Harpswell Coastal Flooding Risk Assessment

1 INTRODUCTION

The risks of coastal flooding pose a real and immediate danger to the town of Harpswell. The potential for a storm event with moderate storm surge to strike at a time of particularly high tides currently puts road infrastructure at risk. Sea level rise will compound and expand these risks. Even modest rises in mean water level will put coastal infrastructure at risk due to an increased frequency of flooding events.

Sea level is a real long term issue for the coastal towns of Maine. Clear data exists showing that sea level has risen consistently over the last century and has been rising quicker in recent decades. Local tide gauges here in Maine corroborate the global trend. Regardless of cause global temperatures are up from measured averages and likely to continue rising over the foreseeable future. This will result in more and faster sea level rise in the decades to come. For more data on the topic of sea level rise in Maine see this presentation given by Pete Slovinsky, Maine State Geologist: http://midcoastcog.org/wp-content/uploads/2014/05/MCOG-COASTAL-HAZARDS-RESILIENCY-WORKSHOP.pdf

Sea level rise also has a potential impact on coastal habitats, most significantly coastal marshes. Coastal marsh extents are highly dependent on the frequency of inundation they experience. Rises in sea level will lead to marsh areas transitioning mud flats and even open water. In order to retain the marsh habitat, suitable upland areas must be preserved to allow for the marsh to migrate inland. Further restrictions to water flow, such as culverts and dams, will need to be removed or enlarged to allow sufficient sea water into an area to support a marsh.

This report will present roads and marsh areas at risk to sea level rise and storm surge flooding within the Town of Harpswell. It will identify stretches of road at risk of being flooded by high water events. This inventory can be used to prioritize road upgrades and to make emergency responders aware of potential access problems. Areas that may allow for future migration of marsh lands will also be identified along with possible restrictions to flow of tidal waters. This information can serve as a starting point for prioritization of habitat areas for future preservation efforts.

It is important to start planning for the effects of sea level rise now. Adapting our coastal infrastructure to either remove it from risk or make it resilient to flooding will not be a cheap or easy process. The sooner that action can be started the better a plan can be made to fund projects and spread out costs. To protect the future of marsh habitats we must be aware of areas that important for them to be able to migrate too in the event of sea level rise. Development in these areas now will restrict marsh resiliency for decades if not centuries to come.

2 DATA

This analysis is built on two data sources. The road impacts are based on a sea level rise model developed by Peter Slovinsky, with the Maine Geological Survey. The marsh migration work is built on a model available from the National Oceanic and Atmospheric Administration (NOAA). Both data sets cover sea level rises of 1 to 6 feet above current water levels. The datasets are both "bath tub" models, meaning that they only takes into account the rise in water level. Wave activity and restrictions to water flow are not modeled. Wave activity will likely cause areas exposed to direct wave action to begin to experience erosion and flooding at water heights below those shown. Similarly not including restrictions to water flow may result in some low lying areas being show as inundated by a certain water height before they would be in practice. This is due to a restriction, such as an undersized culvert, not allowing a sufficient volume of water into the area to bring the level up to that being experienced on the other side of the barrier before the tide goes back out.

Data on road impacts including maps of potential inundation extents determined by the Maine State Geological Survey are available on the MCOG website, (http://midcoastcog.org/projects/coastal-hazard-resiliency-sea-level-rise/. The model measures from a base line of the Highest Astronomical Tide (HAT) which represents the highest predicted tide level in a year. It functions as a model of increased water level regardless of cause and so can be used to identify areas at risk from storm surge as well as sea level rise. Measuring from HAT provides a "worst case" prediction of highest possible inundation extents when looking at storm surge and a reasonable risk factor when looking at sea level rise scenarios.

