Christchurch Bay and Harbour Flood and Coastal Erosion Risk Management Study

Technical Annex 11: Historical Habitat Change in Christchurch Harbour

Halcrow Group Limited

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Contents Amendment Record

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Contents

1 Introduction

1.1 Aims and Objectives

The aim of this assessment was to review the historical change to the shoreline in Christchurch Harbour with the ultimate objective to discover any potential threat that to the adjacent landfill site that could be brought about by erosion of Stanpit Marsh. Whilst this investigation was carried out, the remainder of Christchurch Harbour was also assessed. Two sets of aerial photographs (1971 and 1997) were used to carry out the assessment, and photographs taken in 1989 and 1995 were used to support them for clarity.

1.2 Study area

Christchurch Harbour is located on the south west coast of the England, within Dorset. It is bounded to the south west by Bournemouth and Poole Bay and the New Forest to the north east. The Harbour is enclosed by Hengistbury Head, a spit-promontory feature that acts to protect the Harbour from the predominant wind and wave regime. Two major habitat types have developed in the intertidal zone of the harbour, including salt marsh and reedbed. Stanpit Marsh is the most extensive of these habitats and is located in the centre of Christchurch Harbour (see Figure 1).

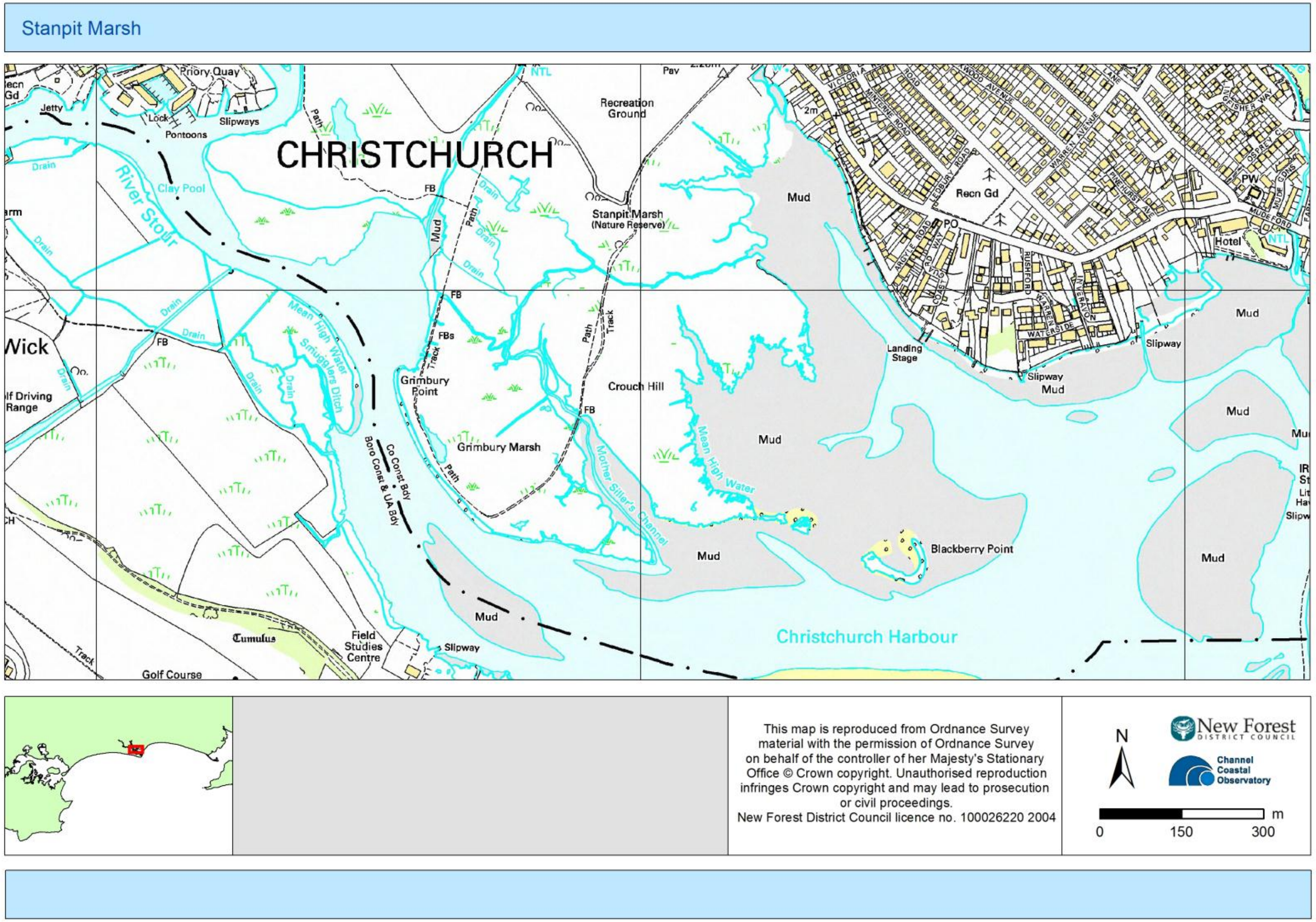

Figure 1. Location Map of Stanpit Marsh in Christchurch Harbour

Methods

1.3 Assessment of Salt Marsh Retreat Rates

1. Two sets of aerial photographs were used to carry out habitat classification; black and white 1971 and colour 1997. A site visit also took place, which enabled a more detailed inspection of the vegetation types on and around Stanpit Marsh and Christchurch Harbour.
2. The main habitat types that exist within Christchurch Harbour were first identified using the 1997 photographs. These include: (a) salt marsh (b) reed bed (c) mixture of salt marsh and reed bed (d) unknown and (e) no data.
3. Salt marshes are vegetated areas in the upper part of the intertidal zone, which are generally protected from severe wave exposure (see Figure 2).

Figure 2: Salt marsh vegetation on Stanpit Marsh (facing east).

4. Reedbeds are classified as wetland vegetation and are dominated by stands of the common reed *Phragmites australis.* They often grow in marshes and swamps, along streams, lakes, ponds, ditches, and wet wastelands. Reedbeds are ephemeral in nature, i.e. reeds colonise open water (see Figure 3). Over time leaf litter builds up and the reedbed dries up where it is then colonised by alder and willow.

