



Association for the Preservation of Cape Cod

P. O. Box 636

Orleans, Massachusetts 02653

BOARD OF DIRECTORS

PRESIDENT

John J. Carr
Horsfield

VICE PRESIDENT

Barbara Egan
South Wellfleet

SECRETARY

Susan and Gage
W. Brewster

TREASURER

Arthur C. Jones
S. Wellfleet

Viola Boleyn
Brewster

Robert L. Brown
Wellfleet

John Davis
Barnstable

Arvid B. Graves
Orleans

William MacNary
S. Falmouth

James E. Nickerson
Bass River

James S. Peace
B. Dennis

John G. Schall
Orleans

Carl B. Sherman
Barnstable Beach

Marjorie L. Simmel
S. Falmouth

Steve Thompson
S. Falmouth

Robert F. Whitlock
Falmouth

EXECUTIVE DIRECTOR
Arthur W. Snyder

DIRECTOR OF RESEARCH
David J. Magnuson

BOARD OF SCIENTIFIC
ADVISORS

Robert F. Whitlock
Chemist, Chairman

Robert S. Biskind
Ecologist

William S. Giese
Physical Oceanographer

James R. Hall
Hydrologist

William H. Nickerson
Ecologist

Robert W. Rish
Limnologist

John Sprague
Hydrologist

Arthur N. Strahler
Ecologist

John M. Teal
Marine Ecologist

November 20, 1974

Mr. Wilbur Rockwell
Chairman, Board of Selectmen
Wellfleet, Ma. 02667

Subject: Herring River Dike,
Operation of Water Control System

Dear Mr. Rockwell:

After the Massachusetts Commissioner of Natural Resources issued his December 17, 1973, Order of Conditions (file 77-2) governing the reconstruction of the dike at Herring River, APCC became concerned because the then Selectmen and the Massachusetts Department of Public Works gave no indication of any intent to comply. Faithful compliance would require the ascertaining of essential baseline data on the part of the Selectmen and a modification of the valving arrangement on the part of the DPW to properly accommodate the two-way tidal flow mandated by the Order. Since no moves were made to meet either of these needs, APCC decided it would be consistent with APCC objectives to attempt to partially fill the vacuum, and decided to determine accurately: the nature of the salt water flow through and above the dike; the inside tidal range; and the nature of plant and animal life as they existed in the lower basin.

We did, and still do, find it incredible that the DPW made no move to modify the valving arrangement to fit the Order of Conditions. Minor modifications, involving no delay and very little expense, would have served these new conditions much better than they can be served with the inferior design you are now left with. However, APCC could do nothing on its own to cure that sort of deficiency.

APCC sought and obtained the assistance of Dr. John Teal and Dr. Ivan Valiela, eminent scientists in estuarine matters. They enlisted for us the services of Ms. Allison Snow, a Hampshire College student doing studies at Woods Hole. She volunteered to make field observations over a period of time, and to secure samples of flora and fauna for laboratory analysis. Additionally, we secured the services of John Moody, whose training and avocation is in the field of physical oceanography. He provided and installed a continuously recording tide gauge above the dike and took salinity measurements in the river. As a final step, we employed the services of Underwater Technicians, Inc., to explore the interior of the old dike structure. Measurements and photographs were taken to confirm computer calculations,

which had been provided by Mr. Moody, concerning the extent of the effective opening in the old dike. The results of these studies are reported in detail in the two attachments.

What we know now is that natural forces, given the chance they have had to reassert themselves in the lower river basin, are re-establishing a highly productive salt marsh. Although it is not yet large in size, there is already a flourishing population which includes not only the typical marsh grasses but all the intertidal animals common to the Cape area. Most prominently, these include oysters, crabs, mussels, eels, menhaden, bluefish, bass, and numerous shorebirds. Osprey, also, have been observed fishing in the river. There is no reason to doubt that the herring run can be re-established when the headwater ponds are restocked. Reintroduction of herring into those ponds will go a long way toward keeping them clean and free of eutrophication, which is the fate of many Cape ponds today.

