The Delineation Of The Seaward Limits Of A Coastal Marine Protected Area Using Non-Terrestrial (Subsurface) Boundaries - The Musquash Estuary MPA.

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ABSTRACT

The Musquash Estuary is located approximately 20 km to the west of the city of Saint John, New Brunswick. It has been identified as being one of the last intact coastal estuaries in the Bay of Fundy and has thereby recently been recognized as a potential Marine Protected Area (MPA) under the Department of Fisheries and Oceans MPA programme.

The proposed boundaries for the Musquash MPA are based upon conventional, terrestrial landmarks. It was proposed that subsurface boundaries might provide a more suitable method of delineating an area for a MPA. In addition to the official boundaries for the MPA, the establishment of a potentially protective buffer zone on the seaward side of the estuary has been discussed by the MPA working group that would be prone to fewer restrictions than that of the actual MPA. Final boundary delineation was to remain open to further discussion pending further scientific information. This study thus investigated the boundary requirements for the seaward extent of the Musquash MPA and the protective buffer zone.

Various hydrographic data sets were collected to establish an oceanographic profile of the Musquash Estuary for the purpose of investigating any potential geomorphic and/or oceanographic boundaries. These data sets primarily included Acoustic Doppler Current Profiling (ADCP), EM3000 multibeam, and Knudsen sidescan and single beam sonars. Methodologies and survey results are presented.

Analysis of bathymetric and backscatter data sets reveal that the original, proposed boundaries (defined arbitrarily by extrapolation between terrestrial targets) do have a sight coincidence to a sedimentary boundary at the outer limit of the estuary. No sediment boundary was established near the scallop zone. In contrast, the acoustic evidence indicates significant movement of sediment between the open bay and the estuary. Analysis of ADCP data, in conjunction with the other data sets, revealed complex oceanic processes in and near the estuary mouth and an estimation of the

flushing patterns at the entrance to the harbour was defined. The seaward extent of the MPA boundaries are proposed based on these analyses. Conclusions and recommendations for future work are discussed.

INTRODUCTION & BACKGROUND

Canada's Ocean Act of 1997 provides legislative means to provide protection for selected marine areas of Canadian internal waters. Under the Oceans Act, an area can be designated as an Marine Protected Area (MPA) to conserve and protect one or more of the following:

- Commercial and non-commercial fishery resources, including marine mammals, and their habitats.
- Endangered or threatened marine species and their habitats.
- Unique habitats.
- Marine areas of high biodiversity or biological productivity.
- Any other marine resource or habitat as is necessary to fulfill the mandate of the Minister.

The Musquash Estuary is located approximately 20km southwest of Saint John in the Bay of Fundy. Being recognised as one of the last intact coastal estuaries in the Bay (Harvey, et al., 1998; Platt 1998) it was formally identified as an Area of Interest (AOI) by the Department of Fisheries and Oceans (DFO) in February, 2000. This action signifies a primary step in the process towards full MPA designation.

The initial boundary loci for the proposed Musquash MPA are based upon criteria that have been used traditionally in marine boundary delineation. Specifically, the high water mark defines the extent of the MPA zone with respect to the terrestrial margin and straight line segments defined from terrestrial markers delimit the extent of the seaward limit of the estuary and a special scallop zone at the entrance to the bay. The head of the tide delimits the inland reach of the proposed MPA at a small hydroelectric dam, located 16km from the Bay of Fundy. Figure 1 illustrates the location of the Musquash Estuary and the proposed boundaries for the MPA.

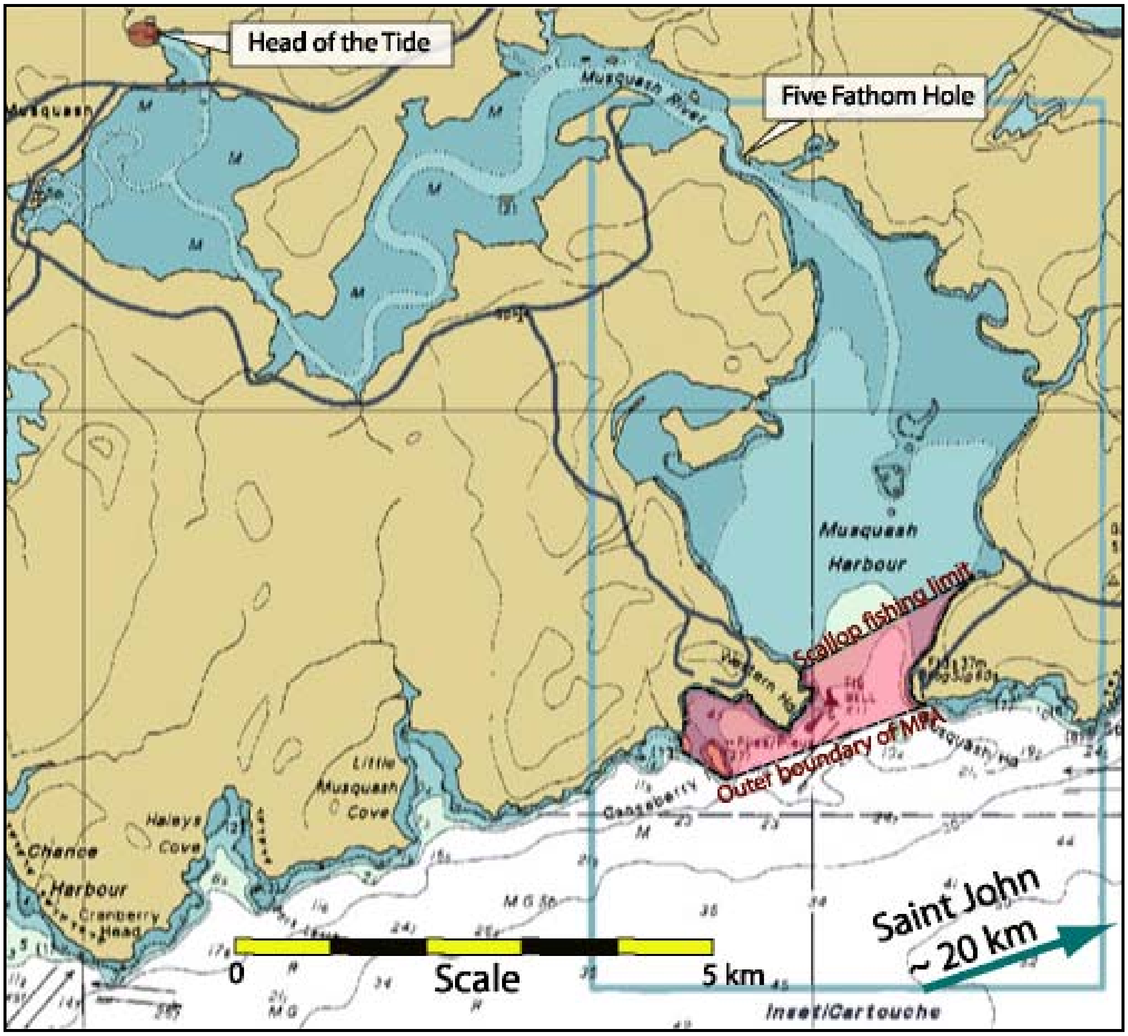


Figure 1: The Musquash Estuary, showing the initial proposed boundaries for the MPA. The red section is the prime study area for this investigation (background CHS chart # 4128).

