SALT MARSH LOSS IN THE WESTPORT RIVERS

MARCH 2017

PROJECT PARTNERS

Westport Fishermen's Association

The WFA raised concern about the marsh loss, provided the majority of funding for an intern's salary, and provided access to the study sites.

Buzzards Bay Coalition

The Coalition coordinated the project, hired and managed an intern, and provided funding toward the intern's salary and aerial images.

Buzzards Bay National Estuary Program

The BBNEP provided GIS training, support, and detailed analysis of aerial images.

Marine Biological Laboratory Ecosystems Center

The MBL designed the field protocol and provided training and equipment for the field and laboratory portion of the project.

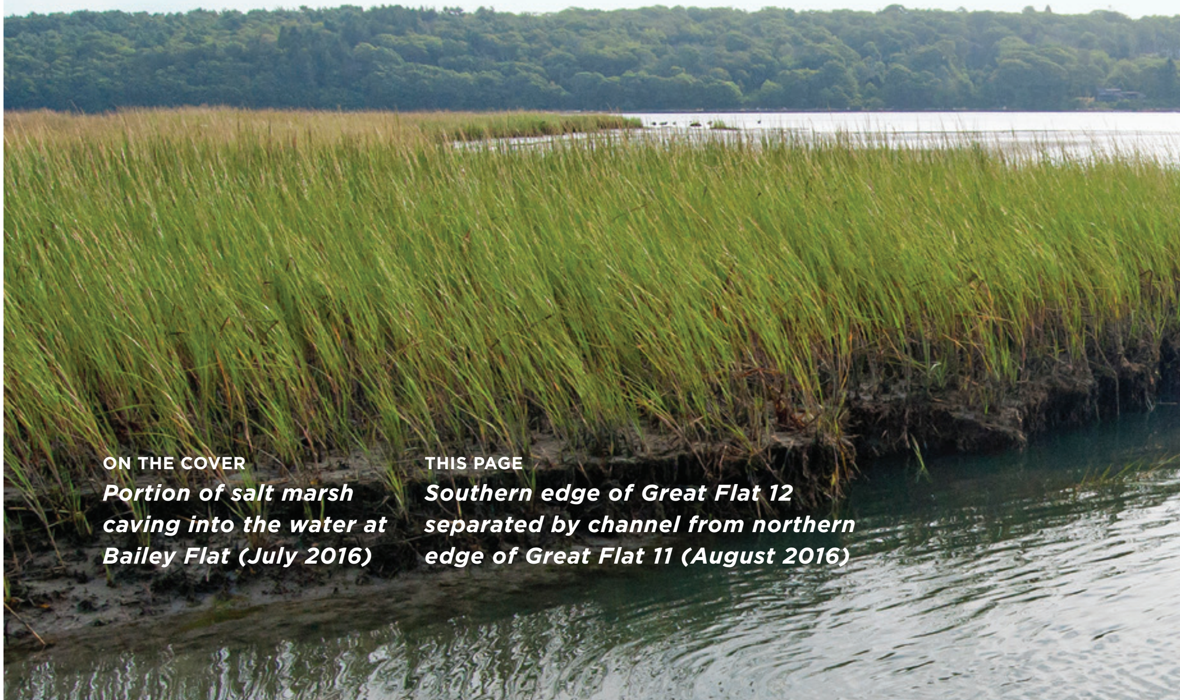
PROJECT OVERVIEW

In recent years, Westport residents noticed that the salt marsh islands in the Westport Rivers, particularly in the West Branch, were disappearing rapidly. Salt marsh islands are a characteristic feature of both branches of the Westport Rivers. These productive coastal wetlands are important because they protect properties from storm surges, remove nutrients from the water and carbon from the atmosphere, and provide critical habitat for fish, shellfish, and shorebirds.

In response, the Westport Fishermen's Association, the Buzzards Bay Coalition, the Marine Biological Laboratory Ecosystems Center, and the Buzzards Bay National Estuary Program partnered to measure the rate of salt marsh loss in the Westport Rivers and try to identify causes of this erosion.

There are several potential factors that could be affecting salt marsh loss in the Westport Rivers, including sea level rise, hurricanes and storms, and overgrazing of marsh plants by wildlife. Recent studies have shown that nutrient over-enrichment (from nitrogen pollution) can also be a driver of salt marsh loss. Both branches of the rivers suffer from nitrogen pollution primarily from septic systems. Other sources of nitrogen in Westport are agricultural runoff, stormwater, and lawn fertilizer.

This research project focused on defining the amount of salt marsh acreage that has been lost in the Westport Rivers over the last 80 years and whether those losses have accelerated in recent years. Field work was performed at six salt marsh islands to determine what is causing the marshes to degrade.



ON THE COVER
Portion of salt marsh caving into the water at Bailey Flat (July 2016)

THIS PAGE
Southern edge of Great Flat 12 separated by channel from northern edge of Great Flat 11 (August 2016)

SUMMARY CONCLUSION

- The Westport Rivers are losing salt marsh islands at a troubling rate that has accelerated in recent years.
- At the six islands studied, marsh area has consistently declined in the last 80 years by an average of 48%.
- Both sea level rise and nitrogen pollution contribute to marsh loss in the Westport Rivers.
- Additional pressures that were not a focus of this study such as storms, dredging, and crabs may also add to marsh loss.

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What could be making the marshes disappear?

The salt marshes of the Westport River estuary are part of a complex ecosystem. Multiple, often inter-related, factors are likely involved in marsh loss.

