Shoreline Change Rate Estimates

Franklin County

August 2001

Prepared by:
Emmett R. Foster[1]
Jenny Cheng[2]

[1] *Office of Beaches & Coastal Systems*
Florida Dept. of Environmental Protection
Tallahassee, FL

[2] *Beaches & Shores Resource Center*
Florida State University
Tallahassee, FL

Report No. BCS-01-03
Florida Department of Environmental Protection
Office of Beaches and Coastal Systems

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 Jenny Cheng of the Beaches and Shores Resource Center. Mr. Foster is the author and editor of the text, calculations, and base graphics. Ms. Cheng formatted and assembled the report, detailed the graphics, plotted the profiles, and assisted with outlining and referencing. 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

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 EXECUTIVE SUMMARY

Franklin County is moderately developed and has a large and complex coastal system strongly influenced by many nearshore and offshore shoals. The western part of St. George Island from Sikes Cut to West Pass is strongly erosional for a large distance west of the Cut, highly unstable with a recent net erosional trend at Cape St. George, and net accretional towards West Pass. The shoreline for about 18,000 feet updrift of Sikes Cut is also erosional, an unusual condition believed to result from an adjustment in shoreline orientation which was occurring before the cut was made in 1954, but which is now strongly influenced by the inlet. A large portion of St. George has been stable, between approximately R-70 and R-93. Eastward to the end of the island at East Pass, there has been mild erosion on the order of -1 to -3 ft/yr, with the exception of a net accretion trend in the shelter of the East Pass ebb shoals.

On Dog Island the center of the island is highly erosional whereas the ends are highly accretional. The higher erosion rate estimates are on the order of -7 ft/yr.

On Alligator Point there are three sub-zones each with a different wave climate due to the presence and movement of offshore shoals. The zone from R-196 to R-210 (Southwest Cape) is generally mildly accretional at +1 to +2 ft/yr. Waves reach this area mostly by traversing between large offshore shoals.

The zone from R-210 to R-220 is erosional in the western half and accretional in the eastern half. Waves attack this area by traversing between large offshore shoals which have likely shifted westward over time. The moving or shifting shoals have sheltered the eastern part and exposed the western part to attacking waves.

The zone from R-220 to R-239 at Bald Point, the edge of Ochlockonee Bay, appears to have a net sand transport reversal point at about R-223. This time a changing shoal system has exposed the R-220 to R-223 area to south-westward moving waves, and the R-223 to R-232 area to north-eastward moving waves. Moderate erosion on the order of -3 to -4 ft/yr exists in the more highly eroding areas. There is accretion in the northernmost sheltered zone at Bald Point.

In conclusion, there are numerous localized zones of erosion, accretion, and stability along the Franklin County coast, influenced by the many near and offshore shoals. The majority of the coast experiences net east to west sand transport, consistent with the rest of the Florida Panhandle.

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

Franklin County is located in northwest Florida (Figure 1) on the Gulf of Mexico. The coast is moderately developed with single family and multi-family dwellings, as well as low rise motels and condominiums. It includes five distinct open coast segments. Starting from the Gulf County line as the west boundary, there are, from west to east: St. Vincent Island, the western third of St. George Island, the eastern two-thirds of St. George Island, Dog Island, and the Alligator Point to Bald Point segment. There are five entrances to Apalachicola Bay and St. George Sound; these entrances separate the open coast segments from each other and adjacent counties. Again from west to east, the entrances are: Indian Pass, West Pass, Sikes Cut, East Pass, and the (unnamed) east entrance to St. George Sound between Dog Island and Alligator Point. At the east end of Bald Point is Ochlockonee Bay, which is the tidal exit of the Ochlockonee River.

There are 239 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. There are no physical reference “R” monuments on St. Vincent Island, a National Wildlife Refuge. There are also no reliable mean high water (MHW) surveys of that area from the past two decades known to the author. St. Vincent Island will not be reviewed further in this report, since recent reliable data is not available.

Other large portions of Franklin County in public ownership are the following: Cape St. George State Preserve (R-1 to R-51), St. George Island State Park (R-105 to R-149), and portions of the Bald Point area are being developed into a state park, from approximately R-235 northward.

3.2 Coastal Setting

3.2.1 Waves and Tides

Tides are diurnal along this coast with mean tide ranges that linearly increase, more or less, from west to east, ranging from 1.08 ft at Indian Pass to 1.95 ft at Alligator Point (NOS 1988).

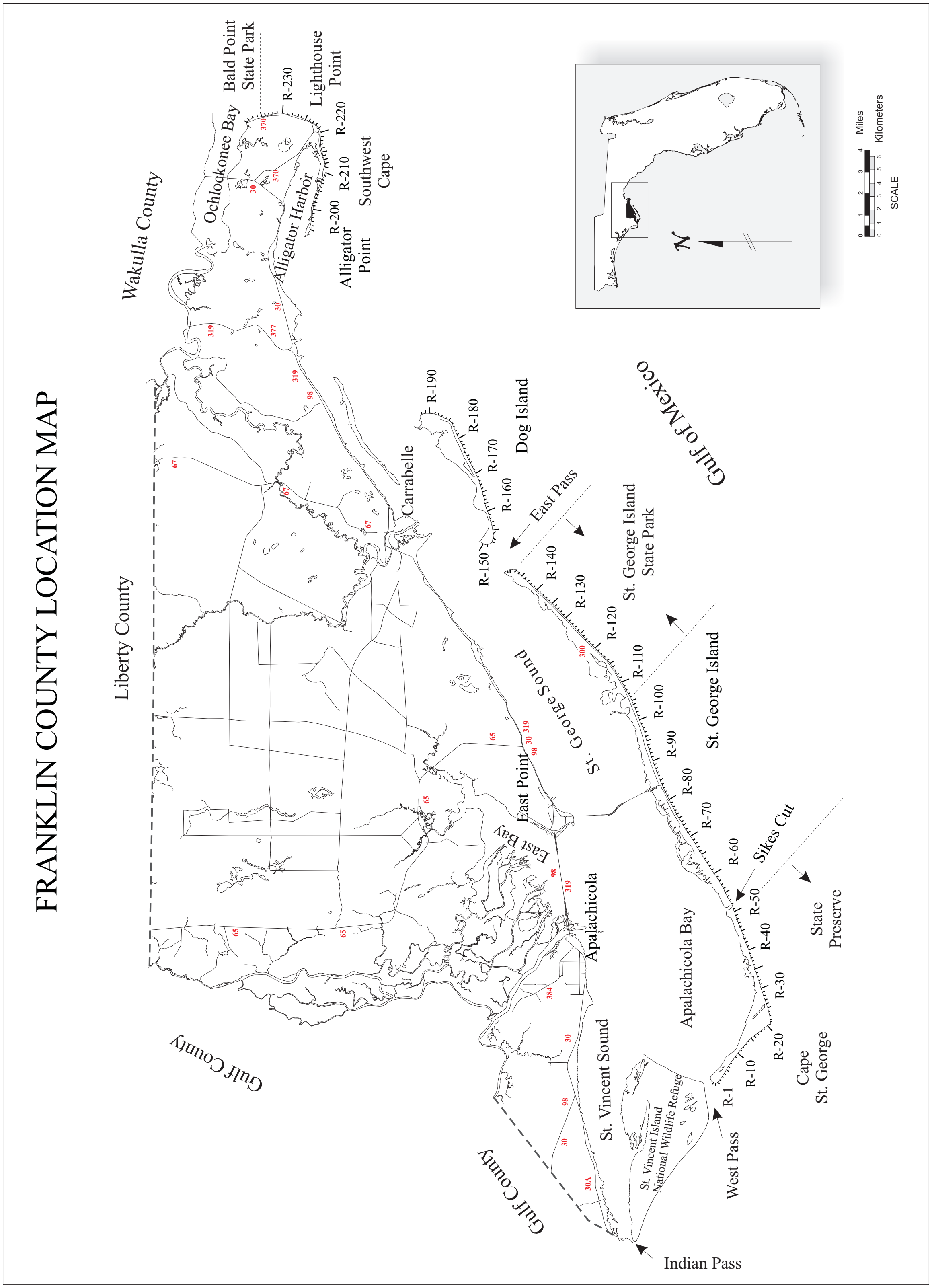


Figure 1. Study area showing Franklin County, Florida.

Wave directions and magnitudes actually impacting the coast are affected by the many shoals that exist both in the nearshore and offshore, as well as by the orientations of the islands (i.e. what wave directions can reach there). For most of St. George Island, east of the Cape, and Dog Island, the most frequent direction of wave attack is from the east-southeast (WES/USACE, 1999). For St. George Island, west of Cape St. George, the most frequent and longest fetch direction is from the southwest. For the Alligator Point zone, different areas are aligned to face different directions and waves must traverse through extensive offshore shoals.

In all areas, the highest waves occur in winter months and occasionally during the tropical storm season (WES/USACE, 1999).

3.2.2 Longshore Transport

Consistent with the wave information discussed above and the shoreline change patterns to be discussed, the overall direction of net littoral transport along the open coast of Franklin County is generally from east to west, as modified by the nearshore and offshore shoals throughout the county. The strongest pieces of evidence for this are the following: a stronger erosion pattern west of the Sikes Cut jetties; the larger ebb shoals and fluctuating shoreline deposition zones west of Indian Pass and West Pass; the larger portion of the ebb shoal on the west side of East Pass; and the erosion pattern inbetween the shoals southwest of Lighthouse Point. Exceptions will be discussed later.

The major shoals of this county can be viewed in any navigational chart of the area, and in the historic bathymetric maps (e.g. in the DEP Historic Shoreline Database).

There are no recent estimates of net longshore sand transport volumes known to the author. Dean and O'Brien (1987) provide the following estimates: at West Pass 115,000 cu. yds./yr. westward; at Sikes Cut and East Pass 175,000 cu.yds./yr. westward.

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. Hurricanes in this area caused extensive property damage, and beach and dune erosion. The most severe hurricane affecting this area in the past 20 years was probably Hurricane Kate in 1985. Hurricane Opal in 1995 was also significant. The regional effects of recent hurricanes have been discussed by Leadon (1999) and Leadon et al (1998).

3.3 Inlets

3.3.1 Indian Pass

This inlet separates the eastern end of Gulf County from St. Vincent Island (National Wildlife Refuge) in Franklin County. It is navigable by small boats. There is a large ebb shoal along the western Gulf County side which supplies sand to the beaches there and westward. The shoals change frequently and randomly, affecting the shoaling, refraction, and diffraction conditions. Most of the Gulf County shoreline in the vicinity of the shoal has been experiencing frequent random large-scale beach width changes.

3.3.2 West Pass

West Pass had been maintained for navigation until 1948. From 1900 to 1948, approximately 466,000 cu. yds. of dredged material had been removed from the channel and disposed of offshore. (Dean and O'Brien, 1987)

3.3.3 Sikes Cut

Sikes Cut was cut through St. George Island by local interests in 1954. Two jetties were constructed by the Army Corps of Engineers in 1956 to stabilize the channel. The channel has been maintained by dredging. During the time period 1956 to 1986, approximately 1,278,000 cu. yds. of dredged material were disposed of in the bay or Gulf or in eroded areas at the landward ends of the jetties. (Dean and O'Brien, 1987). Recent correspondence (4/01) from the Corps indicates that the inlet was last dredged in 1997. Since about 1980 the Corps has bypassed or used suitable dredged sand for shoreline stabilization adjacent to the jetties and within the inlet (R. Clark - Personal Communication). Numerous maintenance dredging projects averaged 40,000 cu. yds. per year between 1958 and 1975 (Zeh, 1980). Sikes Cut is part of the federal Apalachicola Bay Navigation Project.

3.3.4 East Pass

This inlet is located at the eastern end of St. George Island, separating it from Dog Island. It is part of the federal Carrabelle Harbor Navigation Project. No dredging of the Pass itself has occurred, at least in recent decades (R. Clark - P. C.).

3.4 Engineering Projects

Sikes Cut was discussed in a previous section. Other projects include a number of relatively small coastal armoring installations constructed along the coast of the Alligator Point complex. Starting at the west end, there are seven groins, still functional, at and west of R-196, which were contructed prior to 1973, per DEP aerial photos, and may have been constructed 1971-72 (per R. Clark - Personnal Communication). There is also a 200+ ft revetment west of R-196, constructed approximately 1983-84 (R. Clark - P. C.).

Moving eastward, the next zone of armoring is between R-210 and R-213. A small “KOA revetment” at R-212 existed as a rubble structure visible in DEP 1973 aerial photography. A larger rock structure approximately 1000 ft in length was built about 1986 to protect the county road washed out by Hurricane Kate (R. Clark - P. C.). It was continued westward about 1993-4 and eastward about 1995 (R. Clark - P. C.). A series of private bulkheads and walls were built between R-210 and 212, beginning in the mid to late1970’s through at least 1992 (R. Clark - P. C.). There were also at least two revetments built in the vicinity of R-214 from 1983 to 1986 (R. Clark - P. C.).

A concrete wall to protect a road segment was constructed from west of R-223 to about R-224, probably after Hurricane Alma in 1966 (R. Clark - P. C.), and prior to 1973. It has since been largely destroyed, but is still visible and having some influence on the coast. The road to Bald Point has been relocated twice through 1998.

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 shoreline change 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

In this report it is helpful to discuss coastal Franklin County by segments, west to east. As previously indicated, a lack of recent data prevents any useful discussion of St. Vincent Island at this time.

Data problems also exist in the Dog Island and the Alligator point to Bald Point segments. There was no DEP field survey until 1981 in these two latter segments. In addition there are known but as yet unresolved vertical control problems with 1996 DEP data on Dog Island. Since the amount of data is limited in general in this county, the database was supplemented in both segments with mhw estimates taken from DEP 1974 controlled aerial photos in order to have at least some visually verifiable data from the early 1970's available. Using data from 1981 on would be very limiting due to the relatively short time frame.

In general, it is also noted that the 1996 DEP survey (and perhaps 1997 survey as well) can arguably be considered to be a post-storm survey, relatively close in time to Hurricane Opal in 10/95. Therefore, because of limited choices, the data available for this analysis is not as good as one would hope for and caution is advised in its' use. Perhaps the change rate estimates in the last two segments can best be considered to be order of magnitude estimates.

5.1 St. George Island, West Pass to Sikes Cut, Including Cape St. George: R-1 to R-51

Figures 2 and 3 show this zone in plan view with selected historic shorelines. Shoreline (MHW) change rate estimates are provided in Figure 4 and Table A-1 (Appendix A). First examined will be the West Pass to Cape area, R-1 to R-21, as shown in Figure 2. The coastal process appears to be a cyclic pattern of the Cape building out westward, sometimes accompanied by an erosion pocket on the downdrift (northwest) side, followed by loss of the Cape buildup to the northwest, the sand being distributed along the entire length of shoreline to R-1. This cycle appears to have occurred several times, with occasional variations due to storms rounding out the Cape more than usual, such as shown in the 1996 MHW shoreline.

The sand to supply this process most likely comes primarily from the erosion of St. George Island between Sikes Cut and the Cape, as shown in Figure 3 in plan view. This area also has a somewhat complicated erosion process consisting of two patterns working additively on the shoreline. Regardless of Sikes Cut there has been erosion

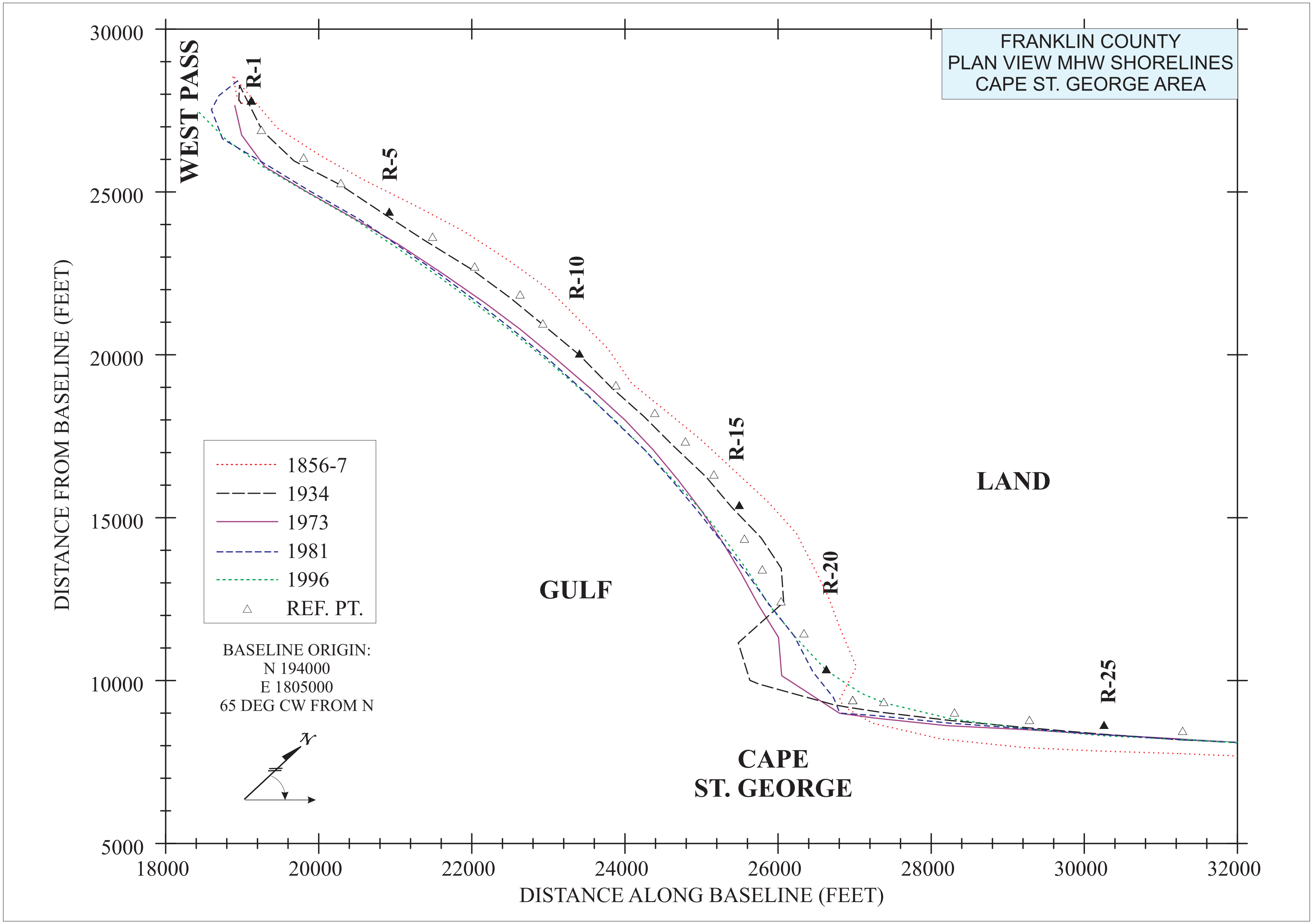


Figure 2. Plan view map of Franklin County, Florida (Cape St. George Area), comparing years 1856-7, 1934, 1973, 1981, and 1996.

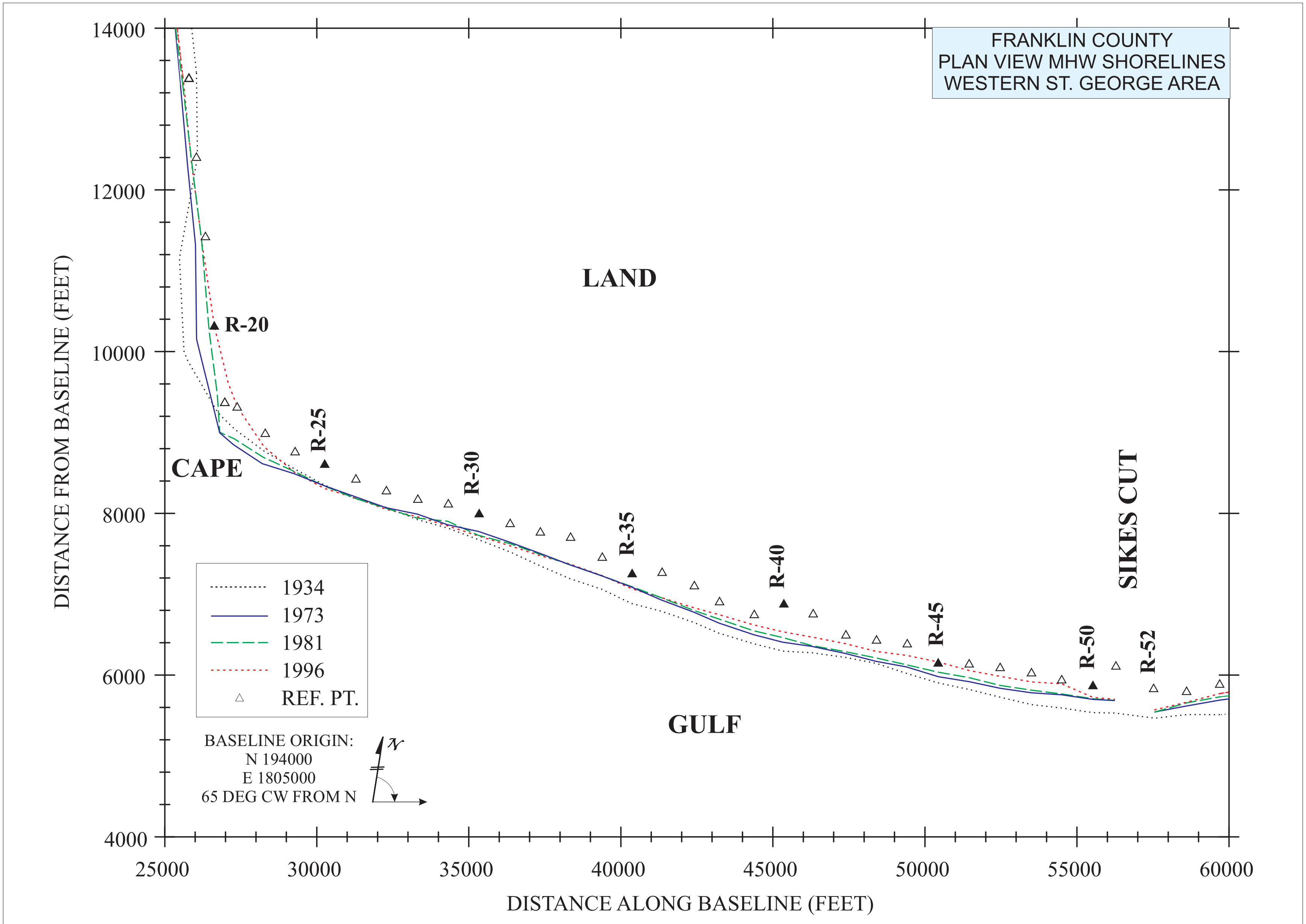


Figure 3. Plan view map of Franklin County, Florida (Western St. George Area), comparing years 1934, 1973, 1981, and 1996.

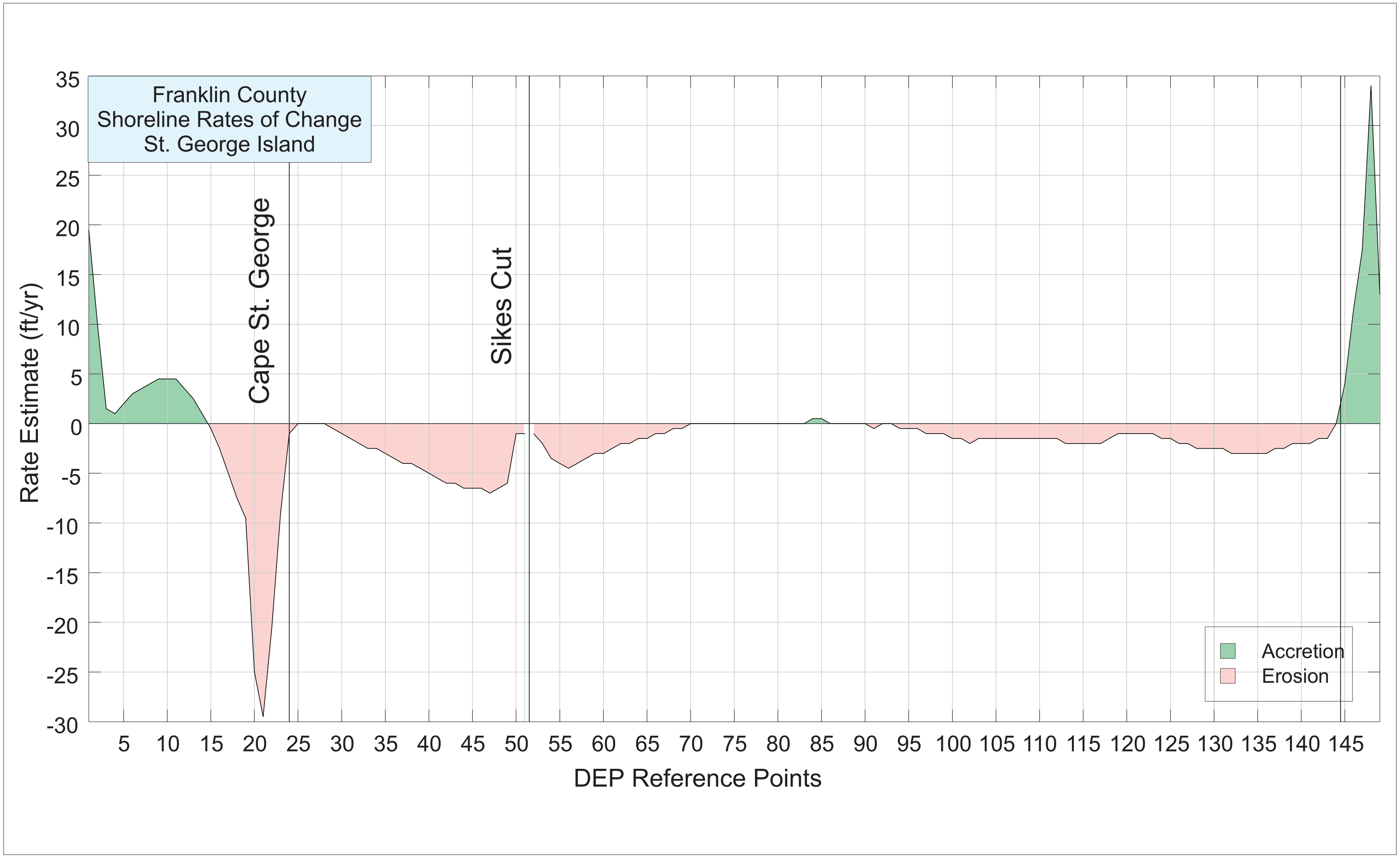


Figure 4. Shoreline rate of change estimates for Franklin County, Florida (St. George Island).

or flattening of the shoreline bulge which extended from about R-27 to about R-70, as shown in the 1934 shoreline of Figures 3 and 5. With the construction of Sikes Cut there has been an overlaid or additional pattern of progressive erosion extending from the inlet jetties westward, implying a sand supply deficit caused by the inlet. The total erosion is the sum of these two patterns. The latter pattern is commonly found in Florida and was discussed by Foster (1995).

Referring back to Figure 2 again, the Cape St. George area itself, approximately R-19 to R-24 has experienced significant net losses since at least 1973, possibly as a result of several factors including the ongoing cycle, storms, reduced sand supply, and also possibly from reduced protection via the offshore shoals moving or wearing down.

Regarding estimates of the magnitude of shoreline changes in the area, Table A-1 (Appendix A) and Figure 4 list and show the author's choices. Recall that the objective is to estimate change rates relating to recently active conditions. To that end, for the R-1 to R-22, West Pass to Cape St. George area, the time period 1973 to 1996 was selected to calculate erosion "trends" developed from least-squares and simple end-point calculations. The process and changes at many reference points here are highly non-linear (see the plots in Appendix B), so a "trend" is possibly the best estimate of recent shoreline change magnitude available using this data at this time. Those trend estimates range from an accretion maximum of + 19.5 ft/yr at R-1 to an erosion maximum of -29.5 ft/yr at R-21, 1973 to 1996. The transition between a net accretion trend and a net erosion trend occurs between R-15 and R-16.

Moving eastward from the eroding Cape, R-23 to R-51, the highly erosive Cape values taper rapidly to zero at about R-25, and then increase steadily to -7 ft/yr at R-47. The rates decrease rapidly to -1 ft/yr in the immediate lee of the west jetty of Sikes Cut, R-50 and 51, most likely due to occasional filling from dredging operations. The time periods over which approximately linear change rates are calculated also change, being shorter closer to the Cape and the inlet in order to capture recent conditions.

5.2 St. George Island, Sikes Cut to East Pass: R-52 to R-149

In comparison to the just reviewed western third of St. George Island, this segment of coast is relatively sedate. As shown in the rate estimates of Figure 4 and the plan views of Figures 5 and 6, there are two zones of moderate erosion.

The western zone begins at the eastern jetty of Sikes Cut and extends eastward to approximately R-70. The highest averaged rate of erosion calculated for this area is -4.5 ft/yr, which tapers down to zero at R-70. Note that the rates are smaller close to the jetty. This pattern of erosion is unique in Florida, i.e. erosion on the updrift side of inlet jetties. The interpretation is that this area is part of the seaward bulge in shoreline orientation which extended from about R-27 to about R-70, which is still

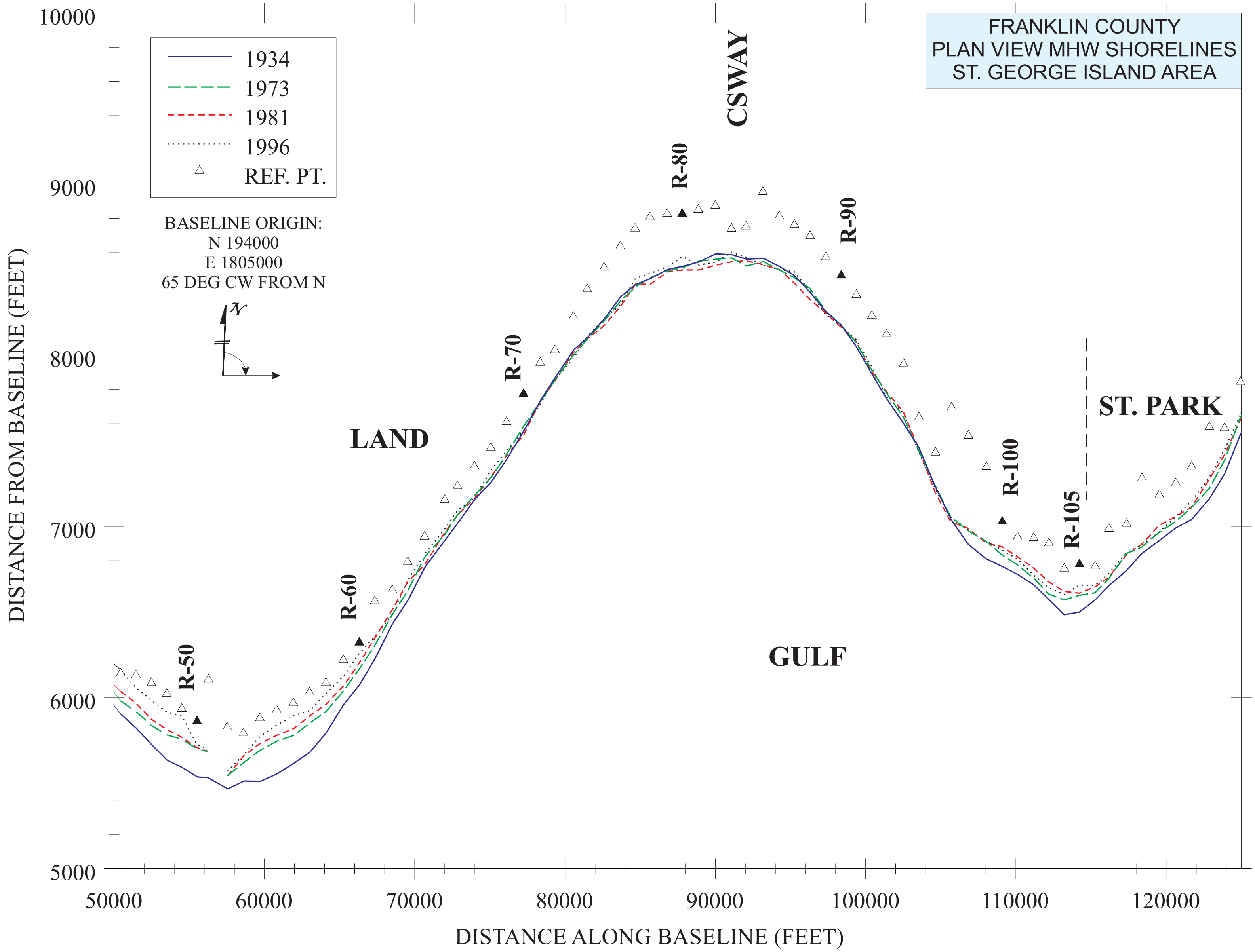


Figure 5. Plan view map of Franklin County, Florida (St. George Island Area), comparing years 1934, 1973, 1981, and 1996.

