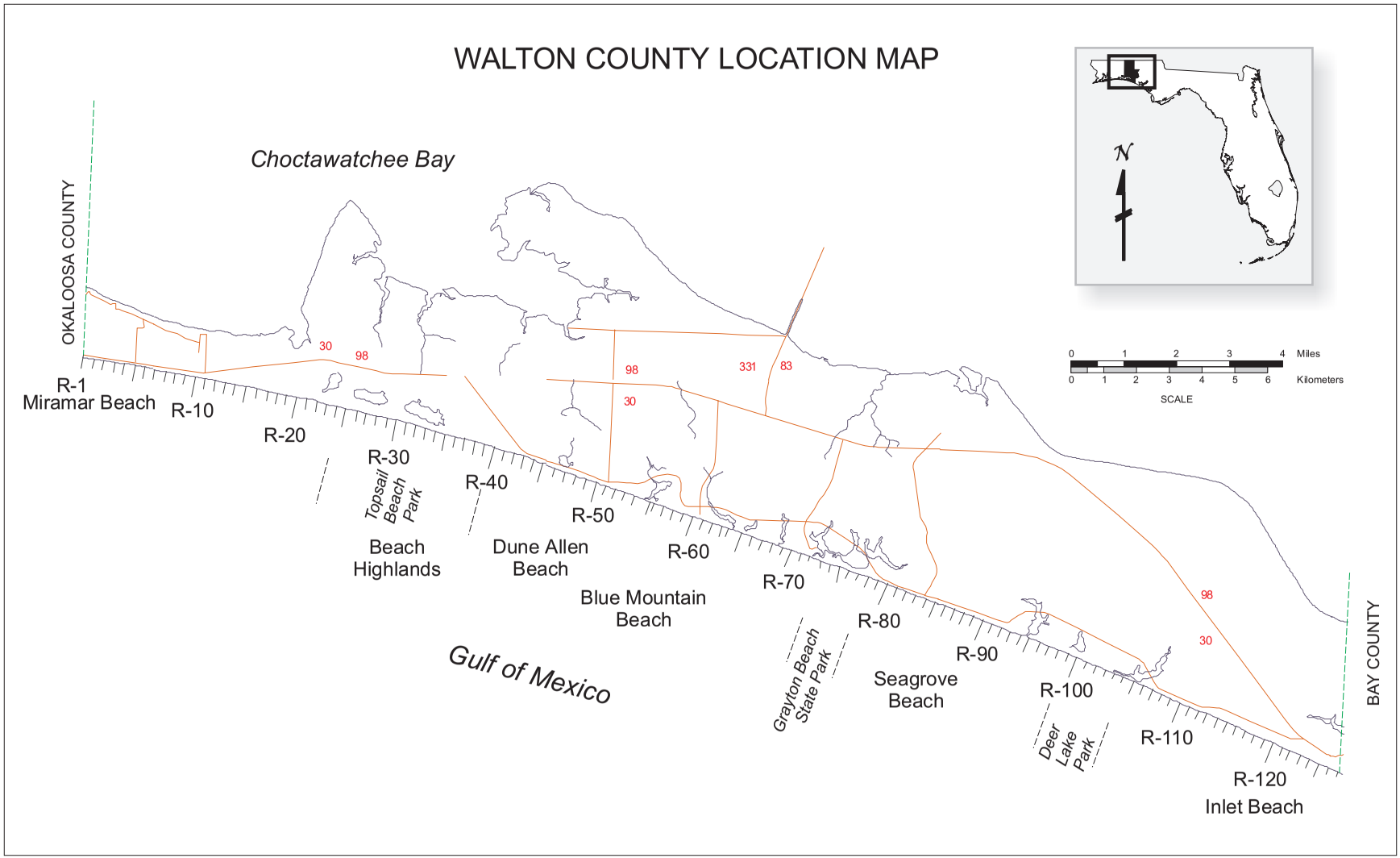

Figure 1. Study area showing Walton County, Florida.

Walton County (WIS station G1030, 57m depth) is 2.6 ft (0.8 m) and the mean wave period is 5.1 seconds. The most frequent wave direction is out of the south-southeast.

3.2.2 Longshore Transport

Net longshore transport is to the west, based on the observations that erosion occurs on the west side of St. Andrew Bay Entrance in adjacent Bay County to the east, and accretion occurs on the east side of East Pass in adjacent Okaloosa County to the west. Quantitative estimates for Walton County have not been located in a literature search. Presumably, however, the rate is between 270,000 and 110,000 yd^3/yr, which represent rates of longshore sediment transport at East Pass and St. Andrew Bay Entrance, respectively (Dean and O'Brien, 1987).

3.2.3 Storms

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. There are no obvious indications of major storms permanently changing the MHW shoreline erosion pattern in Walton County to date. The regional effects of recent hurricanes have been discussed by several authors including Dean and Sutor (1998, 1999), Jones et al. (1999), Leadon (1999), and Leadon et al. (1998).

3.3 Engineering Projects

There have been neither any significant nourishment projects nor coastal armoring placed in Walton County. In addition, there is no conclusive geomorphic evidence to suggest that there are any significant nearshore hardbottom features. As noted previously, there are at least two beach areas having significant peat deposits, and probably several more.

Immediately following Hurricane Opal in 1995, beach scraping, performed by Walton County authorities and private individuals, occurred throughout most of the developed areas of Walton County. It is not yet clear what effect the scraping may have had on the MHW shoreline (Jones et al., 1999; Dean and Sutor, 1998).

Certainly, the 1998/1999 Bay County nourishment project, along 17 miles of adjacent beach to the east, will supply sand to Walton County. However, the magnitude and extent of any positive effects are uncertain at this time.

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).

5 SHORELINE CHANGE

Comparative rates have been calculated for the 1872 to 1995 (pre-Hurricane Opal) and 1872 to 1997/98 time periods. The November 1998 survey data is post-Hurricane Georges. The rate calculation results are listed in Table A-1 (Appendix A) and are shown graphically in Figure 2. There is little difference between the two selected time periods, both showing the same general erosion pattern. In general, the latter period (1872 to 1997/98) yields slightly more erosive estimates, possibly due to the effects of Hurricanes Opal (10/1995) and Georges (09/1998). Still, all rate estimates fall within the range of +0.5 to -0.5 ft/yr.

A plan view comparison of the MHW shorelines of recent surveys in 1972, 1981, 1995, and 1998 is shown in Figures 3, 4, and 5. The later two figures show the same information as Figure 3 but at a greater magnification for convienence of viewing. From the perspective of Figure 3, it can be seen that, although exaggerated by scale, Walton County's shoreline is not straight, but curved. In addition, there is a minor headland feature that exists between R-50 and R-70, near the center of the county, which is coincident with the highest upland ground elevations in the county at Blue Mountain Beach. Regarding shoreline change comparisons, it appears that significant fluctuations in shoreline width occur, but the net changes overall are minimal, as suggested by the rate estimates. A comparison of the most seaward shoreline, the 1995 pre-Opal shoreline, is made with the earliest shoreline in the historic record, 1872, in Figure 6. This shows their similarity and reflects the net changes indicated in Figure 2 and Table A-1.

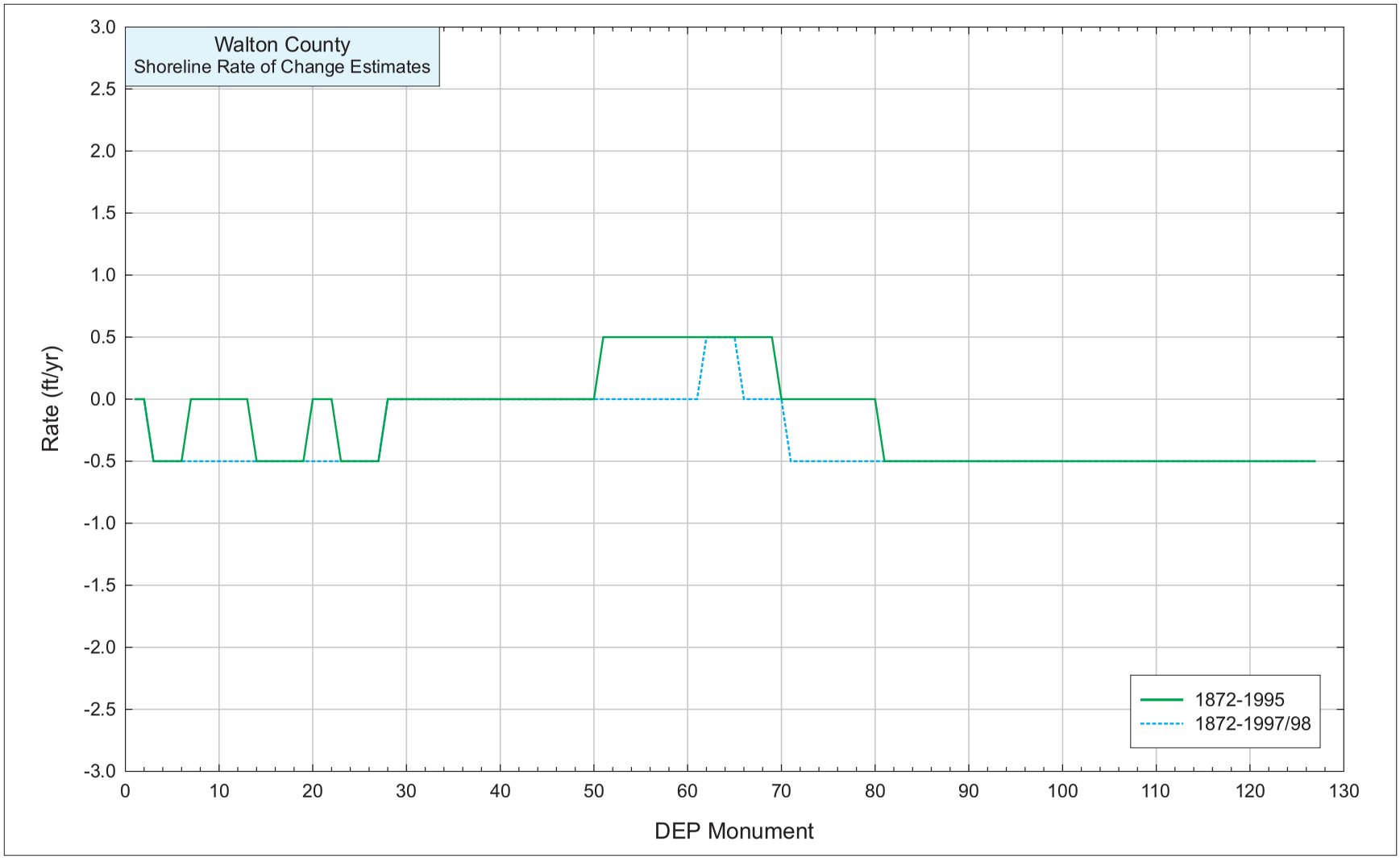

Figure 2. Shoreline rate of change estimates for Walton County, Florida.

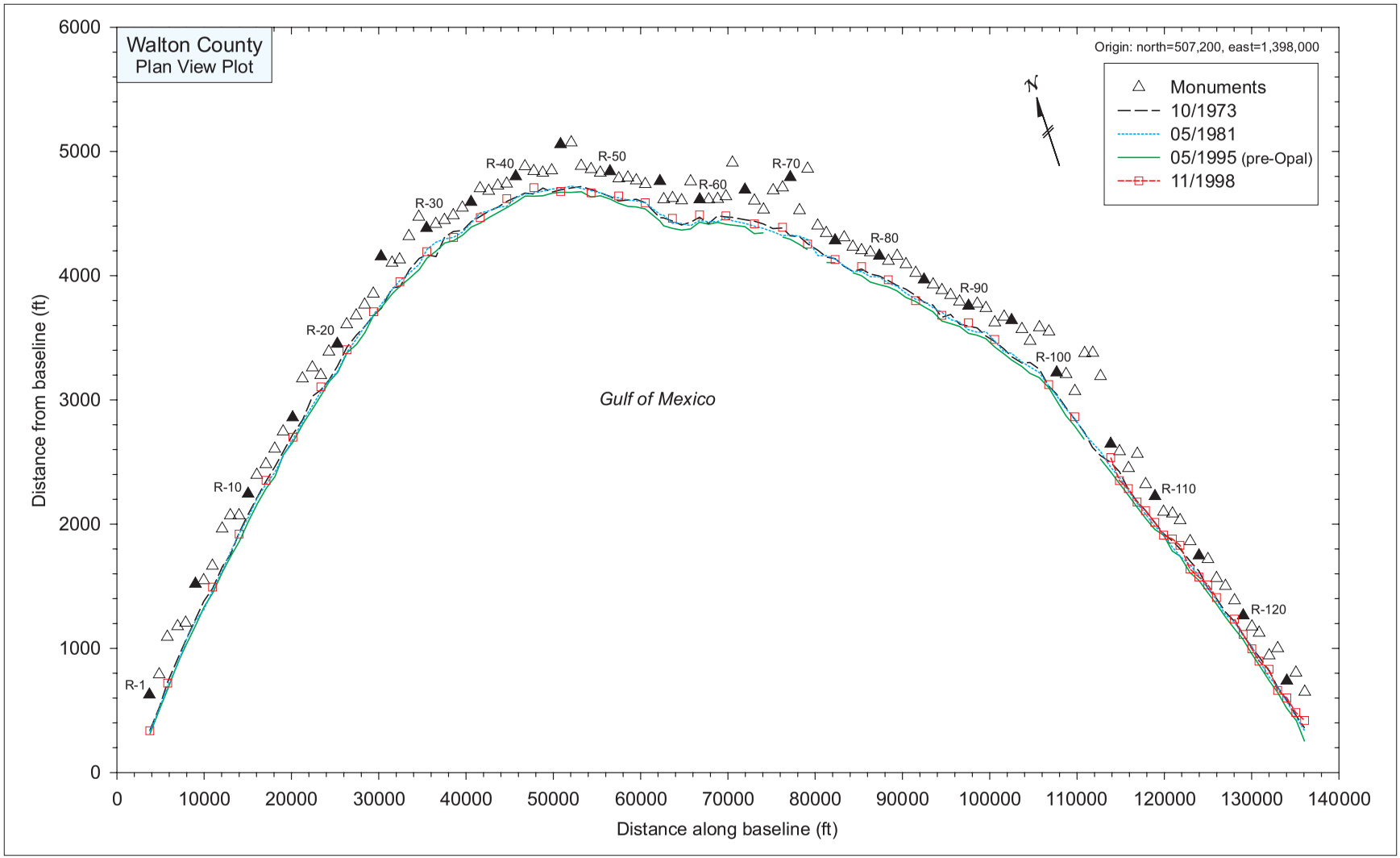

Figure 3. Plan view map of Walton County, Florida, comparing shorelines from 1973, 1981, 1995 (pre-Opal), and 1998.

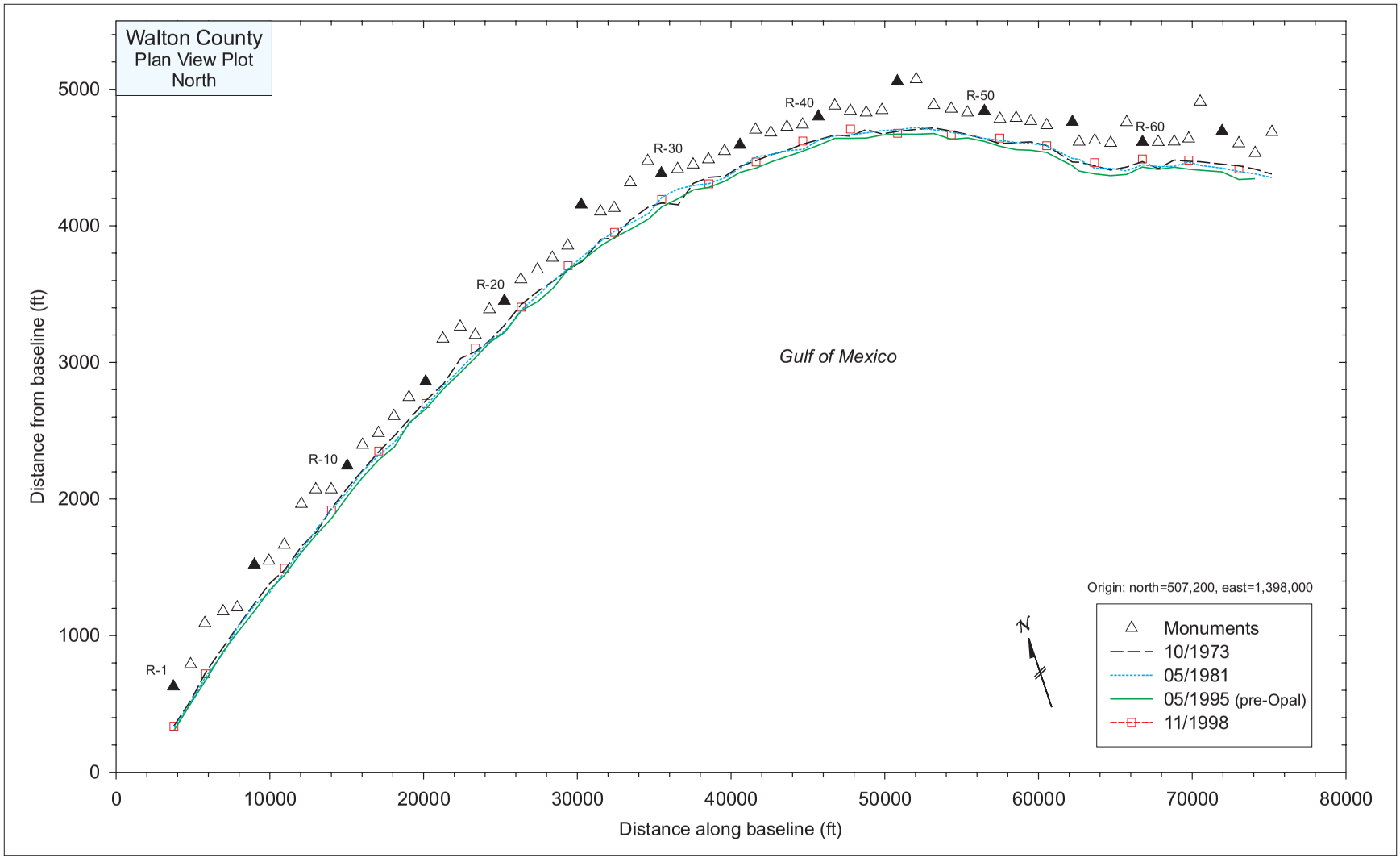

Figure 4. Plan view map of Walton County, Florida, west, comparing shorelines from 1973, 1981, 1995 (pre-Opal), and 1998.

