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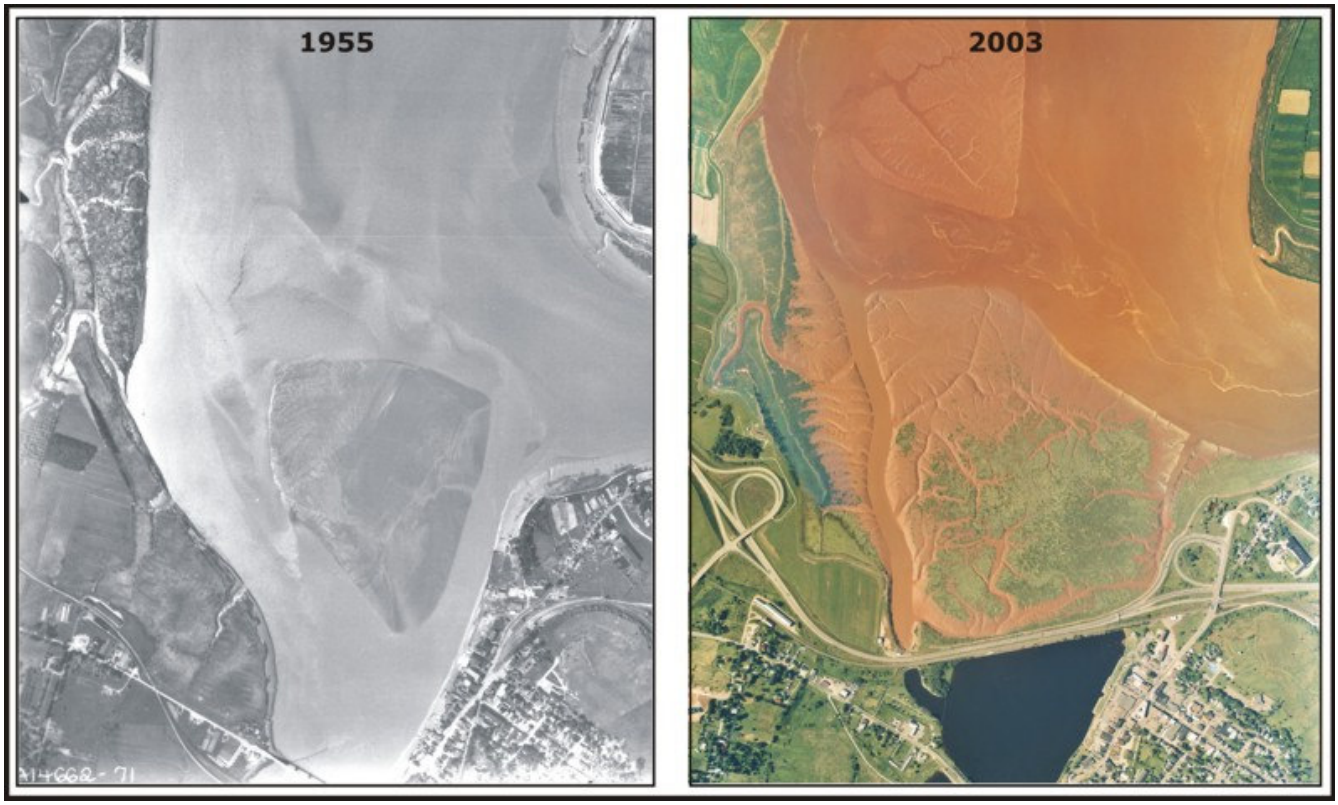
FINAL REPORT

DEVELOPMENT of a SERIES of HISTORICAL DIGITAL MOSAICS DEPICTING CHANGE in INTERTIDAL HABITAT in the MINAS BASIN



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Gulf of Maine Council on the Marine Environment

BoFEP Bay of Fundy Ecosystem Partnership

INTRODUCTION

In a 'natural' world, salt marshes represent a delicately balanced system between hydrodynamic forces and ecological, sedimentological and morphological responses. However, this balance may be changed as a result of anthropogenic forcing functions such as construction of engineering structures, dredging or altering landuse activities. Over the last century, the majority of rivers entering into the Bay of Fundy have been highly modified through the construction of tidal barriers. The construction of these barriers resulted in either partial or complete obstruction to tidal flow in many areas around the Bay. Tidal barriers effectively decrease turbulent energy in the tidal system causing sediments and other particles to drop from suspension and accumulate as deposits of mud, sand and silt. In other areas, localized erosion is initiated either directly upstream or downstream of a partially restrictive barrier. Ecosystems inhabiting this zone, such as mudflats and salt marshes, are some of the first environments to feel the effects of coastal modification[17]. These changes have cascading impacts on intertidal ecosystems, some negative and others positive. Overall however, the cumulative impacts of tidal barriers on intertidal ecosystems of the Bay of Fundy are unknown. This is of particular concern with increasing interest in removing or modifying tidal barriers in an effort to 'return the tides'. Without a solid or known baseline of past and present 'states' of these systems, assessing or predicting the success of restoration activities in the context of the whole system is difficult.

In addition, cycles of progradation and retreat have been documented on a number of marsh and intertidal systems[6,7,1,,16]. These cycles have been linked to changes in sea level[1,3] and in the tidal prism due to human activities such as tidal barrier construction[5,3,8,16,17] or dredging[8,7], changes in wind/wave climate [1,13,7], sediment supply[3,9], cliff morphology[10,13,12], intertidal sedimentation[14,16] and changes in the location of the major tidal channel[6,12,13,2,15]. One of the most effective ways of documenting these changes is through the analysis of rectified aerial photographs within a GIS system. This is the preliminary stage that is required before any true questions regarding the 'why' of these changes can be addressed.

The purpose of this research project was to assess and integrate all available historical aerial photography into the comprehensive digital geodatabase initiated in 2004. This study focused on the Southern Bight of the Minas Basin and compliments on-going initiatives to quantify the changes in ecosystem habitat in the Minas Basin. These mosaics will be used to quantify changes in ecosystem habitat in the Minas Basin and address questions of *why* and *at what rate* these changes are occurring in subsequent research.

METHODOLOGY

A senior undergraduate geography major (Peter Horne) with a background in geomatics and physical geography was hired on a full time basis throughout the summer of 2005. All of the GIS work was conducted using ArcGIS 9.0 in the Maritime Provinces Spatial Analysis Research Centre (MP_SpARC) at Saint Mary's University and was supervised by Dr. Danika van Proosdij and Greg Baker (MP_SpARC geomatics research technician).

Relevant flight lines were identified (Appendix A) and individual aerial photographs were examined at either the Department of Natural Resources Archives or Land Information Services in Halifax and assessed for suitability for intertidal analysis. Photographs were classified based on

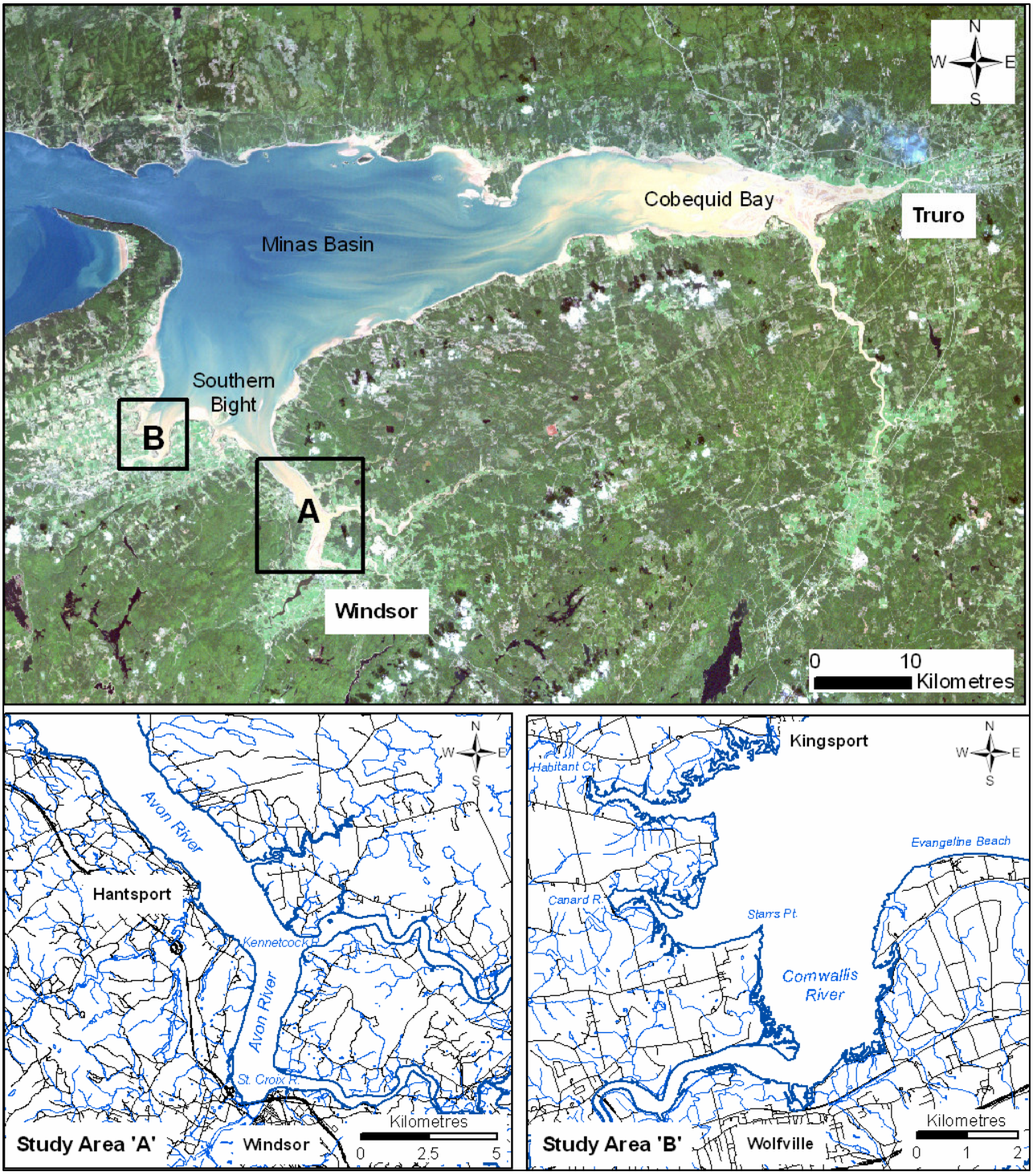

Figure 1: Location of study areas for mosaic creation 'A' = Avon and 'B'= Cornwallis

the visibility of sections of the intertidal zone based on the following criteria: *low* (entire intertidal zone visible including main river channel thalwegs), *between low to mid* (entire intertidal zone visible but cannot distinguish main river channel thalweg), *mid* (majority of mudflat not visible except intersection between low marsh and mudflat), *between mid to high* (low marsh edges not

visible) and *high* (majority of intertidal surface covered by tidal waters). Older photographs were ordered from the National Archives based on flight line information. This process was quite tedious since many of the earlier photographs were either not available or image numbers did not correspond with flight lines provided. In many cases, it was impossible to get a complete set of 'low tide' photographs for the entire Southern Bight area. As a result, two primary study areas (Figure 1) were created: *Avon* and *Cornwallis.* This division also facilitated the creation of manageable mosaics.