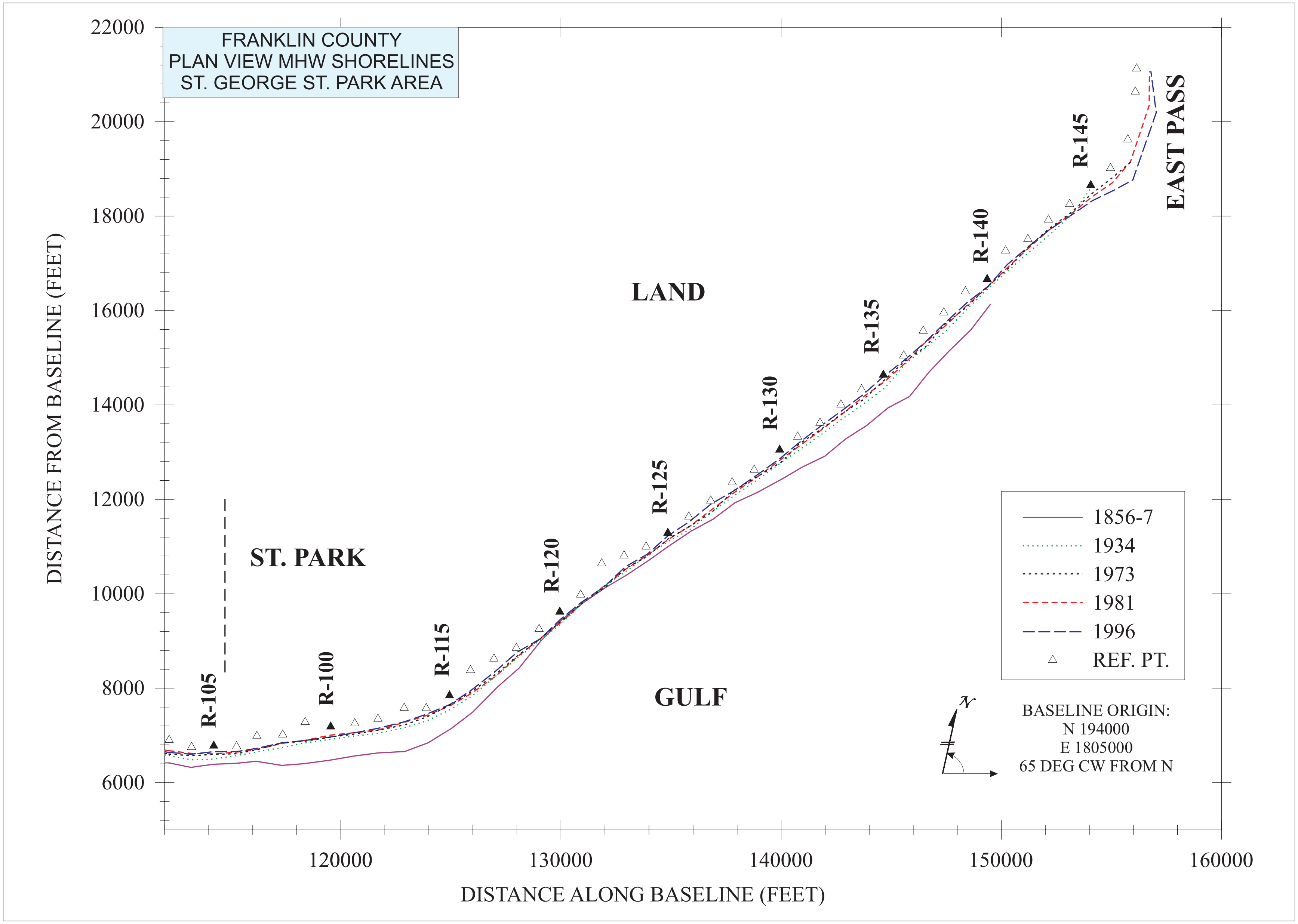


Figure 6. Plan view map of Franklin County, Florida (St. George St. Park Area), comparing years 1856-7, 1934, 1973, 1981, and 1996.

eroding or flattening out. The preferred physical orientation on the updrift side of any coastal barrier is not a seaward bulge but is instead an inward curved semi-triangular shaped fillet with the widest point at the barrier. The shoreline updrift of Sikes Cut will continue eroding until it reaches an orientation like that, consistent with the sand supply and wave climate. Irregularities in the orientation of the eroded 1996 plan view shoreline of Figure 5, between R-52 and R-70, may be due to nearshore shoal local refraction effects, possible subsurface harder or less erosive strata, or possibly just that survey being in a post Hurricane Opal near time frame.

Between R-70 and about R-93, the shoreline has remained relatively stable. Eastward however, the erosion pattern may be interpreted as primarily the continuation of the erosion or flattening out of the seaward bulges shown in Figures 5 and 6. In the process of these bulges (associated with offshore shoals) flattening out, sand moves in both lateral directions. This, coupled with seasonal easterly transport into the shelter of the east pass ebb shoals, can account for the easterly growth of the island in the period 1856-7 to 1934. These factors are still probably at work to a limited extent, although sand is now also probably bypassed onto the end of the island via the shoals as well. It is not clear whether any underlying pattern of progressive erosion westward from the inlet is embedded within the net erosion pattern, but it is possible. If so, erosion west of East Pass will increase in the future.

Erosion rate estimates range mostly between -1 and -2 ft/yr from R-97 to R-127, then increase to -3 ft/yr inbetween R-132 and R-136. There is a transition to an accretional recent trend in the shoreline east of R-144, in the relative shelter of the East Pass ebb shoals. The phrase “recent trend” is useful in this area affected by the ebb shoals since large beach width fluctuations would be expected.

5.3 Dog Island: R-150 to R-193

The island is shown in plan view in Figure 7, and rate of change estimates are graphed in Figure 8. The erosion pattern on Dog Island can be simply described as eroding in the middle and accreting at the very ends. By way of interpretation, it appears that the island formed with a bulging seaward orientation that has since (at least since the 1800’s) been flattening out, i.e. eroding. There are irregular nearshore shoals still affecting the shape of the island. There may also be an underlying erosion pattern, obscured by the larger pattern, that represents dominant westward moving wave energy and an increasing deficit of sand supply from the Dog Island Reef area. If so, this latter pattern will in the long term become the primary factor, perhaps eventually changing the shape of the island towards a concave orientation, a massive erosional change.

The highest erosion rates are found in the most seaward bulging central part of the island, approximately R-163 to R-170, at -5 to -6 ft/yr. An erosional spike also has occurred in the vicinity of R-184, but this is a shoal influenced area subject to large

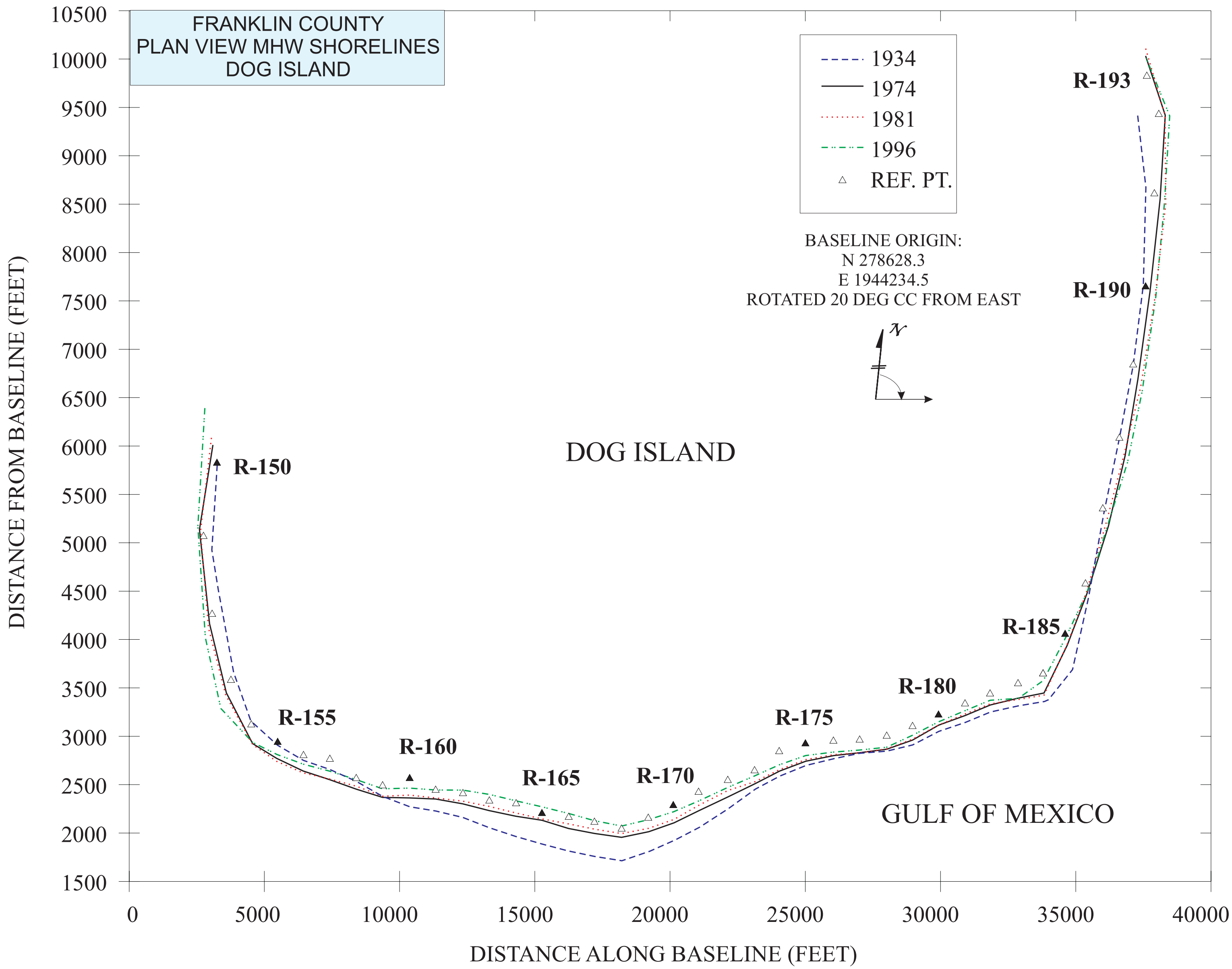


Figure 7. Plan view map of Franklin County, Florida (Dog Island), comparing years 1934, 1974, 1981, and 1996.

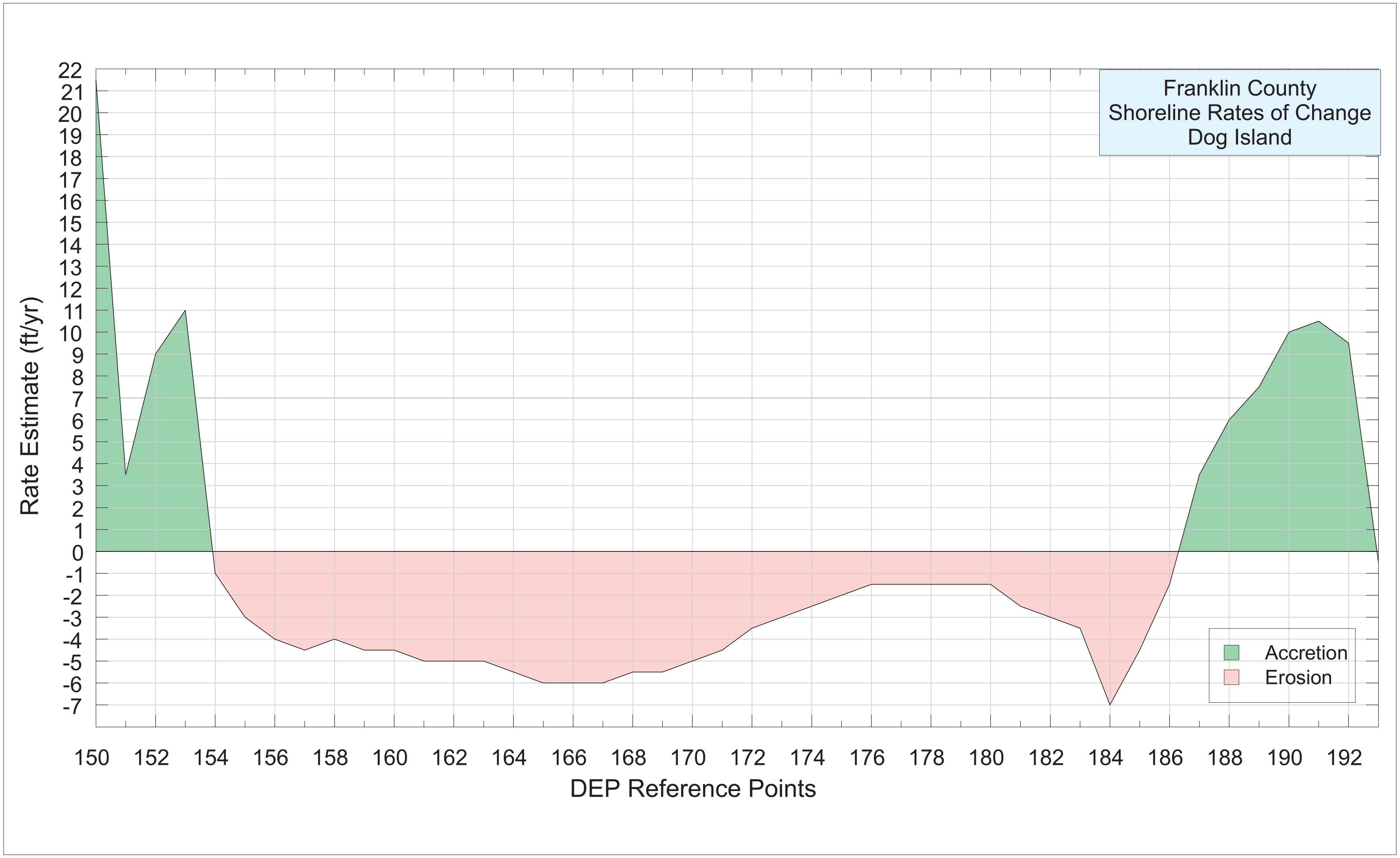


Figure 8. Shoreline rate of change estimates for Franklin County, Florida (Dog Island).

beach width fluctuations, and this spike may be more of a recent storm influenced "trend".

5.4 Alligator Point to Bald Point: R-194 to R-239

In this report, Alligator Point is considered to be the entire peninsula extending from Lighthouse Point westward (See Figure 1). For this section please refer to shoreline plan view Figures 9, 10 and 11, and plotted change rates in Figure 12.

There are three sub-zones in the Alligator Point to Bald Point segment controlled by their relationship to the large offshore shoals in this area. The first extends from R-194 to R-210. This sub-zone appears to receive sand primarily from the east, around Southwest Cape, and perhaps from the offshore shoals. Because of the very large shallow offshore shoal, called South Shoal, off Southwest Cape, higher energy waves reach the area mostly from the south, inbetween South Shoal and Dog Island Reef. These waves either hit the area relatively straight on or with a mildly westward net direction, particularly at the western end. Several groins were constructed in the vicinity of R-196 westward, pre-1973. These have acted as terminal groins, causing downdrift westward erosion and moderate updrift accretion.

Overall, the area between R-210, at Southwest Cape, and R-196 has been mildly accretional, on the order of +1 to +2 ft/yr, 1934 to 1997/8. The erosion west of the R-196 groins has been very high, as much as -16 ft/yr, 1974-1997.

The second sub-zone lies between R-210 and R-220, from Southwest Cape to Lighthouse Point. The pattern of shoreline change here has been accretional from R-219 to R-216, transitioning rapidly to erosional from R-215 to R-211. Accretion has been as high as +5 ft/yr at R-219. Erosion has been as great as -6 ft/yr at R-212. This change pattern, shown in the plan view of Figure 9, is indicative of a westward shifting channel of wave attack between the shoals off Southwest Cape and the shoals off Lighthouse Point. Either the shoals are moving or otherwise shifting westward, sheltering and exposing different areas to wave attack as they move.

The observed westward translation of the point of land from R-220 to R-219 over the period 1934 to 1997 in the plan views of Figures 9 and 10 is strong evidence of this process. The beach in the vicinity of R-220 to R-223 has consequently become erosional, on the order of -2.5 ft/yr, as the offshore shoal offered less and less shelter. This pattern will likely continue.

The third and last sub-zone extends from R-220 to the end of the county at R-239, the edge of Ochlockonee Bay at Bald Point. The erosion pattern in this area is again interpreted as related to the complexity of the offshore shoals. Figures 10 and 11 show this area in plan views. It appears there is a net sand transport reversal point at about R-223. A possible coastal process interpretation is that as the shoal off

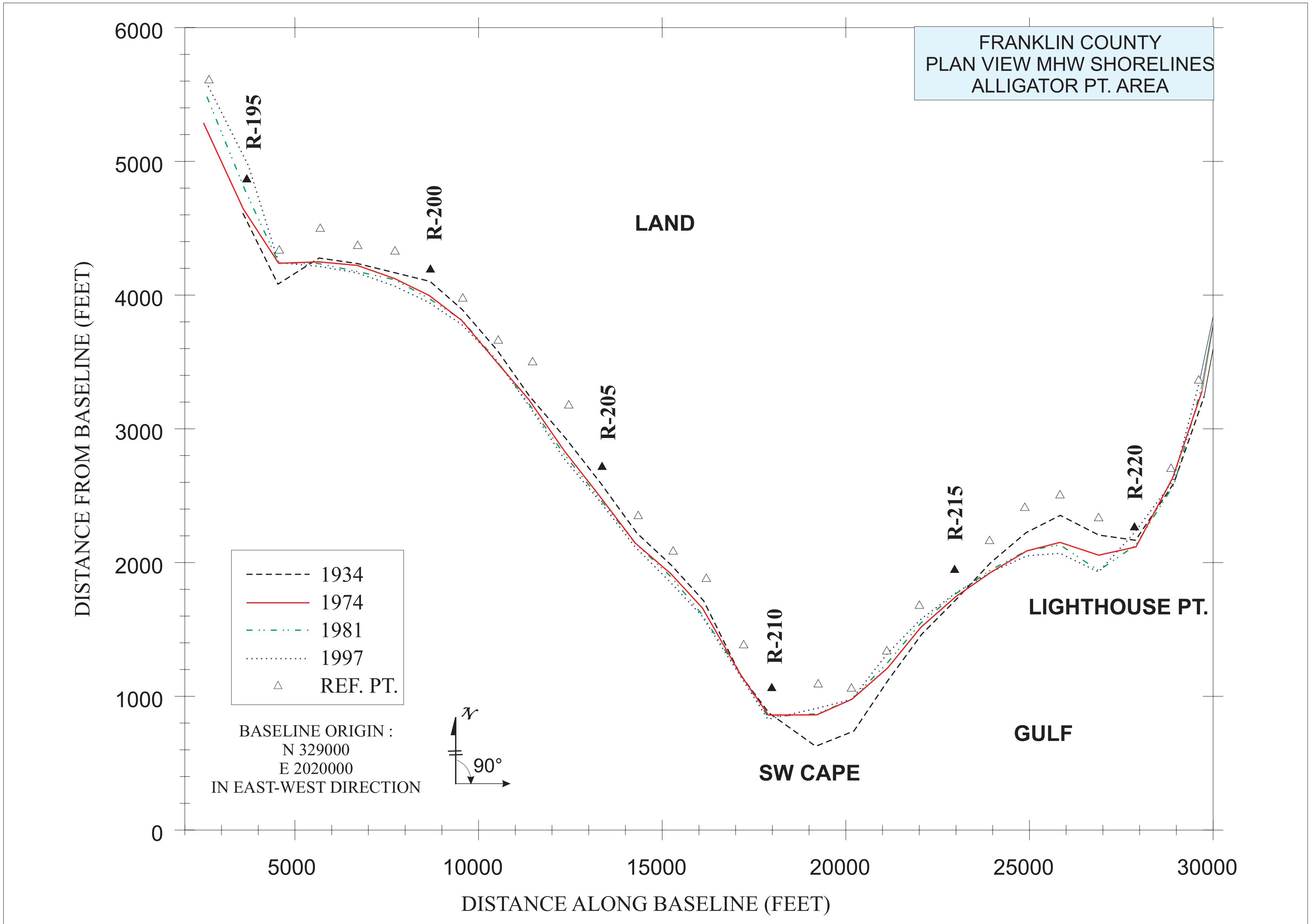


Figure 9. Plan view map of Franklin County, Florida (Alligator Point Area), comparing years 1934, 1974, 1981, and 1997.

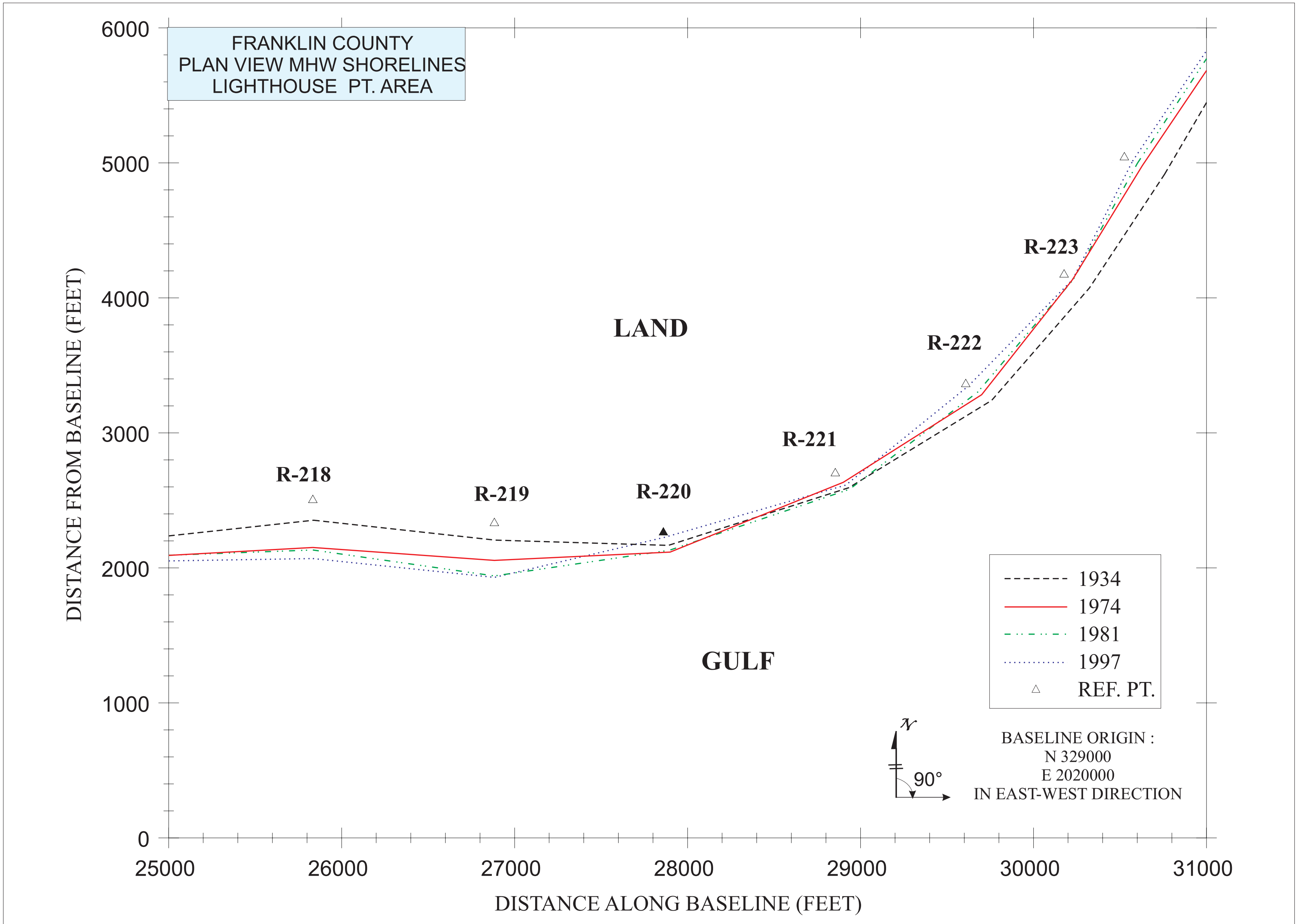


Figure 10. Plan view map of Franklin County, Florida (Lighthouse Point Area), comparing years 1934, 1974, 1981, and 1997.

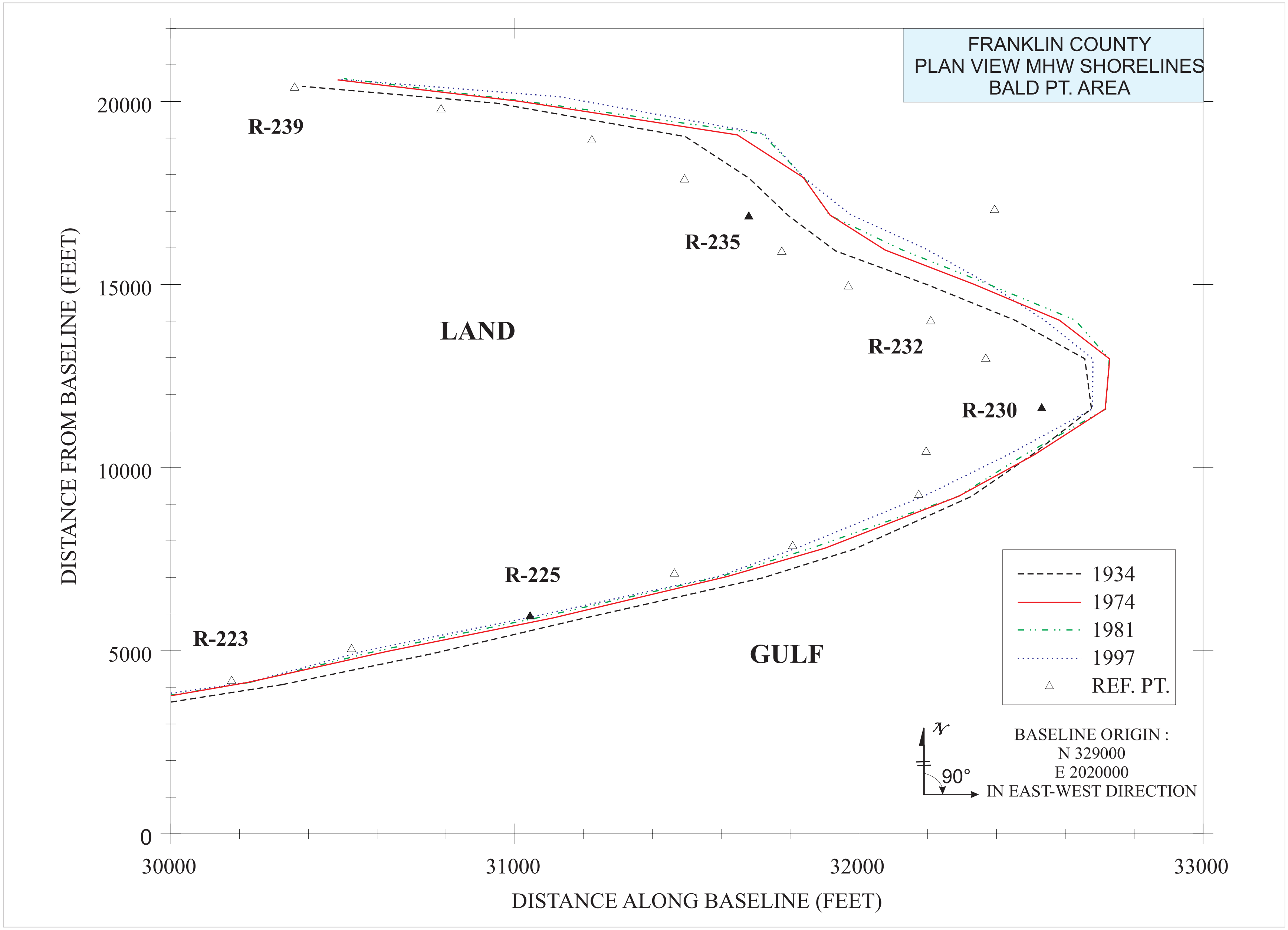


Figure 11. Plan view map of Franklin County, Florida (Bald Point Area), comparing years 1934, 1974, 1981, and 1997.

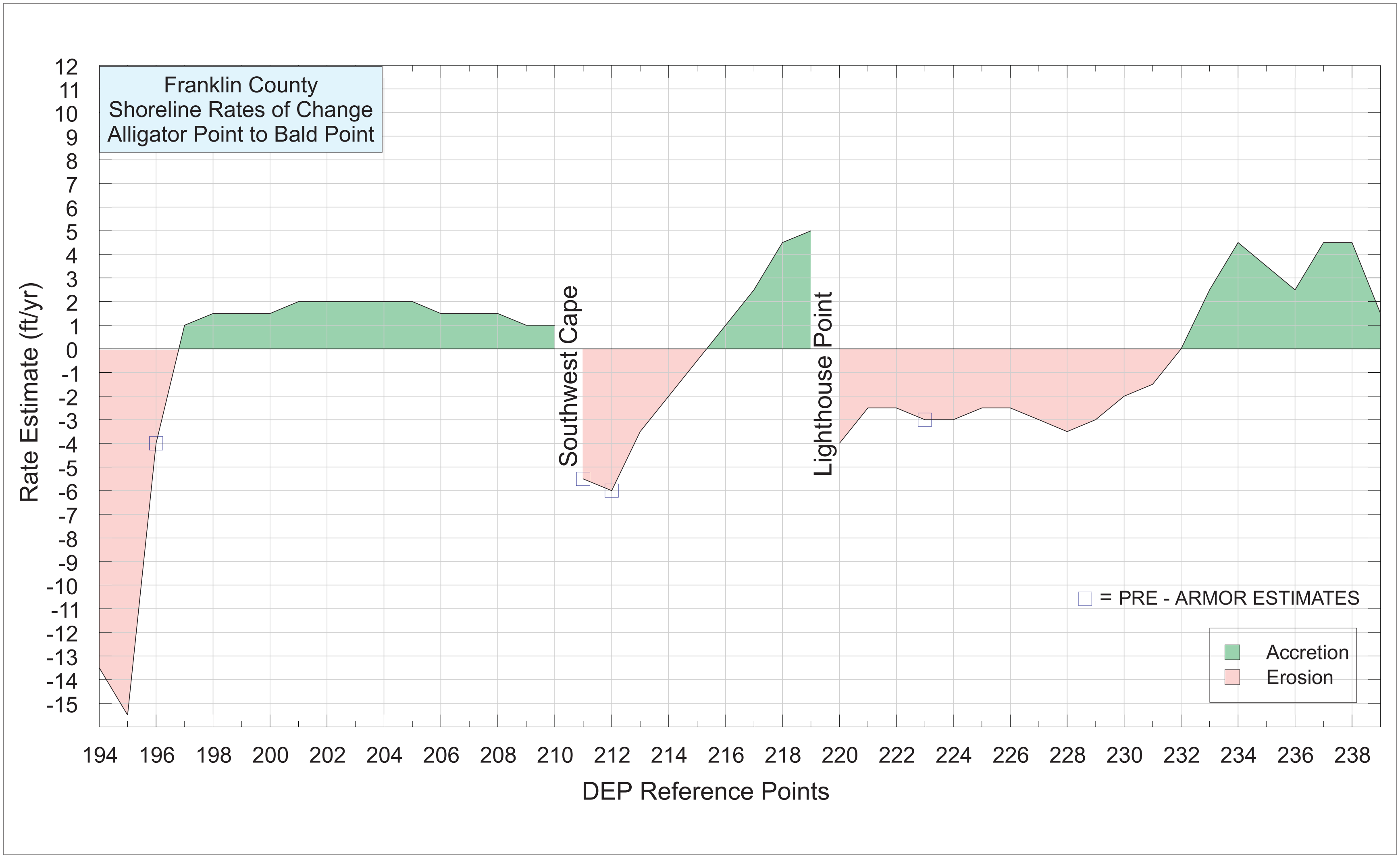


Figure12. Shoreline rate of change estimates for Franklin County, Florida (Alligator Point).

Lighthouse Point moved or shifted south-westward it opened a wider wave channel between it and the Bald Point shoals. The shoreline between R-223 and R-220 became increasingly exposed to waves from the east. The shoreline from R-223 to about R-232 became increasingly exposed to waves from the southeast. This would result in the shoreline change patterns shown in Figures 10 and 11. The beach remains accretional in the shelter of the shoals off Bald Point. The highest averaged erosion rate estimates between R-220 and R-232 are -4 and -3.5 ft/yr. The highest averaged accretion rate estimate between R-232 and R-239 is +4.5 ft/yr.

6 REFERENCES

Dean, R. G. and O'Brien, M. P., 1987. Florida's West Coast Inlets: Shoreline Effects and Recommended Action. University of Florida, Coastal and Oceanographic Engineering Department, Gainesville, FL, UFL/COEL-87/018, 100 p.

Foster, Emmett R., 1995. The Common Thread in Inlet-induced Erosion: Basic Theory and Florida Examples. In: Proceedings of the Eighth National Conference on Beach Preservation Technology. Tallahassee, FL: Florida Shore and Beach Preservation Association, pp. 227-242.

Foster, Emmett R., 1992. Thirty Year Erosion Projections in Florida: Project Overview and Status. In: Proceedings of the 23rd International Conference on Coastal Engineering, Venice, Italy. American Society of Civil Engineers (ASCE), NY, Vol. 2, pp. 2057-2070.

