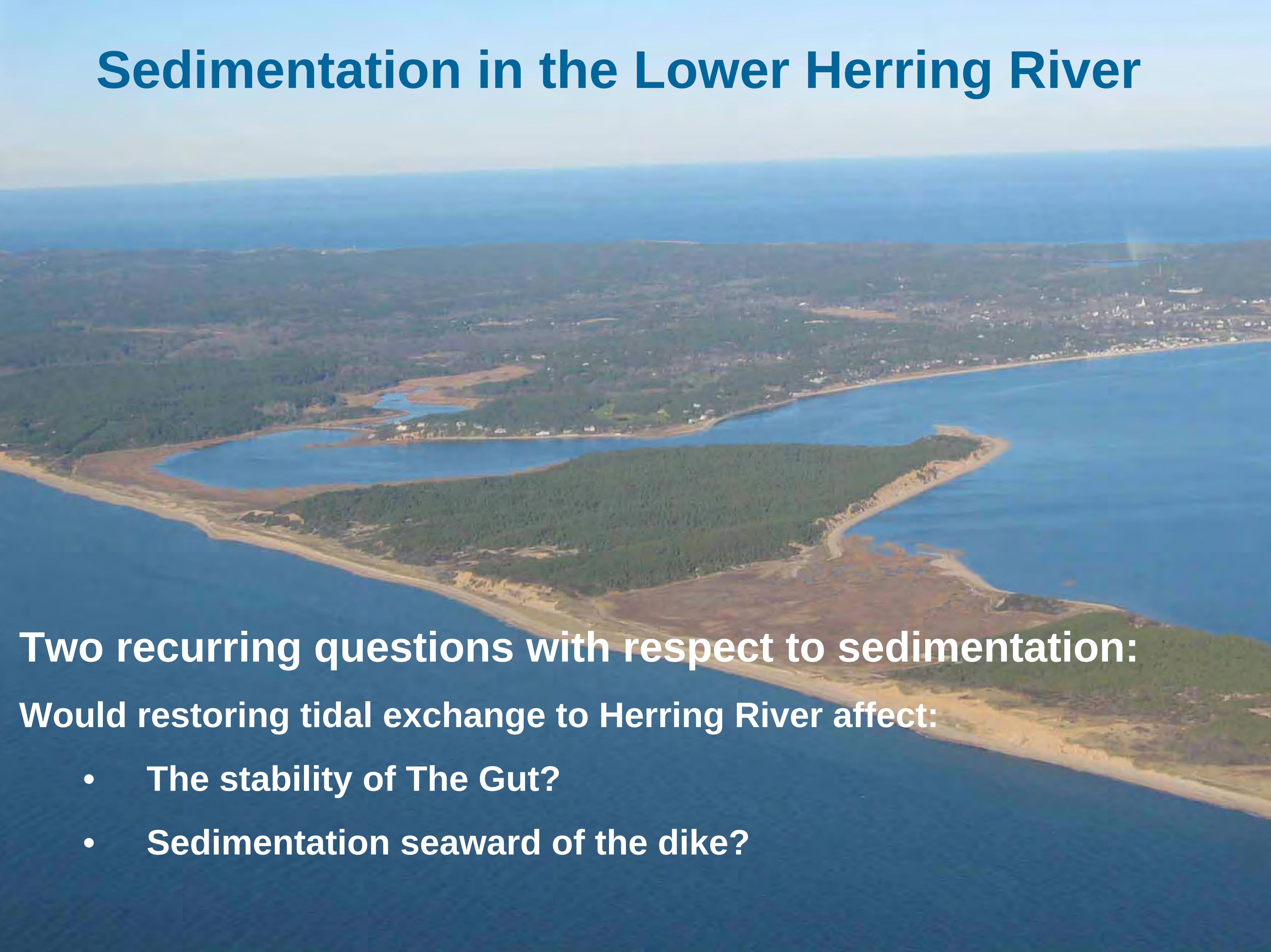
# Sedimentation in the Lower Herring River