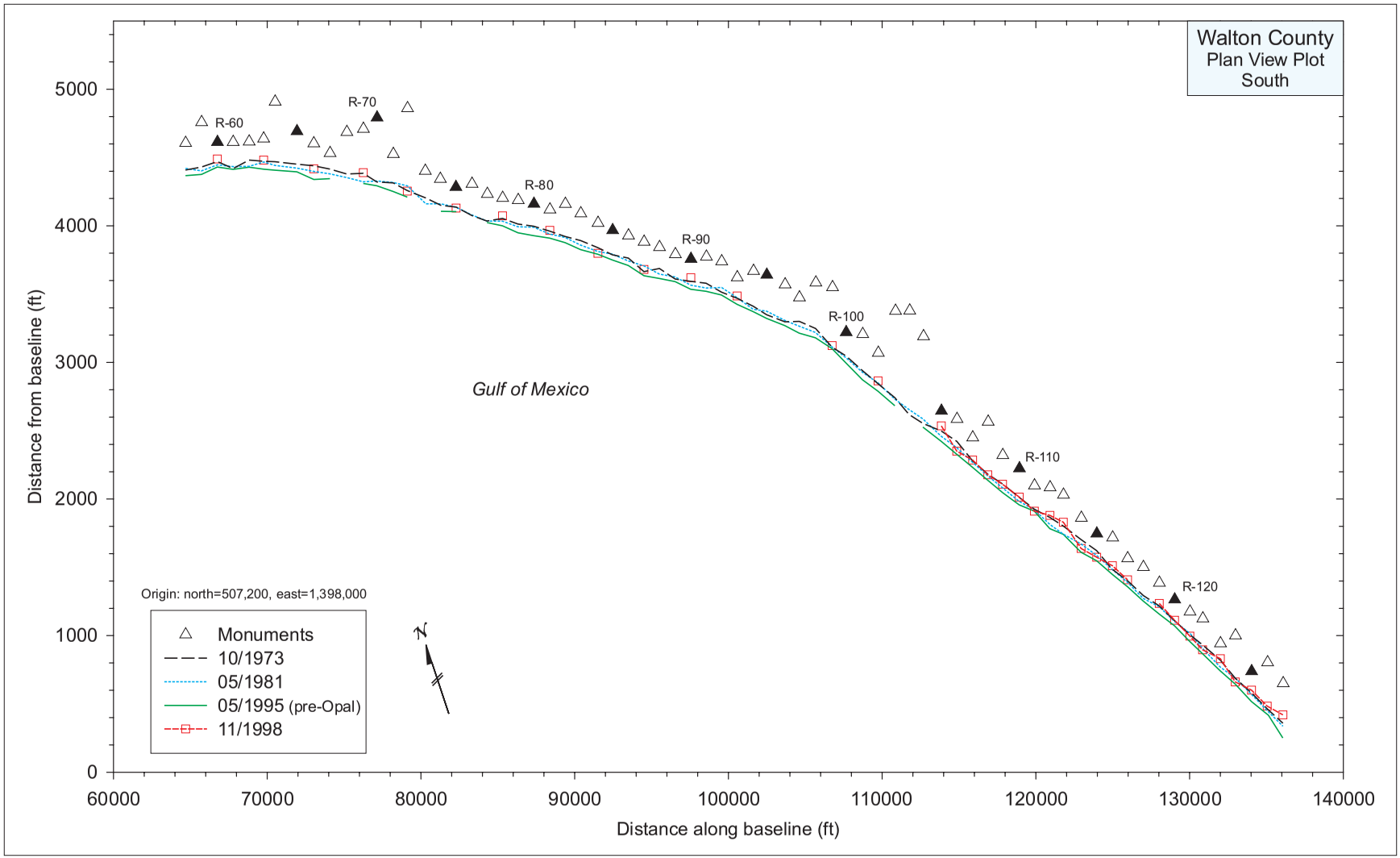

Figure 5. Plan view map of Walton County, Florida, east, comparing shorelines from 1973, 1981, 1995 (pre-Opal), and 1998.

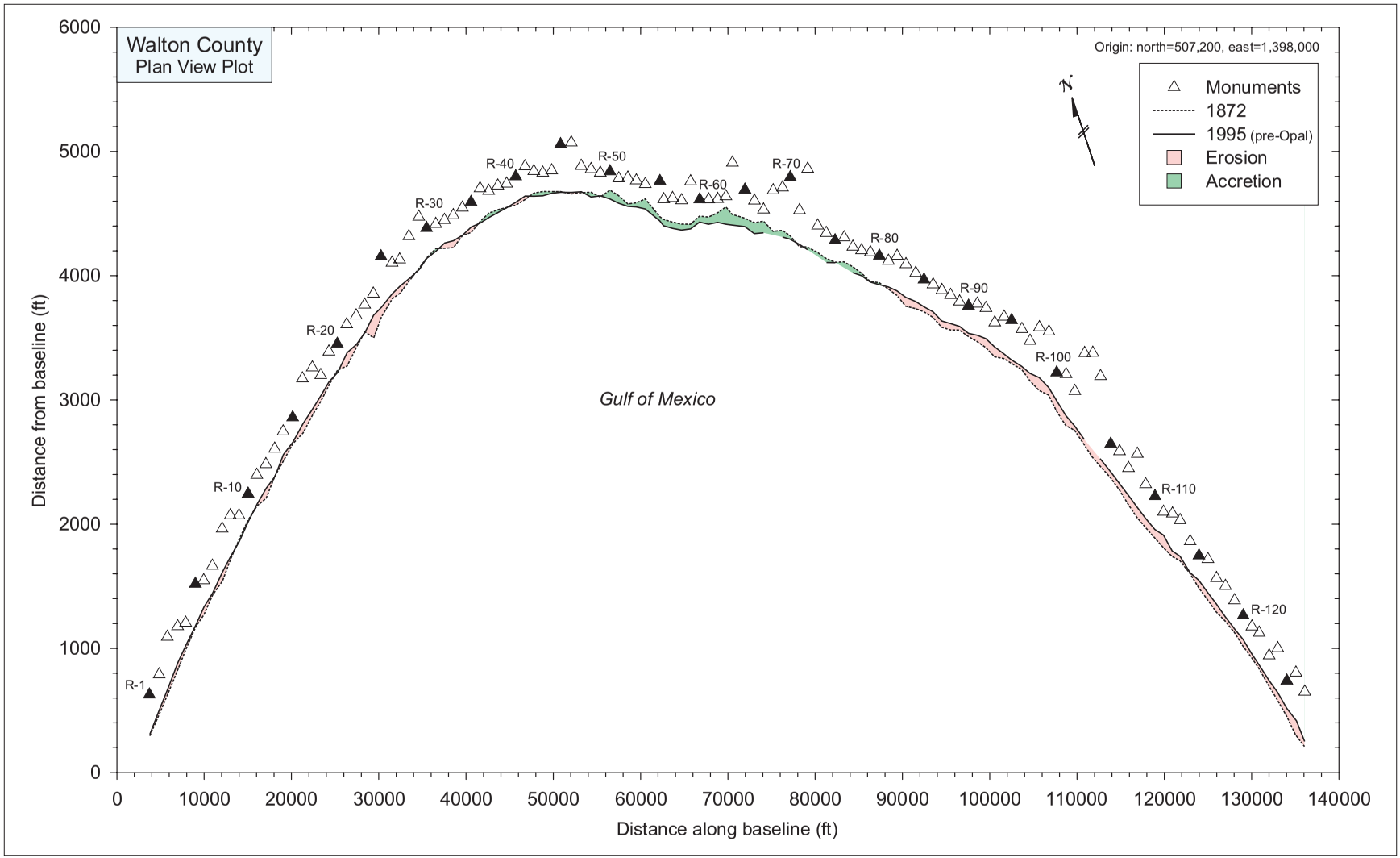

Figure 6. Plan view map of Walton County, Florida, comparing shorelines from 1872 and 1995 (pre-Opal).

6 SUMMARY

Review and analysis of the available survey data record indicates that survey data comparisons most appropriate for shoreline erosion rate estimates are the 1872 to 1995 (pre-Opal) and 1872 to 1997/98 time periods. Both time periods show virtually identical patterns of erosion with rate estimates falling within the range of +0.5 and -0.5 ft/yr. Therefore, for any future planning purposes, a conservative erosion rate estimate of -1 ft/yr should be used county-wide.

A low magnitude of shoreline change was found irrespective of the time period selected and of major storms, such as Hurricane Opal in 1995. This is believed to be due to a shoreline orientation that is well adapted to the prevailing wave climate and and relatively abundant sand supply, as well as a lack of significant tidal inlets near the county. The future sand supply should be adequate due to the large renourishment project in Bay County to the east. Probably the main concern from an erosion standpoint in this county is the fact that the primary bluff or dune face is vulnerable to recession during major storm events, threatening buildings that may be sited too close to the edge or with inadequate foundations.

7 REFERENCES

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8 APPENDICES

8.1 Appendix A: Shoreline Change Rate Estimates

Table A-1: This table and accompanying figure provide rates based on the method described in Section 4.

Table A-1. Shoreline change rate estimates for Walton County, Florida.

Range	Method	Original Rate Estimates (ft/yr)		Concensus Rate (ft/yr), 1872 to 1997/98	Comments
		1872 to 1995 (pre-Opal)	1872 to 1997/98		
1	RA	0.2	-0.1	0.0	no average
	LS	0.0	0.2		
	EP	-0.3	-0.1		
2	RA	-0.4	-0.3	0.0	3 pt average
	LS	-0.4	-0.3		
	EP	-0.5	-0.3		
3	RA	0.3	-0.5	-0.5	5 pt average
	LS	-0.3	-0.2		
	EP	-0.7	-0.4		
3	RA	0.2	-0.5	-0.5	7 pt average ↓
	LS	-0.4	-0.4		
	EP	-0.7	-0.4		
4	RA	-0.5	-0.3	-0.5	
	LS	-0.4	-0.3		
	EP	-0.5	-0.3		
5	RA	-0.3	-0.1	-0.5	
	LS	-0.3	-0.3		
	EP	-0.6	-0.1		
6	RA	-0.4	-0.4	-0.5	
	LS	-0.2	-0.1		
	EP	-0.3	-0.5		
6	RA	-0.4	-0.1	-0.5	
	LS	-0.3	-0.1		
	EP	-0.5	-0.1		
7	RA	-0.5	-0.7	-0.5	
	LS	-0.7	-0.7		
	EP	-0.6	-0.6		
8	RA	-0.5	-0.2	-0.5	
	LS	-0.4	-0.2		
	EP	-0.4	-0.2		
9	RA	-0.3	0.2	-0.5	
	LS	-0.2	-0.1		
	EP	-0.3	0.2		
10	RA	-0.2	0.1	-0.5	
	LS	0.0	0.1		
	EP	-0.2	0.1		
11	RA	-0.5	-0.1	-0.5	
	LS	-0.4	-0.3		
	EP	-0.5	-0.1		
12	RA	0.0	-0.1	-0.5	
	LS	-0.6	-0.5		
	EP	-1.1	-0.6		
13	RA	-0.2	0.0	-0.5	

Table A-1. Shoreline change rate estimates for Walton County, Florida.

Range	Method	Original Rate Estimates (ft/yr)		Concensus Rate (ft/yr), 1872 to 1997/98	Comments
		1872 to 1995 (pre-Opal)	1872 to 1997/98		
	LS	-0.3	-0.2		
	EP	-0.6	0.0		
14	RA	-0.2	-0.4	-0.5	
	LS	-0.1	-0.1		
	EP	-0.2	-0.4		
15	RA	-0.4	-0.1	-0.5	
	LS	-0.4	-0.2		
	EP	-0.4	-0.1		
16	RA	-0.8	-0.6	-0.5	
	LS	-0.7	-0.7		
	EP	-0.4	-0.6		
17	RA	-0.1	-0.9	-0.5	
	LS	-0.8	-0.7		
	EP	-0.8	-0.4		
18	RA	-0.7	-0.5	-0.5	
	LS	-0.5	-0.3		
	EP	-0.9	-0.4		
19	RA	-0.3	-0.2	-0.5	
	LS	-0.3	-0.2		
	EP	-0.3	-0.2		
20	RA	0.0	0.2	-0.5	
	LS	0.1	0.2		
	EP	0.0	0.2		
21	RA	0.0	0.5	-0.5	
	LS	-0.5	-0.4		
	EP	-1.0	-0.9		
22	RA	-0.5	-0.2	-0.5	
	LS	-0.3	-0.3		
	EP	-0.3	-0.2		
23	RA	-0.3	0.1	-0.5	
	LS	0.0	0.1		
	EP	-0.4	0.1		
24	RA	0.1	0.4	-0.5	
	LS	-0.9	-0.9		
	EP	-1.7	-1.5		
25	RA	-0.6	-0.6	-0.5	
	LS	-0.6	-0.5		
	EP	-0.9	-0.6		
26	RA	-0.2	-0.6	-0.5	
	LS	-0.2	-0.4		
	EP	-0.2	-0.3		
27	RA	0.4	-0.6	-0.5	
	LS	-0.2	-0.2		

Table A-1. Shoreline change rate estimates for Walton County, Florida.

Range	Method	Original Rate Estimates (ft/yr)		Concensus Rate (ft/yr), 1872 to 1997/98	Comments
		1872 to 1995 (pre-Opal)	1872 to 1997/98		
	EP	-0.7	-0.5		
28	RA	0.4	-0.2	0.0	
	LS	-0.1	-0.2		
	EP	-0.6	-0.2		
29	RA	0.1	0.1	0.0	
	LS	0.0	0.1		
	EP	-0.6	0.1		
30	RA	-0.2	0.0	0.0	
	LS	-0.1	0.0		
	EP	-0.4	0.0		
31	RA	-0.1	0.2	0.0	
	LS	0.1	0.3		
	EP	-0.1	0.2		
32	RA	-0.2	-0.6	0.0	
	LS	-0.3	-0.4		
	EP	-0.5	-0.3		
33	RA	0.4	-0.6	0.0	
	LS	-0.2	-0.1		
	EP	-0.6	-0.4		
34	RA	-0.2	0.0	0.0	
	LS	0.1	0.1		
	EP	-0.2	0.0		
35	RA	0.2	-0.5	0.0	
	LS	-0.2	0.0		
	EP	-0.8	-0.4		
36	RA	-0.2	0.1	0.0	
	LS	0.2	0.1		
	EP	-0.2	0.1		
37	RA	-0.2	0.3	0.0	
	LS	0.2	0.2		
	EP	-0.2	0.3		
38	RA	-0.2	0.2	0.0	
	LS	-0.1	0.0		
	EP	-0.4	0.2		
39	RA	0.1	0.0	0.0	
	LS	0.0	0.2		
	EP	-0.6	0.0		
40	RA	-0.5	-0.2	0.0	
	LS	-0.3	-0.2		
	EP	-0.4	-0.2		
41	RA	0.0	-0.2	0.0	
	LS	0.0	-0.1		
	EP	0.0	-0.2		

Table A-1. Shoreline change rate estimates for Walton County, Florida.

Range	Method	Original Rate Estimates (ft/yr)		Concensus Rate (ft/yr), 1872 to 1997/98	Comments
		1872 to 1995 (pre-Opal)	1872 to 1997/98		
42	RA	0.0	0.2	0.0	
	LS	0.0	0.2		
	EP	-0.3	0.2		
43	RA	-0.1	0.3	0.0	
	LS	0.1	0.5		
	EP	-0.1	0.3		
44	RA	0.0	0.1	0.0	
	LS	0.0	0.2		
	EP	0.0	0.1		
45	RA	0.0	0.0	0.0	
	LS	-0.2	0.0		
	EP	0.0	0.0		
46	RA	-0.5	-0.1	0.0	
	LS	-0.4	-0.2		
	EP	-0.4	-0.1		
47	RA	-0.3	-0.1	0.0	
	LS	-0.1	0.0		
	EP	-0.3	-0.1		
48	RA	0.0	0.0	0.0	
	LS	0.0	0.2		
	EP	0.0	0.3		
49	RA	-0.2	-0.1	0.0	
	LS	0.0	0.2		
	EP	-0.2	-0.1		
50	RA	0.2	0.7	0.0	
	LS	0.6	0.7		
	EP	0.2	0.6		
51	RA	0.0	0.4	0.0	
	LS	0.3	0.6		
	EP	0.0	0.5		
52	RA	-0.1	0.2	0.0	
	LS	-0.2	-0.1		
	EP	-0.1	0.2		
53	RA	-0.2	0.3	0.0	
	LS	0.0	0.2		
	EP	-0.2	0.3		
54	RA	0.2	0.8	0.0	
	LS	0.5	0.6		
	EP	0.2	0.7		
55	RA	-0.2	0.3	0.0	
	LS	0.2	0.2		
	EP	-0.2	0.3		
56	RA	0.1	0.1	0.0	

Table A-1. Shoreline change rate estimates for Walton County, Florida.