Nitrogen

Water quality in the West Branch has steadily declined over the past 25 years due to increased nitrogen pollution. The concentration of nitrogen in the West Branch exceeds the amount of nitrogen recommended for healthy estuaries. Excess nitrogen can increase the amount of marsh grass (like over-fertilizing your lawn), but it can also cause the underground root network to become sparse and weak (e.g., Deegan et al, 2012). This low “roots to shoots” ratio can destabilize the marsh and lead to marsh banks crumbling into the water.

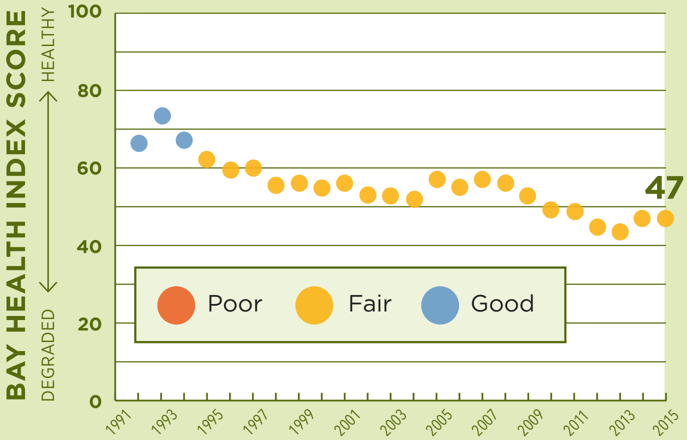
Sea Level Rise

Salt marshes naturally expand and contract over time. To persist, salt marshes must accumulate new sediment in balance with sea level rise. If sea level increases faster than a marsh can build up new sediment, or trap sediment suspended in the water, then the marsh will likely begin to drown.

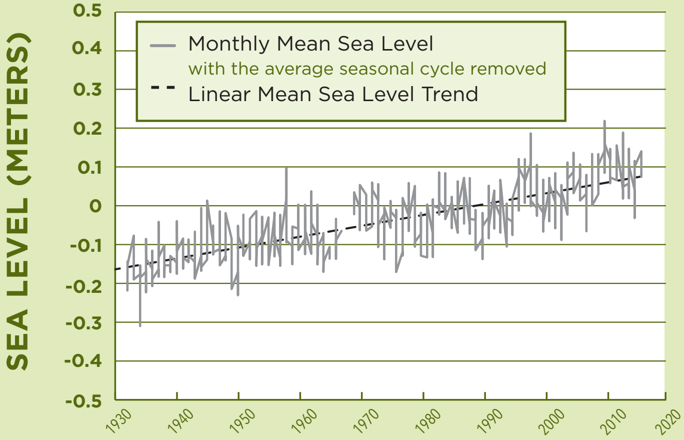
Storms

Since 1934, there have been 42 storms that have caused a storm surge that possibly inundated the marshes. These storms include winter storms, tropical storms, and hurricanes. Storms can move sediment in the water, which can lead to erosion by changing the pattern of flow around the marshes. Dredging can have similar impacts on marshes.

Westport River, West Branch



Sea Level in Woods Hole, MA
AS RECORDED BY NOAA



Crabs

The native purple marsh crab grazes on salt marsh grass. An overabundance of purple marsh crabs has been shown to be a critical factor in salt marsh degradation in Narragansett Bay and on Cape Cod (e.g., Holdredge et al, 2009).