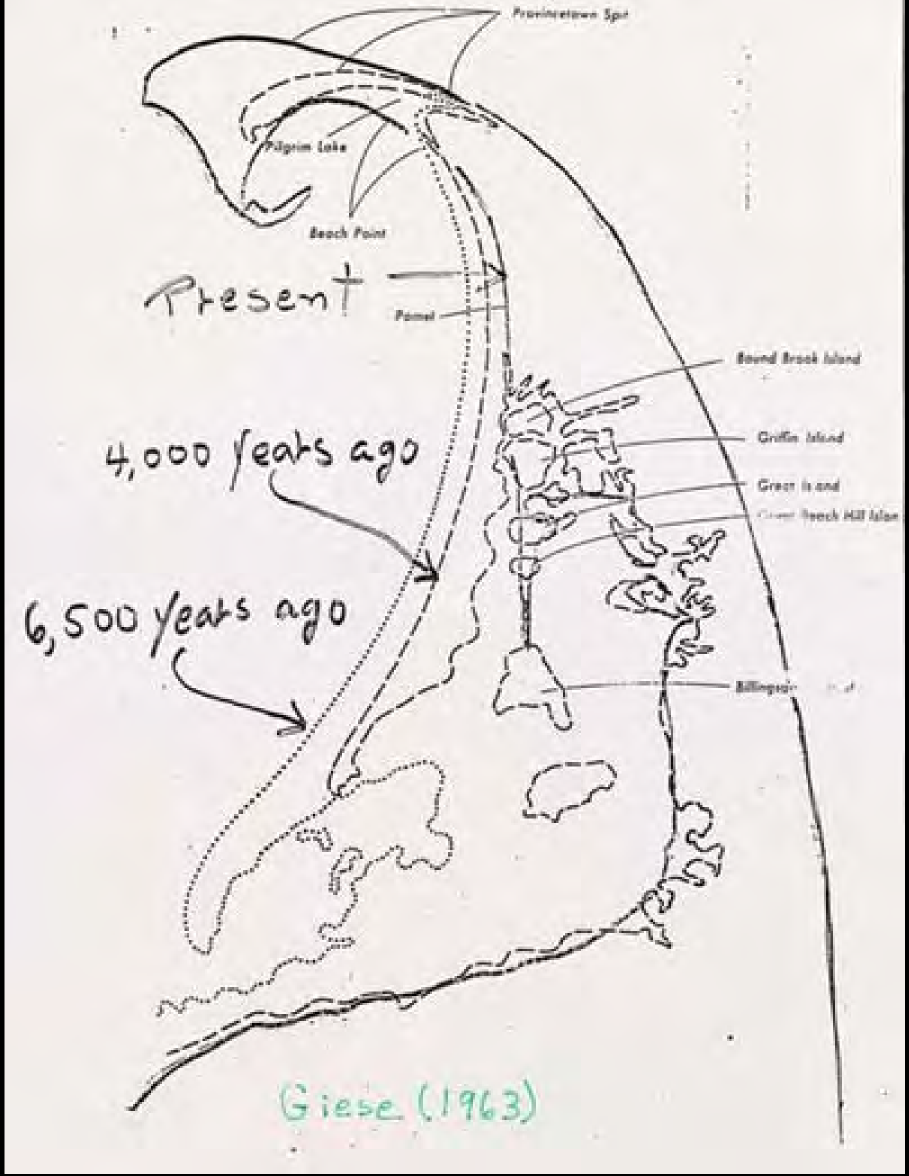


## Two recurring questions with respect to sedimentation:

**Would restoring tidal exchange to Herring River affect:**

- **The stability of The Gut?**
- **Sedimentation seaward of the dike?**

# Part I.
# The Stability of The Gut



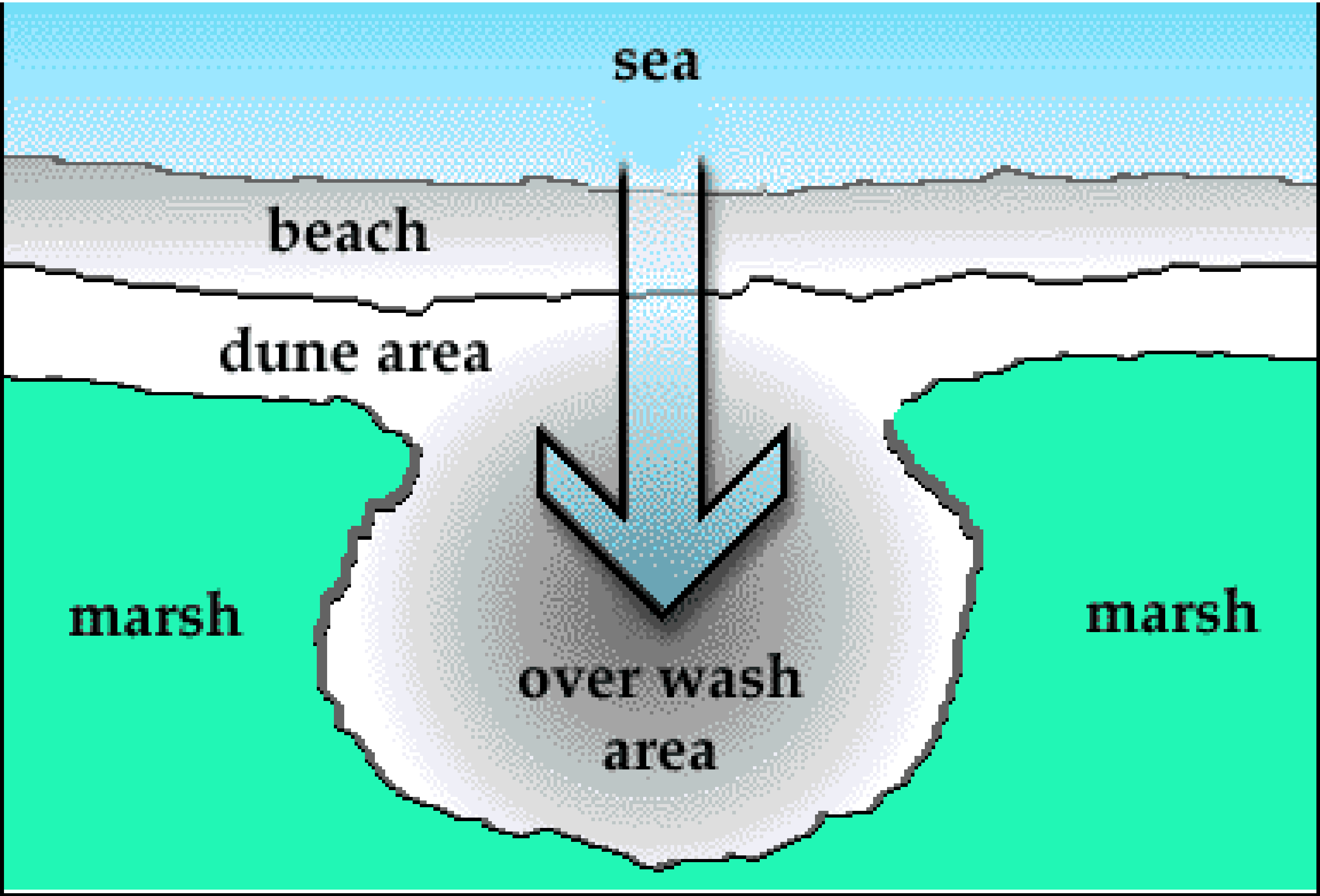

The stability of barrier beaches along the Cape Cod Bay shore has always been controlled by Bay coastal processes, i.e. sea-level rise, wave attack from the west, and sediment supply from the north, and not by forces within Wellfleet Harbor. The original barrier beach, built from sand eroded from the Atlantic Ocean bluffs and carried around the Cape's tip into the Bay, has migrated eastward with sea-level rise.

This eastward movement eventually caused the barrier system to migrate against Bound Brook I., Griffin I., Great I. and Great Beach Hill, connecting them by a series of tombolos (barrier beaches that link islands). At this point, the Herring River, which previously had flowed directly into the Bay between Griffin and Great Islands, was diverted into modern Wellfleet Harbor.

Relationship of Herring River Main Ebb Channel to The Gut: This modern aerial photo shows the wide salt marsh and intertidal mudflat that currently separates the river ebb channel from Cape Cod Bay. Note lack of scouring along this channel even along the outside of the large bend; this shows the weakness of ebb currents relative to the stability of The Gut's flats and marsh.

Marsh Stability: Although the barrier beach has continued to migrate eastward, the salt marsh behind it, and facing the river channel, has maintained its width for many decades.

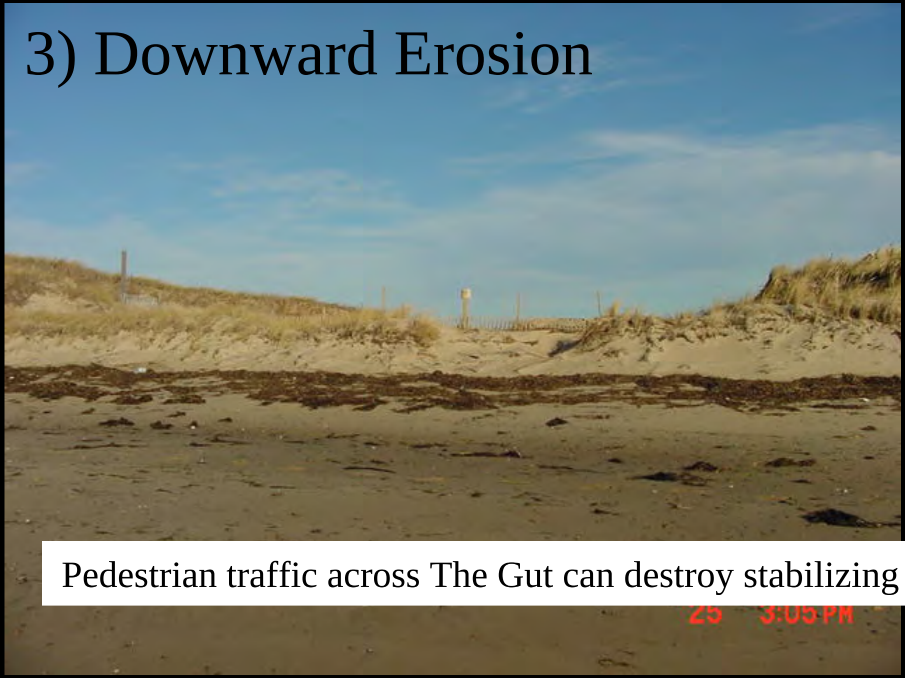

Barrier beaches often overwash during storms, with seawater and sand carried onto the dunes and marsh surface; however, permanent breaches (e.g. an inlet) are only maintained where there are big differences in water levels on the outside and inside of the barrier beach. This does not occur in the Herring River mouth because of the large opening for water flow south of Jeremy Point.




Efficient exchange of Cape Cod Bay and Harbor water through the large opening south of Jeremy Point causes water levels to differ very little on either side of The Gut barrier beach throughout the tidal cycle.

For this reason, formation of an open inlet at The Gut is unlikely.







Pedestrian traffic across The Gut can destroy stabilizing vegetation and lead to the erosion of sand and overwashes.




Dune protection by citizens, the Town and the Seashore have averted and/or repaired dune damage.