Range	Method	Original Rate Estimates (ft/yr)		Concensus Rate (ft/yr), 1872 to 1997/98	Comments
		1872 to 1995 (pre-Opal)	1872 to 1997/98		
	LS	0.1	0.2		
	EP	0.1	0.4		
57	RA	-0.3	0.2	0.0	
	LS	0.2	0.3		
	EP	-0.3	0.4		
58	RA	0.0	0.1	0.0	
	LS	0.0	0.2		
	EP	-0.5	0.4		
59	RA	-0.1	0.2	0.0	
	LS	-0.1	0.2		
	EP	-0.1	0.3		
60	RA	-0.1	0.4	0.0	
	LS	0.2	0.3		
	EP	-0.1	0.4		
61	RA	0.1	0.4	0.0	
	LS	0.1	0.4		
	EP	0.5	0.5		
62	RA	0.6	0.5	0.5	
	LS	0.4	0.5		
	EP	0.7	0.6		
63	RA	0.3	0.9	0.5	
	LS	0.6	0.8		
	EP	0.6	1.1		
64	RA	0.4	0.7	0.5	
	LS	0.3	0.5		
	EP	0.5	0.7		
65	RA	0.5	0.4	0.5	
	LS	0.4	0.4		
	EP	0.6	0.6		
66	RA	0.1	1.1	0.0	
	LS	0.5	0.7		
	EP	0.1	0.7		
67	RA	0.5	0.8	0.0	
	LS	0.3	0.5		
	EP	0.3	0.8		
68	RA	-0.1	0.0	0.0	
	LS	-0.5	0.0		
	EP	-0.1	0.0		
69	RA	-0.2	0.3	0.0	
	LS	0.1	0.2		
	EP	-0.2	0.4		
70	RA	0.0	0.2	0.0	
	LS	-0.3	-0.1		

Table A-1. Shoreline change rate estimates for Walton County, Florida.

Range	Method	Original Rate Estimates (ft/yr)		Concensus Rate (ft/yr), 1872 to 1997/98	Comments
		1872 to 1995 (pre-Opal)	1872 to 1997/98		
	EP	-0.4	0.2		
71	RA	-0.7	-0.1	-0.5	
	LS	-0.8	-0.6		
	EP	-0.7	-0.1		
72	RA	-0.2	0.2	-0.5	
	LS	-0.2	-0.1		
	EP	-0.2	0.2		
73	RA	-0.1	0.2	-0.5	
	LS	-0.3	-0.1		
	EP	-0.4	0.2		
74	RA	-0.7	0.3	-0.5	
	LS	-0.5	-0.1		
	EP	-0.7	0.3		
75	RA	-0.2	0.0	-0.5	
	LS	-0.3	-0.1		
	EP	-0.2	0.0		
76	RA	0.1	0.3	-0.5	
	LS	-0.2	0.0		
	EP	-0.4	0.3		
77	RA	0.1	0.5	-0.5	
	LS	0.0	0.2		
	EP	-0.3	0.4		
78	RA	-0.1	0.2	-0.5	
	LS	0.0	0.1		
	EP	-0.4	0.2		
79	RA	-0.6	0.0	-0.5	
	LS	-0.4	-0.3		
	EP	-0.8	0.0		
80	RA	-0.1	0.1	-0.5	
	LS	-0.1	-0.2		
	EP	-0.1	0.1		
81	RA	-0.4	-0.1	-0.5	
	LS	-0.4	-0.2		
	EP	-0.6	-0.1		
82	RA	-0.5	-0.5	-0.5	
	LS	-0.6	-0.6		
	EP	-0.3	-0.3		
83	RA	-0.5	-1.0	-0.5	
	LS	-1.0	-0.9		
	EP	-1.0	-0.6		
84	RA	-0.5	-0.7	-0.5	
	LS	-0.4	-0.5		
	EP	-0.5	-0.5		

Table A-1. Shoreline change rate estimates for Walton County, Florida.

Range	Method	Original Rate Estimates (ft/yr)		Concensus Rate (ft/yr), 1872 to 1997/98	Comments
		1872 to 1995 (pre-Opal)	1872 to 1997/98		
85	RA	-0.4	-0.7	-0.5	
	LS	-0.5	-0.5		
	EP	-0.6	-0.3		
86	RA	-0.1	-0.6	-0.5	
	LS	-0.4	-0.5		
	EP	-0.6	-0.4		
87	RA	-0.3	-0.7	-0.5	
	LS	-0.5	-0.4		
	EP	-0.8	-0.4		
88	RA	-0.2	-0.8	-0.5	
	LS	-0.5	-0.5		
	EP	-0.6	-0.4		
89	RA	-0.4	-0.2	-0.5	
	LS	0.0	-0.1		
	EP	-0.3	-0.2		
90	RA	0.4	-0.2	-0.5	
	LS	-0.1	-0.1		
	EP	-0.9	-0.2		
91	RA	0.4	-0.8	-0.5	
	LS	-0.4	-0.4		
	EP	-0.8	-0.4		
92	RA	-0.8	-0.6	-0.5	
	LS	-0.4	-0.6		
	EP	-0.3	-0.6		
93	RA	-0.1	0.1	-0.5	
	LS	-0.6	-0.4		
	EP	-1.1	-0.6		
94	RA	-0.1	-0.5	-0.5	
	LS	-0.4	-0.3		
	EP	-0.9	-0.3		
95	RA	0.5	-0.2	-0.5	
	LS	0.1	0.1		
	EP	-0.7	-0.2		
96	RA	-0.5	-0.2	-0.5	
	LS	-0.3	-0.2		
	EP	-0.5	-0.2		
97	RA	0.2	-1.1	-0.5	
	LS	-0.6	-0.6		
	EP	-1.3	-0.5		
98	RA	0.0	-0.4	-0.5	
	LS	-1.0	-0.9		
	EP	-1.5	-0.9		
99	RA	0.4	-0.8	-0.5	

Table A-1. Shoreline change rate estimates for Walton County, Florida.

Range	Method	Original Rate Estimates (ft/yr)		Concensus Rate (ft/yr), 1872 to 1997/98	Comments
		1872 to 1995 (pre-Opal)	1872 to 1997/98		
	LS	-0.1	-0.2		
	EP	-0.7	-0.5		
100	RA	0.3	0.0	-0.5	
	LS	-0.4	-0.6		
	EP	-0.8	-0.7		
101	RA	0.0	-0.3	-0.5	
	LS	-0.7	-0.8		
	EP	-1.3	-0.7		
102	RA	0.5	-0.4	-0.5	
	LS	-0.2	-0.3		
	EP	-0.9	-0.3		
103	RA	0.2	-0.8	-0.5	
	LS	-0.4	-0.4		
	EP	-0.9	-0.4		
103	RA	-0.4	-0.2	-0.5	
	LS	-0.7	-0.9		
	EP	-1.1	-1.1		
104	RA	0.1	-1.0	-0.5	
	LS	-0.5	-0.7		
	EP	-1.0	-0.5		
105	RA	0.1	-0.8	-0.5	
	LS	-0.5	-0.4		
	EP	-1.3	-0.4		
106	RA	-0.1	-1.0	-0.5	
	LS	-0.5	-0.6		
	EP	-0.6	-0.4		
107	RA	-0.3	-0.8	-0.5	
	LS	-0.7	-0.8		
	EP	-1.0	-0.6		
108	RA	0.1	0.1	-0.5	
	LS	-0.6	-0.5		
	EP	-1.0	-0.7		
109	RA	-0.2	-0.7	-0.5	
	LS	-0.7	-0.7		
	EP	-1.1	-0.6		
110	RA	0.0	-0.1	-0.5	
	LS	-0.5	-0.6		
	EP	-1.0	-1.1		
111	RA	-0.2	0.3	-0.5	
	LS	-0.4	-0.3		
	EP	-0.8	-0.8		
112	RA	-0.6	-0.7	-0.5	
	LS	-0.6	-0.5		

Table A-1. Shoreline change rate estimates for Walton County, Florida.

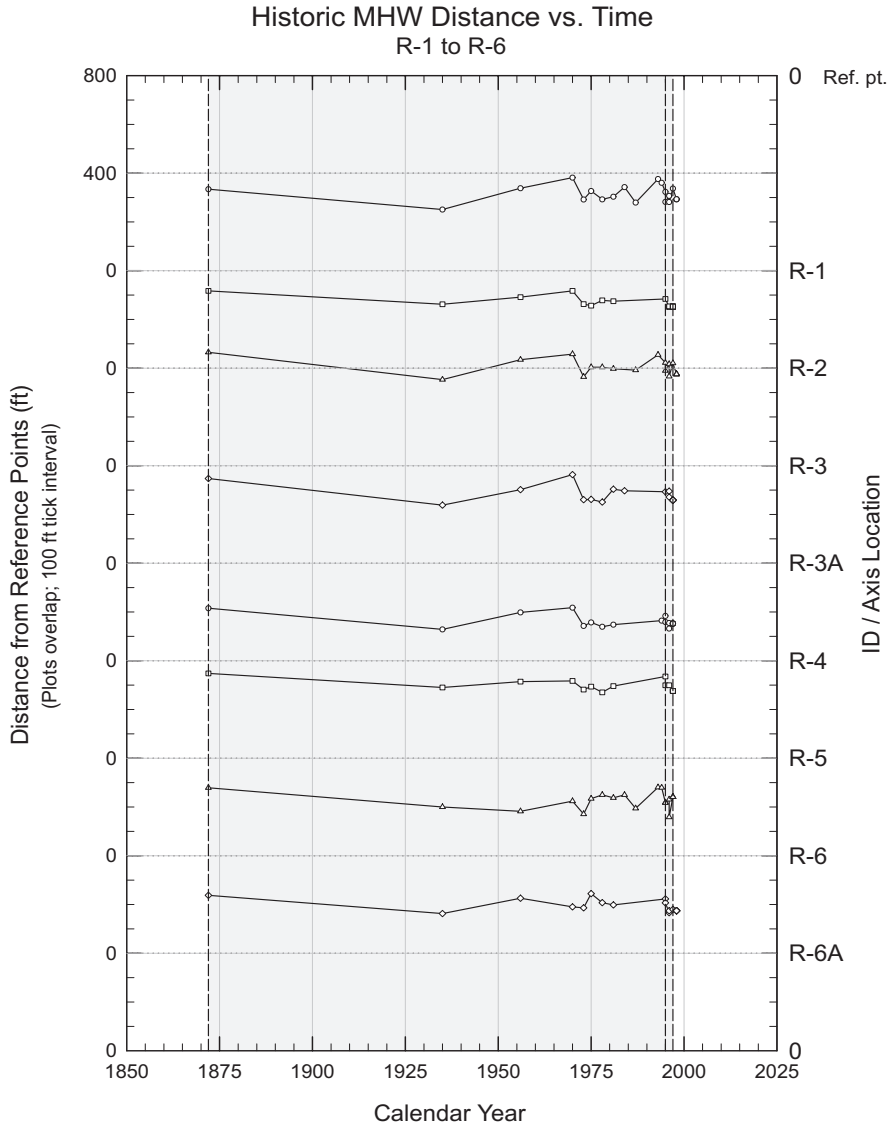
Range	Method	Original Rate Estimates (ft/yr)		Concensus Rate (ft/yr), 1872 to 1997/98	Comments
		1872 to 1995 (pre-Opal)	1872 to 1997/98		
	EP	-1.1	-0.4		
113	RA	-0.4	-0.3	-0.5	
	LS	-0.4	-0.4		
	EP	-1.0	-0.3		
114	RA	-0.5	-0.1	-0.5	
	LS	-0.3	-0.2		
	EP	-0.3	-0.1		
115	RA	0.3	-1.0	-0.5	
	LS	-0.3	-0.6		
	EP	-0.7	-0.5		
116	RA	0.2	-0.9	-0.5	
	LS	-0.4	-0.5		
	EP	-1.0	-0.5		
117	RA	-0.5	-0.2	-0.5	
	LS	-0.4	-0.3		
	EP	-0.9	-0.5		
118	RA	-0.6	-0.3	-0.5	
	LS	-0.3	-0.4		
	EP	-0.3	-0.3		
119	RA	-0.2	-0.2	-0.5	
	LS	-0.5	-0.5		
	EP	-0.8	-0.2		
120	RA	-0.2	-0.7	-0.5	
	LS	-0.4	-0.4		
	EP	-0.8	-0.4		
121	RA	0.0	-0.3	-0.5	
	LS	-0.4	-0.3		
	EP	-0.6	-0.3		
122	RA	-0.7	-0.3	-0.5	
	LS	-0.3	-0.4		
	EP	-0.5	-0.3		
123	RA	0.0	-0.7	-0.5	
	LS	-0.4	-0.3		
	EP	-1.1	-0.4		
124	RA	-0.1	-0.9	-0.5	↑ 7 pt average
	LS	-0.5	-0.5		
	EP	-0.6	-0.5		
125	RA	0.2	-0.6	-0.5	5 pt average
	LS	-0.6	-0.6		
	EP	-1.2	-0.5		
126	RA	0.7	0.2	-0.5	3 pt average
	LS	-0.7	-0.6		
	EP	-1.4	-0.9		

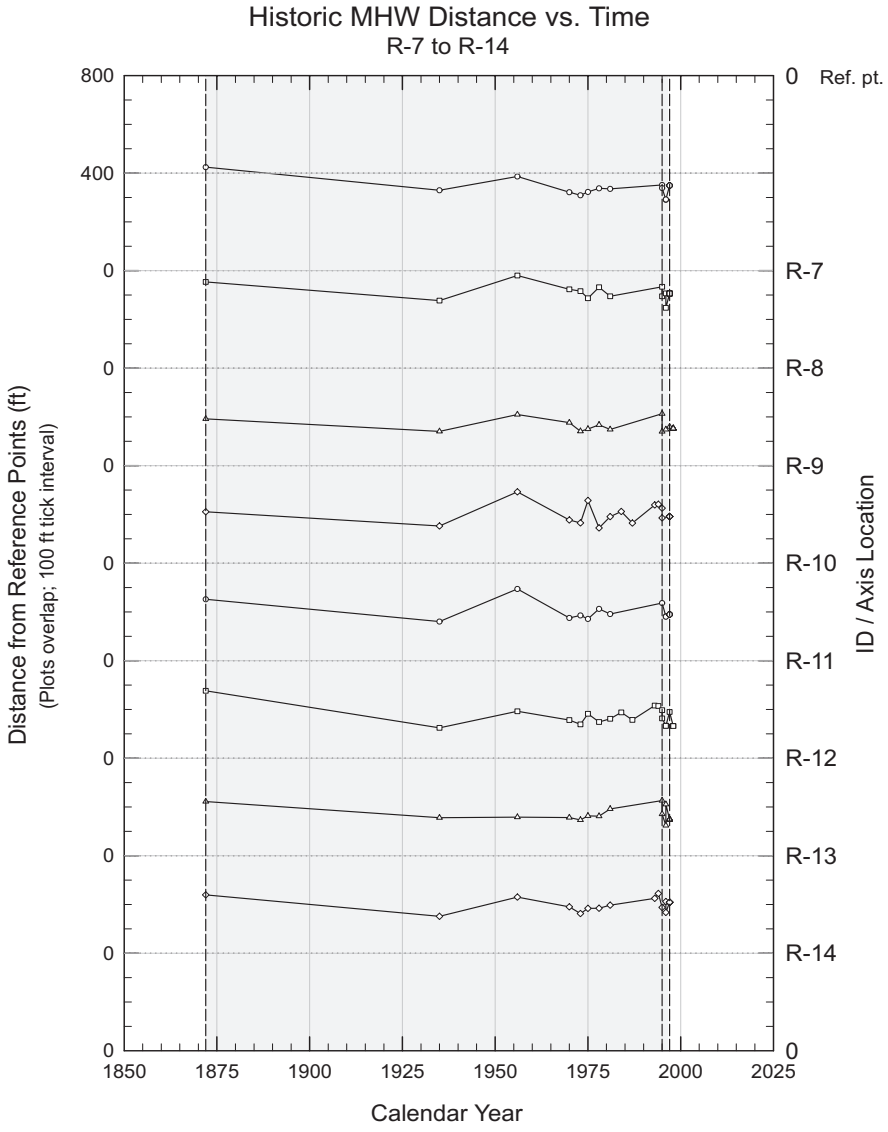
Table A-1. Shoreline change rate estimates for Walton County, Florida.