Figure 3: Reed bed at Stanpit Marsh (facing south)

5. At some locations, if the salt marsh and reed bed were found in close vicinity of one another and it proved impossible to differentiate between the two using the aerial photographs, the habitat type was termed salt marsh/reedbed.
6. To aid with the classification of the black and white aerials the 1997 were digitised (see below) first.
7. To digitise each habitat type, the maps were enlarged on screen to a 1:3000 scale. The outlines of each individual habitat type were traced to form a polygon, which ultimately represented the distribution of vegetation type.
8. This process was repeated for the black and white 1971 aerial photographs.
9. To qualify where any historical change was taking place within Christchurch Harbour, the polygons produced for both 1971 and 1997 were overlain and the difference recorded. Measurements were taken at 100m intervals to ensure a fair and representative sample.
10. Arrows were plotted onto the polygon layer of the 1997 salt marsh line to highlight those areas that are either accreting, eroding or have not changed since 1971.
11. The polygons could then be used to calculate the individual area of each habitat type; and statistical analysis then could be carried out on the output data to eventually assess the historical change of the marsh.
12. To aid with the statistical analysis and erosion analysis; the habitat types within Christchurch Harbour were broken down into three key areas. These were (i) Stanpit Marsh (ii) South Christchurch and (iii) Islands.

13. Using the calculation methods in Arcview, the areas of the polygons were calculated to give: (a) individual areas of each habitat type (b) the combined areas of each habitat type across the whole Harbour (c) the areas of each habitat type in Stanpit Marsh, South Christchurch and Islands.
14. Calculation of the polygon area in Arcview also produced an additional data to include count of polygons, area in meters (m) and hectares (ha) and perimeter of the classified habitat type. This raw data was then exported into EXCEL.
15. This process was repeated for the black and white 1971 aerial photographs.
16. Statistical analysis of habitat area was then carried out in EXCEL to help quantify the changes that have occurred within the Harbour between 1971 and 1997. Analysis was split into two parts (i) sections within Christchurch Harbour divided into habitats and (ii) individual habitat analysis.