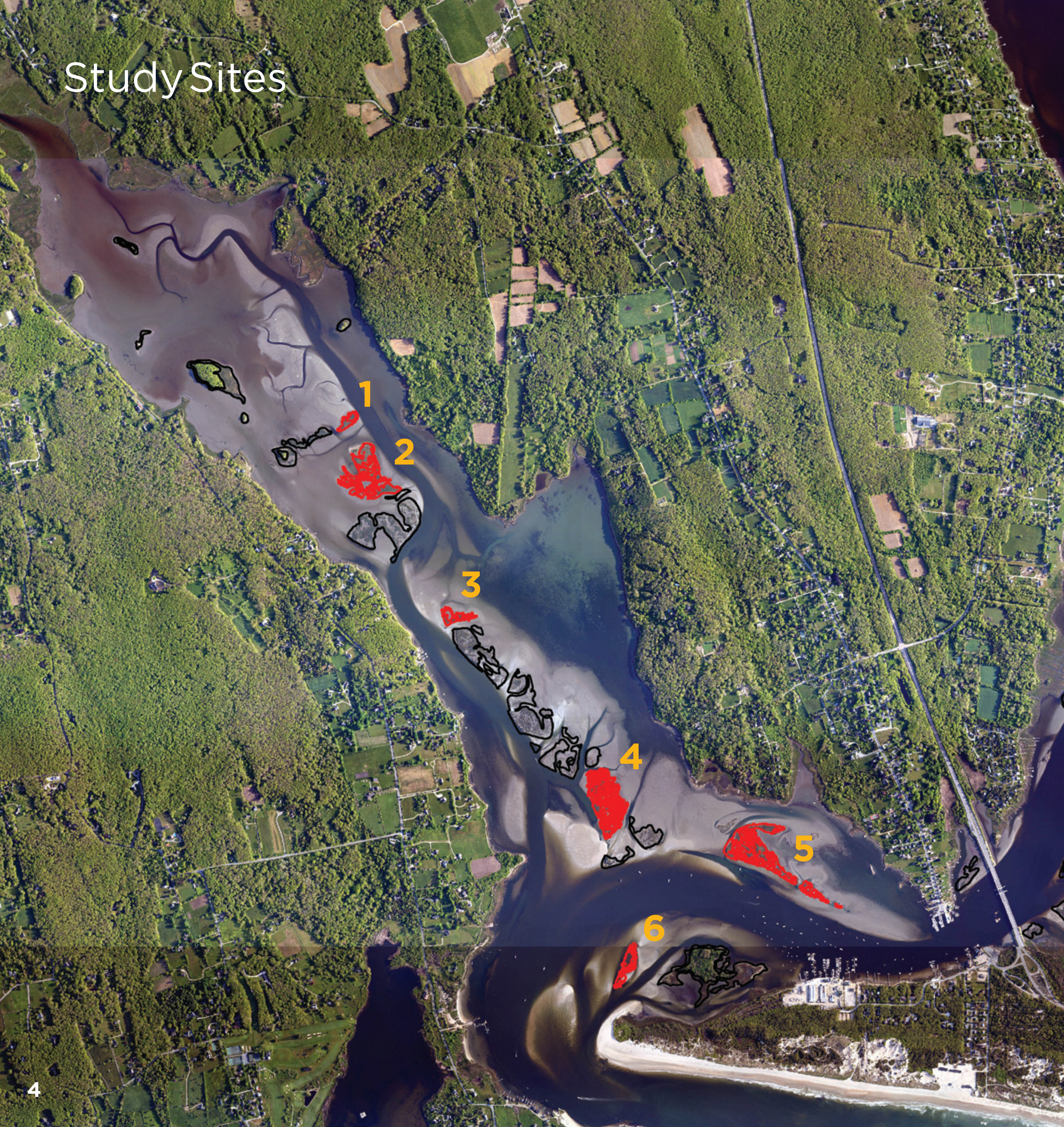
LOOKING AT THE MARSHES UP CLOSE

To determine the influence of nitrogen pollution on marsh loss in the West Branch, we collected field samples at six study sites. At each site, we gathered core samples of the top 1 foot of sediment along with the grass and plant species growing on top of the core. The live roots in the core were separated and weighed.

For each sample, we compared the density of roots in the core to the amount of marsh grass growing above the sediment core. We then compared the relative density of roots to above-ground grass to the amount of nitrogen in the water near each site, using the 25-year-long record of data collected through the Buzzards Bay Coalition's Baywatchers Program.

Marsh core showing layer rich in peat surrounded by more sandy layers.

Collecting a marsh core sample (July 2016)


Study Sites
1
2
3
4
5
6

The project assigned names to all the salt marsh islands in the Westport Rivers. Of those, six were selected as study sites. We focused on the West Branch, which residents report is experiencing worse marsh losses.

All study sites were islands and had no major structures or ditches. Three of the sites are relatively large islands and three are relatively small. We also took into consideration the physical location of the islands. The West Branch has a higher amount of nitrogen in the northern section, whereas closer to the river mouth there is a lower concentration of nitrogen. The six sites lie along this gradient, which helps us decipher differences among sites with various concentrations of nitrogen pollution and wave activity.

1

NORTH OF SANFORD FLAT 3

The smallest site, located highest upriver on the nutrient gradient, but calmer currents.

2

SANFORD FLAT C

A larger site with higher elevation relative to the other upriver sites.

3

GREAT FLAT 12

The second-smallest site, in the upper portion of the nutrient gradient.

4

GREAT FLAT 1

One of the largest sites, with a network of smaller islands making up the flat. This site is mid-way up the nutrient gradient, and lies with a natural channel on both sides.

5

WHITES FLAT

This site is slightly calmer than Bailey Flat, but still very low on the nutrient gradient.

6

BAILEY FLAT

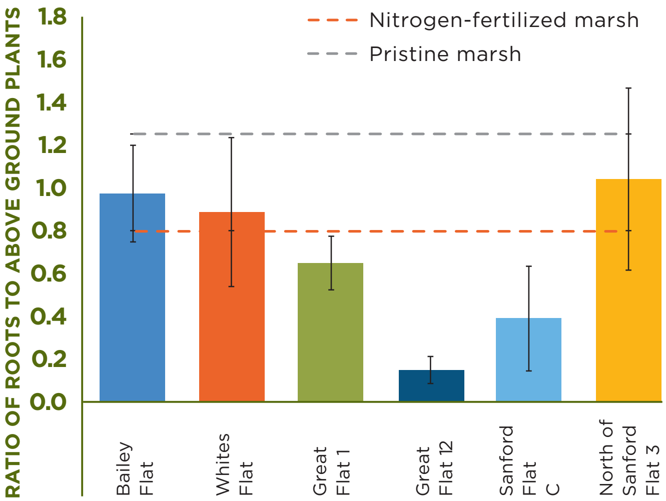
The site closest to the mouth of the river, with the most exposure to currents and the least nutrients.

Results

Nutrient over-enrichment has been shown to decrease the ratio of underground roots to above-ground plant material in some New England salt marshes (Deegan et al, 2012; Watson et al, 2014). At all six study sites, we found a relatively low ratio of "roots to shoots" compared to a pristine salt marsh. **This finding suggests that all marsh islands in the Westport Rivers are vulnerable to loss due to nitrogen pollution**.

However, the differences between the six study sites did not directly match the gradient of nitrogen concentrations in the West Branch. Nitrogen pollution typically increases as you move upriver from the mouth. The site with the lowest ratio of roots to above-ground plants was Great Flat 12, which is located midway up the West Branch. It is also the site that has experienced the greatest loss in area since 1938. Great Flat 1 and Sanford Flat 3 also had "roots to shoots" ratios that were worse than an artificially nitrogen over-enriched marsh, and are also located midway up the river. At Bailey Flat, Whites Flat, and North of Sanford Flat 3, the ratio fell between that of an artificially nitrogen over-enriched marsh and a pristine marsh.

