

HISTORICAL MAPS OF GRAND LAKE MEADOWS

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HISTORICAL MAPS OF GRAND LAKE MEADOWS

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PREFACE

This technical report is a reproduction of a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Engineering in the Department of Geodesy and Geomatics Engineering, December 2013. The research was supervised by Dr. Emmanuel Stefanakis, and funding was provided by the Grand Lake Meadows Endowment Fund.

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ABSTRACT

Grand Lake Meadows is a historically and ecologically significant wetland in New Brunswick. This research studied Grand Lake Meadows through the analysis of historical maps held at the Provincial Archives of New Brunswick. The map analysis aimed to uncover previously unknown societal and geomorphological information about the area. Once the historical maps were identified, analyzed, and georeferenced, they were posted on the internet and made accessible through dynamic web-based map mashups using OpenLayers and Web Map Services. A series of supporting web pages were created to encourage site visitors to explore the Grand Lake Meadows historical maps through a series of puzzles and quizzes created with Hypertext Preprocessor, JavaScript, and Scalable Vector Graphics. The website aims to support existing initiatives which promote awareness and the significance of this area.

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List of Symbols, Nomenclature or Abbreviations

API	Application Programming Interface
BP	Before Present
CFB	Canadian Forces Base
CGI	Common Gateway Interface
CSS	Cascading Style Sheets
DNR	Department of Natural Resources
GDAL	Geospatial Data Abstraction Library
GGE	Geodesy and Geomatics Engineering
GIS	Geographic Information System
GNB	Government of New Brunswick
GLM	Grand Lake Meadows
GLMPMC	Grand Lake Meadows Project Management Committee
HA	Hectares
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
JPG	Joint Photographic Experts Group
JS	JavaScript
KM	Kilometres
KML	Keyhole Markup Language
MB	Megabyte
MP4	Moving Picture Expert Group Layer 4 (movie file format)
NRCan	Natural Resources Canada
NBDNR	New Brunswick Department of Natural Resources
OGC	Open Geospatial Consortium
OWS	OGC web services
PBA	Project Boundary Area
PHP	Hypertext Preprocessor
PID	Parcel Identifier
PNG	Portable Network Graphics (image file format)
SNB	Service New Brunswick
SVG	Scalable Vector Graphics
TIFF	Tagged Image File Format
TPS	Thin Plate Spline
USB	Universal Serial Bus
UML	Unified Model Language
UNB	University of New Brunswick
URL	Uniform Resource Locator
W3C	World Wide Web Consortium
WCS	Web Coverage Service
WMS	Web Map Service

1. INTRODUCTION

A map is a visual representation of a place in time. A well-designed map can often communicate historical information to a reader more quickly and simply than text [University of Saskatchewan, 2013]. Additionally, as place names and boundaries change over time, a series of historical maps are an excellent medium to follow this migration path [Miller-Wilson, 2013]. This research aims to analyze a collection of historical maps to uncover previously unknown information about Grand Lake Meadows (GLM). Specifically of interest is identifying any societal or geomorphological changes in GLM as identified through historical map analysis. The results of this research, including digital copies of the historical maps, are accessible online (http://gaia.gge.unb.ca/glm/en/index_en.html). A combination of map-mashups, puzzles, and quizzes have been developed to encourage site visitors to explore the historical map collection and to learn more about this wonderfully unique area.

1.1. Background

Located in central New Brunswick, and spanning both Sunbury and Queens counties, GLM is considered a historically and ecologically significant area in the province (Figure 1.1). GLM is the largest freshwater marsh/wetland in the province with

a total area of over 5,000 hectares (ha) [Paponnet-Cantat and Black, 2003]. The boundaries of GLM as used in this research follow the definition as put forth by Washburn and Gillis Associates Ltd [1996].

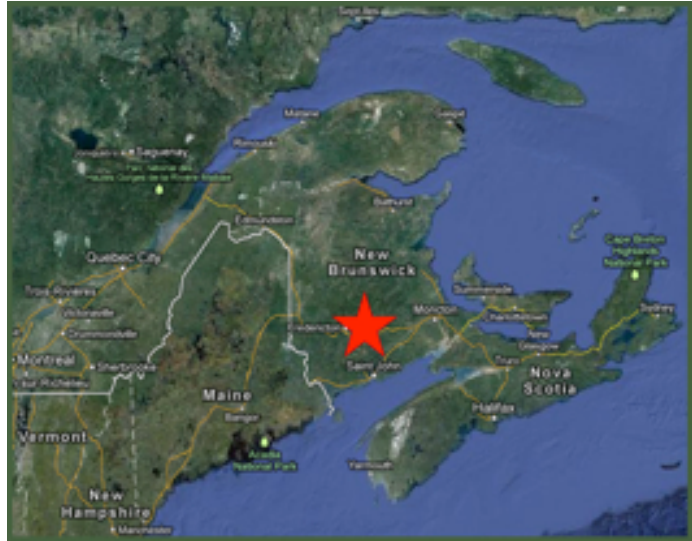
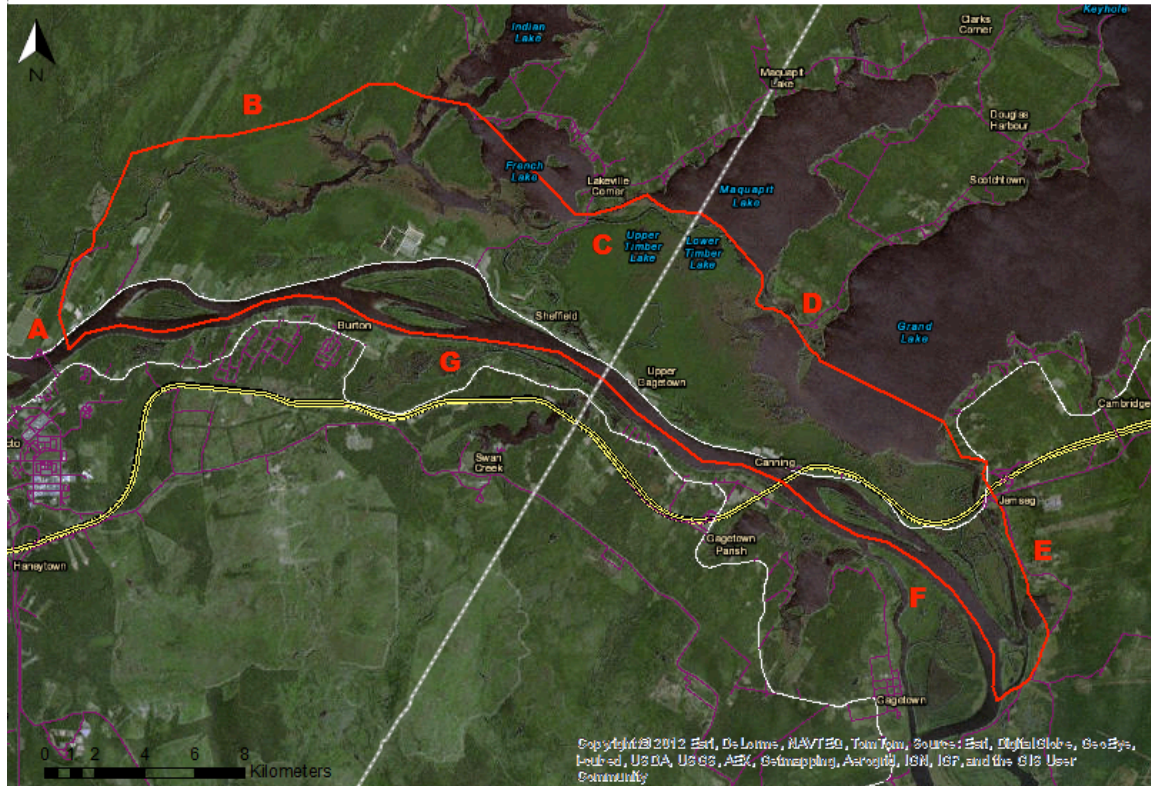


Figure 1.1
Grand Lake Meadows location in New Brunswick.

Washburn and Gillis [1996] were responsible for a preliminary environmental impact assessment of the proposed rerouting of the Trans-Canada highway in the 1990s and defined the area of GLM as being bounded: on the east by the Jemseg River: to the north by various bodies of water including Grand Lake, Back Lake, Maquapit Lake, French Lake, and two extensive thoroughfares - the Main Thoroughfare and the Lower Thoroughfare: the southern extent of the GLM area is bound by the Saint John River: the western limit as being a road that connects McGowans Corner to Lakeville Corner [Washburn & Gillis, 1996; Paponnet-Cantat and Black, 2003], as shown in Figure 1.2.

GLM is known for its diverse ecology and the abundant wildlife: especially its waterfowl during the spring and fall migration [Zelazny, 2013]. This diversity is due to three factors: (a) the presence of Grand Lake, (b) extensive floodplains, and (c) the presiding water levels over the growing season [Zelazny, 2013]. The GLM project area



Legend

NBRoads
 — <all other values>

ROADCLASS
 — Highway
 StudyArea
 World Imagery

Study Area:

A: western most extent
 B: across Portobello Creek National Wildlife Area
 C: Main Thoroughfare: French to Maquapit Lake
 D: Lower Thoroughfare: Maquapit to Grand Lake
 E: Jemseg River
 F: study area north of Gagetown Island
 G: study area follows St. John River

NB Roads dataset courtesy of Service New Brunswick

Figure 1.2
 Grand Lake Meadows project boundary.

consists primarily of a broad flat floodplain and wetland meadow with elevations ranging from sea level up to ~16 meters [Paponnet-Cantat and Black, 2003] (see Figure 1.3).