Foster, Emmett R. and Savage, Rebecca J., 1989. Methods of Historical Shoreline Analysis. In: Coastal Zone '89. American Society of Civil Engineers (ASCE), NY, Vol. 5, pp. 4434-4448.

Leadon, Mark E., 1999. Beach, Dune and Offshore Profile Response to a Severe Storm Event. In: Kraus, N. C. and McDougal, W. G. (Eds), Coastal Sediments '99, Proceedings of the 4th International Symposium on Coastal Engineering and Science of Coastal Sediment Processes. American Society of Civil Engineers (ASCE), NY, Vol.3, pp. 2534-2549.

Leadon, M. E., Nguyen, N. T., and Clark, R. R., 1998. Hurricane Opal: Beach and Dune Erosion and Structural Damage Along the Panhandle Coastal of Florida. Tallahassee, FL: Florida Department of Environmental Protection, Bureau of Beaches and Coastal Systems, BCS Number 98-01.

National Ocean Service, 1988. Published Tidal Benchmark Sheets. Available from World Wide Web <http://co-ops.nos.noaa.gov/bench.html>. ASCII format.

Waterways Experiment Station [cited 1999]. Wave Information Study, Gulf of Mexico Phase I: 1976-1995. Vicksburg, MS: U.S. Army Corps of Engineers. Available from World Wide Web at Coastal Engineering Data Retrieval System (CEDRS) <http://bigfoot.wes.army.mil/u023.html>. ASCII format.

Zeh, T. A., 1980. Sikes Cut, Glossary of Inlets Report #7. Florida Sea Grant College Report Number 35, University of Florida, Dept. of Coastal and Oceanographic Engineering, Gainesville, FL, 39p.

7 APPENDICES

7.1 Appendix A: Shoreline Change Rate Estimates

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

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

Range	Time Span	Method			Rounded Concensus Average	Comments
		RA	LS	EP		
West Pass						
1	1973-1996	N/A	17	22.4	19.5	1 PT. AVG.
2	1973-1996	″	9.7	10.5	10	1 PT. AVG.
3	1973-1996	″	2.2	1	1.5	1 PT. AVG.
4	1973-1996	″	1.2	0.4	1	3 PT. AVG.
5	1973-1996	″	1.1	0.6	2	5 PT. AVG.
6	1973-1996	″	3.1	3.2	3	7 PT. AVG.
7	1973-1996	″	3.7	4	3.5	↓
8	1973-1996	″	4.1	5.1	4	
9	1973-1996	″	4.2	5.6	4.5	
10	1973-1996	″	4.2	5.4	4.5	
11	1973-1996	″	3.9	5.5	4.5	
12	1973-1996	″	3.5	5.4	3.5	
13	1973-1996	″	3.1	4.6	2.5	
14	1973-1996	″	2.2	2.6	1	
15	1973-1996	″	0.9	-0.1	-0.5	↑
16	1973-1996	″	-3.3	-2.4	-2.5	7 PT. AVG.
17	1973-1996	″	-6.4	-4.5	-5	5 PT. AVG.
18	1973-1996	″	-8	-5.7	-7.5	3 PT. AVG.
19	1973-1996	″	-10.4	-9	-9.5	1 PT. AVG.
20	1973-1996	″	-23.4	-26.3	-25	1 PT. AVG.
21	1973-1996	″	-29.7	-29.3	-29.5	1 PT. AVG.
22	1973-1996	N/A	-20.4	-21	-20.5	1 PT. AVG.
Cape St. George						
23	1973-1996	-9	-8.4	-9.4	-9	1 PT. AVG.
24	1973-1996	-0.9	-1.5	-0.9	-1	1 PT. AVG.
25	1973-1996	1.7	0.9	1.4	0	3 PT. AVG.
26	1934-1996	-0.2	0.1	-0.2	0	5 PT. AVG.
27	1934-1996	0.4	0.7	0.4	0	7 PT. AVG.
28	1934-1996	-0.6	-0.5	-0.6	0	↓
29	1934-1996	-0.4	-1	-0.4	-0.5	
30	1934-1996	0	-1.1	-0.7	-1	
31	1934-1996	-1.5	-1.7	-1.2	-1.5	

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

Range	Time Span	Method			Rounded Concensus Average	Comments
		RA	LS	EP		
32	1934-1996	-1.6	-2.2	-2	-2	
33	1934-1996	-2.5	-3.2	-2.9	-2.5	
34	1934-1996	-2.6	-3.2	-2.7	-2.5	
35	1934-1996	-2.9	-3.9	-2.9	-3	
36	1934-1996	-2.9	-3.3	-2.7	-3.5	
37	1973-1996	-2.6	-2.2	-2.4	-4	
38	1973-1996	-4.2	-4	-4.5	-4	
39	1973-1996	-5.2	-4.9	-5.3	-4.5	
40	1973-1996	-5.2	-5.6	-5.6	-5	
41	1973-1996	-4.6	-5.7	-5	-5.5	
42	1973-1996	-5.4	-6.4	-5.3	-6	
43	1973-1996	-5.7	-6.2	-5.4	-6	
44	1973-1996	-5.7	-6.6	-6.2	-6.5	
45	1973-1996	-9.1	-8.8	-7.9	-6.5	↑
46	1973-1996	-6.5	-7.1	-6	-6.5	7 PT. AVG.
47	1973-1996	-6.9	-7	-6.4	-7	5 PT. AVG.
48	1973-1996	-6.2	-6.7	-5.8	-6.5	3 PT. AVG.
49	1973-1996	-5.7	-6.8	-5.9	-6	1 PT. AVG.
50	1973-1996	N/A	N/A	-1.1	-1	1 PT. AVG.
51	1973-1996	N/A	N/A	-0.7	-1	1 PT. AVG.
Sikes Cut						
52	1973-1996	N/A	N/A	-1.1	-1	1 PT. AVG.
53	1973-1996	N/A	N/A	-2	-2	1 PT. AVG.
54	1973-1996	N/A	N/A	-3.5	-3.5	1 PT. AVG.
55	1973-1996	N/A	N/A	-4.1	-4	1 PT. AVG.
56	1934-1996	-4.6	-4.3	-4.5	-4.5	1 PT. AVG.
57	1934-1996	-4.1	-4.2	-3.9	-4	3 PT. AVG.
58	1934-1996	-4	-3.7	-3.7	-3.5	5 PT. AVG.
59	1934-1996	-2.8	-2.6	-2.7	-3	7 PT. AVG.
60	1934-1996	-3.4	-3.2	-3	-3	↓
61	1934-1996	-2.5	-2.5	-2.1	-2.5	
62	1934-1996	-1.4	-1.5	-0.9	-2	
63	1934-1996	-2.4	-2.1	-1.9	-2	

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

Range	Time Span	Method			Rounded Concensus Average	Comments
		RA	LS	EP		
64	1934-1996	-1.5	-1.2	-1.2	-1.5	
65	1934-1996	-1.2	-1.2	-1.1	-1.5	
66	1934-1996	-1.6	-1.5	-1.2	-1	
67	1934-1996	-0.2	-0.5	-0.2	-1	
68	1934-1996	-1.4	-1.3	-1.2	-0.5	
69	1934-1996	-1	-1	-0.8	-0.5	
70	1934-1996	-0.1	0	-0.1	0	
71	1934-1996	0.3	0.4	0.3	0	
72	1934-1996	0.1	0	0.1	0	
73	1934-1996	0.6	0.5	0.8	0	
74	1934-1996	-0.1	0.1	-0.1	0	
75	1934-1996	0	0.1	0	0	
76	1934-1996	0.9	1.1	0.7	0	
77	1934-1996	-0.6	-0.1	-0.6	0	
78	1934-1996	-0.5	-0.3	-0.5	0	
79	1934-1996	-0.3	-0.5	-0.3	0	
80	1934-1996	-1.1	-0.3	-0.9	0	
81	1934-1996	0.3	0.2	0.3	0	
82	1934-1996	1	1.1	0.8	0	
83	1934-1996	-0.2	0.5	-0.2	0	
84	1934-1996	-0.2	0.3	-0.2	0.5	
85	1934-1996	0.8	0.8	0.6	0.5	
86	1934-1996	0.3	0.5	0.3	0	
87	1934-1996	-0.4	0.3	-0.4	0	
88	1934-1996	-0.1	0.3	-0.1	0	
89	1934-1996	0.3	0.3	0.3	0	
90	1934-1996	0.1	0.1	0.1	0	
91	1934-1996	-0.6	-0.5	-0.6	-0.5	
92	1934-1996	-0.7	-0.7	-0.7	0	
93	1934-1996	-0.1	-0.4	-0.1	0	
94	1934-1996	-0.9	-1.1	-1	-0.5	
95	1934-1996	0.4	0.4	0.4	-0.5	
96	1934-1996	0.2	0.5	0.2	-0.5	

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

Range	Time Span	Method			Rounded Concensus Average	Comments
		RA	LS	EP		
97	1934-1996	-0.2	-0.3	-0.2	-1	
98	1934-1996	-1.3	-1.6	-1.3	-1	
99	1934-1996	-2.1	-2	-1.7	-1	
100	1934-1996	-1.8	-2	-1.5	-1.5	
101	1934-1996	-1.8	-1.9	-1.4	-1.5	
102	1934-1996	-1.2	-1.5	-0.9	-2	
103	1934-1996	-1.1	-1.4	-1.1	-1.5	
104	1934-1996	-2.7	-2.5	-1.9	-1.5	
105	1934-1996	-2.6	-2.5	-2.5	-1.5	ST. PARK
106	1934-1996	-1.2	-1.3	-1.4	-1.5	↓
107	1934-1996	-1	-1	-1.2	-1.5	
108	1934-1996	-2	-2	-1.7	-1.5	
109	1934-1996	-0.8	-1	-0.8	-1.5	
110	1934-1996	-1.1	-1.3	-0.8	-1.5	
111	1934-1996	-1.4	-1.4	-1	-1.5	
112	1934-1996	-1.7	-1.8	-1.8	-1.5	
113	1934-1996	-2.3	-2.1	-2	-2	
114	1934-1996	-3	-2.6	-2.3	-2	
115	1934-1996	-1.8	-2.1	-1.8	-2	
116	1934-1996	-1.6	-1.8	-2	-2	
117	1934-1996	-2.3	-1.6	-1.6	-2	
118	1934-1996	-2	-1.7	-1.9	-1.5	
119	1934-1996	-0.5	-0.8	-0.5	-1	
120	1934-1996	-1.8	-1.4	-1.5	-1	
121	1934-1996	-0.6	-0.3	-0.6	-1	
122	1934-1996	0.1	0	0.1	-1	
123	1934-1996	-1.6	-1.4	-1.6	-1	
124	1934-1996	-0.4	-0.1	-0.4	-1.5	
125	1934-1996	-1.5	-1.3	-1.9	-1.5	
126	1934-1996	-3.4	-2.7	-2.7	-2	
127	1934-1996	-3.9	-2.5	-2.8	-2	
128	1934-1996	-2.4	-2.1	-1.6	-2.5	
129	1934-1996	-3.1	-2.5	-1.7	-2.5	

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

Range	Time Span	Method			Rounded Concensus Average	Comments
		RA	LS	EP		
130	1934-1996	-1.4	-1.5	-1.6	-2.5	
131	1934-1996	-2.3	-2.4	-2.4	-2.5	
132	1934-1996	-3.8	-3.2	-2.9	-3	
133	1934-1996	-3.1	-3.1	-2.8	-3	
134	1934-1996	-4	-3.8	-3.1	-3	
135	1934-1996	-4.8	-4.3	-3.9	-3	
136	1934-1996	-2	-1.7	-1.5	-3	
137	1934-1996	-3	-2.2	-1.8	-2.5	
138	1934-1996	-3.4	-3.5	-2.8	-2.5	
139	1934-1996	-2.7	-2.2	-2	-2	
140	1934-1996	-0.9	-1.3	-0.7	-2	↑
141	1934-1996	-3.3	-2.5	-2.1	-2	7 PT. AVG.
142	1934-1996	-1.8	-2.2	-1.9	-1.5	5 PT. AVG.
143	1934-1996	-1.9	-2	-1.6	-1.5	3 PT. AVG.
144	1934-1996	0	-0.5	0	0	1 PT. AVG.
145	1934-1996	4.3	3	4.4	4	↓
146	1973-1996	12	11.2	11.8	11.5	
147	1973-1996	N/A	18.2	17.1	17.5	
148	1976-1996	N/A	33	35.5	34	↑
149	1976-1996	N/A	9.9	15.8	13	1 PT. AVG.
East Pass						
150	1974-1996	19.4	23.3	21.9	21.5	1 PT. AVG.
151	1974-1996	4.9	3.1	3.1	3.5	↓
152	1974-1996	7.4	9.6	9.7	9	
153	1974-1996	8.5	13	11.9	11	
154	1974-1996	-0.6	-1.5	-0.6	-1	↑
155	1974-1996	-3.9	-3.2	-1.9	-3	1 PT. AVG.
156	1974-1996	-4.1	-4.9	-3.2	-4	3 PT. AVG.
157	1974-1996	-4.8	-5.2	-4	-4.5	5 PT. AVG.
158	1974-1996	-5.4	-5.6	-4.5	-4	7 PT. AVG.
159	1974-1996	-5.1	-5.4	-4.1	-4.5	↓
160	1934-1996	-3.8	-3.1	-3.1	-4.5	

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

Range	Time Span	Method			Rounded Concensus Average	Comments
		RA	LS	EP		
161	1934-1996	-4	-3.6	-3.5	-5	
162	1934-1996	-4.8	-4.8	-4.5	-5	
163	1934-1996	-5.8	-5.5	-5.5	-5	
164	1934-1996	-6.1	-6.3	-5.9	-5.5	
165	1934-1996	-5.8	-6.5	-6.2	-6	
166	1934-1996	-6.3	-6.5	-6.2	-6	
167	1934-1996	-6.2	-6.6	-6	-6	
168	1934-1996	-6	-6.4	-5.8	-5.5	
169	1934-1996	-5.5	-5.8	-5.3	-5.5	
170	1934-1996	-5	-5.2	-4.8	-5	
171	1934-1996	-4.8	-5	-4.4	-4.5	
172	1934-1996	-4.7	-4.2	-3.6	-3.5	
173	1934-1996	-2.7	-2.3	-2.3	-3	
174	1934-1996	-2	-1.8	-1.9	-2.5	
175	1934-1996	-1.9	-1.7	-1.6	-2	
176	1934-1996	-1.3	-1.3	-1.1	-1.5	
177	1934-1996	-0.5	-0.8	-0.5	-1.5	
178	1934-1996	-1	-1.1	-0.6	-1.5	
179	1934-1996	-1.9	-1.8	-1.6	-1.5	
180	1934-1996	-2.4	-2.2	-1.6	-1.5	↑
181	1934-1996	-2.5	-2.3	-2	-2.5	7 PT. AVG.
182	1934-1996	-2.5	-2.3	-2	-3	5 PT. AVG.
183	1934-1996	-1.8	-1.8	-1.2	-3.5	3 PT. AVG.
184	1974-1996	-6.3	-8.1	-6	-7	1 PT. AVG.
185	1974-1996	-4.5	-5.2	-4.4	-4.5	↓
186	1934-1996	-1.6	-1.7	-1.3	-1.5	
187	1934-1996	3.4	3.6	3.1	3.5	
188	1934-1996	5.7	6.6	6.3	6	3 PT. AVG.
189	1934-1996	9.1	7.3	6.9	7.5	↓
190	1934-1996	10.7	8.2	7.7	10	
191	1934-1996	14.7	13.2	11.4	10.5	
192	1974-1996	11	10.2	7.6	9.5	1 PT. AVG.
193	1974-1996	-0.3	-0.2	-0.3	-0.5	1 PT. AVG.

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

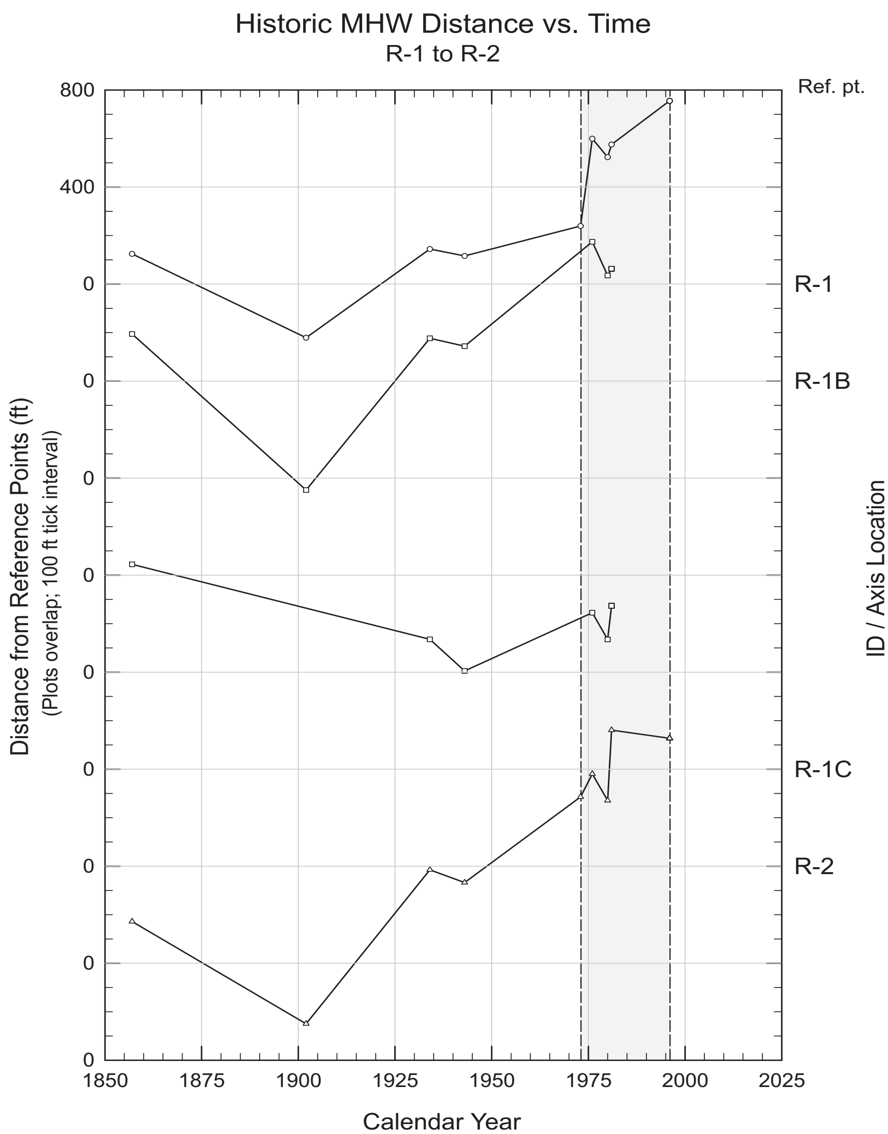
Range	Time Span	Method			Rounded Concensus Average	Comments
		RA	LS	EP		
End Dog Island and Begin Alligator Point						
194	1974-1997	-16.4	-11	-13.2	-13.5	1 PT. AVG.
195	1974-1997	-16.6	-13.9	-15.3	-15.5	1 PT. AVG.
196	1934-1974	-4.5	-4.2	-3.9	-4	PRE - ARMOR
197	1934-1998	1	1.1	0.9	1	1 PT. AVG.
198	1934-1998	1.5	1.4	1.3	1.5	3 PT. AVG.
199	1934-1998	1.7	1.5	1.5	1.5	5 PT. AVG.
200	1934-1998	2.4	2.7	2.5	1.5	7 PT. AVG.
201	1934-1998	1.9	1.8	1.9	2	↓
202	1934-1997	1.1	1.2	1.2	2	
203	1934-1997	1.3	1.2	1.1	2	
204	1934-1998	2.6	2.4	2.8	2	
205	1934-1997	1.9	2.1	2.2	2	
206	1934-1997	1.4	1.5	1.8	1.5	↑
207	1934-1997	2.4	2	2.1	1.5	7 PT. AVG.
208	1934-1997	2	1.9	2	1.5	5 PT. AVG.
209	1934-1997	0.1	-0.2	0.1	1	3 PT. AVG.
210	1934-1997	1	1	0.9	1	1 PT. AVG.
211	1934-1974	-3.7	-6.7	-5.9	-5.5	PRE - ARMOR
212	1934-1974	-4.9	-6.5	-6.1	-6	PRE - ARMOR
213	1934-1997	-3.8	-3.2	-3.1	-3.5	1 PT. AVG.
214	1934-1997	-2.2	-2	-1.8	-2	3 PT. AVG.
215	1934-1997	-1	-1	-0.8	-0.5	5 PT. AVG.
216	1934-1997	1.3	1.4	1.1	1	7 PT. AVG.
217	1934-1997	3.1	3.2	2.8	2.5	5 PT. AVG.
218	1934-1997	4.6	5.1	4.5	4.5	3 PT. AVG.
219	1934-1997	5.7	4.9	4.4	5	1 PT. AVG.
220	1974-1998	-4.7	-4.4	-3.6	-4	1 PT. AVG.
221	1934-1998	-0.4	-0.5	-0.4	-2.5	3 PT. AVG.
222	1934-1997	-2.9	-2.3	-2.7	-2.5	1 PT. AVG.
223	1934-1974	-3.1	-3	-2.9	-3	PRE - ARMOR
224	1934-1998	-2.6	-3.2	-2.9	-3	1 PT. AVG.
225	1934-1997	-2.6	-2.7	-2.4	-2.5	3 PT. AVG.

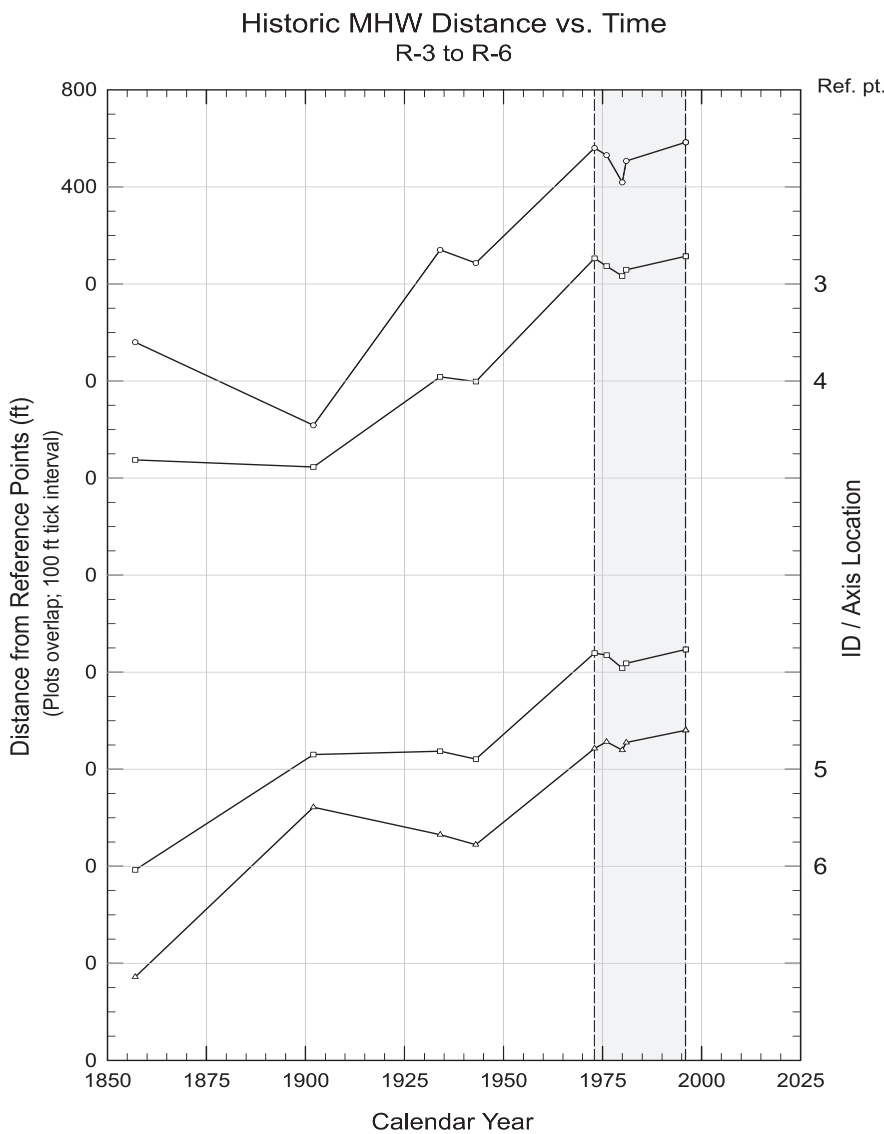
Table A-1. Shoreline change rate estimates for Franklin County, Florida.

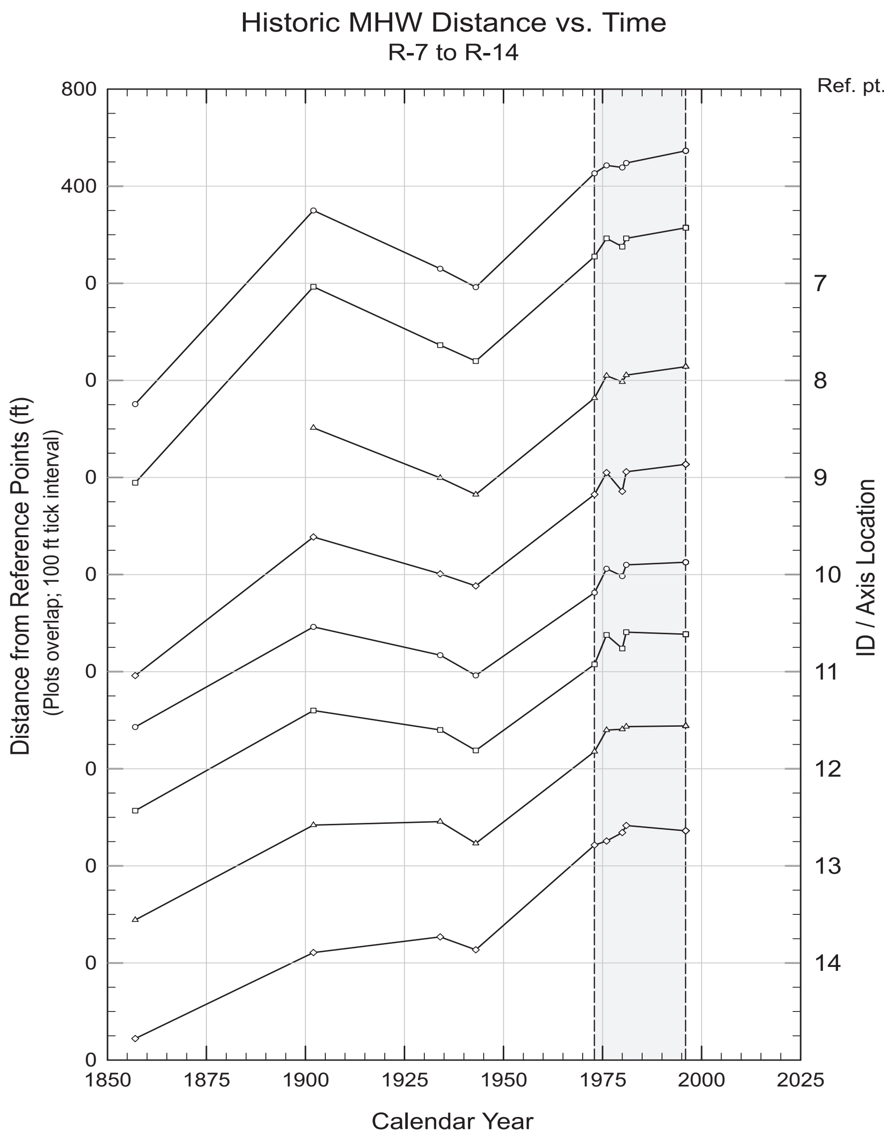
Range	Time Span	Method			Rounded Concensus Average	Comments
		RA	LS	EP		
226	1934-1997	-2	-2.4	-2.1	-2.5	↓
227	1934-1997	-3	-2.8	-2.7	-3	
228	1974-1997	-4.8	-4.8	-4.3	-3.5	
229	1974-1997	-2.6	-2	-3.3	-3	
230	1974-1997	-0.9	-0.6	-1.6	-2	
231	1974-1997	-2.2	-1.6	-2.1	-1.5	
232	1974-1997	-1.4	-0.5	-1.9	0	
233	1974-1997	3.2	3.8	1.9	2.5	
234	1974-1997	6.4	6.6	5.3	4.5	
235	1974-1997	4.3	4.4	2.7	3.5	
236	1974-1997	0.1	1	0.1	2.5	
237	1974-1997	3.6	4.1	3.6	4.5	↑
238	1974-1997	9.8	9.6	7.3	4.5	3 PT. AVG.
239	1974-1997	0.7	3	0.7	1.5	1 PT. AVG.

7.2 Appendix B: Stack Plots

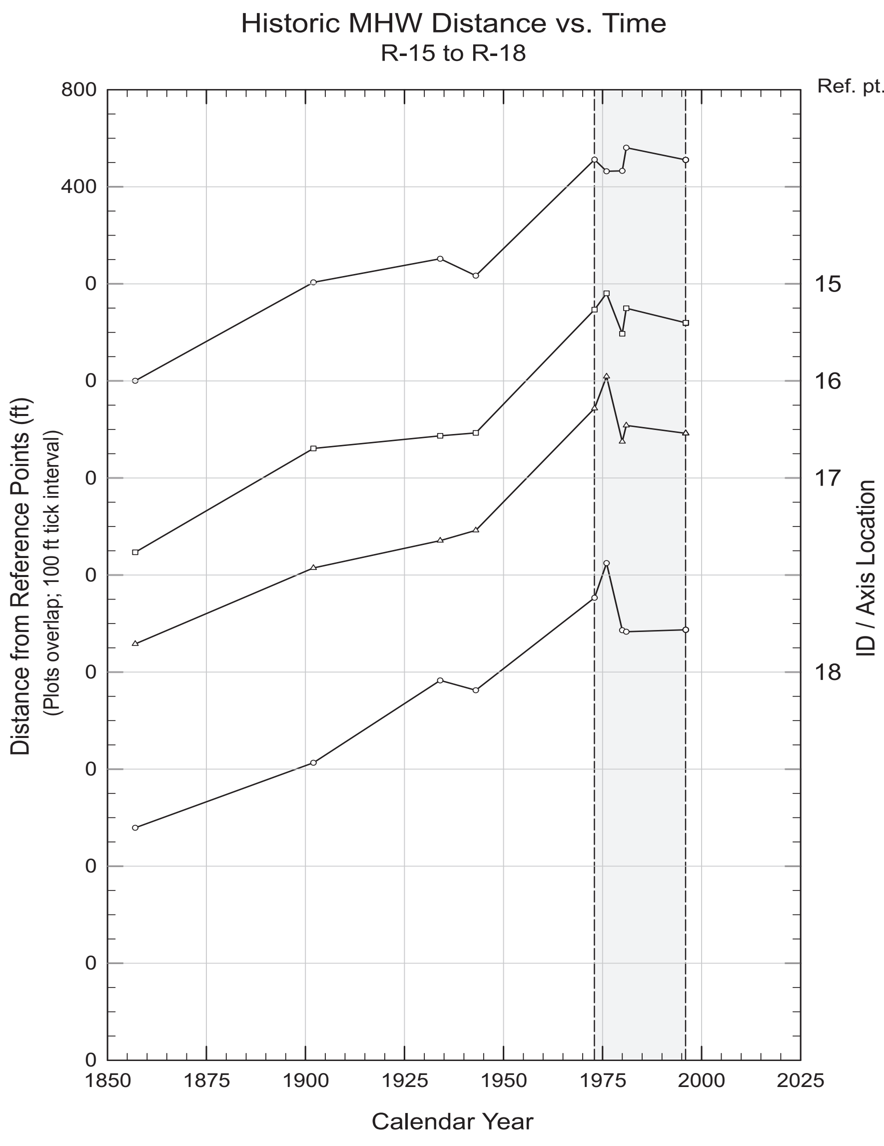
Stack plots from Historic Shoreline Database, Florida Department of Environmental Protection, Office of Beaches and Coastal Systems; slightly modified by authors.


