Atlantic Climate Adaptation Solutions Association
Solutions d'adaptation aux changements climatiques pour l'Atlantique

Nova Scotia Department of Agriculture - Marshlands Atlas
Cumberland, Kings & Hants County

By
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Report prepared by: Dr. Danika van Proosdij and Barbara Pietersma-Perrott from the Department of Geography and Maritime Spatial Analysis Research Centre at Saint Mary's University and commissioned by the Atlantic Climate Solutions Association (ACASA), a non-profit organization formed to coordinate project management and planning for climate change adaptation initiatives in Nova Scotia, New Brunswick, Prince Edward Island and Newfoundland and Labrador and supported through the Regional Adaptation Collaborative, a joint undertaking between the Atlantic Provinces, Natural Resources Canada and regional municipalities and other partners.

Project Management: Resource Stewardship Land Protection, Nova Scotia Department of Agriculture

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Maritime Provinces Spatial Analysis Research Centre (MP_SpARC)

Saint Mary's University

Applied Geomatics Research Group (AGRG)

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Acronyms

MMRA	Maritime Marshlands Rehabilitation Administration
NSDA	Nova Scotia Department of Agriculture
SMU	Saint Mary's University
NSGC	Nova Scotia Geomatics Centre

Introduction

As part of the Nova Scotia Department of Agriculture's (NSDA) commitment to the Climate Change Action Plan, the NSDA undertook a project to create an updated inventory of the dykes and flood control structures it maintains around the Bay of Fundy, specifically around the Cumberland Basin and the Southern Bight of the Minas Basin (See figure 1). As part of NSDA's commitment SMU was contracted to create a GIS product to depict historic and current day dyke and flood control structures.

Historically the dykes around the Bay of Fundy were constructed for the purpose of protecting agricultural lands. After WWII the Federal Government created an organization called the Maritime Marshlands Rehabilitation Administration (MMRA) which used modern construction techniques to reconstruct existing or recently breached dykes. At the same time each approved marsh was incorporated and the marsh boundaries were drawn onto plans. The introduction of historical maps and data into the GIS environment is advantageous, as it not only preserves such information, but also enables the enhancement of current data. Moreover, it permits the opportunity for comparative analysis of both spatial and temporal data and their associated attributes.

To introduce historical maps into the GIS environment, forty-two hand drawn historical marsh plans of the Hants, Kings and Cumberland County area were digitally scanned and georeferenced. A number of vector features of these historical marsh surveys were digitized including: dykes, aboiteaux, inner dykes, old dykes, ditches, creeks, dyke right of way, shoreline protection, toe of marsh, ditch elevations, marsh elevations and property boundaries. As well, present day vector data such as building footprints, property boundaries and surveyed features such as dyke center lines and aboiteaux were added to the GIS. Lidar data, satellite imagery and aerial photography were also added.

The resulting product is a forty-two map atlas of the marshland and dyke structures of Hants, Kings and Cumberland County. The atlas has become a valuable resource for the NSDA as the data is digital and can therefore be searched and queried. For example a map user can easily determine the length of a dyke, its height, the aboiteaux along the dyke and protection in front of the dyke. The current survey data can be used to determine areas along a dyke which are vulnerable to overtopping and in turn management decisions regarding dyke construction and maintenance can be made.

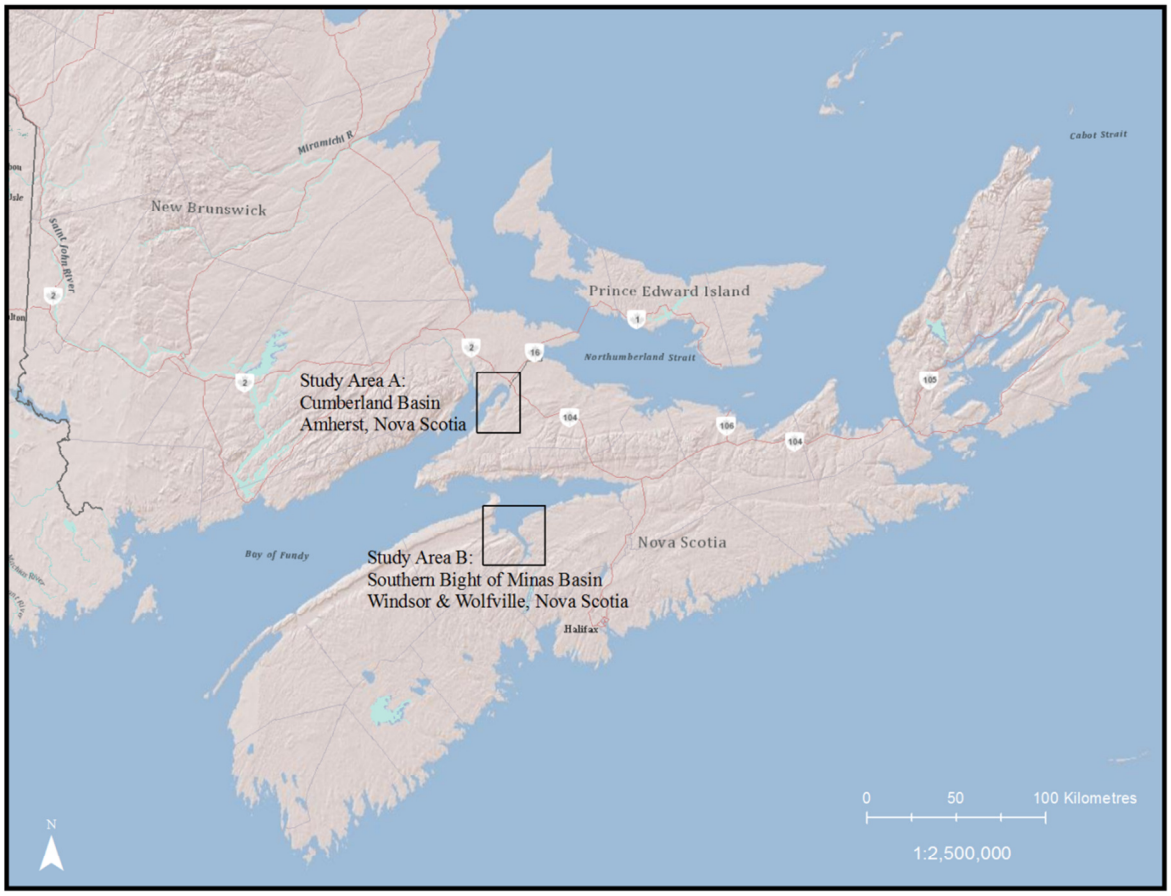


Figure 1: Study Area

Rationale and Objectives

This project represents an opportunity to add value through the RAC project, improving the understanding of the body of knowledge regarding the infrastructure and land assets being protected by the dykes. This project also provides baseline data on current and potential critical dyke elevations. This will support the NSDA's planning and maintenance objectives for coastal protection and will also provide critical data that can be used for risk and vulnerability assessments on climate change to be done under the Atlantic Climate Adaptation Solutions project. The data on current critical dyke elevations will also provide an opportunity to model future flood events. The project also addresses a current knowledge gap (incomplete and inaccurate data) presented by a paper based dyke mapping system.