We are of the opinion that the introduction of even a moderately increased amount of tidal flow onto the Herring River flood plain would spread, many times over, the productive marsh area in the lower basin, yet raise the maximum tide level only a matter of inches.

The mean water level just inside the dike is now only about 8" above mean sea level in the harbor. This level inside can be expected to drop with any increased opening. (With no dike at all there would be no significant difference in mean level.) Increased coverage at high tide would convert much of the flat cattail area shown on an accompanying map to spartina grasses. The greater the area covered and uncovered with each tide, the larger the area fertilized and cultivated by nature (free, that is), and the more tons per acre of annual crops produced to feed marine life.

To accomplish these ends, we suggest the following:

1. A continuous reading tide gauge should be reinstalled until the new situation is stabilized.
2. The two tide valves should be rigged so they do not completely close on an incoming tide but remain open an amount matching the condition of the openings in the old structure. (See diagram attached) A 12 to 15 degree opening should suffice.
3. Given the above, then the gate valve, at the start, need be opened only half way. This combination would closely duplicate what is now going on. The tide range should then be monitored against the baseline data we have provided and the gate valve adjusted accordingly.

4. Assuming conditions one and two above, we believe the range of tide in the river should thereafter be gradually increased by further opening of the gate valve (in steps) until the range is increased from 1.7 feet to about 3.5 feet. Actual elevations would be about 4.0' and 7.5' above mean low water in the harbor. We do not believe this would raise the high tide level at High Toss culvert to any more than the top of the opening. The mean level there would probably remain close to the present level.
5. Since the area affected by the tides above the dike is within the National Seashore, we urge the Selectmen to make the Interior Department a partner in the effort to optimize the great opportunity that is at hand. Their access to expertise should prove highly beneficial. They are committed conservationists with a primary interest in the area.
6. When the changeover from the old dike to the new is effected, it should be accomplished with minimal interruption of tidal flow. This so as not to deprive the salt marsh communities of the continuous supply of salt water which is their life blood. Many of the species, of course, are seasonally dormant, but not all.

Plagued as we are by skyrocketing food prices, in a world short of seafood and protein in all forms, we hope you will agree it would be unconscionable not to bend every effort to preserve and extend this food factory and marine nursery. Every effort should be made to make the Herring River complex as productive as possible simply by allowing nature to do the job, without recompense and without further hindrance.

Yours respectfully,


H. Eugene Carr
President, APCC

HEC:ep
Encl.

cc: Commissioner Arthur Brownell, D. N. R.
Assoc. Commissioner Malcolm Graf, D. P. W.
Laurence Hadley, Superintendent, National Seashore ✓
James G. Maguire, Chairman, Wellfleet Conservation Comm.

Allison Snow
Box 618
Woods Hole, Mass.

October 7, 1974

Herring River Marsh Study - Preliminary Report

ABSTRACT

The purpose of this study is to examine the present (summer 1974) condition of the salt and freshwater marsh communities at the Herring River, Wellfleet. By determining the distribution and general abundance of marine and freshwater species, the effects of the construction of a new dike can be understood relative to the present situation. Salinity and tidal flow have been measured by Mr. John Moody of North Falmouth.

HISTORICAL BACKGROUND

In 1908 a dike was constructed to regulate and reduce tidal flow into the Herring River and extensive adjacent salt marsh. Two flap-per valves allowed a one-way flow of water out of the marsh, and one gate valve could be opened or closed to accommodate the arrival and departure of herring, which continued upstream to spawn in one of several freshwater ponds.

As a result of the dike, tidal flow was drastically reduced. Salt marsh species died off completely and were replaced by brackish and freshwater species. The upper reaches of the marsh filled in considerably with trees and shrubs able to tolerate the high water table. The area just north of the dike became a freshwater impoundment bordered on the north by extensive cattail marshes.

Recent interest in the Herring River marsh has been aroused by the gradual deterioration of the old dike valves over the past five or six years. Incoming tidal water is now flowing through the valves and into the estuary. Salt marsh species, especially Spartina alterniflora, have begun to recolonize the lower edges of the river. A fringe of bordering trees has died off, but it is not certain whether this has been caused by increased tidal flow or occasional freshwater flooding.