The classification of ‘Floodplain Wetland’ is used for GLM because on any given year approximately 85% of the area is inundated by seasonal floodwaters [Dickinson, 2008]. In addition to the seasonal floodwaters, tidal effects displace water in GLM. The Bay of Fundy experiences the worlds largest tides, with a peak tidal range of over 16

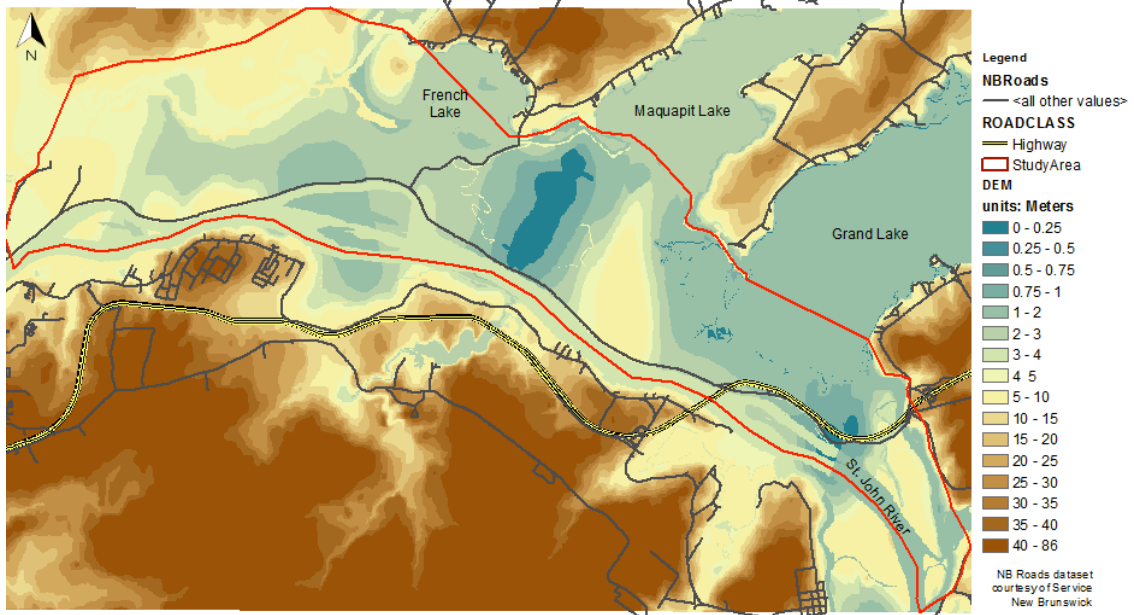


Figure 1.3

Digital Elevation model (DEM), Grand Lake Meadows. DEM data from Geobase.ca.

metres [Force, 2013]. The effect of the tides are observed in the GLM project area and reach as far up the St. John River as Fredericton, NB. This diurnal tidal effect causes widespread flooding and deposits a thin new layer of soil in GLM [GNB, 2013].

“Outside of the flood season GLM contains almost 22,000 ha of open water with swamps and marshes concentrated in several areas” [Dzikowski, Kirby, Read and Richards, 1984; NBDNR, 1998; Dickinson, 2008]. Nearly 82% of this open water (17,870 ha) is considered part of Grand Lake. Grand Lake is the largest open body of water in New Brunswick being a total of 20 kilometres (km) long and five km wide [GNB, 2013]. This large body of water acts as a heat sink: moderating local temperatures, creating the warmest climate in the province, and extending the growing season [D’Arcy, 2008]. The climate modification influence of Grand Lake coupled with moist, rich soils has yielded a unique collection of diverse vegetation and wildlife species

in GLM [Zelazny, 2013]. Additionally, GLM contains the largest number of tree species found in New Brunswick, including the Silver Maple, Butternut, and Bur Oak, each of which has adapted to the high flooding frequency and are scarce outside the region [Zelazny, 2013].

With records dating as far back as 6000 years [Paponnet-Cantat and Black, 2003] human settlers have been attracted to GLM for several reasons. The system of rivers and lakes provides relatively easy transportation and fresh water fishing year-round [GLM, 2013]. The rich, moist soil found in GLM was excellent for planting crops, while the moderated climate and rich ecosystem was full of animals which provided meat and leather skins for clothing and shelter [Wright, 1949 (p112)]. Additionally many resources were available for making tools and medicines [Queens County Heritage, 2013].

Records indicate that by the early 1600s GLM was inhabited by Maliseet (Wolastoqiyik) and Mi'kmaq people [Zelazny, 2013]. During the 17th and 18th centuries settlers including the Dutch, English, French, and Loyalists came to this area and vied for these rich resources [Queens County Heritage, 2013]. In 1659 the first English trading post on the St. John River was established at the mouth of the Jemseg River [Wright, 1949 (p112)]. In 1667 the land was turned over to French control and the trading post began to be used for both trading and military influence [Genealogist, 2009]. Between 1674 and 1783 many battles were fought for ownership and control of this area. More settlers arrived in GLM beginning in 1783. These were primarily expelled Loyalists

from America who, during and after the American Revolution, settled in and around GLM [Genealogist, 2009].

In the 1800s' land disputes dissipated. Coal and lumber industries emerged and became very prosperous, attracting more settlers [Wright ,1949 (p115)]. As these additional settlers arrived, the resources in GLM were exploited at an increasing pace. Evidence of resource depletion was recognized in the 1880s. A progressive forest program by the newly formed, Canadian Forestry Association was developed [Summerby-Murray and Campbell, 2013 (p125)] to manage the use and consumption of forest resources. After nearly 20 years, the Forests Act was passed in NB.

At the beginning of the Cold War in 1947 the Canadian government was looking for a location to establish a suitable training facility for the Canadian Army [Bruce, 2013]. The area under consideration was the plateau west of the St. John River between St. John and Fredericton. In the early 1950s the expropriation of lands began as the construction of facilities for Canadian Forces Base (CFB) Gagetown began in the village of Oromocto [GovCda, 2013]. This expropriation is referred to by some as the “end of farming” in the area as settlers were forced from their land and relocated to other areas in the province [Shalala D'Aoust, 2013]. This base and expropriation of lands, while being outside to the GLM project area, impacted those living in GLM.

Transportation routes in the region were improved to facilitate this base. The improvements included railway connections provided by the Canadian National and the Canadian Pacific Railway, a new alignment of the Trans-Canada Highway (Route 2) in the early 1960s, and the construction of a new bridge across the St. John River at the

village of Burton [FoundLocally, 2013]. In the late 1990s another re-alignment of the Trans-Canada Highway began. This expanded the Trans-Canada Highway to a 4-lane freeway in order to meet the regions growing transportation needs and was completed in 2001 [GNB, 2013]. This highway traversed six kilometers of GLM and involved building two new bridges: one over the St. John River and the other spanning Jemseg River and affected an estimated 55 ha of GLM wetlands [Blair, 2004].

In 1990 the New Brunswick provincial government declared GLM a “provincially significant area” [GLM, 2013]. This land received a classification of “Class II Protected Natural Area” - which limits use of the area to low-impact recreational activities and traditional food gathering activities, while restricting industrial commercial and agricultural developments [Zelazny, 2013]. The Province of NB partnered with the five other easternmost provinces, the Canadian Wildlife Service, Ducks Unlimited Canada, and Wildlife Habitat Canada to form the Eastern Habitat Joint Venture [PCNWA/GLM Mgmt. Plan, 2000]. Since establishing this joint venture 3,050 ha of land in GLM has been secured [PCNWA/GLM Mgmt. Plan, 2000]. Additionally, the GLM Project Management Committee (GLMPMC) was developed in order to raise awareness of the cultural and historical significance of this area.

The wonderfully unique ecology of the GLM project area led to a history of increasing settlement, the increasing settlement led to a profusion of development, and the profusion of development led to concerns over a threat to its ecology – which has given rise to the strong desire to protect the area and increase awareness of its importance. But this is just an overview. This research examines the details of the

historical map collections, and aims to uncover previously unknown details of the area and will aid towards this increase in awareness.

1.2. Research Question

Can previously unknown information about Grand Lake Meadows be uncovered through the analysis of historical maps?

1.3. Research Objectives

The objectives of this research are threefold:

- Creation of table which identifies historical maps within the project boundary area. This table will include the date, description, and location at Provincial Archives of New Brunswick (PANB) where the original maps may be found.
- Identification of changes in land use and an evaluation of the geomorphological and societal changes within GLM from the 18th century to present day.
- Development of an on-line educational and awareness program about GLM. Though the content will be geared towards New Brunswick middle school children, it will be accessible to all.

1.4. Methodology

The methodology followed is shown in Figure 1.4. Each of the steps listed will be described in detail in subsequent chapters of this thesis.



Figure 1.4
Methodology

1.5. Thesis Organization

The remainder of the thesis is outlined as follows: in Chapter 2, types of historical documents are introduced, including source document classifications and primary source documents. Also found in this chapter is an introduction to the methodology employed for the analysis of historical maps. This is followed by a review of the existing research

and historical knowledge as it pertains to GLM in Chapter 3. Chapter 4 describes the methodology in greater detail: from how the historical maps were identified, scanned, and analyzed, to how they were made available to the public via the internet. Chapter 4 also includes details of the education component implemented on the website and the “teachers only” content, which is based upon the framework of the Historical Thinking Project. In Chapter 5 website performance, validation, and assessments are discussed. Finally, in Chapter 6 the project findings are summarized and recommendations for future research within GLM are described.

2. REVIEW OF AVAILABLE HISTORICAL RESOURCES, ANALYSIS, AND PROCUREMENT

Before getting into the details of the map collections, a brief general discussion about historical documents, the need to critically analyze them, and the most effective ways of learning from them is described.