The following deliverables and outcomes have resulted from this project:

A user-friendly, digital cartographic product (in ArcReader 10) that includes the following information:

- Geo-referenced Historic MMRA marsh plans;
- Digitized historic dykes, aboiteaux, inner dykes, old dykes, ditches, creeks, dyke right of way, shoreline protection, toe of marsh, ditch elevations, marsh elevations and property boundaries;
- Present day vector data such as roads, building footprints, property boundaries;
    - All identified infrastructure that falls within the boundaries of the incorporated marsh (buildings, roads etc. and are either under the mandate of the Agricultural Marshland Conservation Act or local Municipalities with respect to development)
    - Infrastructure that is outside of the incorporated marsh, but is influenced by fresh or salt water flooding of the marsh (relative to top of dyke elevation).
- Updated surveyed features such as dyke center line elevations and aboiteaux elevations and dimensions;
- Lidar data, satellite imagery and aerial photography.

Methodology and Approach

Task 1: Retrieving and scanning historical maps

- Maps were collected and digitally scanned using large format digital scanners. It was determined that the surveys could be scanned at a resolution of 400dpi without risking substantial loss in legibility. Furthermore, it was concluded that the documents were equally legible in both grayscale and colour. Thus given that the file sizes would be more manageable, greyscale format was chosen.

Task 2: Digital Manipulation

- Scanned maps were brought into an image manipulation software package (Adobe Photoshop CS2) and subsequently renamed and rotated so that all images were right reading.

Task 3: Geo-referencing

- The renamed maps were brought into the ArcGIS environment where they underwent geo-referencing. The scans were geo-referenced using planimetric data such as roads and water features as well as surveyed dyke and aboiteaux data provided by the NSDA, and lidar data and satellite imagery. This data was used to guarantee that the scans were geo-referenced as precisely as possible. The *marline* shapefile provided by the NSDA was also used as a reference to ensure accuracy of the rectifications. This shapefile closely resembled the outer extents of the marsh boundaries and offered less confusion than other planimetric data.

Task 4: Digitization of Historic Features

- New empty shapefiles were created for digitization and population of associated attribute table data. See Appendix B for an account of the shapefiles.
- It is pertinent to understand the numerous symbols and abbreviations found on the surveys. Thus, an original copy of the survey legend was found and employed as a means to decipher some of the data on the scans. Appendix C provides a recreated version of the legend.
- For the purpose of the project, elevation data was deemed as one of the most important features to digitize. Thus along with the dyke and aboiteaux locations, marsh and channel/ditch heights were recorded.

Task 5: Sourcing Present Day Data

- **Current Aboiteaux** – survey data was supplied by Darrell Hingley and additional data relating to aboiteaux dimensions, construction etc. was provided by Ken Carroll both of the NSDA. See Appendix D for metadata relating to this shapefile.
- **Current Dykes** – survey data was also supplied by Darrell Hingley, NSDA. Additional data relating to construction and critical elevation was added by Ken Carroll, NSDA and data

relating to Sea Level Rise was added by SMU. See Appendix E for metadata relating to this shapefile.

- **Property Boundaries** - supplied by the Nova Scotia Geomatic Centre. It includes data from the Nova Scotia Property Records Database.
- **Building Footprints** - supplied by the Nova Scotia Geomatic Centre (NSGC). Although the NSGC does not guarantee its accuracy, the data is more detailed than the 1:10,000 building polygon data.
- **1:10,000 basedata** - Nova Scotia Geomatics Centre (Data Locator). The NSRN (Road Network) and NSHN (Hydrographic Network) shapefiles were used.
- **Variances** - This data was originally supplied by Hank Kolstee, NSDA with updates since 2003 supplied by John McCabe, NSDA.
- **HHWLT** – This data was supplied by undergraduate student Brittany MacIssac as part of her project "Modification of Marshland Boundaries to Incorporate Climate Change for Hants County, Nova Scotia"
- **Recommended Marsh Boundary** - This data was supplied by undergraduate student Brittany MacIssac as part of her project "Modification of Marshland Boundaries to Incorporate Climate Change for Hants County, Nova Scotia"

Task 6: Layout and Design of Atlas

- Discussions with NSDA staff led to the development of a layout and design that was suitable to the needs of the department.

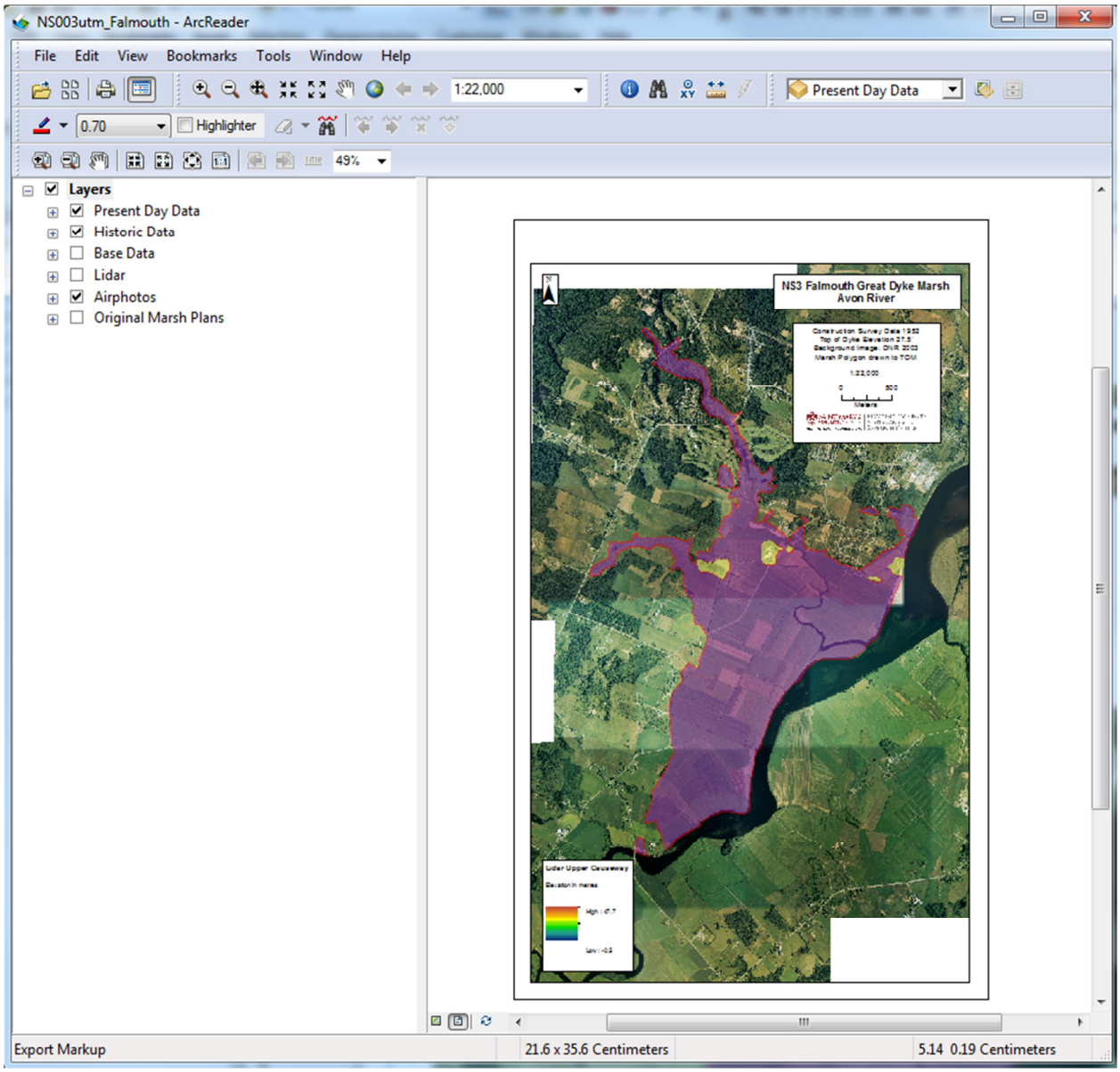


Figure 2: Atlas Layout & Design

Task 7: Training

- A two hour training session to NSDA staff on the use of the Marshlands Atlas and related software, ArcReader 10 was presented in early March 2012. Staff were also provided a seven page handout to assist with troubleshooting and use of Atlas (See Appendix F)