# CONCLUSIONS (Part 1: The Gut)

- **Formation and continued stability of The Gut is based on sand supply and sea-level rise.**

- **The Gut influences the Herring River rather than vice versa as evidenced by:**
  1) **Large bend in the river during The Gut's formation.**
  2) **Existence of a wide mudflat.**

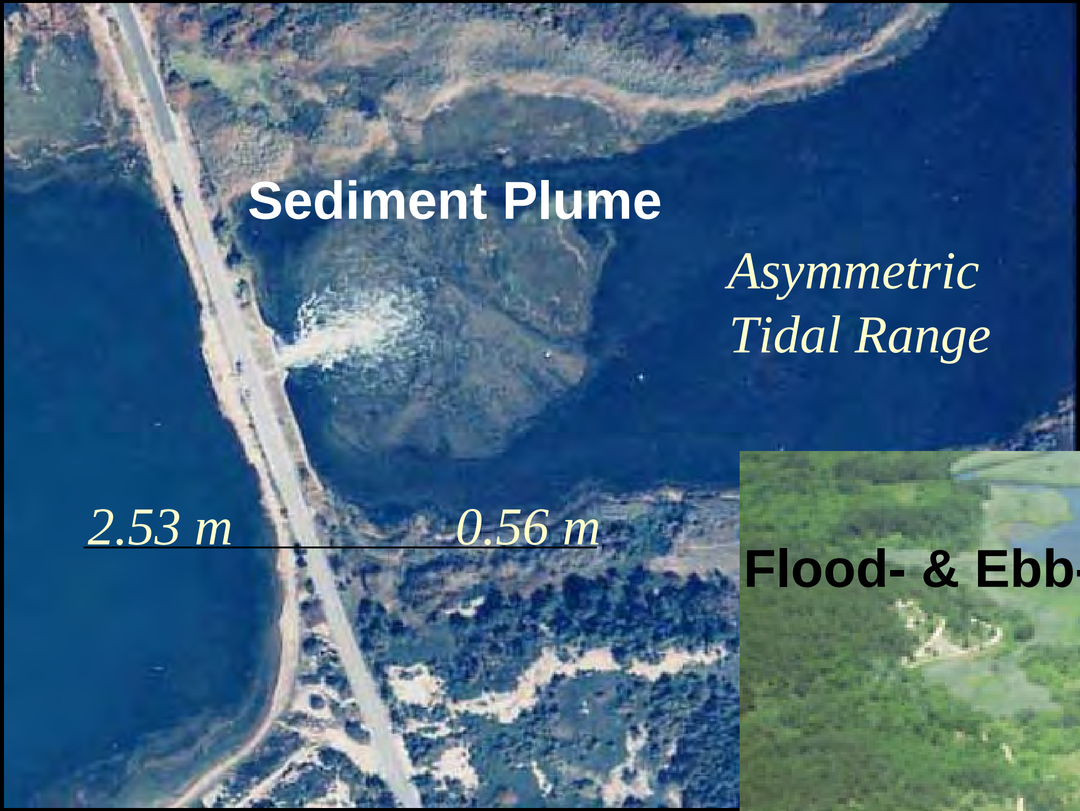
- **The Gut is may overwash, but is unlikely to breach during storm because of:**
  1) **marsh, and**
  2) **wide opening between Wellfleet Harbor and CC Bay.**

- **Pedestrian traffic increases erosion and the possibility of a blowout, but measures have been taken by the Town of Wellfleet and the National Seashore to monitor and reduce the impact.**

# Part II.
# Sedimentation seaward of the Herring River Dike

**Would restoring tidal exchange to Herring River affect sedimentation seaward of the dike?**

Objective:  Determine sedimentation patterns below the dike and predict changes associated with the Herring River restoration.

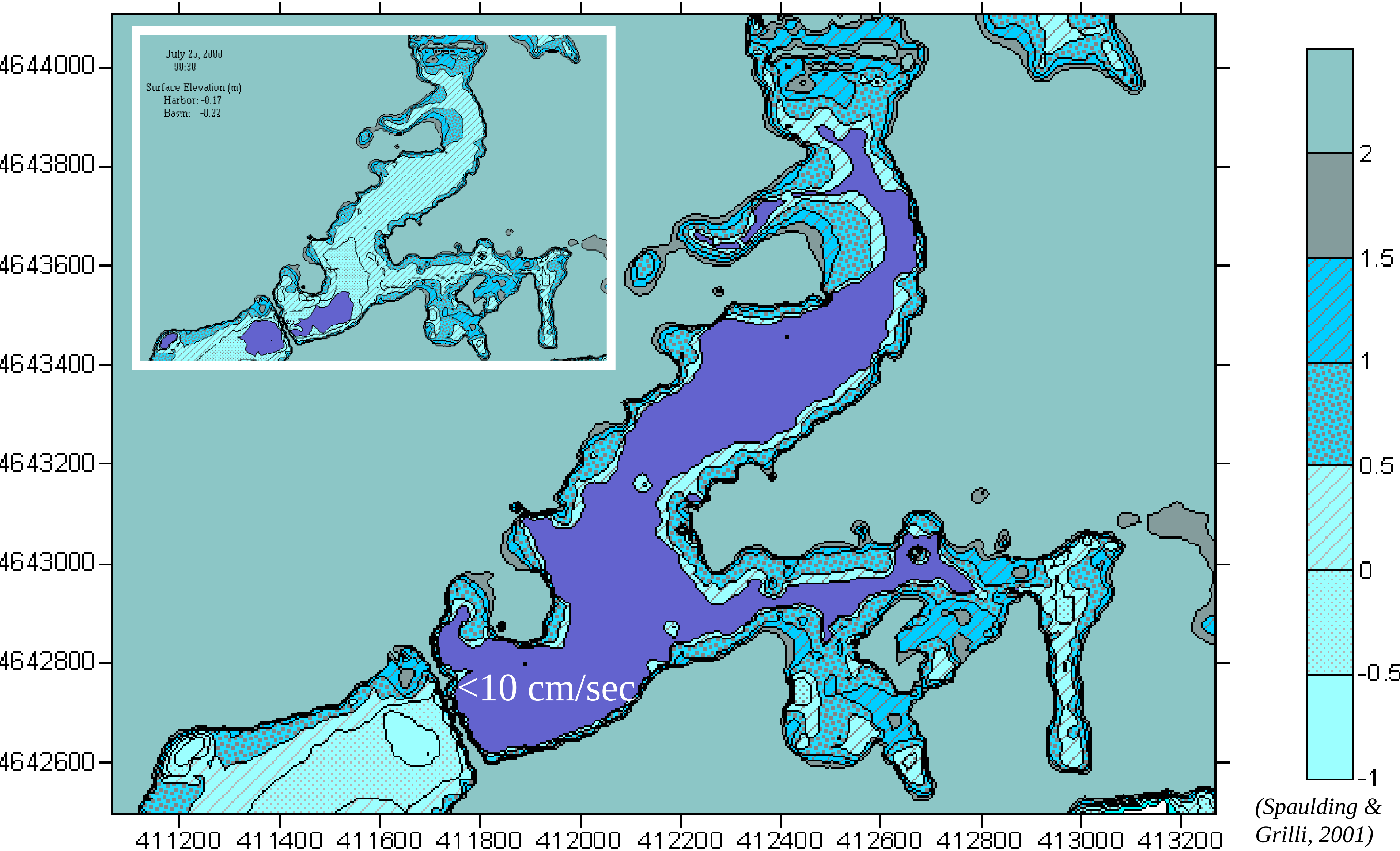




The dike’s restriction on tidal flow causes an asymmetric tidal range, with flood tide velocities much higher than ebb tides and, consequently, formation of a much more pronounced flood-tide, than ebb-tide delta.

The ebb-tide delta just seaward of the dike has been stabilized with oysters, while the floodtide delta above the structure is still forming, indicating more rapid flows..