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

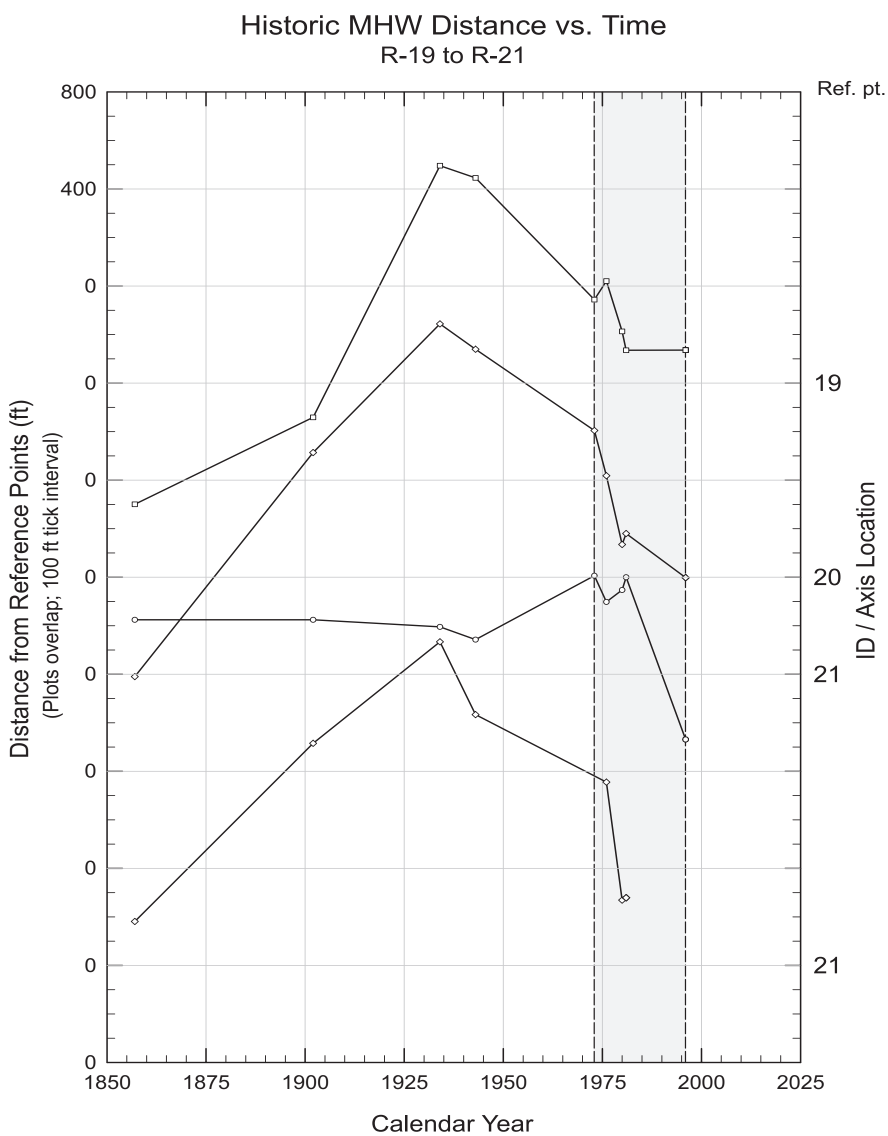

Historic MHW Distance vs. Time
R-3 to R-6
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
3
4
5
6
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year



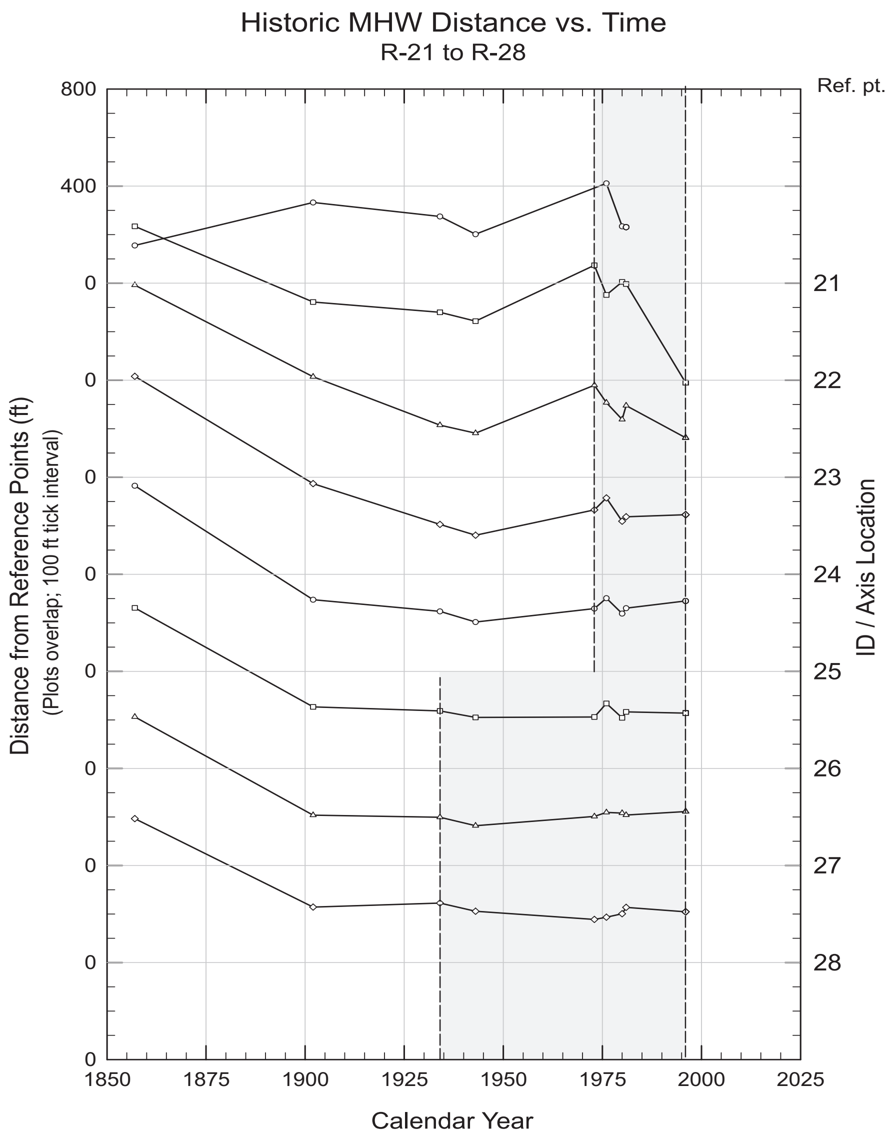
Historic MHW Distance vs. Time
R-7 to R-14
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
Ref. pt.
7
8
9
10
11
12
13
14
ID / Axis Location



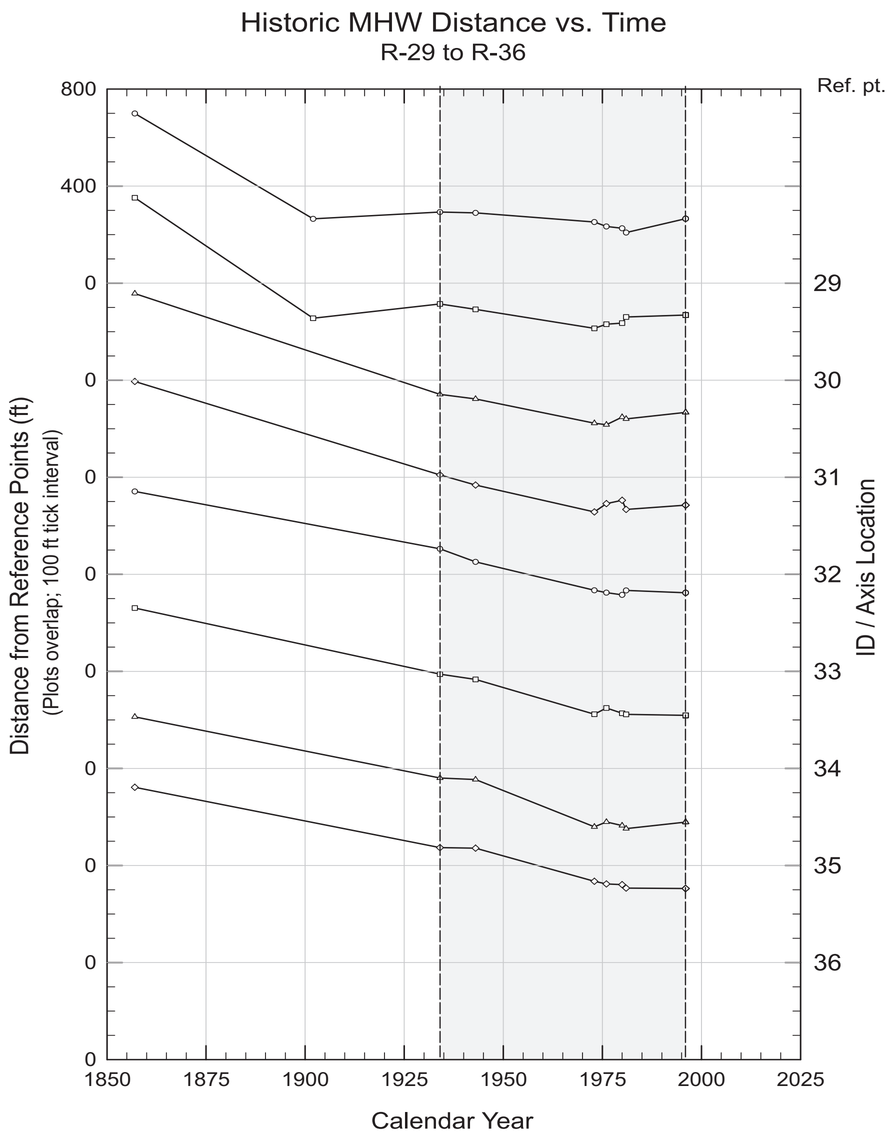
Historic MHW Distance vs. Time
R-15 to R-18
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
15
16
17
18
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year



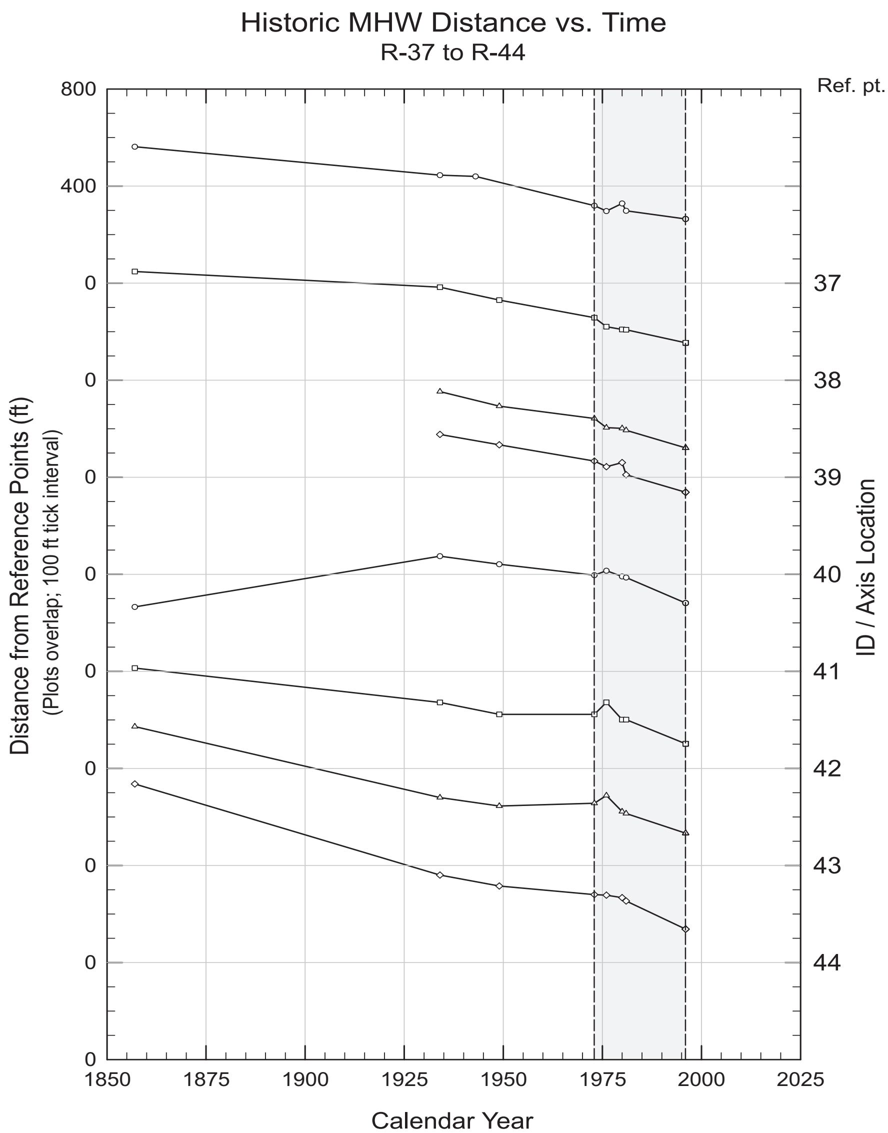
Historic MHW Distance vs. Time
R-19 to R-21
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
19
20
21
21
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

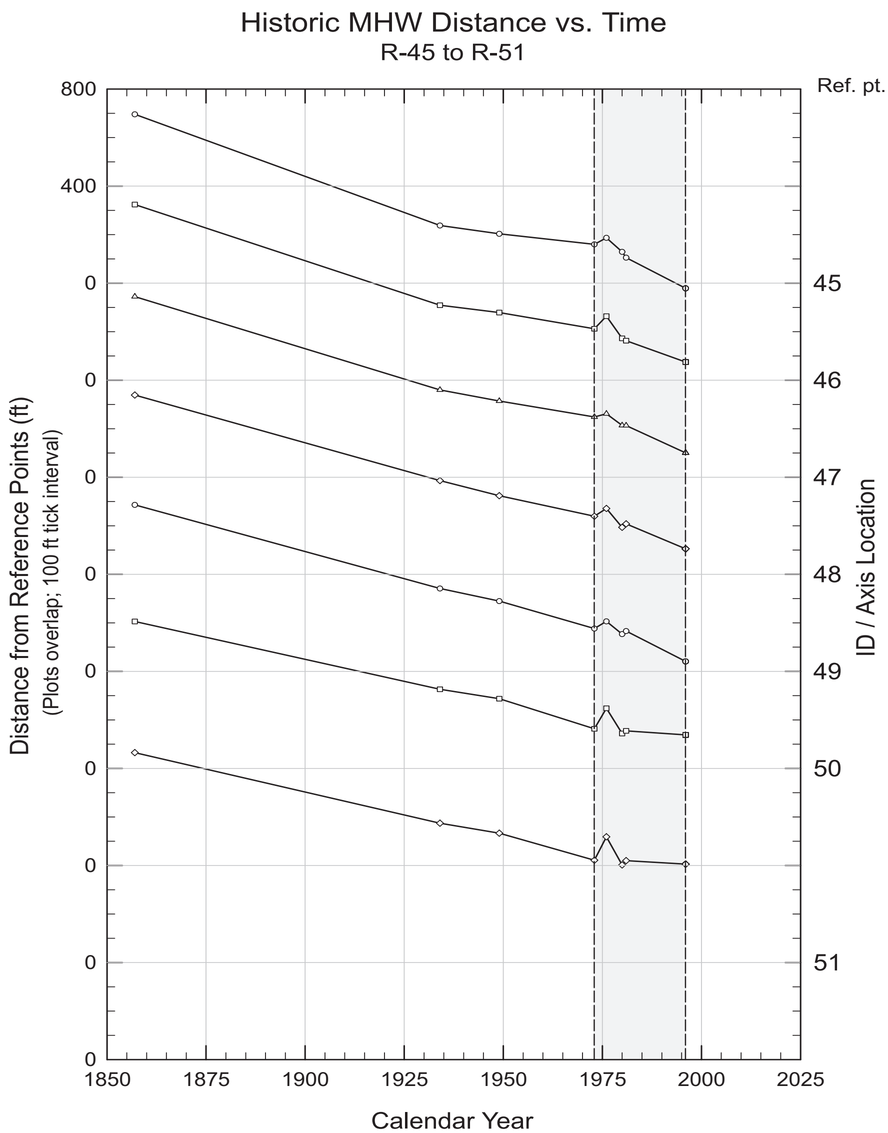


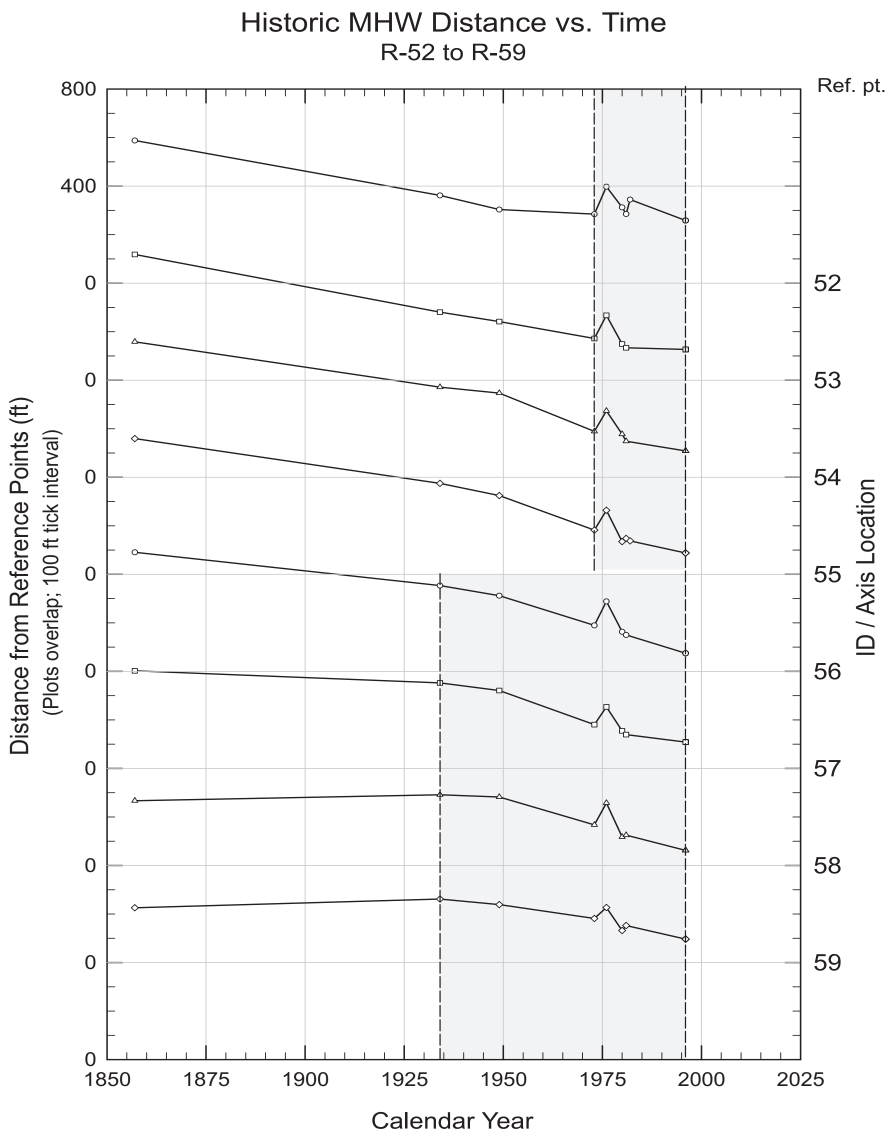
Historic MHW Distance vs. Time
R-21 to R-28
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
0
21
22
23
24
25
26
27
28
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

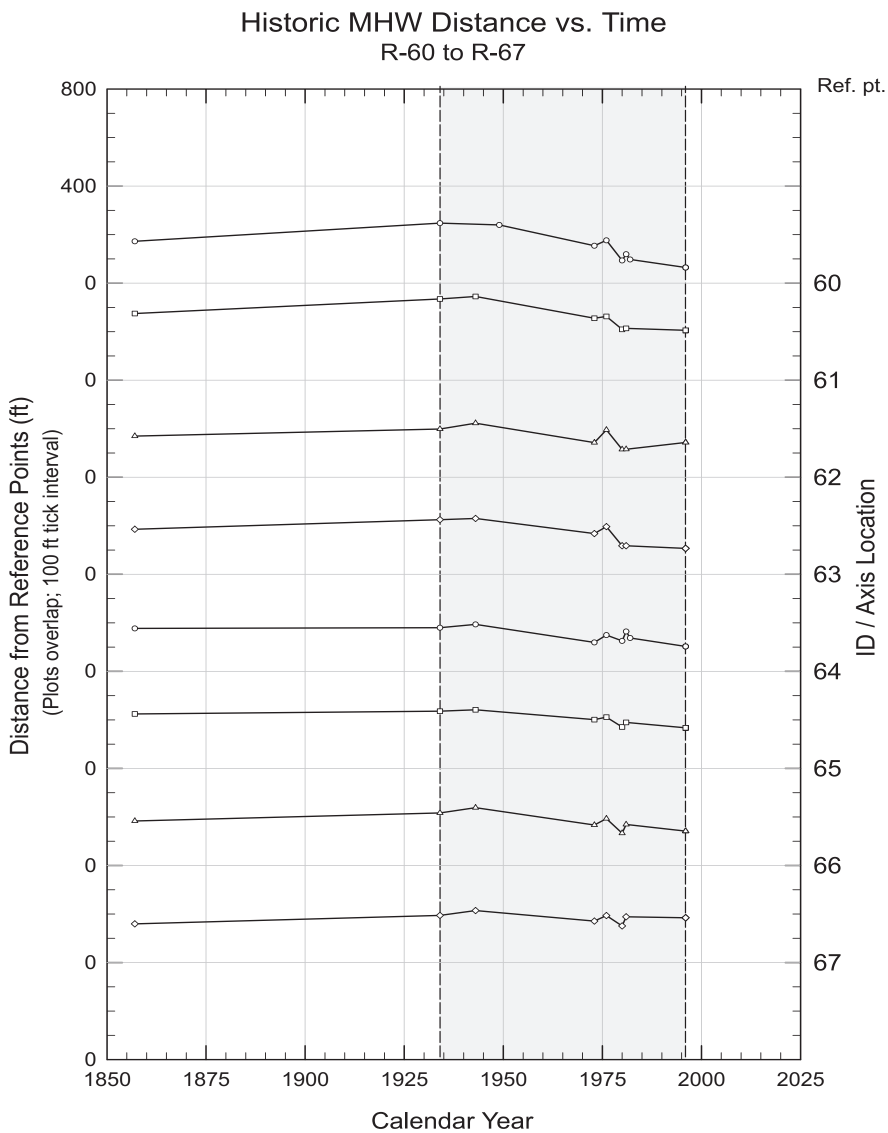


Historic MHW Distance vs. Time
R-29 to R-36
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
0
29
30
31
32
33
34
35
36
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location

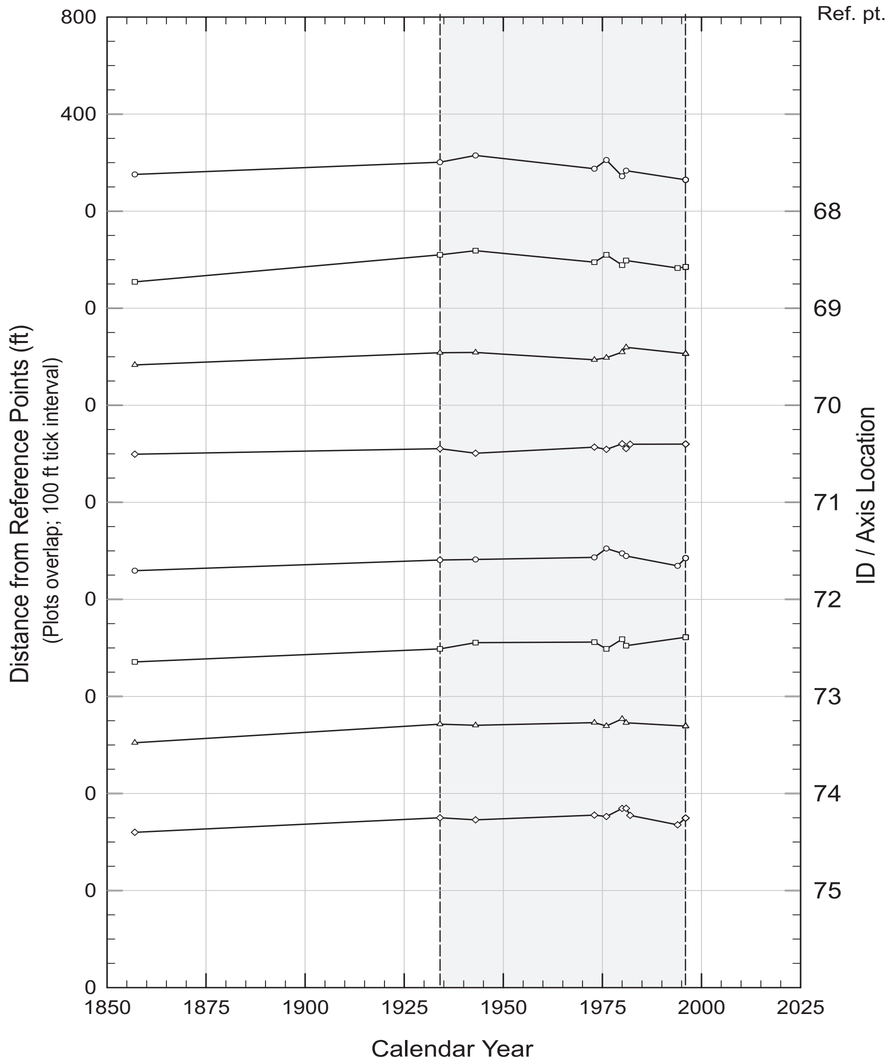

Historic MHW Distance vs. Time
R-37 to R-44
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
37
38
39
40
41
42
43
44
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

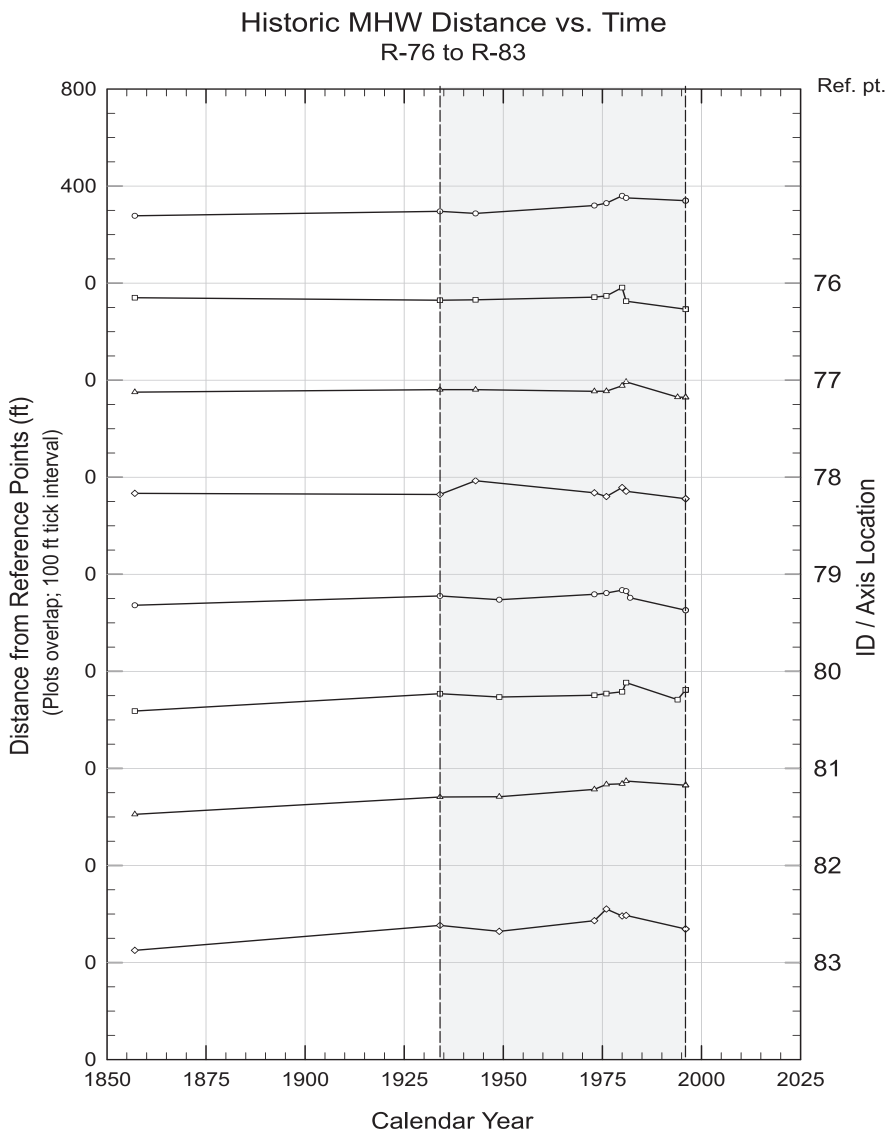

Historic MHW Distance vs. Time
R-45 to R-51
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
Ref. pt.
45
46
47
48
49
50
51
ID / Axis Location


Historic MHW Distance vs. Time
R-52 to R-59
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
52
53
54
55
56
57
58
59
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location

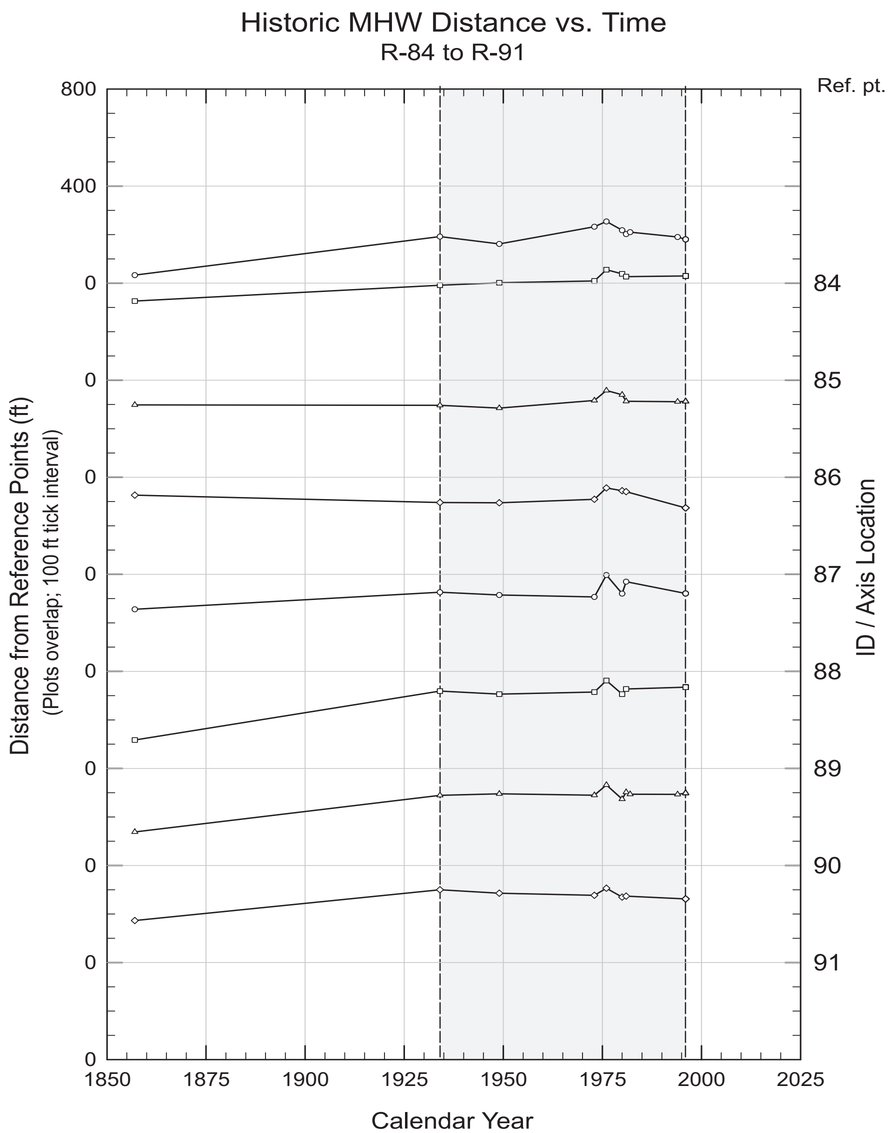

Historic MHW Distance vs. Time
R-60 to R-67
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
60
61
62
63
64
65
66
67
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location