The official goal of an MPA is to ensure adequate protection and conservation of the selected area (DFO, 1997). With respect to the Musquash Estuary, the question has been raised as to whether or not these boundaries provide sufficient protection to guarantee the accomplishment of these aims. From an administrative viewpoint, straight line boundaries based on terrestrial landmarks are easier to enforce and provide convenient demarcation for mariners to locate. With the notion that an MPA should be delimited with the requirements of protection and conservation, this study investigated the use of natural, geomorphic seabed features and oceanographic processes as criteria in the delimitation of the both the outer boundary of the Musquash MPA and the limit of the special scallop zone..

METHODOLOGY

To meet the needs of the survey, the intertidal and shallow subtidal seabed and water column within, and beyond, the proposed boundary of the MPA needed to be investigated for:

- Surficial sediment distribution
- Fine scale bathymetric relief
- Tidal current patterns over a typical tidal cycle.

To meet the surficial sediment distribution aims, acoustic backscatter from fixed mounted sidescan and multibeam was used. The multibeam also provided the fine scale relief for the subtidal areas. To meet the current mapping needs an ADCP was deployed from a vessel using a bottom tracking mode.

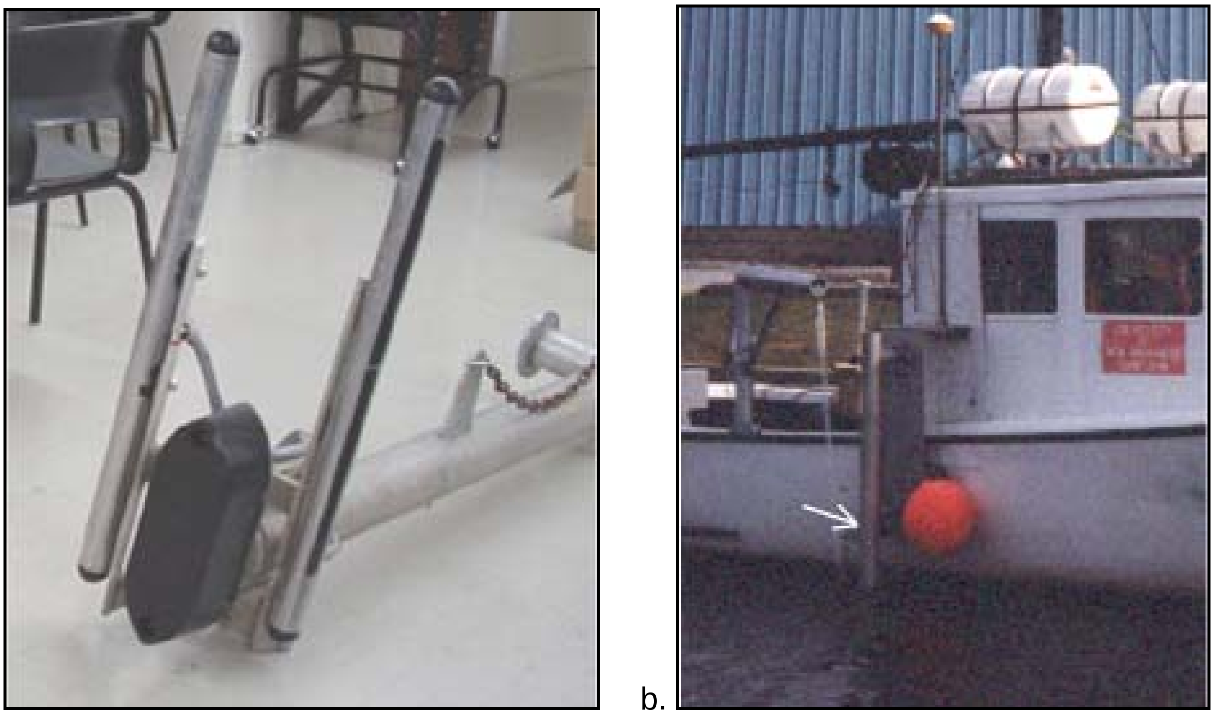
A Knudsen 200 kHz sidescan sonar (UNB research vessel *Mary-O*) and Simrad EM3000 multibeam sonar (*CHS Plover)* were the primary survey tools used in the preliminary phase of the survey, completed in May, 2001. Of primary interest for this survey was the backscatter data from both platforms for the use in sea bottom sediment classification. The depth of the estuary and the exposed area just outside the headlands ranges between 1 metre and 40 metres with a significant portion of the estuary harbour even being exposed at low tide. Considering this depth range and the fact that it is a macrotidal estuary (6-8 metre tidal amplitude), these two complementary platforms were chosen for the survey.

Three-quarters of the water in the Musquash Estuary is flushed twice daily with the tidal forces of the Bay of Fundy (Kristmanson, 1974). As a consequence, it is thought that complex circulatory processes are being produced in and around the narrow headlands of the estuary mouth. Kristmanson (1974) took salinity and temperature measurements in the estuary and hypothesized that waters from the ebb tide may be re-entering the bay on the succeeding flood tide. If this is indeed the case, a better understanding of flow patterns into the estuary is necessary for effective, long-term management and the possible establishment of an environmental buffer zone. In order to better comprehend the flushing patterns and the oceanographic interaction with the bay a survey of the tidal currents was also designed and carried out in September, 2001. The methodologies for each of the three survey systems are discussed separately.

Sidescan Survey

A single-headed EM3000 multibeam (mounted level) yields a narrow bottom coverage swath of merely 15 metres in 5 metres of water (typical water depths achievable in the intertidal zone). By contrast, a sidescan sonar can maintain a fixed across-track range of 100 metres in these depths and thus is ideal is such conditions, even working in depths of less than 2 metres while keeping consistent coverage. Using this system and keeping consistent line spacing of 80 metres (providing 20metres of overlap) very efficient use of ship time can be achieved in such shallow waters. Furthermore, one does not risk potential damage to an expensive multibeam transducer while investigating hazardous coastal areas.

The UNB research vessel *Mary-O* is equipped with a retractable pole-mount which allows for rapid and easy deployment of a selection of sonar transducers. For this survey, two Knudsen KEL28SS sidescan staves and a Knudsen 320B/P single beam echo sounder were used, as illustrated in Figures 2a and 2b.



a. b.