2.1. Historical Documentation: Categories and Source Types

Seven distinct categories of historical documentation have been recognized: (a) maps/geographic information system (GIS), (b) interviews, (c) legal records and government documents, (d) images, (e) manuscript and artifact collections, (f) periodicals/newspapers/magazines, and (g) scientific and quantitative data [Wagstaff and Gant, 2009]. Of these categories, maps are unique in that they contain information not retained by any other source [Rumsey and Williams, 2013]. The old adage ‘a picture is worth a thousand words’ applies not only to photographs, but even more so towards maps, as maps are an effective tool for visualization and for rapid communication of information [Seager, 2005]. The “form” or “style” of a map provides insight into a past era and culture, and the “substance” literally provides a record of past landscapes and features, some of which may no longer exist [Seager, 2005]. A particular advantage of a

map is the ability to convey nonlinear and simultaneous knowledge [Seager, 2005].

Maps portray in a single page, a rich contextualization which may, in text, take many pages to convey [Seager, 2005]. While a single historical map is able to show static information from a moment in time, a collection of maps over an extended period of time is very effective at illustrating changes over time.

Maps are the main documents which are being analyzed in this research and are considered a “primary source” type document (some maps - those merely incorporating and adapting existing material – may be considered “secondary source” documents, however the maps of interest in this research are all primary source documents). For historical research purposes, primary source documents are always preferred - regardless of the document category. A primary source document is one that has the least degrees of separation with the subject that is being studied: it is closest in both time and space [Wagstaff and Gant, 2009]. Primary source documents are written or created during the time under investigation, and the sources were present during the event or time [Princeton, 2013]. Examples of primary source documents include: original documents (e.g., letters, diaries, interviews, maps), creative works (e.g., poetry, novels, music, art), and relicts or artifacts (e.g., pottery, furniture, clothing) [Princeton, 2013]. If primary source documents are unavailable, secondary source documents may be used. Secondary source documents are those that are directly related to, or explicitly “about” a primary source - but are one or more steps removed from the event [Wagstaff and Gant, 2009; Princeton, 2013]. Secondary source documents may include publications such as textbooks, magazine articles, commentaries, or encyclopedias [Princeton, 2013].

2.2. Critical Analysis: Reading Historical Documents

Regardless of category or source type, historical documents require analysis to evaluate their content. Each category of historical documents contain a unique set of information, and therefore the analysis of each varies slightly. Common questions which are asked and answered the during analysis of any document category include:

- Who is the author?
 - Determining the author of the document may lead to additional questions including: are any other details known about the author (e.g., age, profession, gender), possible biases or motivation, and whether the author was an observer or participant [Bélanger, 2006].
- Time and location of creation?
 - Time and location are important to deduce as these may influence the content of the historical document [Bélanger, 2006]. This will also identify whether the document is a primary or secondary source document.
- Who was the document intended for?
 - Whether the document was intended for private or public consumption can also effect the interpretation and analysis [Bélanger, 2006].
- Is it consistent with other historical documents of the time and location?

- One needs to evaluate the content of the historical document for consistency or contradictions with other sources, as any errors or allusions made by the author may need to be further analyzed or explained [Bélanger, 2006].

Specifically, with respect to the analysis of maps, many researchers follow a template similar to that found in Figure 2.1, which is presently used by researchers at Harriet Irving Library, UNB. Creating and using a map analysis worksheet provides a standardized framework for questions which are to be asked and answered with respect to each map. Furthermore, maps “are embedded in a history they help to construct” [Wood, Fels, & Thomas Leiper Kane Collection, 1992], this means that although maps may appear to be simply factual, they must be read as contextualized documents [Seager, 2005]. Maps do not just reflect reality, they help to create it [Seager, 2005]. In analysis it is important to identify the moment in time a map was created and the social and personal context of those making it, as maps can and do inherit the influence and interest of the map makers [Seager, 2005]. Mapmakers place on a map what the user needs to see to support their purposes, and they adjust the levels of details on the map accordingly. It is therefore important to know the purpose of a map in order to explore beyond the map itself [Seager, 2005].

1. Take a moment to look at the map carefully. Identify a few key features about the map that will help you find the location depicted:
 - a. _____
 - b. _____
 - c. _____
 - d. _____

2. What is the date of the map?

3. List 3 unique characteristics of the map that differentiate it from a map of today:
 - a. _____
 - b. _____
 - c. _____

4. What is the evidence in the map that suggests why it was drawn?

5. In order to find the location on this map, what question would you ask the map maker about this map?

Figure 2.1
Map Analysis Worksheet from UNB, Harriet Irving Library

2.3. Historical Documents in Education

This research project has been undertaken with the support of the Grand Lake Meadows Project Management Committee (GLMPMC), with one of the stated aims

being the development of a web-based educational component describing the history of the area. This has been pursued while adhering to current ideas and practices in teaching historical material.

Using historical documents is one of the easiest and most engaging ways to teach young people how to think critically and make sound decisions [Edmonds, Hull, Janik, and Rylance, 2005]. Many educators and developers of curriculum are in the process of revising education content and teaching styles with an emphasis on critical thinking skills in children [Canadian Heritage, 2013]. A project called ‘The Historical Thinking Project’ was designed to foster this new approach to historical education [Canadian Heritage, 2013]. The intention is to teach history in a more meaningful way and to include assessment as well as exercises which foster learning and curiosity in students [Canadian Heritage, 2013] - as opposed to previous methods which focused primarily on memorization and recitation. This framework promoted by The Historical Thinking Project revolves around six core concepts, namely: historical significance, cause and consequence, historical perspective-taking, continuity and change, use of primary source evidence, and the ethical dimension of history [Canadian Heritage, 2013].

- Historical significance centres around reviewing historical events and determining which elements are significant. To classify an event as “significant” the event must have resulted in great change over a long period of time and affected a great number of people,
- Cause and consequence can be thought of as determining the underlying or preceding conditions that led to this significant event.

- The premise of historical perspective-taking is to try to understand the vantage point of someone living (for example) in the 1700s.
- However this can be quite difficult. Students are encouraged to practice ‘historical empathy’, where they attempt to understand the social, cultural, intellectual, and emotional circumstances which shaped the lives of now historical figures.
- Once students are able to understand history as a series of interconnected events (instead of a list of events) they reach a different sense of the past and are better able to identify continuity and change.
- Using primary source evidence is our most direct connection to history, since this evidence originated during the time and in the place being investigated.
- The final historical thinking framework relates to ethical dimensions. Ethical dimensions can be thought of as: “What responsibilities do historical crimes and sacrifices impose upon us today?” [Canadian Heritage, 2013], or by understanding and making judgements between the state of our present day society and those of “bygone societies”.

2.4. Historical Collections

The Provincial Archives of New Brunswick (PANB) “collects, preserves and makes available” [GNB Archives, 2013] historical records for the province of New

Brunswick. These records, which depict and have bearing upon the history of New Brunswick, are available and accessible to all [GNB Archives, 2013]. Record classifications that are accessible at PANB include (but are not limited to): birth records, marriage certificates, census records, land grants, and school registration records.

A number of PANB map collections were accessed, reviewed, and incorporated in this research. The majority of the maps found at PANB are in the Land Grants collection: these maps identify individuals and corporate bodies who acquired Crown Land [GNB Archives, 2013]. The Land Grant records “were created and maintained by the Surveyor General, cum Commissioner of Crown Lands, cum Commissioner of Lands and Mines, cum Minister of Natural Resources, cum Minister of Natural Resources and Energy” [GNB Archives, 2013]. The earliest maps found in the Land Records collections at PANB were from 1783 and the earliest found within the GLM project boundary area are from 1785. A selection of PANB resource collections which were used in this project are listed in Table 2.1. The collections used were identified by the index (white finding aid) which is available from the front desk at PANB. The finding aid is a binder which describes the content of each microfiche in any given collection [GNB Archives, 2013]. Many of these collections are readily available for viewing, though some require a request be submitted in order to retrieve the resource. The map holdings at PANB are public holdings and there are presently no copyright restrictions in place on their use or distribution.

In addition to the PANB resources, historical maps from Archives & Special Collections at Harriet Irving Library (HIL) UNB, the New Brunswick Museum

Table 2.1
Research Collections held at PANB which were used

Collection ID	Collection Long Name	Source/Format
RS656-34	Crown Lands Maps and Plans	Microfiche
RS656-1J	Crown Lands Maps and Plans	Microfiche
RS656-1K	Crown Lands Maps and Plans	Microfiche
RS656-7	Crown Lands Maps and Plans	Microfiche
RS656-17S	Crown Lands Maps and Plans	Microfiche
RS686C	New Brunswick Land Grants, 1784-1997	Microfilm: F17274, F17285
RS687B	Land Grant Survey Plans	Microfiche

and the NB Department of Natural Resources (DNR), Public Services (http://www2.gnb.ca/content/gnb/en/services/services_renderer.15496.html) were also obtained and utilized in this research. A few maps were also found online at GeoGratis, the Natural Resources Canada site (<http://geogratis.gc.ca/geogratis/Home?lang=en>).

The Archives and Special Collections houses a collection of books, periodicals, and maps. These holdings are available for all members of the university as well as those outside the university to review [Archives and Special Collections, 2013]. The map collections held at the Archives and Special Collections at HIL, UNB were reviewed and one map which illustrates the settlement patterns in the 1800s in New Brunswick was found and used. Due to Crown copyright and licensing restrictions, this map was not allowed to be posted on-line. In place of posting the map online, data were digitized from this map and this data was used in the web application. Typically, the maps at Archives and Special Collections are not at readily available for viewing. It is

recommended to review the Rolodex of available maps and submit a request to have the maps retrieved from the archives.