The NOAA model is available on their website at http://coast.noaa.gov/slr/. This model works from a baseline of the Mean High High Water (MHHW). This is approximately the extent that sea level can be expected to reach on any given day and is more appropriate a measuring point than HAT when looking at marsh migration as marsh habitat relies on daily tidal inundation rather than extreme high water events. The model adds land cover data to the elevation data and makes a prediction as to areas in which marsh habitat will be able to migrate inland. This includes an identification of current moderately and highly developed lands that represent an impediment to natural marsh migration. A layer of known culverts and dams in the area was also created to identify potential barriers to the free flow of tidal water. This layer is not complete and does not include any information as to the size of culverts. For the purposes of this study a scenario envisioning 3 feet of sea level rise over the next 100 years was used for evaluating likely areas of marsh migration.

3 ROAD INFRASTRUCTURE

The following roads are potentially at risk from coastal flooding.

Road	1 foot	2 feet	3.3 feet	6 Feet
Basin Point Road – Bridge	X	X	X	X
Wallace Shore Road (both before and after bridge)	X	X	X	X
Little Crow Point (past intersection with Tuttle Road)	X	X	X	X
Long Point Road – Near intersection with Little Crow Point	X	X	X	X
Tuttle Road/Long Point Road/Little Crow Point		X	X	X
Shore Road		X	X	X
Dingley Island Road – Bridge		X	X	X
Bethel Point Road – Bridge		X	X	X
Abner Point Road/Lube Lane		X	X	X
High Head Road – Bridge		X	X	X
Garrison Cove Road (near Bailey Island Bridge)			X	X
Oakhurst Island Road – Either side of bridge			X	X
Route 123 – Bridge/Potts Point Road			X	X
Route 123 – Near Skofield Cove			X	X
Long Point Road – Near intersection with Dirigo Lane			X	X
Gun Point Road (near intersection with Long Point Road)			X	X
Hopkins Island Road			X	X
Cundy's Point Road				X
Harpswell Island Road – Bridge near Eagle Bluff				X
Route 24 – Before and after the Bailey Island Bridge				X
Bethel Point Road – Culvert near Little Ponds Road				X
Basin Cove Road				X

On the following pages are a few examples of roads of particular concern:

Route 123 (Harpswell Rd.)

Route 123 at the Brunswick/Harpswell Border

As Route 123 crosses into Harpswell it dips down through a low spot that brings it to just above sea level with inlets encroaching from both sides. This road will experience flooding at 3.3 feet above the current Highest Annual Tide. Route 123 is one of the primary routes into Harpswell and as such is an important road for emergency vehicles.