1.4 Sections within Christchurch Harbour divided into habitats.

1. The area of each habitat type in (m), in each section of the harbour for both 1971 and 1997 was used to calculate the change in area (m) over time.
2. The rate of change was calculated by taking the difference and dividing it by 26, the number of years between 1971 and 1997.
3. The percentage change calculates that loss or gain of habitat relative to the initial value in 1971. This was done by taking the difference in area between the two years and finding it as a percentage of the salt marsh area in 1971.

1.5 Individual habitat analysis.

1. For this analysis the area of habitat type was concentrated on and how that habitat differed across each section within the harbour.
2. The same method as outlined above was used to calculate difference in area and rate of change of the habitat type.
3. The figures calculated were then graphed to help visualise the historical changes that have taken place in Christchurch Harbour and compared with the output from the erosion analysis to give an indication of historical behaviour of Christchurch Harbour including Stanpit Marsh, South Christchurch and the Islands.

2 Results

2.1 Qualitative analysis

Figure 4 shows the area of each habitat extent as in 1971; Figure 5 as in 1997 and Figure 6 shows the qualitative results produced by the historical change analysis between 1971 and 1997. Zones of erosion, accretion and no change are clear and can be broken down into sections or habitats. It is firstly evident that a lot of the salt marsh area and only some salt marsh/reed bed are eroding; while areas of reed bed are accreting. This is true of both Stanpit Marsh and South Christchurch. However, little or no change is taking place to the more sheltered shoreline of Stanpit Marsh. Accretion of the reed bed is more prominent to the north west of Christchurch Harbour, where the Avon and Stour create a fluvially dominated sector and provide the fresh water input that is necessary to sustain the growth of reed bed.

Between 1971 and 1997 the islands have depleted in volume and area, such that the one existing closest to Stanpit Marsh in 1971 has since disappeared. The most seaward island has elongated and become thinner since 1971, while the island between the two has migrated in a northerly direction.

2.2 Quantitative Analysis

Based on polygon and area analysis in Arcview, Figures 7 and 8 below simply show the distribution of habitat type within Christchurch Harbour and how it differs between 1971 and 1997. It is seen that the distribution of salt marsh is far greater than the amount of reed bed or reed bed/salt marsh and that is itself generally less than reed bed, with exception to Stanpit Marsh. It is also evident that the proportion of salt marsh to reed bed is greater in Stanpit Marsh to South Christchurch; and there is more reed marsh located on the more western and southern margins of Christchurch Harbour than in Stanpit Marsh.

The change in habitat and the rate at which this takes place between 1971 and 1997 is shown in Figure 9. Salt marsh has eroded the most during this time, with losses in area reaching 85,000m^2. Areas of reed bed have accreted by 16,000 m^2 and salt marsh/reedbed accreted by 44,000m^2. These changes have occurred across the whole harbour, but appear to have been more substantial in South Christchurch than on Stanpit Marsh, as shown by Figure 10 and discussed below.

Stanpit Marsh has suffered losses of salt marsh in the region of 3,000m^2/year but a gain of reed bed in the region of 105m^2/year and a gain of salt marsh/reed bed in the region of 3,000m^2/year. The net loss of wetland habitat is therefore 105m^2/year. The changes occurring across South Christchurch are less substantial, with an increase in salt marsh of 31 m^2/year and reed bed of 500 m^2/year; but a decrease in salt marsh/reed bed of 1300 m^2/year. This is a net loss of 780m^2/year of wetland habitat in the southern areas of Christchurch Harbour. It can therefore be said that the net historical change taking place within the Christchurch Harbour is greatest across the southern coastline, but the gross change is in fact taking place to the north at Stanpit Marsh, where the greater losses of salt marsh are being balanced by the growth of salt marsh/reedbed.