The DNR, Public Services hosts a large collection (over 100,000) of digital aerial photographs dating back to 1928 [GNB, 2013]. These photographs are available for purchase at a price of \$12.00 each (as of 09/2013). The process of acquiring the aerial photographs from DNR, Public Services is quite easy: one can simply email a request or visit their office (http://www2.gnb.ca/content/gnb/en/services/services_renderer_15496.html). For this research, only one parcel of land (PID) was requested and aerial photographs from 1934, 1945, and 1951 were acquired. Additional images for the remainder of the 1900s could have been acquired for this PID or other PIDs in GLM. It was decided that acquiring and analysis of the entire project area aerial photography to this project would be cost prohibitive and beyond the proposed scope of work. It is recommended that future research could undertake this task. As with the maps from Archives and Special Collections the aerial photographs from DNR, Public Services have some usage restrictions. The main restriction is that visitors are not able to download and save the full resolution image from any site other than DNR, Public Services.

3. PREVIOUS RESEARCH

Considering the significance and importance of GLM to New Brunswick, this region has understandably been the subject of previous studies. Primarily this previous interest has focused on the flora and fauna of the meadows, although research has also been conducted with respect to native people, immigrant settlers, transportation within the meadows, and public attachment to the area.

3.1. Fauna

A scientific literature review of published research on the flora and fauna of the meadows was completed in 2001 by Legere [2001]. This review was undertaken to determine if there was a lack of information regarding any species within GLM. Legere [2001] found extensive research regarding fish and bird species, but limited research pertaining to mammals, invertebrates, and herptiles.

The extensive birding research is due, in large part, to the unique ecosystem within GLM which provides habitat for nearly all of the bird species found in New Brunswick [Washburn and Gillis, 1996]. At the time of Legere's report (in 2001) approximately 120 different species of birds had been observed in GLM. As noted by Kroodsma [1978] in Washburn and Gillis [1996] much of the distribution and nesting

habitats of bird species is well reported for the spring and summer months: however, the winter activities remain relatively undocumented. Legere [2001] found Ducks Unlimited are responsible for many improvements with respect to water level management strategies and maintenance of stable water levels within GLM specifically to increase the population of brood-rearing waterfowl.

Within the province of New Brunswick 55 different species of mammals have been identified [Legere, 2001]. Twenty-four of these 55 species have been found to inhabit or use the wetland [Legere, 2001]. Of the large mammals which were identified, deer and moose are considered to be the most abundant in GLM, though very little has been documented regarding their habitation [Legere, 2001]. Legere recommended further studies should be conducted with respect to mammals in GLM: specifically large mammals such as deer and moose. Additional recommendations include research on herptiles and invertebrates as limited information has been found for either of these groups [Legere, 2001].

3.2. Flora

In 2006, a report entitled 'Flora of the Grand Lake Meadows' was published on behalf of the New Brunswick Federation of Naturalists. This work, completed by Papoulias, Chaplin, and Bishop (Papoulias et al., 2006) resulted in an extensive catalogue

of the vascular plant species within the GLM project boundary area as well as descriptive habitat and community types within GLM.

The vascular plant survey took place between 2004 - 2005 and vegetation was identified via aerial photo interpretation and field analysis. A total of 480 different vascular plant species (or subspecies) belonging to 86 different families were documented [Papoulias et al., 2006]. Of these vascular plants 23% are considered exotics or naturalized exotics [Papoulias et al., 2006]. They found 20% of all the vascular plants found in GLM were rare or considered 'uncommon' throughout the rest of the province. A total of sixteen different habitat or community types were described within the GLM [Papoulias et al., 2006] - these are illustrated in Figure 3.1. Papoulias et al. [2006] took these 16 community types and separated them into four broad categories based on their disturbance regimes: aquatic, wetlands, floodplains, and disturbed habitats. Papoulias et al. [2006] defined each of these categories as follows:

- The aquatic category is identified as permanently flooded bodies
- The wetland category is composed of relatively flat land that is flooded for part of the year, typically related to the spring freshet. Primarily represented by yellows and oranges in Figure 3.1
- The classification of floodplain was given to the slightly elevated areas, found primarily along the northern shore of the St. John River, which experiences brief spring flooding and are indicated in Figure 3.1. by pink and green
- Disturbed habitats are those that have been altered by human activity, and are shown in light and dark grey in Figure 3.1

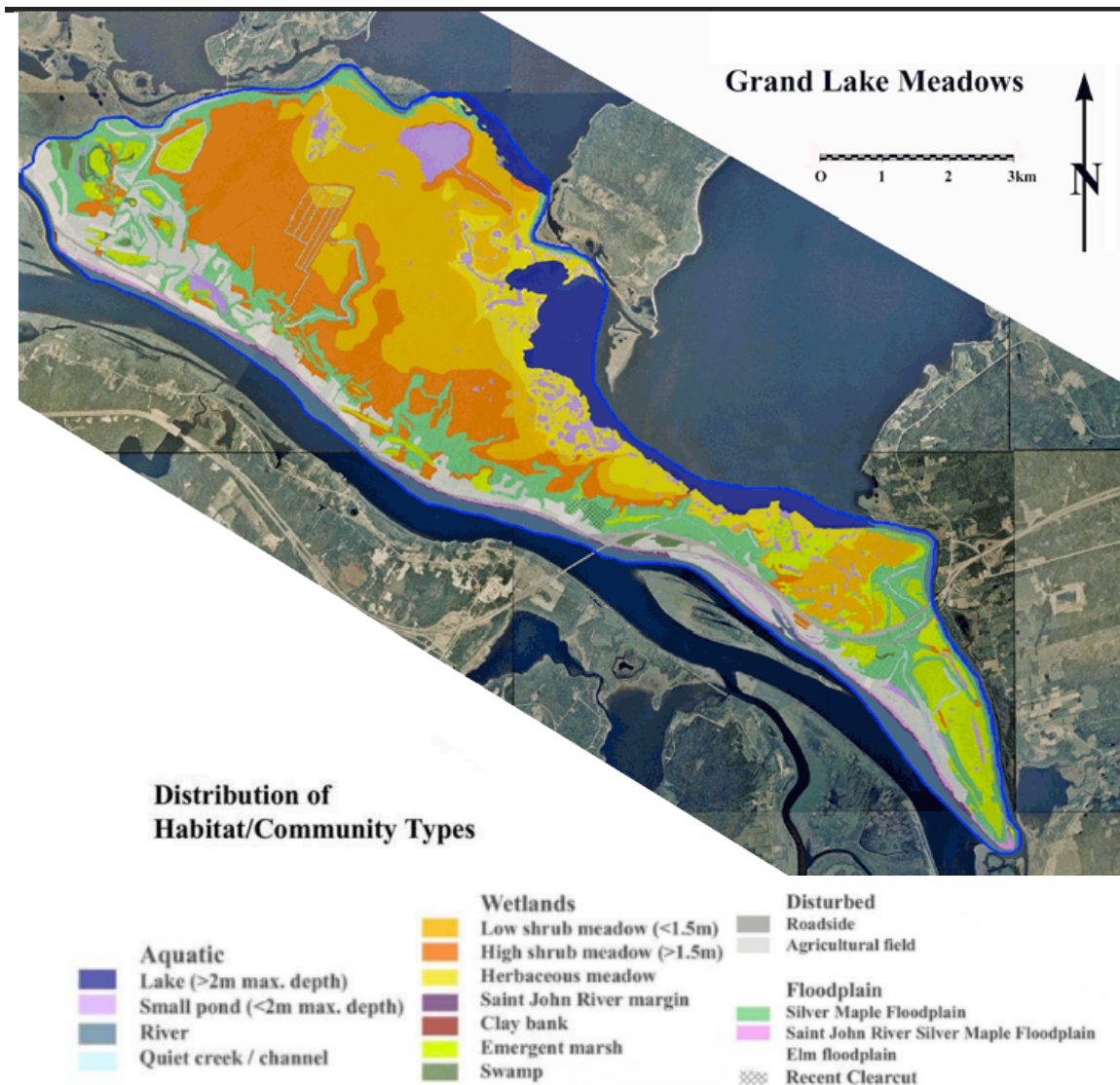


Figure 3.1
Grand Lake Meadows Distribution of Habitat/Community Types. from Papoulias et al., 2006

The conclusion reached by Papoulias et al., [2006] was that “the Grand Lake Meadows Project Boundary Area can be considered a highly diverse and unique parcel of land: at both the species and ecosystem level”. Additionally “the floristic communities of the project boundary area contain an assemblage of species which are rarely found elsewhere in the province, making this an exceptional and ecologically significant

wetland". Papoulias et. al., findings support previous statements regarding the unique climate and ecosystem of GLM.

Previously unknown information regarding tree species distribution and horticulture were identified by Paponnet-Cantat and Black [2003] through analysis of the remnants of an archaeological excavation which was completed in 1999. On well drained slopes the authors found primarily horticultural crops, including small fruits and vegetables. The tree species distribution across the region as described by Paponnet-Cantat and Black are as follows:

- White Pine along the riverbanks which receive coarse alluvial deposits
- Bur Oak, Green Ash, Butternut and Silver Maple along the fertile interval soils
- Ironwood, Basswood, Butternut, White Ash, Green Ash, and Silver Maple which are almost exclusive to the region along the broad and fertile alluvial floodplains
- Sugar Maple, Red Maple, Basswood, Ironwood, White Ash, and Red Oak stands in the areas which flood less frequently
- Red Oak and White Ash along the sandy shorelines
- Red Spruce, Hemlock, Red Maple, White Birch, and Trembling Aspen on the well-drained upland soils

3.3. Transportation

A proposal to re-route a section of the Trans-Canada Highway through GLM was the basis of an environmental report completed in 1993 [Environment Canada, 2000]. This proposed four-lane highway was to traverse six kilometres of GLM and involved the building of two bridges, one crossing the St. John River and the other crossing Jemseg River [Blair, 2004]. The environmental report indicated that an estimated 55 hectares of habitat of the wetland would be lost or directly affected by the building of this highway.