# Hydrodynamic Model for Herring River




*(Spaulding & Grilli, 2001)*

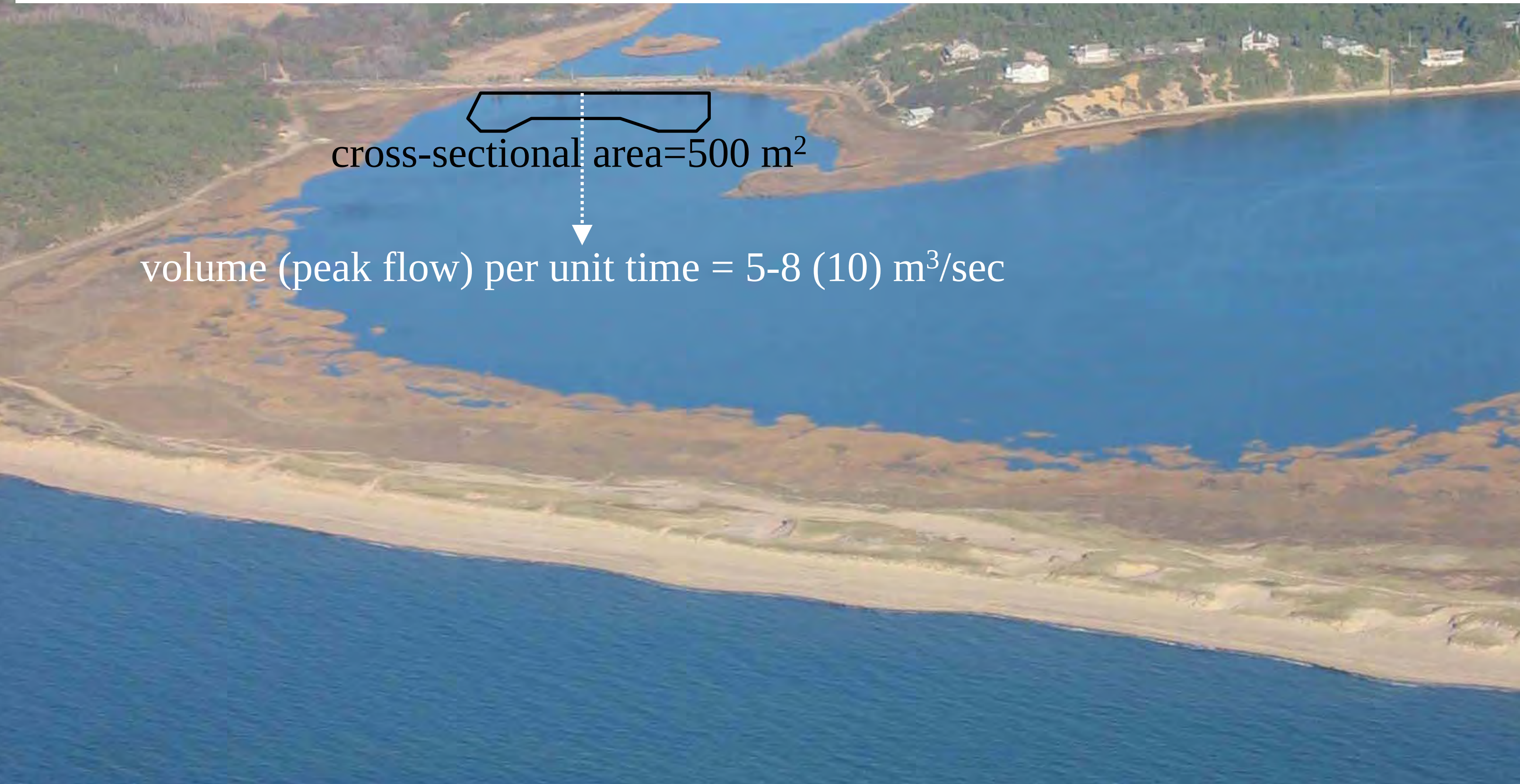
Given sediment type, the threshold flow velocity to resuspend sediment from the Herring River channel is about **20 cm/s (centimeters per second).**

A conservatively high estimate for flow volume in the Herring River channel is 10 $m^3$/sec.

A minimum cross-sectional area for the channel is 500 $m^2$. Therefore, current velocity =

$$\frac{\text{Volume per unit time}}{\text{Cross-sectional area}} = \frac{10\ m^3/sec}{500\ m^2} = 0.02\ m/sec = 2\ cm/sec$$

With all culverts open velocity would triple to 6 cm/sec, still only 30% of the critical 20 cm/sec threshold to lift sediment. Also, most rapid flow, and consequent net sediment transport, is upstream during flood tides, not downstream toward shellfish beds. Finally, cross-sectional area increases with distance below the dike, further slowing ebb velocities and reducing sediment transport.



The following series of historic charts and aerial photos shows that the Herring River channel below the present dike has been in the same location since at least 1848, before the dike was constructed.