Figure 2: Retractable pole housing three Knudsen transducers (a) and the deployment of the pole on the UNB research vessel *Mary-O* (b).

Ideally, using the two staves simultaneously would have provided consistent 160 metre line spacing as each sonar is directed oppositely in the port-starboard axis. However, since only one control unit was available only one stave could be used at any given time. The low frequency 28 kHz single beam echo sounder was consistently used for bottom tracking. Positioning was achieved using two DGPS services; Coast Guard and Landstar, while the survey software Aldebaran was used for survey design and provided real-time positioning feedback to the operators and coxswain. A pulse length of .2 milliseconds was used throughout the survey, permitting an approximate range resolution of 15 centimetres.

All data processing was completed using Ocean Mapping Group software tools.
In an effort to maximize the coverage of the estuary, surveying times were centred around one of the two daily high tides. Doing so permitted the vessel to make

approaches close to shores that would not be possible at lower water levels. Typically, the vessel would leave the mooring at Five Fathom Hole 2-3 hours prior to high water and, working in a grid, ease towards a shoreline as the water level rose, attempting to capture the high water signature on the shore. For days when this was not possible due to mechanical and technical delays, surveys were conducted in deeper waters of the estuary where operations at lower water levels were still possible. With the exception of the shorelines and the upper estuarine river, mostly rectangular grid patterns were used in design of the survey. The *Mary-O* was operational for a total of nine days between April 30 and May 24, 2001. This reflects the low rate of efficiency that could be achieved when most of the survey area actually lies in the intertidal zone.

EM3000 Multibeam Survey

As with the sidescan survey, the design of the multibeam survey was also dictated by high water levels in the Musquash. For the duration of the two-week survey, the CHS hydrographic survey launch *Plover* was moored at the Coast Guard base in Saint John, New Brunswick, necessitating a 60-90 minute one-way transit for each survey day in the Musquash. Most days began with an early-morning departure from Saint John Harbour and commonly lasted 8-10 hours.

Being a fully-outfitted CHS hydrographic multibeam launch, the *Plover* possesses a POS-MV motion sensor which incorporates DGPS positioning and pitch, roll & heave corrections into the sounding data in real time. Although the Bay of Fundy and the Musquash are very well mixed oceanographically, sound-velocity profiles were still taken in the morning on the transit from Saint John using an AML SVP-16 sound speed probe. The transit also provided the opportunity to gather additional data for this corridor, increasing the density of bathymetric coverage of the coast of New Brunswick.

As with the sidescan survey, most surveying within the estuary itself was limited by the two hours just prior to high water due to the shallow depths of the inner Musquash harbour. In contrast to the sidescan survey, however, the multibeam survey was focused primarily on the relatively deeper waters near the headlands. The operators proceeded in a concentric fashion, generally following the depth contours of the area, expanding the coverage on a daily basis. Once the daily tidal window of opportunity had passed, work continued outside of the estuary in deeper waters using a grid survey design. The survey design software package Merlin was used on board the Plover for positioning, survey design and real-time coverage feedback. In all, the *Plover* was operational for ten days while surveying the Musquash. All data processing was completed using data processing software tools developed by the Ocean Mapping Group at UNB.

The EM3000 system provides estimates of the bottom backscatter strength, automatically back corrected for operational changes in source level, pulse length and receiver gains. These data are provided over a range of grazing angle from as low as 25 degree to 90 degrees at nadir (Fig. 3d). Unlike the sidescan imagery, which is dominated by the low grazing angle data, the higher aspect EM3000 data sweeps through a large range of grazing angles that provides an unusual image for interpretation. In a partial effort to compensate for this, an angle-dependent gain function is built into to the TVG by Simrad. Whilst this works well for data away from nadir, it does not adequately account for rapid changes in the shape of the angular response near nadir . As a result, before additional processing steps, the maps of surficial backscatter distribution are dominated by the grazing angle effect with a pronounced high backscatter corridor immediately beneath the ships track (Figure 3a).

Normal procedure to correct for this is to regionally estimate the average shape of the backscatter angular response curve (the regional variation in backscatter strength as a function of grazing angle) This is then used to try and remove the effect (Figure 3b). For the wide range of sediment types encountered in the Musquash, however, it was found that the shape of the angular response curve was grossly different between some lithologies (Fig. 3d). As a result a method, developed within the OMG, was used which locally estimated the shape of the angular response curve and normalised the image using that (Figure 3c). Using this method, the most useful map of regional sediment distribution was obtained.

Figure 3d: representative angular response curves found in the Musquash region. Curves 1 through 4 are derived from the locations indicated in Figure 3a. Curve 5 is derived from the lower backscatter sediments within the harbour.