Figure 7: Harbour Sections and their Compositon (1971)

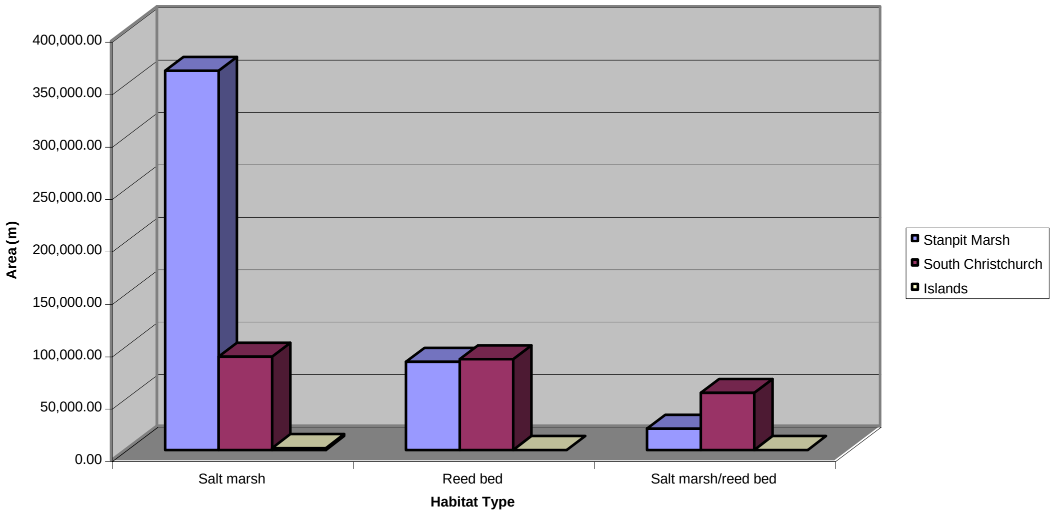

Figure 8: Harbour Sections and their Composition (1997)