Average Below to Above Ground Plant Material

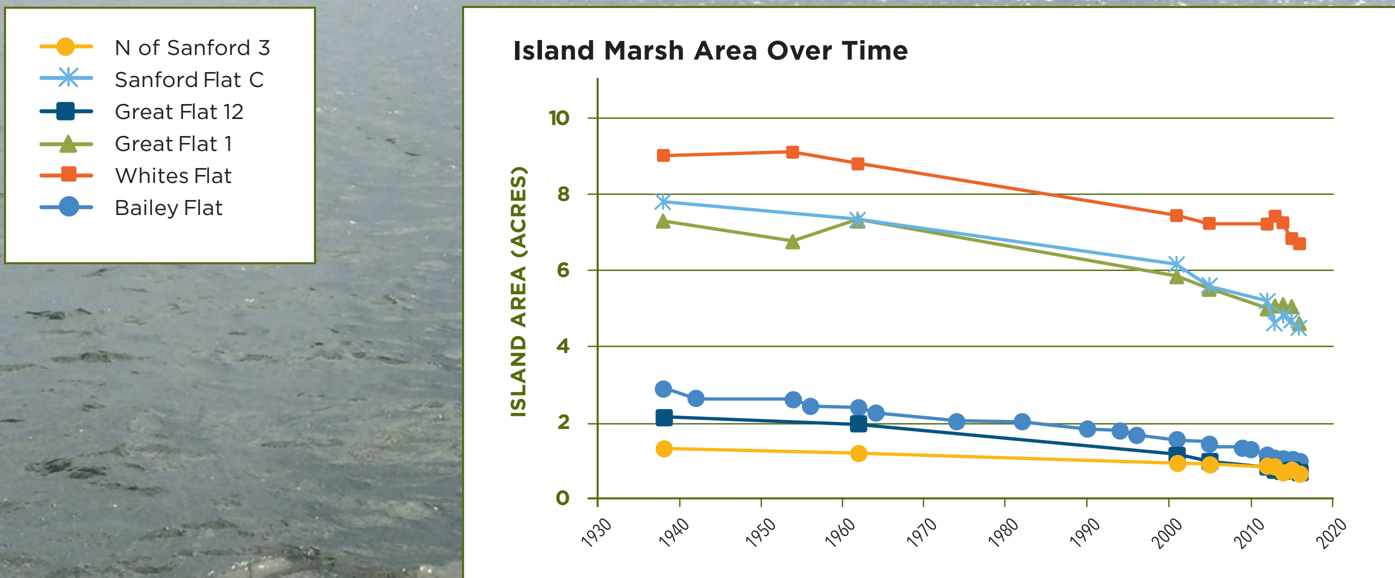


LOOKING AT THE MARSHES FROM AFAR

Salt marshes naturally change shape over time, decreasing in some places and building in others. To understand how much the salt marsh islands have changed in the past and whether they are disappearing rapidly now, we analyzed aerial images of all six study sites going back to the 1930s. Using specialized mapping software (GIS), we determined how many acres of marsh existed in each aerial image. At least nine aerial images were analyzed for each site. The majority of the images were from the last 15 years, when more aerial images have become available.

According to this analysis, every site has lost between 26 and 66% of its marsh area since 1938. Most troubling, the rate of loss has dramatically increased since 2001. Marsh loss frequently occurred along the marsh edges in low elevation areas. Another common form of marsh loss was through tide pools that form on top of the marsh and eventually connect to the river, creating a channel through the middle of the marsh. These channels expose new areas of salt marsh to tidal fluctuations, which increases erosion.

The next few pages describe the loss of salt marsh acres at each of the six study sites.

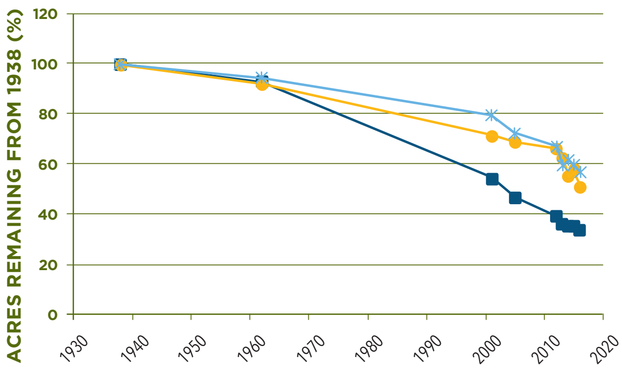


LEGEND

NOV 1934
DEC 1938
JUN 1942
APR 1954
MAY 1956
APR 1962
APR 1964
FEB 1974
JUN 1982
APR 1990
JUN 1994
APR 1996
APR 2001
JUN 2001
APR 2005
JUN 2005
APR 2009
SEPT 2009
APR 2010
AUG 2010
JUN 2012
JUN 2013
APR 2014
SEP 2014
MAY 2015
OCT 2016