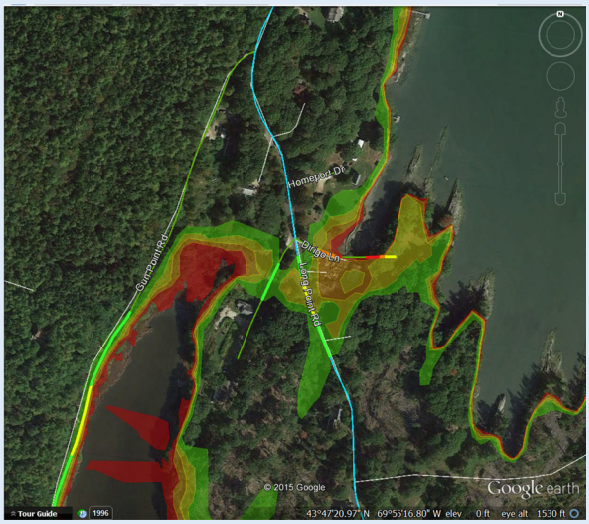
Basin Point Road

Basin Point Road at the top of Basin cove, near its intersection with Route 123

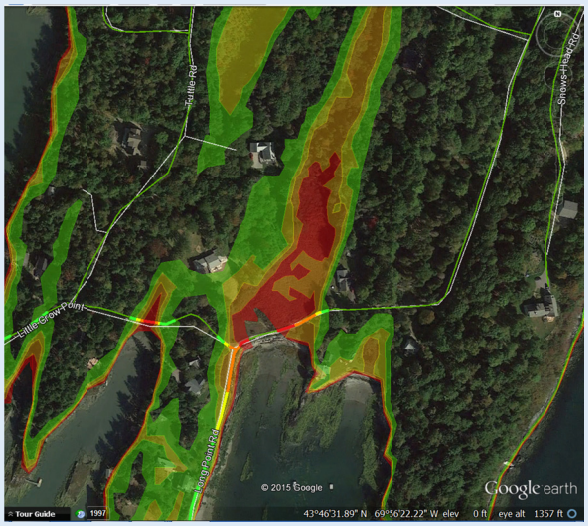
This section of road will be exposed to additional erosion under any scenario and definitely experience flooding at 2 feet. It is likely that under 1 foot of sea level rise the road would not be flooded. The

elevation data showing potential for flooding at 1 foot of rise is likely in error and reflects the bottom of the stream flowing under the road and not the surface of the road itself. If the road becomes impassible at this point it will cut off vehicular access to the entirety of Basin Point, impacting a significant number of residences.

Long Point Rd



Long Point road near its intersection with Gun Point Road.



Long Point Road near its intersection with Little Crow Point Road.

Long Point Road will experience flooding at multiple points. The area on the right is important as it is the farthest point "upstream" Long Point road will be affected, meaning that a flood here will cut off the largest amount of residences. It is also part of the publicly maintained road network. The area on the left shows a part of Long Point Road that is at risk of flooding due to currently experienced high water events that will be even more likely with any amount of sea level rise. This portion of the road is private but does still put a significant number of residences at risk of being cut off from the mainland.

What to do

In addition to the roads identified by the model any roads built along the water will experience increased risk of damage as sea levels rise. While these roads may not be in danger of flooding under the calm water represented in the bathtub model, waves could over top low lying roads during high water events. Increased exposure to wave energy will also increase erosion and possibly put roads at risk of being undermined. This is particularly true in areas where roads intersect streams outlets. The infrastructure to support the stream crossing (namely culverts) is an added point of risk and culvert infrastructure should be regularly inspected to ensure that it is adequate to handle the conditions it experiences. Undersized culverts are also a threat to marsh migration and we will return to this issue in that section.

To address these infrastructure issues the town must prioritize what roads are most important to be fixed based on their risk level and how many residents are affected. At risk roads need to be raised above the level of risk and culverts should be sized upwards to accommodate increased flows (see example below). Particular attention should be given to bridge approaches. With the predicted timeline of sea level rise being in the decades and this estimate working from the high point of Highest Annual Tide only the roads impacted by 1 foot of additional water are at immediate risk. This means that many upgrades may be incorporated into the existing road maintenance and rebuilding schedule. In order to spread costs and inconveniences over as long a period of time as possible the process of road upgrades should be started as soon as possible.

Long Reach Lane Culvert Upgrade

Before Culvert Update (4/2012 image)

After Culvert Update (9/2014 image)

The culvert under Long Reach Lane was replaced in 20**XX** as part of a **project**. Note the back up of water on the inland side as the tide recedes in the before picture. Water was similarly restricted from entering the inland area as the tide came in. The larger culvert allows for significantly improved tidal flow.