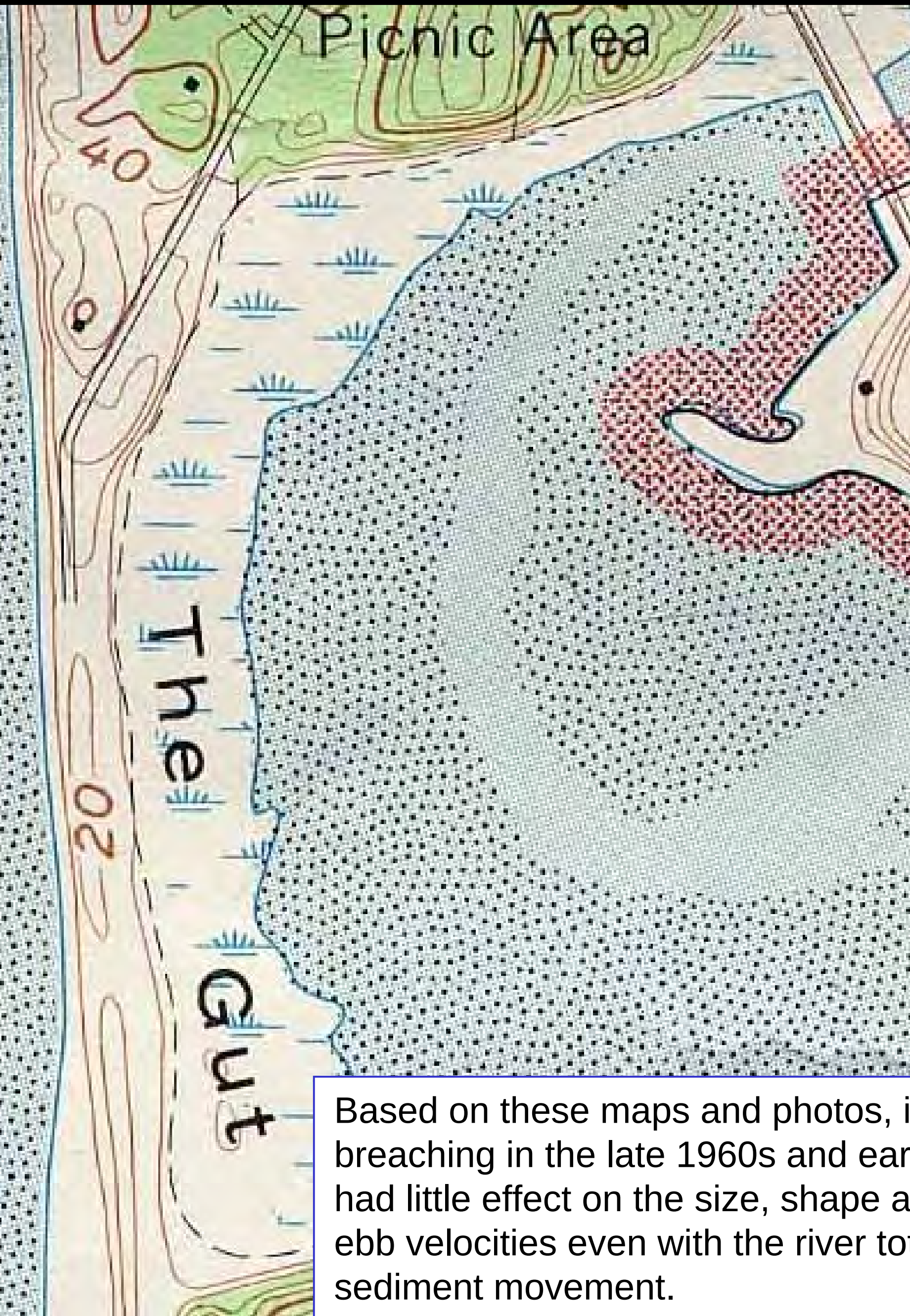
1848

1960

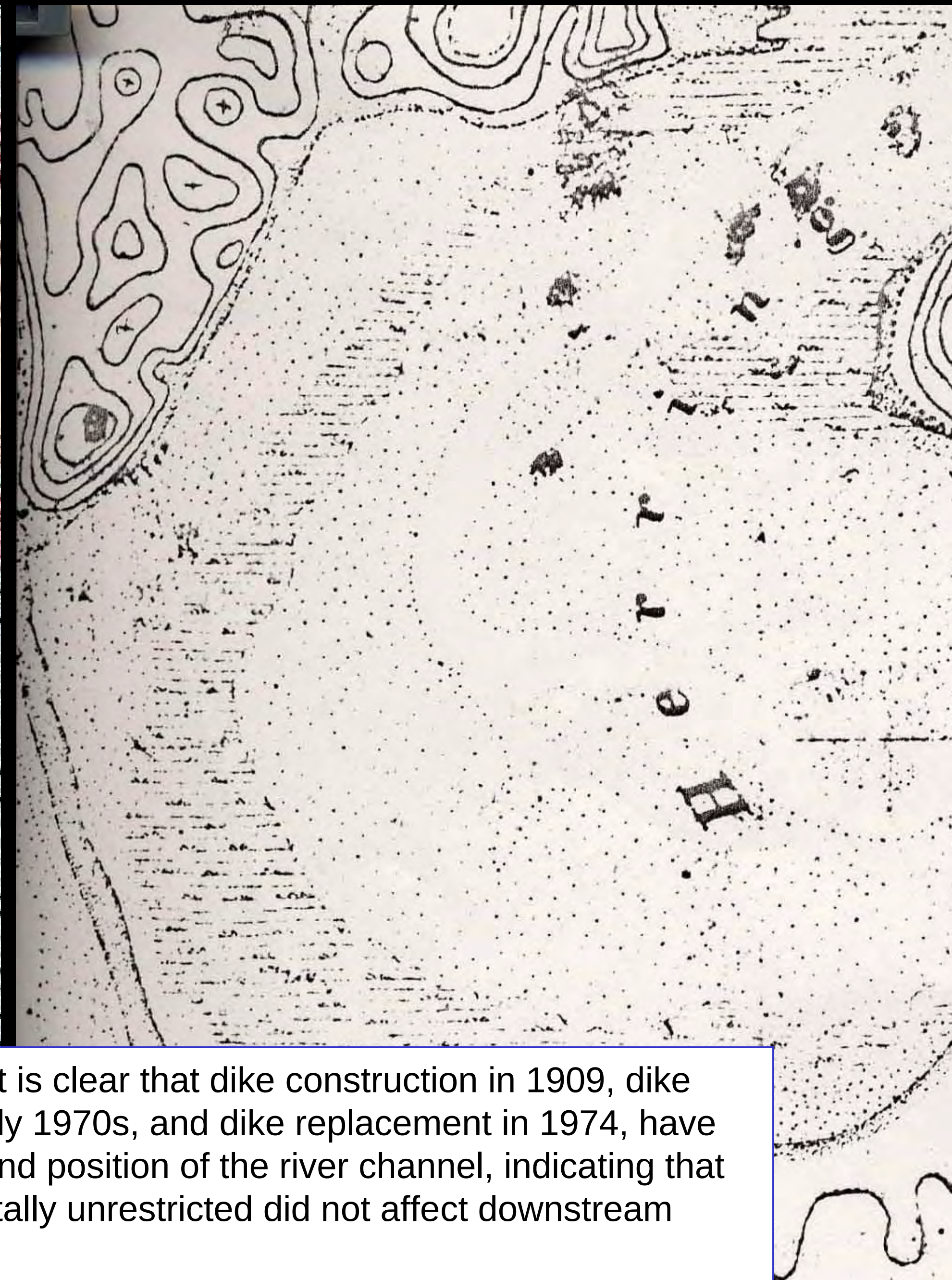
1987

**2001**

**1974 (Representative 1960-2001)**

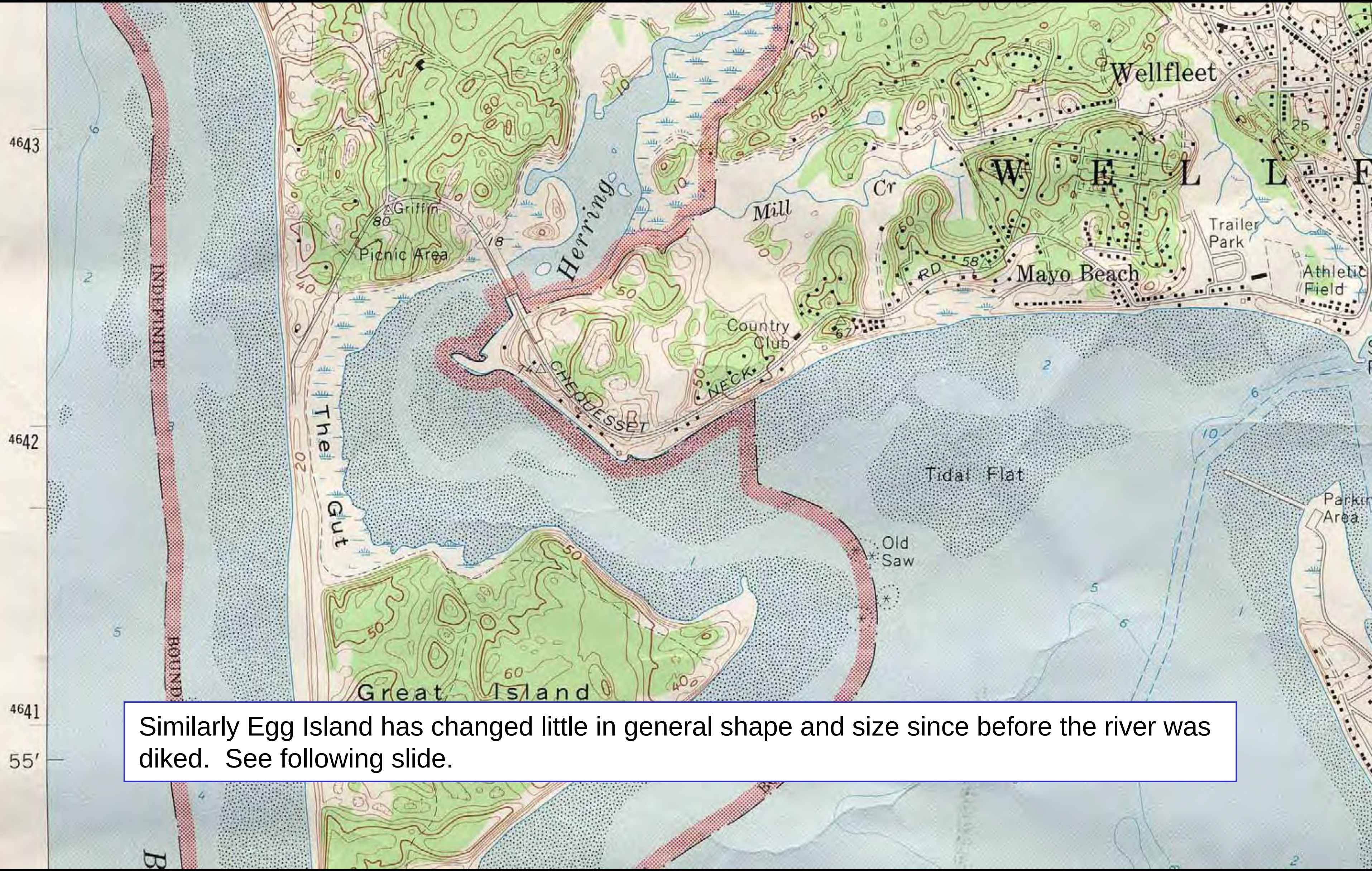



**1848 (Pre-dike Configuration)**



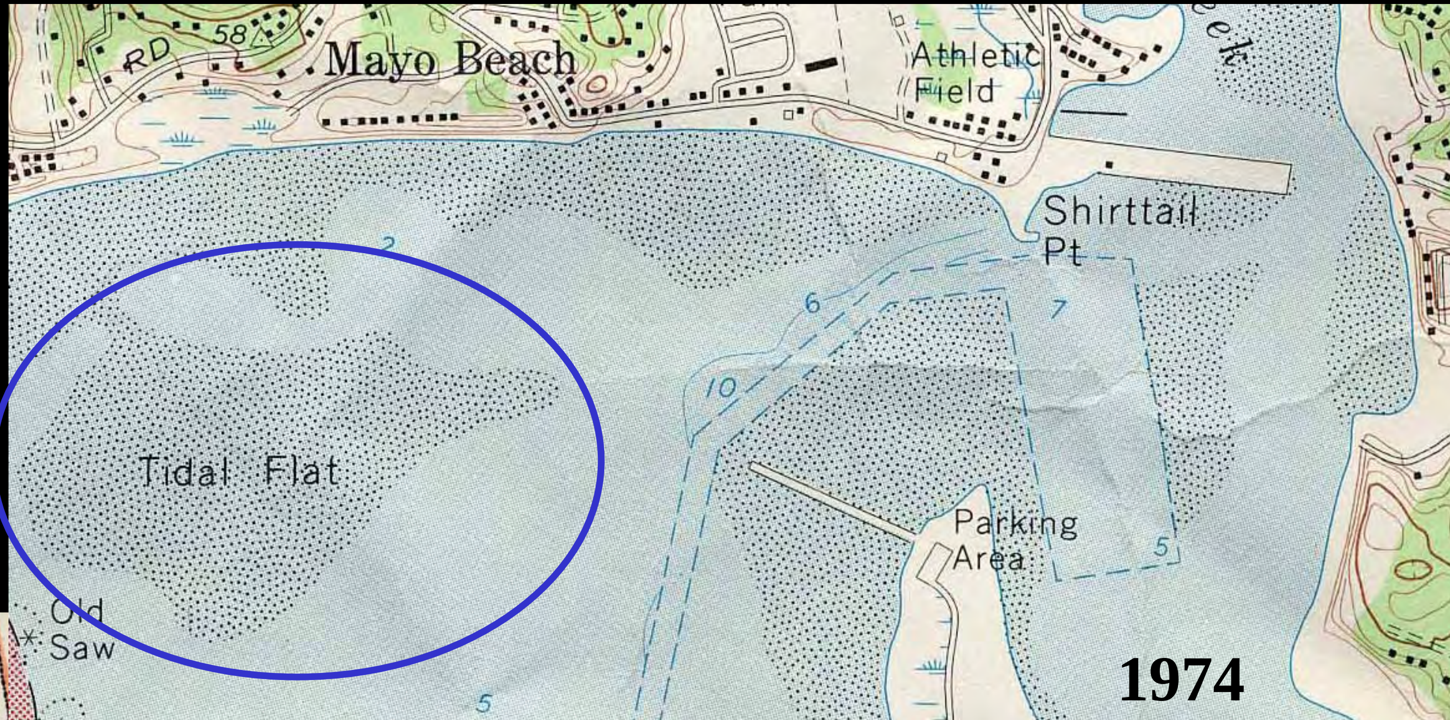
Based on these maps and photos, it is clear that dike construction in 1909, dike breaching in the late 1960s and early 1970s, and dike replacement in 1974, have had little effect on the size, shape and position of the river channel, indicating