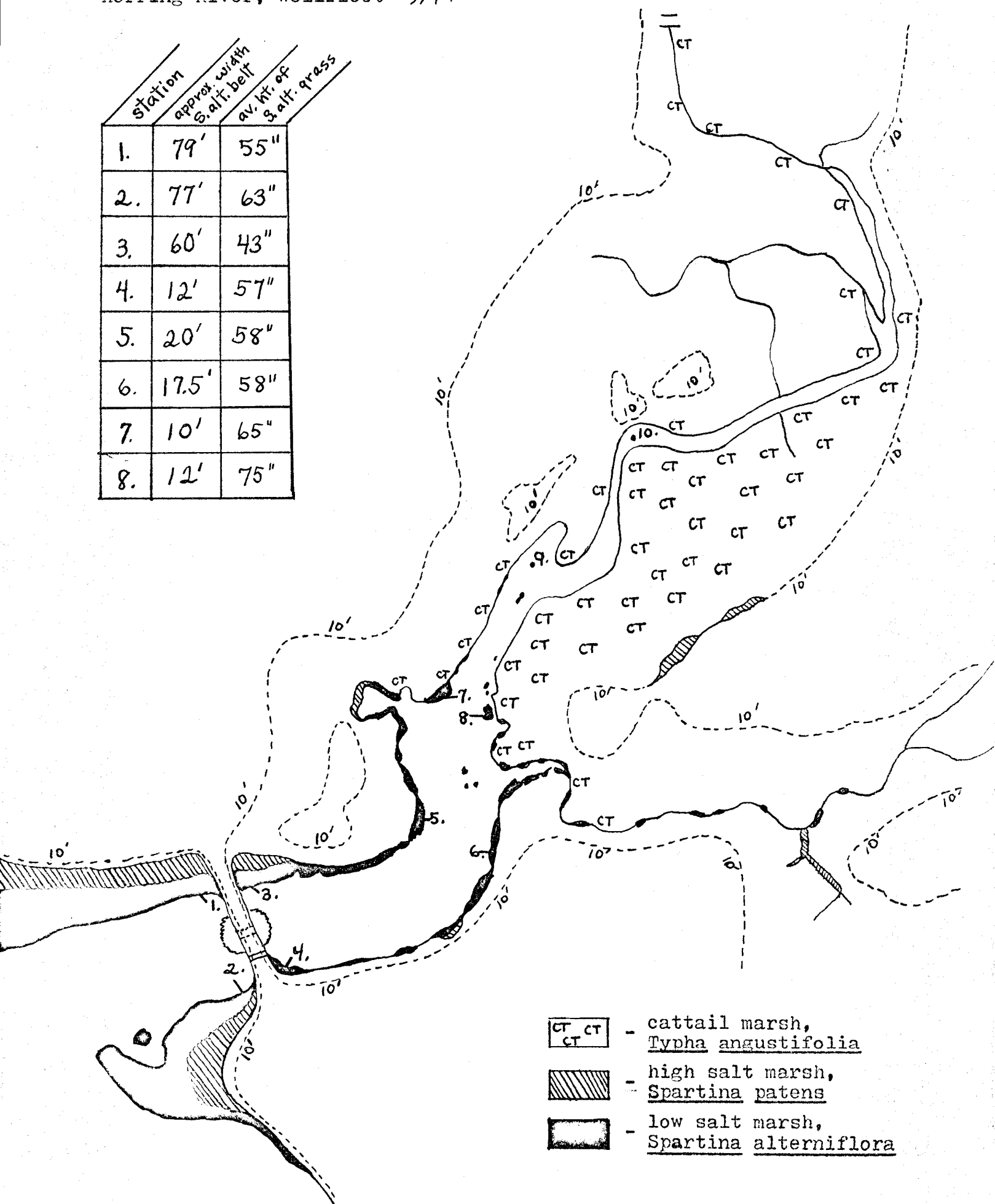
METHODS

To establish a baseline from which further changes may be observed, four transects and two additional stations were set up at various points along the river (see map). Although a small degree of tidal

Distribution of S. alterniflora, S. patens, & Typha angustifolia

Herring River, Wellfleet 9/74

station	approx. width S. alt. belt	av. ht. of S. alt. grass
1.	79'	55"
2.	77'	63"
3.	60'	43"
4.	12'	57"
5.	20'	58"
6.	17.5'	58"
7.	10'	65"
8.	12'	75"



flow can be observed as far upstream as the culvert and road crossing, this was used as the cut-off point in the study because salinity measured here was negligible.