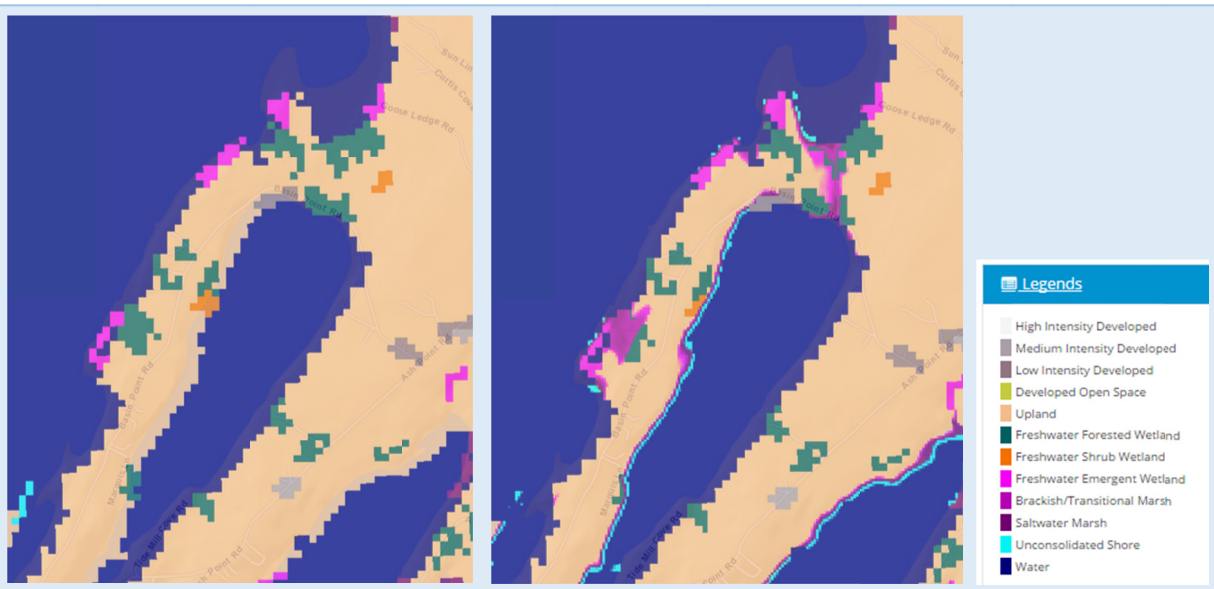
Harpswell has an additional challenge in that many of its most at risk roads are privately owned and maintained. Raising, repairing, and replacing roads are all expensive propositions that may be significant burdens for property owners on a road. Particularly when a road does not serve a large number of properties. State law prohibits public funds being spent on maintaining or repairing private roads. This makes it very hard for the town to give aid to residents to improve their roads. In other parts of the country the problem of private roads at risk to sea level rise has been solved by transferring ownership of particularly important and at risk roads to a public entity. These areas have all been in states with stronger county government than Maine and have resulted in county responsibility for the road. This is not really a possibility in Maine. The town could take ownership of private roads in order to actively spend money on their improvement. It may not be feasible for a municipality to take on this additional maintenance burden and attempting to do so will likely be a contentious decision. One action the town can take in order to prevent adding to this problem is to modify the town road ordinance to call for new or improved roads to be built further above current sea levels and to have larger culverts.

4 Marsh Migration

Coastal marshes are important as a barrier to wave energy, a breeding ground for many marine species, and as an important nutrient source for the aquatic food web. Marshes have a significant ability to absorb high water and wave action in storm events. They filter stream sediment and produce a high load of organic nutrients. This high nutrient environed combined with the shelter provided by marshes make them an important nursery ground for the young of a wide variety aquatic organisms.

Sea level rise will have significant impacts on coastal habitats. Salt water marshes are highly dependent on elevation above sea level and the extent of daily tides. A marsh is finely stratified along lines entirely dependent on how much salt water plants are exposed to, which is in turn directly related to how often and for how long an area is inundated by tides. As sea levels rise marsh habitats will migrate inland to stay in their preferred band of salinity and inundation. This will only be possible where appropriate inland areas exist. A marsh needs relatively flat, undeveloped land that will be flooded by the tide on a daily basis. This will not be available adjacent to all marshes due to topographic or development restrictions and so in order to maintain this habitat care must be taken to ensure that marshes are given the opportunity to spread where appropriate conditions exist. The following are examples of particularly notable potential marsh migration areas. A list of the most likely marsh migration areas of a significant size is included as an appendix to this report.