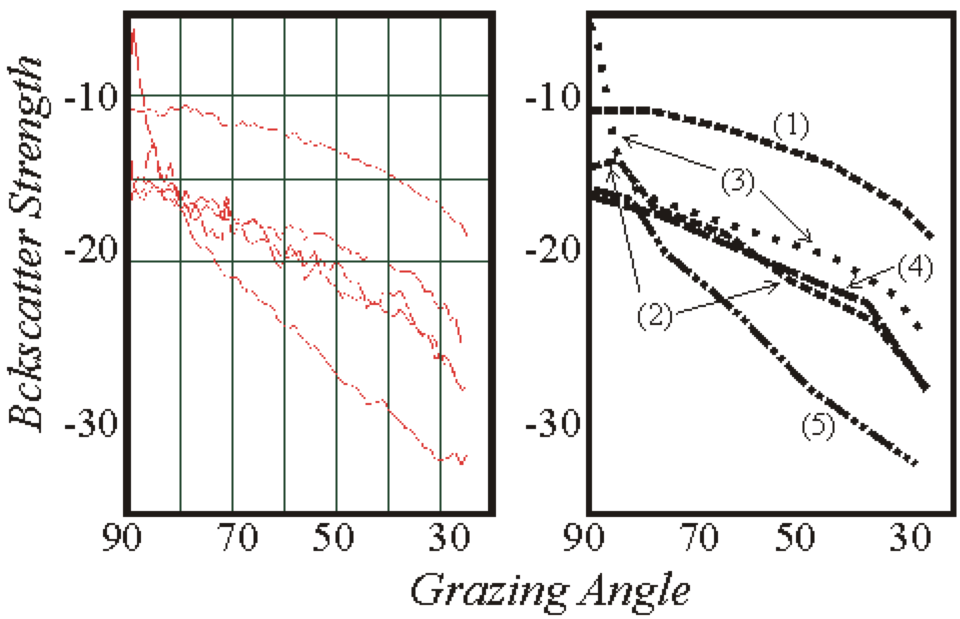
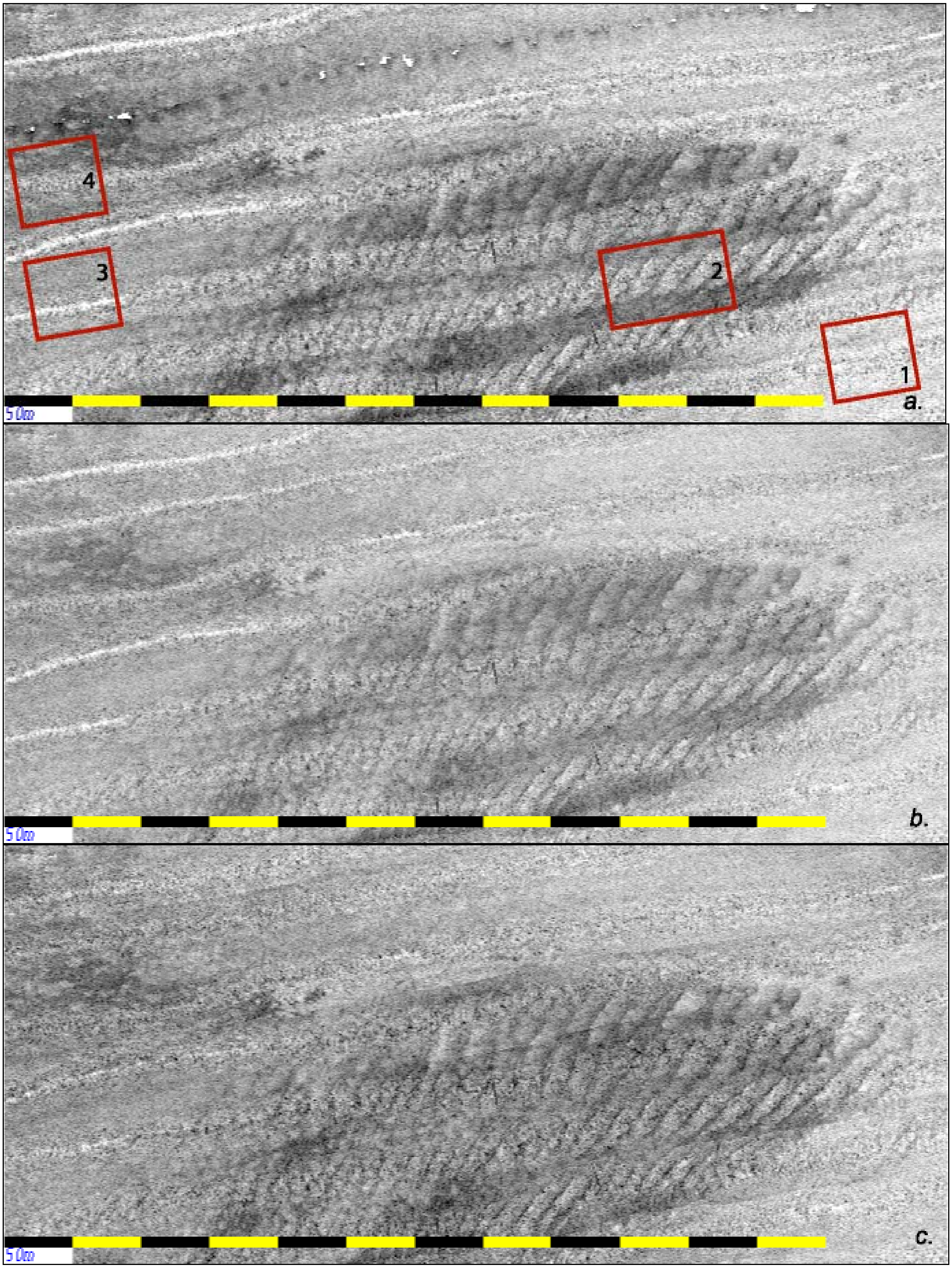


Figure 3: Sample area of Musquash EM3000 backscatter image illustrating (a) uncorrected sidescan mosaic (b) the result of averaging the backscatter angular response curve and (c) the effect of localized corrections producing the final result. The location for these images is indicated in Figure 5.

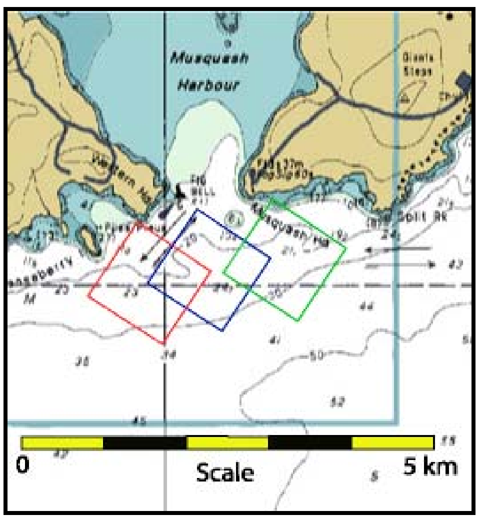


4
3
2
1
50m
a.
50m
b.
50m
c.

Acoustic Doppler Current Profile (ADCP) Survey

An ADCP measures the velocity and direction of water particles with reference to the seabed in discrete, user-defined slices of the water column. By steaming in a repetitive course for the duration of a complete tidal cycle one can observe the changing current patterns for this period for a given area. Three overlapping diamond patterns of 1 km^2 each were hence designed that would capture a significant part of the signature of the current patterns at the mouth of the Musquash Estuary.

For this survey the RD Instruments 600kHz Workhorse Monitor was the model that was used. A special accessory mount was designed to allow the attachment of the ADCP to the retractable pole on the *Mary-O*. Positioning was accomplished using DGPS and Aldebaran was again used to provide course feedback for the coxswain. Unlike the sidescan and multibeam survey phases, this survey was conducted in September, 2001. Figure 4a illustrates the three diamonds that were designed for this survey.

a. 

b. 

Figure 4: (a) Diamond pattern selected for the ADCP survey of the entrance to Musquash Estuary. Red = west diamond; Blue = central diamond; Green = east diamond (background CHS Chart #4128). (b) ADCP transducer (red, white & blue) mounted on pole on the *Mary-O*. The black transducer is downward-looking echosounder.

SURVEY RESULTS

Full coverage of the primary subtidal study area was obtained with the multibeam system while the remaining areas (mainly intertidal) were surveyed with the sidescan. Some overlap was achieved in the primary study area. This provided a comprehensive profile of the sediment distributions in the estuary for the use in boundary-related management decisions. With regards to the ADCP survey, the west and central diamonds were completed while the east diamond could not be terminated due to time limitations. Furthermore, successive attempts to complete the east diamond ADCP survey in November 2001 proved to be futile due to weather constraints. Nevertheless, the completion of the east and central diamonds did provide preliminary, quantitative evidence of circulation patterns near the mouth of the estuary. Results of each of the three surveys shall be discussed individually.