General Discussion

The Marshlands Atlas has become a valuable tool for staff of the NSDA, specifically for Aboiteau Superintendents who are responsible for the day-to-day management of the dyke and aboiteau structures. For example they have used the Atlas to plan the placement of rock protection along dykes and foreshore areas. Within a GIS they are quickly able to show contractors where rock should be placed and they can plan the safest route using the road data included in the Atlas. With ArcReader's measurement tools they can also estimate the length and area of protection required. Employees are also able to query property data and determine ownership of properties that fall under the mandate of the Agricultural Marshland Conservation Act; this becomes important for potential development projects happening in these sensitive areas. With the addition of lidar data, employees can click on a point and instantly know the associated elevation of that point. Dykes have also been symbolized using critical and construction elevations supplied by the NSDA and therefore employees can quickly determine where dykes may be in need of repair and potentially vulnerable to storm events. This project has also begun to address the current knowledge gap (incomplete and inaccurate data) presented by a paper based dyke mapping system. Employees now have access to pertinent data needed to make informed management decisions.

Conclusions and Recommendations

As a tool for climate change adaptation the Marshlands Atlas provides important data on current and potential critical dyke elevations as well as information about the dimensions of aboiteaux, these data are crucial for modelling future flood events. The Atlas also supports NSDA's planning and maintenance objectives for coastal protection and provides critical data that can be used for risk and vulnerability assessments on climate change.

General recommendations to improve Marshlands Atlas:

- Consider migrating data into a file geodatabase to better manage all data types relating to the Atlas. As an example the historic data is organized by county with shape files for each feature (12 shape files per county), which makes for a lot of shape files. It may be more efficient to combine all the data for the province.
- Each marsh has a separate map document which requires many updates, it may be more efficient to have only one map document for the Province thus requiring only one update if data changes.
- Consider developing a Web Mapping Service to serve maps online. Currently the Atlas is distributed to employees on external hard drives which is cumbersome. Using an online service would allow data to be distributed more quickly, especially when data or maps are updated or changed. The Minerals Branch of the NS Department of Natural Resources http://www.gov.ns.ca/natr/meb/pubs/pubs3.asp has some good examples.
- Consider developing a department wide GIS strategy that integrates GIS data collected by surveyors and aboiteau superintendents in a consistent way and as part of common GIS infrastructure.

References

MacIsaac, Brittany. 2011: Modification of Marshland Boundaries to Incorporate Climate Change for Hants County, NS. Saint Mary's University, 24p. (Student Project)

Van Proosdij, D. and Pietersma-Perrott, B. 2011: Shore Zone Characterization for Climate Change Adaptation in the Bay of Fundy. Saint Mary's University, 33p. http://atlanticadaptation.ca/

List of Tables and Figures

Appendices

Appendix A: Data Submission to the Atlantic Adaptations Solutions Association

Saint Mary's University – Dept. of Geography
NSDA Marshlands Atlas: Kings, Hants and Cumberland County
January 11, 2012

Final Product Data Paths

This document is to support and detail the filing system of the final submission.
All data provided is in NAD 1983 UTM Zone 20N unless otherwise stated.
Please see shapefile metadata for definitions of all attributes.

H:\Marshlands_Atlas\ . . .

README_Data_paths.pdf – this document

Executive Summary.pdf – one page summary of the project along with location maps of marshes.

Master_Report_NSDA.pdf - Full report describing the project.

H:\Marshlands_Atlas\Hants, Kings or Cumberland . . .

Hants_co_Atlas.pdf – PDF version of maps.

Legend_hants.pdf – Legend to accompany individual maps when printing.

NS###utm_marshname.pmf – ArcReader 10 document of each map.

***Completed_MXD* -** Contains the completed MXD file for each marsh.

Project_Files

Digitized_shps - Contains shapefiles of digitized marsh features as well as one shapefile supplied by the NS Department of Agriculture (variances.shp). **Please see the shapefile's metadata for definitions of all attributes.**

Layer_files - contains layer files used to symbolize digitized features.

Marpoly_utm – contains original marsh polygon shapefiles with appropriate transformations applied, supplied by the NS Department of Agriculture.

***Rect_Scans* -** Rectified scans with .txt files

H:\Marshlands_Atlas\Data . . .

\ACAS_data – contains a geodatabase of all data collected for the ACAS "Shore Zone Characterization for Climate Change Adaptation in the Bay of Fundy" project, including aboiteau and dyke structures used in the Marshlands Atlas.

\Basedata - Contains 1:10,000 base data from the Nova Scotia Geomatics Centre (Data Locator).

\Darrell_data - Survey data for aboiteaux and dyke centre lines provided by Darrell Hingley, NS Department of Agriculture.

\Juan_Imagery - Hurricane Juan Aerial Photography (2004) http://www.gov.ns.ca/natr/forestry/GIS/

\Lidar_reclass - 2m resolution lidar clipped to an 11m elevation (1m above highest dyke in Nova Scotia). Original Lidar(April 2007) provided by the Applied Geomatics Research Group (AGRG).

\Logo - MP_Sparc logo

\Mosaics - Airphoto mosaics of the Cornwallis (2002) and Avon River (2003), original aerial photographs provided by the NS Department of Natural Resources and Nova Scotia Geomatics Centre.

\Nova Scotia Satellite Imagery - Quickbird (2008, 2009) and Worldview (2009) images of Cumberland County and the Cornwallis River.

\NSGC_Data - Building footprints and the Property Records Database for Nova Scotia (Jan 2011), provided by the Nova Scotia Geomatics Centre.

\Orig_Marsh_ShpFiles - Original marsh polygons provided by the NS Department of Agriculture's – Land Protection, all shapefiles are in ATS 77.

\Rec_Boundaries - This data was supplied by undergraduate student Brittany MacIssac as part of her project "Modification of Marshland Boundaries to Incorporate Climate Change for Hants County, Nova Scotia"

Appendix B: Shapefiles for Historic Features

To digitize dykes.shp:

Dykes – Line Feature (Filename: dykes.shp)		
Field	Type	Source of Data
Elev_ft	Double	Located on survey (usually lower right hand side)
Elev_m	Double	Calculated using field calculator (Elev_ft * 0.3048)
Tract_no	Short Integer	Survey or sketch map used in NSDA interview
NSDA_no	String	Found on title block of scanned survey
Length_m	Double	Calculated using *Calculate Geometry*. Can also be cross referenced with measurements written adjacent to dyke ends on surveys.
River	String	Usually found written on survey, otherwise use marsh locator maps.
Const_date	Short Integer	Found in Construction Survey Data title block on lower left side of survey.
Prelim_sur	Short Integer	Found in Preliminary Survey Data title block on lower left side of survey.

1. Start an edit session;
2. Ensure that the target found on the editing toolbar is set to the appropriate shapefile;
3. Click on the *sketch* tool;
4. Find the start point of the centreline of the dyke illustrated in one of the scanned images;
5. Click along the centreline of the dyke following the curves until the endpoint;
6. Right click and select *finish sketch;*
7. Open the attributes of the shape file by right clicking on the shape file in the table of contents and *Open Attribute Table*;
8. Right click on the length_m field and choose Calculate Geometry to calculate length in metres;
9. After all dykes and their corresponding measurements for the particular marsh scan are complete, the remaining fields may be calculated by opening the attribute table and using the *Field Calculator* if attributes are the same. This may be done by selecting all of the lines, opening the associated attribute table and ensuring that only the selected features are visible.