The archaeological and cultural importance of Jemseg has long been known to the Wolastoqiyik (Maliseet) [Blair, 2004]. Given the history and the importance of this region, an archaeological excavation was undertaken in 1996 and 1997, prior to the approval and construction of a new bridge across the Jemseg River [Blair, 2004]. The finding of a burial-like feature halted the excavations and the proposed highway route was modified with a slight jog to avoid this feature [Blair, 2004] (see Figure 3.2). From the materials recovered at archaeological dig site, eight different periods of occupation in Jemseg were identified. These indicate a human presence in this area, dating back at least 10,000 years and possibly longer [Blair, 2004].



Figure 3.2
Jog in Trans-Canada Highway at Jemseg River crossing, Google satellite image, 2013.
Approximate locations of proposed road and dig site, as per Blair, S. [2013]

3.4. Land Use and Human Occupation

In 2003, Paponnet-Cantat and Black reported their findings of land-use and occupancy changes during the 20th century in GLM. Their primary source evidence included the remnants from the full-scale archaeological excavation completed in 1999. This was the excavation implemented prior to the approval and construction of the new bridge across the St. John and Jemseg Rivers. Additionally, Paponnet-Cantat and Black

[2003] referenced topographic maps from 1938 and 1957 to identify man-made structures and to ascertain land-use and occupancy changes. Analysis of the topographic maps found an increase in structures built between 1938 and 1957, with a decline by 1993. It was hypothesized by Paponnet-Cantat and Black [2003] that this decline was due to soldiers lost during World War II or possibly urbanization.

Paponnet-Cantat and Black [2003] were also able to identify agricultural uses in GLM. They noted locations of topographic relief and well drained slopes the soil is relatively fertile and the presence of (primarily) horticultural crops - vegetables and small fruits - were found. In the area of Jemseg, farming records date back 300 years [Paponnet-Cantat and Black, 2003].

Forestry has long been played a major economic and cultural role in New Brunswick [Parks Canada, 2013]. The floodplain forest of GLM was harvested for personal and commercial uses [GLM, 2013]. The commercial uses of lumber have changed over the years and have serviced industries such as shipbuilding, house framing, furniture making, etc. The interconnected rivers and waterways provided an efficient way to transport these fallen trees through a method referred to as “log driving” [Parks Canada, 2013].

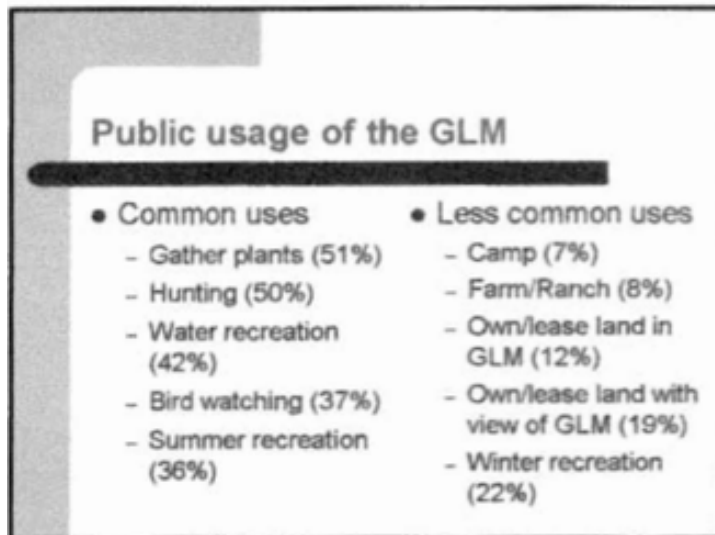
Hibbert [2008] documented First Nations traditional activities in GLM. The focus of his research was on hunting, fishing, gathering, and the medicinal and ceremonial activities of the Maliseet, with the goal of increasing awareness and preserving the oral history of the region. A web application was created which illustrated

the locations of Maliseet traditional activities, archaeological, and ecological sites within GLM project area. After searching, this website was not found online (September 2013).

5. Public Opinion, Education, and Awareness

In 2000, a questionnaire was submitted to the public to determine the strength of public attachment to GLM and the specific features which are tied to this attachment [Bowden, 2000]. This questionnaire was prepared by Bowden on behalf of the GLM Project Management Committee (GLMPMC) to determine the socio-cultural impact of the proposed highway re-routing through GLM. Data from 166 respondents were collected [Bowden, 2000]. Over 90% of the responses indicated some use of GLM with

Table 3.1
Public usage in GLM, from Bowden, G. [2000].



Public usage of the GLM	
<ul style="list-style-type: none">● Common uses	<ul style="list-style-type: none">● Less common uses
<ul style="list-style-type: none">- Gather plants (51%)- Hunting (50%)- Water recreation (42%)- Bird watching (37%)- Summer recreation (36%)	<ul style="list-style-type: none">- Camp (7%)- Farm/Ranch (8%)- Own/lease land in GLM (12%)- Own/lease land with view of GLM (19%)- Winter recreation (22%)

the largest recorded usage being plant gathering, followed closely by hunting (Table 3.1). The results of the questionnaire found a strong positive sense of attachment to GLM with either a practical or utilitarian connection [Bowden, 2000].

When asked how public and private money should be spent to compensate the local residents for the socio-cultural impact of the Trans-Canada highway being re-routed through GLM the majority of the responses indicated preservation (as much as possible) and public education about nature and the environment as most being important, Table 3.2. [Bowden, 2000].

Table 3.2
Project Evaluation Criteria - How important do you think it is that the project... (results in percent), from Bowden, G. [2000].

	Not at all important	Not very important	Important	Very important
Educates the general public about nature and the environment?	1.3	13.8	46.9	38.1
Educates school age children about nature and the environment?	1.3	8.8	41.3	48.8
Draws visitors to the area?	7.1	34.0	44.2	14.7
Preserves the wetlands in as pristine a condition as possible?	.6	7.6	35.7	56.1
Allow people to directly experience the Grand Lake Meadows?	5.1	17.2	54.1	23.6
Restricts activities affecting plants and animals in the wetlands?	3.2	19.9	38.5	38.5

With respect to proposed future projects within GLM, it was found that local residents preferred projects involving passive use of GLM: for example, building trails or facilitating school trips to the meadows, Table 3.3 [Bowden, 2000]. Bowden [2000] found through the responses to his questionnaire that residents' opinions opposed those

of political elites: the political elite having a strong viewpoint of attracting visitors to the region while residents felt their needs outweighed the importance of attracting visitors.

Table 3.3
Future Project preference, from Bowden, G. [2000].

	First Choice	Second Choice	Third Choice	Fourth Choice	Total Count
Build trails in GLM	33	20	11	17	81
Regional Interpretive Center	27	25	8	11	71
School field trips to GLM	25	23	23	12	83
GLM Interpretive Center	21	26	15	11	73
Upgrade existing parks	14	16	26	26	82
Rest stop on Highway 102	11	19	27	14	71
Build trails outside GLM	11	14	13	17	55
Expand local historical society	10	3	11	12	36
Support Birding Festival	3	8	10	17	38
Build blinds for bird watching	3	4	11	14	32
N	158	158	155	151	158

In 2003, an educational program was created to raise awareness of the natural and cultural significance of GLM [Tantramar, 2005]. This program the '*Grand Lake Meadows Wetland Education Program*' was created through GLMPMC and led by the New Brunswick Department of Natural Resources (NBDNR) [Tantramar, 2005]. It took two years to compile the educational program and it was presented to teachers in the region during a workshop in 2005 [Tantramar, 2005]. The underlying concept of the program was GLM 'through the seasons' [Tantramar, 2005]. The program was received positively by teachers indicating that "this education program supports many science and social studies curriculum outcomes: including exploring natural ecosystems, improving language skills, and enhancing local history knowledge" [Tantramar, 2005].

4. METHODOLOGY

The focus of this research was to use historical maps as primary source material and determine what (if any) new information could be determined with respect to geomorphological and societal changes within GLM. The project was divided into a series of individual steps: (a) mine the archives, (b) georeferencing the images, (c) analysis and feature identification. The maps were then (d) enriched with additional historical content, (e) added to a website and made available to the public and finally (f) an educational component was developed. The following sections outline each of these steps in detail.

4.1. Mine the Archives

Searching the Provincial Archives of New Brunswick (PANB) with the assistance of archivist Mary-Ellen Badeau, a series of historical map holdings were identified (Table 2.1). Primarily, these holdings were part of the Land Grants collection, however topographic maps of GLM were also identified in other PANB collections. The historical maps at PANB are available in different media: microfilm, microfiche, paper, and digital format. The microfilm and microfiche were searched and images within the project area were scanned and saved to Joint Photographic Experts Group (jpg) image file format - as

specified in the profile of the PANB scanner. Adjustments for brightness and contrast were made to ensure that the most readable scan was obtained and a maximum resolution of 600 dpi (dots per inch) was chosen. The resulting image files are (on average) 40MB, with average image size of 6280 x 4460 cells. A naming convention which included the name of the collection, section or film number, and suffix of '_a' identified the images and provided reference to the source location (Figure 4.1). A spreadsheet was maintained which stored this information along with the date the map was published. As the project progressed, it was realized that including the year into the naming convention of images would have improved the process considerably.

- Example image name: *RS656-1J3-15QU_1_1_a*.
- Collection name: *RS656-1J*
- Film number: *3-15QU Fiche #1*
- Image on the film: *_1_a*
 - (multiple images exist on each microfiche, and sometimes multiple scans per microfiche were used)

Figure 4.1
Sample file naming convention

The historical map collections available at Harriet Irving Library (HIL), Archives and Special Collections are paper based. There was a high-resolution camera and stand available to take digital images of these maps. Once the images were captured, the camera was returned to the Special Archives and Collections desk at HIL. The images received a watermark indicating copyright and ownership and were available for pickup on a USB key approximately one week later. Copyright restrictions on the collections at HIL prohibit posting copies of the digital maps online. Working with this restriction data were digitized from the map and the digitized features were added to the web application.