Standing crop and benthic samples were collected at each station, and the width of the belt of salt marsh was measured. Details on techniques and data will be included in the final report, which will also incorporate salinity and tidal flow data already written up by John Moody.

CONCLUSIONS

Although many other components of the marsh could also be examined, such as the fish or insect populations, it is possible from this information to map the extent of recolonization of salt marsh species into what has been a freshwater marsh for approximately sixty years, and to discover the general health and productivity of this new community.

At this point, it seems that, although it does not cover a great deal of area, the fringe of salt marsh (predominantly "low marsh": S. alterniflora) is already supporting a flourishing population of intertidal animals, including fiddler crabs (Uca pugilator), ribbed mussels (Modiolus demissus), oysters (Crasostrea virginica), and many other invertebrates. Larger crabs, eels, menhaden, bluefish, shorebirds, and even osprey have recently been observed feeding on the upstream side of the dike, where eelgrass and various marine algae are also abundant. Mudflats exposed at low tide, covered with a low stand of decomposing cattail stalks, are being recolonized by small clumps of S. alterniflora. If tidal flow remains constant or increases, it can be expected that recolonization will continue at a rapid rate.

Although freshwater ecosystems also support valuable wildlife, the salt marsh community has been emphasized in this report for two reasons. First, organic production in estuaries, and salt marshes in particular, is vital to the coastal food chain. Filter feeders such as shellfish require circulating water rich in organic matter and nutrients. It has been estimated that production in some salt marshes may be as great as ten tons of organic matter per acre per year,¹ which is about sixteen times greater than average agricultural wheat production. Obviously, the town's tidal marshes are one of its most valuable resources.

Secondly, salt marshes are important in the life histories of many fish, such as bluefish, striped bass, [redacted], flounder, and alewives, as

1. Odum, Eugene P., 1961, "The Role of Tidal Marshes in Estuarine Production", N.Y. State Cons. Dept., "Conservationist", June-July 1961

a habitat for young fish or route to spawning grounds. It is a sad fact that a large per cent of New England's salt marshes have been destroyed by man, but this pattern is being reversed in Wellfleet, where the Herring River salt marsh is being restored. The new dike presently under construction is required by the Department of Natural Resources to allow the amount of tidal flow to remain constant, if not increase.

This study is being supervised by Dr. Ivan Valiela, Boston University Marine Program; Dr. John M. Teal, Woods Hole Oceanographic Institute; and Dr. Paul J. Godfrey, University of Massachusetts. A final report will be submitted as soon as the data has been analyzed.

SUMMARY OF HERRING RIVER ESTUARY TIDAL AND SALINITY DATA

Salinity

The salinity of water is defined as the number of grams of salt in 1000 grams of water. If there were 30 grams of salt this would be written 30 o/oo (30 parts per thousand).

Salinity measurements in the Herring River Estuary were made using an AO refractometer accurate to ± 1 o/oo. Figure 1 shows the salinity along the axis of the estuary for low tide, mid tide, and high tide. The dotted line for part of the high tide curve indicates the values which have been estimated since the boat ran out of gas before reaching that area.