EM3000 Results

Down time was very minimal for the *Plover*, being operational for nine of twelve possible survey days. In addition to full coverage of the primary study area, significant zones in the upper estuary and outside the harbour were also surveyed. Although not directly pertinent for this study, the collection of such a significantly large data set can only improve the knowledge for future management of the estuary. Figure 5 illustrates the extent of the backscatter coverage of the estuary and surrounding area.

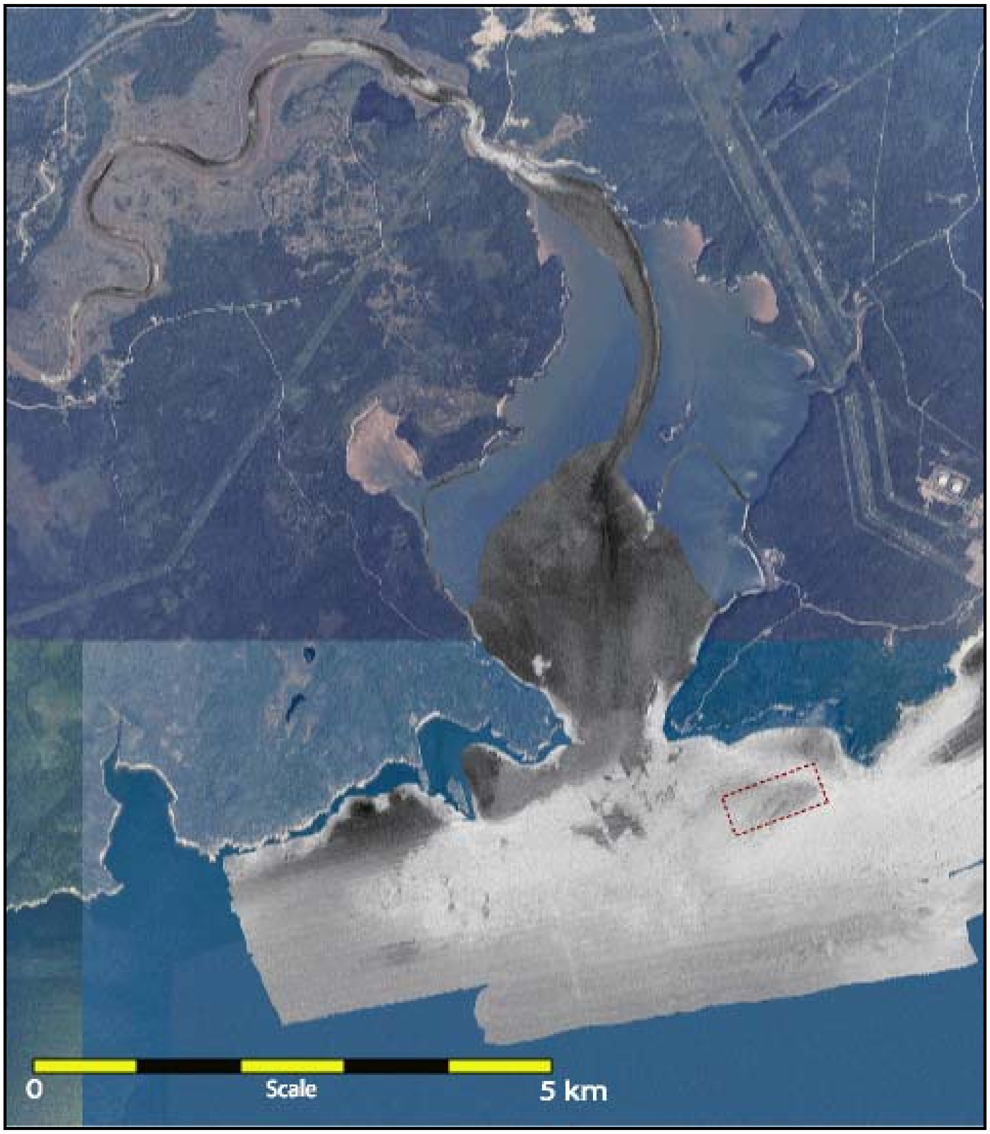


Figure 5: Overview of EM3000 coverage in the Musquash Estuary. Dark regions are low backscatter while lighter regions are high backscatter. Red box detail indicates location of images used in Figure 3. Note that the survey extent was limited to below the low water mark (background orthophoto SNB).

The darker regions indicate areas where less acoustic energy is reflected back to the transducer by the seabed and is interpreted as being fine grained (sand and mud) sediments (low backscatter). The lighter regions indicate high backscatter, interpreted as being coarse sand, gravel and bedrock. The interior seabed of the harbour is homogenously low backscatter while there is a clear indication of a change in sediments to harder rock just at the entrance to the harbour. This has been indicated by the dashed red line in Figure 6.

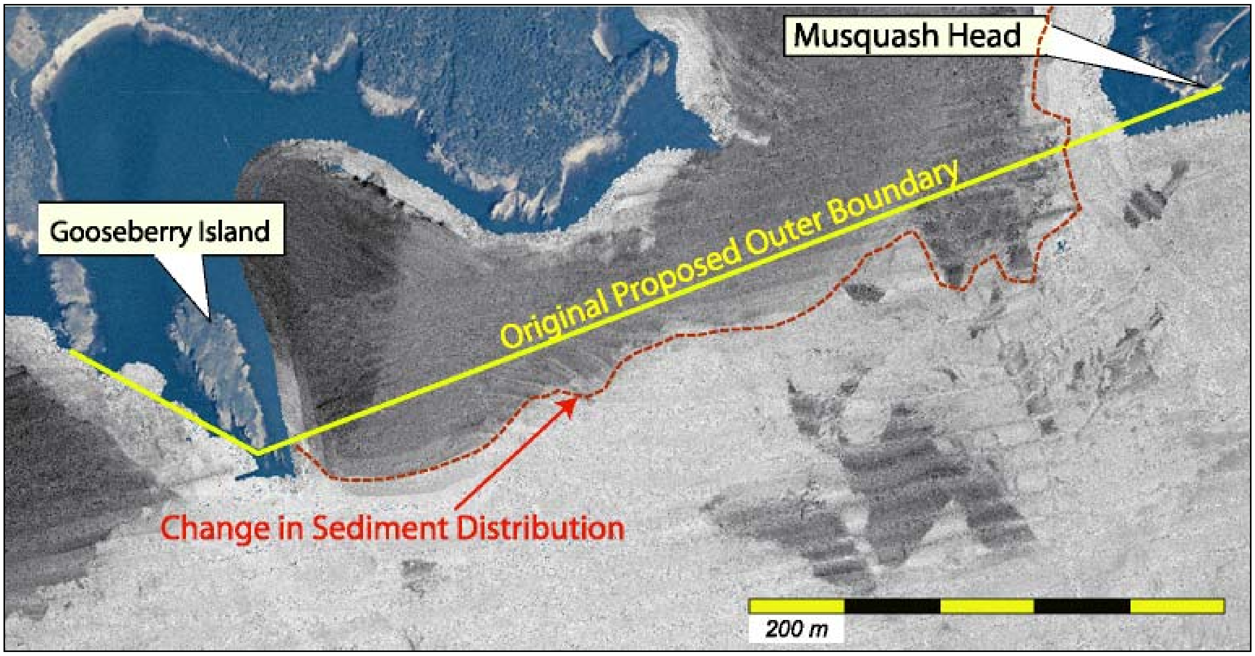


Figure 6: EM3000 backscatter image of the outer extent of Musquash Harbour showing the change in sediment distribution and the original proposed outer MPA boundary (background orthophoto SNB).