Aerial photographs from the 1900s were acquired from the Department of Natural Resources (DNR), Public Services in digital format (jpg). The photographs are the property of the DNR and while they are allowed to be posted and included in the GLM website, restrictions regarding downloading content (full resolution image) were adhered to. The aerial photographs used in this research were from 1934, 1945, and 1951 and cover one section of the project area. Additional years' images are available to the end of the century, as are images for the remainder of the project area. Future research could further utilize these photographs and others which cover the remainder of the project area.

Other maps used in this research, as described in section 2.4 were available online and the digital image files were downloaded. These files retained their original names and were saved in a folder structure which indicated the source provider.

4.2. Review and Georeference

All digital images were georeferenced using Quantum GIS (QGIS) and the Georeferencing plug-in to the map projection used in New Brunswick (NB): New Brunswick Stereographic Double projection and the NAD83 CSRS datum (see Figure 4.2). The process of georeferencing is used to align the historical digital images with existing geographically referenced data. This process relies on matching common points between the historic digital image and points from the geographically referenced dataset

(Figure 4.3). The historical map scans required rotation, translation, and scaling to be displayed in the NB projection. In order to facilitate these transformations, the thin plate spline (TPS) algorithm was selected and the images were resampled using the cubic spline method. The QGIS Help menu lists TPS algorithm as “a modern georeferencing method which is able to introduce local deformations in the data and is useful when using low quality originals”. The inclusion of the cubic spline method allows the resulting georeferenced image to be smoothed [QGIS Help]. By selecting ground control points (red dots in Figure 4.3.) which were well spaced across the extent of the historic digital image geometric distortion introduced in the resultant image was minimal. The geographically referenced datasets included Service New Brunswick (SNB) datasets

```

PROJCS ["NAD83 (CSRS) / New Brunswick Stereo",
  GEOGCS ["NAD83 (CSRS) ",
    DATUM ["NAD83_Canadian_Spatial_Reference_System",
      SPHEROID ["GRS 1980", 6378137, 298.257222101,
        AUTHORITY ["EPSG", "7019"]],
      AUTHORITY ["EPSG", "6140"]],
    PRIMEM ["Greenwich", 0,
      AUTHORITY ["EPSG", "8901"]],
    UNIT ["degree", 0.01745329251994328,
      AUTHORITY ["EPSG", "9122"]],
      AUTHORITY ["EPSG", "4617"]],
    UNIT ["metre", 1,
      AUTHORITY ["EPSG", "9001"]],
    PROJECTION ["Oblique_Stereographic"],
    PARAMETER ["latitude_of_origin", 46.5],
    PARAMETER ["central_meridian", -66.5],
    PARAMETER ["scale_factor", 0.999912],
    PARAMETER ["false_easting", 2500000],
    PARAMETER ["false_northing", 7500000],
    AUTHORITY ["EPSG", "2953"],
    AXIS ["Easting", EAST],
    AXIS ["Northing", NORTH]
  ]

```

Figure 4.2
 EPSG:2953 NAD83(CSRS) / New Brunswick Stereographic parameters.
 Source: Spatial Reference, 2013

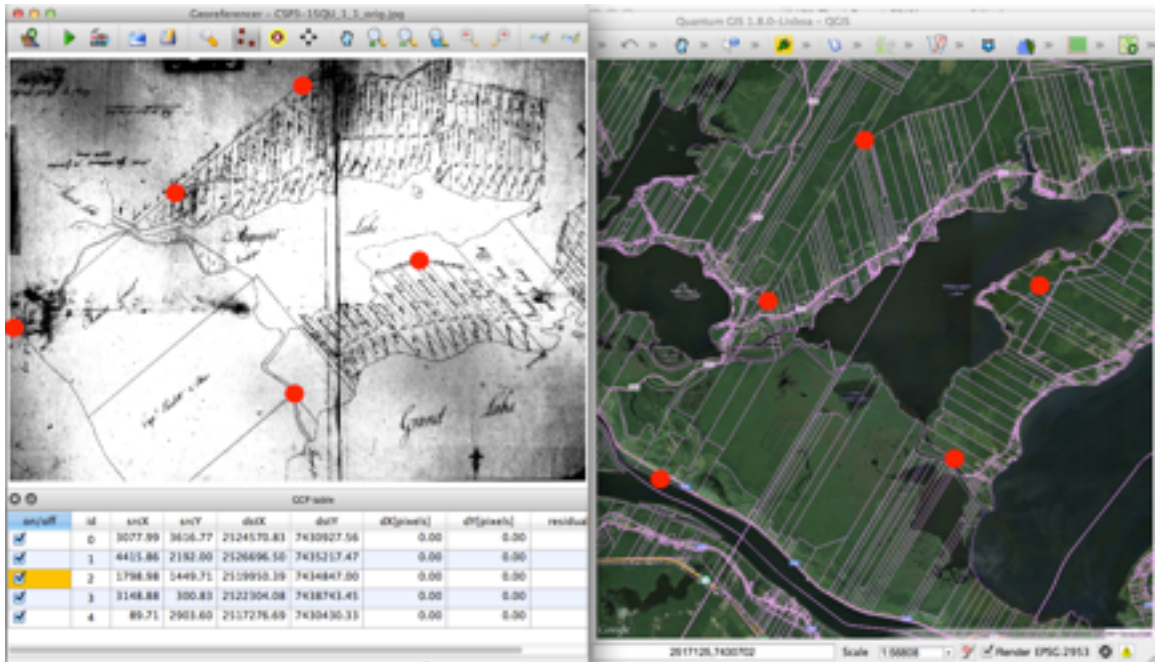


Figure 4.3

Georeferencing in Quantum GIS, selection of control points for georeferencing

(parcel data, county boundaries, and topographic plans) and Google Earth digital imagery. Control point locations used for georeferencing included common property boundaries, county boundaries, or other common features between the historical map scans and the geographically referenced dataset. The resulting georeferenced historical map is shown overlaid on Google Earth digital imagery and SNB county boundaries in Figure 4.4.

Reports were created along with the georeferenced image to determine the residuals of each transformation, a sample report is shown in Figure 4.5. A review of the residuals was completed as was a visual comparison of the resulting image to the base map data. In many cases, control points needed to be reselected or additional control points added to improve the georeferencing results. As the digital images were

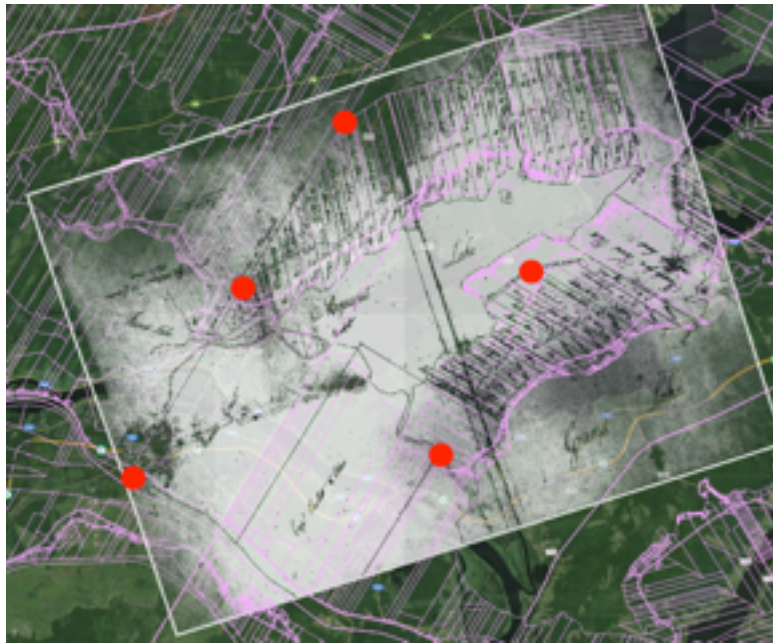
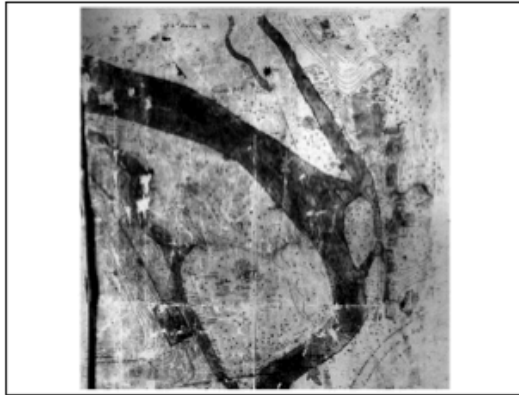


Figure 4.4
Sample Georeferencing Result

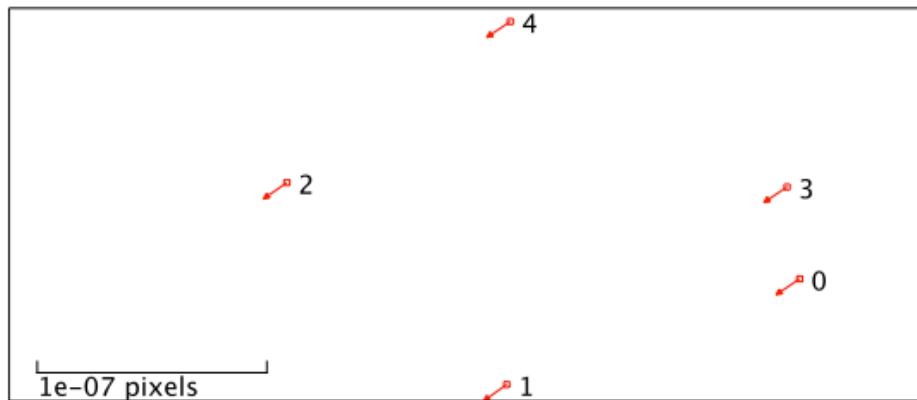
georeferenced, the geographic coverage extent of the resultant image were added to a shapefile called “imagekey.” In addition to the polygon representing the boundary, attribute information including image name, date, and source location were added to each polygon feature. Figure 4.6 shows the imagekey shapefile displaying both the graphic extent of the historical map scans and the recorded attributes. This shapefile was used to keep a record of which images had been georeferenced and for easy identification of the coverage area of each image.