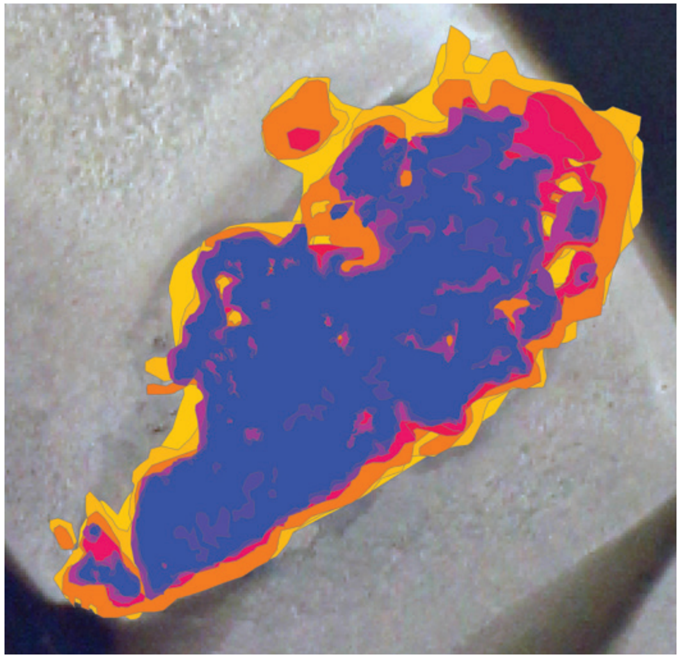
N of Sanford 3
Sanford Flat C
Great Flat 12

Relative Island Marsh Area Over Time



NORTH OF SANFORD FLAT 3

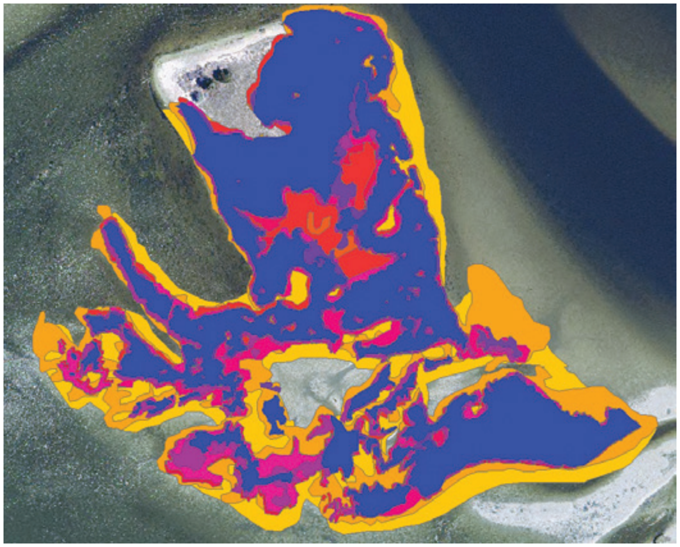
The smallest and northernmost island in this study, North of Sanford Flat 3 has very few tide pools and channels. North of Sanford Flat 3 historically had the slowest rate of marsh loss of all six sites. But since 2012, the rate of marsh loss has increased, and North of Sanford Flat 3 has lost marsh at a faster rate than Bailey Flat or Great Flat 12. In 1938, North of Sanford Flat 3 was 1.3 acres; today, it's 0.7 acres – about half the size.



SANFORD FLAT C

Sanford Flat C is located just south of North of Sanford Flat 3. It is one of the three large island sites. There is an upland area at Sanford Flat C, with a few trees and brush. The rest of the site is at a fairly low elevation, making it susceptible to loss.

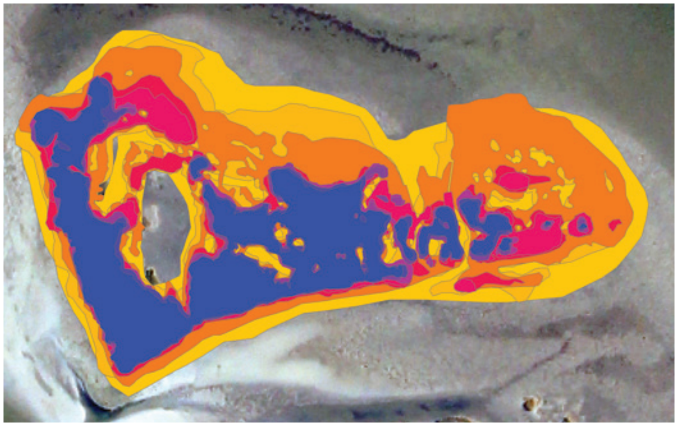
Since 1938, Sanford Flat C has been losing more acres per year than any of the other study sites Overall, 43% of the total 7.8 acres of marsh area in 1938 was lost. Sanford Flat C is unique from the other islands because it lost a large area of marsh in the interior of the site due to the expansion of tide pools.



GREAT FLAT 12

Great Flat 12, another one of the small island sites, is located approximately halfway up the West Branch. It has the lowest elevation of all the sites, making it particularly susceptible to sea level rise and storms.

Great Flat 12 had the largest percent loss we observed: 66% of its 2.2 acres of marsh area in 1938 has been lost. Aerial images from 1982 and 1994 were not high enough quality for interpretation with mapping software. However, these images show a dramatic loss of land between these two dates. It is possible that this was due to Hurricane Bob, which passed through the area in 1990.