All of the photographs were scanned at an appropriate dpi to provide 1-m ground resolution. For example, 1:10,000 scale photographs were scanned at 300 dpi (minimum = 254 dpi) to allow for greater clarity in the image during the rectification process. The images were then georeferenced and rectified in ArcMap using 1:10,000 digital topographic map sheets and referenced to UTM Zone 20N NAD 1983 CSRS 98. Mosaics were generated using a custom AML created by Greg Baker (Saint Mary's University Maritime Provinces Spatial Analysis Research Center – MP_SpARC) and 'cleaned' in Adobe Photoshop. Some color correction was performed if it was critical to interpretation (e.g. blurry boundary or sharp contrast) however original colors were retained where possible to permit future digital processing and analysis. Therefore some of the mosaics are more 'patchy' than others. Table 1 summarizes the dates of photographs used and resultant mosaics.

	Decade						
Study Area	***1940s***	***1950s***	***1960s***	***1970s***	***1980s***	***1990s***	***2000s***
Avon	1944, 45	1954, 55	1964	1973	High tide	1992	2003
Cornwallis	1945	High tide	High tide	1977	1987	1992	2002

Table 1: Summary of mosaics created based on available aerial photography

RESULTS

Approximately 950 aerial photographs from 256 flight lines from 1944 to 2004 were examined. Results of the assessment are summarized in Appendices A and B. Approximately one third of the flight lines were determined not to be suitable for analysis of the intertidal zone. A total of 343 photos were found to be suitable for inclusion into the project. A detailed list of photographs currently residing at Saint Mary's University are included in Appendix C. Unfortunately the lack of

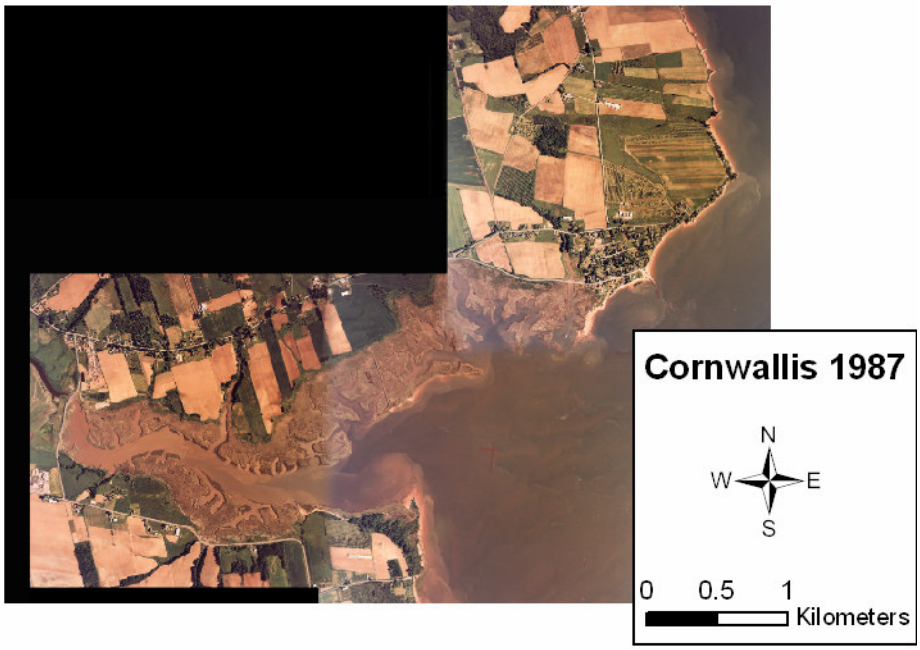

Figure 2: Example of 'between mid to high' tide level in 1987 Cornwallis mosaic.

low tide photography had the most impact on the Cornwallis area where no mosaics were able to be created for the 1950s and 1960s. The 1987 mosaic generated for this area was also of limited value since the tide level covered the lower portion of the marsh and in many locations the marsh/mudflat boundary was not visible. Fortunately, the mosaics created for the 1970s, 1990s and 2000s were able to display the entire intertidal zone quite effectively and will be of excellent use in subsequent analysis. The mosaics presented in the following figures were created from all of the photographs available for a given decade where the tide was at mid to low tide positions. In some instances a photograph was included if it showed critical shoreline elements or engineering structures (e.g. causeway or wharf) even if the marsh was partially covered with water (Figure 2).

DISCUSSION and CONCLUSIONS

In general, the creation and use of historical aerial photo mosaics to document and quantify changes in coastal habitat is a relatively straight forward procedure. However the macrotidal conditions of the Upper Bay of Fundy present some considerable challenges to the seamless creation of images. Flight lines are generally flown along a west-east transect within each county, essentially bisecting the Southern Bight. As a result, it is next to impossible to have identical tidal conditions for the entire mosaic. In addition, since the Minas Basin covers four different counties (Figure 3) and flights are flown on a county basis, this can result in the western shore of the Avon River being flown as much as 4 years before or after the eastern shore. For example, Hants County was flown in 1973, 1981, 1992 and 2003/04 while the adjacent Kings County was flown in 1977, 1987, 1992 and 2002. Furthermore, at times a county may be divided even further (e.g. Hants 2003/04).