Basin Point



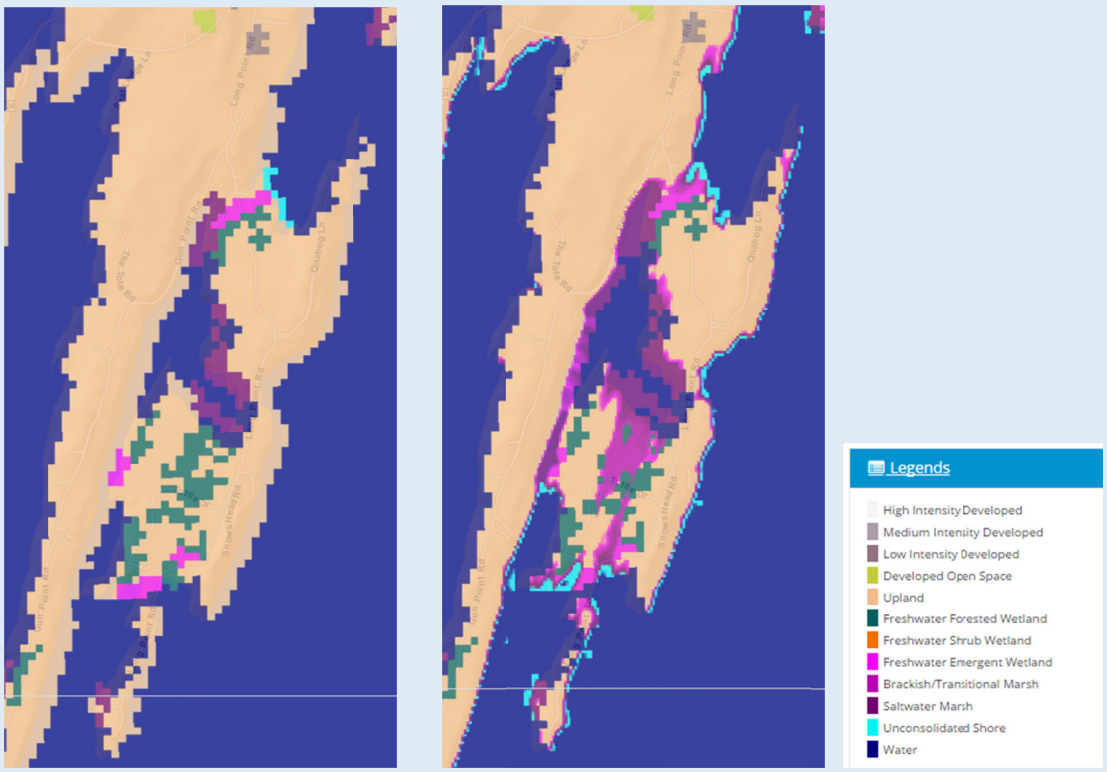
Current land cover

Predicted land cover with 3ft of sea level rise over 100 years.

There are two major areas of potential marsh migration on Basin Point. The first is where the point splits from the main land and shows the potential for the point to become an island. This area is part of the Curtis Farm land preserve and so is protected from development. The second area is on the outer side of the point in the center of the above maps. This area is currently forested fresh water wetlands

but will be inundated significantly more often by ocean water as sea level rises. This area is on private property and is the affected area is largely within the Shoreland zone.