Historic MHW Distance vs. Time
R-68 to R-75

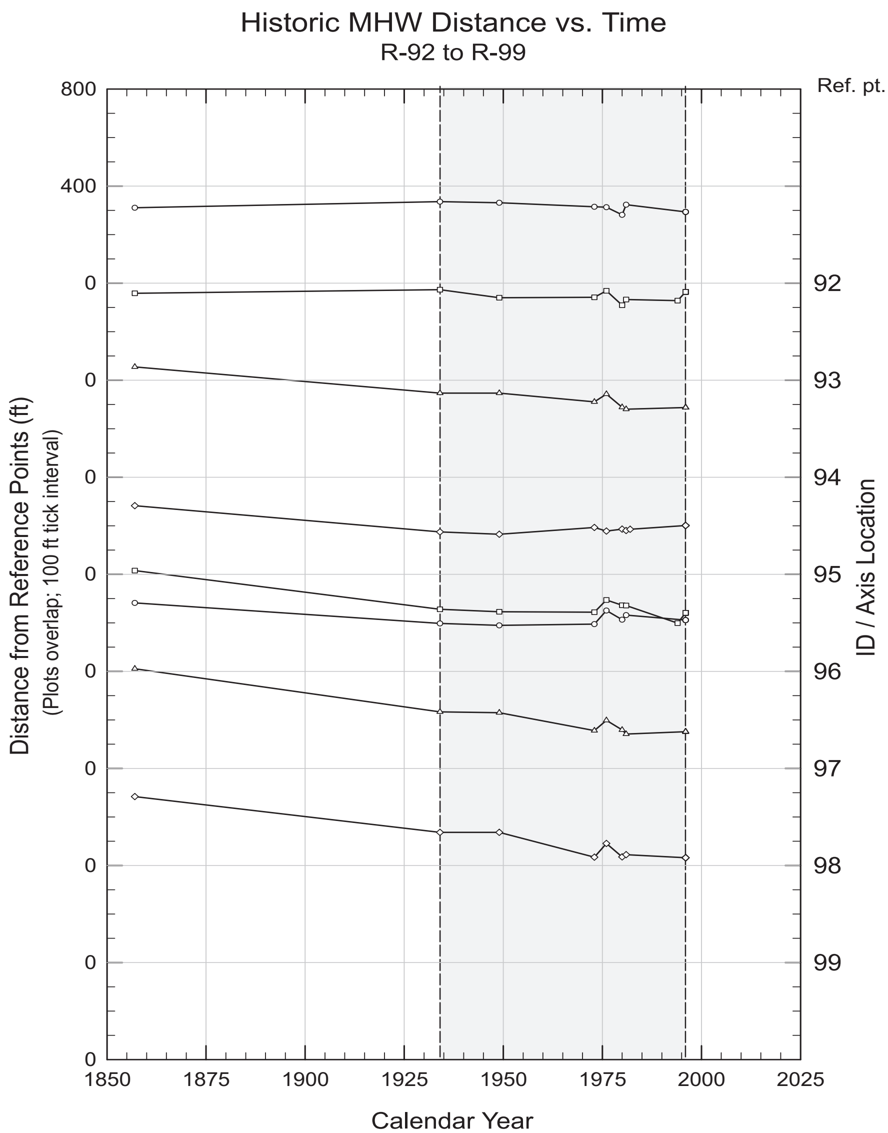


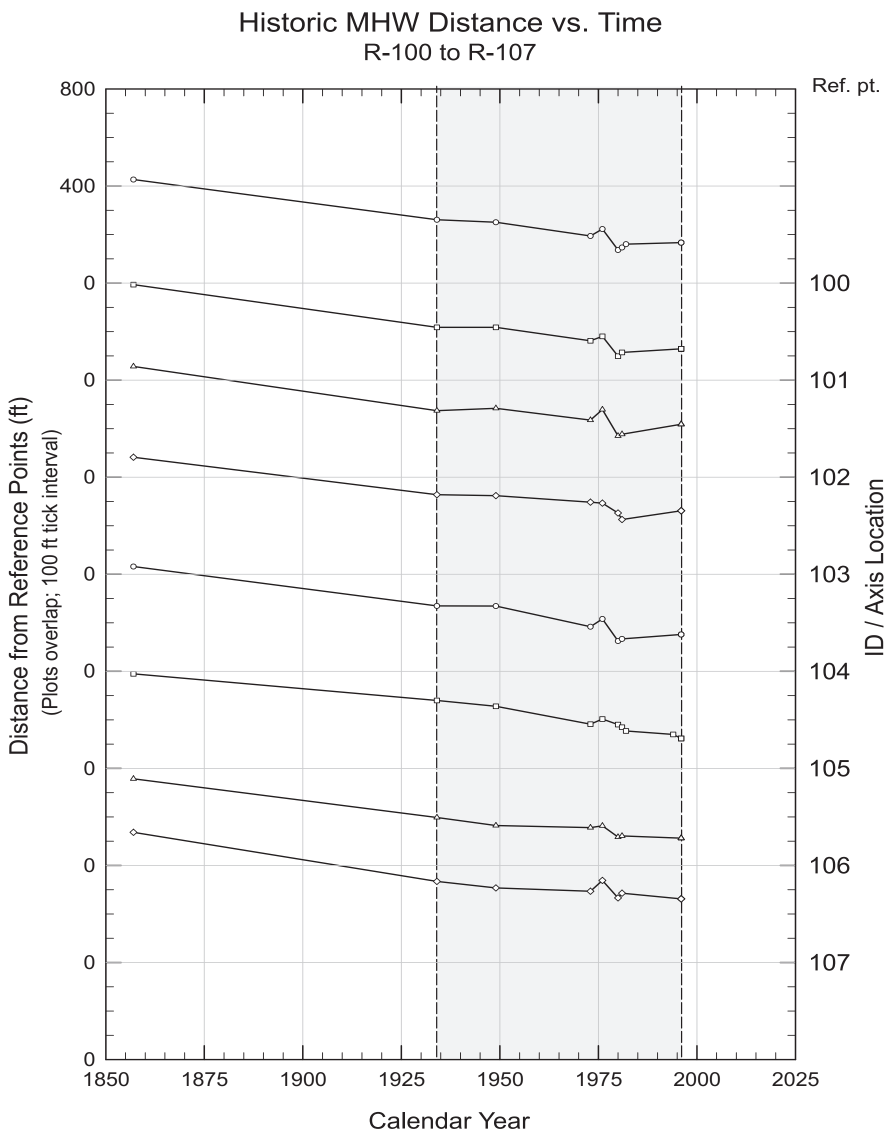


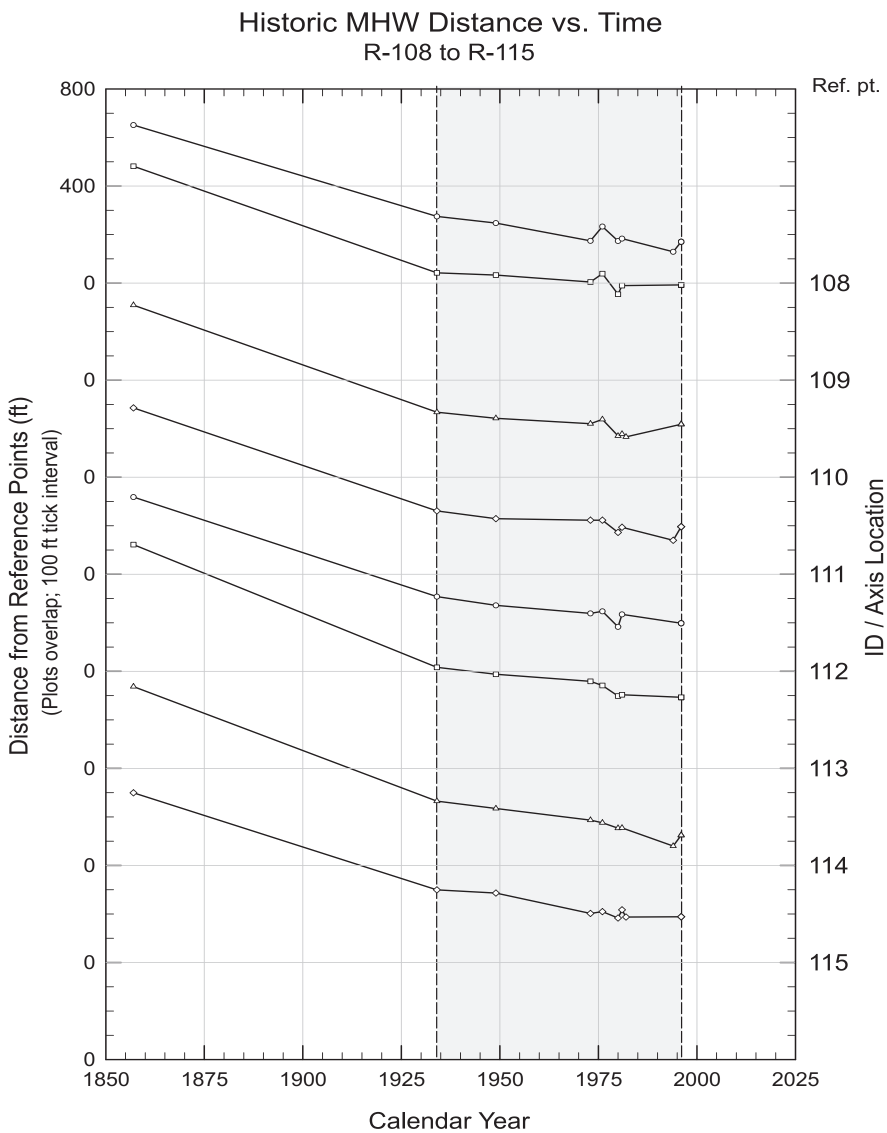
Historic MHW Distance vs. Time
R-76 to R-83
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
76
77
78
79
80
81
82
83
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

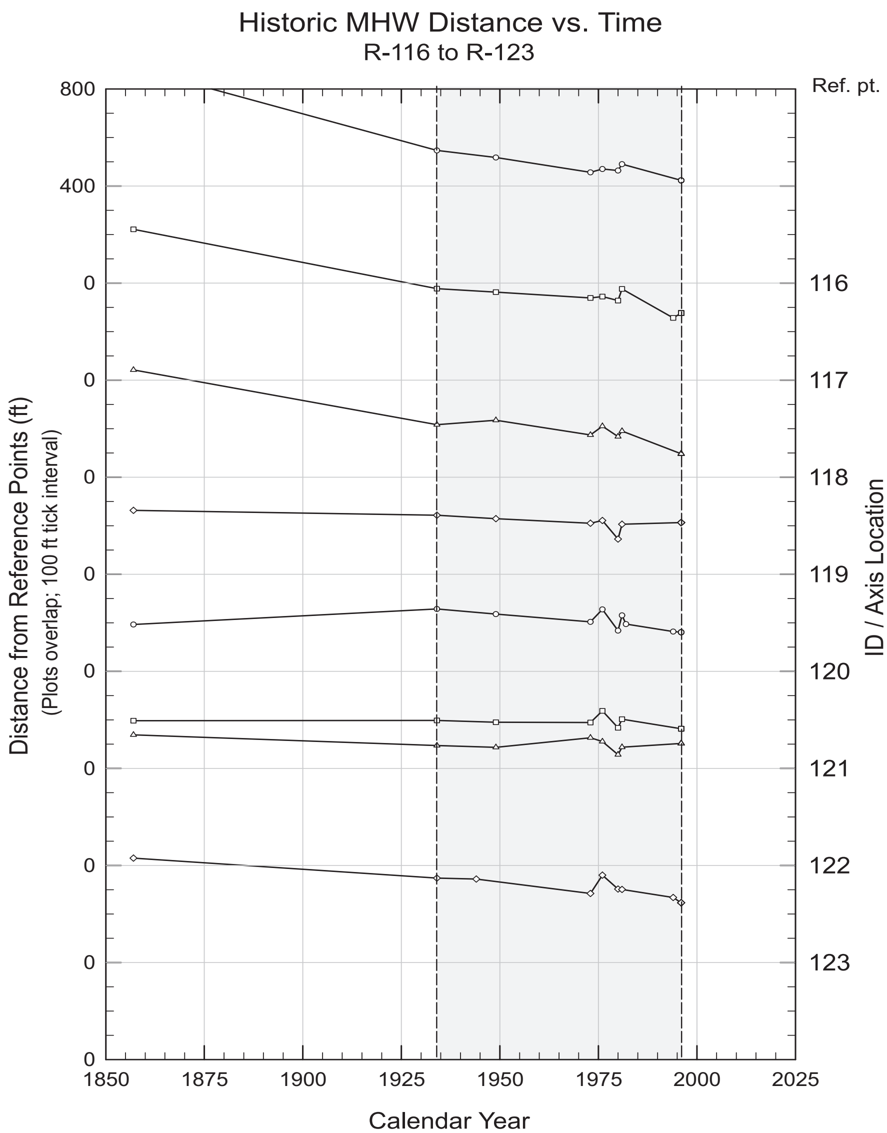


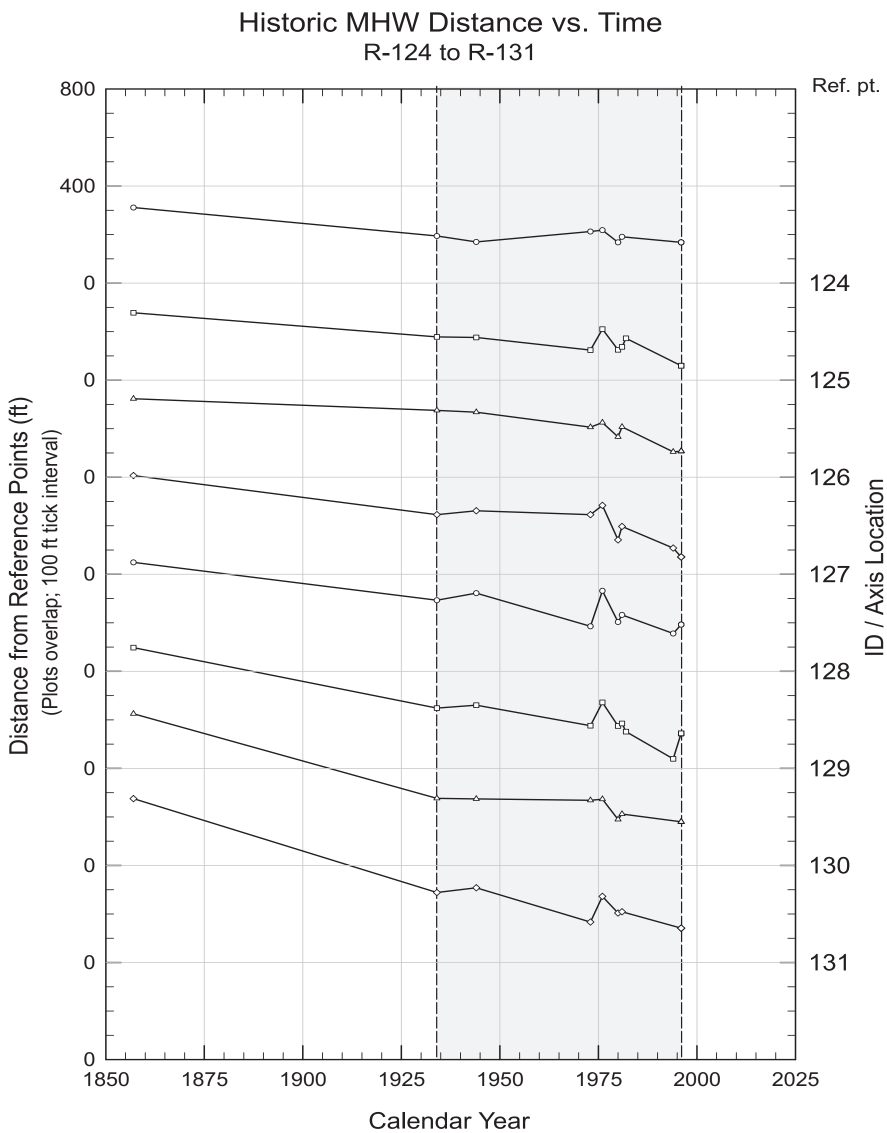
Historic MHW Distance vs. Time
R-84 to R-91
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
84
85
86
87
88
89
90
91
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location


Historic MHW Distance vs. Time
R-92 to R-99
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
92
93
94
95
96
97
98
99
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

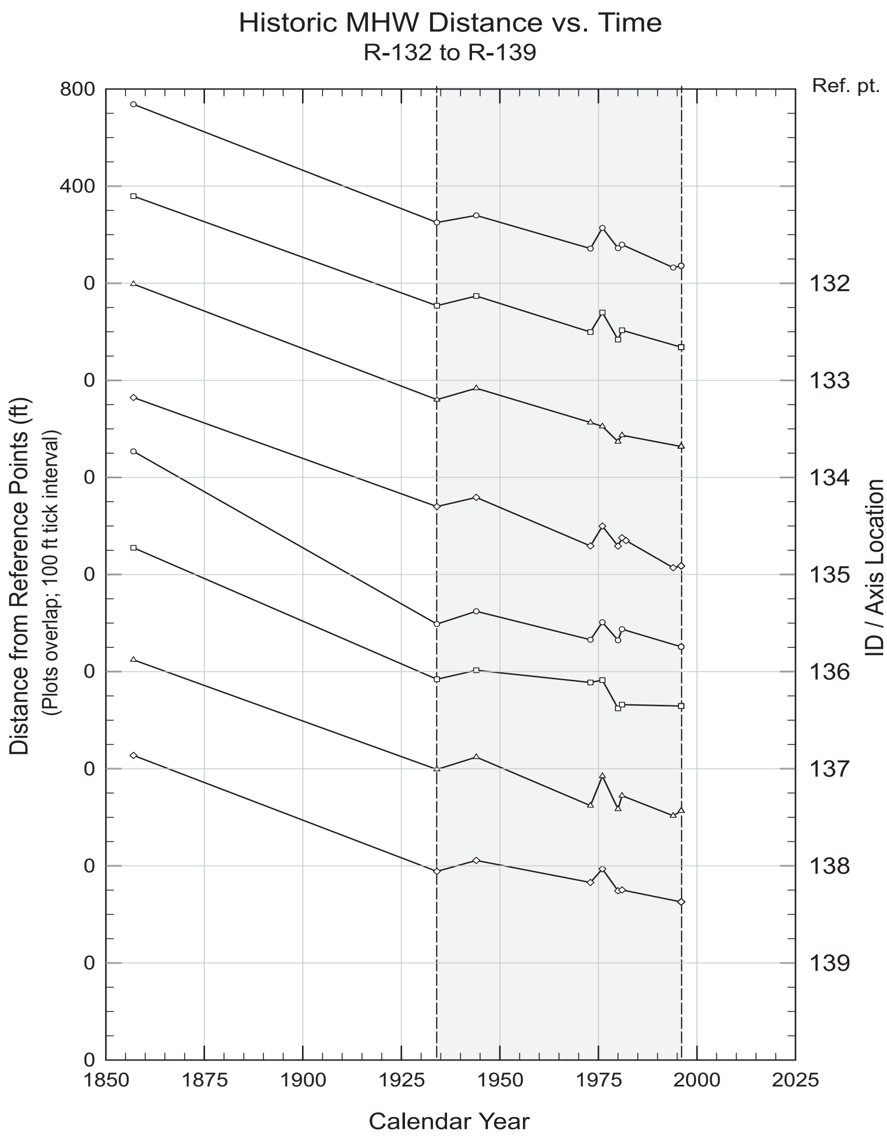

Historic MHW Distance vs. Time
R-100 to R-107
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
100
101
102
103
104
105
106
107
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year


Historic MHW Distance vs. Time
R-108 to R-115
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
108
109
110
111
112
113
114
115
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
Calendar Year

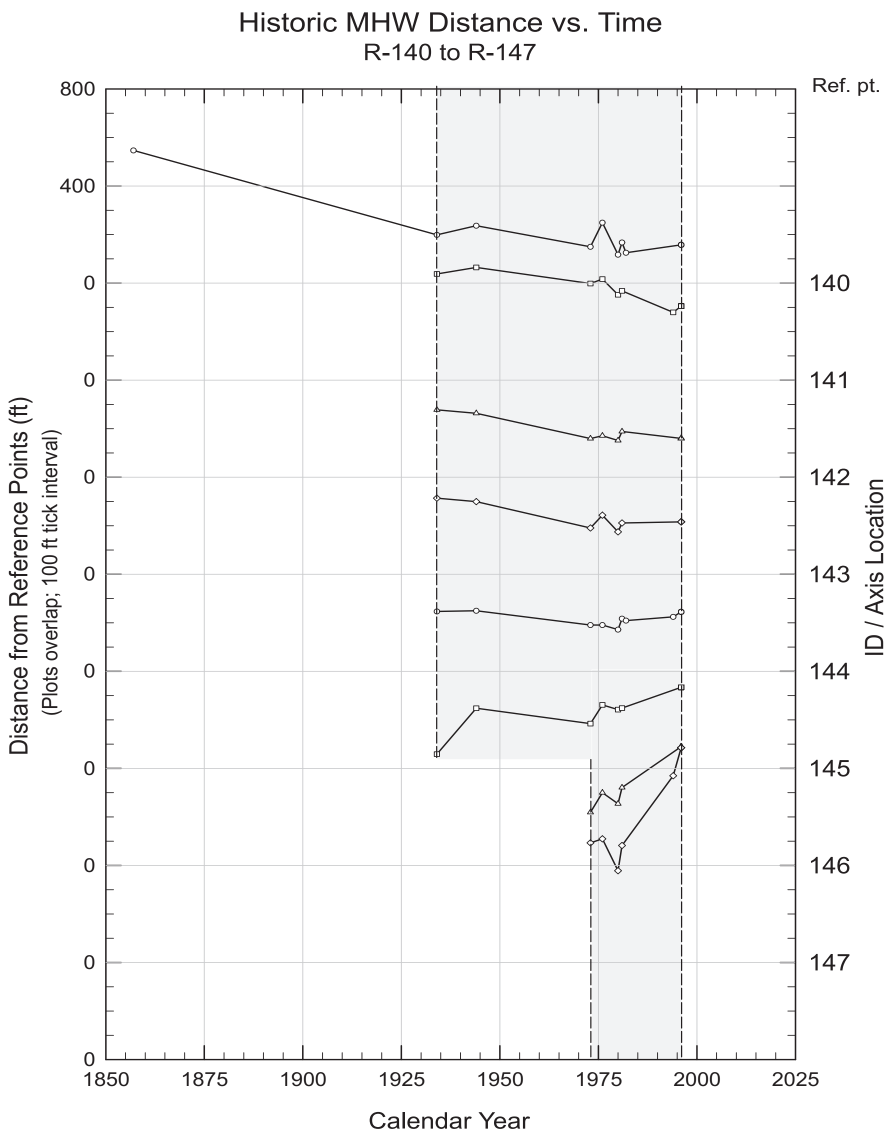

Historic MHW Distance vs. Time
R-116 to R-123
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
0
Ref. pt.
116
117
118
119
120
121
122
123
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year



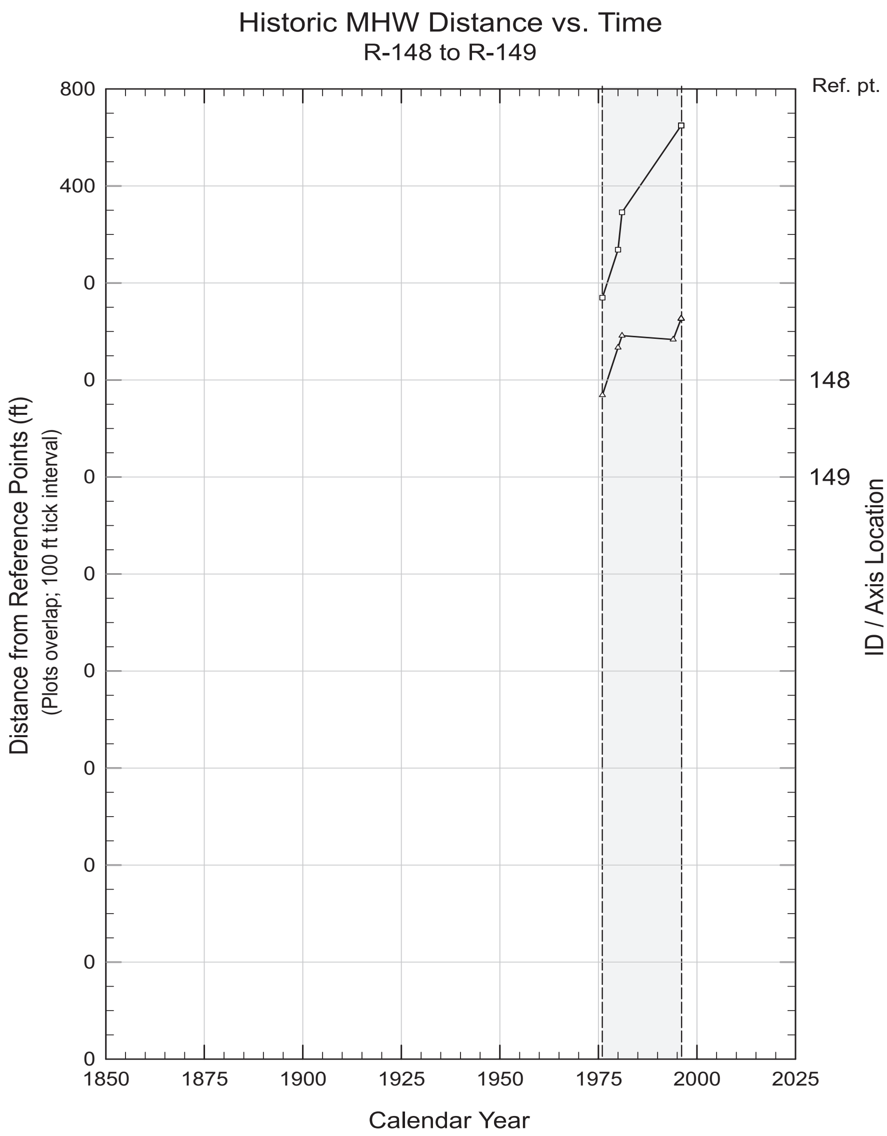
Historic MHW Distance vs. Time
R-124 to R-131
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
124
125
126
127
128
129
130
131
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location

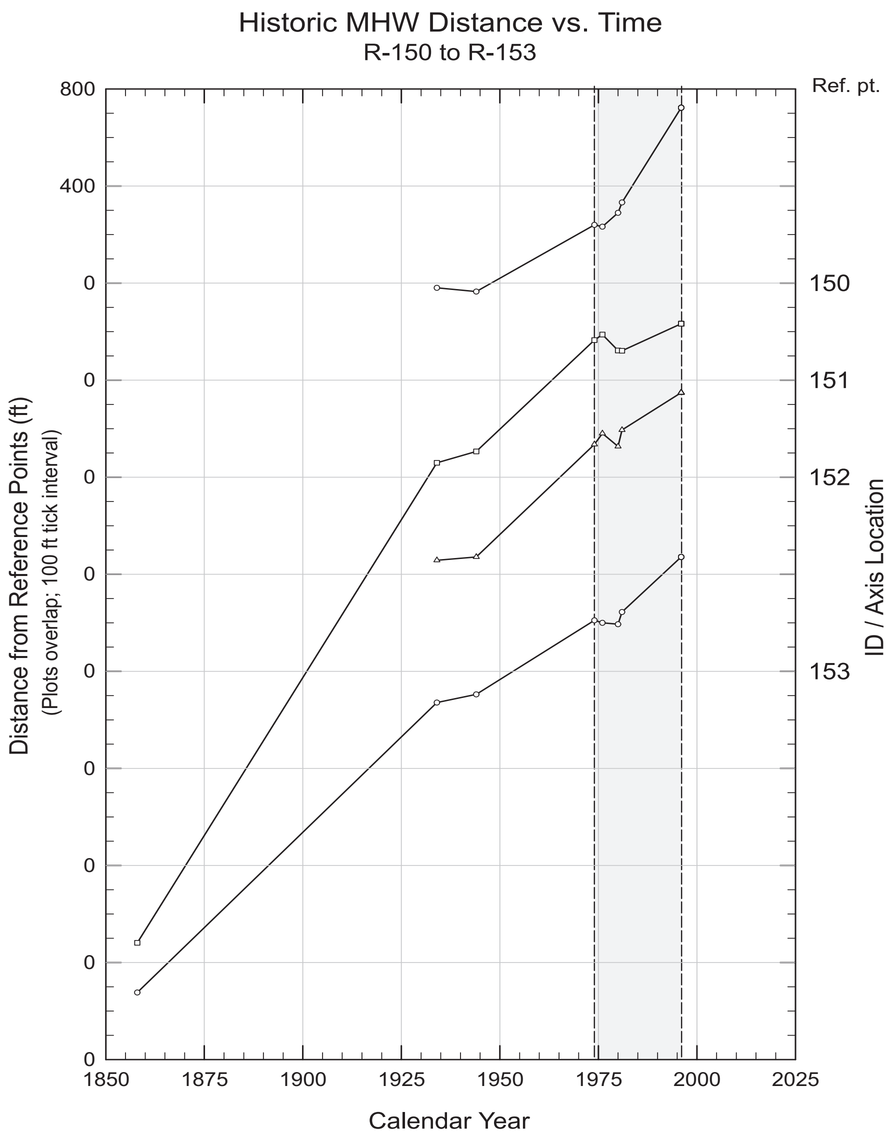


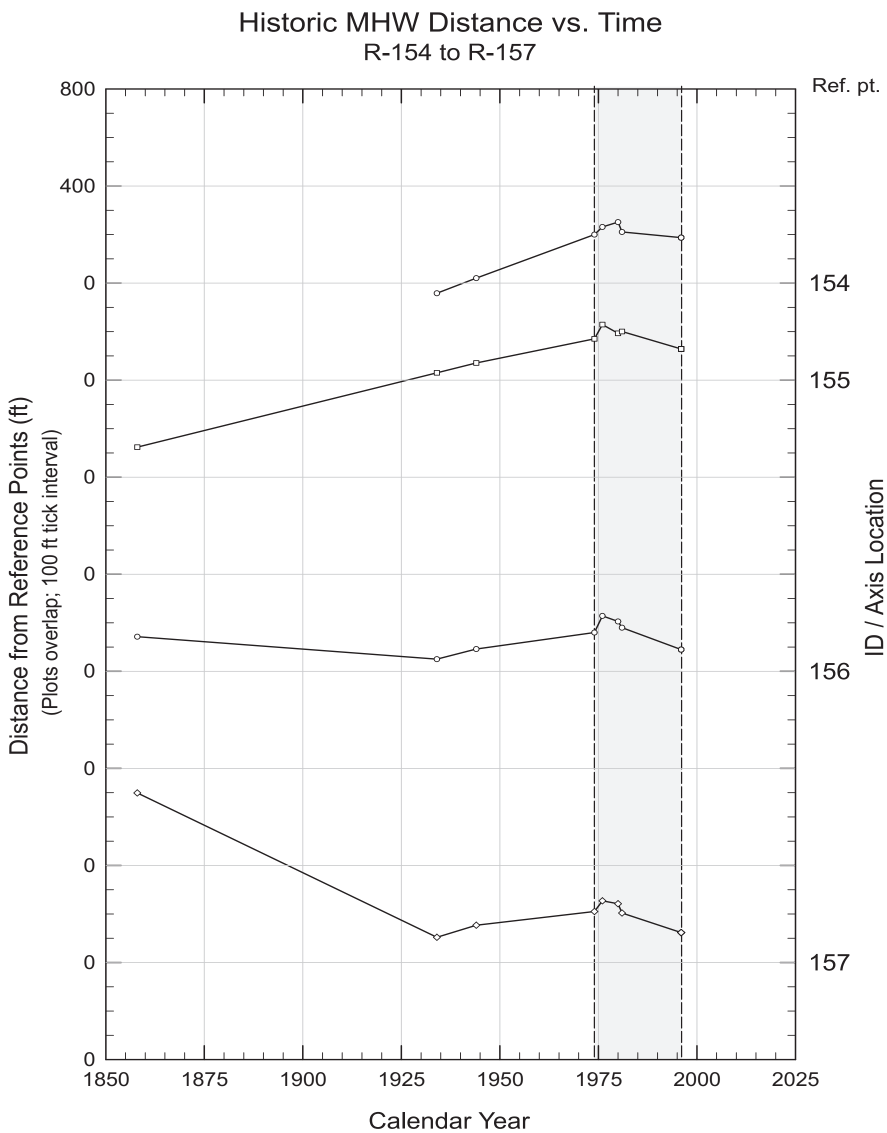
Historic MHW Distance vs. Time
R-132 to R-139
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
132
133
134
135
136
137
138
139
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

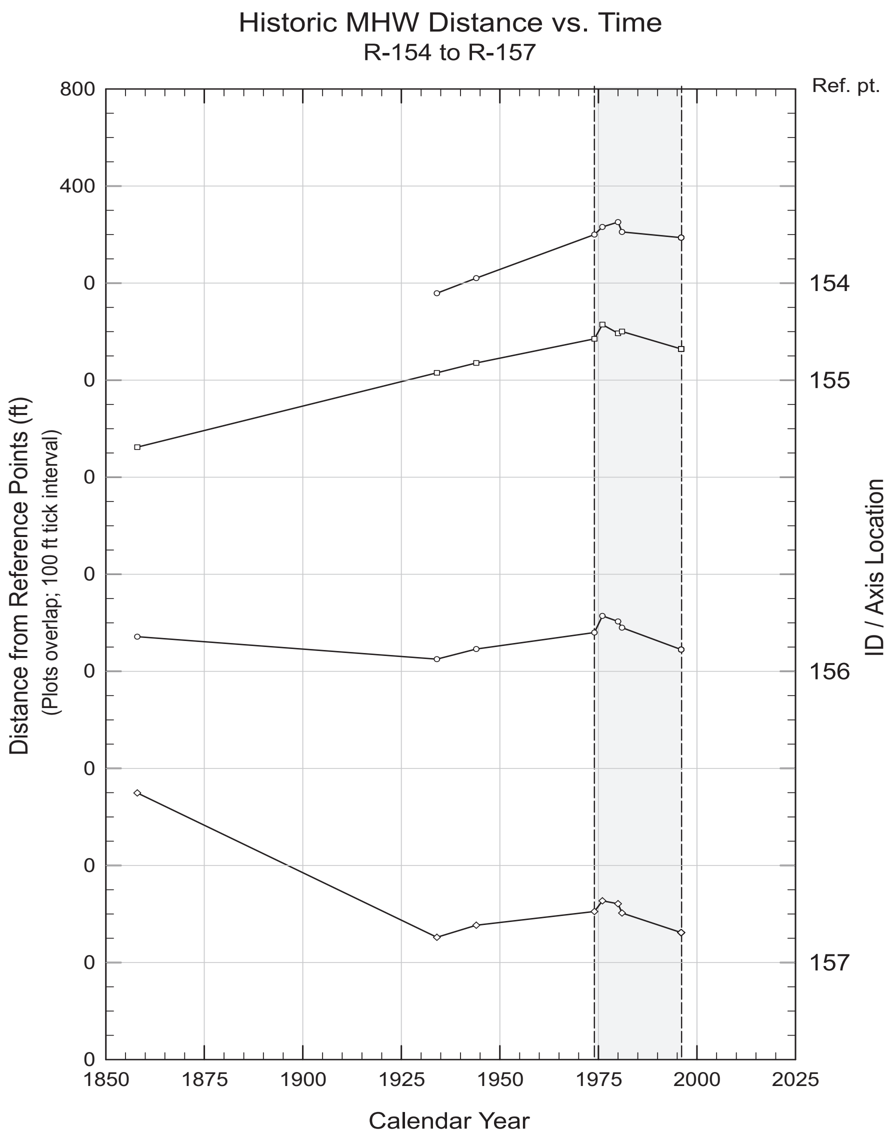


Historic MHW Distance vs. Time
R-140 to R-147
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
140
141
142
143
144
145
146
147
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