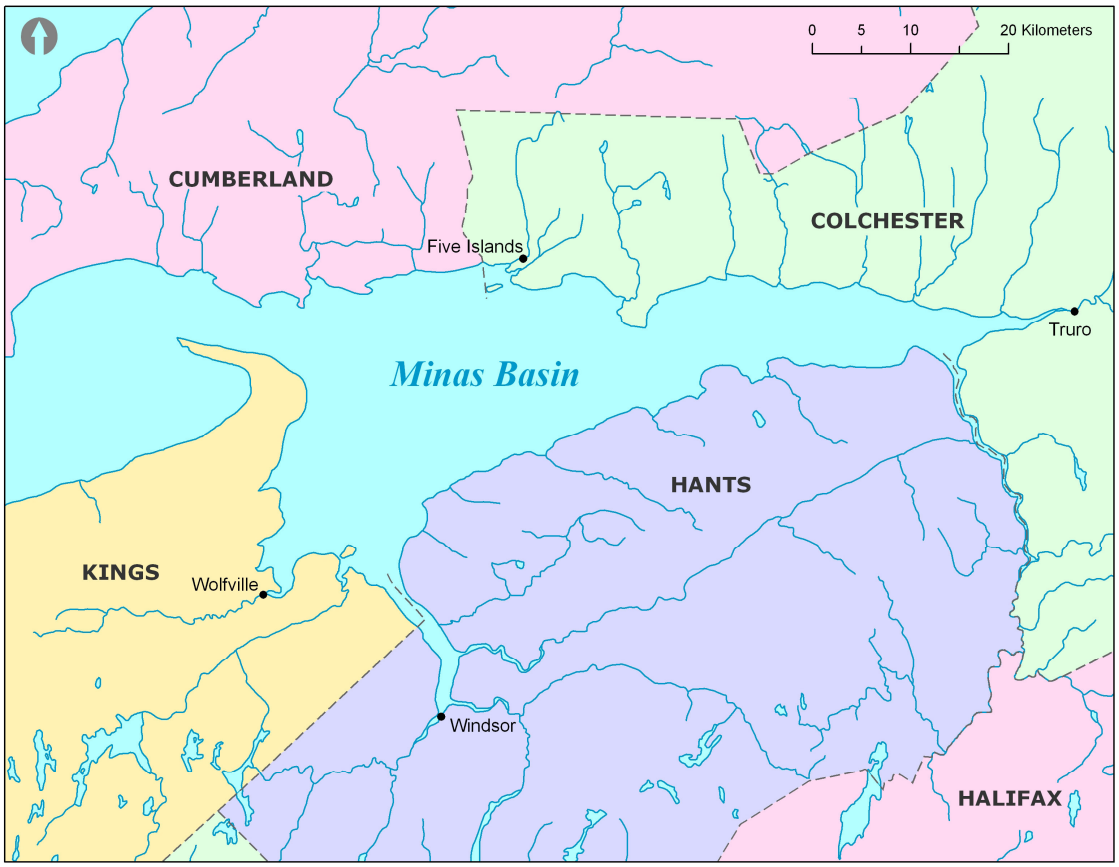

Figure 3: County Boundaries around the Minas Basin

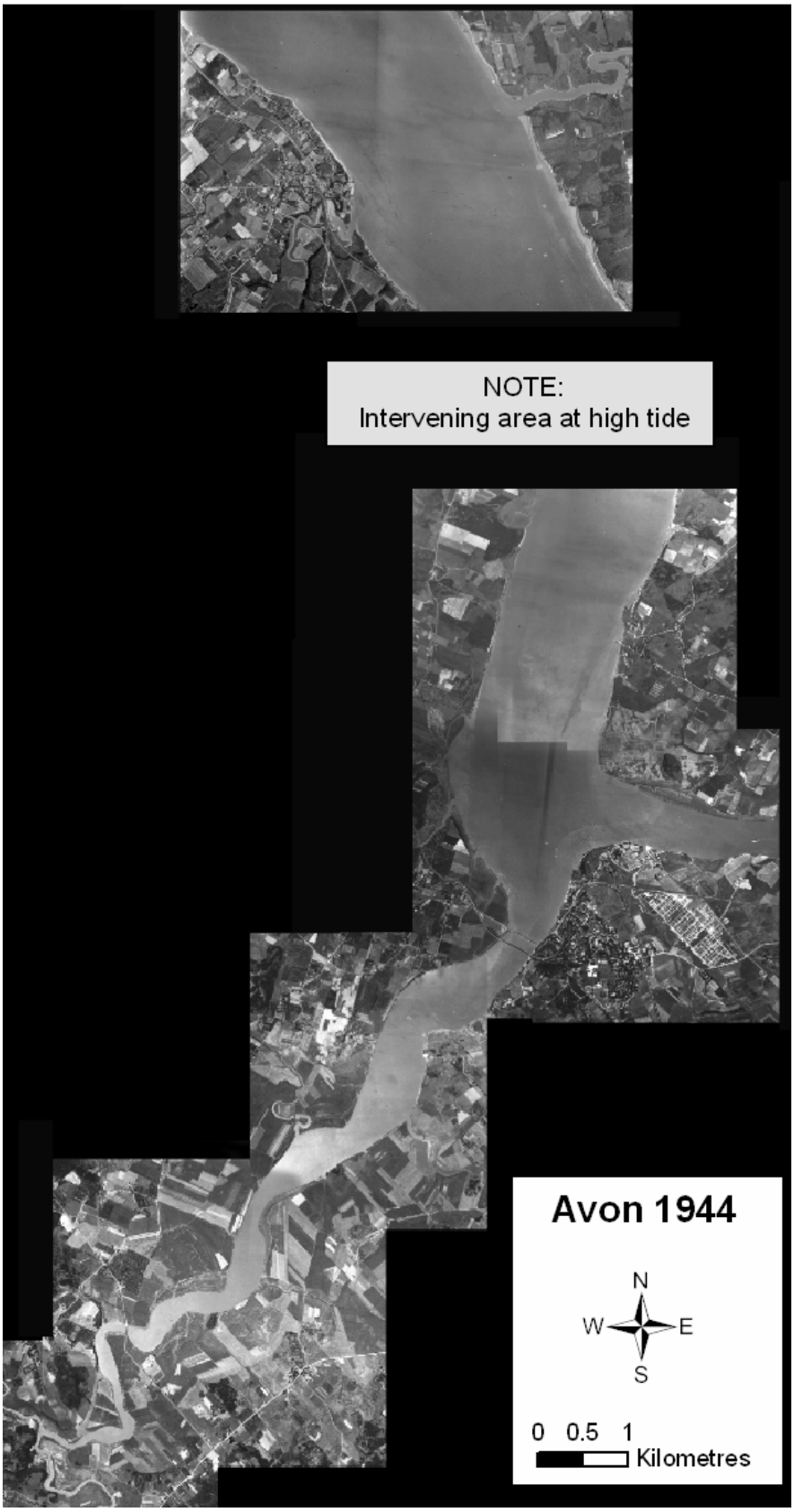

Figure 4: Avon 1944 mosaic created from 1: 15, 840 scale aerial photographs. Mosaic ground resolution = 1

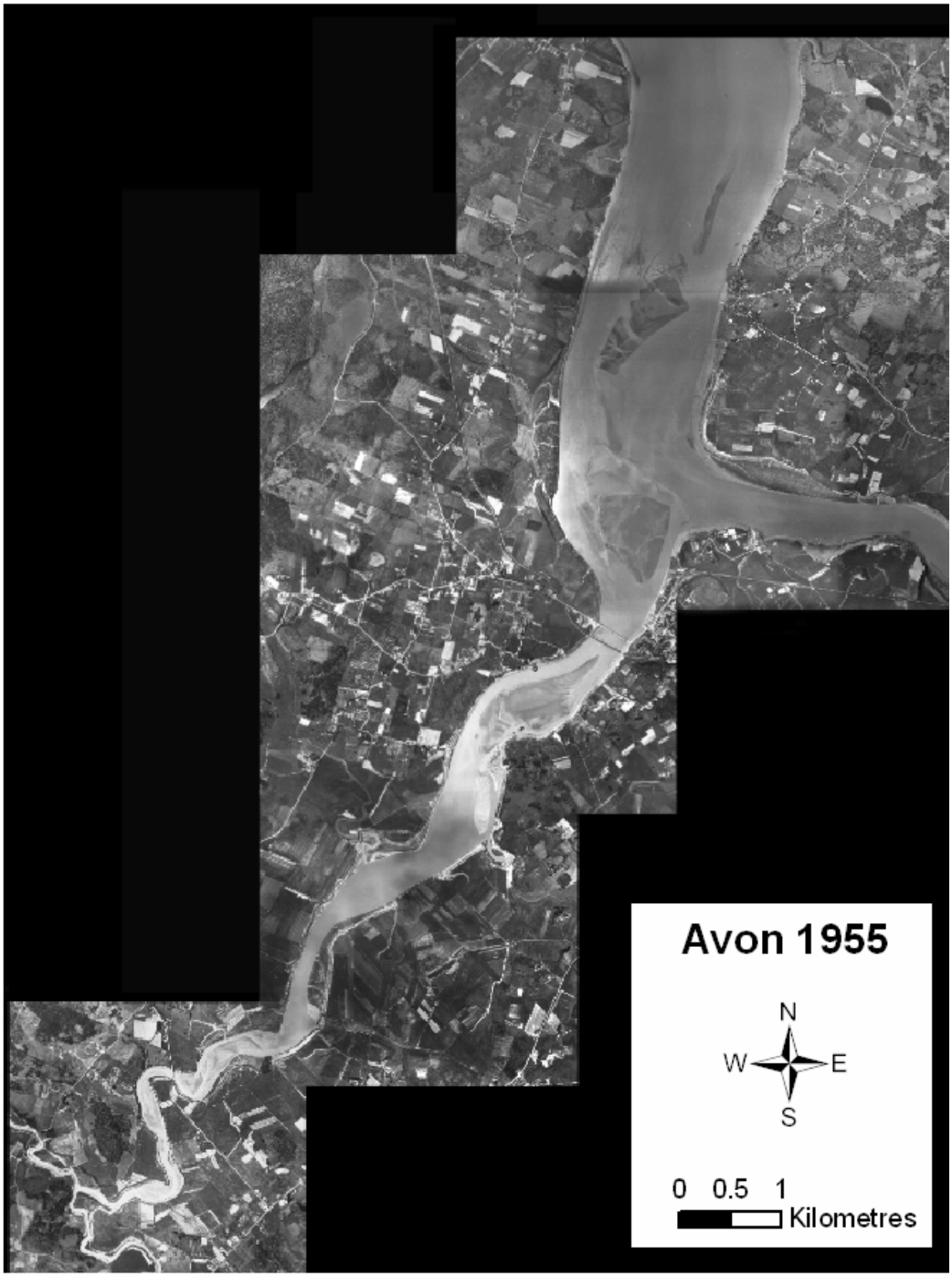

Figure 5: Avon 1955 generated from 1:15, 840 scale aerial photographs which were at mid to low tide levels. Mosaic ground resolution = 1 m.