Marsh_Heights - Point Feature (Filename: marsh_heights.shp)		
Field	**Type**	**Source of Data**

River	String	Usually found written on survey, otherwise use marsh locator maps.
Elev_ft	Double	Found on survey. Typically a double digit number rounded to the first decimal. Often accompanied with a point (pencil mark). (Refer to symbols in appendix)
Elev_m	Double	Calculated using field calculator (Elev_ft * 0.3048)
Surv_date	Short integer	Found in Construction Survey Data title block on lower left side of survey.
NSDA_no	String	Found on title block of scanned survey.

To digitize marsh_heights.shp:

1. Start an edit session;
2. Ensure that the target found on the editing toolbar is set to the appropriate shapefile;
3. Click on the *sketch* tool;
4. Find a marsh height illustrated in one of the scanned images;
5. Click on the point;
6. Open the attributes of the shape file by right clicking on the shape file in the table of contents and *Open Attribute Table*;
7. Click in the box which records marsh elevation (elev_ft);
8. Enter the associated elevation;
9. After all marsh heights and their corresponding measurements for the particular marsh scan are complete, the remaining fields may be calculated by opening the attribute table and using the *Field Calculator* if the attributes are the same. This may be done by selecting all of the points, opening the associated attribute table and ensuring that only the selected features are visible.

Ditch_Heights - Point Feature (Filename: ditch_heights.shp)		
Field	**Type**	**Source of Data**
Elev_ft	Double	Found on survey. Typically a single digit number rounded to the first decimal. Accompanied with a letter 'c' and a dash. (Refer to symbols in appendix)
Elev_m	Double	Calculated using field calculator (Elev_ft * 0.3048)
Ditch_name	Double	Randomly marked along some ditches
NSDA_no	String	Found on title block of scanned survey.
River	String	Usually found written on survey, otherwise use marsh locator maps.
Tract_no	Short Integer	Survey or sketch map used in NSDA interview.
Const_date	Short integer	Found in Construction Survey Data title block on lower left side of survey.

To digitize ditch_heights.shp:

1. Start an edit session;
2. Ensure that the target found on the editing toolbar is set to the appropriate shape file;
3. Click on the *sketch* tool;
4. Find a ditch height illustrated in one of the scanned images by locating an elevation accompanied by the letter 'c';
5. Click on the point;
6. Open the attributes of the shape file by right clicking on the shape file in the table of contents and *Open Attribute Table*;
7. Click in the box which records ditch elevation (elev_ft);
8. Enter the associated elevation;
9. After all ditch heights and their corresponding measurements for the particular marsh scan are complete, the remaining fields may be calculated by opening the attribute table and using the *Field Calculator* if the attributes are the same. This may be done by selecting all of the points, opening the associated attribute table and ensuring that only the selected features are visible.

Ditch_lines - Line Feature (Filename: ditch_lines.shp)		
Field	**Type**	**Source of Data**
NSDA_no	String	Found on title block of scanned survey.
River	String	Usually found written on survey, otherwise use marsh locator maps.
Tract_no	Short Integer	Survey or sketch map used in NSDA interview
Const_date	Short Integer	Found along ditch line with the letter 'D'
Ditch_name	String	Randomly marked along some ditches
Prelim_sur	String	Found in Preliminary Survey Data title block on lower left side of survey.

To digitize ditch_lines.shp:

1. Start an edit session;
2. Ensure that the target found on the editing toolbar is set to the appropriate shape file;
3. Click on the *sketch* tool;
4. Find a ditch line illustrated in one of the scanned images. The line may or may not include associated ditch heights. Moreover, the ditch line may appear as a natural channel or manmade with associated arrows indicating the direction of flow;
5. Ensure that the snapping to ditch heights option is turned on by selecting within the editor toolbar;
6. Click along the line, snapping to any associated ditch elevations;
7. Right click and finish sketch;
8. If there are various tracts within the marsh, record the tract number connected with the ditch;
9. After all ditch lines and their corresponding measurements for the particular marsh scan are complete, the remaining fields may be calculated by opening the attribute table and using the *Field Calculator* , if the attributes are the same. This may be done by selecting all of the points, opening the associated attribute table and ensuring that only the selected features are visible.

Old_dyke - Line Feature (Filename: old_dyke.shp)		
Field	**Type**	**Source of Data**
NSDA_no	String	Found on title block of scanned survey.
River	String	Usually found written on survey, otherwise use marsh locator maps.
Length_m	Double	Calculated using *Calculate Geometry*.

To digitize old_dyke.shp:

1. Start an edit session;
2. Ensure that the target found on the editing toolbar is set to the appropriate shapefile;
3. Click on the *sketch* tool;
4. Find the start point of the old dyke illustrated in one of the scanned images;
5. Click along the line until an endpoint;
6. Right click and select finish sketch;
7. Open the attributes of the shape file by right clicking on the shape file in the table of contents and *Open Attribute Table*;
8. Right click on the length_m field and choose Calculate Geometry to calculate length in metres;
9. After all old dyke lines and their corresponding measurements for the particular marsh scan are complete; the remaining fields may be calculated by opening the attribute table and using the *Field Calculator, if the attributes are the same.* This may be done by selecting all of the points, opening the associated attribute table and ensuring that only the selected features are visible.

Inner_dyke - Line Feature (Filename: inner_dyke.shp)		
Field	**Type**	**Source of Data**
NSDA_no	String	Found on title block of scanned survey.
River	String	Usually found written on survey, otherwise use marsh locator maps.
Length_m	Double	Calculated using *Calculate Geometry*.

To digitize inner_dyke.shp:

1. Start an edit session;
2. Ensure that the target found on the editing toolbar is set to the appropriate shape file;
3. Click on the *sketch* tool;
4. Find the start point of the inner dyke illustrated in one of the scanned images;
5. Click along the line until an endpoint;
6. Right click and select finish sketch;
7. Open the attributes of the shape file by right clicking on the shape file in the table of contents and *Open Attribute Table*;
8. Right click on the length_m field and choose Calculate Geometry to calculate length in metres;
9. After all inner dyke lines and their corresponding measurements for the particular marsh scan are complete; the remaining fields may be calculated by opening the attribute table and using the *Field Calculator*, if attributes are the same. This may be done by selecting all of the points, opening the associated attribute table and ensuring that only the selected features are visible.

aboiteaus - Point Feature (Filename: aboiteaus.shp)		
Field	**Type**	**Source of Data**
NSDA_no	String	Found on title block of scanned survey.
Tract_no	Short Integer	Survey or sketch map used in NSDA interview
River	String	Usually found written on survey, otherwise use marsh locator maps.
Orig_const	Short Integer	Found on sluice information table on survey.
Ori_len_ft	Double	Found on sluice information table on survey.
Ori_w_in	Double	Found on sluice information table on survey. Changed measurement to inches
Ori_h_in	Double	Found on sluice information table on survey. Changed measurement to inches
Ori_dia_in	Double	Found on sluice information table on survey.
Aboite_no	String	Found next to illustration of aboiteau on scanned survey.
Out_elevft	Double	Found on sluice information table on survey.
In_elevft	Double	Found on sluice information table on survey.

To digitize aboiteau.shp:

1. Start an edit session;
2. Ensure that the target found on the editing toolbar is set to the appropriate shape file;
3. Click on the *sketch* tool;
4. Find an aboiteax feature illustrated in one of the scanned images;
5. Click on the point;
6. Using the associated data found on either the Aboiteax Update provided by Ken Carroll or the sluice information table on the survey, enter the corresponding fields.