that ebb velocities even with the river totally unrestricted did not affect downstream sediment movement.

# 1974

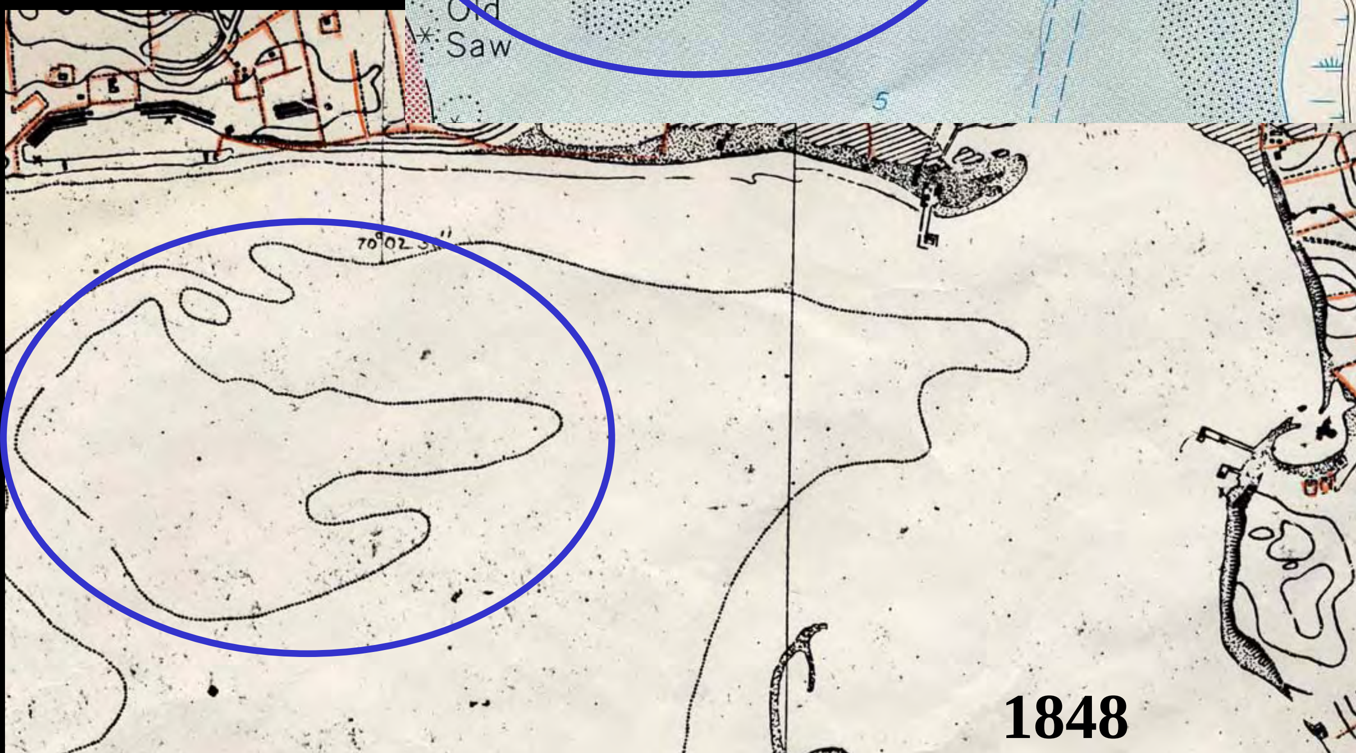



Similarly Egg Island has changed little in general shape and size since before the river was diked. See following slide.

# Northeast Wellfleet Harbor (Egg Island)




1974



1848

Egg Island has changed little in general shape and size since before the river was diked, suggesting that the river has little influence on this sand bar 1.2 miles away.