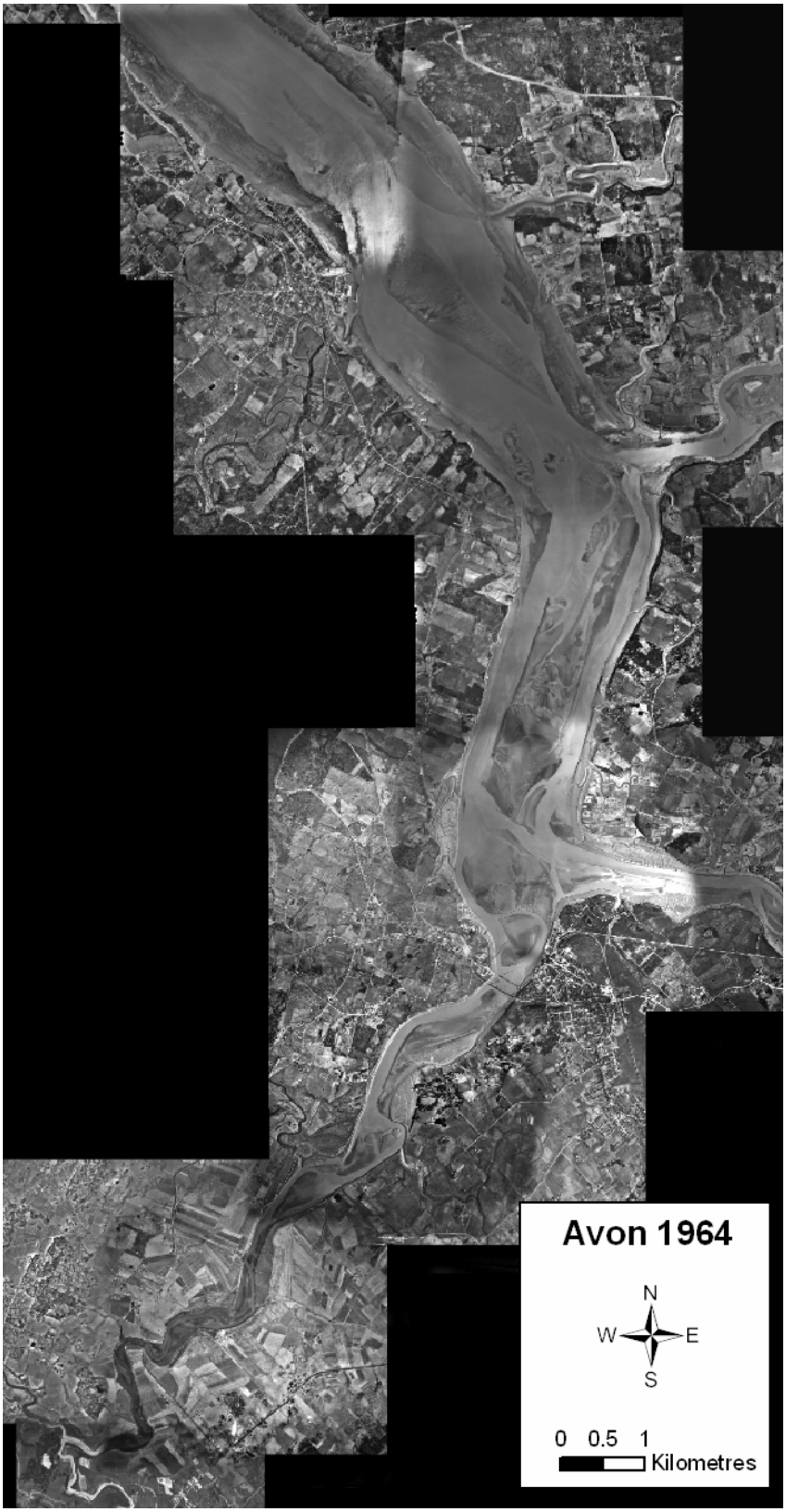

Figure 6: Avon 1964 generated from 1:15,840 scale aerial photographs which were at low tide levels. Mosaic ground resolution = 1 m.

Figure 7: Avon 1973 generated from 1: 16,000 scale aerial photographs. Mosaic ground resolution = 1 m.

Figure 8: Avon 1992 generated from 1: 10,000 aerial photographs. Mosaic ground resolution = 1 m.

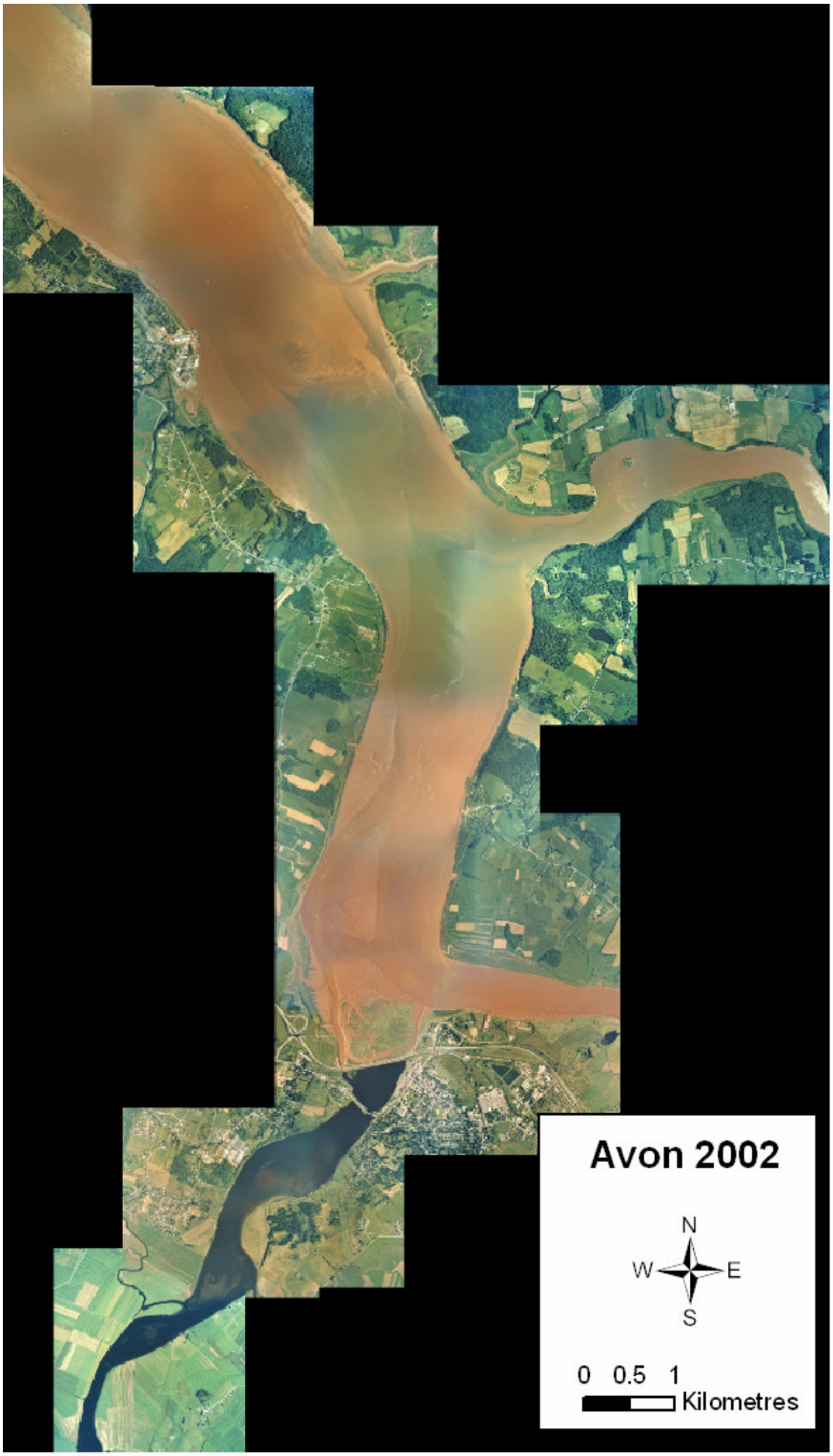

Figure 9: Avon 2002_03 generated from 1: 10,000 aerial photographs from 2002 & 2003. Mosaic ground resolution = 1 m.

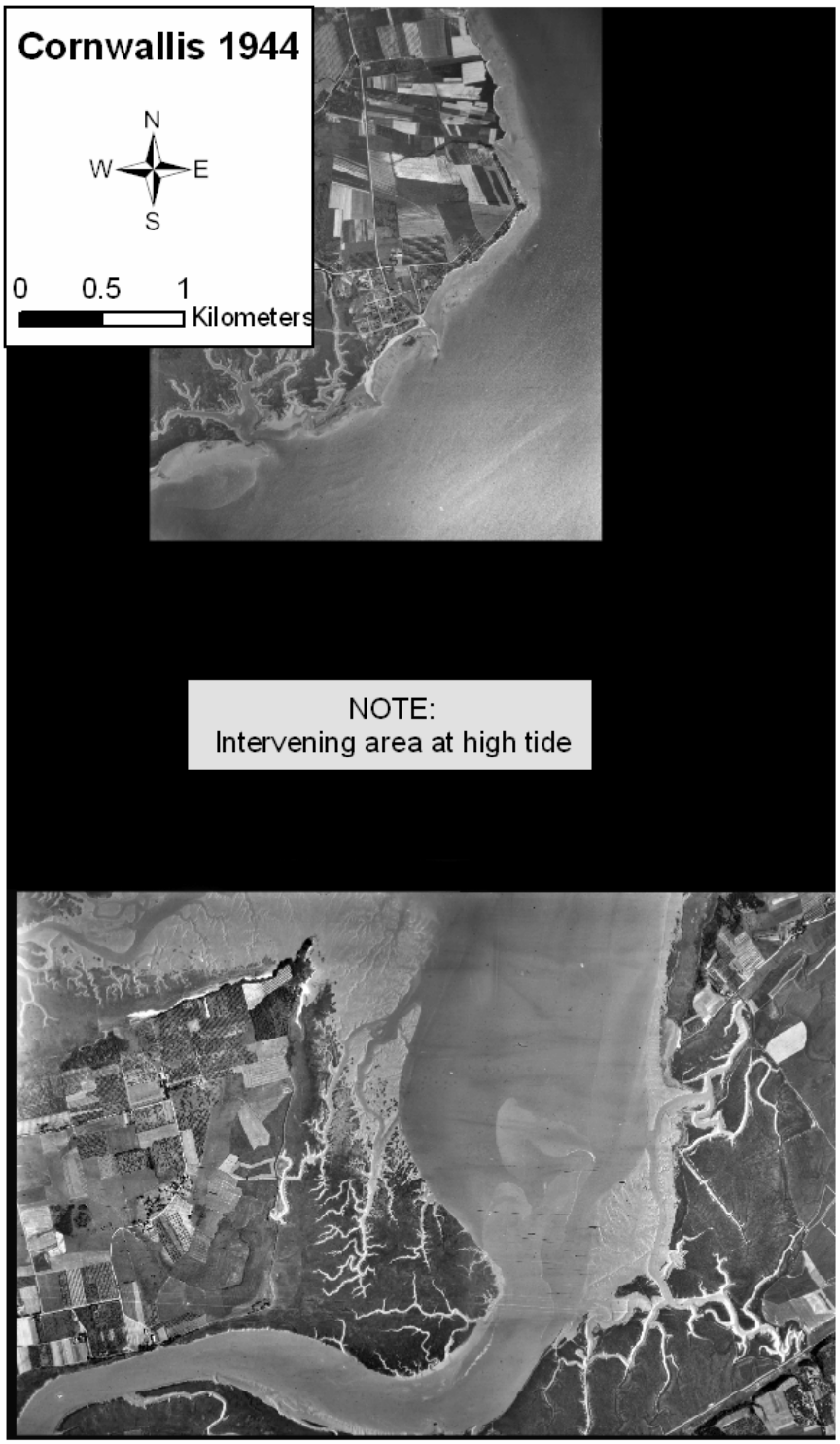

Figure 10: Cornwallis 1944 mosaic generated from 1: 15,840 scale aerial photographs from 1944 and 1945. Mosaic ground resolution = 1 m.