Protection - Line Feature (Filename: protection.shp)		
Field	**Type**	**Source of Data**
NSDA_no	String	Found on title block of scanned survey.
River	String	Usually found written on survey, otherwise use marsh locator maps.
Date_Prot	Short Integer	Usually found written on survey adjacent to protected area, otherwise unknown.
Material	String	Found on survey adjacent to protected area.
Type	String	Same as Material field however only records the acronyms RF, BP, PF etc for symbolization purposes.

To digitize protection.shp:

1. Start an edit session;
2. Ensure that the target found on the editing toolbar is set to the appropriate shape file;
3. Click on the *sketch* tool;
4. Find the start point of the protection line illustrated in one of the scanned images;
5. Click along the line until an endpoint;
6. Enter the associated attributes, including the date of protection and the material used for protection
7. After the date of protection, and material attributes are added, the river name and NSDA number can be calculated in the attribute table using *Field Calculator.* This may be done by selecting all of the desired protection lines, opening the associated attribute table and ensuring that only the selected features are visible.

Toe of Marsh – Line Feature (Filename: toe_marsh.shp)		
Field	**Type**	**Source of Data**
NSDA_no	Text	Found on title block of scanned survey.

See "Appendix B: Symbols Found within Historical Scans for a description and depiction of the toe of marsh.

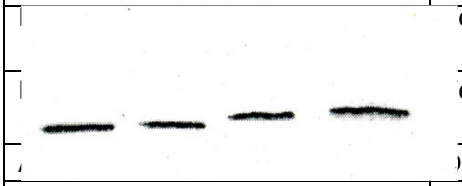
Right Of Way – Line Feature (Filename: rightofway.shp)		
Field	**Type**	**Source of Data**
Elev_ft	Double	Same as Dykes.shp
Elev_m	Double	Same as Dykes.shp
Tract_no	Short Integer	Same as Dykes.shp
Length_m	Double	Same as Dykes.shp
River	Text	Same as Dykes.shp
NSDA_no	Text	Same as Dykes.shp
Const_date	Short Integer	Same as Dykes.shp
Prelim_sur	Short Integer	Same as Dykes.shp
Rightway_f	Double	Usually found between the two right of way lines between the Dykes and indicated with arrows.

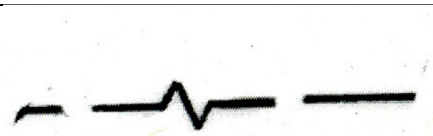
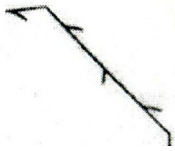
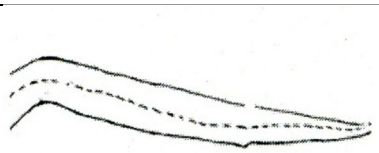
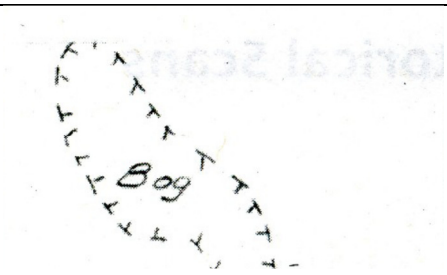
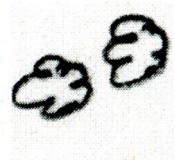
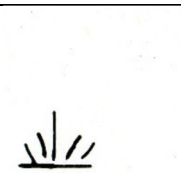
To digitize rightofway.shp

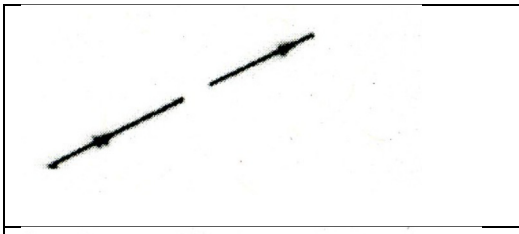
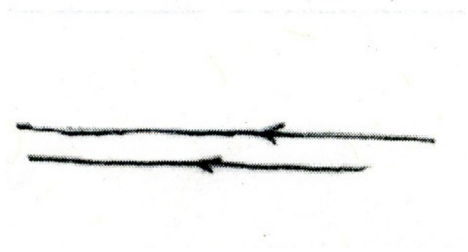
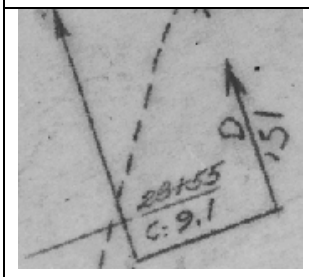
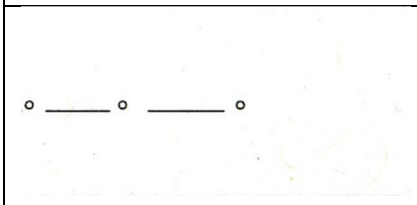
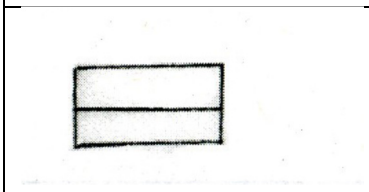
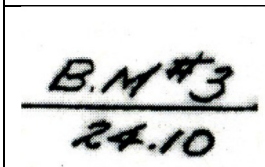
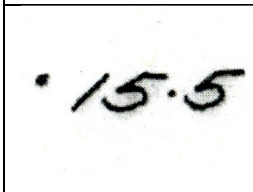
The Right of Way shape file is a copy of Dykes.shp with the "rightway_f" field added. Using the Editor Tool Bar in ArcMap, the dyke centre lines are duplicated and then copied parallel (twice) by the number of feet of the right of way, and original centre lines deleted, then the right of way in feet was noted in the "Rightway_f" field.

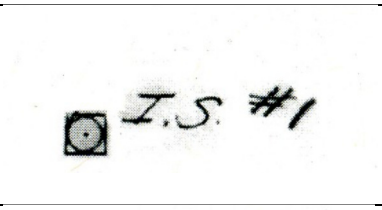
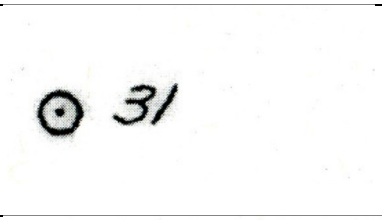
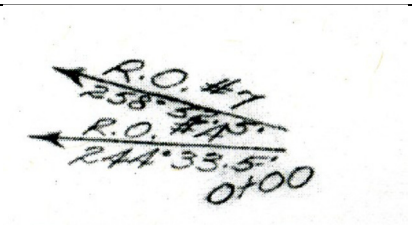
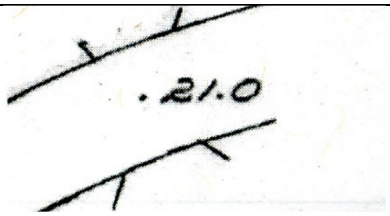
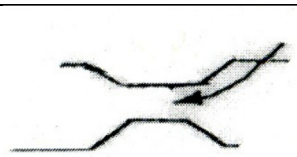
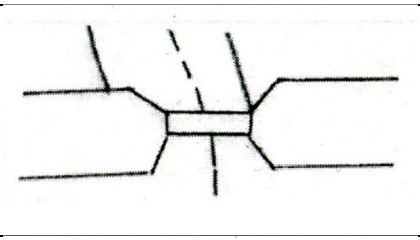
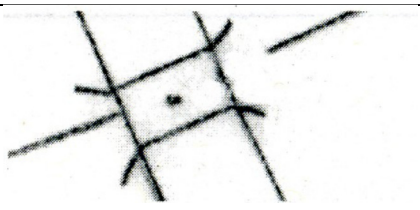
Appendix C: Symbols Found on Historical Scans