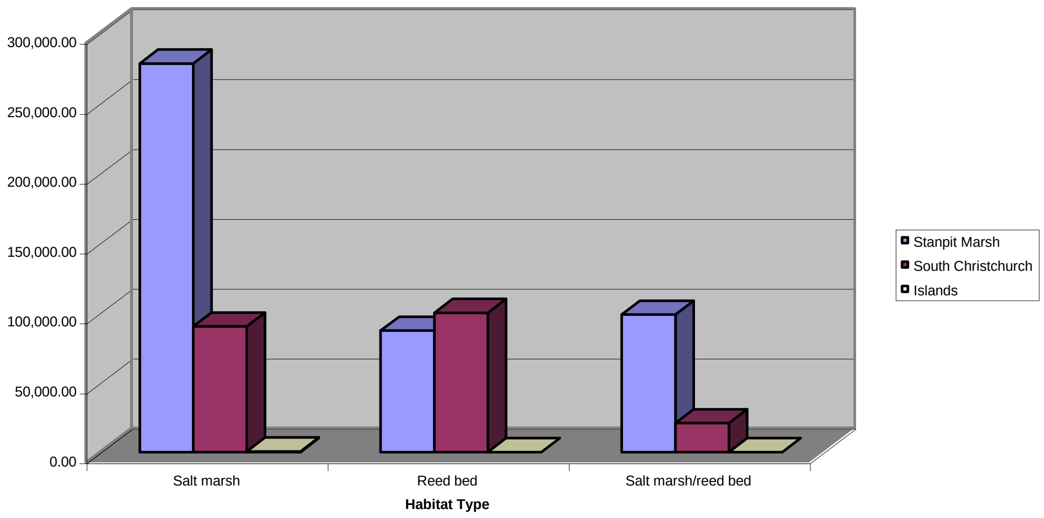

Figure 9: Habitat area change in Christchurch Harbour 1971-1997

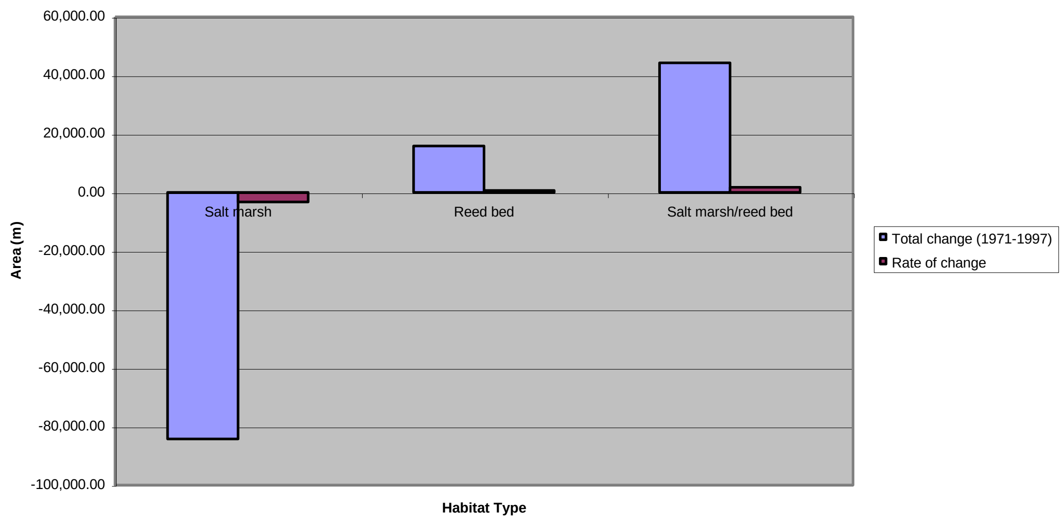

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Figure 10: Total change in area (1971-1997)