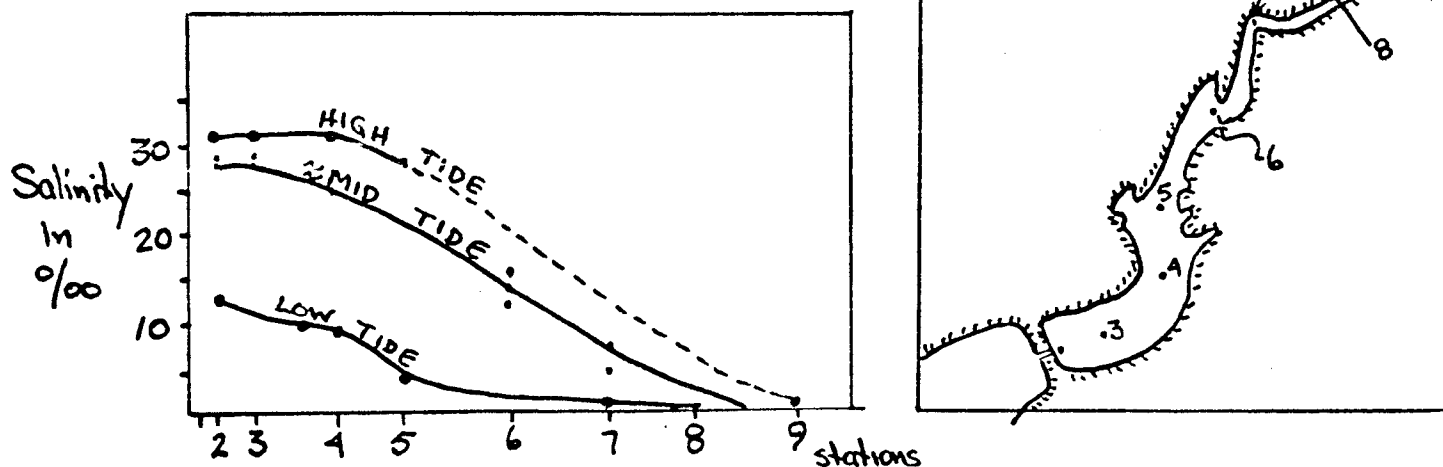


Figure 1. Graph of salinity and map showing the stations.

Maps showing lines of constant salinity (isohalines) at different times during the tidal cycle are in Appendix 1.

Tides

A bubbler tide gauge recorded the tide for 30 days or 60 tides. The average tidal properties are listed in Table 1 below. Heights are measured relative to the DFW tide staffs. (see Appendix 2 for survey data).

The delay of high tide was determined from 9 tides recorded in Wellfleet harbor and 30 tides for Boston.

Three temporary tide staffs were placed about 0.3, 0.7 and 1 mile upstream from the dike. These indicated that during a 6 hour period the tide range was the same along the entire length of the estuary.

Table 1. Herring River Estuary Tidal Properties.

Mean high tide	=	6.5 ft
Mean low tide	=	4.8 ft
Mean tide range	=	1.7 ft
Mean delay of high tide	=	2.2 hrs after Wellfleet or 2.8 hrs after Boston
Approximate surface area	=	2.02×10^6 sq ft or 46 acres
Tidal prism	=	3.43×10^6 cu ft.

The total volume of water that covers this area during a flood tide is called the tidal prism.

The tide curve for June 22 to July 25, 1974 is included in Appendix 3.

Inlet

Figure 2 below shows a drawing of the present inlet. By looking up the inlet the area of the openings was estimated to be 3×6 sq ft or 18 sq ft. The openings are partially blocked which indicated an effective inlet area of 15 sq ft or less.

It would be very helpful and important to get actual measurements for all three openings.