Although not as well-defined as the outer limit, there are delicate changes in the backscatter values in the area of the scallop boundary, indicating a more gradual change in the surficial sediments in this area. Figure 7 shows a detail of the slight backscatter variations in the area of the proposed scallop zone boundary.

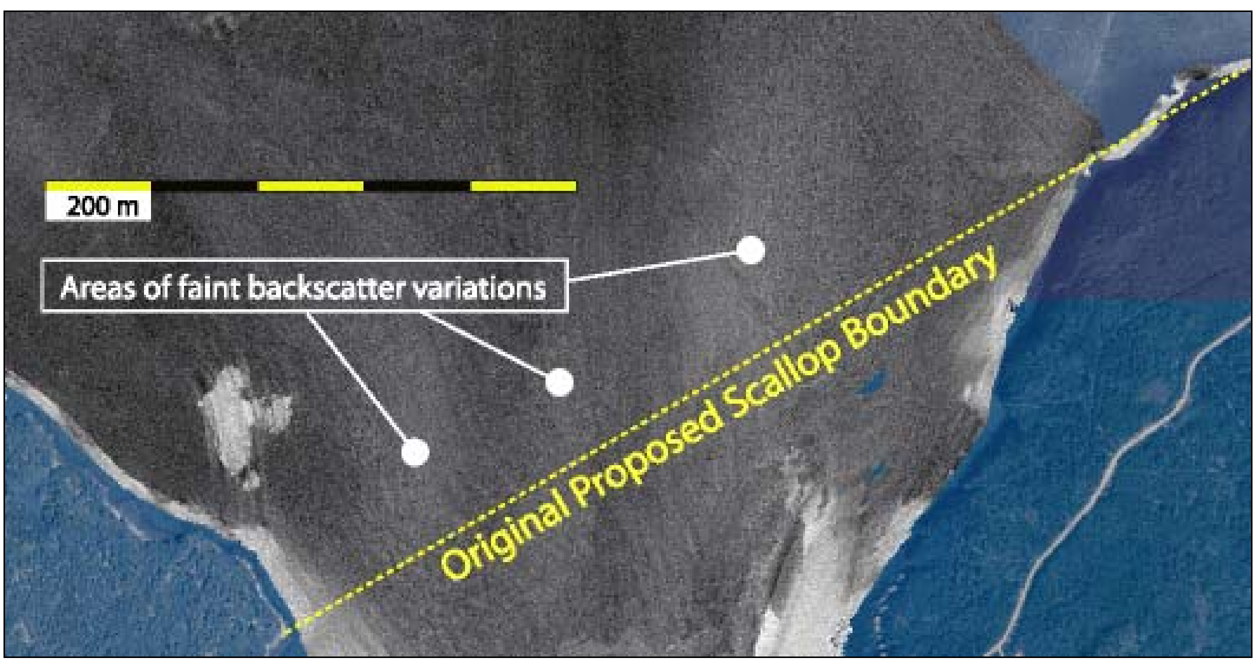


Figure 7: EM3000 backscatter of the scallop zone indicating subtle changes in the seabed sediment distribution (background orthophoto SNB).

Sidescan Results

For the area within the estuary (close to or above the low water mark), including the shallow inland river above Five Fathom Hole, the sidescan proved to be the platform of choice. Coastal approaches in waters of less than 2 metres were consistently surveyed with little difficulty. Although highly undesirable, the possibility of grounding on a rising tide did not present the same risk that it would with the *Plover*, housing a hull-mounted multibeam transducer.

Even though the prime study area was not completely surveyed with this platform it was deemed successful due to the coverage of other important boundary-related areas (i.e. high and low water, scallop zone boundary) and confirmation of the shallow-water capabilities of this system. An overview of the coverage obtained with the sidescan survey is illustrated in Figure 8.

Figure 8: Overview of sidescan coverage in the Musquash Estuary. Detail (a) exemplifies results showing subaerial channels developed on the intertidal mudflats in less than 2 metres of water. Detail (b) presents a low-tide aerial view of the same locale (background orthophoto SNB).

The sidescan data is primarily used for qualitative interpretation of sediment distribution and target detection. Unlike the EM3000 backscatter, the sidescan data has not been properly reduced for source level, beam patterns and receiver gain settings. Furthermore, problematic cable connectors resulted in local artificial attenuation of the signal. To compensate for this, sections of the survey, completed with different power or gain settings (which were held constant for each survey day) were empirically adjusted to minimise contrast. Using this method it is easy to pick out gross seabed change (outcrop to mud) across the entire intertidal zone.

The sidescan imagery was most notably corrupted by shallow oceanographic fronts. Abrupt zones of current shear, visible from the surface, showed up in the sidescan imagery as linear patterns of high backscatter, which of course don't correlate from line to line as the front is being continually advected. Figure 9 illustrates this effect.