During georeferencing, the historic images were rotated to fit into the NB Double Stereographic projection. This created a series of NoData pixels which resulted in a black background surrounding the image, Figure 4.7(a). Geospatial data abstraction library (GDAL) which is a free and open source software was used to change these pixel values to Null. The “gdal_translate” utility was designed to convert to and from a variety

RS656-1J_30-15_1_1a.jpg



Residuals



id	enabled	pixelX	pixelY	mapX	mapY	resX [pixels]	resY [pixels]	resTot [pixels]
0	yes	1795	-1714	2530608.287	7420337.211	-1.01875e-08	6.83985e-09	1.22706e-08
1	yes	958	-2390	2528163.459	7419075.256	-1.00084e-08	7.1559e-09	1.23035e-08
2	yes	330	-1100	2527696.687	7422935.097	-1.01101e-08	6.95877e-09	1.22735e-08
3	yes	1759	-1127	2531000.282	7421689.570	-1.00592e-08	6.72389e-09	1.20995e-08
4	yes	968	-70	2529712.859	7425253.263	-1.01749e-08	6.82931e-09	1.22543e-08

Figure 4.5
Georeferencing report from Quantum GIS

of raster formats and perform helpful geoprocessing operations such as converting NoData value bands to Null [GDAL, 2013]. Gdal_translate was run in the Terminal (command line) window. The issue encountered when using this GDAL utility program was that some areas within the image extents had assigned values of NoData. When gdal_translate was run the pixels surrounding the image were changed correctly from

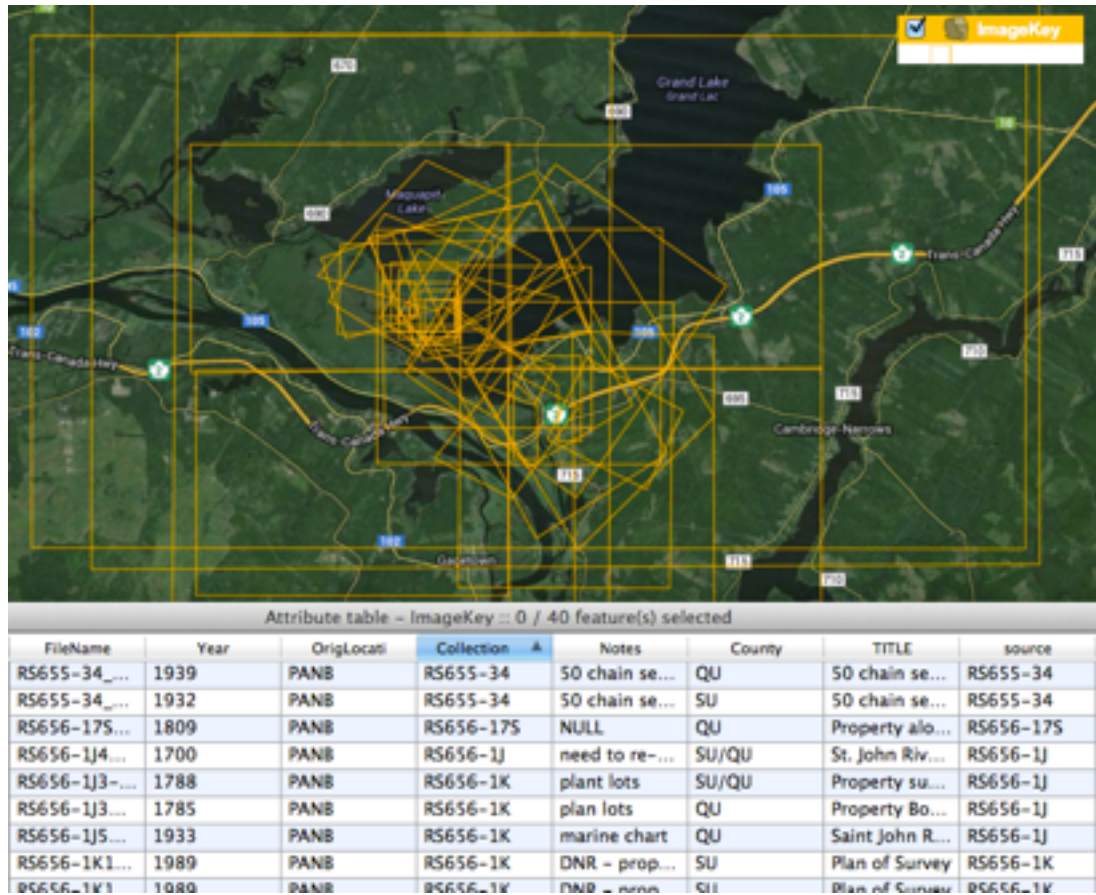


Figure 4.6
Imagekey shapefile and attribute table created from georeferencing of historical map scans. Overlaid on Google Hybrid Map layer in QGIS

NoData to Null, however, the interior pixels with NoData values were also changed to Null, as illustrated by the red circles in Figure 4.7(a, b). Other GDAL utility programs were tried, including: *gdal_fillnodata*, *nearblack*, and *gdal_edit*. Similar results to those shown in Figure 4.7 were encountered. Setting a bounding box for the NoData values was effective at leaving the interior image pixel values unchanged, however this cropped the image to the extent of the bounding box which resulted in significantly greater data loss. Only a small percentage of the images were affected by this issue and minimal

data was lost. It was therefore decided to continue with the `gdal_translate` utility program and accept the minor changes in the images.

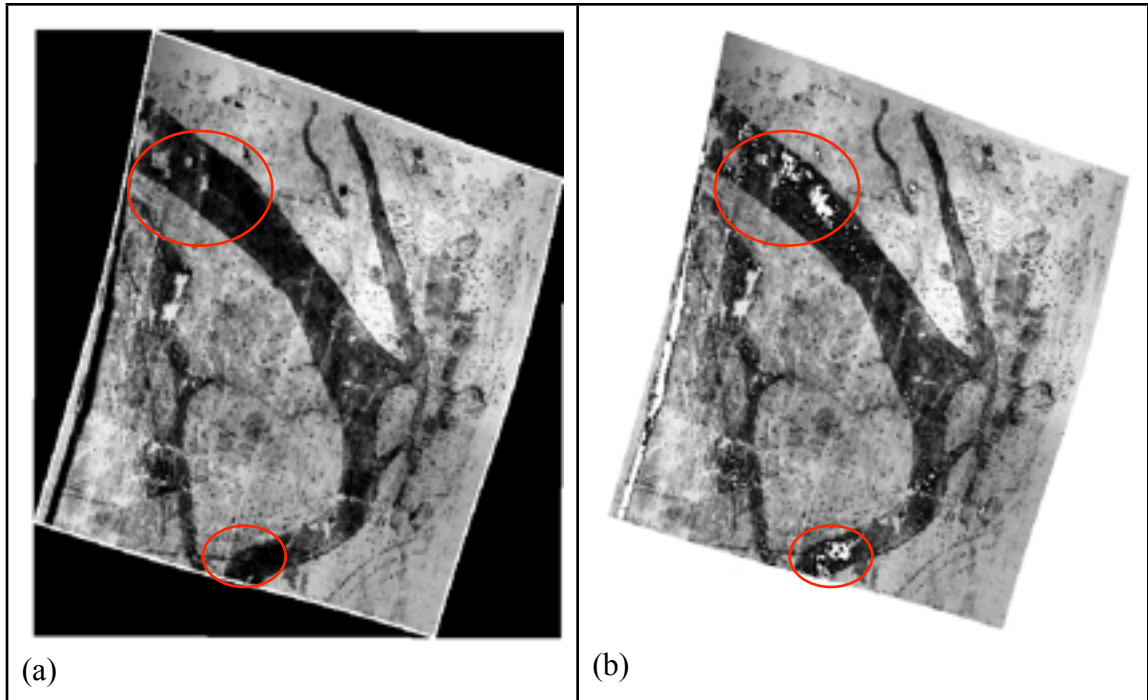


Figure 4.7

Before (a) and after (b) running the `gdal_translate` utility. The red circles in (b) represent the interior pixels which were changed incorrectly to Null values

4.3. Identify Features of Interest, Digitize Content

Each of the georeferenced images identified as being within the project area were analyzed. Many of these did not include the date the map was created and this had to be identified or inferred from other (dated) images from the collection either preceding or succeeding the map in question, or by reviewing surveyor details.