Long Pond Area

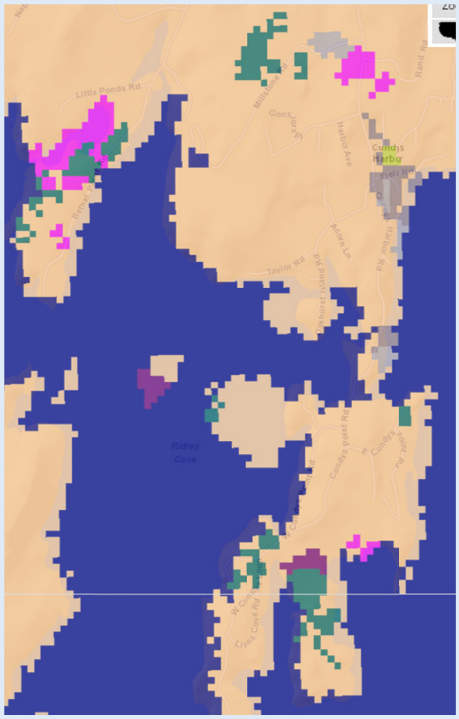


Current land cover

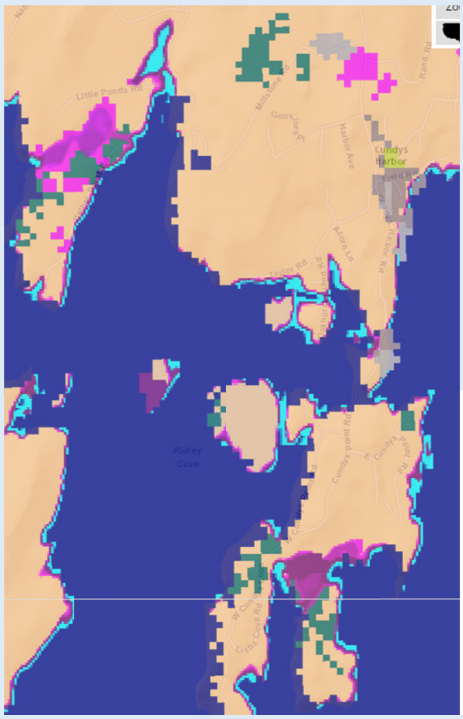
Predicted land cover with 3ft of sea level rise over 100 years.

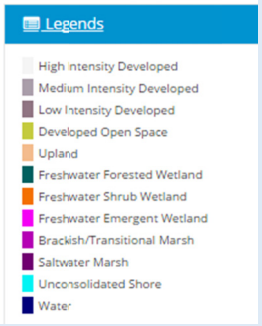
The areas around long pond show the greatest volume of potential for new marsh areas in Harpswell. There is significant amount of land around the pond that is forested wetlands, much of which is low lying land expected to experience flooding at 2 feet above current highest annual tide. The majority of the land in question is inland, adjacent to the pond. Sea water will only be able to access the area by two narrow low areas, (plus a third area to the north if greater levels of sea level rise are experienced). Water flow through the eastern of these paths will be dictated by the size of the culverts under Long Point and Tuttle Roads. The western path is currently dammed. While this dam will be overtopped by even small amounts of sea level rise removing the dam will greatly increase water flow and improve the opportunities for a significant salt water marsh habitat to develop here. Before the dam is removed a more in depth study of what that removal would mean in terms of water flows should be undertaken. While it is unlikely that any structures are under threat to flooding even at water levels of 6 feet over current highest annual tide there is potential for noticeable shifts in land cover types due to water level changes. All of the affected land is privately owned and property owners will have to be a part of any decision to remove the dam. The lake is included in the shoreland zone and so a 250 buffer around the entirety of the lake is zoned as such. However large parts of the potential future marshland in this area are zoned as “Inland,” the least restrictive zone in Harpswell.

Bethel Point and Cundy's Point



Current land cover





Predicted land cover with 3ft of sea level rise over 100 years.

Both Bethel and Cundy's points have areas where the bluff lands at the end of each point will be cut off by expanding marshland. On Cundy's Point the breached area is largely brackish or fresh water wetlands protected by a sandy beach on one side. This beach will see regular over toppings at 2 feet of sea level rise. This will lead to a transition of the fresh water marsh and some low lying forested lands to salt water marsh. At Bethel Point there is a freshwater marsh in part created by a dam between it and the ocean. This dam will be over topped at 3ft above current highest annual tide. At this point water will also reach the marsh overland on the other side of the point. Bethel Point Road runs through this area. Removing this dam and ensuring that the road has a sufficiently sized culvert will allow this marsh to transition to a saltwater marsh easily. Appropriate land exists around the existing marsh to allow it to migrate inward if greater amounts of sea level rise are experienced. Both of these areas are already zoned as Resource Protection areas and a portion of the Bethel Point marsh is on a property protected through deed restrictions.