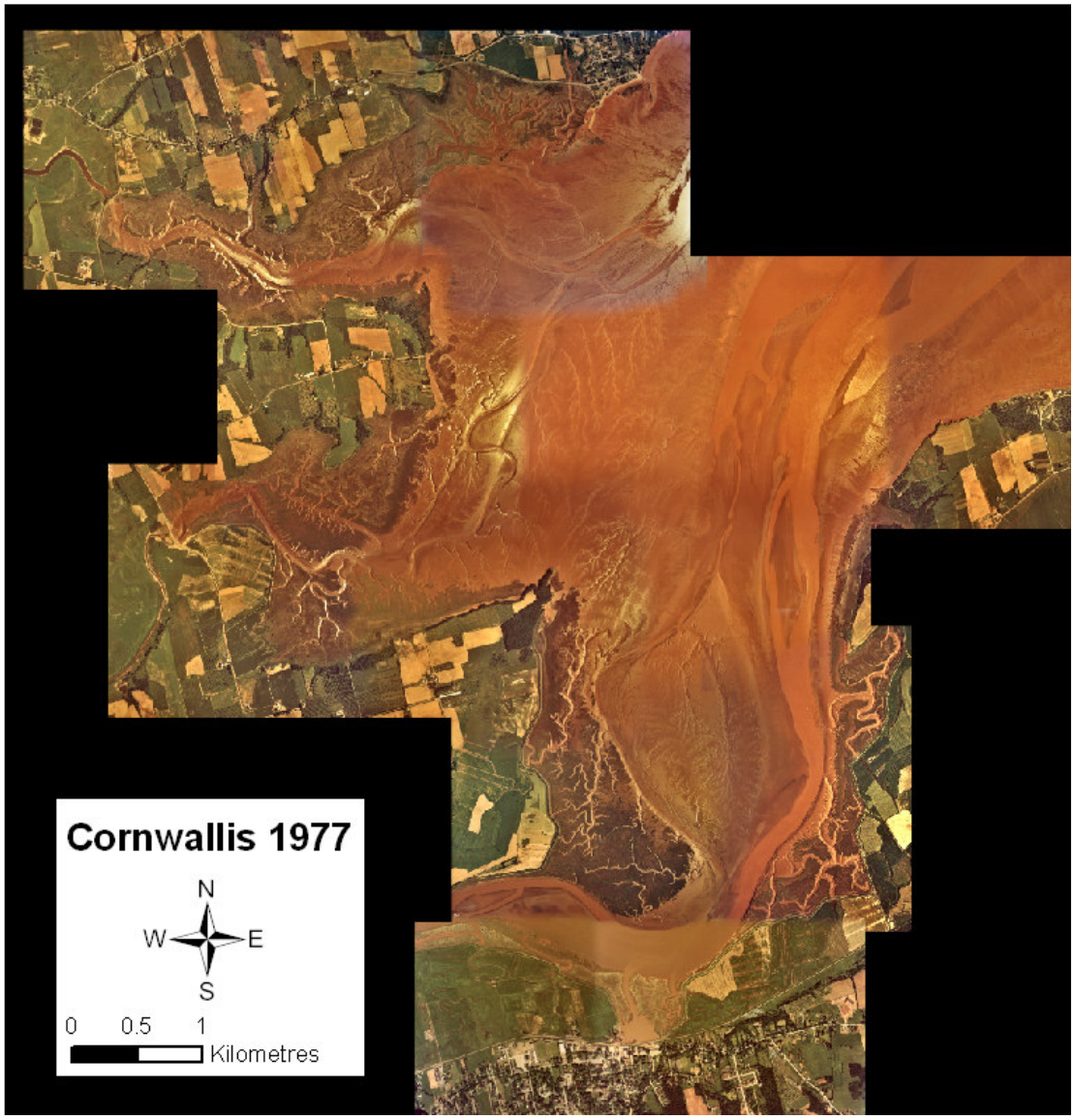

Figure 11: Cornwallis 1977 generated from 1: 10,000 scale aerial photographs. Mosaic ground resolution = 1 m. Note high tide in southern most portion of image adjacent to Wolfville waterfront.

Figure 12: Cornwallis 1992 generated from 1:10,000 scale aerial photographs. Mosaic ground resolution = 1m.

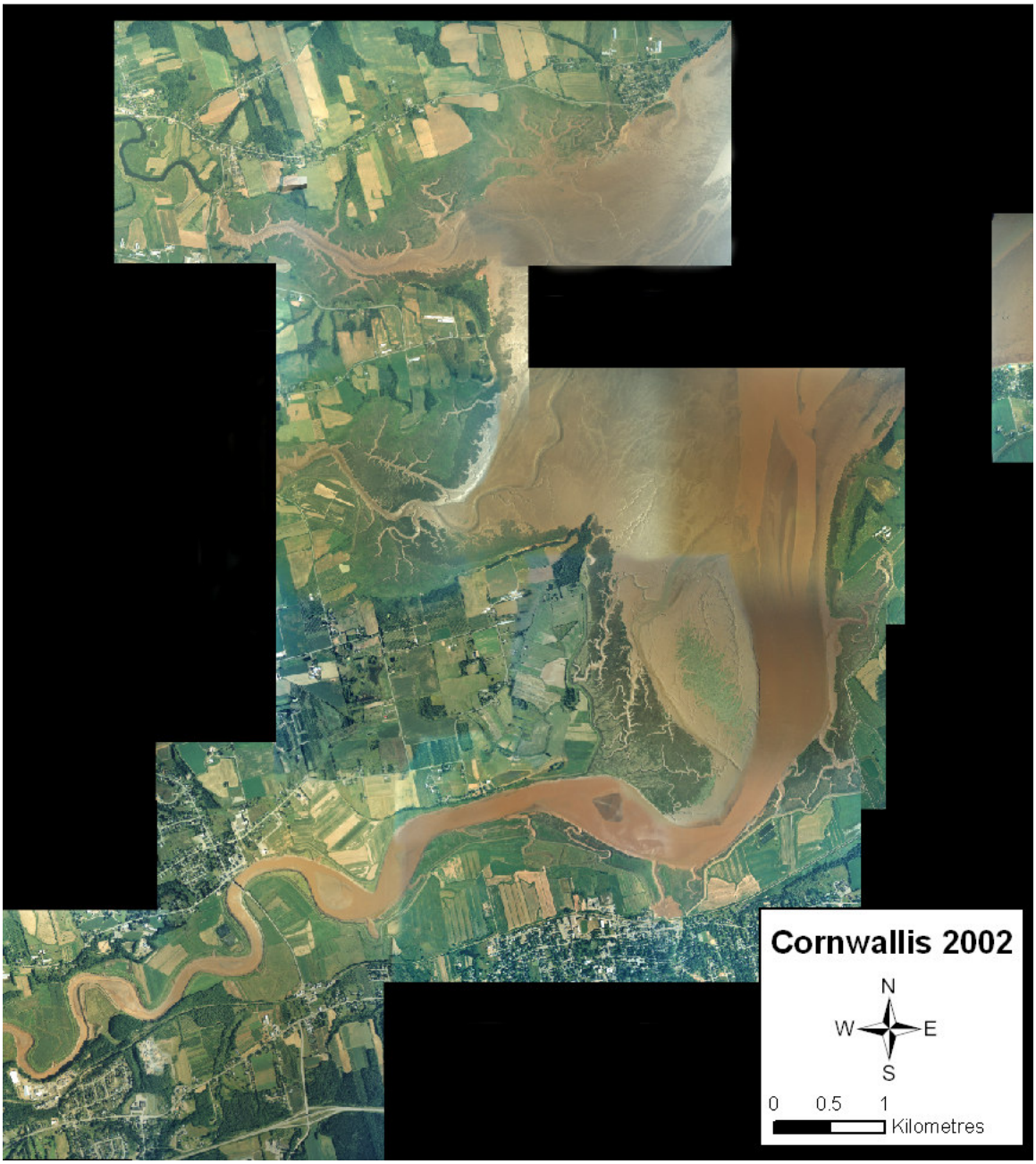

Figure 13: Cornwallis 2002 generated from 1: 10,000 aerial photographs. Mosaic ground resolution = 1m.

Some of the mosaics however, are still able to accurately display the majority of the marsh and mudflat ecosystems. These include Avon 1955, 1973 and 2003 and Cornwallis 1944, 1977 and 2002. The 1992 mosaics for both Avon and Cornwallis have sections at mid to high tide. However the majority of the 1992 image provides excellent depictions of intertidal geomorphology of the region as a whole.

It is recommended that any analyses using the mosaics presented in this report be verified by ground truthing exercises. In addition, aerial photography presents a very good depiction of the

horizontal plane and does not accurately display any vertical variations in intertidal elevations. These variations can have a significant impact on area determinations and should be included in subsequent analyses. This project however does provide a strong first step to examining the question of what changes have occurred in intertidal ecosystems in the Southern Bight over approximately the last 60 years. Further analyses are needed to begin to address why these changes are occurring.