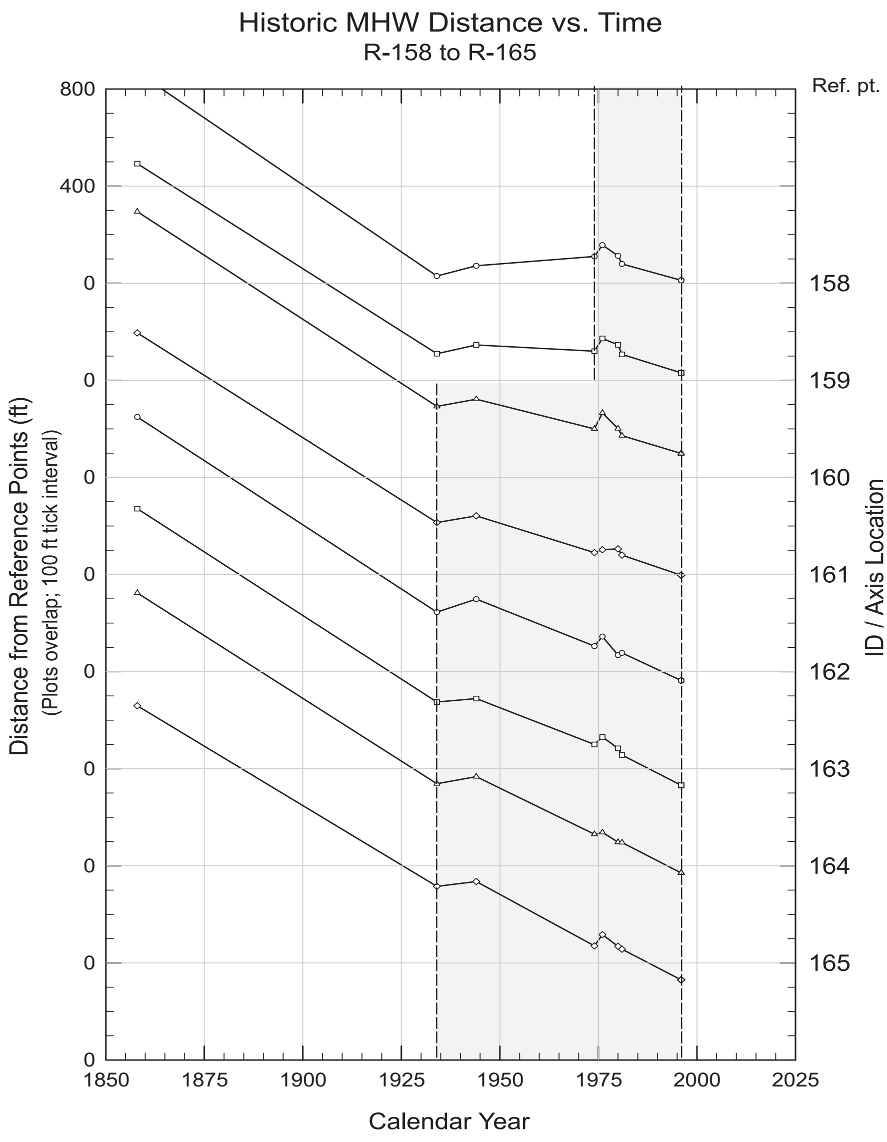

Historic MHW Distance vs. Time
R-148 to R-149
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
148
149
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

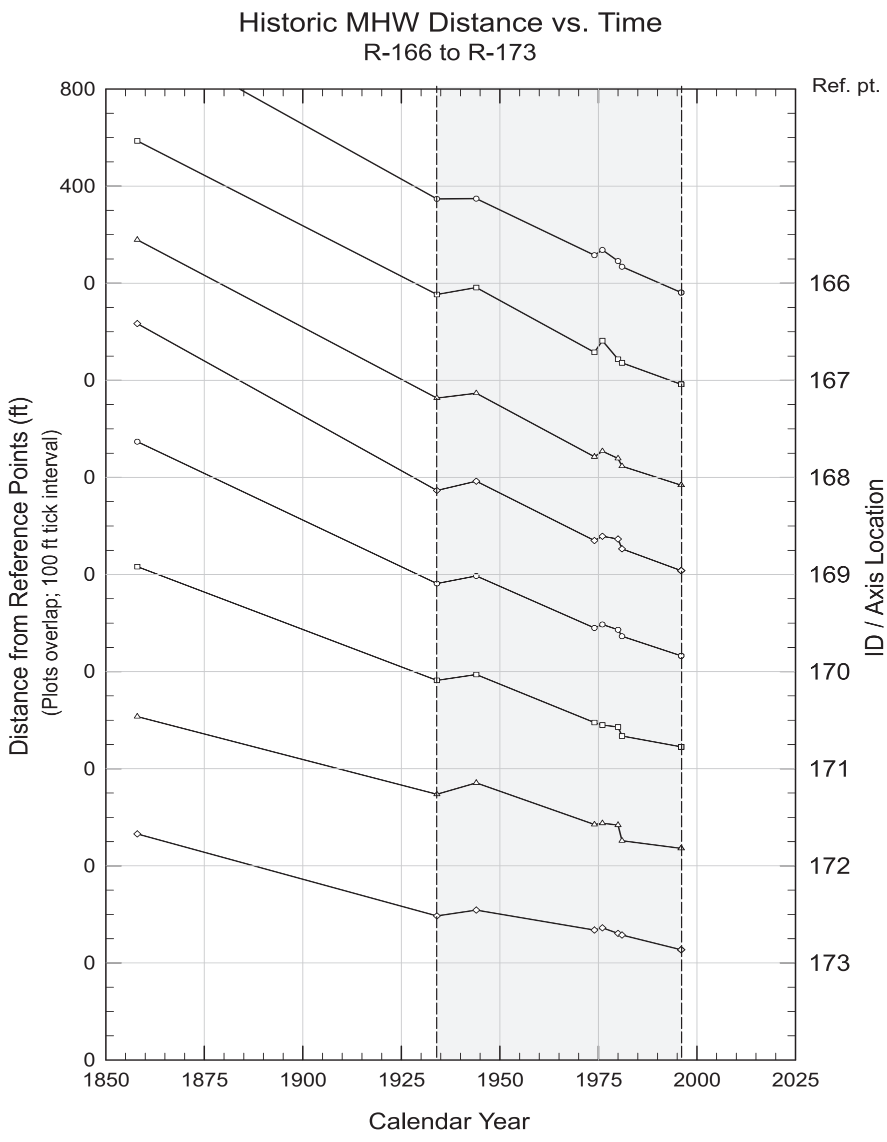

Historic MHW Distance vs. Time
R-150 to R-153
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
150
151
152
153
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year


Historic MHW Distance vs. Time
R-154 to R-157
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.
154
155
156
157
ID / Axis Location

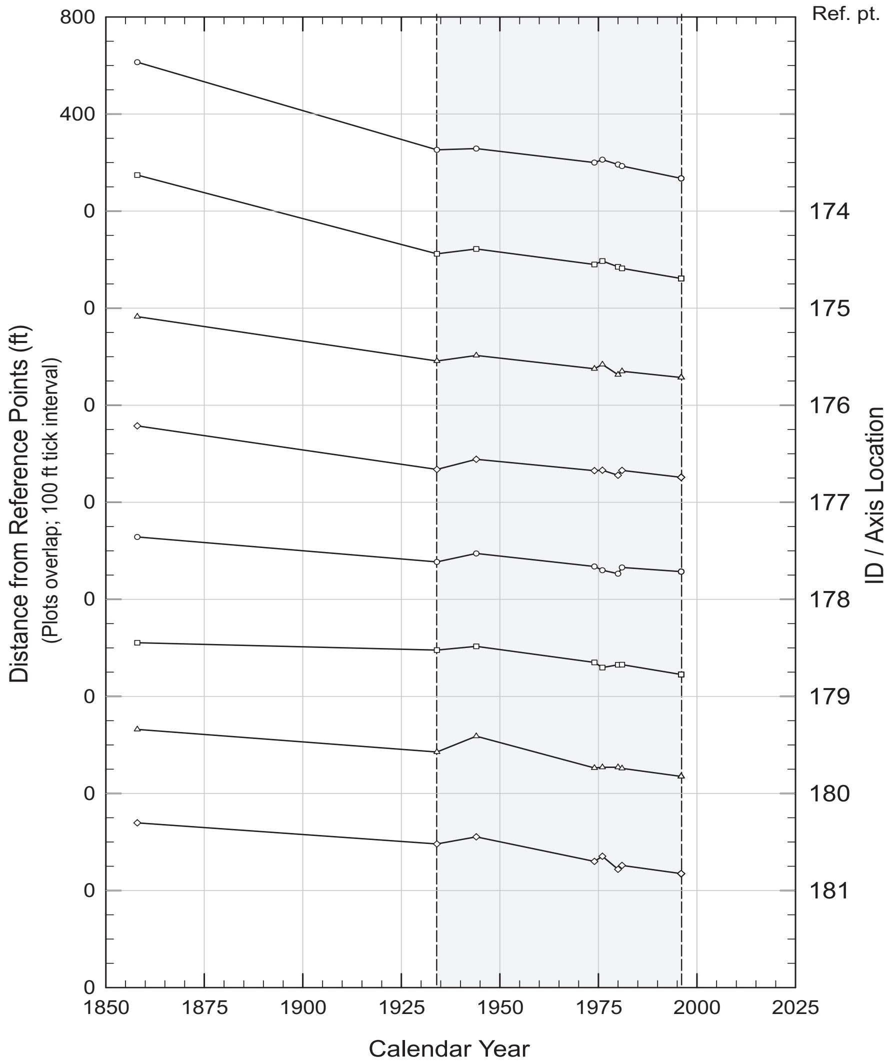


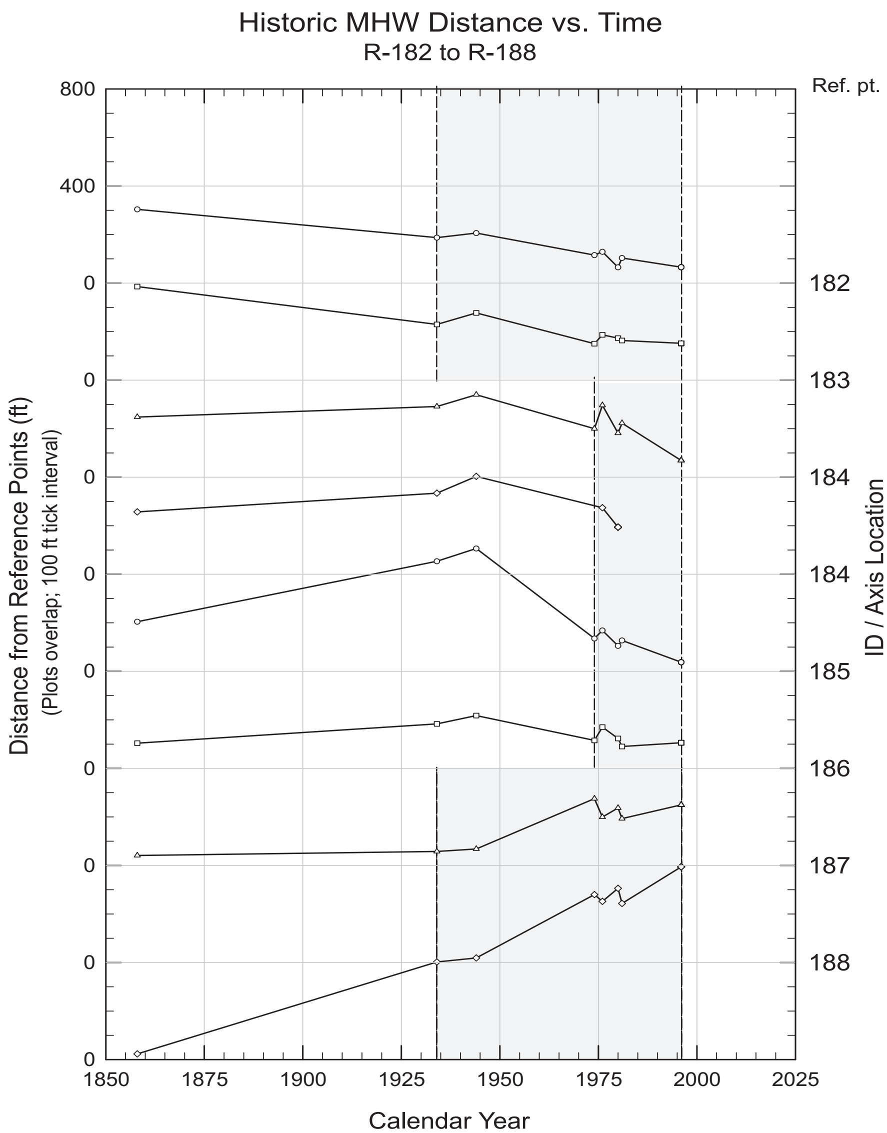
Historic MHW Distance vs. Time
R-154 to R-157
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
154
155
156
157
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location

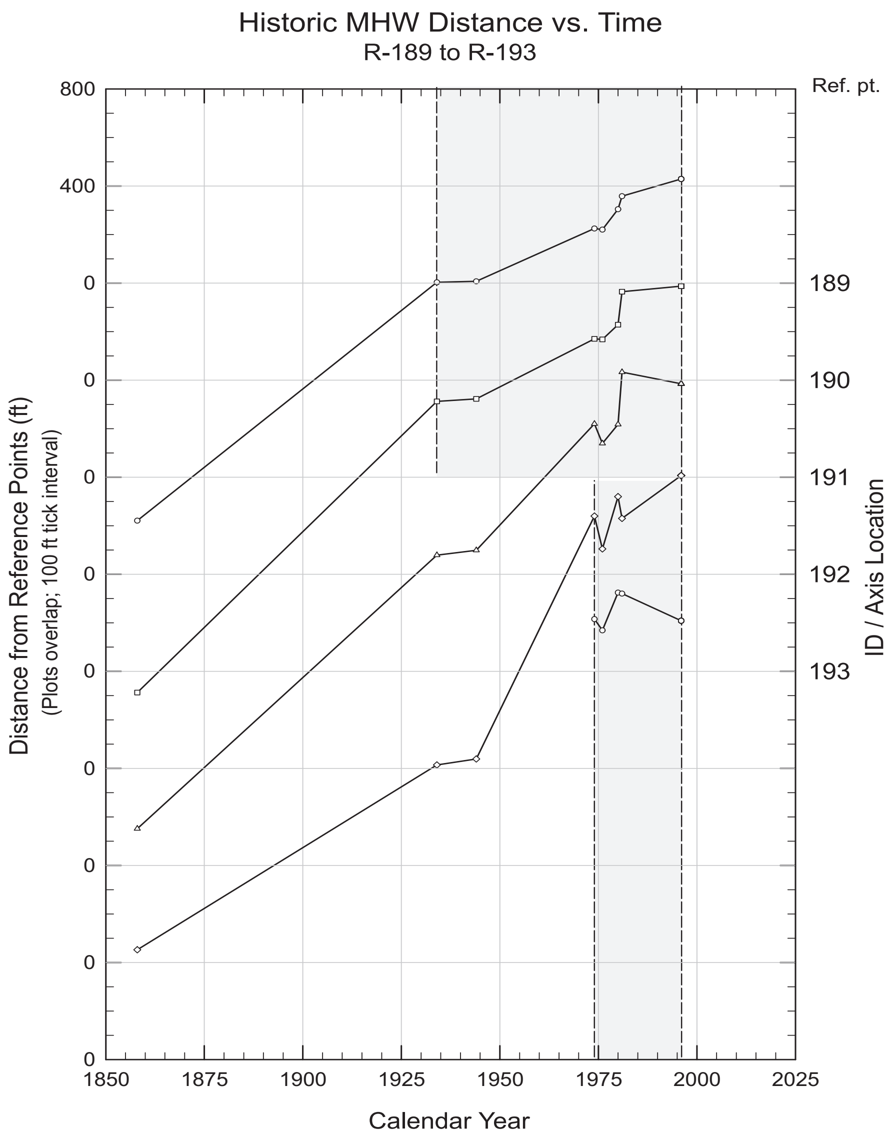

Historic MHW Distance vs. Time
R-158 to R-165
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
158
159
160
161
162
163
164
165
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

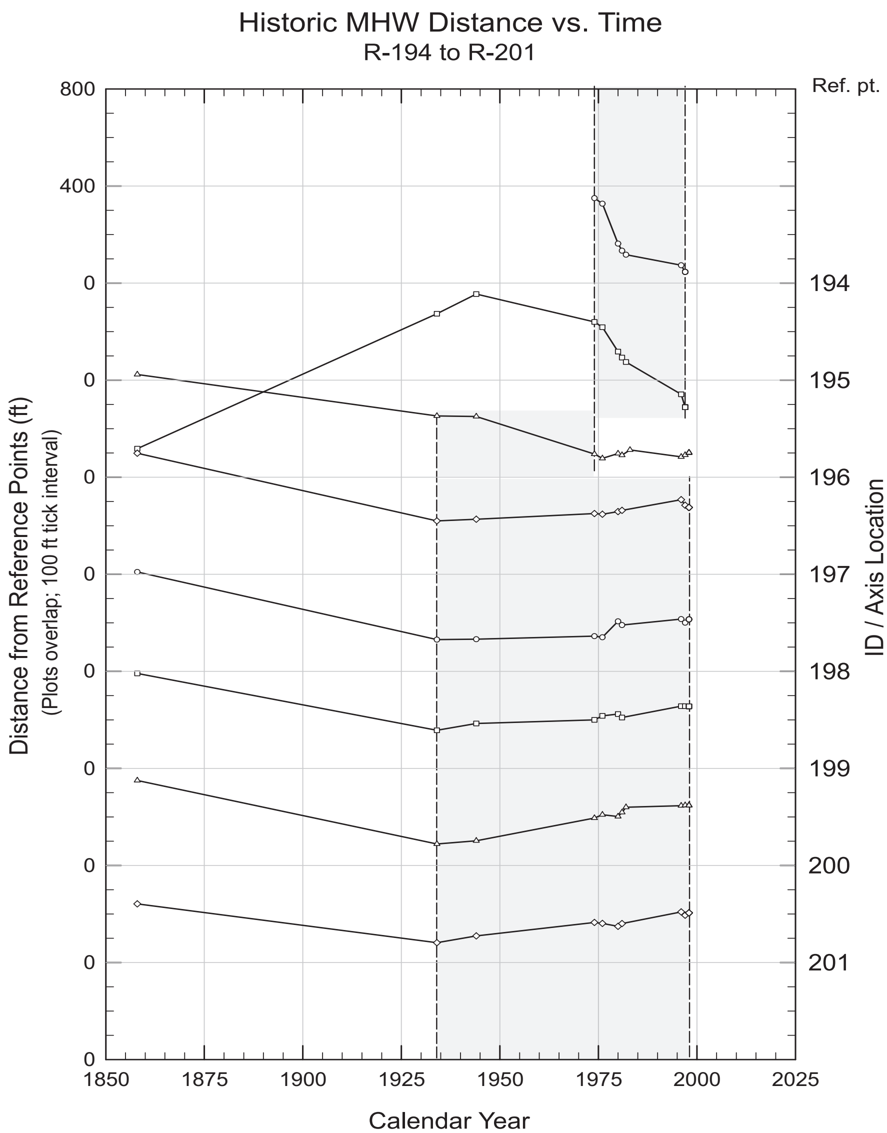

Historic MHW Distance vs. Time
R-166 to R-173
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
166
167
168
169
170
171
172
173
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location

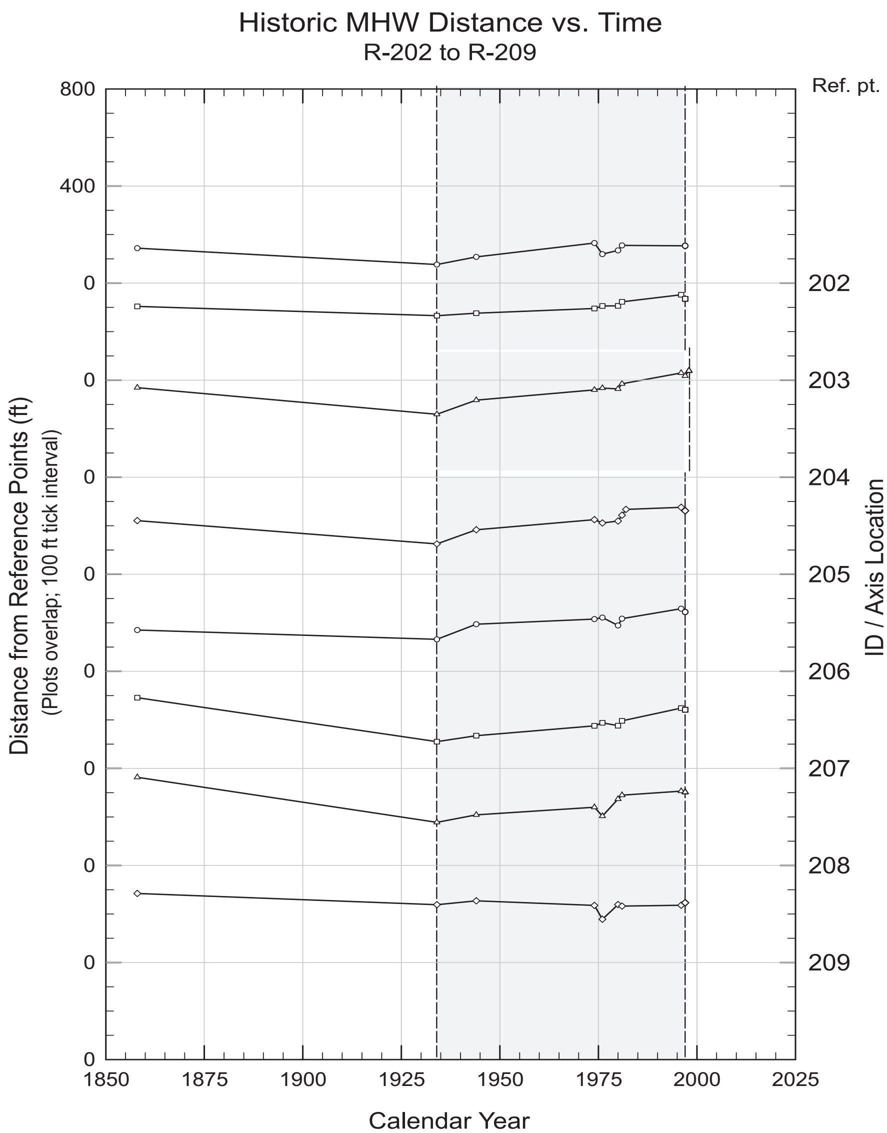
Historic MHW Distance vs. Time
R-174 to R-181



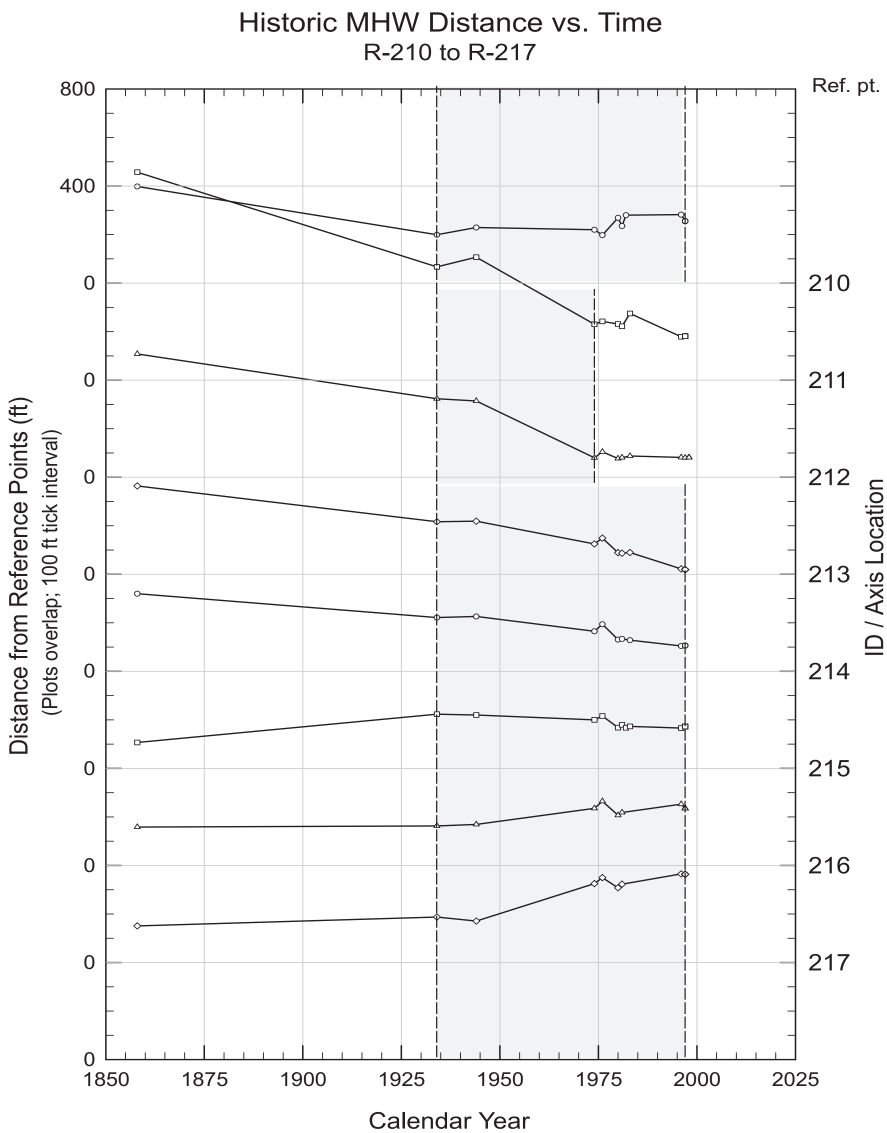

Historic MHW Distance vs. Time
R-182 to R-188
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
182
183
184
184
185
186
187
188
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location


Historic MHW Distance vs. Time
R-189 to R-193
Ref. pt.
800
400
0
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)
ID / Axis Location
189
190
191
192
193

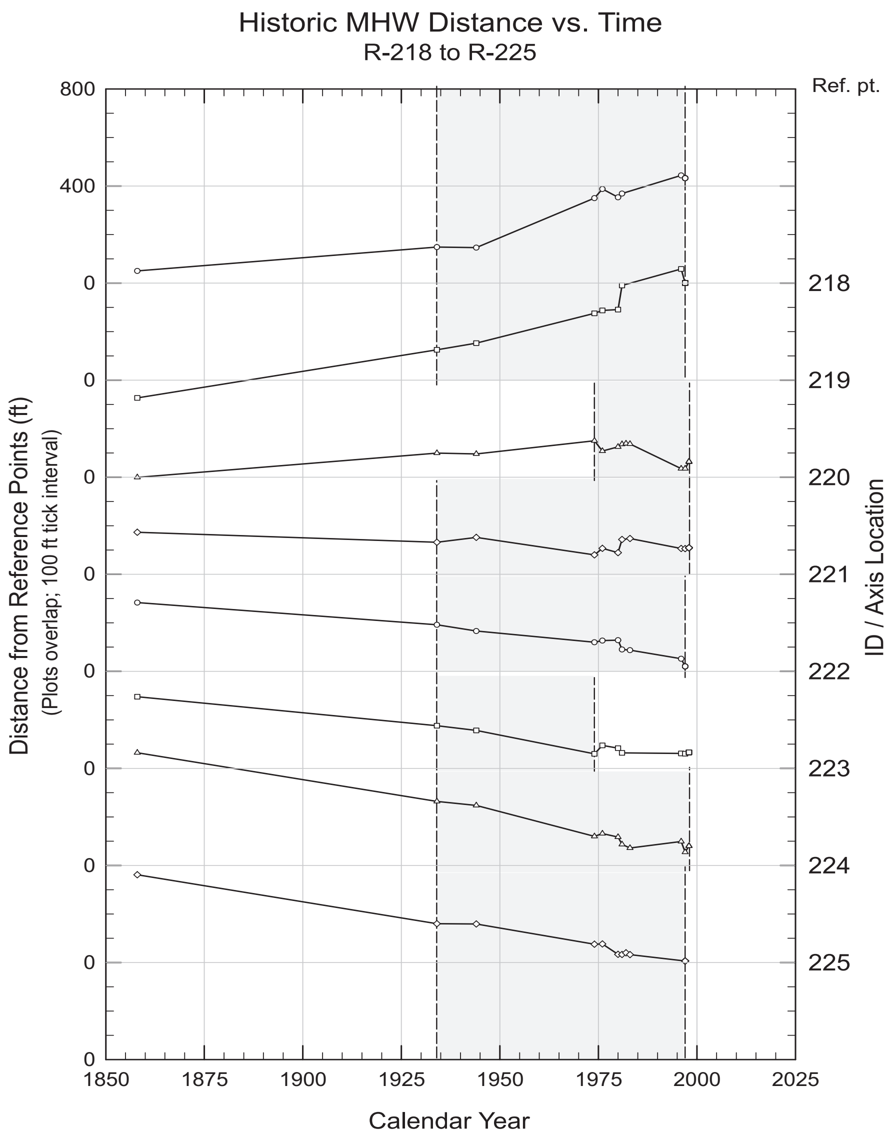

Historic MHW Distance vs. Time
R-194 to R-201
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
800
400
0
0
0
0
0
0
0
0
0
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Ref. pt.
194
195
196
197
198
199
200
201
ID / Axis Location



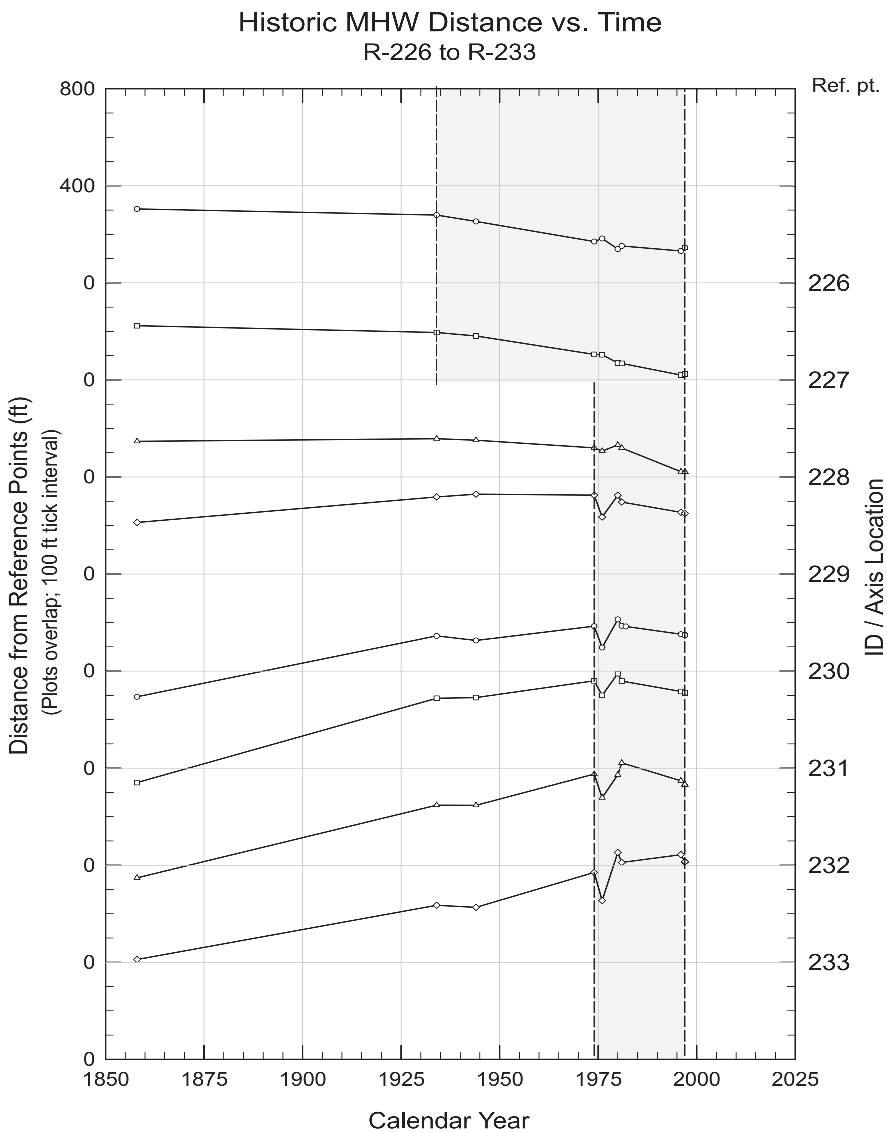
Historic MHW Distance vs. Time
R-202 to R-209
800
400
0
0
0
0
0
0
0
0
0
0
Ref. pt.
202
203
204
205
206
207
208
209
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year