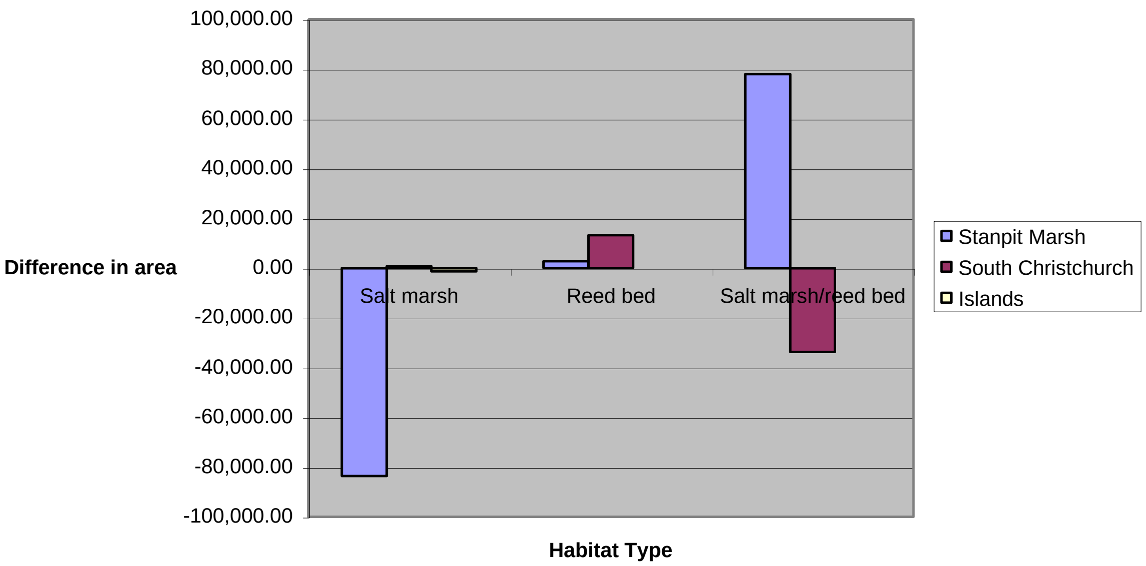

Table 1 further quantifies the changes across the salt marsh in terms of the percentage change or loss, from which it can be seen that the actual losses of habitat from the harbour are relatively low. Between 1971 and 1997, the area of salt marsh habitat in Stanpit marsh has reduced by 23.1%, yet the amount of reed bed has increased by 3.2% and salt marsh/reed bed has also increased by 384.6%, or by triple its original area. The losses to South Christchurch do outweigh the gains, where 61.9% of salt marsh has been lost between 1971 and 1997 and only 0.9% of salt marsh and 15.2% of reedbed accretion has taken place. Greatest erosion has occurred to the islands where 75.8% of the existing habitat was lost between 1979 and 1997. The average percentage change for each area of habitat across the whole Harbour is 27%, which equates to 1%/year. This can be explained by considering the percentage change to each area of habitat in the Harbour. Losses of salt marsh have been in the region of 19%, but outweighed by the growth of reedbed and salt marsh/reedbed, which has increased by approximately 69%. There has therefore been an increase in the area of habitat by 50% between 1971 and 1997, and it is suggested that the coastline in Christchurch Harbour is accreting by 1.92%/year.

Section	**Habitat type**	**Percentage Change (1971-**
Stanpit marsh	Salt marsh	-23.1
	Reedbed	3.2
	Salt	385.6
South Christchurch	Salt marsh	0.9
	Reedbed	15.2
	Salt	-61.9
Islands	Salt marsh	-75.8
	Reedbed	0
	Salt	0
Total		**244.1**
Average percentage		**27.0**
Christchurch Harbour	Salt marsh	-18.6
	Reedbed	9.3
	Salt	59.3
Total		**50.0**

Table 1: Percentage change in habitat area (1971-1997).

3 Conclusion

3.1 Conclusion

3.1.1 General

Figures 7 to 10 show how the historical analysis is quantified, in that the areas within Christchurch Harbour occupied by salt marsh and salt marsh/reed bed are eroding; while areas of reed bed and in Stanpit Marsh, areas of salt marsh/reedbed are accreting. The results also confirm that the degree of net historical change between 1971 and 1997 has been greatest across South Christchurch as opposed to Stanpit Marsh. Figure 11 summaries the historical change of Christchurch Harbour

3.1.2 Stanpit Marsh

The more western margins of Stanpit Marsh display an accretionary trend, which is evident by the growth of reed bed in a seaward direction. This is also seen where a small freshwater inlet to the east of the marsh has effectively closed due to the growth of reed bed. On the more exposed margins of Stanpit Marsh, typically where the development of salt marsh has taken place, the shoreline is eroding. Within the more sheltered margins of the marsh little or no change has taken place.

3.1.3 South Christchurch

Reed bed growth is taking place along the length of this section, with areas of salt marsh between and to the north and south eroding. This distribution of accretionary reed bed mirrors the growth of that which is taking place across the main river on Stanpit Marsh, and also where Stanpit Marsh is showing signs of erosion.

4 Discussion

The analysis carried out for Christchurch Harbour shows that between 1971 and 1997 there has been an increase in the area of reed bed habitat and salt marsh/reed bed and a reduction in the salt marsh. This historic change has been more prominent across Stanpit Marsh than South Christchurch, but does display a greater net change across South Christchurch; and as Figure 8 shows, the actual rate of change is relatively low compared to the total change.

When the total losses of wetland habitat are considered, between 1971 and 1997 Stanpit Marsh has suffered losses by erosion in the region of 23%; South Christchurch in the region of 70% and the Islands have experienced a reduction in area by 76%. Such changes could relate to a general change in the local hydrodynamic regime. This would include an increase in the amount of freshwater that is entering Christchurch Harbour and is thus responsible for the increase in area of reed bed. The growth of reed bed and loss of salt marsh could also be a result of an eroding shoreline that brings the salt marsh into contact with more fresh groundwater and fluvial water flow. Higher sea levels in response to climate change could be responsible for the general erosion of salt marsh within the harbour, whereby the rate of water level rise is too great and the related sediment deposition to little to allow for salt marsh accretion at a pace that is equal to water level change. Aerial photographs also indicate that the sand-grade sediment is the most abundant source of material within the harbour and considering that salt marsh forms via the deposition of fine material such as silt and clay, the existing conditions do not provide the source for the continued development of salt marsh.