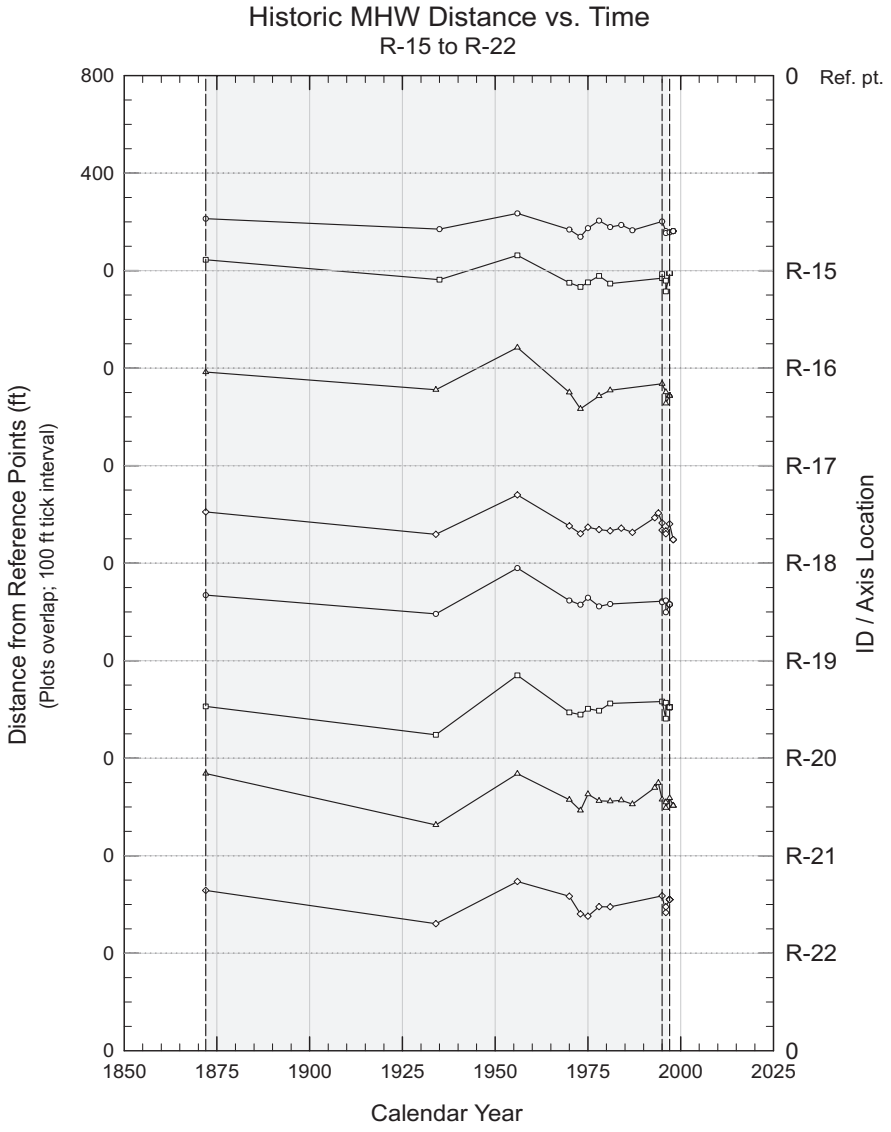
Range	Method	Original Rate Estimates (ft/yr)		Concensus Rate (ft/yr), 1872 to 1997/98	Comments
		1872 to 1995 (pre-Opal)	1872 to 1997/98		
127	RA	0.2	-1.0	-0.5	no average
	LS	-0.5	-0.5		
	EP	-1.7	-0.3		

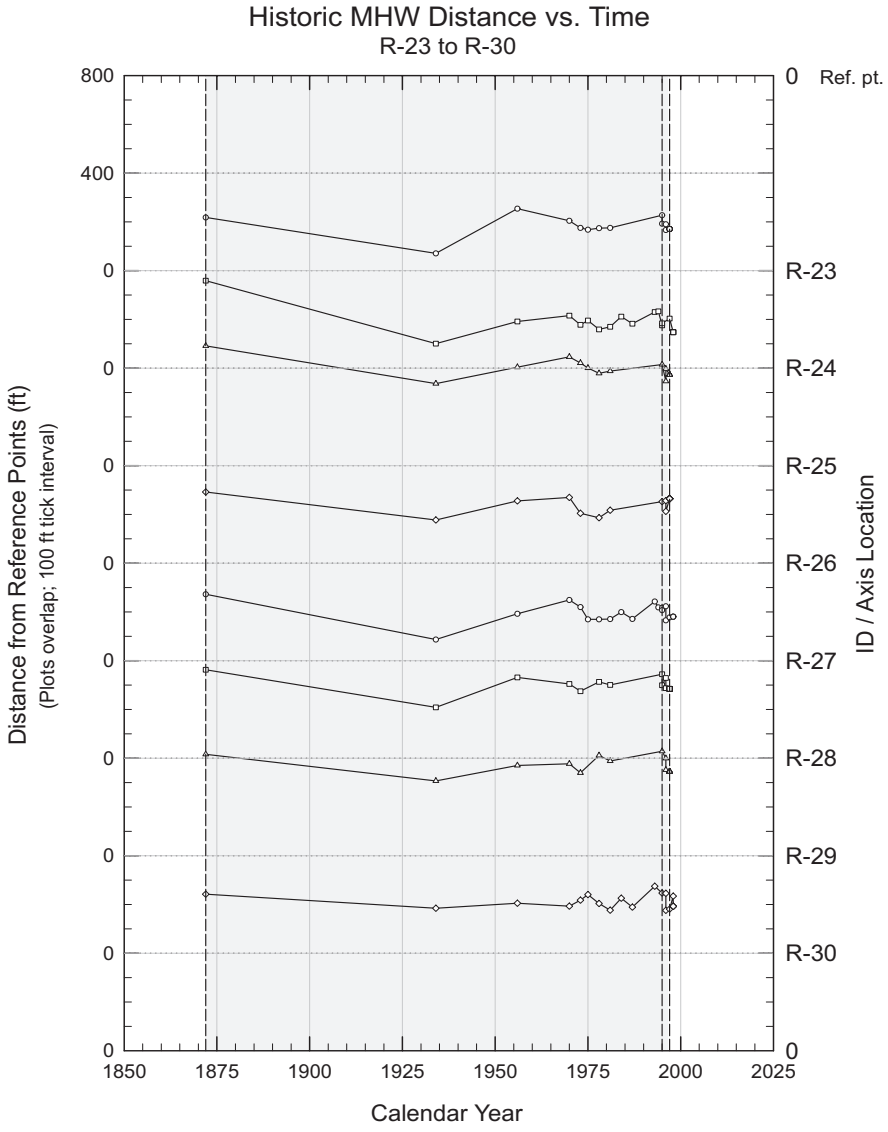
8.2 Appendix B: Stack Plots

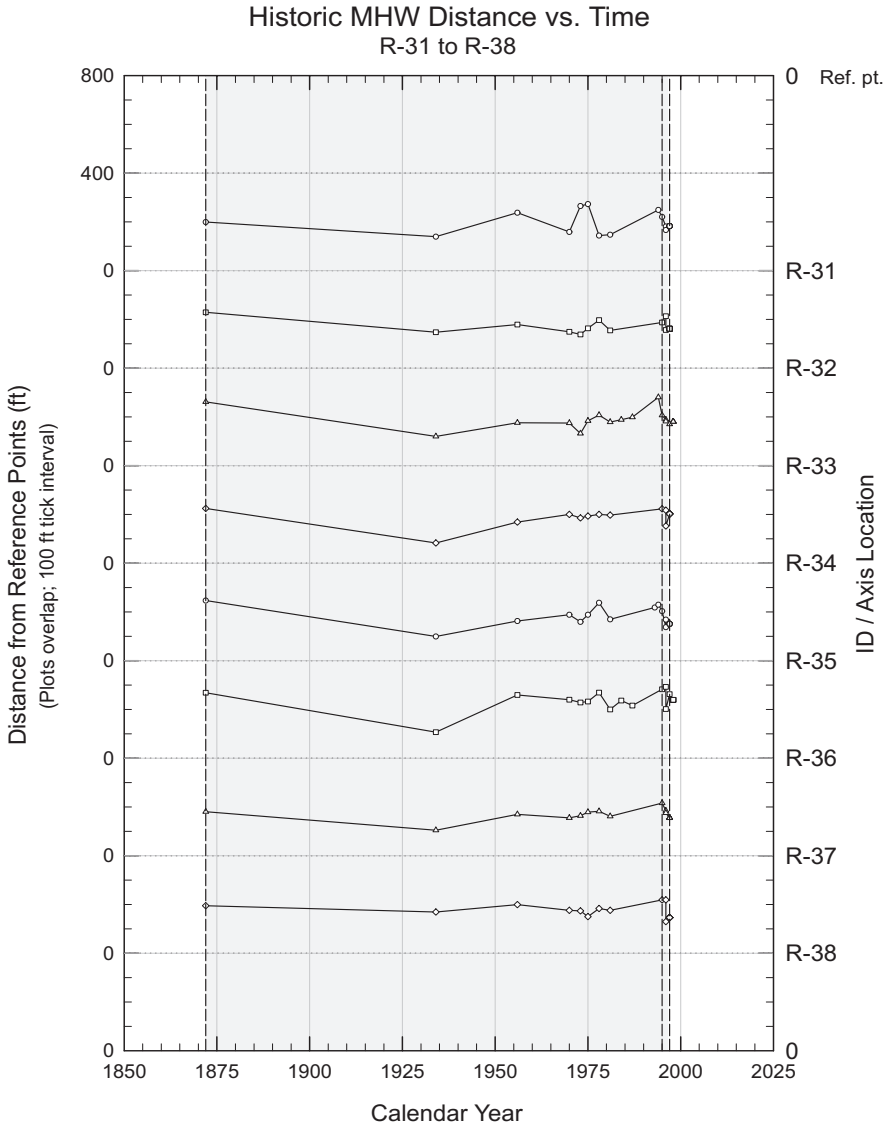
Stack plots from Historic Shoreline Database, Florida Department of Environmental Protection, Office of Beaches and Coastal Systems; slightly modified by authors.

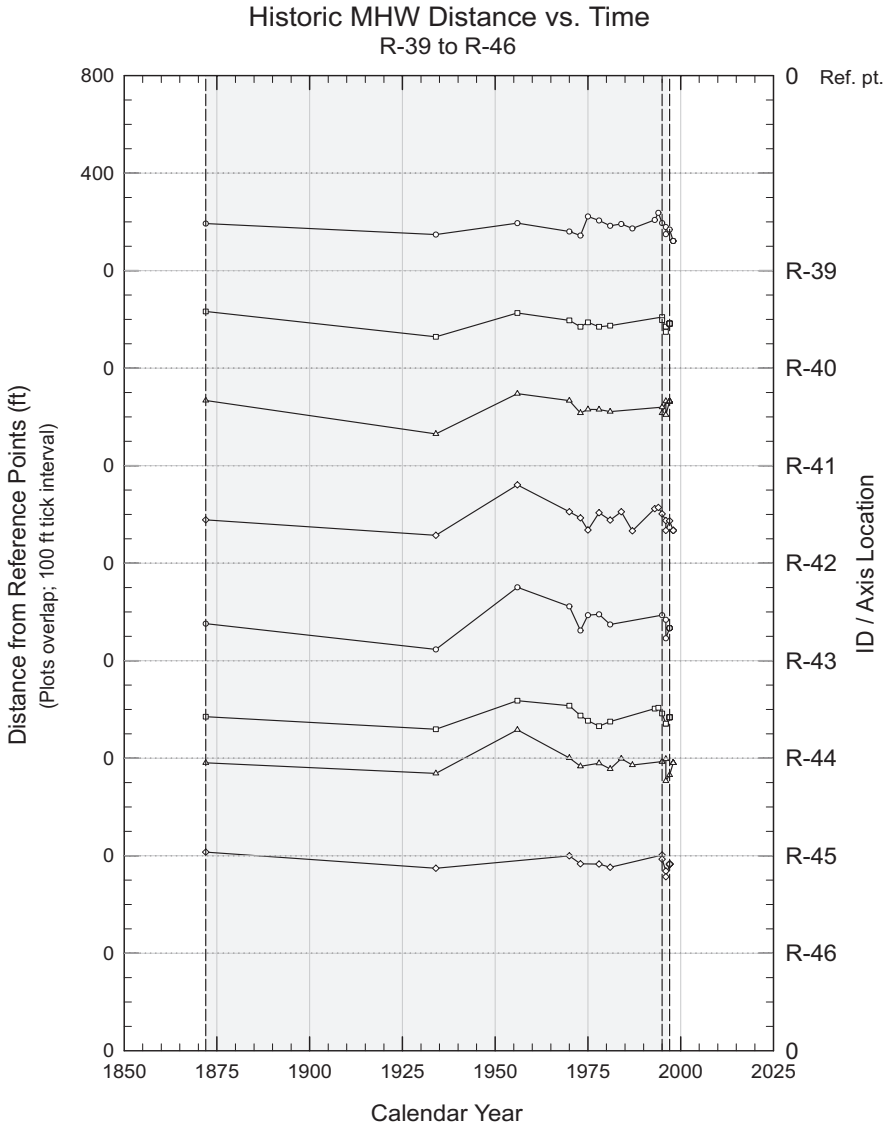

Historic MHW Distance vs. Time
R-1 to R-6
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
0 Ref. pt.
R-1
R-2
R-3
R-3A
R-4
R-5
R-6
R-6A
0
ID / Axis Location

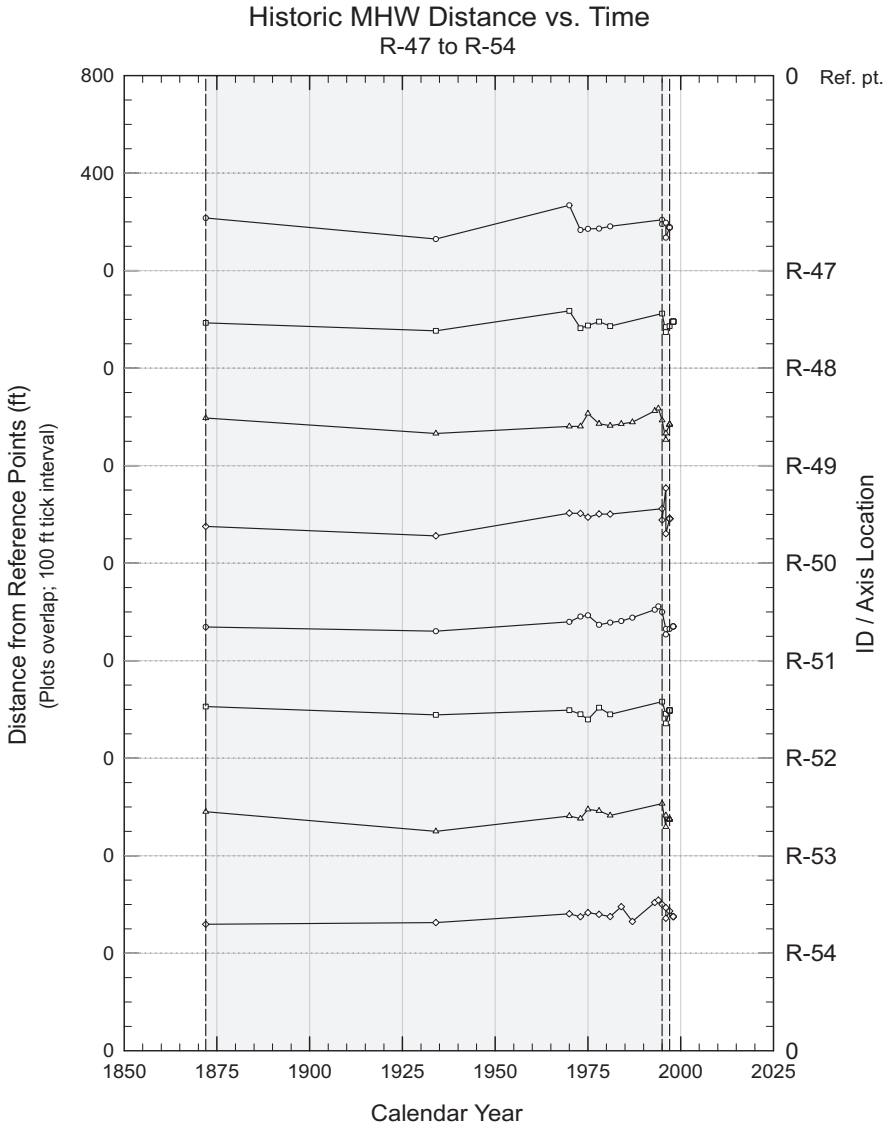

Historic MHW Distance vs. Time
R-7 to R-14
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
Ref. pt.
R-7
R-8
R-9
R-10
R-11
R-12
R-13
R-14
0
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