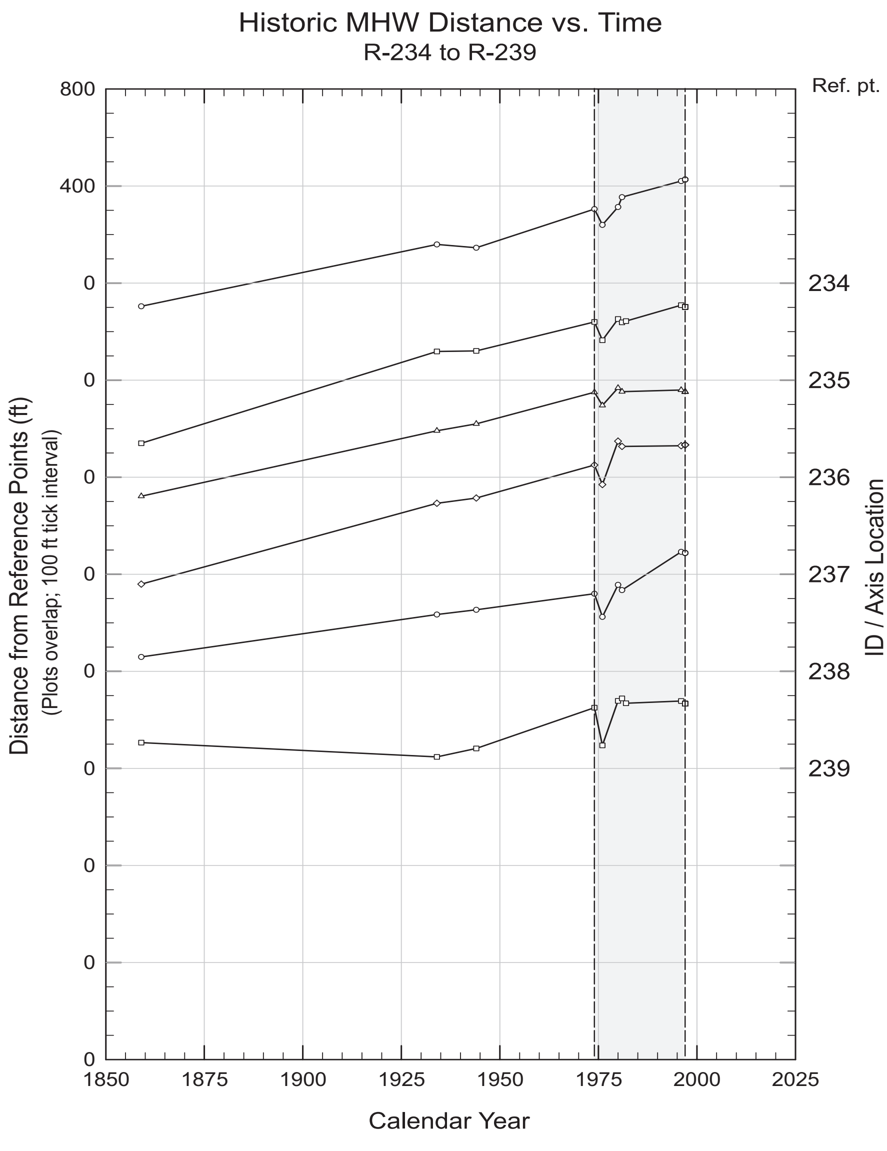
Historic MHW Distance vs. Time
R-210 to R-217
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
210
211
212
213
214
215
216
217
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location



Historic MHW Distance vs. Time
R-218 to R-225
Ref. pt.
800
400
0
0
0
0
0
0
0
0
218
219
220
221
222
223
224
225
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

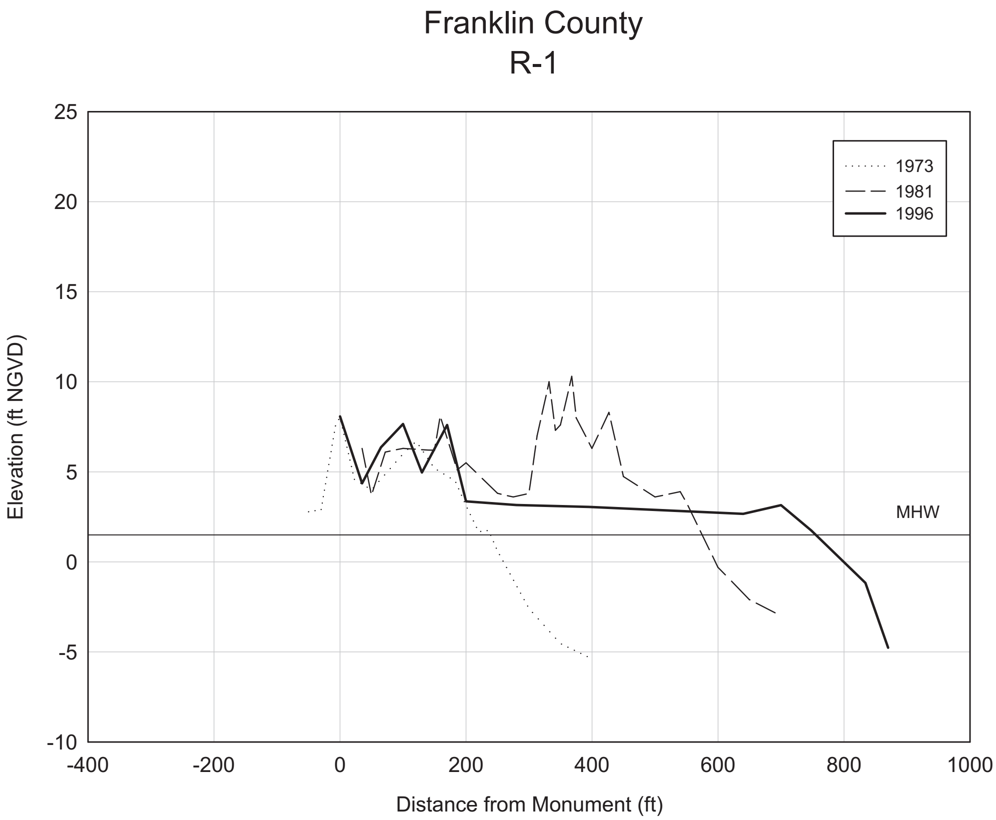


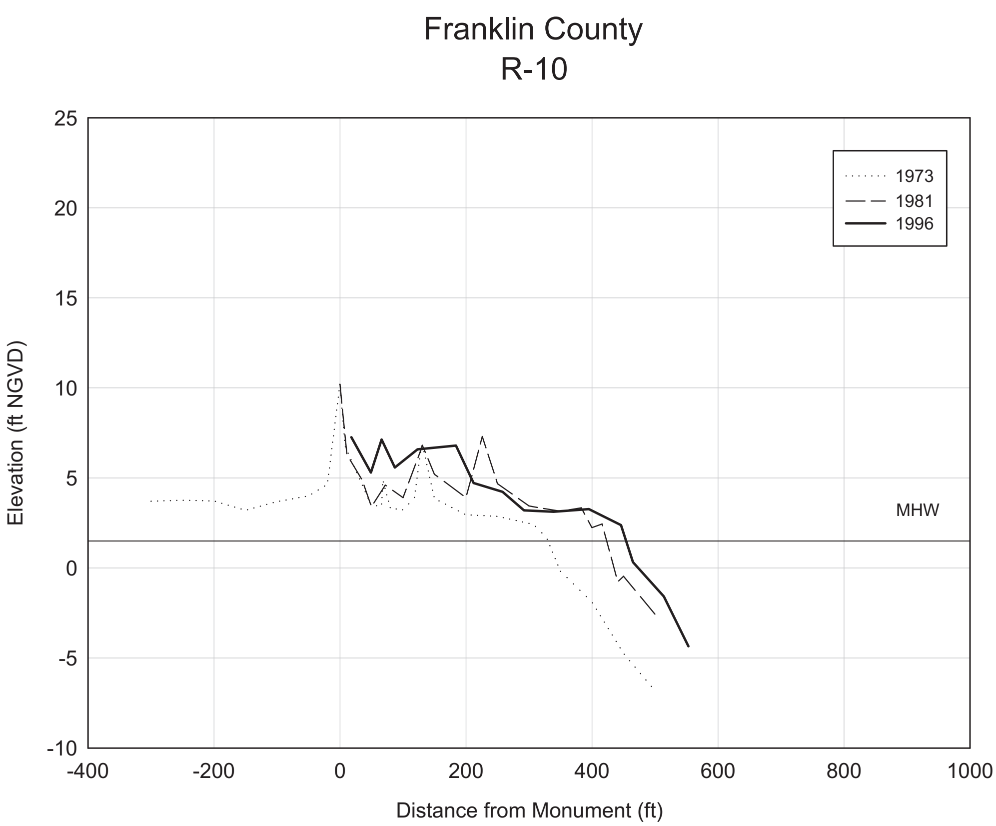
Historic MHW Distance vs. Time
R-226 to R-233
Ref. pt.
800
400
0
0
0
0
0
0
0
0
0
226
227
228
229
230
231
232
233
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year



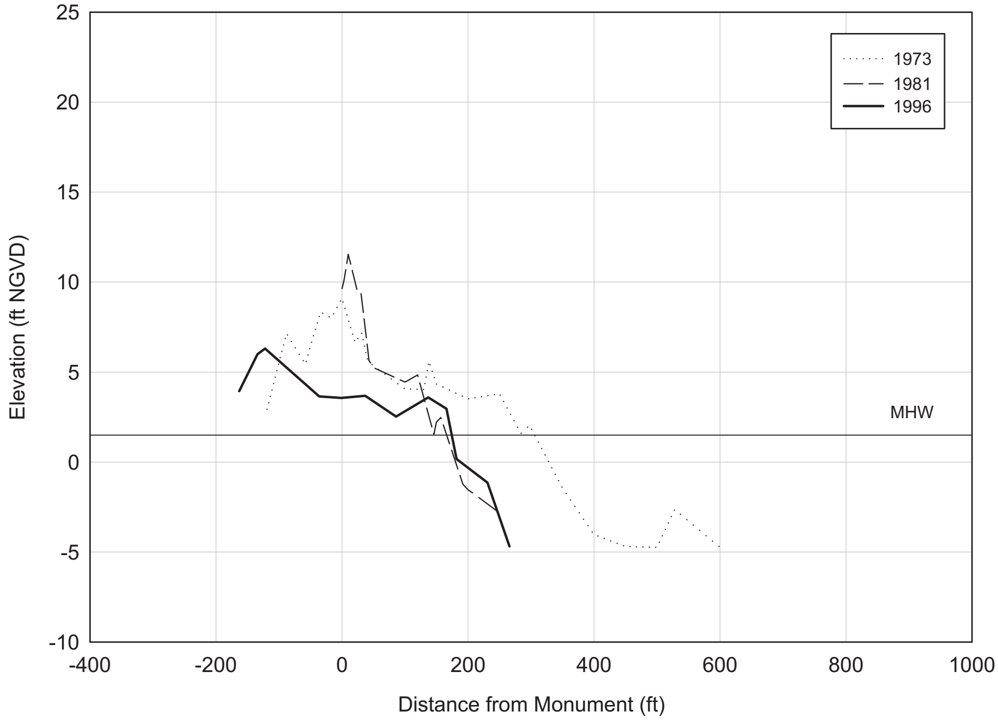
Historic MHW Distance vs. Time
R-234 to R-239
Ref. pt.
800
400
0
234
235
236
237
238
239
Distance from Reference Points (ft)
(Plots overlap; 100 ft tick interval)
ID / Axis Location
1850
1875
1900
1925
1950
1975
2000
2025
Calendar Year

7.3 Appendix C: Profile Plots

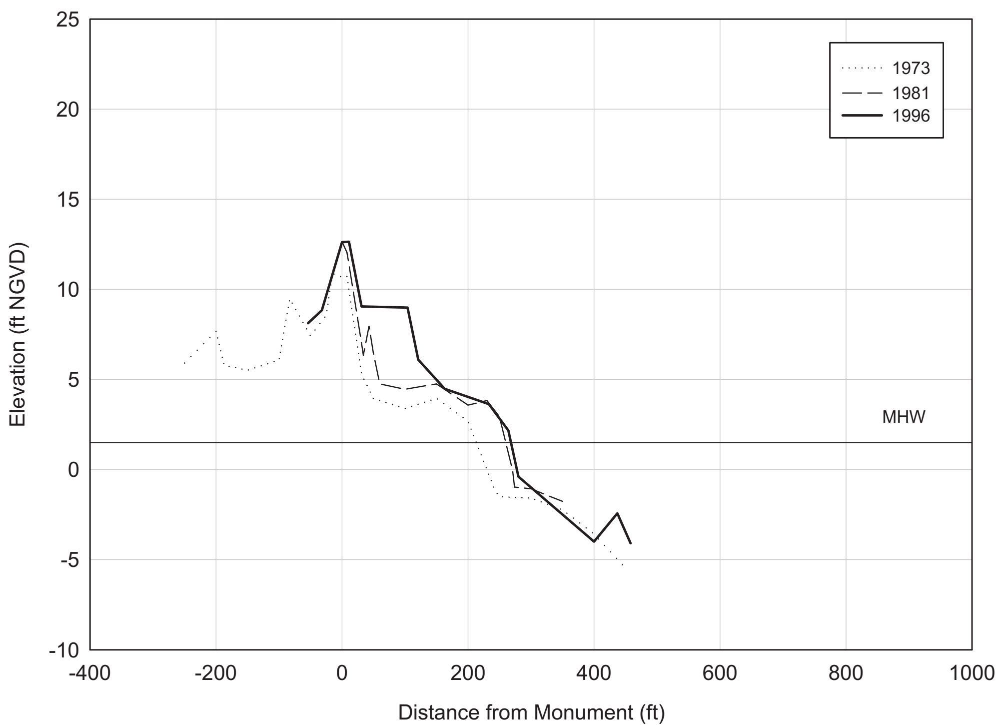

Franklin County
R-1
1973
1981
1996
MHW
Elevation (ft NGVD)
Distance from Monument (ft)
25
20
15
10
5
0
-5
-10
-400
-200
0
200
400
600
800
1000

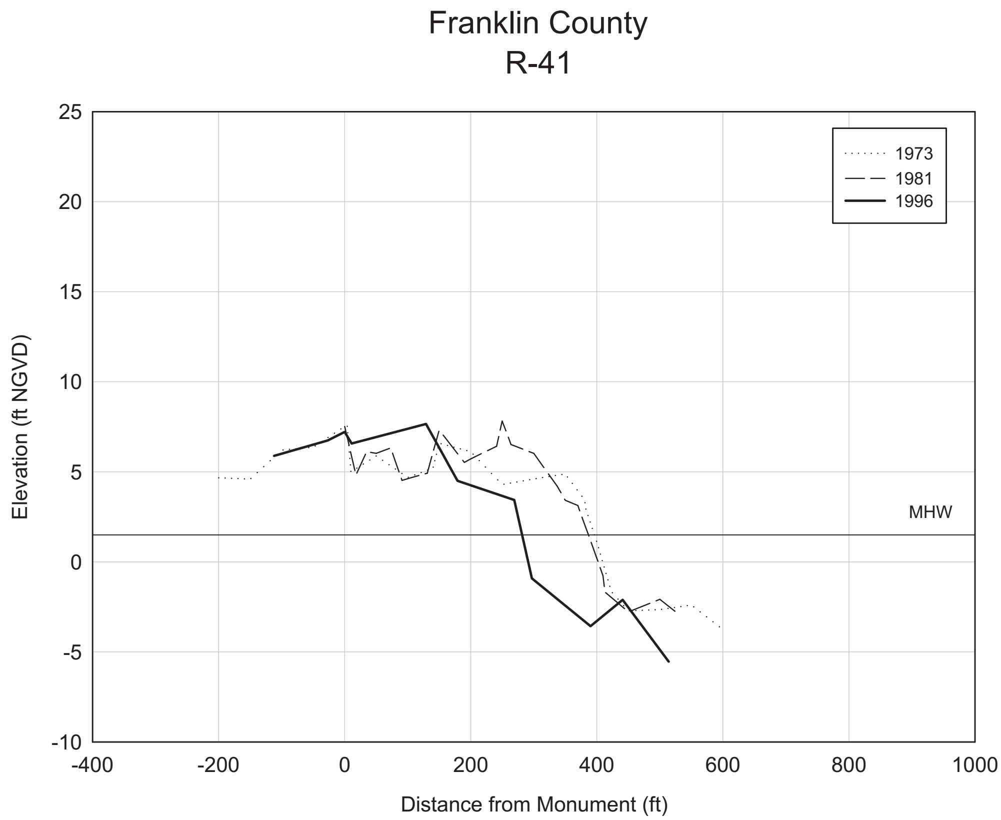

Franklin County
R-10
1973
1981
1996
MHW
Elevation (ft NGVD)
Distance from Monument (ft)
25
20
15
10
5
0
-5
-10
-400
-200
0
200
400
600
800
1000

Franklin County
R-18

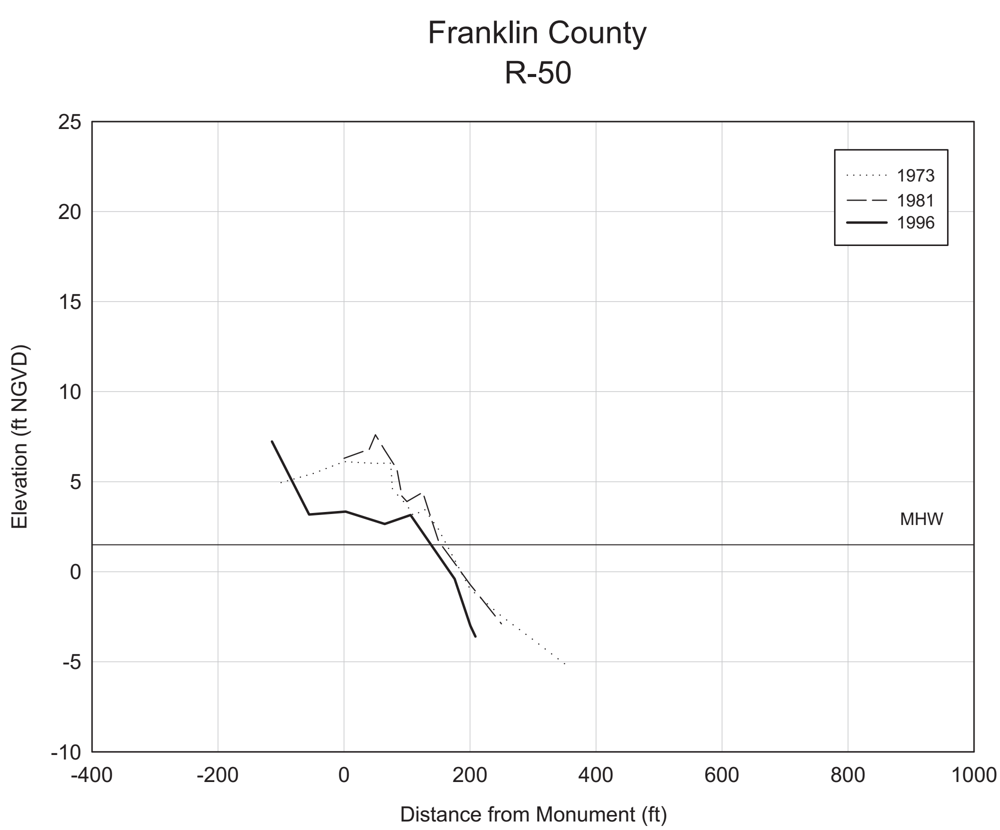


Franklin County
R-30



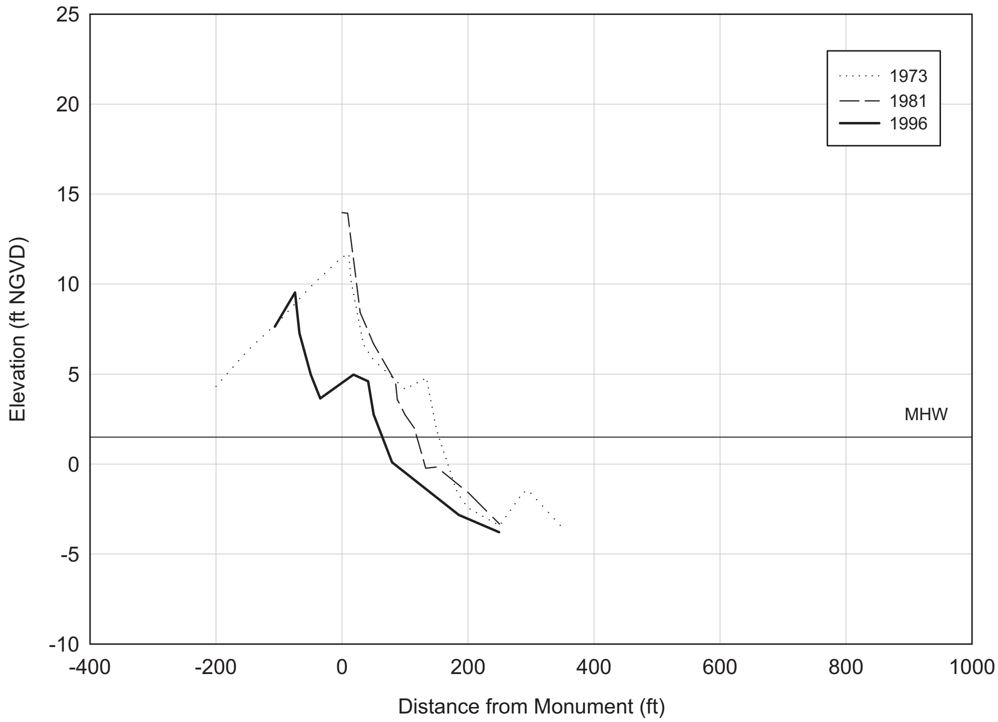


Franklin County
R-41
1973
1981
1996
MHW
Elevation (ft NGVD)
Distance from Monument (ft)
25
20
15
10
5
0
-5
-10
-400
-200
0
200
400
600
800
1000

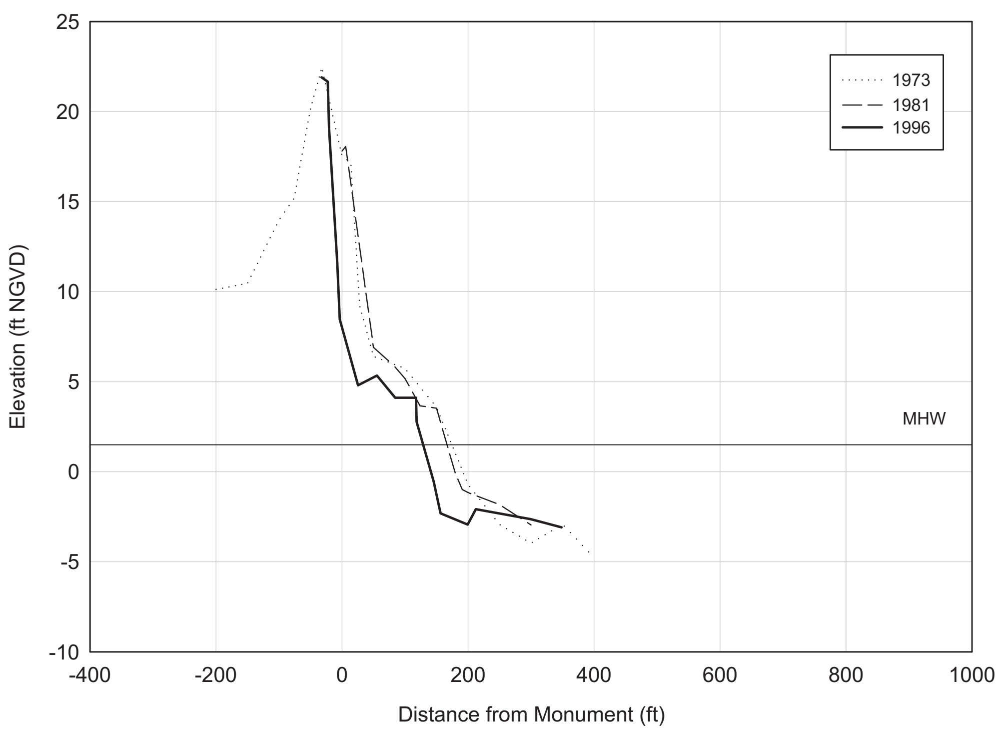


Franklin County
R-50
1973
1981
1996
MHW
Elevation (ft NGVD)
Distance from Monument (ft)
25
20
15
10
5
0
-5
-10
-400
-200
0
200
400
600
800
1000