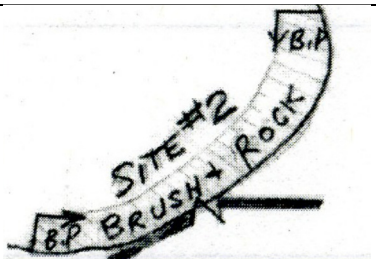
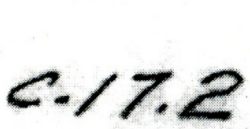
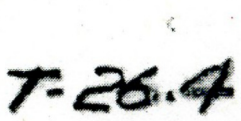
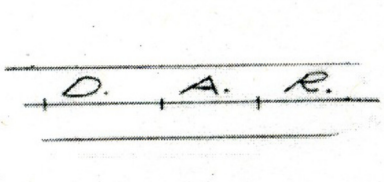
Property – Polygon Feature (Filename: property.shp)			
Field	**Type**		**Source of Data**
	ext	Protecting Dyke	Found on title block of scanned survey.
	ext		Found within the property boundaries of each property
	ouble		Calculated Geometry
Origin_own	Text		Usually found in surround as a chart.
Area_acres	Double		Calculated Geometry
Tract_no	Short_int		Survey or sketch used in NSDA interview
Acres_plan			Usually found in surround as a chart. Acres to H.W. line only.

Symbol	Description	Comments
	Protecting Dyke	Digitize as old dyke.

	Old or Broken Dyke	
	Inner Dyke	
	Boundary line	For example a property boundary.
	Creek	
	Bog	
	Upland area	
	Marsh	
	High Water Line (HWL) or Toe of Marsh	

	Drainage Ditch	If the line is solid it acts as a property line, see below.
	Drainage Ditch and property line	
	Shows that ditch was constructed in 1951	
	Fence line	
	Building	
	Benchmark and elevation value	
	Spot Elevation (general)	

	Iron Stake (boundary post)	
	Transit Station	
	Reference Bearings	
	Culvert	
	Culvert	
	Bridge	
	Bridge	

	Brush face – stream control and rocking	Digitized as protection.
	Aboiteau (generally assigned a number)	
	Elevation of bottom of creek	
	Elevation of top of dyke	
	Dominion Atlantic Railway	
Ac.	Acres	
Rt. of way	New Dyke and Right of Way	
B.P.	Bank Protection	
E.C.	End of curve	
B.C.	Beginning of curve	
S.L.	Sluice information and dimensions	
Armco gate	Type of gate (other types: stainless steel ,Robb, Waterman)	
Flaired inlet	Flair inside aboiteau to increase	

	capacity	
Grouted	Between pipes and old aboiteau (square vs. round)	
Transit Bks.	Transit Books for surveying	
Level Bks.	Level Books for elevation	
T.B.M.	Temporary Benchmark	

Appendix D: Current Aboiteau Metadata

Field	Type	Source of data/Definition
NSDA_no	String	Marsh number the Nova Scotia Department of Agriculture (NSDA) uses to identify its marshes/dykes.
tract_no	SmallInteger	Tract number.
aboite_no	String	Aboiteau number the NSDA uses to identify its aboiteaux.
const_date	Small Integer	Construction date.
abt_mat	String	Aboiteau material.
length	Double	length in feet.
size	Double	size of pipe in inches.
size_w	Double	Width of pipe. This field is used if the pipe is square and has a width and a height. Measurements are in inches.
size_h	Double	Height of pipe. This field is used if the pipe is square and has a width and a height. Measurements are in inches.
size_ins	Double	Inside dimension of pipe in inches.
size_ins_w	Double	Inside width of pipe. This field is used if the pipe is square and has a width and a height. Measurements are in inches.
size_ins_h	Small Integer	Inside height of pipe.This field is used if the pipe is square and has a width and a height. Measurements are in inches.
barrels	Small Integer	Number of barrels.
barrel_typ	String	Barrel type, whether it's square or circular.
barrel_ori	String	If an aboiteau has more than 1 barrel, this field identifies if the barrels are horizontal (laying side by side) or vertical (laying one on top of the other)
gate_size	Double	Size of gate in inches.
gate_siz_w	Double	Width of gate. This field is used if the gate is square and has a width and a height. Measurements are in inches.
gate_siz_h	Double	Height of gate. This field is used if the gate is square and has a width and a height. Measurements are in inches.
gate_type	String	Gate type.
invert_in	Double	Invert elevation inside, represented in feet.
invert_out	Double	Invert elevation outside, represented in feet.
flared	String	Indicates whether the aboiteau is flared or not, with a yes or no.
comments	String	Comments
PointId	Double	Original field from survey data
Northing	Double	Original field from survey data
Easting	Double	Original field from survey data
OrthHeight	Double	Original field from survey data, values are in metres
Code	String	Original field from survey data
Attributes	String	Original field from survey data
photo	Raster	Geo-tagged photos taken as part of the ACAS Shorezone Characterization Project.