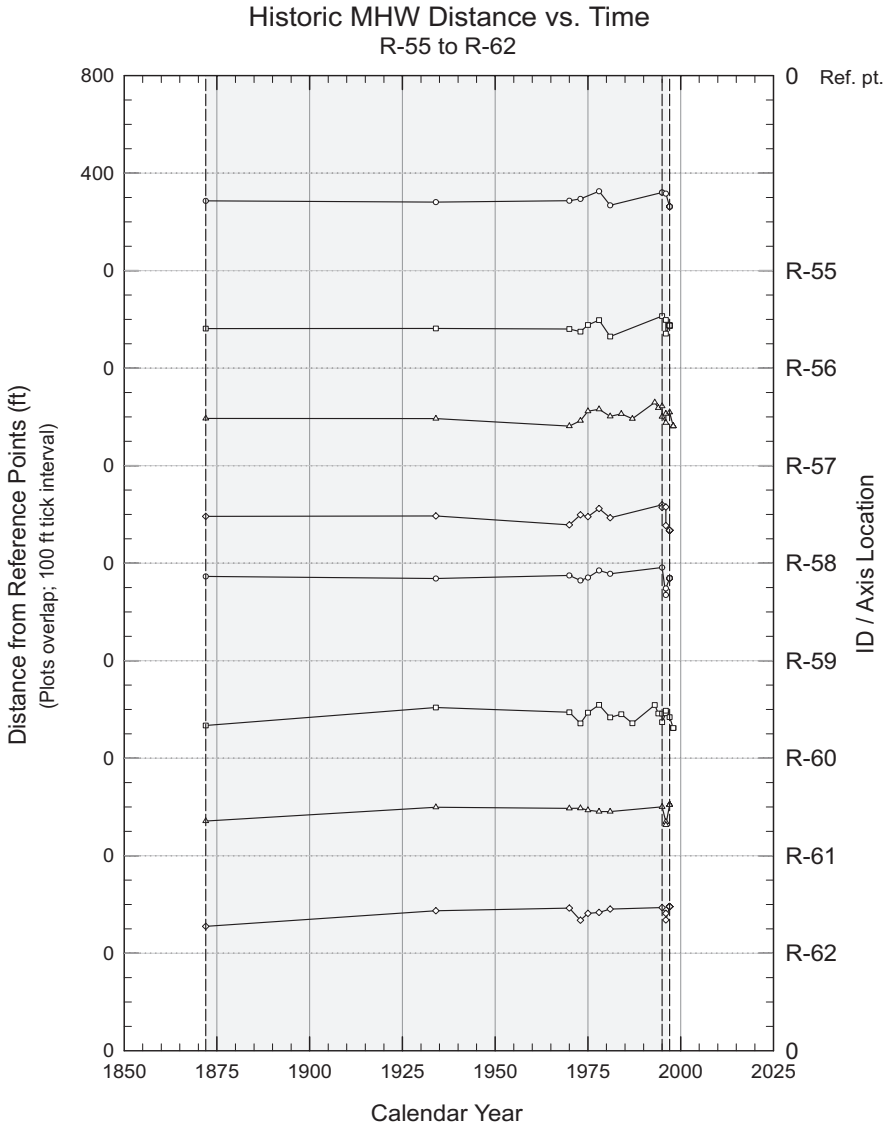

Historic MHW Distance vs. Time
R-15 to R-22
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
Ref. pt.
R-15
R-16
R-17
R-18
R-19
R-20
R-21
R-22
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

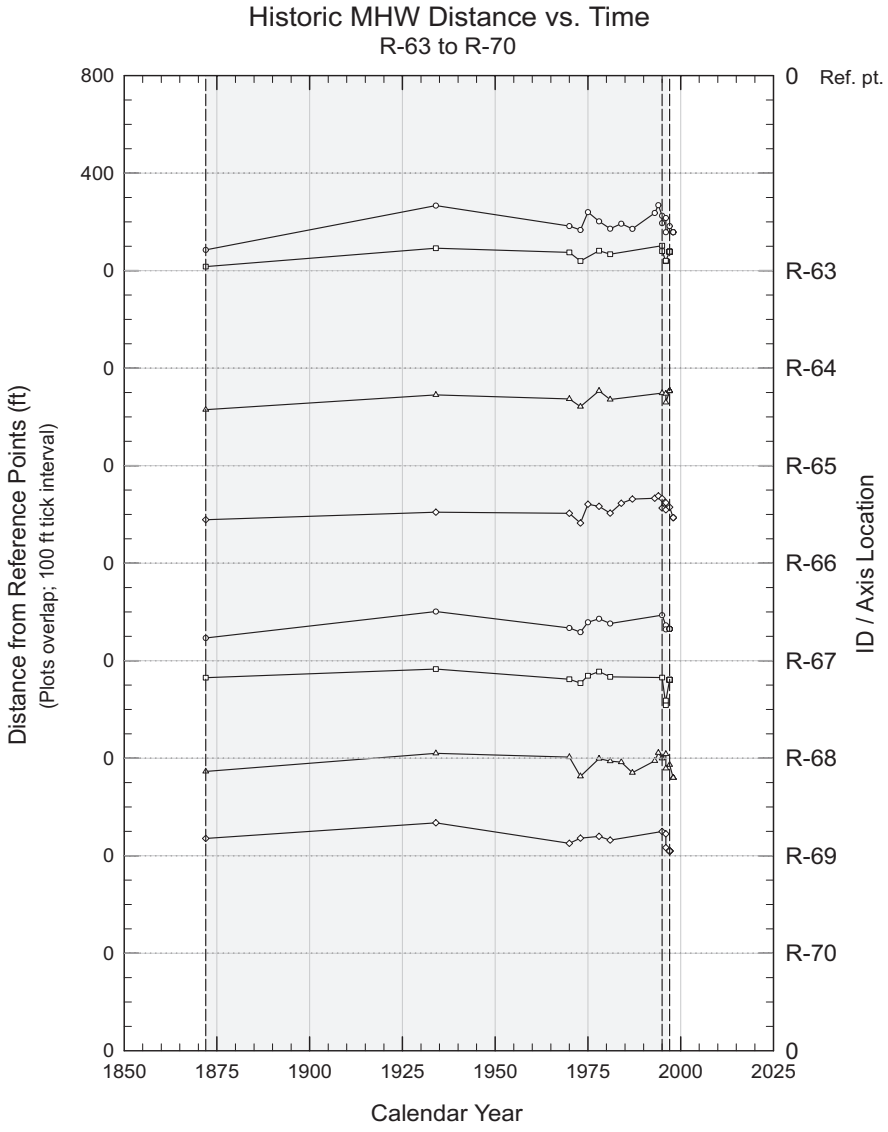

Historic MHW Distance vs. Time
R-23 to R-30
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
Ref. pt.
R-23
R-24
R-25
R-26
R-27
R-28
R-29
R-30
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

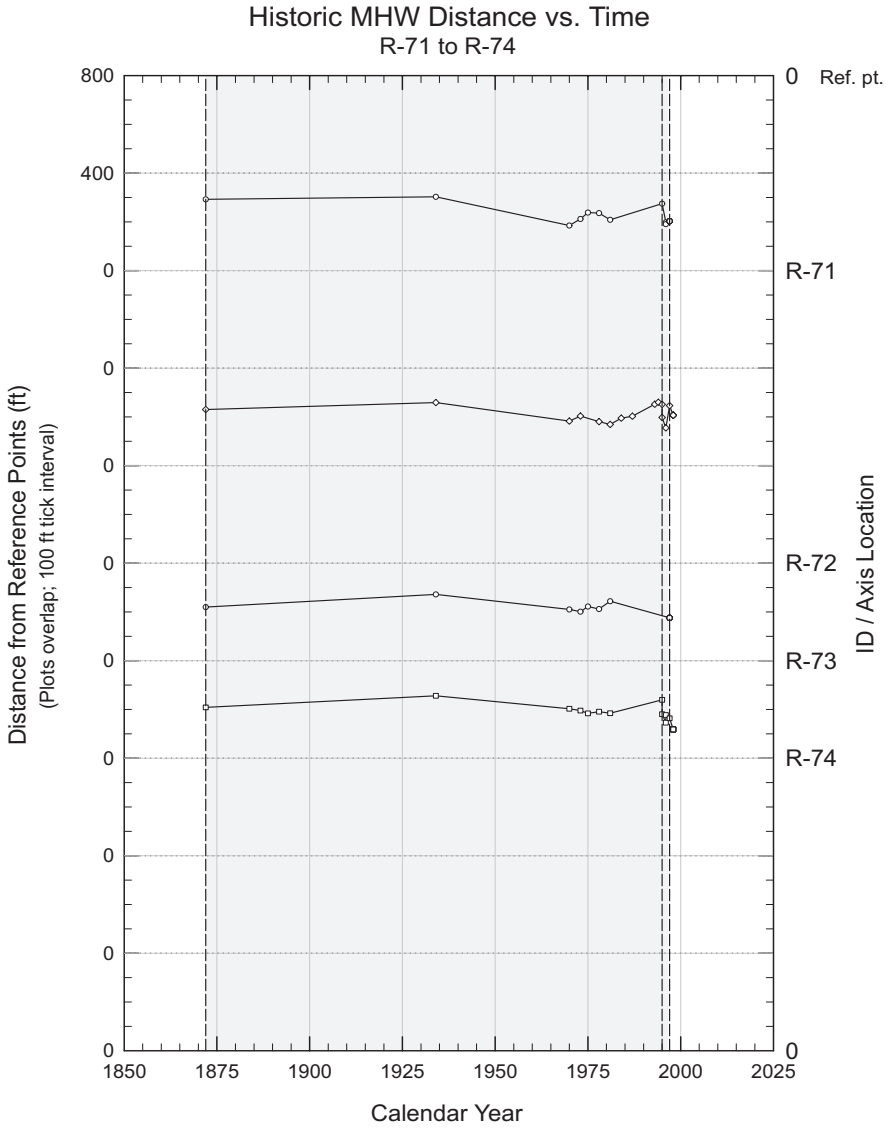

Historic MHW Distance vs. Time
R-31 to R-38
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
0 Ref. pt.
R-31
R-32
R-33
R-34
R-35
R-36
R-37
R-38
0
ID / Axis Location

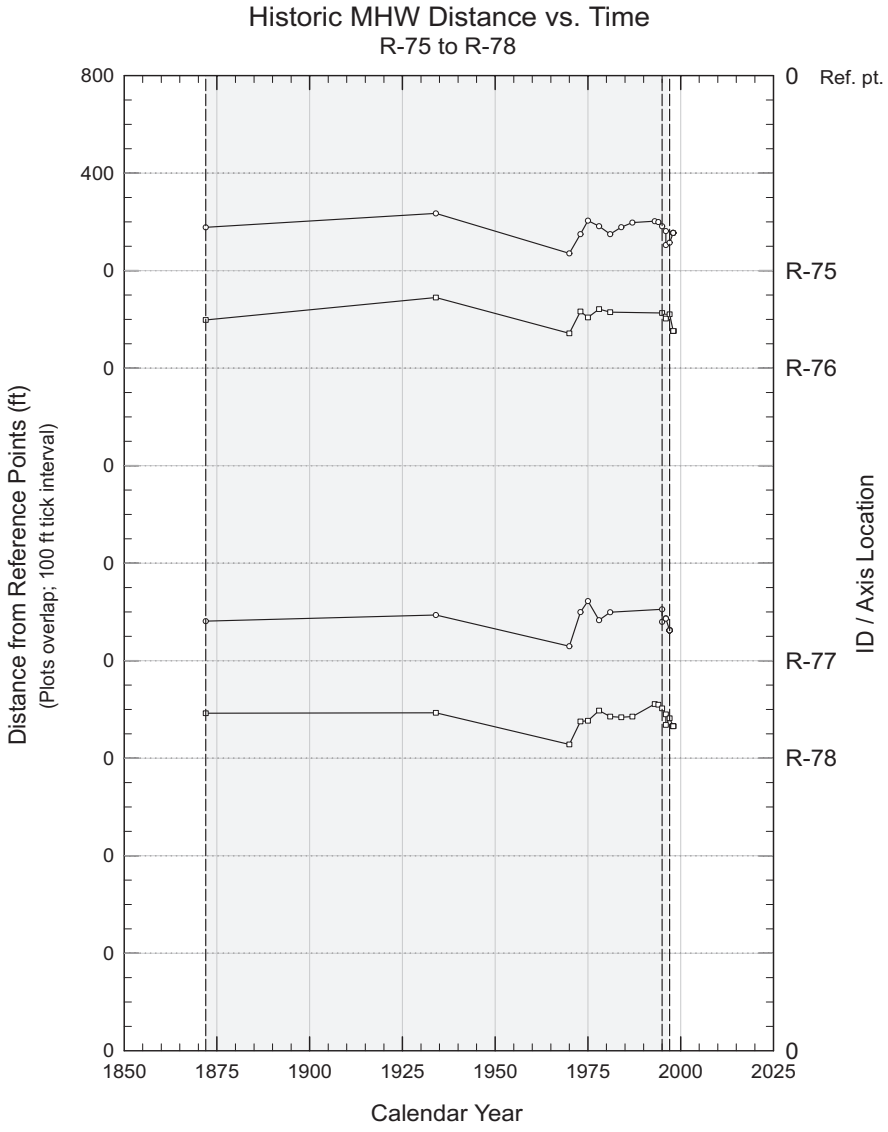

Historic MHW Distance vs. Time
R-39 to R-46
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
0
Ref. pt.
R-39
R-40
R-41
R-42
R-43
R-44
R-45
R-46
0
ID / Axis Location

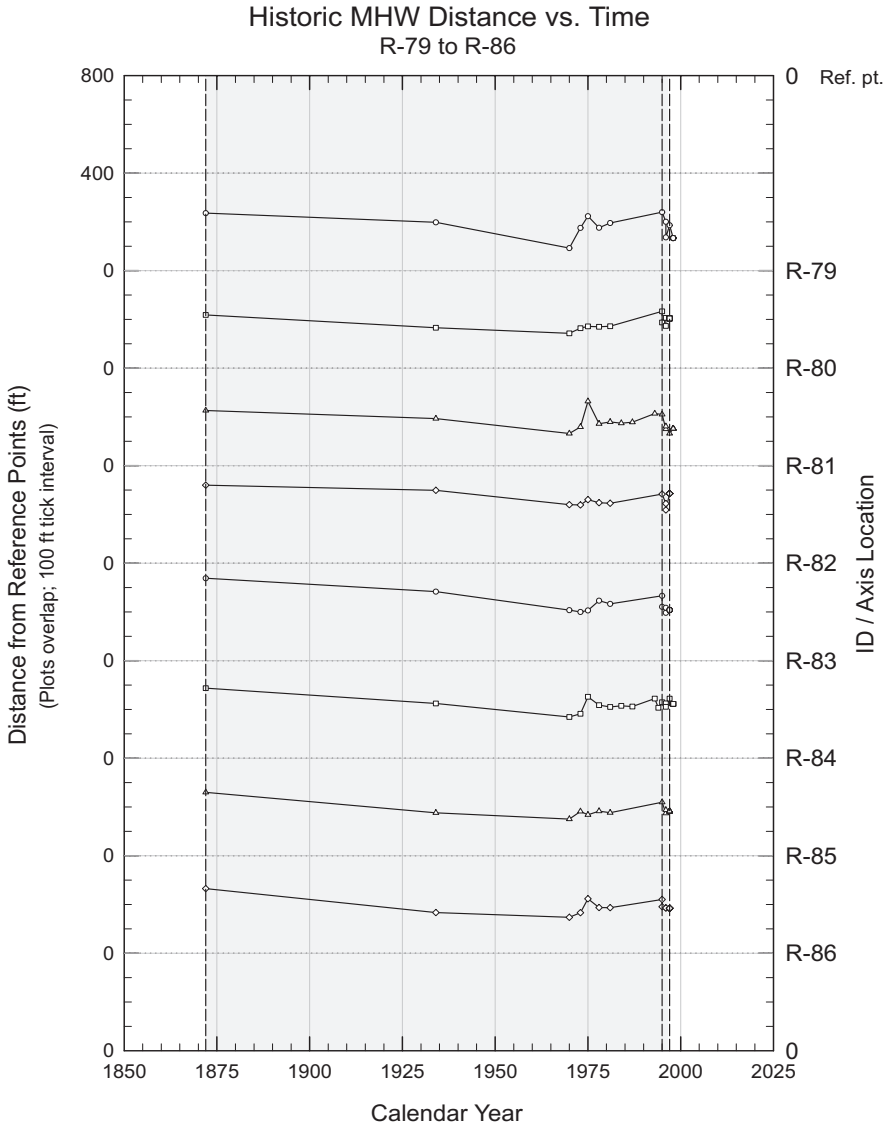

Historic MHW Distance vs. Time
R-47 to R-54
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
0 Ref. pt.
R-47
R-48
R-49
R-50
R-51
R-52
R-53
R-54
0
ID / Axis Location

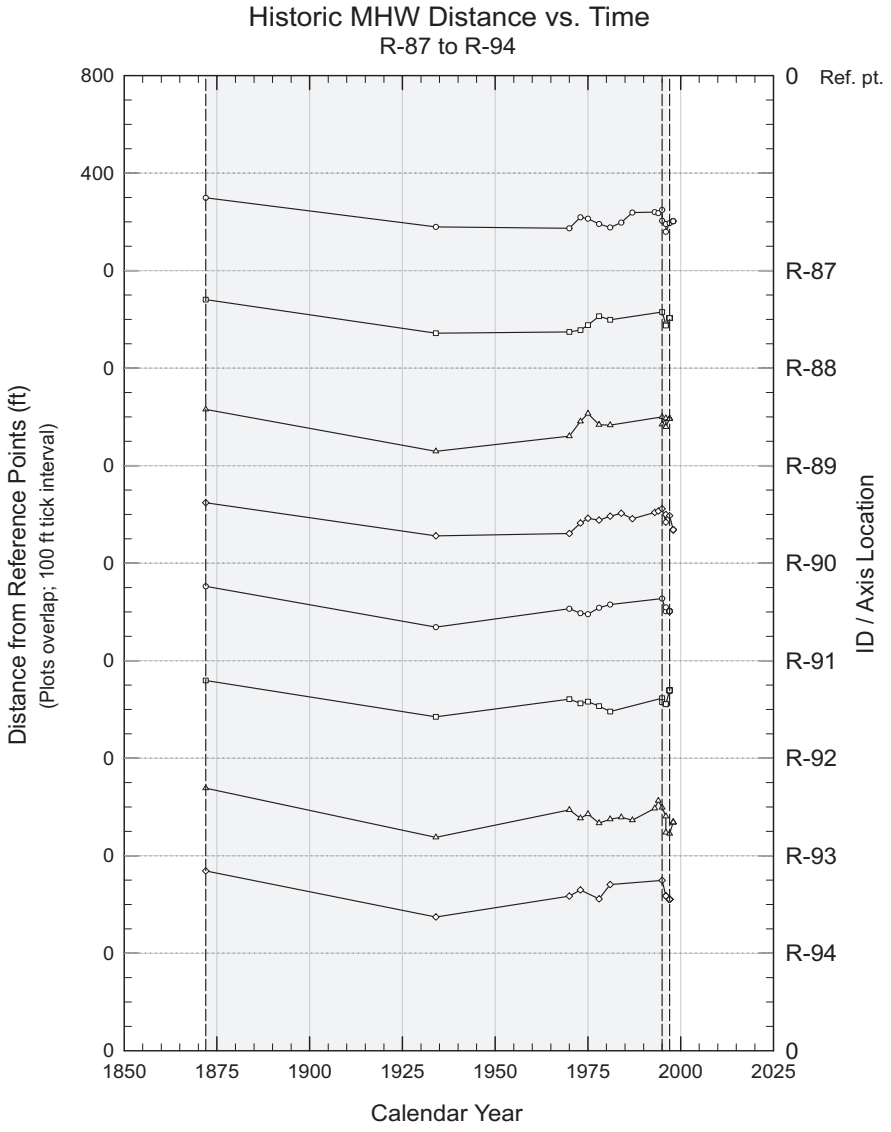

Historic MHW Distance vs. Time
R-55 to R-62
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
Ref. pt.
R-55
R-56
R-57
R-58
R-59
R-60
R-61
R-62
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