ACKNOWLEDGEMENTS

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APPENDIX A

Historical Flight Lines Examined and Housed at Saint Mary's University

Flight Lines in Collection

Year	County	Area
1945	Kings/ Hants	Avon River
1945	Kings	Cape Split down
1954	Kings/ Hants	Wolfville
1954	Hants	below Windsor
1954	Hants/ Colchester	Cobequid Bay
1955	Hants	Avon River
1961-68	Kings/ Cumb/ Colc	Cape Split & Chignecto Bay
1967	Kings/ Hants/ Colc./ Cumber.	Cape Split
1967	Kings	bad quality
1967	Kings	Cape Split
1973	Hants	same as below
1973	Hants/ Halifax	same as above
1975	Cumberland/ Colchester	
1977	Kings	Cape Split
1981	Hants	along coast
1985	Colchester/ Cumberland	
1985	Cumberland	
1987	Kings	Cape Split
1992	Colchester	Truro
1992	Colchester/ Hants	
1992	Kings/ Hants	Windsor
1992	Kings/ Hants	Wolfville
1994	Colchester/	
1994	Colchester	Truro
2002	Kings/ Hants	Windsor
2002	Kings/ Hants	Wolfville
2003	Kings/ Hants	Windsor
2003	Kings/ Hants	Wolfville
2004	Kings/ Hants	Wolfville

APPENDIX B: Aerial Photographs Available at Saint Mary's University MP_SpARC

Year	Flight Line	Photo #
1944/45	A8645	56, 58
	A8646	82, 84
	A8719	34
1955	A14662	72
	A14713	88, 90
Year	**Flight Line**	**Photo #**
1964	A18352	73, 74, 75, 76, 205, 208, 209
	A18354	208
	A18357	60, 62, 64, 81, 86, 202, 204, 206, 208, 210,
		214, 216
	A18439	44, 46, 48, 49, 50, 51
	A18503	81
Year	**Flight Line**	**Photo #**
1973	A30670	135, 156, 157, 160
	A30671	1, 223, 224
	A30672	143, 145
	A30674	157(x2), 159(x2), 161(x2), 162
	A30676	6, 7, 8, 10, 12(x2), 13, 81, 83(x2), 85(x2),
		87(x2), 88, 89, 92(x2), 94(x2), 96, 178(x2)
	A30893	118, 120, 121
1975	75040	104, 106, 108, 129, 131, 133, 135, 137,139,
		144, 152, 154, 156, 158, 171, 173, 191
1977	A77300	1, 3, 16, 18, 46, 48, 57, 59, 61
	A77301	45, 47, 49, 58, 59, 60, 62, 63, 65, 67, 68,
		70, 150, 151, 153, 155, 157, 159, 161
	A77316	1, 66, 68
	A77317	24
Year	**Flight Line**	**Photo #**
1981	81326	15, 17
	81328	146
	81332	16, 17(x2), 19(x2), 21(x2), 23, 24, 25, 27,
		98, 99, 100, 106, 166, 168
1987	87304	35, 37, 75

Year	Flight Line	Photo #
1992	92300	87, 89, 91, 93, 95, 97
	92301	62 (x2)
	92302	43, 45, 47, 52, 54, 56, 58
	92303	46, 48, 50, 52, 55, 57, 59, 61(x2), 63(x2), 172,
		173, 175, 176, 178, 190(x2), 192(x2), 211
	92305	35, 37, 76, 77, 79, 80, 82, 84, 86
	92316	48, 50, 52, 53, 55, 57, 60, 61, 62, 63, 88,
		90, 92
	92317	96 (x2), 98, 119, 121, 123, 135, 137
	92318	51, 53, 55, 57, 59, 61
	92333	55, 140
	92334	11, 15, 25, 57, 59
	92343	97, 99, 101, 103, 105, 107
	92344	20, 22, 28
	92354	16
	92363	87, 95
	92379	63, 73
	92389	61
	92391	6
1994	94001	8, 10, 12, 14, 16, 18, 20, 22, 67, 68, 70,
		124, 126
	94002	2, 56, 73

Year	Flight Line	Photo #
2002	02307	145, 146(x2), 148, 180, 181, 183, 185, 187,
		189
	02308	38, 75, 77, 79, 80, 81, 87, 113, 114, 116,
		153, 155, 157, 163, 164, 165
	02309	3, 5, 13, 17, 18
	02322	115, 116, 118, 120, 122, 130, 140, 142, 175
	02327	113
	02329	144, 146, 190, 192, 193, 198, 200, 202, 203
2003	03301	15, 16(x2), 24
	03302	22, 24, 26
	03004	180, 181, 183, 185, 187, 189, 191, 192,
		213, 215, 216, 217, 218, 219, 220
	03308	10, 25, 93, 95, 97, 99, 101, 103, 162, 164,
		169, 171
	03316	27
	03317	19, 21, 23, 24
	03318	19, 31
	03321	93, 95, 97(x2), 105
2004	04308	1, 3, 83
	04314	17, 18
	04325	2, 3
	04328	1, 3

APPENDIX C: Assessment of Historical Aerial Photographs

1931 to 1945

21H/08				Tide Level				
Best Cov	Flight Line	Photo Range	Date	Low	Between	Mid	Between	High
2-14	A-8718	1 to 15	1945		X			
17,19 / 21,22	A-8718	16 to 22	1945		X			
24,26 / 29,31	A-8718	23 to32	1945		X			
34,36 / 42,44	A-8718	33 to 45	1945		X			
2,3,4,6	A-6532	1 to 6	1939				X	
1-33	A-6531	1 to34	1939				X	
39-45	A-5925	39 to 45	1938	X				
21H/01				Low	Between	Mid	Between	High
69,71 / 78,80	A-8718	69 to 80	1945	x				
64,66	A-8718	56 to 68	1945	X				
24,26	A-8650	23 to 41	1945	X				
18,20	A-8650	16-20	1945	X				
79,81,82	A-8719	79 to 82	1945				X	
71-77	A-8719	71 to 77	1945				X	
64-70	A-8719	59 to70	1945			X		
37-41	A-8719	59 to 70	1945			X		
25-35	A-8719	24 to 36	1945		X			
96-98	A-8719	87 to 98	1945		X			
44256	A-10178	1 to 21	1946			X		
38534	A-3619	1 to 8	1931	X				
22-30	A-3624	22 to 30	1931	X				
92-102	A-3624	92 to 102	1931	X				
na	A-8719	98 to 102	1945					X
45-61	A-8645	42 to 66	1945		X			
na	A-8646	46 to 60	1945					X
na	A-8647	85 to 70	1945					X
5,6	A-8647	1 to 9	1945			X		
39-47	A-8648	39 to 50	1945			X		
na	A-8725	1 to 24	1945					X
na	A-8726	75 to 93	1945					X
na	A-8727	4 to 22	1945					X

11E/05				Low	Between	Mid	Between	High
31-35	A-5922	30 to 35	1938	X				
35-41	A-5922	41 to 65	1938	X				
40-50	A-5913	40 to 50	1938		X			
58-68	A-5923	58 to 67	1938	X				
50,51	A-6524	50 to 51	1939	X				
28-38	A-5925	28 to 38	1938	X				
39-71	A-5925	39 to 85	1938	X				
85-99	A-5926	84 o 99	1938			X		
na	A-5927	1 to 30	1938					X
na	A-5927	56 to 75	1938					X
11E/06				Low	Between	Mid	Between	High
na	A-5912	23 to 33	1938					X
98	A-5913	98	1938			X		
19,20	A-6655	18 to 20	1939			X		
58-66	A-5923	58 to 66	1938	X				
43040	A-5924	11 to 17	1938	X				
1,4 / 64,66,68	A-5926	to 4 & 64 to 6	1938	X				
45-47	A-5654	45 to 47	1939		X			
2,4	A-5922	1 to 4	1938	X				
na	A-5913	10 to 15	1938					X
41,43,45	A-6526	41 to 45	1939	X				
85,87 / 97-99	A-5924	82 to 99	1938	X				

1953 To 1955

				Tide Level				
Best Cov	**Flight Line**	**Photo Range**	**Date**	**Low**	**Between**	**Mid**	**Between**	**High**
73, 74, 75	A-14285	73 to 80	1954		X			
63,65	A-14192	62 to 70	1954	X				
142-143	A-14010	140 to 143	1954		X			
142-144	A-14489	145-140	1954		X			
37,39	A-14489	35 to 40	1954		X			
39,41	A-14490	35 to 43	1954	X				
200-206	A-14486	197-203	1954	X				
124-126	A-14486	127-121	1954			X		
84-88	A-14491	82 to 88	1954		X			
173, 174, 175	A-14392	174-176	1954	X				
107-111	A-14282	101 to 112	1954			X		
na	A-14285	27 to 28	1954					X
1,3,5	A-14093	1 to 5	1954		X			
218-220	A-14092	216-224	1954				X	
81- 89 / 101,1	A-14092	81-105	1954				X	
148-168	A-14010	148-169	1954			X		
1,3	A-14088	1 to 5	1954				X	
21-31	A-14286	19-31	1954				X	
51-59	A-14285	58-45	1954			X		
na	A-14285	60-63	1954					X
61-63	A-14285	61 to 63	1954			X		
64-74	A-14285	64 to 74	1954			X		
35-53 / 56,58	A-14192	35 to 44	1954			X		
63,65	A-14192	45 to 62	1954			X		
100-128	A-14010	101 to 130	1954			X		
170, 171	A-14010	175 to 170	1954			X		
148, 150	A-14087	150 to 135	1954			X		

				Low	**Between**	**Mid**	**Between**	**High**
195, 196	A-14010	193 to 198	1954				X	
187-195	A-14287	177 to 209	1954				X	
60-98	A-14010	60 to 99	1954				X	
19-37	A-14192	19 to 37	1954				X	
158-168	A-14087	158 to 169	1954				X	
170-178	A-14087	170 to 178	1954				X	
47,48 / 51,52	A-14282	47 to 52	1954			X		
53,55 / 57,58	A-14282	53 to 59	1954			X		
1-7 / 11,13	A-14661	4 to 14	1954				X	
15,17 /24-30	A-14661	15 to 26	1954				X	
1-7	A-14668	1 to 7	1954	X				
1,3,5 / 12,14 /	A-14630	1 to 24	1954			X		
39,41 / 53,55,5	A-14668	39 to 58	1954			X		
79 , 81, 83	A-14668	66 to 83	1954			X		
49, 51	A-14661	48 to 52	1954			X		
13-21	A-14668	13 to 25	1954			X		
53,55	A-14661	53 to 56	1954			X		
77-91	A-14661	67 to 95	1954			X		
150-170	A-14661	145 to 170	1954		X			
184-196 / 201	A-14661	179 to 210	1954			X		
na	A-14803	1 to 9	1954					X
na	A-14738	22 to 35	1954					X
82-90	A-14713	82 to 93	1954		X			
69-77	A-14662	65 to 78	1954		X			
85-93	A-14662	84 to 94	1955	X				
47,49,51	A-14714	46 to 52	1955		X			
10,12	A-14663	5 to 15	1955		X			
44,45	A-14745	44 to 66	1955		X			