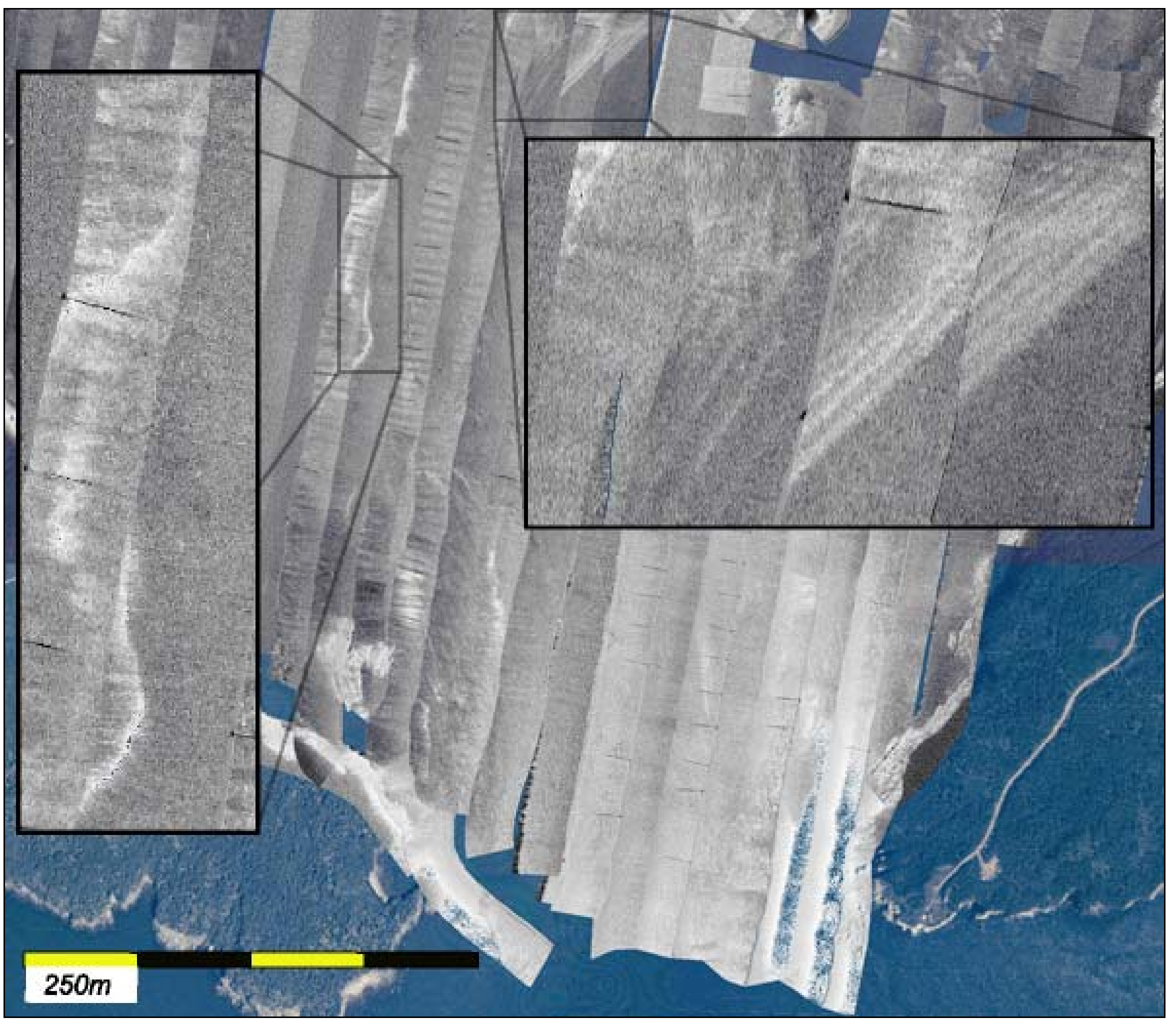


Figure 9: Two details of Knudsen sidescan data showing oceanographic fronts which appear in the image as linear striping of high backscatter (background orthophoto SNB).

The most useful value obtained from the sidescan imagery was the practical delimitation of the ordinary low water. This was achieved by noting the truncation of the intertidal mud flat channels. These were particularly well defined (see figure 8). As the EM3000 data could not practically be deployed above the low water mark, at this time the sidescan provides the most effective means of remotely characterising the intertidal mudflat sediment distribution.

Analysis of the sidescan data near the scallop zone reaffirms that of the EM3000 backscatter. Although no abrupt change was observed in the distributions of the surficial sediments, slight variations in the backscatter strength is evident in the data (see. Figure 10).

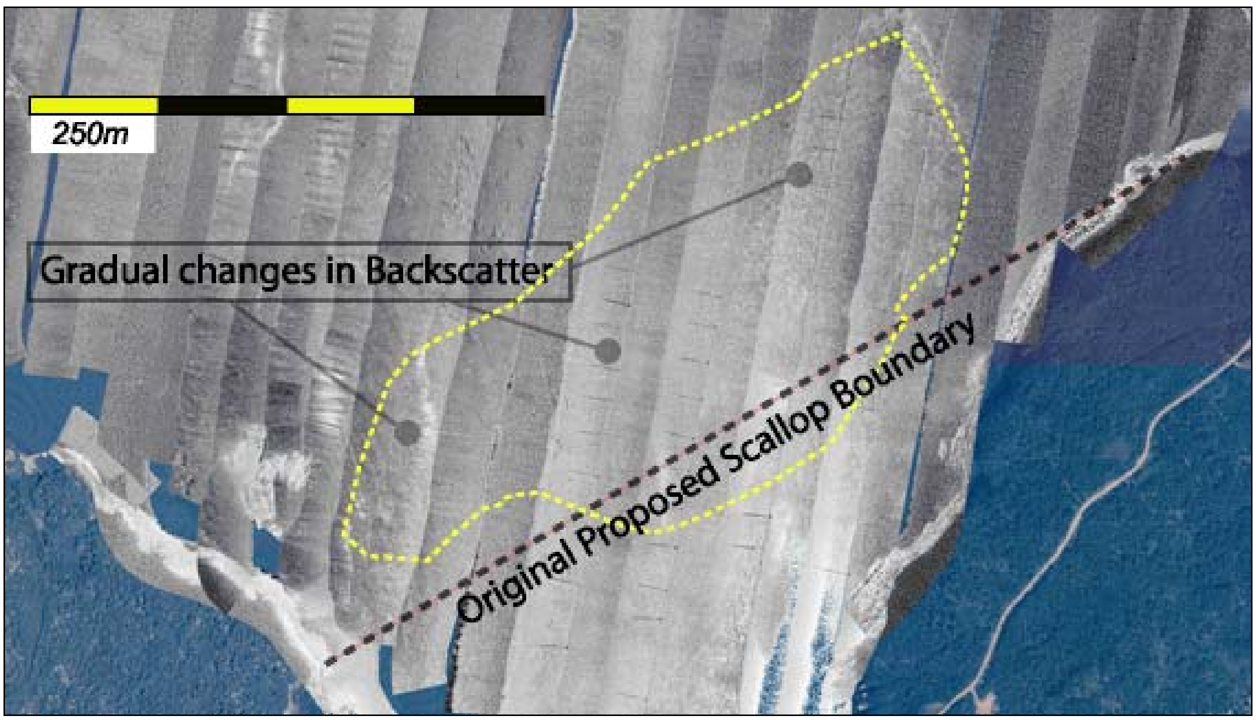


Figure 10: Detail of Knudsen sidescan data near the scallop zone boundary showing subtle changes in backscatter (background orthophoto SNB).

ADCP Results

From September 11-13, 2001 the west and central diamond patterns were successfully surveyed for the desired 12.5 hour tidal cycle. Although the east diamond was not completed, it is the authors' opinion that the two completed data sets still provide a fairly good indication of the tidal current patterns in the region.

Using software tools developed by the Ocean Mapping Group, it is possible to plot the ship's track with the instantaneous velocity and direction of the water column. Merging several consecutive circuits provides a time-series of the magnitude and direction of the currents for the surveyed area. This is best visualised with an animation thus the results will simply be described here.