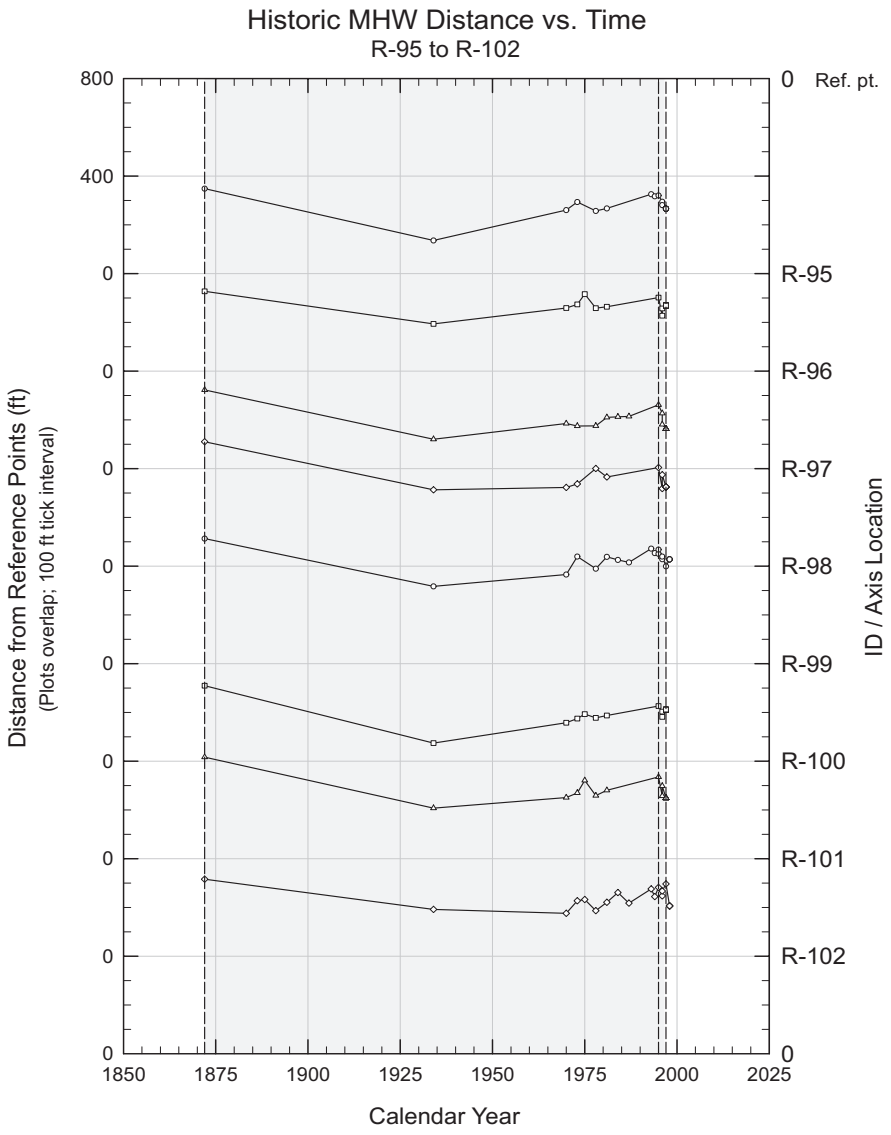

Historic MHW Distance vs. Time
R-63 to R-70
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
0
Ref. pt.
R-63
R-64
R-65
R-66
R-67
R-68
R-69
R-70
0
ID / Axis Location

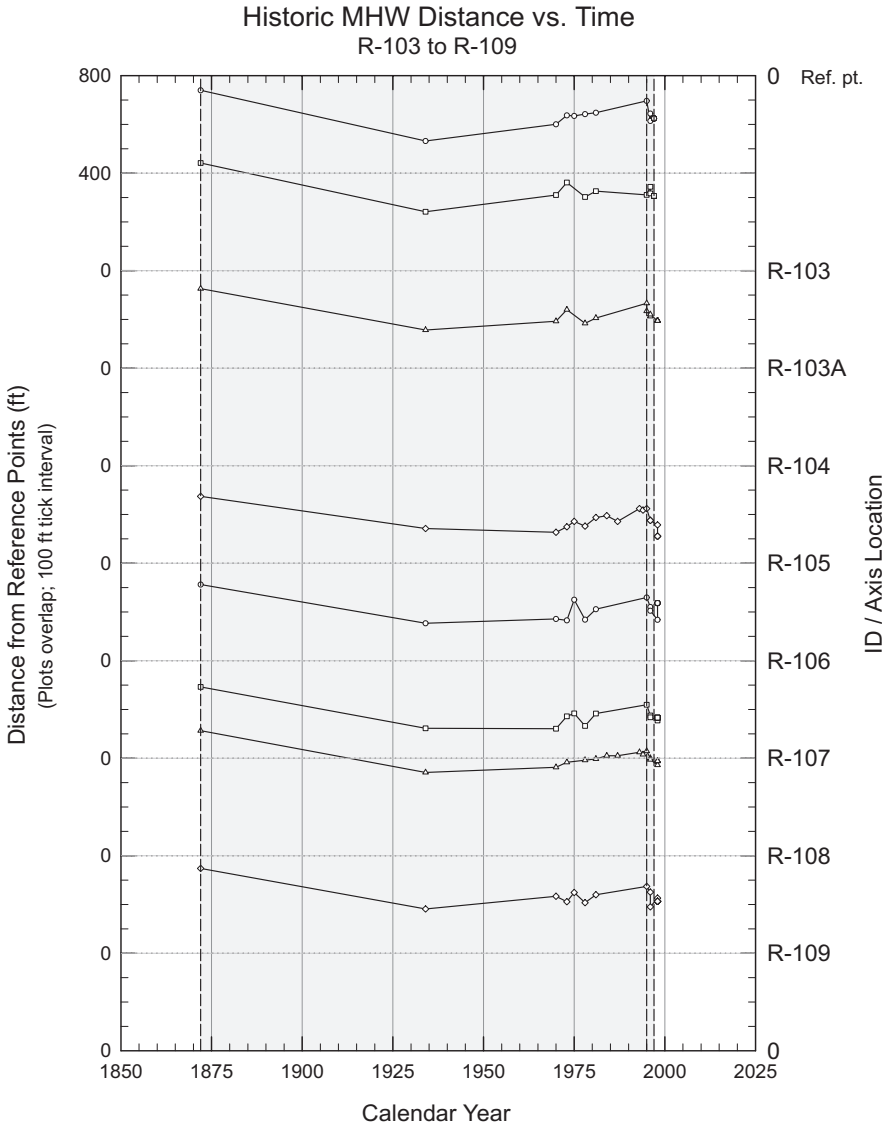

Historic MHW Distance vs. Time
R-71 to R-74
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
0
Ref. pt.
R-71
R-72
R-73
R-74
0
ID / Axis Location

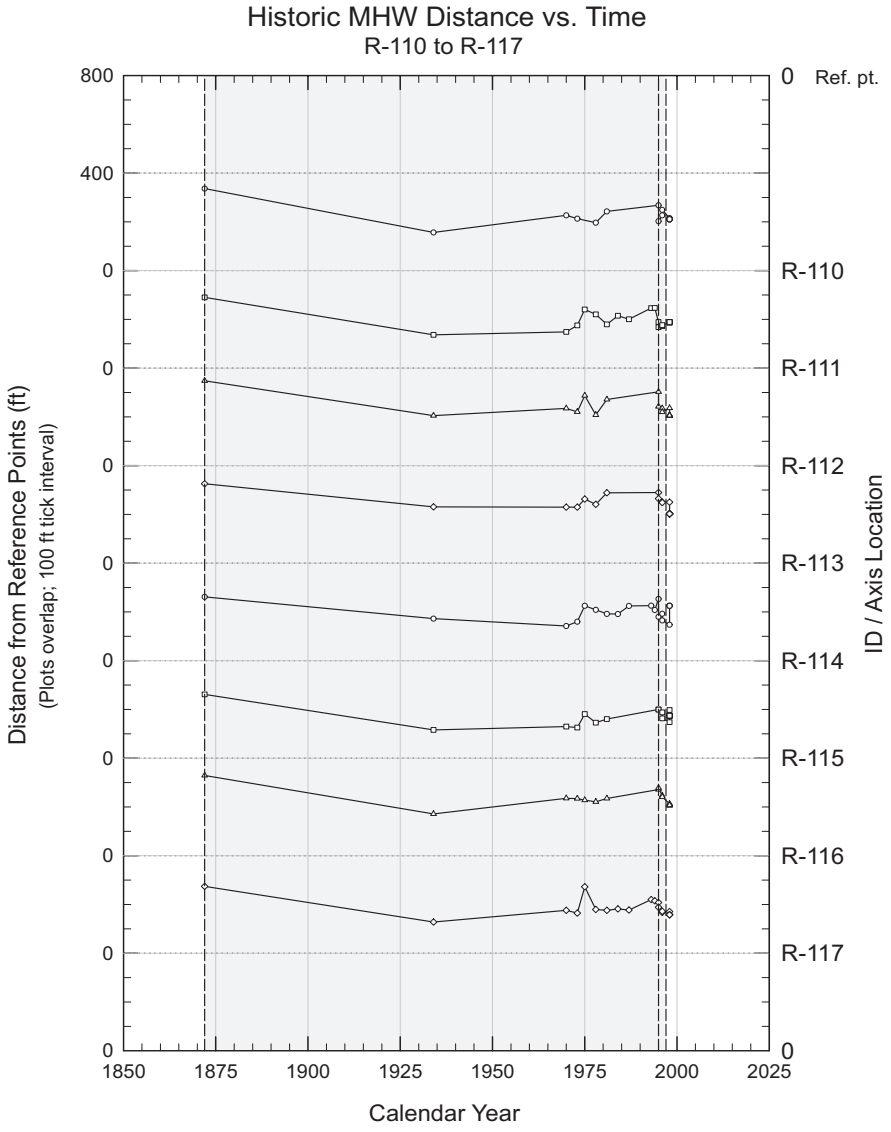

Historic MHW Distance vs. Time
R-75 to R-78
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
0
Ref. pt.
R-75
R-76
R-77
R-78
0
ID / Axis Location

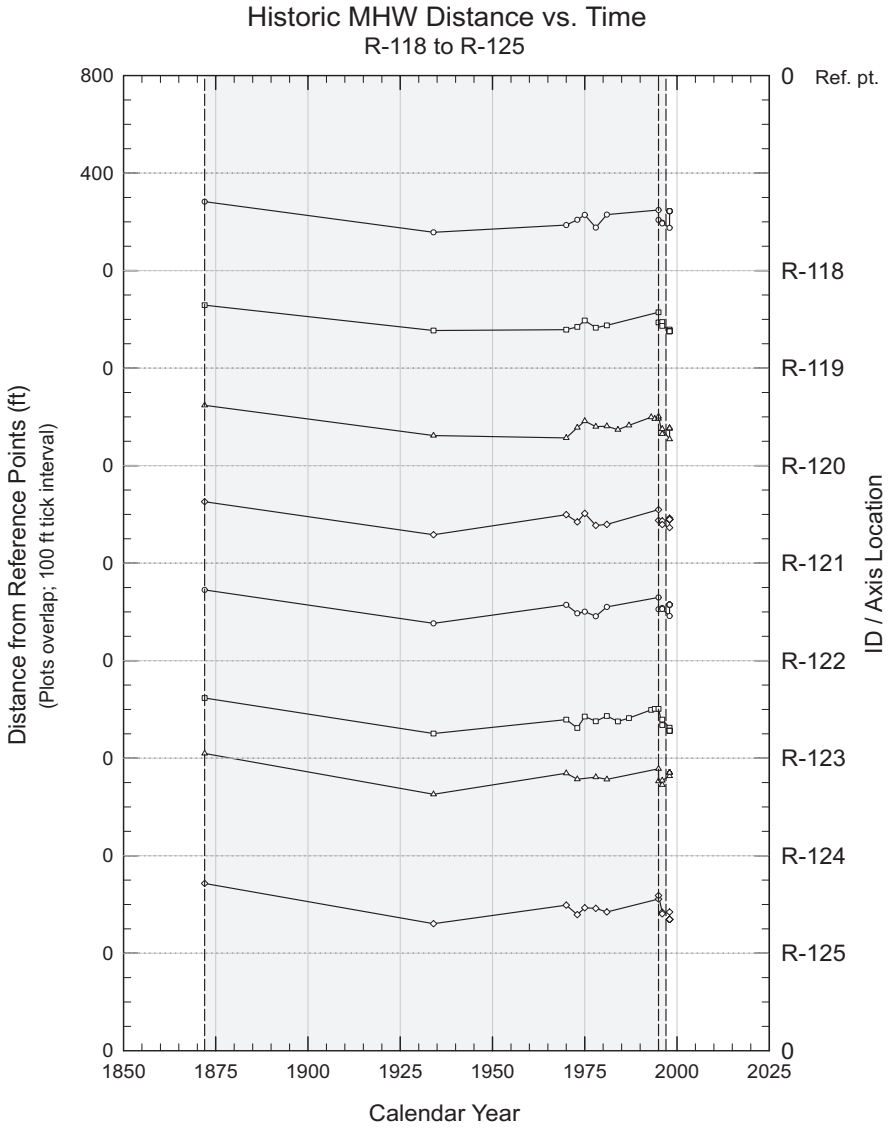

Historic MHW Distance vs. Time
R-79 to R-86
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
0
0
Ref. pt.
R-79
R-80
R-81
R-82
R-83
R-84
R-85
R-86
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

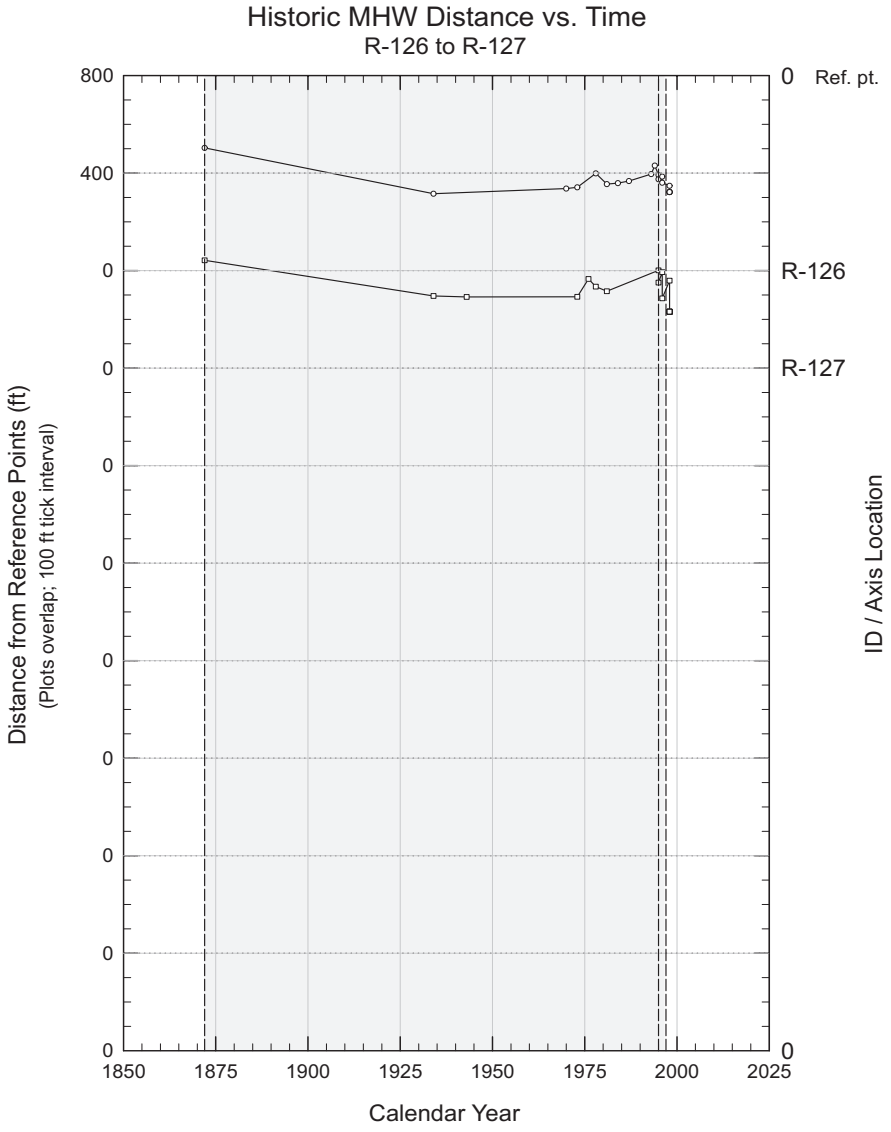

Historic MHW Distance vs. Time
R-87 to R-94
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
0
Ref. pt.
R-87
R-88
R-89
R-90
R-91
R-92
R-93
R-94
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year