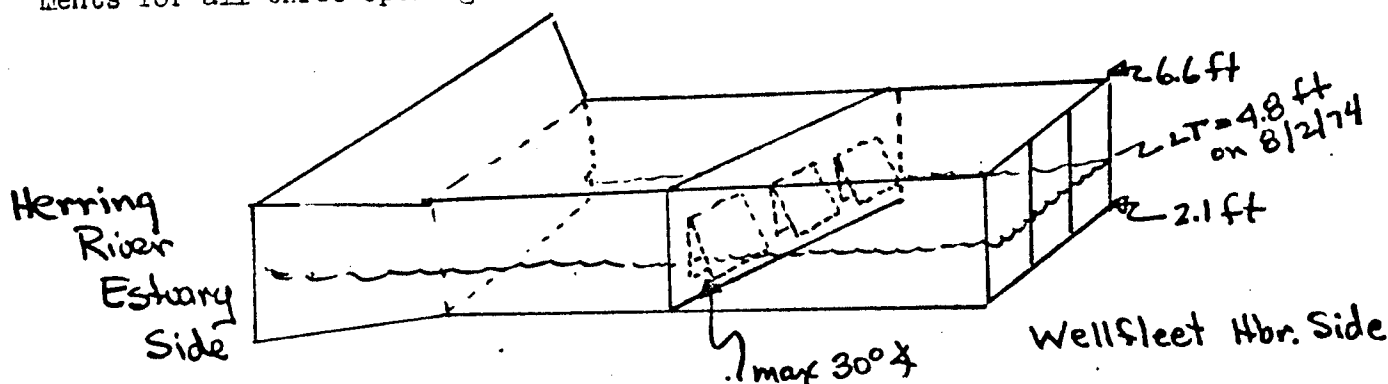


Figure 2. A sketch of the present inlet

A numerical model of the inlet's affect on the tides was constructed. This models assures that the inlet area is constant or in other words the inlet is always covered by water. From observations this seems to be true for about 80-90% of a tidal cycle.

Using the measured estuary tide and Wellfleet's tide the numerical model predicted an inlet area of 11.3 sq ft, a tide range of 1.8 ft and a time delay of high tide of 2.8 hours. This agrees closely with the values above and in Table 1. Part of the difference is probably due to the inlet being only partially covered.

The model predicted tidal prisms for different inlet areas. Figure 3 is a graph of these results. The tidal prisms are expressed as the ratio:

$$\text{Tidal prism ratio} = \frac{\text{tidal prism for inlet area 'a'}}{\text{present tidal prism}}$$

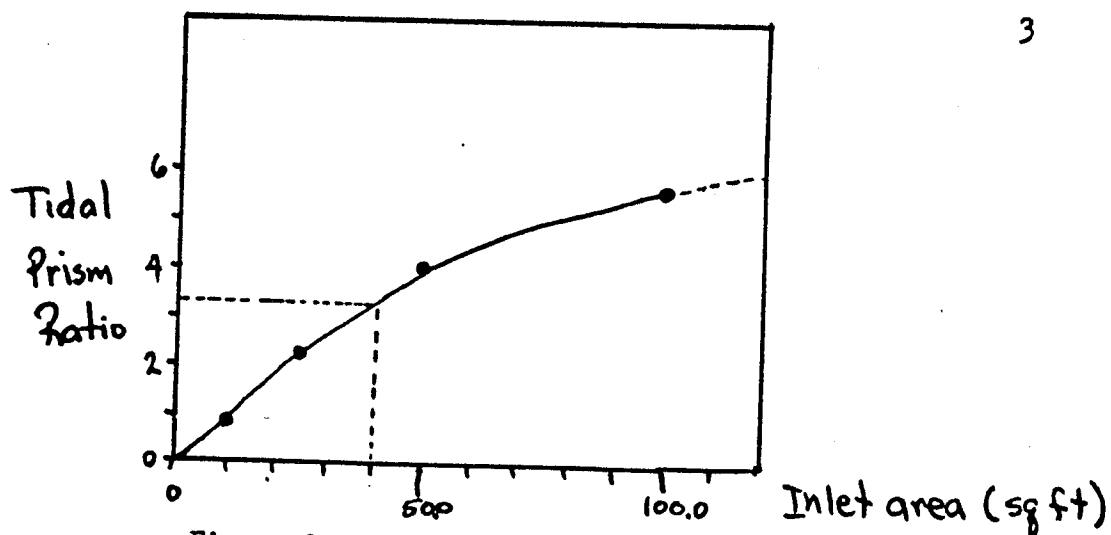


Figure 3. Tidal prisms vs inlet area

If a new inlet were constructed with an effective area of 40 sq ft then looking at Figure 3 the tidal prism would be 3.3 times the present tidal prism.

DIAGRAM SHOWING WATER PASSAGES - OLD
 HERRING RIVER DIKE. Flappers ① & ② had bottom sections
 which have carried away. Flapper ③ appended to gate valve
 no longer closes tightly but remains partially open on incoming
 tide allowing large volume of water to pass.