The vertical sampling bin was user-defined and selected to be 0.5 metres, but the data can be represented as averaged vectors from all the bins from the seabed to the transducer. Aligning several surveys both spatially and temporally (aligning phase shift in tides) provides a visual image of the tidal currents. This work is currently in progress.

Based on work completed to date, we are able to infer that from the two completed full diamonds that it appears that water flows into the Musquash from the west as the tide rises, with the majority of the volume being directed to a channel on the east side of the narrows. Water is ejected from the estuary on the ebb tide and currents appear to flow south and back to the west. Although this survey alone cannot reaffirm the theory that waters from the ebb tide may be re-entering the bay on the subsequent flood tide, the currents that have been observed over the two tidal cycles indicate that it may be likely. Moreover, as residual flow in the Bay of Fundy is counter-clockwise and of a longer period, two days of ADCP surveying cannot fully represent the entire process. It seems apparent that the tidal interaction between the bay and Musquash Estuary is complex.

The ADCP surveys indicate that, within a single tidal cycle, the primary exchange of water between the estuary and the bay occurs preferentially from the region to the west of the mouth (flux in on the flood and flux out on the ebb). This observation is reinforced by the EM3000 backscatter data (Fig. 5) which clearly indicate an extension of the finer grained sediment lobe to the west. Thus in defining the practical bounds of the MPA it should be borne in mind that activity to the west of the mouth is more likely to influence the estuary (at least over a single tidal cycle). The proposed linear boundary, whilst defined for convenience, happens to include Gooseberry Cove and thereby is already asymmetric to the west.

DISCUSSION OF RESULTS

The assumption made in this research is that the placement of any boundary should reflect the goals of its establishment. This investigation has assumed that the placement of the outer boundary of the Musquash MPA should reflect the primary goal of the MPA – protection and long-term conservation of the protected area. The outer boundary placement should provide adequate jurisdictional means to facilitate the successful fulfilment of this goal. If the MPA was to be buffered adequately enough to isolate it from any potential *environmental* harm, then clearly the original straight line boundary is not sufficient. Potentially harmful oil spills, for example, can occur kilometres from the Musquash Estuary and still reach its waters. The sediment boundary illustrated in Figure 6 closely follows the extent of the estuary and deviates only slightly from the proposed straight line limit. The use of such a natural boundary to delimit the outer extent would prove equally as ineffective against environmental threats.

It is fortunate that the line of convenience happens to reasonably track a major change in surficial seabed type. Clearly an abrupt change in the seabed is occurring close to this region. Although investigations as part of this study have not been undertaken to look at benthic fauna, such a change in backscatter (most likely a shift from sand and mud to a deflated gravel pavement) is most likely to reflect a change in benthic habitat. The sharp boundary reflects the rapidly changing hydrodynamic regime at the estuary mouth, from coast normal to coast parallel current field, as indicated by the ADCP results.

To the mariner, the use of straight lines as limits are much easier to respect as they are generally more visible. From a management point-of-view, they also provide a much easier method of enforcement, both terrestrially and on the water. Delimiting the outer boundary of the Musquash using sediment distributions would entail tendering buoys to demarcate the (complicated) line and/or restricting any access or activities based upon GPS coordinate values. Although the change in sediment distributions at the mouth of the Musquash is clearly visible in the backscatter of the EM3000 data, it not clear whether delimiting the outer boundary based on this criterion would be the most appropriate solution. Furthermore, given the strong currents and potential for sediment transport in the area, this limit could possibly be in a constant state of fluctuation. This would imply an ambulatory boundary.

As with the outer boundary, the precise purpose of the external buffer zone should be well-established prior to any delimitation. Maximizing environmental protection of the estuary would require a different sized buffer than one that simply would be used to restrict fishing activity (for example). Additionally, one must consider the financial obligations to managing the MPA and enforcing any restrictions into its waters. Larger MPAs are simply more expensive to maintain.

The ADCP work that has been completed for this study provides an indication of the tidal processes for a period of only two tidal cycle. Although promising in the ability to quantify the oceanographic interaction between the Bay of Fundy and the Musquash Estuary, this work is not substantial enough to confidently propose an adequate boundary for an extended buffer zone.

CONCLUSIONS AND RECOMMENDATIONS

The outer extent of the harbour sediments has been geographically referenced through the interpretation of backscatter data. This limit deviates slightly from the original proposed straight line boundary. Little evidence exists for the establishment of an invisible, subsurface boundary if its primary purpose is to control access to the harbour and to restrict fishing activities in the area. Using sediment criteria to delimit this boundary would possibly be more of a hindrance than it would be appropriate. Delimitation of a subsurface boundary would need to be demarcated with buoys or GPS coordinates. Furthermore, an ambulatory sediment boundary could entail repeat surveys in the future to affirm the boundary location, leading to additional expenses.

The lack of a well-defined change in sediment distribution near the proposed scallop zone boundary merely fortifies the argument that a straight line boundary should also be used in for the delimitation of this special zone. Once more, ease of enforcement and definability, coupled with the extremely limited number of fishing boats that will be permitted access to the area, lead to this conclusion.

The ADCP work has affirmed the theory that the estuary's interaction with the Bay of Fundy is biased to the west side of the mouth. More detailed interpretation is not justified with the current data as the interaction is clearly complicated and needs to be more fully understood. If a protective marine buffer zone is to be placed at the entrance to the estuary, then a better understanding of the oceanographic processes in the area is needed for its establishment. A series of comprehensive and systematic ADCP surveys, conducted at different periods (spring and neap tides, e.g.: freshet and mid-summer conditions) would be a means to increase this understanding. Numerical modelling, using boundary constraints based upon the results of these surveys, would aid in visualizing the tidal interaction between the estuary and the Bay of Fundy over a extended period of time, thereby facilitating a more informed management decision for any potential buffer zone establishment.

Based upon this research and related background investigations it is recommended that a straight line boundary be established on both the outer limit of the estuary and the scallop zone that would delimit these areas within which the primary restrictions of the MPA would be enforced. These limitations could involve restricted fishing rights or other constraints that would be seen as appropriate by DFO and the Friends of Musquash working committee. Ease of enforcement and its visibility to mariners, coupled with the lack of grounds for subsurface delimitation lead to this recommendation. The original proposed boundary (Figure 6, solid yellow line) would be practical due to the accessibility to the lighthouse via a road, permitting easier terrestrial enforcement. No other point on the east side of the harbour provides such access.

Upon the establishment of the outer boundary as a straight line, the implementation of an appropriate buffer zone should be seriously considered. This zone would be less stringent in terms of the restricted activities relative to the primary MPA zone, but still constrain potentially harmful traffic and activities. More discussion and investigation pertaining to the nature of such activities and the extent and delimitation of this buffer zone should only be made upon the completion of more systematic oceanographic studies of the area.

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