1964 to 1967

				Tide Level				
Best Cov	**Flight Line**	**Photo Range**	**Date**	**Low**	**Between**	**Mid**	**Between**	**High**
9-43	A-19982	9 to 43	1967	X				
HT	A-20234	1 to 10	1967					X
68, 69	A-19545	68 to 69	1967				X	
1, 5	A-19575	1 to 5	1967				X	
14, 16	A-19985	14 to 20	1967			X		
67, 70- 78	A-19575	67 to 80	1967			X		
40, 41, 42	A-19514	40 to 42	1967			X		
42, 43	A-19985	40 to 45	1967				X	
101, 109	A-19985	100 to 110	1967				X	
171, 179	A-19985	190 to 170	1967				X	
181	A-19986	180 to 220	1967			X		
63- 70	A-19513	55 to 70	1967				X	
HT	A-19512	130 to 140	1967					X
204- 212	A-19514	196 to 212	1967		X			
43, 45	A-19514	43 to 45	1967			X		
36, 38- 82	A-19995	16 to 90	1967			X		
172- 184	A-20770	172 to 205	1967			X		
1- 22	A-20769	1 to 30	1967		X			
72- 80, 84/ 86	A-20769	60 to 80	1967		X			
55/ 57	A-20771	55 to 65	1967					
81	A-20769	80 to 81	1967					
64- 68	A-20769	163 to 169	1967			X		
47- 50, 53, 55	A-19995	145 to 159	1967				X	
217, 219	A-19995	210 to 221	1967				X	

				Tide Level				
Best Cov	**Flight Line**	**Photo Range**	**Date**	**Low**	**Between**	**Mid**	**Between**	**High**
1, 19	A-18353	1 to 19	1964				X	
27, 31	A-18503	27 to 31	1964	X				
1- 11/ 21, 23, 25	A-18350	1 to 25	1964				X	
75, 101/ 112- 114	A-18356	70 to 120	1964	X				
192- 194	A-18356	180 to 195 & 170 to 165	1964	X				
49- 53	A-18439	49 to 60 & 80 to 82	1964	X				
8, 10	A-18358	5 to 10	1964	X				
44- 48	A-18439	35-42 / 5-10	1964	X				
205- 210	A-18352	207 to 210 & 245 to 250	1964	X				
73- 77	A-18352	115 to 220	1964	X				
204, 205	A-18352	204 to 206 & 160 to 165	1964	X				
217	A-18357	214 to 217 & 252 to 254	1964	X				
29, 31	A-18352	24 to 33	1964	X				
212	A-18357	200 to 213	1964	X				
80- 86, 87	A-18357	78 to 90	1964	X				
61- 65	A-18357	60 to 68	1964	X				

1973 to 1978

Cobequid				Tide Level				
Best Cov	**Flight Line**	**Photo Range**	**Date**	**Low**	**Between**	**Mid**	**Between**	**High**
44- 58	A-30671	44 to 58	1973	X				
76- 101, 102	A-30671	75 to 102	1973	X				
134- 148	A-30671	130 to 155	1973	X				
1, 2, 4	A-30671	1 to 10	1973	X				
211- 217	A-30672	205 to 217	1973	X				
143, 145	A-30672	143 to 150	1973	X				
222/ 224	A-30671	215 to 224	1973	X				
119, 121	A-30893	118 to 125	1973	X				
175, 176, 178	A-30676	175 to 178	1973	X				
80- 98	A-30676	80 to 100	1973	X				
6- 12	A-30676	1 to 15	1973	X				
155- 163	A-30674	155 to 165	1973	X				
157- 161	A-30670	150-160	1973	X				
134, 136	A-30670	130-140	1973		X			
60, 62	A-30670	55 to 65	1973			X		
59- 61	A-30671	59 to 62	1973	X				
188, 190	A-30672	188 to 190	1973	X				
176, 178	A-30671	175 to 178	1973	X				
103, 105	A-30671	103 to 107	1973	X				
41, 43	A-30671	40 to 43	1973	X				
185, 187	A-30672	184 to 187	1973	X				
179, 181	A-30671	179 to 182	1973	X				
213, 215	A-30676	212 to 215	1973	X				
Avon								
Best Cov	**Flight Line**	**Photo Range**	**Date**	**Low**	**Between**	**Mid**	**Between**	**High**
11- 35	77315	11 to 35	1977	X				
156-165	77316	156 to 165	1977	X				
145 to 155	77316	145 to 155	1977	X				
132-144	77316	132 to 144	1977	X				
116-131	77316	116 to 131	1977	X				
95-115	77316	95 to 115	1977	X				
69- 75 / 85-94	77316	69 to 75 & 85 to 94	1977	X				
37- 50 / 65* 68	77316	37 to 50 & 65 to 68	1977	X				
1, 2, 30, 32, 34	77316	1 to 5 & 20 to 36	1977	X				
1, 3, 5/ 29, 31	78350	1 to 5 & 25 to 32	1977				x	
145-149 / 155-161	77301	145 to 161	1977	X				
59- 73	77301	59 to 75	1977	X				
43- 57	77301	40 to 58	1977	X				
46- 62	77300	46 to 65	1977	X				
1, 3/ 6, 7/ 11, 19	77300	1 to 20	1977		X			
	77319	82 to 115	1977					X
	77319	45 to 81	1977					X
24, 26	77317	24 to 30	1977		x			

Cape Split	**Flight Line**	**Photo Range**	**Date**	**Low**	**Between**	**Mid**	**Between**	**High**
2 to 8	75063	1 to 18	1975	X				
91 to 121, 122	75044	94 to 122	1975	X				
77, 84	75044	75 to 93	1975	X				
110, 113, 126, 137	75046	107 to 137	1975	X				
159 to 164, 194, 198, 299	75041	155 to 199	1975			x		
19, 21, 23	75040	1 to 6 & 19 to 25	1975			X		
	Flight Line	**Photo Range**	**Date**	**Low**	**Between**	**Mid**	**Between**	**High**
178- 198	75038	193 to 198	1975		X			
18 to 27/ 31, 35	75044	6 to 42	1975		X			
Truro	**Flight Line**	**Photo Range**	**Date**	**Low**	**Between**	**Mid**	**Between**	**High**
46-48	75040	104 to 128	1975	X				
160	75040	135 to 151	1975	X				
104- 122	75040	152 to 168	1975	X				
189- 189 / 193-196	75040	169 to 196	1975	X				
1- 3	75042	1 to 6	1975	X				
23- 25	75042	22 to 27	1975	X				
43, 45, 47	75042	43 to 48	1975	X				
63, 65	75042	63 to 67	1975	x				
81, 83, 85	75042	81 to 86	1975	x				

1981 to 1987

Cobequid						**Tide Level**		
Best Cov	Flight Line	Photo Range	Date	**Low**	**Between**	**Mid**	**Between**	**High**
25-29	81314	25 to 30	1981		x			
1-5/71-75	81312	1 to 6 & 71 to 75	1981	x				
78-80/153-155	81312	77 to 82 & 153 to 155	1981	x				
159-161	81312	159 to 161	1981	x				
0	81312	103 to 105	1981					x
2-6,10/45-47	81313	1 to 5, 10 & 45 to 47	1981	x				
44-46/97-99	81313	49 to 35 & 97 to 99	1981	x				
102-110/157-159	81313	102 to110 & 157 to 160	1981	x				
31-69	81314	31 to 59	1981		x			
87-88	81314	60 to 89	1981		x			
90-94/122-123	81314	90 to 95 & 120 to 123	1981		x			
124-132/165-167	81314	124 to 135 & 165 to 167	1981		x			
1-7	81314	1 to 7 & 210 to 213	1981		x			
1,2,3	81317	1 to 3	1981		x			
2-4/68-70	81318	1 to 5 & 68 to 70	1981		x			
109-111/176-180	81318	109 to 111 & 176 to 180	1981		x			
196-200	81318	195 to 200	1981		x			
0	81326	15 to 19	1981					x
0	81328	145 to 148 & 155 to 157	1981					x
165-179	81332	165 to 180	1981	x				
97-109	81332	97 to 109	1981		x			
16-26	81332	16 to 28	1981	x				
1-3	81335	1 to 3	1981			x		
0	81336	77 to 85	1981					x
0	81336	4 to 22	1981					x
0	81337	85 to 90	1981					x
0	81337	1 to 10	1981					x
Truro						**Tide Level**		
Best Cov	Flight Line	Photo Range	Date	**Low**	**Between**	**Mid**	**Between**	**High**
0	85306	30 to 105	1985					x
26-36	85308	26 to 36	1985			x		
18-24	85308	18 to 25	1985			x		
1-9	85308	1 to 9	1985			x		
11-17	85308	10 to 17	1985			x		
190-212	85311	187 to 210	1985			x		
62-70	85311	62 to 72	1985			x		
1-7	85311	1 to 7 & 210 to 213	1985			x		
123-125	85311	123 to 127	1985			x		
56-58	85312	56 to 58	1985		x			
77-79	85313	77 to 79	1985	x				
36-40	85313	36 to 40	1985	x				
1-5	85313	1 to 5	1985	x				
1-54	85315	1 to 60	1985			x		
92-97 / 105-111	85316	92 to 110	1985	x				
2-4	85316	2 to 4	1985		x			
2-4	85317	1 to 5	1985	x				
0	85319	1 to 5	1985					x
2-4	85321	1 to 5	1985	x				
2-4	85325	2 to 4	1985	x				
128-130	85330	128 to 132	1985	x				
199-200	85330	198 to 200	1985	x				
2-4	85331	1 to 5	1985				x	
Avon						**Tide Level**		
Best Cov	Flight Line	Photo Range	Date	**Low**	**Between**	**Mid**	**Between**	**High**
n/a	87301	43 to 46	1987			x		
32-46	87301	32 to 42	1987			x		
76-82	87301	76 to 83	1987			x		
67-70/73-75	87301	67 to 70 & 73 to 75	1987			x		
56-58/63-65	87301	56 to 58 & 63 to 65	1987			x		
84-86/92-94	87301	84 to 86 & 92 to 94	1987			x		
0	87301	17 to 21 & 29 to 31	1987					x
0	87301	14 to 16	1987					x
151-153	87304	150 top 153	1987				x	
128-132	87304	127 to 132	1987				x	
104-106	87304	102 to 106	1987				x	
74-76	87304	74 to 76	1987				x	
0	87304	200 to 214	1987					x
55-67	87305	55 to 67	1987				x	
110/111-117/125-127	87305	110 to 117 & 125 to 127	1987				x	
170-174/190-192	87305	170 to 175 & 190 to 192	1987				x	
93-95	87307	93 to 95	1987	x				
33-41	87323	34 to 41	1987	x				