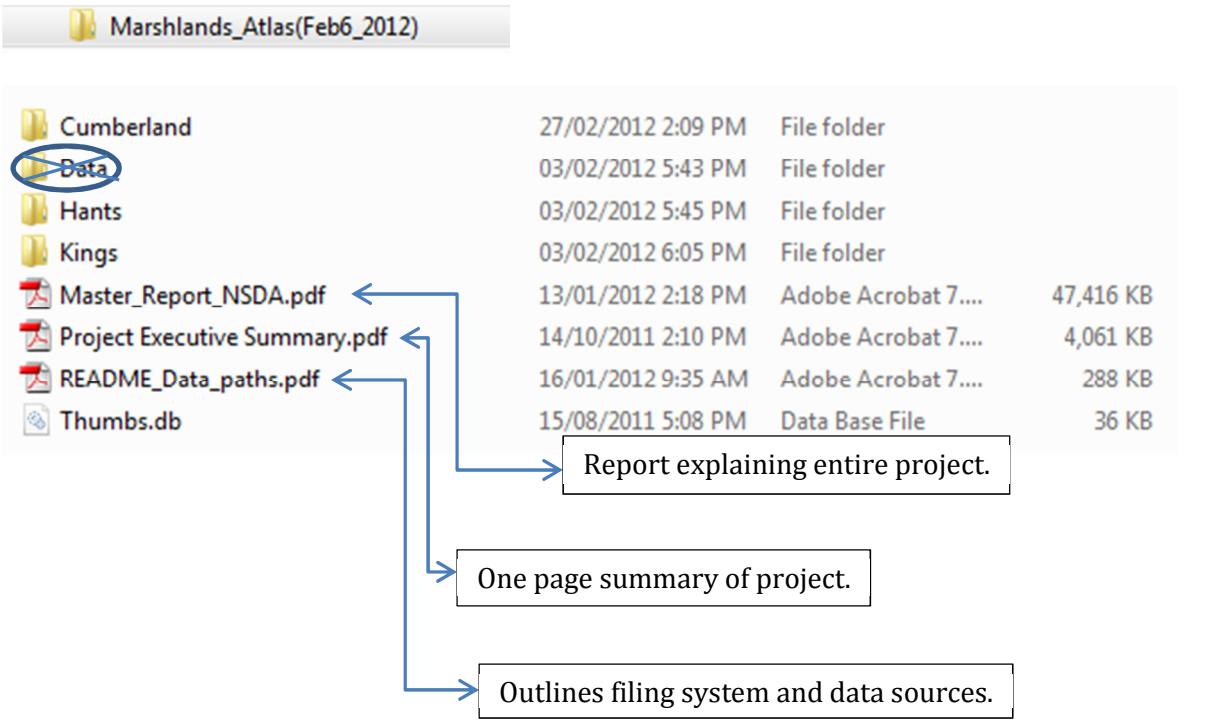
Appendix E: Current Dyke Metadata

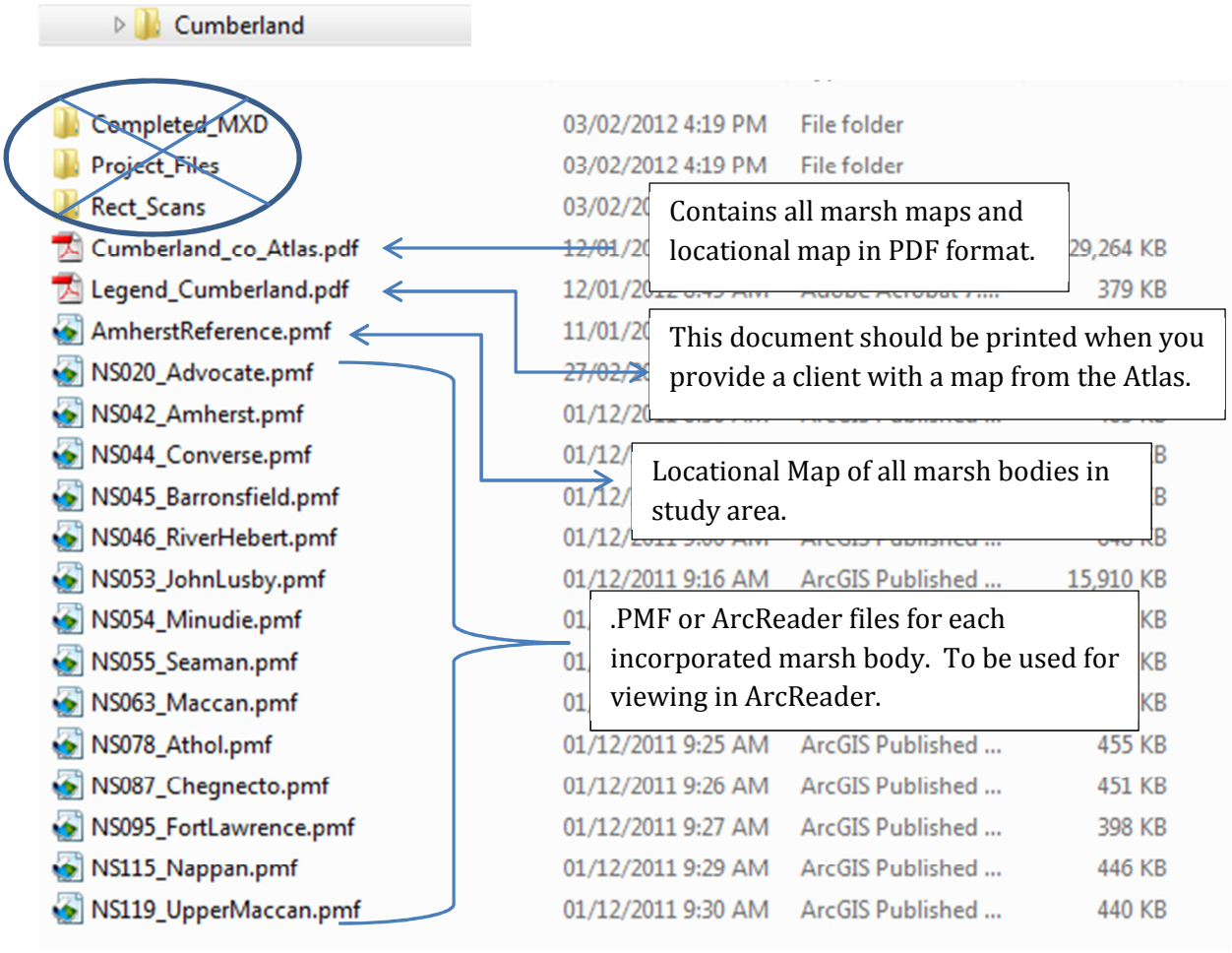
Field	Type	Source of data/Definition
NSDA_no	String	Marsh number the Nova Scotia Department of Agriculture (NSDA) uses to identify its marshes/dykes
SLR	Double	Sea level rise of 0.79 metres, based on 50 year storm.
const_elev	Double	Construction elevation in metres (2001).
crit_elev	Double	Critical dyke elevation in metres (2001).
top_up	Double	top_up = (Crit_elev + SLR) - OrthHeight
OrthHeight	Double	Original field from survey data, values are in metres
const_ft	Double	Construction elevation in feet (2001).
crit_ft	Double	Critical elevation in feet (2001).
height_ft	Double	Surveyed height in feet.
Code	String	Original field from survey data
PointId	Double	Original field from survey data
Northing	Double	Original field from survey data
Easting	Double	Original field from survey data
Attributes	String	Original field from survey data

Appendix F:

Nova Scotia Department of Agriculture
Marshlands Atlas Demonstration

Barbara Pietersma-Perrott
Saint Mary's University
(902) 420-5274
barbara.pietersma@smu.ca


Marshlands_Atlas(Feb6_2012)
Cumberland 27/02/2012 2:09 PM File folder
Data 03/02/2012 5:43 PM File folder
Hants 03/02/2012 5:45 PM File folder
Kings 03/02/2012 6:05 PM File folder
Master_Report_NSDA.pdf 13/01/2012 2:18 PM Adobe Acrobat 7.... 47,416 KB
Project Executive Summary.pdf 14/10/2011 2:10 PM Adobe Acrobat 7.... 4,061 KB
README_Data_paths.pdf 16/01/2012 9:35 AM Adobe Acrobat 7.... 288 KB
Thumbs.db 15/08/2011 5:08 PM Data Base File 36 KB
Report explaining entire project.
One page summary of project.
Outlines filing system and data sources.


Cumberland
Completed_MXD 03/02/2012 4:19 PM File folder
Project_Files 03/02/2012 4:19 PM File folder
Rect_Scans 03/02/20
Cumberland_co_Atlas.pdf 12/01/20 29,264 KB
Legend_Cumberland.pdf 12/01/2012 379 KB
AmherstReference.pmf 11/01/20
NS020_Advocate.pmf 27/02/2
NS042_Amherst.pmf 01/12/20
NS044_Converse.pmf 01/12/
NS045_Barronsfield.pmf 01/12/
NS046_RiverHebert.pmf 01/12/
NS053_JohnLusby.pmf 01/12/2011 9:16 AM ArcGIS Published ... 15,910 KB
NS054_Minudie.pmf 01
NS055_Seaman.pmf 01
NS063_Maccan.pmf 01
NS078_Athol.pmf 01/12/2011 9:25 AM ArcGIS Published ... 455 KB
NS087_Chegnecto.pmf 01/12/2011 9:26 AM ArcGIS Published ... 451 KB
NS095_FortLawrence.pmf 01/12/2011 9:27 AM ArcGIS Published ... 398 KB
NS115_Nappan.pmf 01/12/2011 9:29 AM ArcGIS Published ... 446 KB
NS119_UpperMaccan.pmf 01/12/2011 9:30 AM ArcGIS Published ... 440 KB
Contains all marsh maps and locational map in PDF format.
This document should be printed when you provide a client with a map from the Atlas.
Locational Map of all marsh bodies in study area.
.PMF or ArcReader files for each incorporated marsh body. To be used for viewing in ArcReader.