Historic MHW Distance vs. Time
R-95 to R-102
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
0 Ref. pt.
R-95
R-96
R-97
R-98
R-99
R-100
R-101
R-102
0
ID / Axis Location

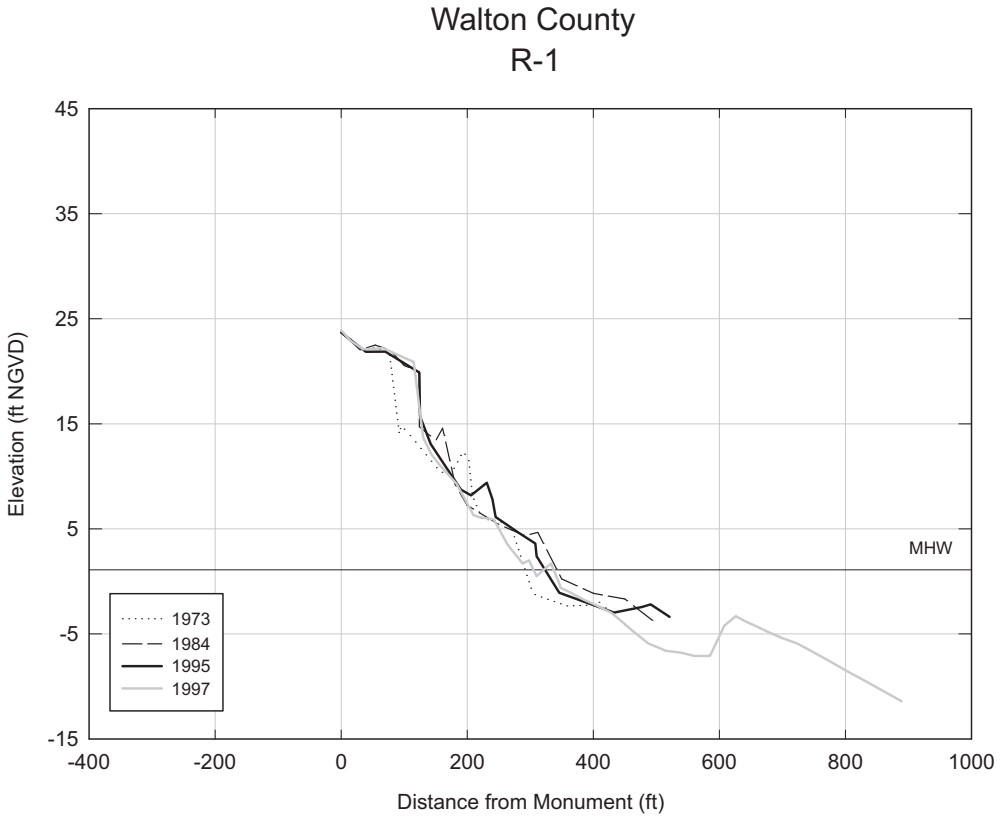

Historic MHW Distance vs. Time
R-103 to R-109
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
0 Ref. pt.
R-103
R-103A
R-104
R-105
R-106
R-107
R-108
R-109
0
ID / Axis Location

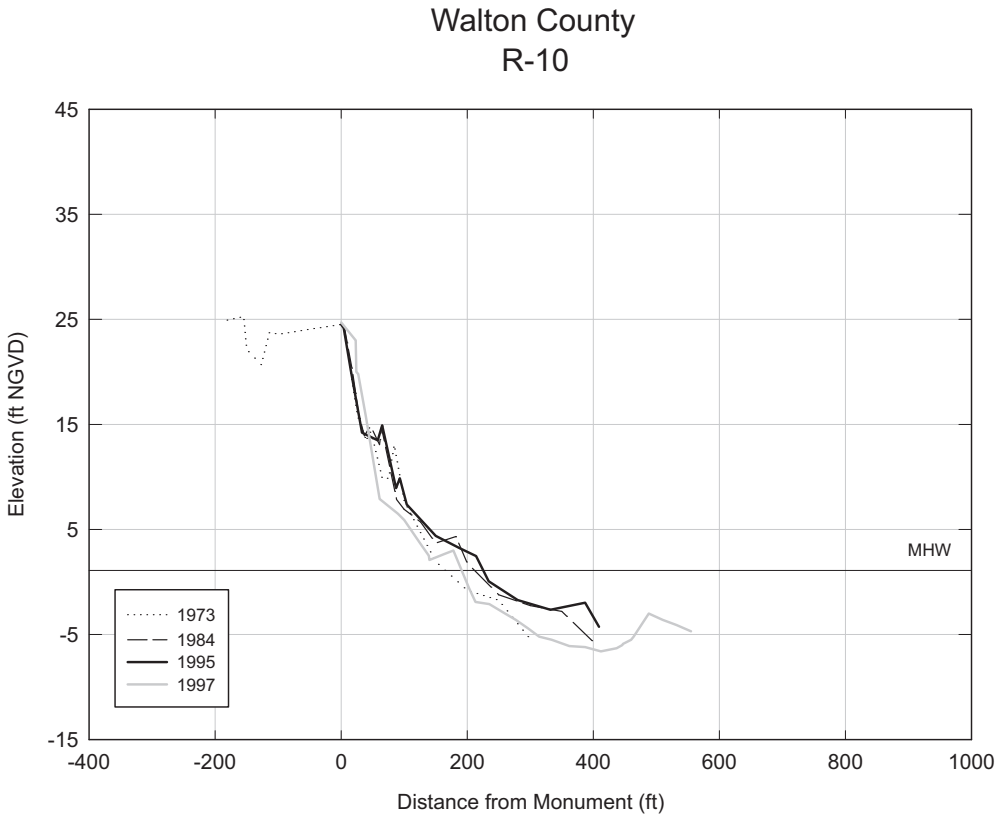

Historic MHW Distance vs. Time
R-110 to R-117
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
0 Ref. pt.
R-110
R-111
R-112
R-113
R-114
R-115
R-116
R-117
0
ID / Axis Location


Historic MHW Distance vs. Time
R-118 to R-125
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
0 Ref. pt.
R-118
R-119
R-120
R-121
R-122
R-123
R-124
R-125
0
ID / Axis Location

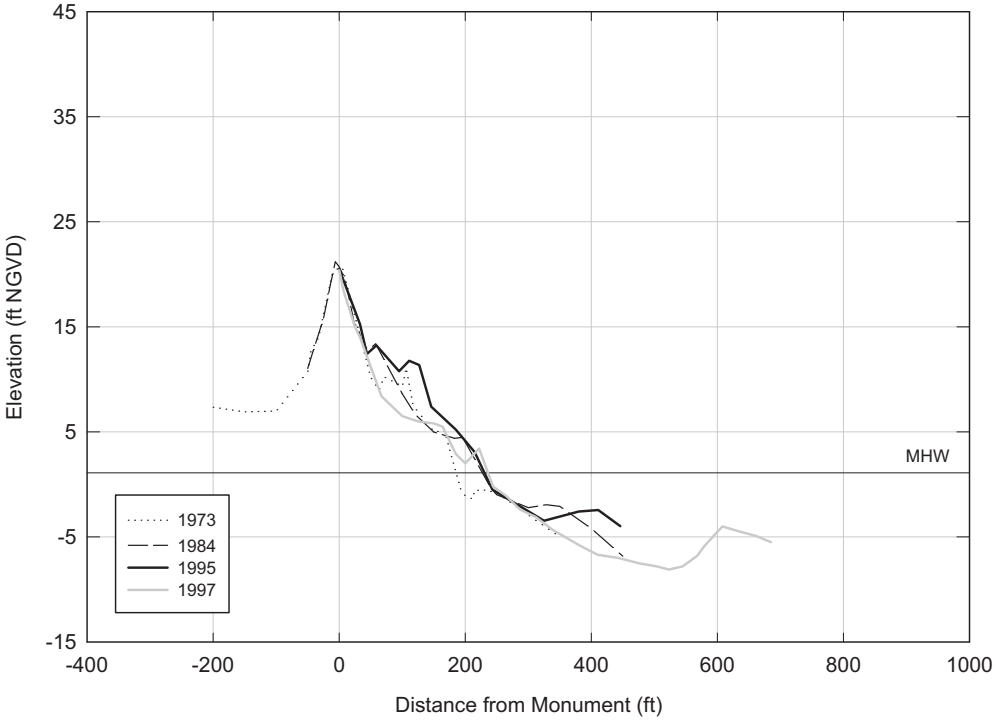

Historic MHW Distance vs. Time
R-126 to R-127
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
0
Ref. pt.
R-126
R-127
0
ID / Axis Location

8.3 Appendix C: Profile Plots

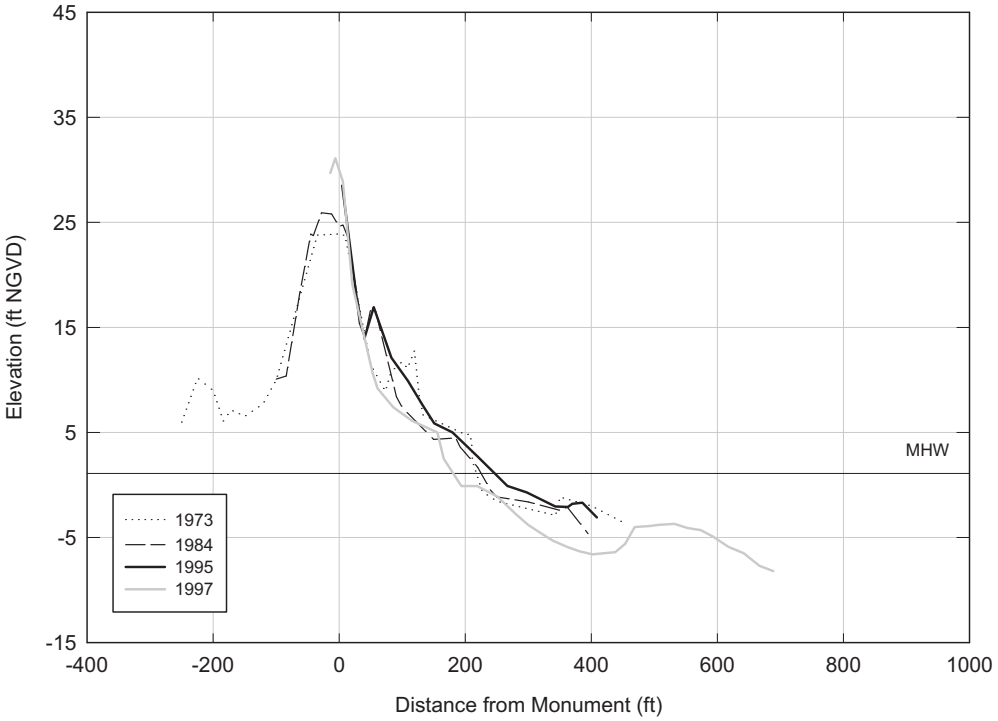

Walton County
R-1
Elevation (ft NGVD)
45
35
25
15
5
-5
-15
-400
-200
0
200
400
600
800
1000
Distance from Monument (ft)
MHW
1973
1984
1995
1997


Walton County
R-10
Elevation (ft NGVD)
45
35
25
15
5
-5
-15
-400
-200
0
200
400
600
800
1000
Distance from Monument (ft)
MHW
1973
1984
1995
1997