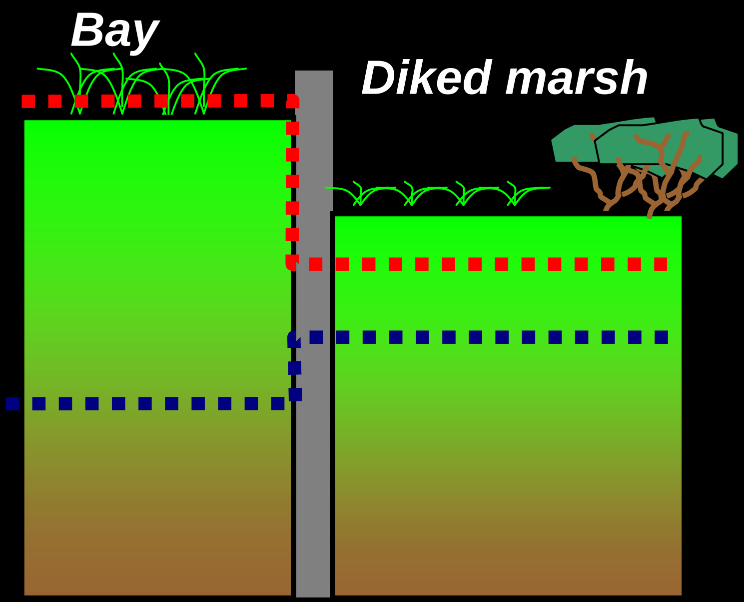
# Sediment Transport Map


Sediment bed forms show the direction of sediment transport into and within Wellfleet Harbor. Egg Island bar receives sediment from the east shore of Great Island. This helps maintain the bar's position relative to mean sea level, important given ongoing sea-level rise.

# Wetland sediment budget

Will restored tidal flooding of the wetland surface increase sediment supply?

Will restored tidal flooding end peat oxidation, pore-space collapse and, thus, reduce subsurface subsidence?

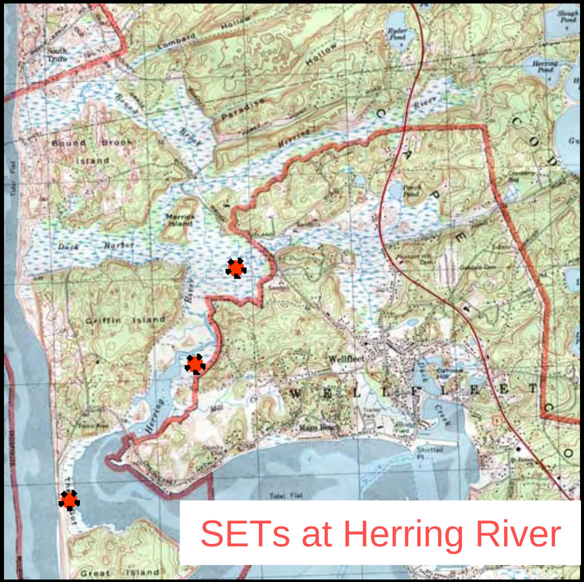



•Much of the marsh above the Herring River dike has subsided since diking and is up to a meter below the elevation of the undisturbed marsh seaward of the dike.

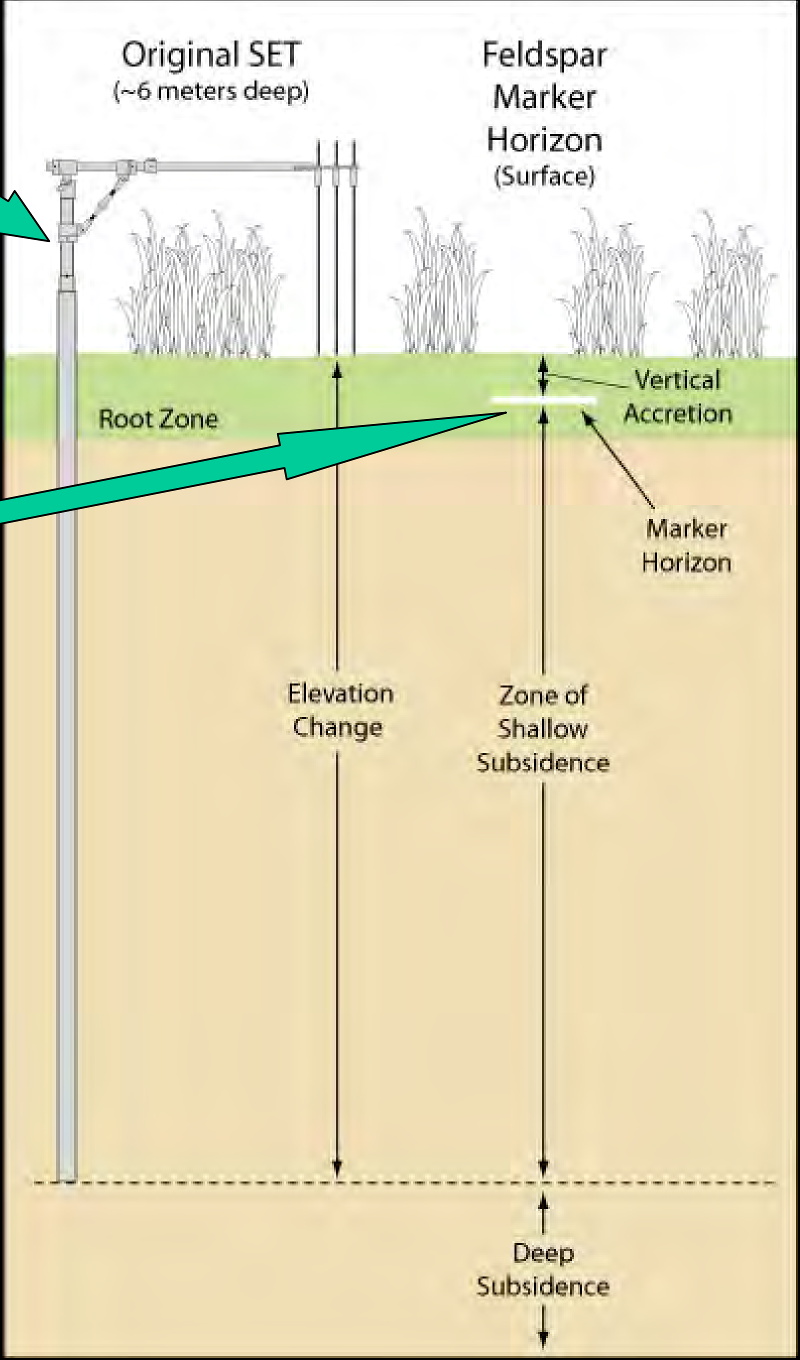
•A serious concern is whether this marsh can recover elevation once tidal flow is restored, in order to avoid "drowning" by constant waterlogging.