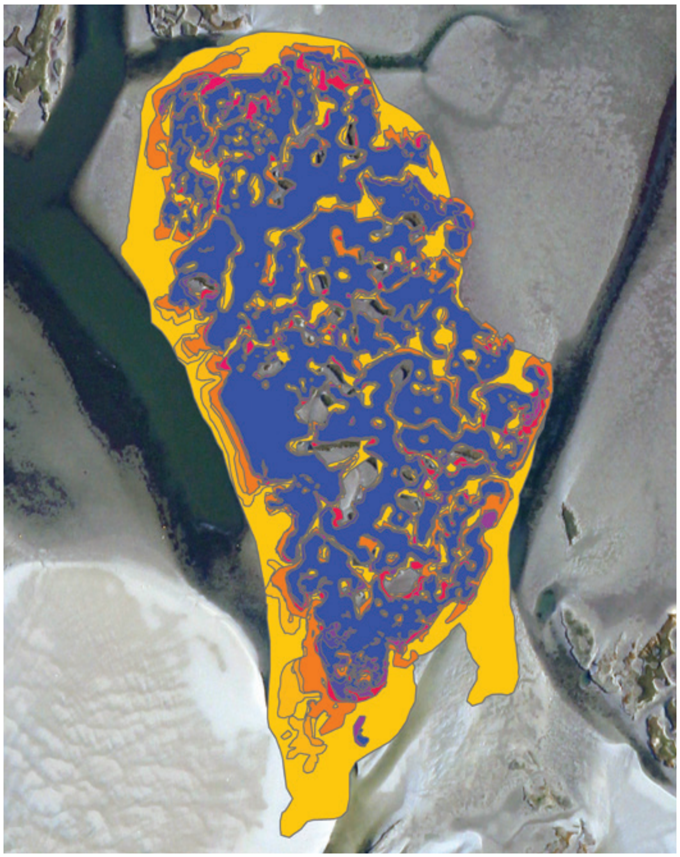
LEGEND

NOV 1934	APR 1990	APR 2010
DEC 1938	JUN 1994	AUG 2010
JUN 1942	APR 1996	JUN 2012
APR 1954	APR 2001	JUN 2013
MAY 1956	JUN 2001	APR 2014
APR 1962	APR 2005	SEP 2014
APR 1964	JUN 2005	MAY 2015
FEB 1974	APR 2009	OCT 2016
JUN 1982	SEPT 2009	

GREAT FLAT 1

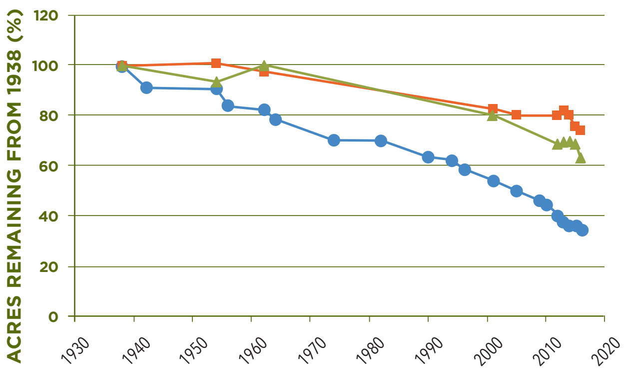
Great Flat 1 is located where the West Branch widens and intersects with the East Branch and the Buzzards Bay inlet. It is the third-largest island we studied.

Out of the six study sites, Great Flat 1 had the second-least marsh loss: 37% of the 1938 marsh area of 7.3 acres has been lost. The areas of greatest loss were along the tidal channel, where the elevation is also the lowest. Great Flat 1 was quite stable between 2012 and 2015, but saw a decrease in marsh area between 2015 and 2016.



Great Flat 1
Whites Flat
Bailey Flat

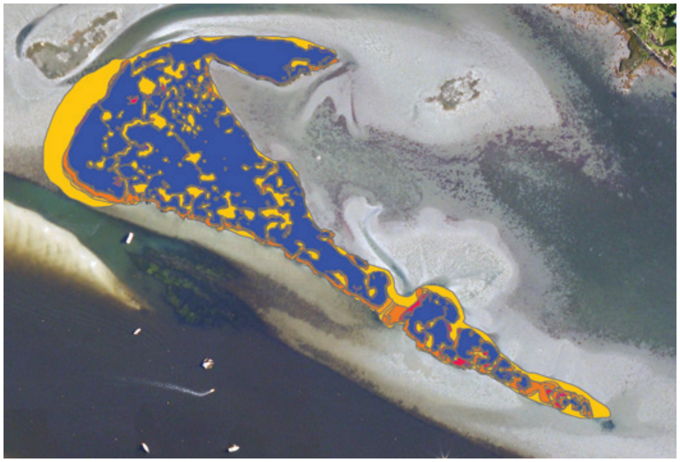
Relative Island Marsh Area Over Time



WHITES FLAT

Whites Flat is located southwest of Great Flat 1, near where the East Branch intersects with the West Branch. It is the largest of the six salt marsh islands studied. Although it has the lowest total percent of marsh lost, it's now the island with the highest rate of loss. Whites Flat was the most stable of the salt marsh islands until four years ago, when the rate of marsh loss accelerated dramatically.