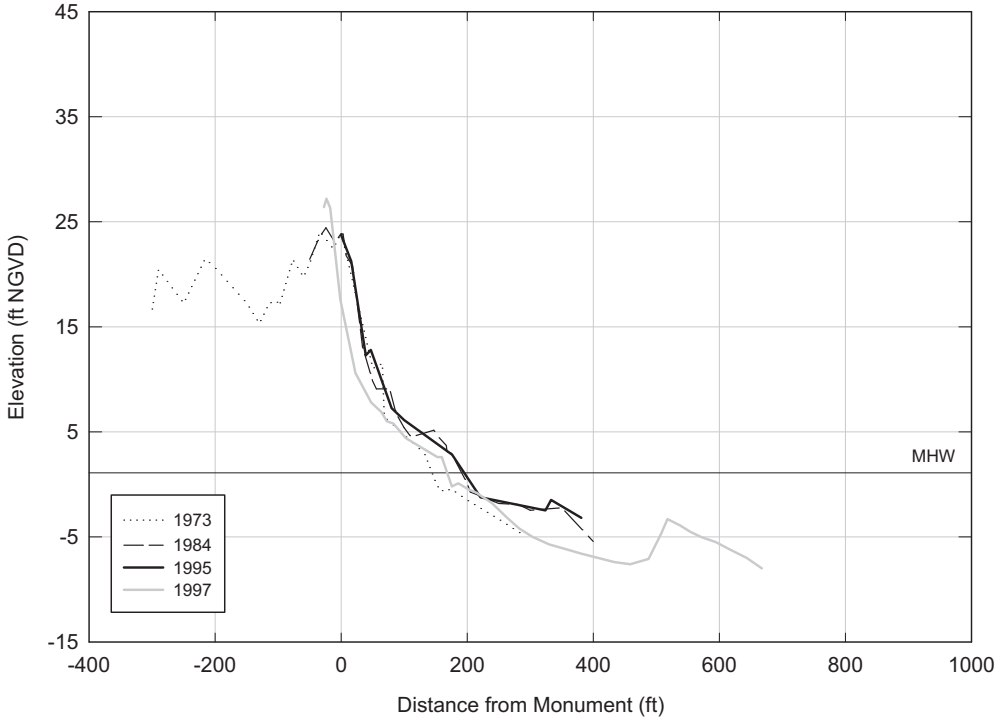
Walton County
R-21



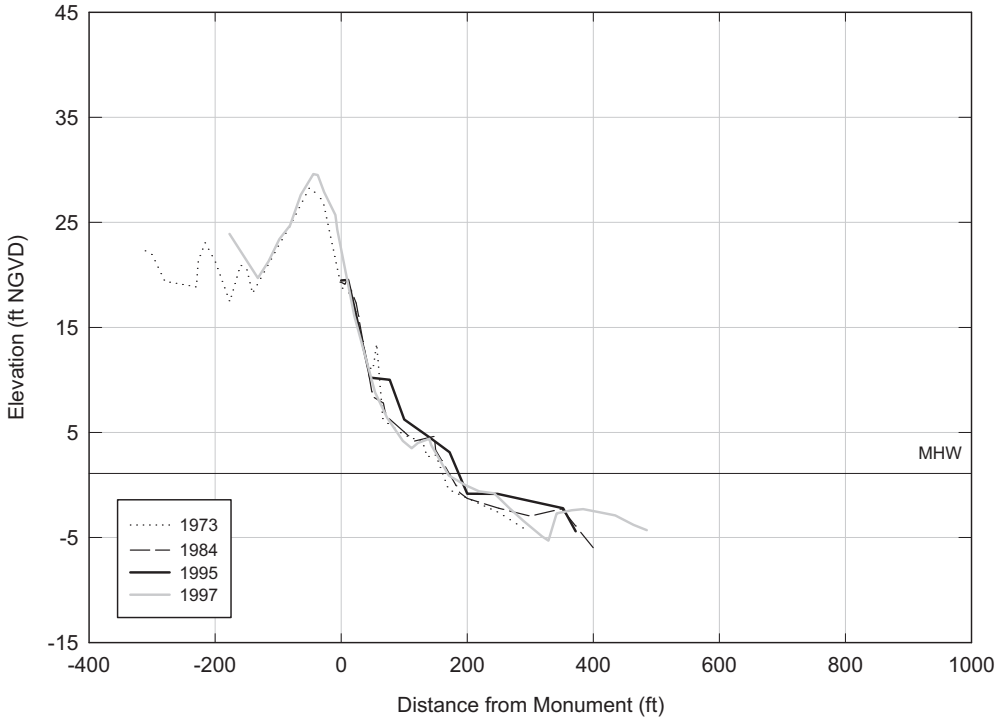
Walton County
R-30



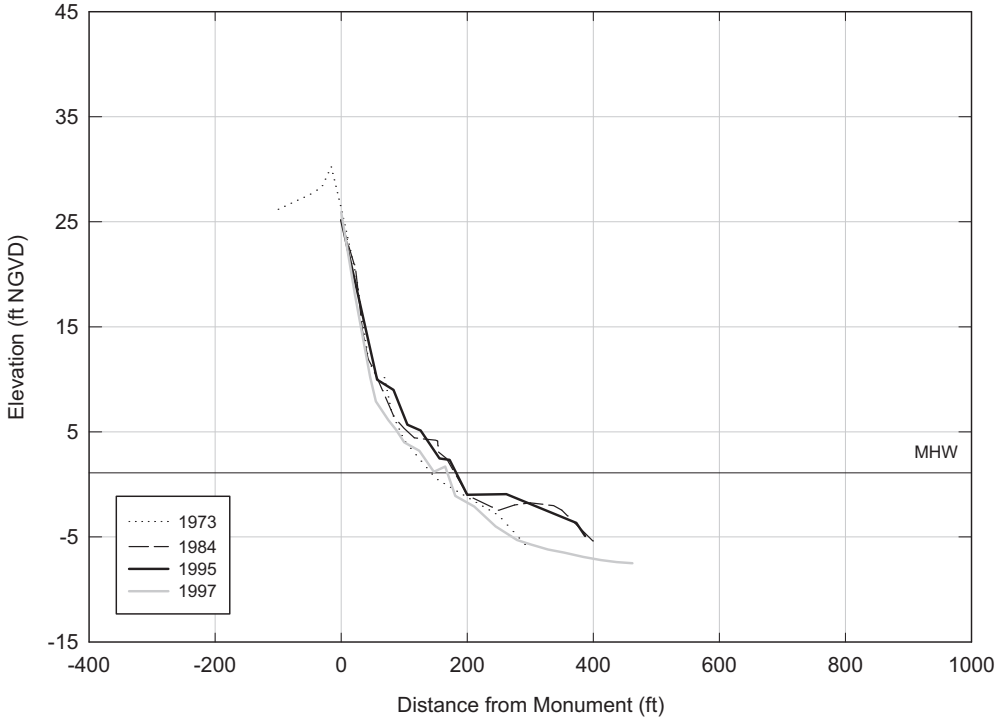
Walton County
R-39



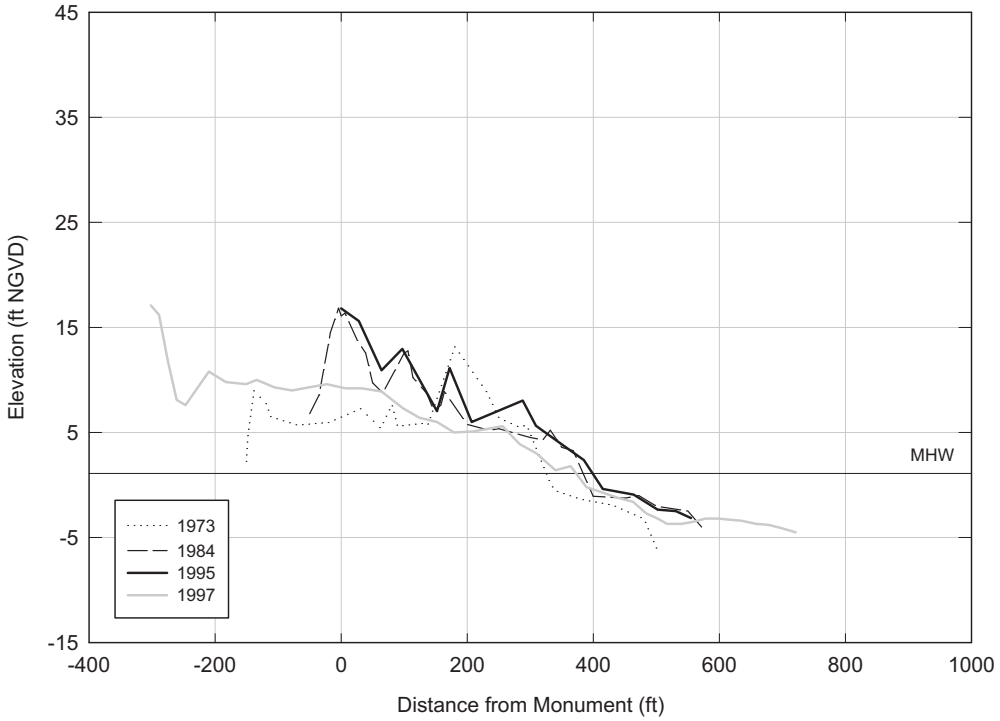
Walton County
R-49

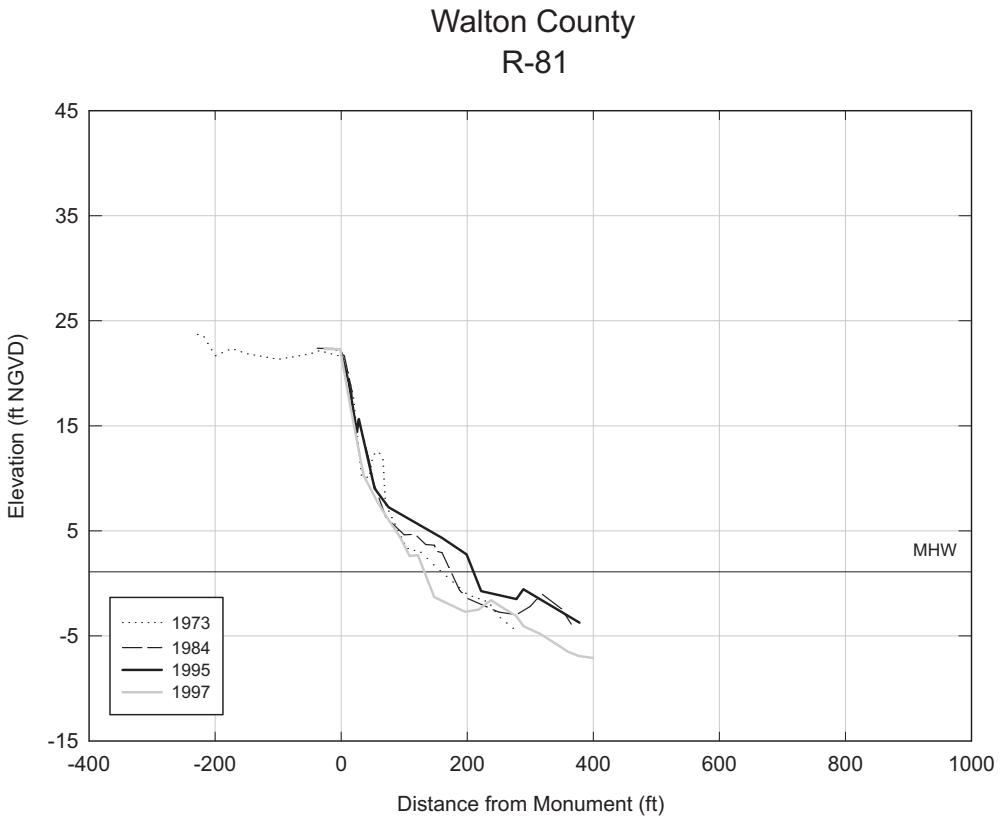


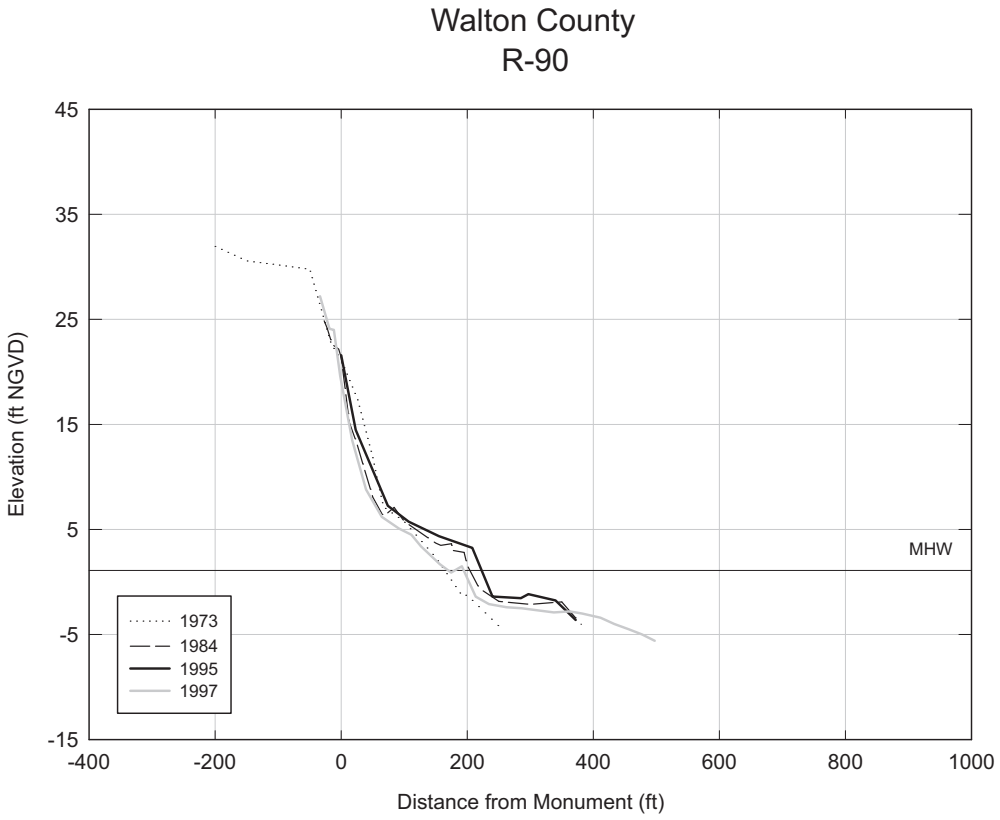
Walton County
R-60

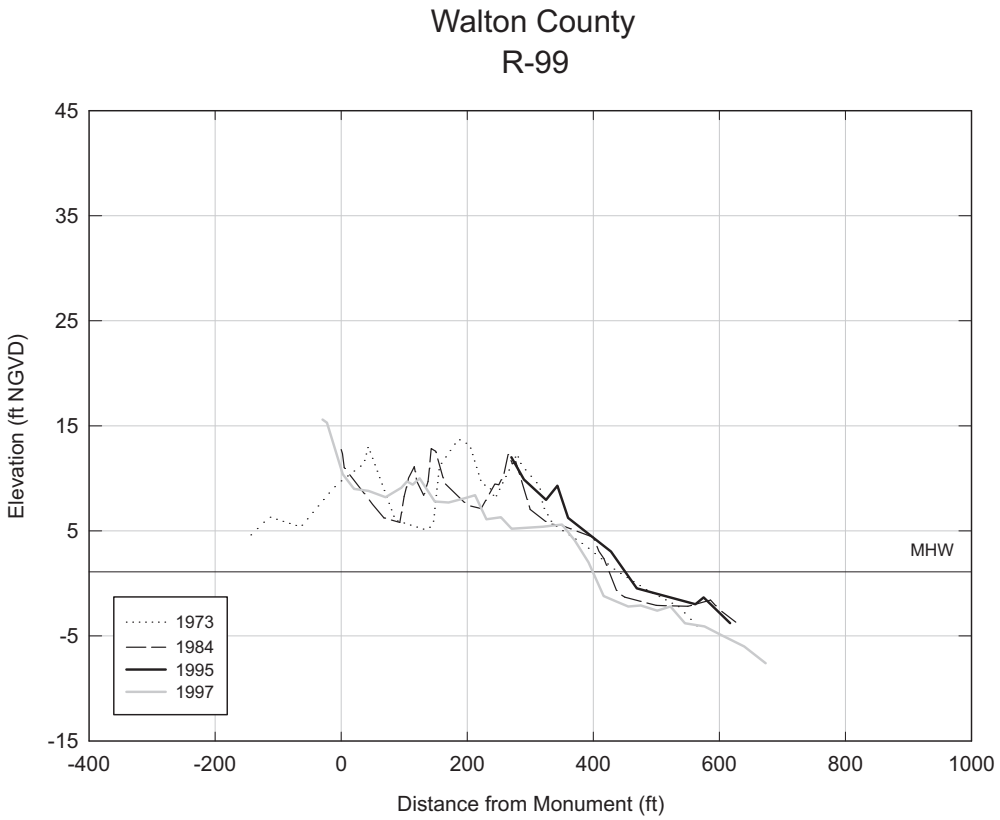


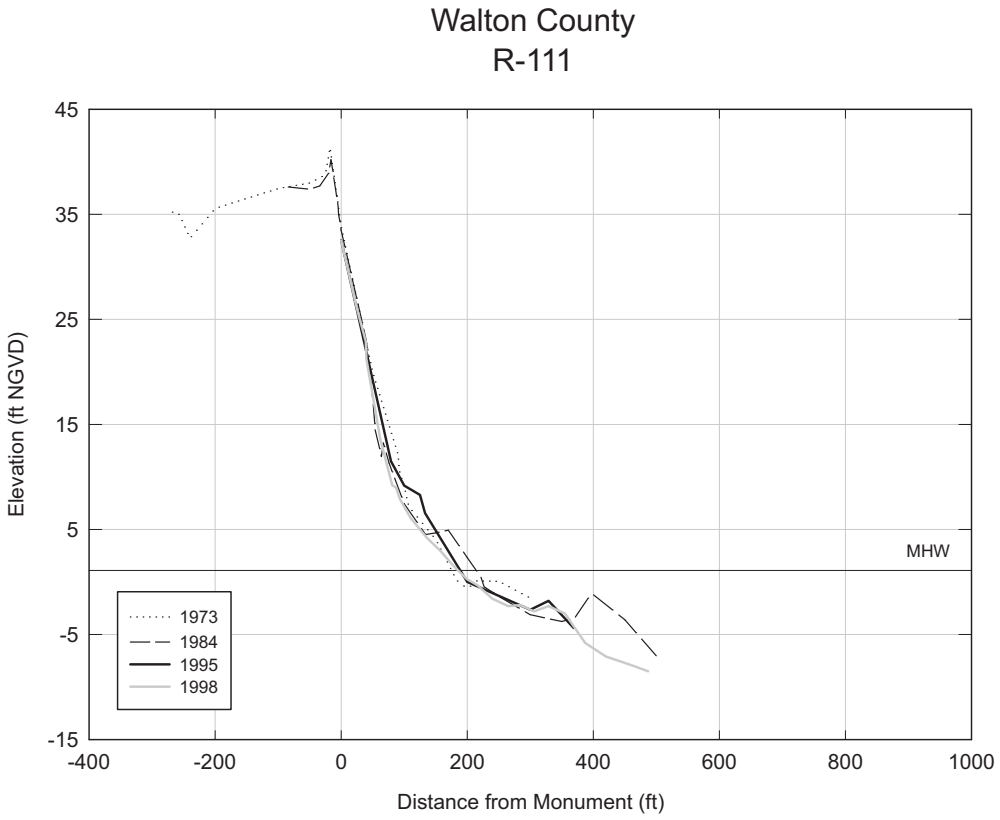
Walton County
R-69



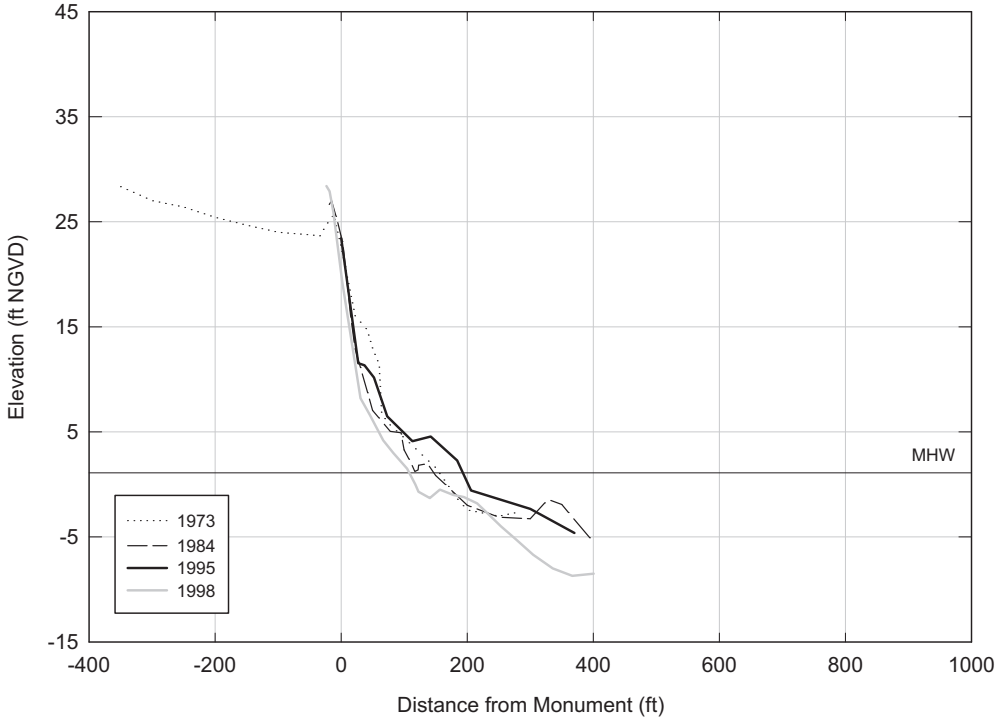

Walton County
R-81
Elevation (ft NGVD)
45
35
25
15
5
-5
-15
-400
-200
0
200
400
600
800
1000
Distance from Monument (ft)
MHW
1973
1984
1995
1997


Walton County
R-90
Elevation (ft NGVD)
45
35
25
15
5
-5
-15
-400
-200
0
200
400
600
800
1000
Distance from Monument (ft)
MHW
1973
1984
1995
1997


Walton County
R-99
Elevation (ft NGVD)
45
35
25
15
5
-5
-15
-400
-200
0
200
400
600
800
1000
Distance from Monument (ft)
MHW
1973
1984
1995
1997


Walton County
R-111
Elevation (ft NGVD)
45
35
25
15
5
-5
-15
-400
-200
0
200
400
600
800
1000
Distance from Monument (ft)
MHW
1973
1984
1995
1998

Walton County
R-120



Walton County
R-126