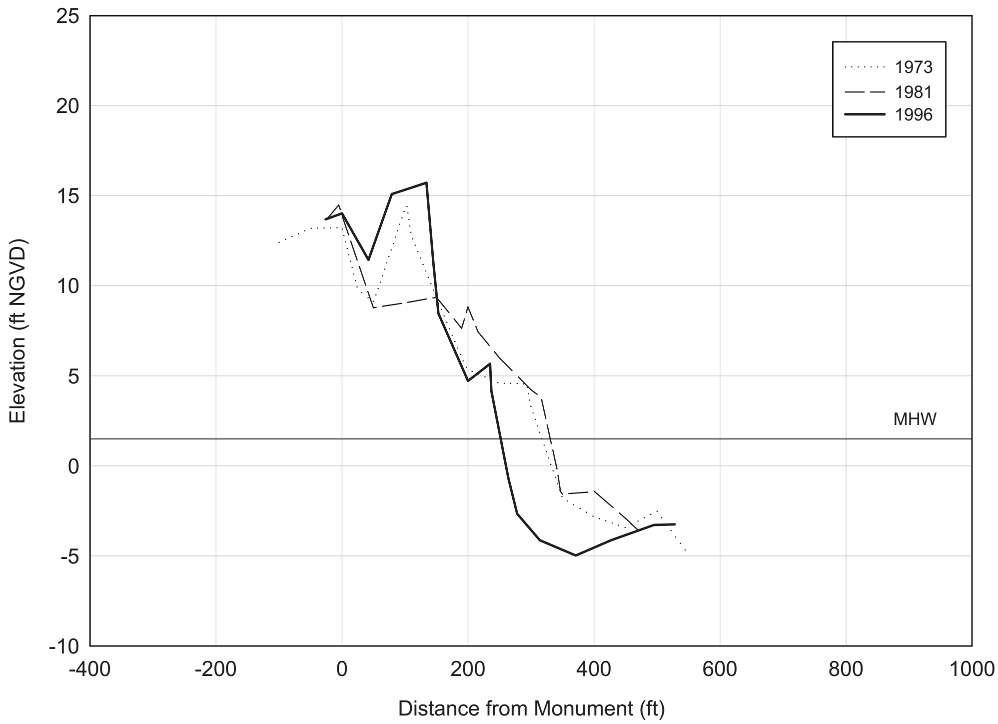
Franklin County
R-60



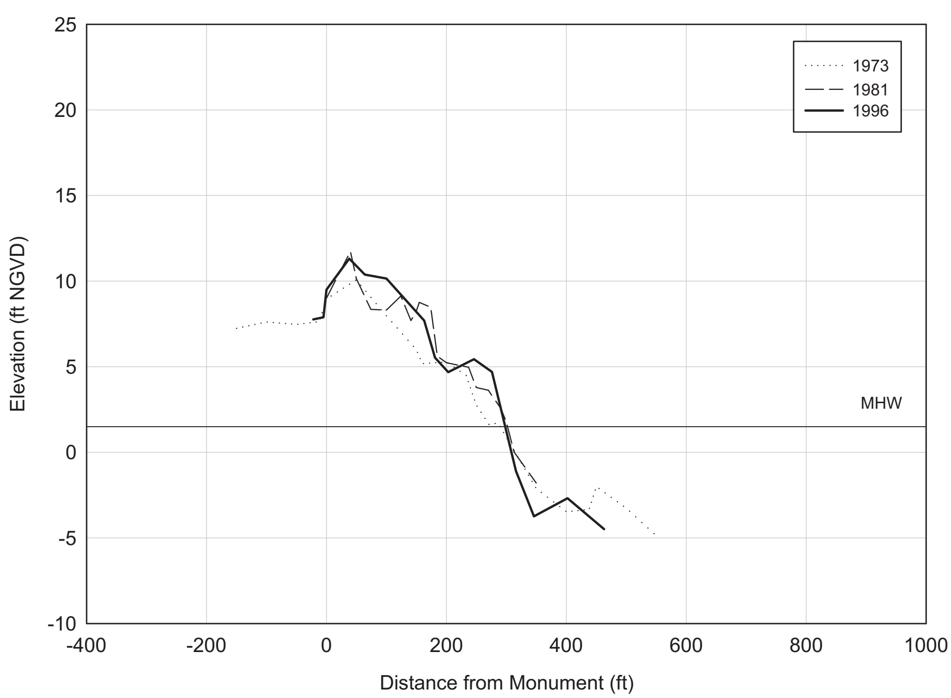
Franklin County
R-68



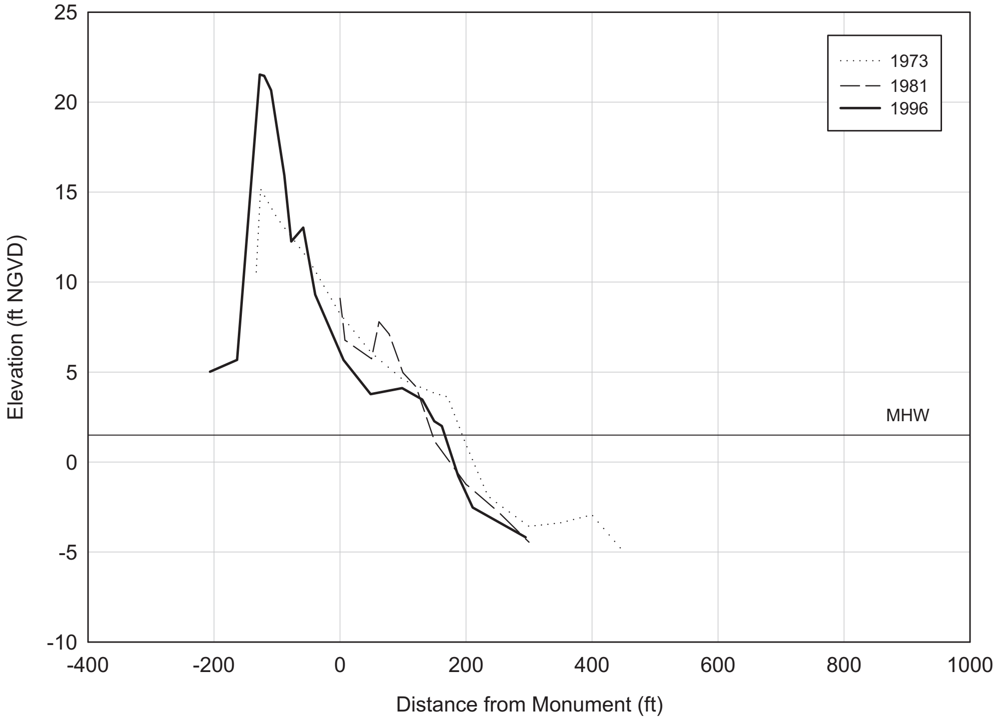
Franklin County
R-80



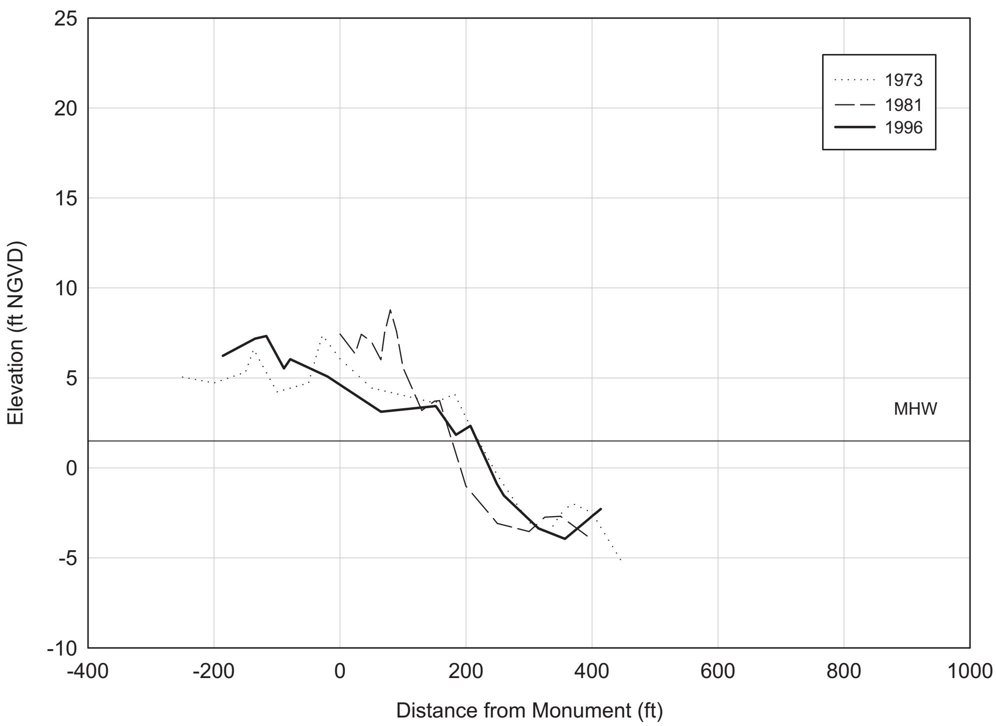
Franklin County
R-90



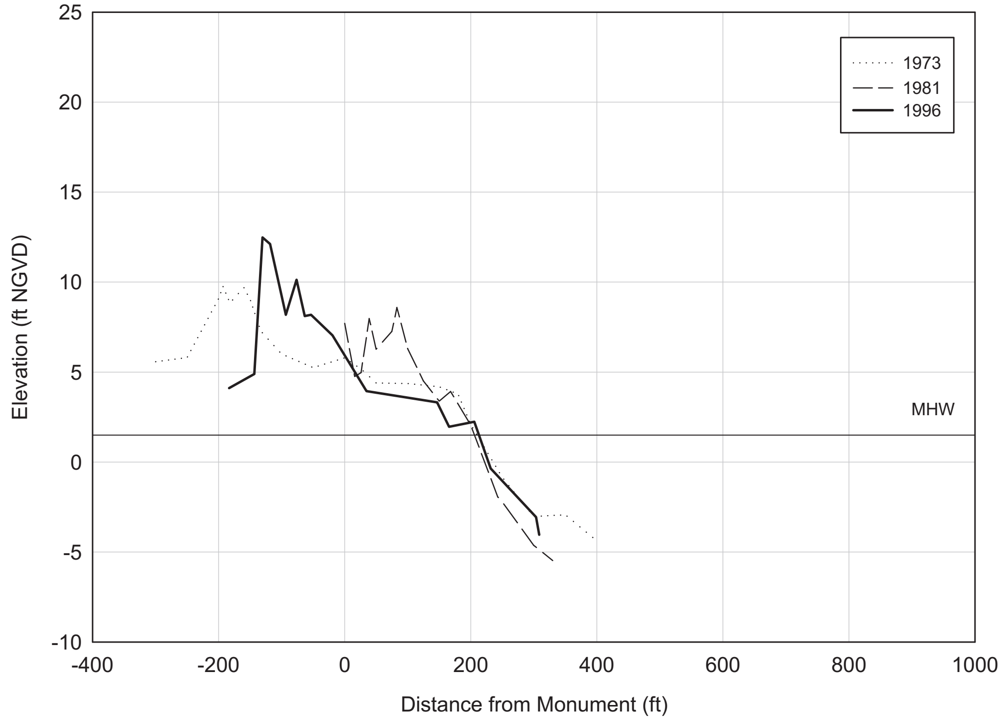
Franklin County
R-100



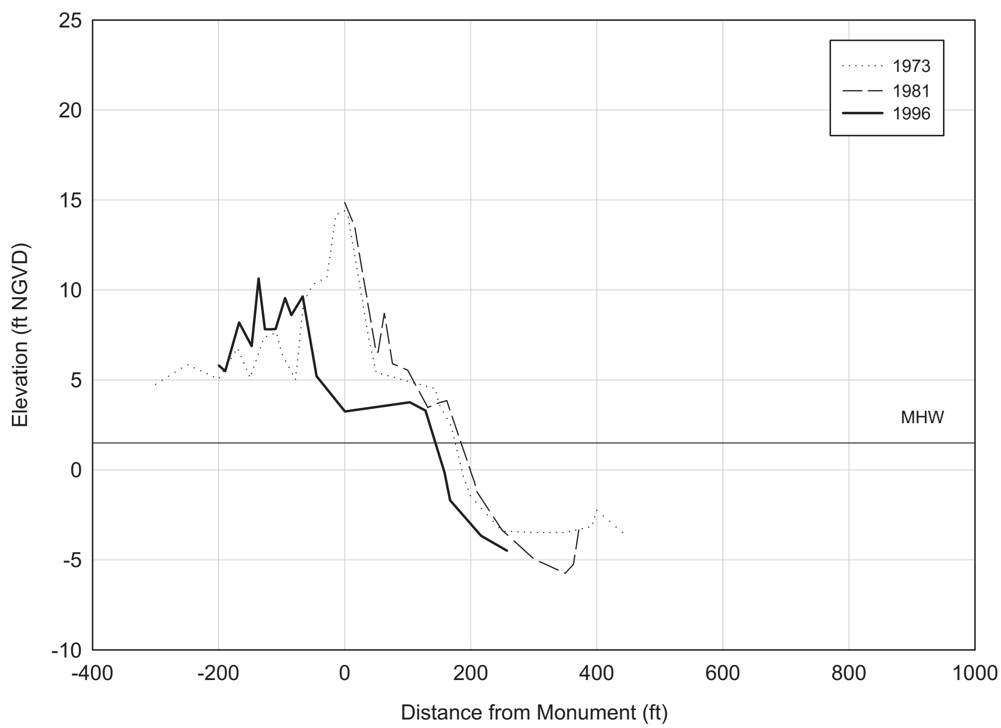
Franklin County
R-110



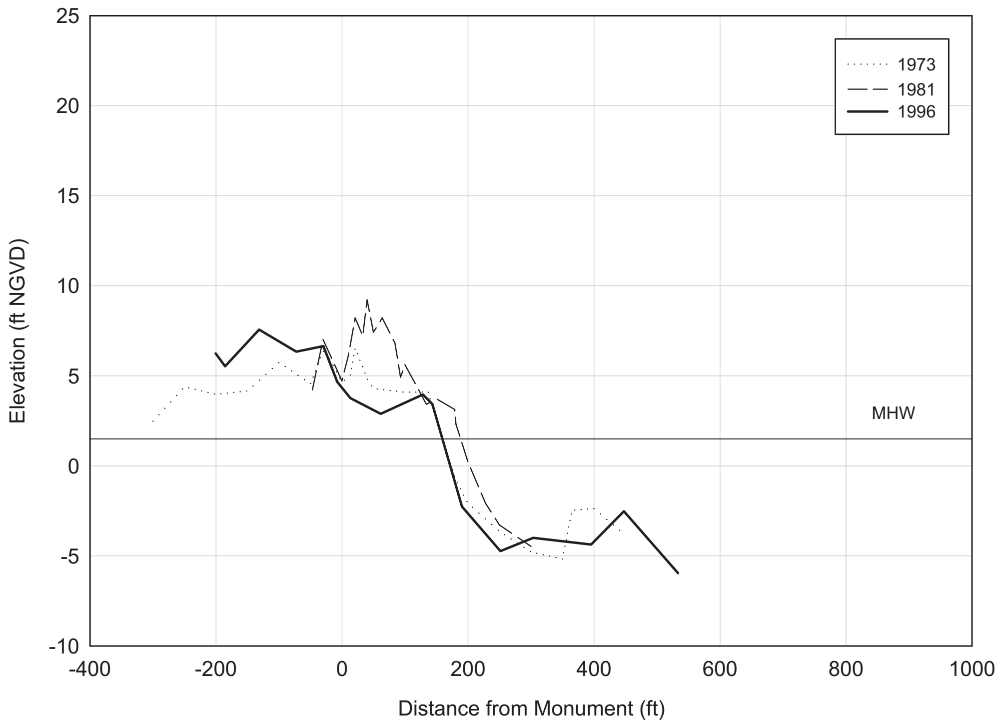
Franklin County
R-119



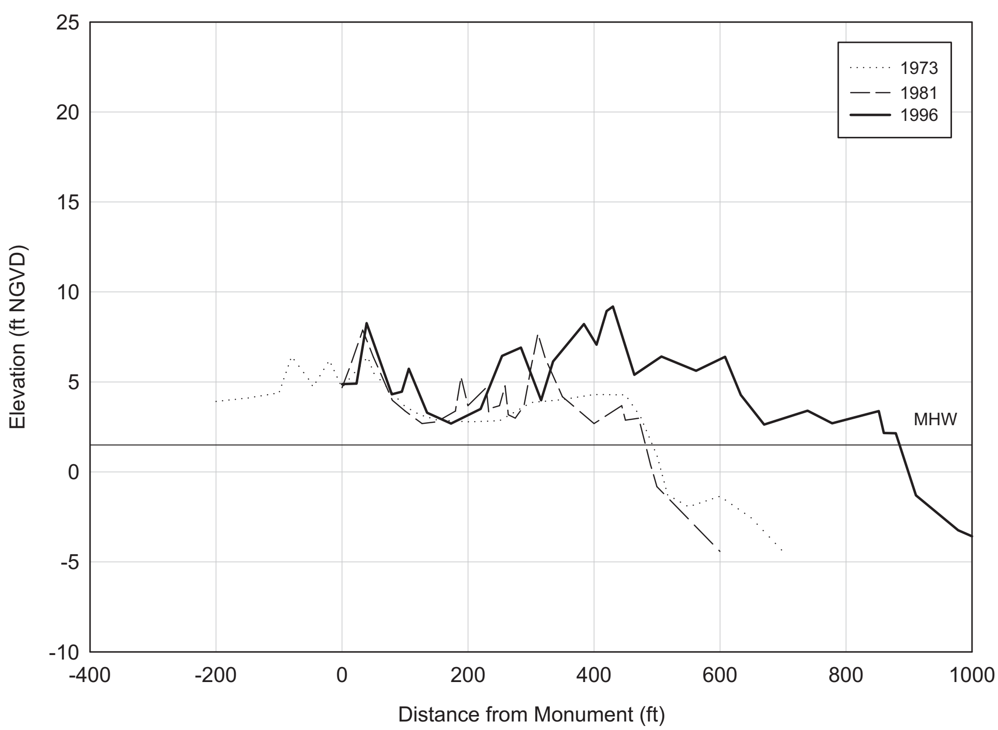
Franklin County
R-129



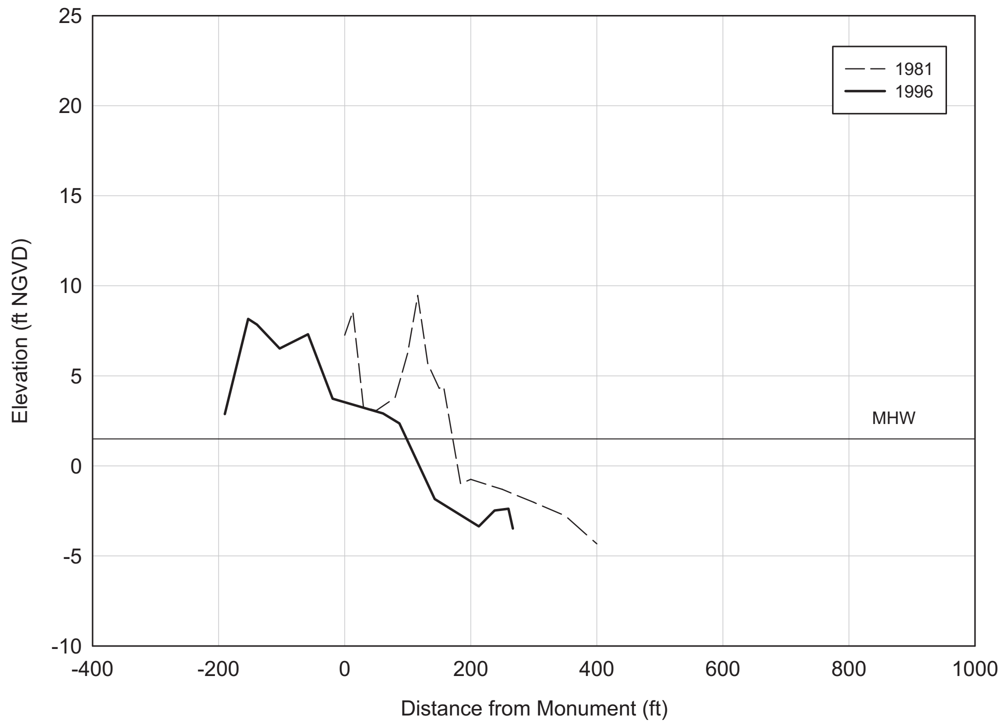
Franklin County
R-142



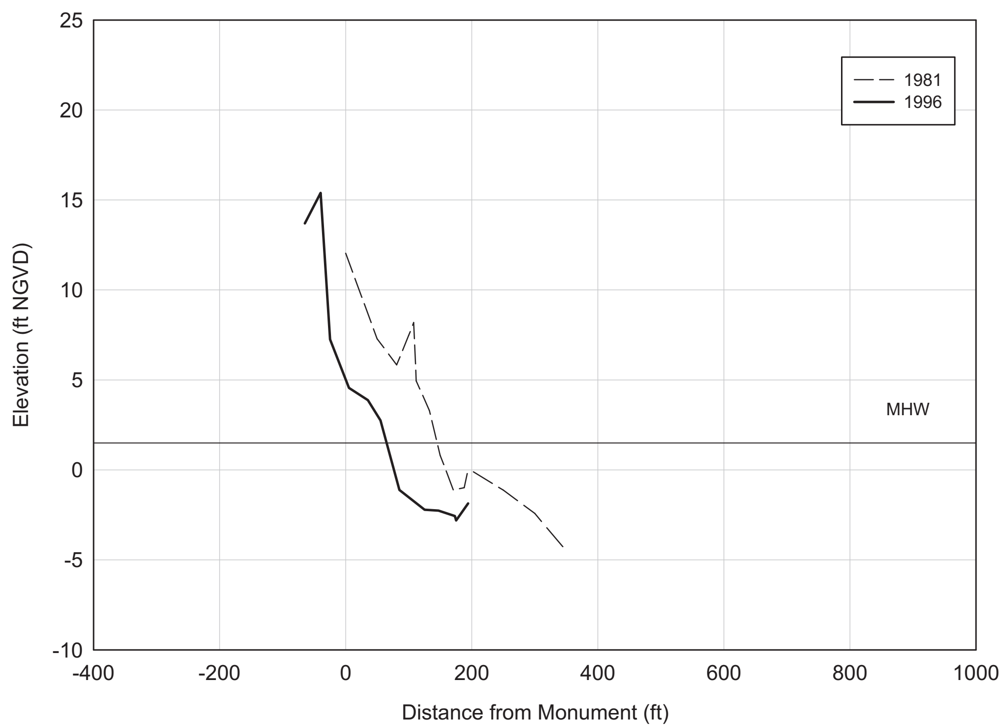
Franklin County
R-147

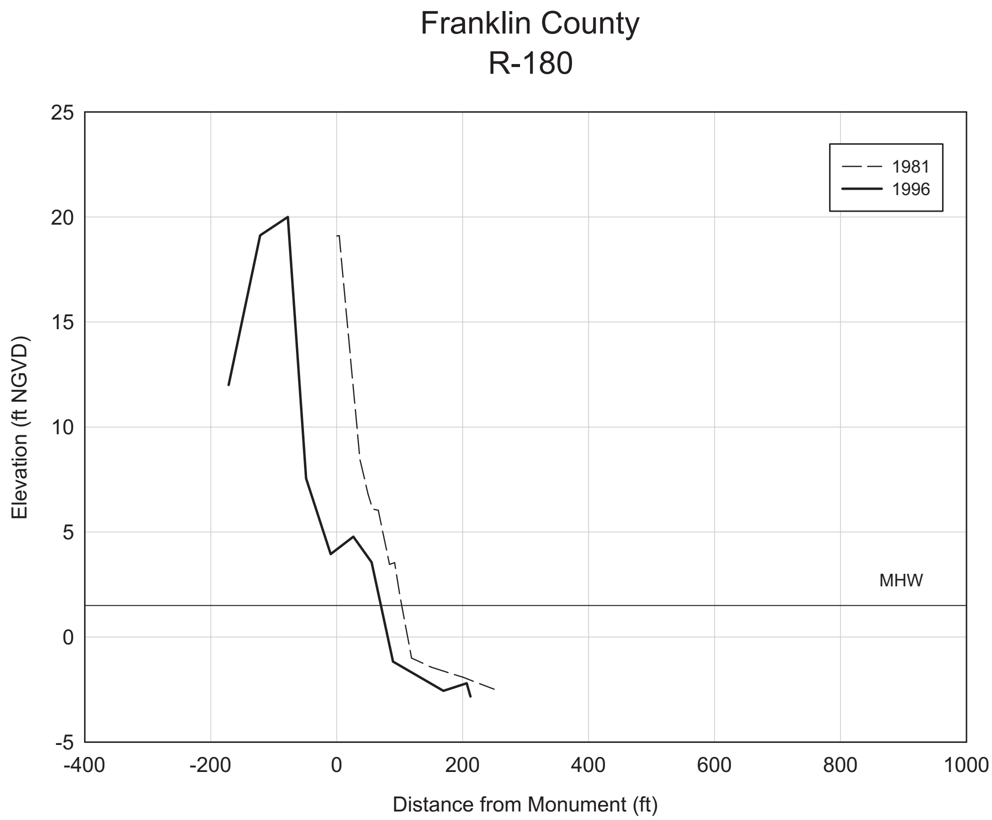


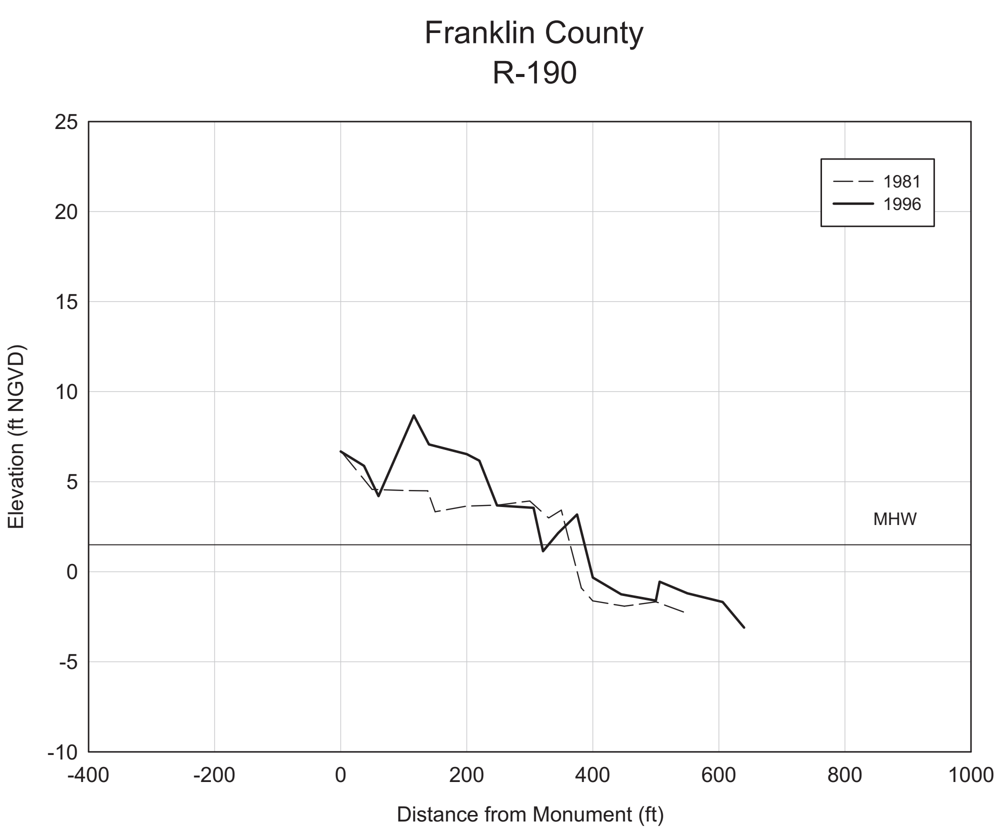
Franklin County
R-160

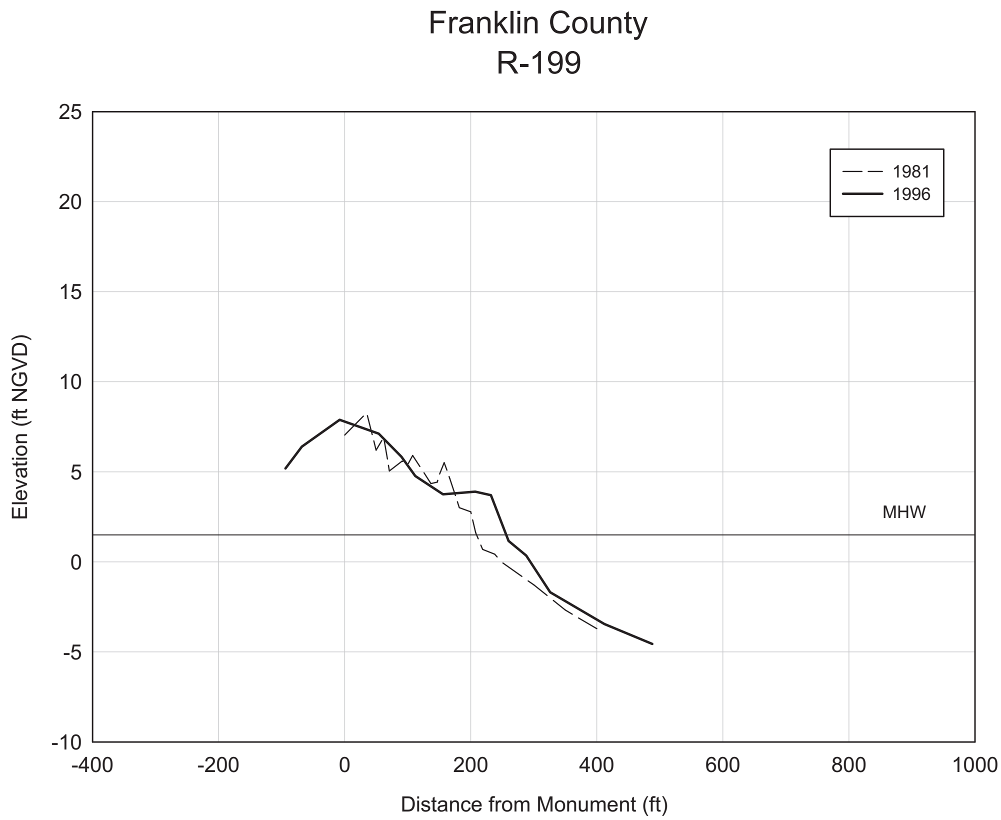


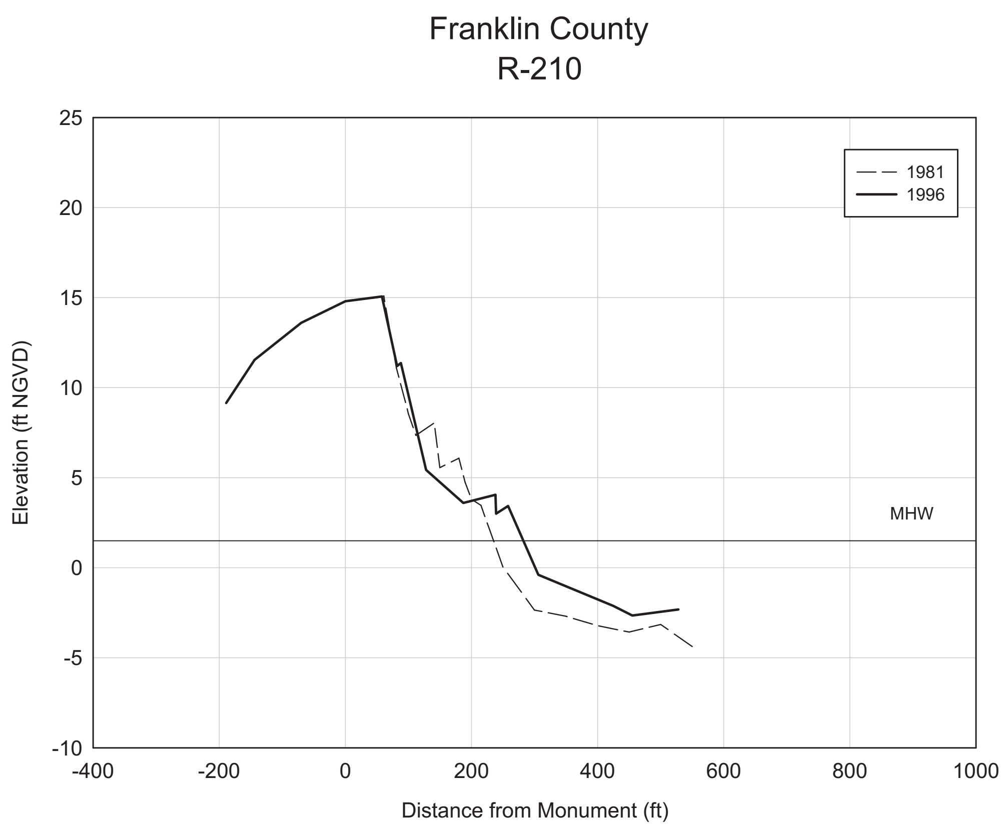
Franklin County
R-170



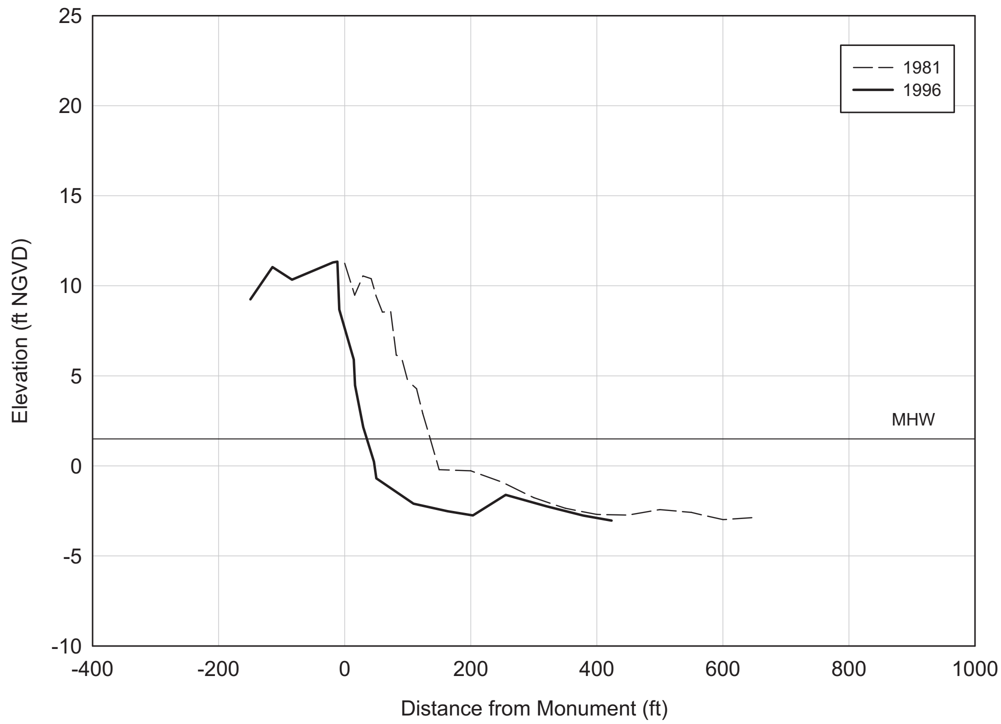

Franklin County
R-180
1981
1996
MHW
Elevation (ft NGVD)
Distance from Monument (ft)
25
20
15
10
5
0
-5
-400
-200
0
200
400
600
800
1000


Franklin County
R-190
1981
1996
MHW
Elevation (ft NGVD)
Distance from Monument (ft)
25
20
15
10
5
0
-5
-10
-400
-200
0
200
400
600
800
1000

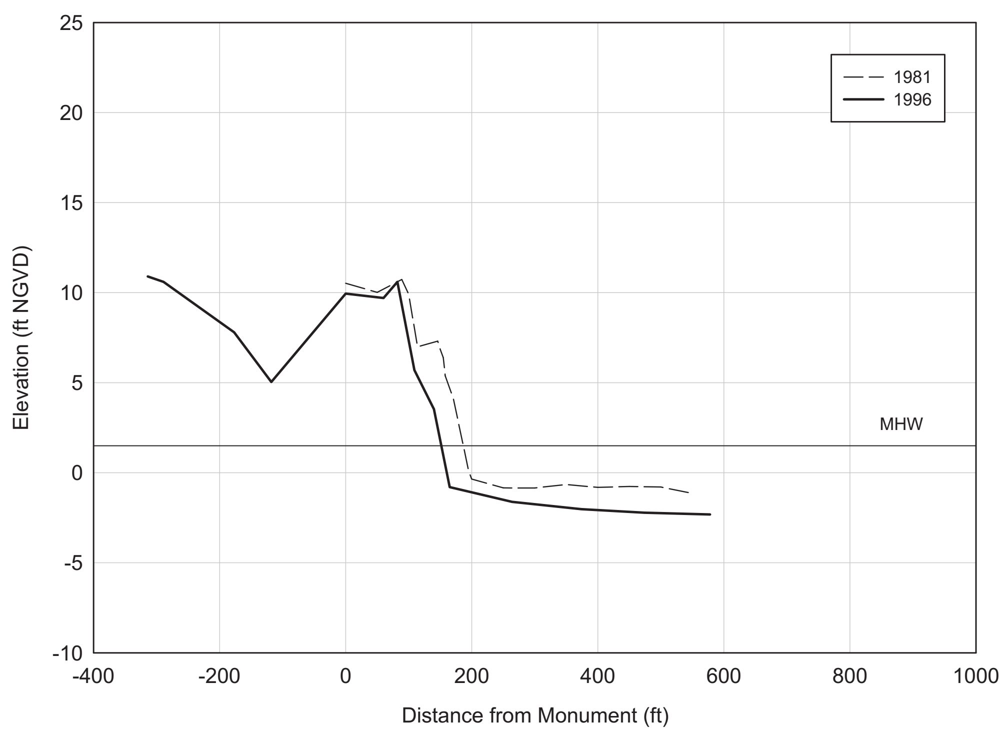

Franklin County
R-199
1981
1996
MHW
Elevation (ft NGVD)
Distance from Monument (ft)
25
20
15
10
5
0
-5
-10
-400
-200
0
200
400
600
800
1000

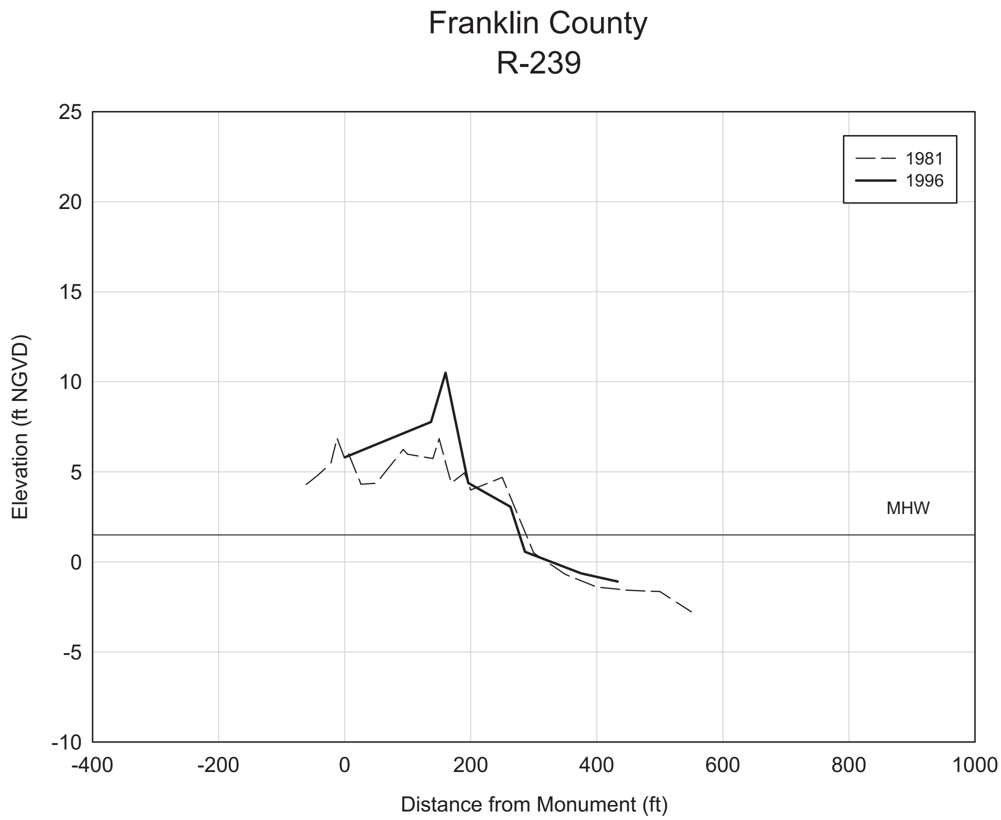

Franklin County
R-210
1981
1996
MHW
Elevation (ft NGVD)
Distance from Monument (ft)
25
20
15
10
5
0
-5
-10
-400
-200
0
200
400
600
800
1000

Franklin County
R-220



Franklin County
R-230




Franklin County
R-239
1981
1996
MHW
Elevation (ft NGVD)
Distance from Monument (ft)
25
20
15
10
5
0
-5
-10
-400
-200
0
200
400
600
800
1000