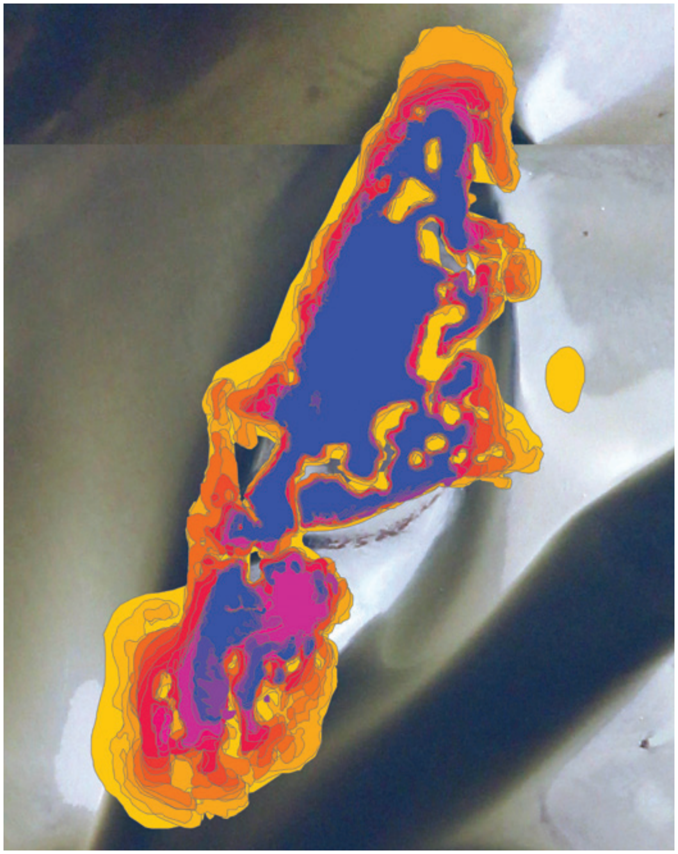
Overall, Whites Flat lost 26% of its 9.1 acres of marsh area since 1938. One of the main areas lost on Whites Flat was near the middle, where a channel opened and separated the southeastern portion of the flat from the rest of it. The channel appeared abruptly in the 1950s; its straight shape suggests that the channel may have been a result of human dredging.



BAILEY FLAT

Bailey Flat is the southernmost site in this study, located near the inlet connecting the Westport Rivers to Buzzards Bay. Bailey Flat had an area of 2.9 acres in 1938, making it the largest of the three small island study sites. We analyzed additional aerial images of Bailey Flat, which provided a more detailed picture of marsh loss over the last 80 years.

The rate of marsh loss at Bailey Flat has generally been quite steady over time, though the rate of marsh loss has increased in the last 15 years. Bailey Flat had the second-greatest marsh loss, with 65% of its total area disappearing between 1938 and 2016. Most of this loss was along the southern edge, which is likely due to heavy wave action from the mouth of the river.



Conclusion: Disappearing Marshes

Over the last 80 years, the West Branch has lost over 12 acres of salt marsh at these six study sites alone. During the past 15 years, salt marshes disappeared at a faster rate than the previous 65 years.

It is difficult to assign a single cause to the accelerating loss of marsh islands in the West Branch. Two key factors that influence marsh health and stability are sea level rise and nitrogen pollution.

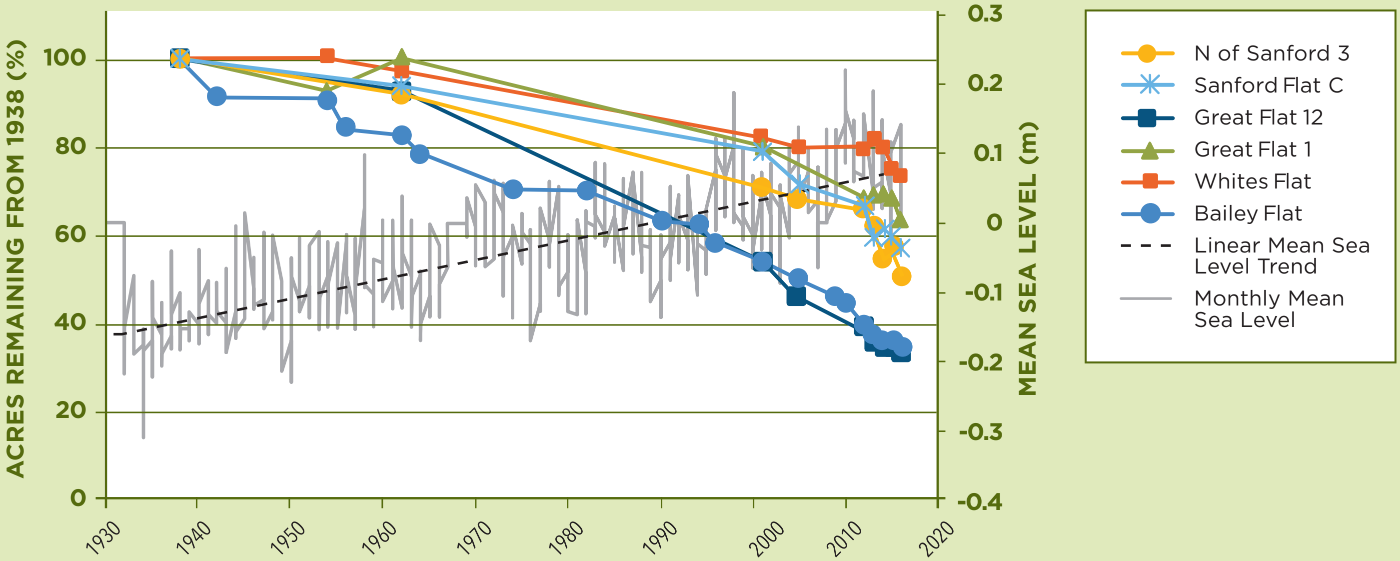
Sea level rise is a natural phenomenon that has been occurring since the last Ice Age but has been accelerating in recent years due to climate change. Marshes have to continue to build up new sediments so they don't lose their lowest-lying areas.