1991 to 1995

Avon River						Tide Level		
Best Cov	Flight Line	Photo Range	Date	Low	Between	Mid	Between	High
154-158/163-165	92316	154 to 158 & 163 to 165	1992	x				
141-145	92316	141 to 145 & 151 to 153	1992	x				
115-117	92316	115 to 118	1992	x				
90-92	92316	88 to 92	1992	x				
93-95	92305	193 to 195	1992				x	
55	92318	50 to 68	1992				x	
45-47/52-54 & 58	92302	43 to 58	1992	x				
170-178/183-185/189-199	92303	170 to 185 & 190 to 195	1992			x		
95-101/108-110/117,124	92317	95 to 112 & 118 to 124	1992				x	
49-63	92316	48 to 58	1992	x				
96, 108	92343	96 to 108	1992	x				
19, 26, 30	92344	18 to 23 & 26 to 30	1992	x				
61-63/67,98	92301	62 to 64 & 66 to 68	1992	x				
0	92391	82 to 84	1992					x
26-32/77-81	92391	25 to 84	1992				x	
2-6/10-12	92391	1 to 11	1992			x		
1-5	92385	1 to 6	1992			x		
1-5	92319	1 to 5	1992				x	
141-143	92318	141 to 143	1992				x	
19-23	92317	19 to 23	1992			x		
Cobequid						**Tide Level**		
Best Cov	**Flight Line**	**Photo Range**	**Date**	**Low**	**Between**	**Mid**	**Between**	**High**
123-129	94012	123 to 130	1994	x				
2-6	94001	1 to 6	1994	x				
112-122	94012	111 to 122	1994	x				
10-14/24-48	94009	10 to 14 & 24 to 46	1994		x			
53-57	94002	52 to 58	1994		x			
7-9	94001	7 to 9	1994	x				
198-202	92314	197 to 202	1994	x				
1-9/ 13 / 17-23	92334	1 to 25	1994	x				
137-141/145-147	92333	136 to 141 & 145 to 147	1994	x				
94-102	92333	93 to 94	1994	x				
46-56	92333	46 to 52 & 54 to 56	1994	x				
Truro						**Tide Level**		
Best Cov	**Flight Line**	**Photo Range**	**Date**	**Low**	**Between**	**Mid**	**Between**	**High**
59-75	94002	60-70 / 74-76	1994		x			
73	94001	67 to 73	1994	x				
124-128	94001	124 to 128	1994	x				
1-3	94002	1 to 3	1994	x				
68-70	94011	98 to 70	1994	x				
197-199	94011	196 to 198	1994	x				
1-3	94011	1 to 3	1994	x				
132-134	94011	132 to 134	1994	x				
204	92314	203 to 204	1992	x				
35-66	92334	63 to 66	1992	x				
31-33	92334	31 to 34	1992	x				
166-168	92333	166 to 168	1992	x				
131-135	92333	132 to 134	1992	x				
90-92	92333	89 to 92	1992	x				
Cape Split						**Tide Level**		
Best Cov	**Flight Line**	**Photo Range**	**Date**	**Low**	**Between**	**Mid**	**Between**	**High**
97-74	94008	67 to 74	1991					x
0	94001	247 to 255	1993					x
1-9	94008	1 to 9	1991					x
2-6	94007	1 to 2	1991			x		
190-194/201-206	94014	195 to 201	1991	x				
22-24	94013	22 to 24	1991	x				
1-3	94009	1 to 3	1991	x				
44-48	94009	44 to 48	1991	x				
0	94014	189 to 193	1991					x
1-9	95020	1 to 9	1995		x			
11-37	95020	10 to 37	1995		x			
0	95007	58 to 64 & 70 to 86	1995					x
0	95008	179 to 181 & 190 to 199	1995					x
114-129	94017	114 to 123	1994	x				
1-9	94009	1 to 9	1994			x		
2-8	94007	1 to 9	1994				x	
2-6	92317	1 to 6	1992	x				
8-18	92317	7 to 18	1992	x				
195-197/200-202	92316	194 to 203	1992	x				
186-187/191-192	92316	186 to 193	1992	x				
177-179/183-185	92316	177 to 185	1992	x				
160-176	92316	166 to 176	1992	x				

2000's

Avon River

				Tide Level				
Best Cov	**Flight Line**	**Photo Range**	**Date**	**Low**	**Between**	**Mid**	**Between**	**High**
119, 121	02307	119 to 121	2002	X				
148	02307	145 to 148	2002	X				
179, 181	02307	179 to 181	2002	X				
71, 72	02307	70 to 72	2002	X				
90, 92/ 98, 99	02307	90 to 92 & 98 to 100	2002	X				
2, 4	02308	1 to 4	2002	X				
13, 15	02308	111 to 115	2002	X				
153, 159- 161	02308	153 to 165	2002	X				
37, 38	02308	36 to 38	2002			x		
81- 87	02308	81 to 87	2002	X				
76, 80	02308	83 to 80	2002	X				
1, 7/ 11, 16,	02309	1 to 7 & 111 to 118	2002	X				
121- 125 / 138, 142/ 131, 133	02322	115 to 125 & 129 to 142	2002		X			
147- 149/ 173	02322	142 to 153 & 160 to 175	2002			X		
110, 112, 114	02327	112 to 114	2002				X	
143, 145, 147	02329	142 to 146	2002					x
189, 195,197 ,202, 203	02329	189 to 203	2002		X			
14 / 23, 25	03301	15 to 17	2003			X		
18,20	03302	14 to 22	2003			X		
	03308	162 to 164 & 169 to 173	2003					X
	03308	3 to 12	2003					X
	03308	91 to 107	2003					X
14-22	03317	14 to 22	2003	X				
89- 99	03321	90 to 96	2003	X				
1, 3/ 14, 16	04308	1 to 3	2004			X		
83, 84/ 29, 31, 33/ 40, 42	04308	83 to 84	2004			x		
	04317	10 to 16	2004					X
	04317	150 to 154	2004					X
	04317	86 to 94	2004					X
	04318	1 to 4	2004					X
94- 100	04322	93 to 100	2004		X			
2, 3	04325	17 to 19	2004			X		
1, 3, 5	04328	1 to 5	2004			X		
1, 3, 5	04331	1 to 5	2004					X
42705	04331	12 to 16	2004					X

Truro

				Tide Level				
Best Cov	Flight Line	Photo Range	Date	**Low**	**Between**	**Mid**	**Between**	**High**
61- 78	04316	67 to 80	2004	X				
10- 26	04312	8 to 26	2004			X		
199- 197	04312	193 to 196	2004			X		
93- 101	04320	91 to 100	2004		X			
22- 24	04320	21 to 24	2004				X	
183, 185, 187	04320	184 to 187	2004		X			
31, 33	04321	31 to 33	2004		X			
103, 105	04321	103 to 105	2004	X				
51, 55	04322	51 to 55	2004	X				
102, 104	04323	102 to 104	2004	X				

Cobequid

				Tide Level				
Best Cov	Flight Line	Photo Range	Date	**Low**	**Between**	**Mid**	**Between**	**High**
1- 7	04314	1 to 7	2004	X				
9- 15	04314	8 to 16	2004	X		X		
147- 151	04311	146 to 151	2004				X	
	04312	135 to 187	2004					X
81, 83, 85	04306	81 to 85 & 97 to 116	2004	X				
	04312	1 to 8	2004					X
	04316	61 to 67	2004					
88, 90	04320	87 to 91	2004				X	
1- 21	04320	1 to 21	2004				X	
156- 180	04320	156 to 180	2004	X				
1- 11	04321	1 to 4 & 8 to 12	2004			X		
26- 34	04304	25 to 34	2004		X			
46- 56	04324	46 to 55	2004	X				
56- 60	04325	55 to 60	2004	X				

Cape split

				Tide Level				
Best Cov	Flight Line	Photo Range	Date	**Low**	**Between**	**Mid**	**Between**	**High**
	04317	1 to 9	2004					X
121- 145	04311	121 to 145	2004				X	
95- 121	04306	98 to 136	2004	X				
12, 14, 16, 18, 20	04313	53 to 55 & 64 to 65 & 72 to 78	2004					X
33- 43	02307	10 to 21	2002			X		
2, 3/ 6, 8	02307	32 to 43	2002			X		
22, 24/ 29, 30	02307	1 to 3 & 7 to 9	2002				X	
45, 47/ 52, 54	02307	22 to 24 & 29 to 31	2002			X		