# *Surface Elevation Table (SET)*

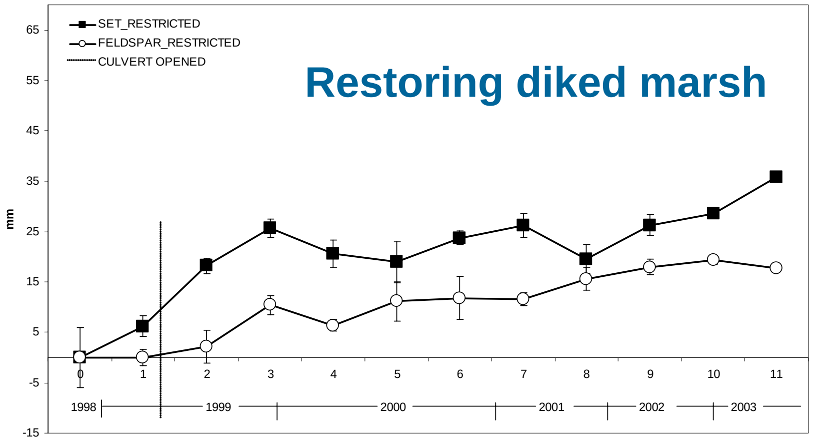
***Feldspar marker horizon***

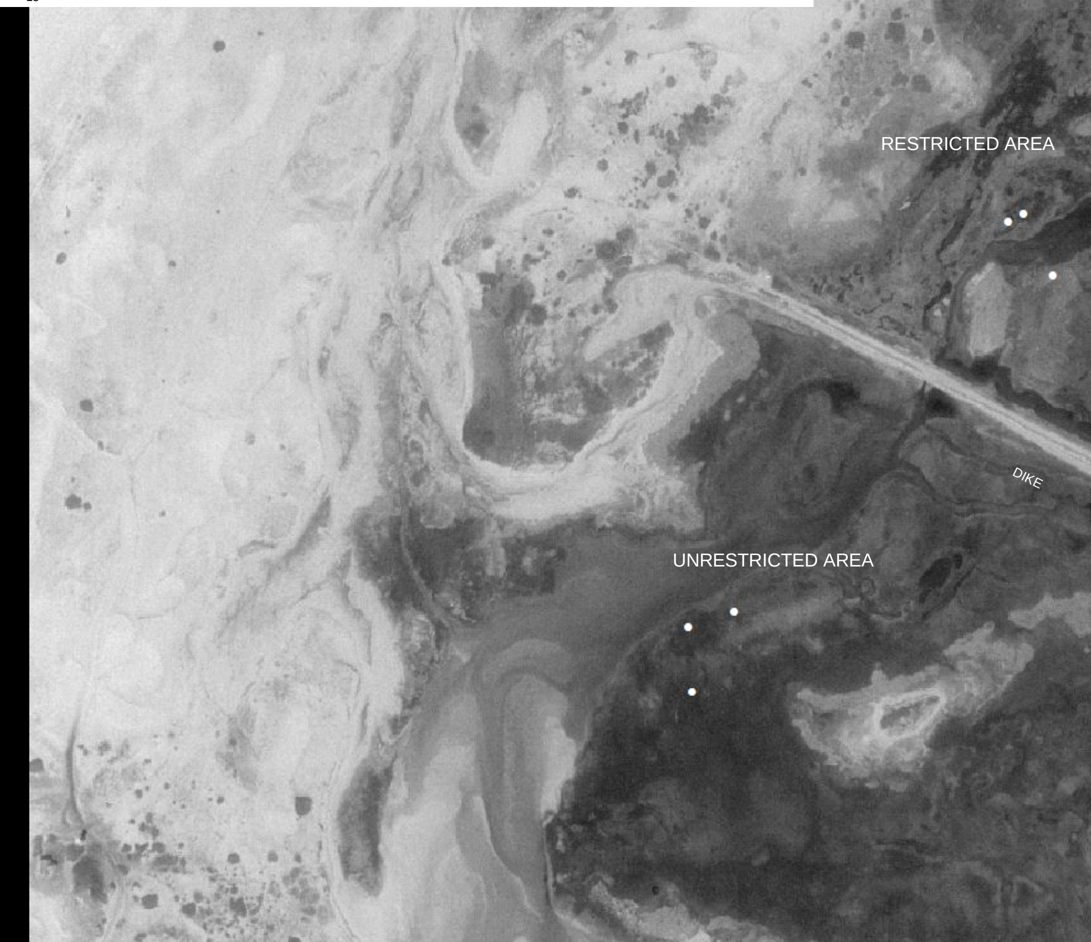



NPS monitors sediment accumulation and sub-surface compaction at several Cape salt marshes, including Herring River, using Surface Elevation Tables.

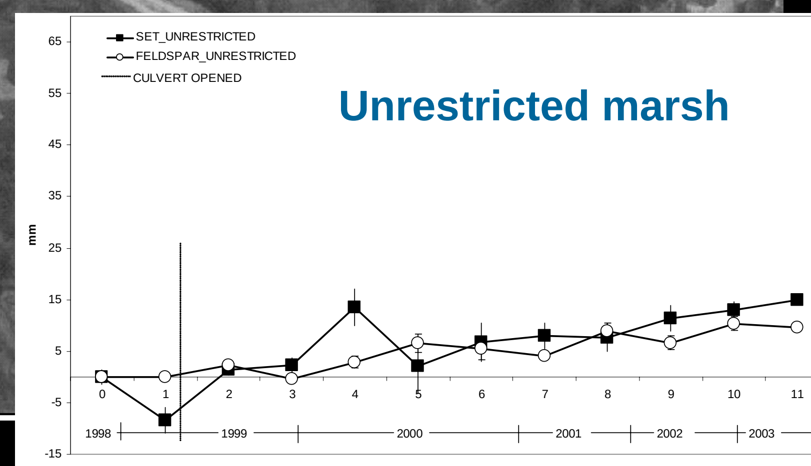


# Hatches Harbor




Happily, sedimentation monitoring at Hatches Harbor, where tides have been restored since 1998, shows rapid sediment accumulation in the diked marsh. And expected from flood-tide dominance, greatest accumulation is in the interior marsh farthest from the dike culverts.



When the dike was rebuilt in the 1970s, fishermen reported both a loss of colonizing shellfish, and increased sedimentation especially just seaward of the structure. The latter is exactly what would be expected with the new dike's blockage of sediment transport to upstream marshes.

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MEMORANDUM

TO: Gary Clayton, Biologist CZM

FROM: Bev Tangvik, Investigator Public Protection Bureau

DATE: March 20, 1979

RE: Herring River, Wellfleet

The following is a summary of telephone interviews with people who live and/or work near the Herring River in Wellfleet. The interviews were conducted to document personal observations and experiences of environmental alterations in the saltmarsh, shellfish and alewifes which they feel are attributable to the new tidal gate in the Herring River Dike.

1. Alton Atwood - Oysterman and member of the Shellfish Advisory Committee. He has lived and worked near the Herring River all his life. Since the new tidal gate was contructed he has observed that the oyster beds have been covered with mud on the Bay side. Before the dike was built the mud was washed away.

2. Steven Kozelka - Chairman of the Shellfish Advisory Committee. He has lived near the Herring River for four years. His observations describe the changes in the shellfish. There are no longer shellfish west of the dike and the area down toward the bay. He attributes this to silting on both sides of the dike. He has seen a reduction in growth rate of the oysters due to less feed coming down river. He believes the dike is detrimental to shellfish in the harbor as well, due to the reduction in feed.

3. Russell Swart - Shell fisherman and member of the Shellfish Advisory Committee. He has lived and worked near the Herring River since 1972. He has observed changes in the shellfish during this time. When the gate was in need of repair in the early 1970's shellfishing was great with lots of shellfish on both sides of the dike. After the dike was fixed all the oysters and steamers died. The river is silting in on the salt water side.

He doesn't believe there were many herring this year.

4. Michael Parlenti - Shellfisherman and member of the Shellfish Advisory Committee. He has lived and worked near the Herring River all his life. His observations are focused on the changes in the shellfish in the area. Before the dike was repaired there were a lot of shellfish on both sides of the dike, but there has been a decline in the shellfish since the reparation of the dike. Since the dike was repaired there has been a reduction in tidal flow causing a decline in food on the salt side. When the dike went under repair sa
and this sand killed the shellfis

He believes the herring in the river are about the same, maybe a little less.

5. Wilber Rockwell - Member of the Conservation Commission. He was Selectman for five years, retired Spring 1978. He believes there has been no detrimental effects to the alewifes with the new dike relative to the old dike and the time when the dike was in need of repair. He observed during the time the dike was in need of repair that trees were killed in the surrounding area due to the two foot difference in water elevation.

# CONCLUSIONS (Part II: Sedimentation)

- Geomorphic analysis of the intertidal area below the Herring River Dike shows little change over the past 155 years.

- With tidal restoration:

    - Dominant sediment transport direction is and will be upriver.

    - Channel velocities would be less than half that required to move sediment except right at the dike.