The marsh that lost the most acreage was the island with the lowest elevation (Great Flat 12). The two islands that experienced the least marsh loss (Whites Flat, Great Flat 1) have relatively high elevations, which helps protect them from sea level rise.

The field work performed in this study showed that nitrogen pollution is an additional pressure on these salt marsh islands. The marshes generally had roots to above-ground plant ratios that were similar to or less than an artificially nutrient over-enriched marsh. This low root density decreases the stability of the marsh and makes it susceptible to erosion. The lowest ratios of roots to above-ground plants were observed at Sanford Flat C and Great Flat 12, two sites relatively far upriver where nitrogen is high.

In conclusion, sea level rise is an important cause of salt marsh loss for low-elevation marsh islands. Nitrogen pollution likely exacerbates this problem. Additional pressures such as grazing by purple marsh crabs, storm surges, and dredging that were not a focus of this study may also further marsh losses.

Island Marsh Area Over Time Compared to Sea Level



Moving Forward to Save the Westport Rivers' Salt Marshes

If this marsh loss continues at the accelerated rate observed between 2012 and 2016, the marsh islands studied could disappear in 15 to 58 years (average 33 years). Reducing nitrogen pollution to the Westport Rivers will help salt marshes grow stronger, healthier root systems and enhance the stability of the marsh islands. Implementing nitrogen reduction recommendations, particularly for residential septic systems, should help improve the health and survival of the rivers' salt marsh islands.

For low-elevation marshes that are most susceptible to sea level rise, the town of Westport could explore the possibility of thin layer placement, a relatively new and somewhat experimental technology that artificially increases marsh height by placing new sediment on top of the existing marsh. This approach has had variable success in other places and needs further testing before widespread application is considered.

REFERENCES

Deegan, L.A., Johnson, D.S., Warren, R.S., Peterson, B.J., Fleeger, J.W., Fagherazzi, S. and Wollheim, W.M. (2012) Coastal eutrophication as a driver of marsh loss. Nature 490(7420): 388-392.

Holdredge, C., M.D. Bertness and A. Altieri. (2009) Role of Crab Herbivory in Die-Off of New England Salt Marshes. Conservation Biology 23(3): 672-679.

Watson, E.B., Oczkowski, A.J., Wigand, C., Hanson, A.R., Davey, E.W., Crosby, S.C., Johnson, R.L., Andrews, H.M. (2014) Nutrient enrichment and precipitation changes do not enhance resiliency of salt marshes to sea level rise in the Northeastern U.S. Climatic Change 125: 501–509.

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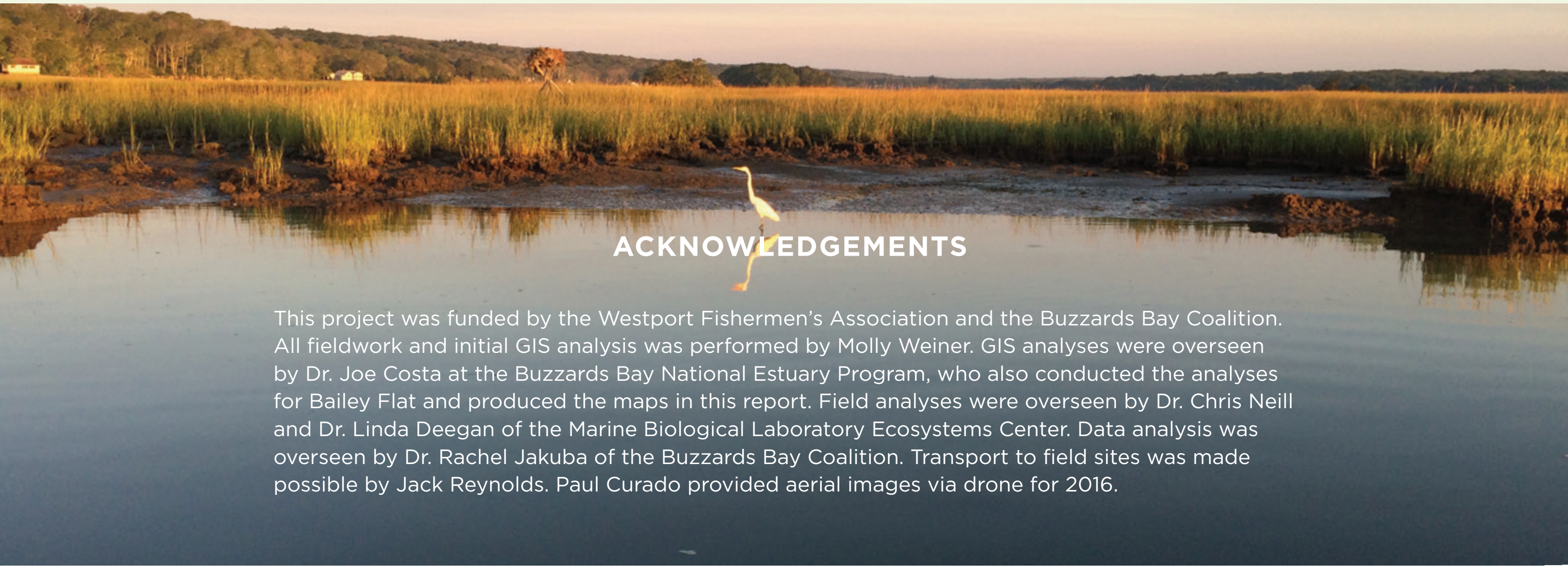

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Westport Fishermen's Association
Established 1983 Westport Massachusetts

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Buzzards Bay
National Estuary Program

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