What to Do

Harpswell is in a good place in terms of marsh migration. Much of the areas where marshes will be able to migrate are already somewhat marshy or at a flooding risk and so are not generally developed. There are two primary actions to be taken to ensure that salt water marshes are in the best position to migrate with rising sea level: preserving likely migration areas and making sure that salt water flows into these areas are not restricted. Many of Harpswell's potential marsh migration areas are already

under some protection. Lands within 250 feet of high water are all part of the Shoreland Zone which gives some minimal protections. In addition most of the existing salt and fresh water marshlands are recognized and zoned as resource protection areas. This gives them, and a 250 foot buffer around them, significant additional protections. Some important marsh migration areas are already protected by the Harpswell Heritage Land Trust. This includes the Curtis Farm Land Preserve mentioned above and the Long Reach Preserve/Easement, both of which cover significant future marsh areas.

The primary restriction of sea water flows into and out of marsh and potential marsh areas is undersized culverts. As mentioned in the road infrastructure section the town should identify and prioritize culverts in need of resizing. These upgrades can then be scheduled over the long term and ideally undertaken in concert with regular road maintenance projects. The Maine Department of Agriculture Conservation and Forestry and Department of Environmental Protection have awarded grant money for culvert upgrading projects in the past and may be one source of funds to undertake these issues. Culvert work will also be complicated by the large amount of privately owned roads in Harpswell. It may be possible to partner with a conservation organization when seeking grant money to get around the restrictions on public funds being used on private roads. There are two coastal dams in Harpswell, both of which represent a serious restriction of tidal flow into potential future salt marsh areas. The current fresh (or possibly brackish) marshes behind these dams are at risk from salt water inundation from other points so retaining the dams will not mean a full retention of current habitats in the long term. These dams are on private property and as with privately owned culverts it would be recommended to partner with a conservation organization to engage with property owners about the removal of the dams.

In order to ensure that marshes have room to migrate likely land must be preserved from development. The town may want to review its shoreland zoning maps and rezone some of the areas of concern as resource protection areas. This approach may be particularly applicable to the Long Pond area. The best way to enact protections on sensitive lands is to work with a land trust such as the HHLT to interact with property owners. The most permanent method would be to have property owners donate or sell the land in question to a land trust for use as a preserve. Less absolute methods include establishing easements or deed restrictions that would not allow development on the environmentally sensitive portions of the property.

5 ACTION POINTS

Roads

To address the at risk public roads in Harpswell the town must undertake a through engineering review of the roads identified in this assessment. This assessment and the accompanying data can be used as a rubric to priorities roads that are most at risk. In most cases roads will have to be raised above the level of risk and culverts will have to be resized.

For private roads Harpswell should reach out to homeowners associations that are responsible for at risk roads. They should be made aware of the risks that their roads face and the consequences that could result from failing to improve them. These consequences include impaired emergency access and loss of the road. The town may want to consider taking ownership of major roads that serve large amounts of properties so that it can take action to address at risk areas.

Marsh Migration

This assessment and the accompanying data can be used to assist the town and other concerned parties to identify and prioritize areas of potential marsh migration that require protection from development. The town should work with property owners and private groups, such as the Harpswell Heritage Land Trust, to ensure that high priority lands are placed under some sort of protection. This could take the form of a easement or the transfer of ownership to a conservation organization. Additionally the town could rezone more marsh lands, and even potential new marsh lands, as being in the resource protection zone. If marsh migration is a considered a town wide concern larger buffers could be enacted to keep future development further away from protected lands.