ArcReader Toolbars

DATA VIEW TOOLS

Open: Opens a document; you must browse to the desired document.

Recent Files: Lists recent ArcReader files; you can open any by clicking on the name.

Print: Prints the map view and legend of your choice to a preformatted map layout.

Toggle Table of Contents: Turns the table of contents on or off.

Zoom In: Zooms in on the map view, centered on a clicked position or dragged rectangle.
Zoom Out: Zooms out from clicked position or dragged rectangle on the map area.
Fixed Zoom In: Zooms in on the map a certain amount.
Fixed Zoom Out: Zooms out on the map a certain amount.
Pan: Moves the geographic area shown within the map view in the direction the cursor is dragged across the screen. To drag, position the cursor over the map view, then hold down the mouse button and "drag" the cursor in the desired direction, releasing the mouse button when through. The map will redraw.

Zoom to Full Extent: Zooms the view to the full geographic extent of all layers.

Go Back: Zooms to show the previous extent/map view. **Go Forward**: Zooms to the next extent.

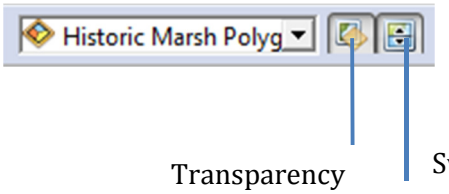
Scale Bar

Identify Feature: Click on a feature (only features within the active layer will respond to identify/search tools). Data/information available for the feature selected is shown in the area of the screen beneath the map view.

Find: Finds a map feature or features within the active layer whose attributes (underlying data) contain a specified string of text. Selected feature(s) are highlighted, and data/information available for the feature(s) selected is shown in the area of the screen beneath the map view.

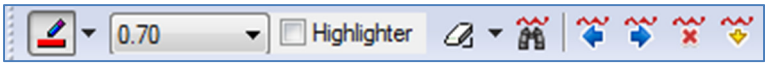
Go to XY: Enter coordinate, and map view will zoom to that location.

Measure: Measure distances on the map view. Click on a beginning location on the map(WAIT until the hourglass goes away), then either move the cursor to a second position and note the distance displayed at the top of the map area, or click on a series of points to create a series of line segments. In the second case, the distance of the current segment as well as the total line distance is displayed.



Layer List Control: Select layer and chose either Transparency or Swipe Layer

MARKUP TOOLS



 Select Colour of Markup

Change Markup Width and Transparency

 Erase Markup

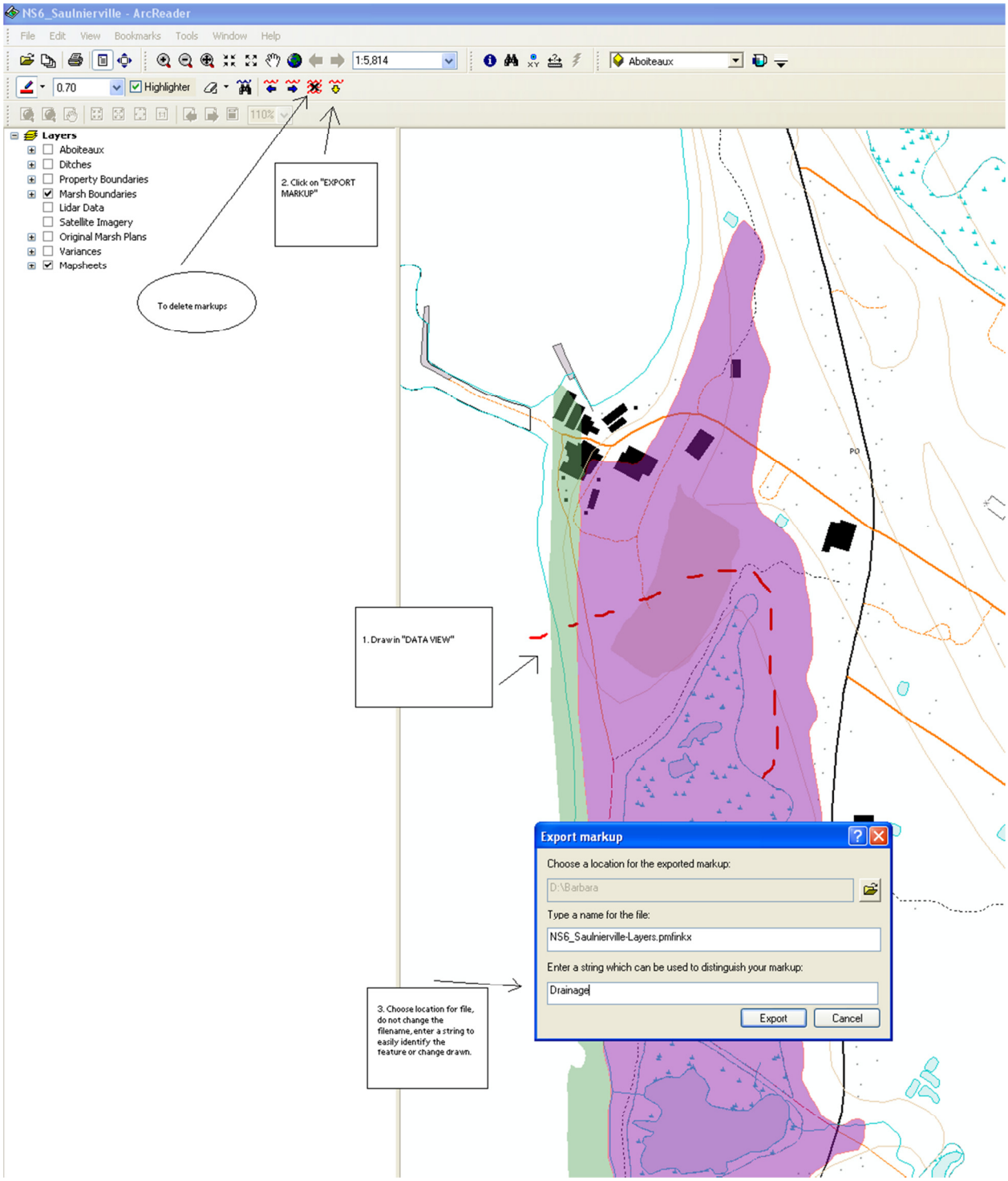
 Find Ink

 Find Previous and Find Next Markup

 Delete Markup

 Export Markup

USING THE MARKUP TOOL



LAYOUT VIEW TOOLS

Page Zoom In: Zooms in on the layout view, centered on a clicked position or dragged rectangle.

Page Zoom Out: Zooms out from clicked position or dragged rectangle on the layout.

Page Pan: Moves the layout around based on where the cursor is dragged. To drag, position cursor over layout, hold down the mouse button and "drag" the cursor in the desired direction, releasing the mouse button when through. The map and page will redraw.

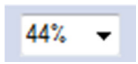
Page Zoom In Fixed: Zooms in on the layout a certain amount.

Page Zoom Out Fixed: Zooms out on the layout a certain amount.

Zoom to Whole Page: Zooms to the whole layout page.

Zoom to 100%: Zooms to real-size of layout page.

Go Back: Goes back to last layout extent. **Go Forward**: Goes forward to next layout extent.



Page Scale: Allows user to set the size of the layout page on the computer screen.

Source: http://www.threepointlearning.org/whos_swimming_in_our_gulf/student_stuff/arcreader_help.pdf

Map Page Overview