In the images which contained land grants, parcels of land were digitized and the name of the land owner was added to a “DigitizedProperty” shapefile (see Figure 4.8). Displayed in Figure 4.8 are yellow, orange, green, and red polygons, each representing the property boundaries or land parcels identified from the historical maps based on the publication year of the historical map. Also found in Figure 4.8 is a table displaying the recorded attribute data associated with each polygon feature. The attribute information was gathered from the historic image, PANB, and from the Service New Brunswick Grant Reference Plan Viewer. For each of the identified properties attribute information

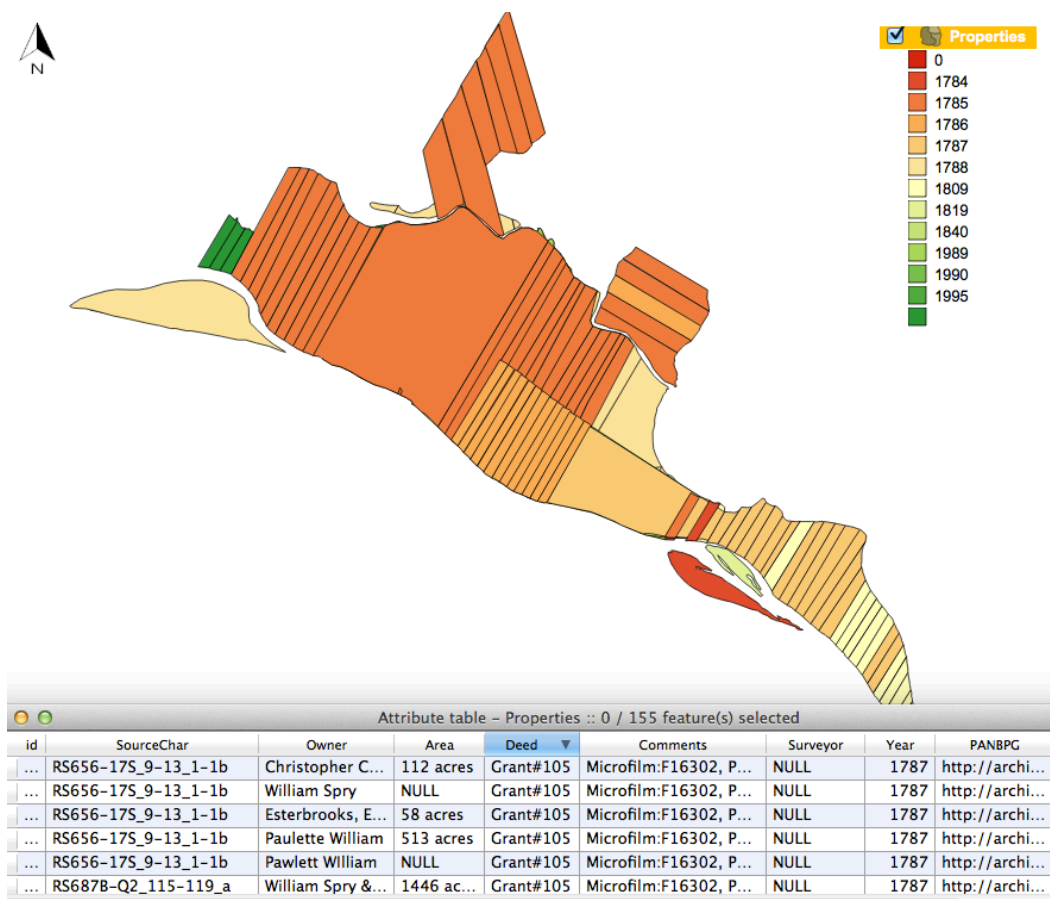


Figure 4.8
Sample map of project area showing polygons which represent property boundaries

including area, deed number, title, and comments were recorded (Figure 4.8). Where available, the land grant information of the polygon (parcel) was linked to the online PANB Land Grants index. When this shapefile “DigitizedProperties” is accessed through the web application and land grants of 1786 are requested, the resulting map appears in Figure 4.9. If you click the “Link to PANB: Land Grant Search” (see Figure 4.9(b)) a new tab opens accessing the online Provincial Archives website and the appropriate Land Grants search result, as shown in Figure 4.10. In the web application this shapefile is accessed via Web Map Service-Time (WMS-T) request and OpenLayers, which will be discussed in greater detail in Chapter 4.5.

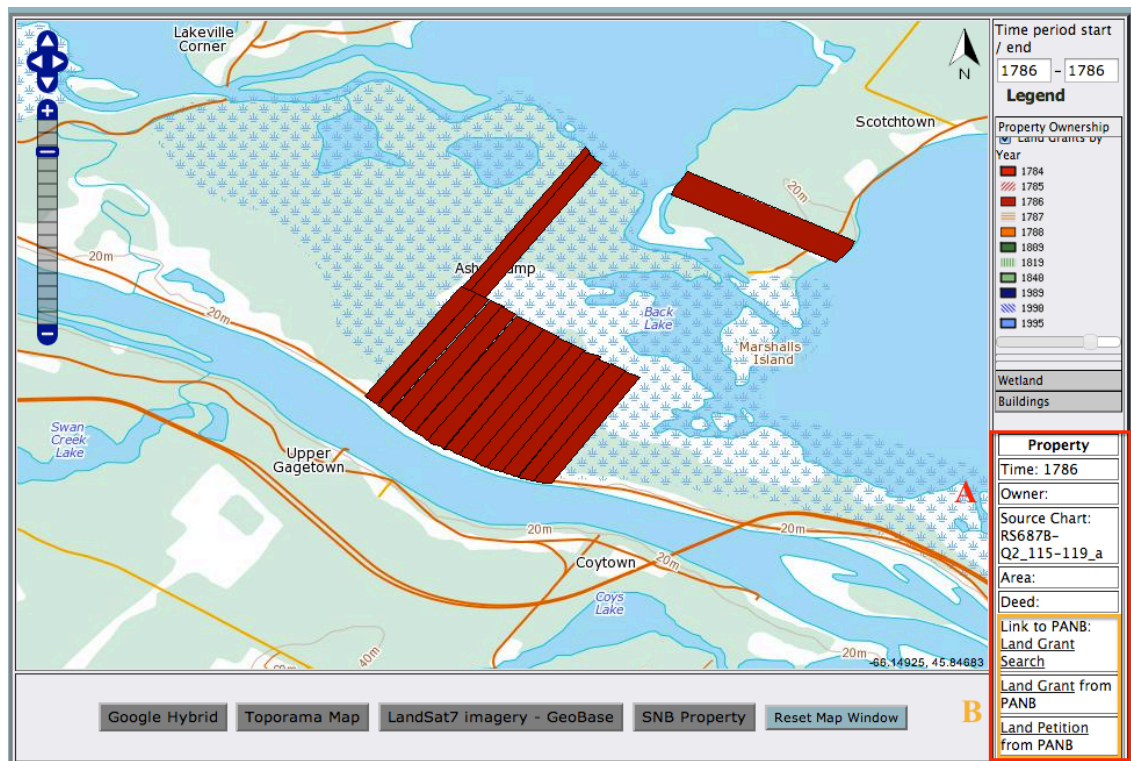


Figure 4.9
Sample from web application showing use of Digitized properties shapefile and resulting attribute capture (A) and the link to the PANB Land Grant records (B)

In addition to property boundaries, other features that were digitized from the georeferenced historical images include the delineation of wetlands, existing buildings, and settler locations.

The screenshot shows the website for the Provincial Archives of New Brunswick. At the top is the logo for New Brunswick Canada. Below it is the title 'Provincial Archives of New Brunswick' and a navigation bar with links for Search, Exhibits and Education Tools, Research Tools, and About PANB. The main heading is 'RS686 :: Index to New Brunswick Land Grants, 1784 - 1997'. There are links for Introduction, Help, and Search Page, and a link to return to the previous page. A table lists the details of the grant, and below it is a list of other names on the grant.

Name	MILLER, Henry
Volume	I
Page	0
Grant number	46
Place	Saint John River
County	Queens
Date	1786-06-10
Accompanying plan	No
Acres	150
Microfilm	F16308
Comment	With 12 Others

Other names on this grant (12):

BRIGGS, Ebenezer 173 acres
 CHURCHILL, Nathaniel 150 acres
 CLUETT, John James 184 acres
 ESTY, Zebulon 117 acres
 HARRINGTON, Andrew 196 acres
 JOSLIN, Andrew 178 acres
 MCDERMOT, James 117 acres
 SLOCUM, Eleazer 184 acres
 TISDALE, Ephram 150 acres

Figure 4.10
 Record at PANB Land Grants. Accessed by clicking ‘Link to PANB Land Grant’
 Search from Figure 4.9

4.4. Enrich Findings

The geospatial data digitized from the historical maps was enriched through the addition of descriptive content. This was accomplished through research into past and

present statuses and activities, previous research on the GLM project area, and discussions with local historians. This information was added as attributes into the shapefiles of each of the digitized features. Figure 4.11 from the Digitized Properties shapefile, illustrates all the attribute data collected for each parcel of land. The attribute data includes information collected directly from the historical map (SourceChar and Owner, Year), information from the PANB online Land Grant search (Deed, Comments, PANBPG, LandGrant) and information from SNB Grant Reference Plan Viewer (Grant Number, Date, Acres). Moreover, when this shapefile is accessed in the web implementation the attribute information (Figure 4.9(d): PANBPG, LandGrant, and LandPetition) links to the PANB database, and returns information such as the Index to the Land Grants (as shown in Figure 4.10). A few of the parcel polygons link directly to scanned PDF copies of the actual Land Grant or Land Petition, Figure 4.12 and 4.13. Additional research could continue this process of linking the parcel data to scanned PDF copies of the original Land Petitions and Land Grants, thus creating easier accessibility to these original documents.

The wetlands shapefile was also enriched with additional attributes including area and perimeter of classified area.

SourceChar	Owner	Area	Deed	Comments	Surveyor	Year	PANBPG	LandGrant	W	LandPetition
NULL	Edward Coy	392 acres	Grant#105	Microfilm F...	NULL	1787	http://archives.gnb.ca/Se...	http://gaia.gpe.unb.c...		NULL
RS656-175...	Joshua Curry	281343.54...	Grant#105	Microfilm F...	NULL	1787	http://archives.gnb.ca/Se...	http://gaia.gpe.unb.c...		NULL
RS656-175...	Christopher...	112 acres	Grant#105	Microfilm F...	NULL	1787	http://archives.gnb.ca/Se...	http://gaia.gpe.unb.c...		NULL
RS656-175...	Esterbrooks...	58 acres	Grant#105	Microfilm F...	NULL	1787	http://archives.gnb.ca/Se...	http://gaia.gpe.unb.c...	http://gaia...	
RS656-175...	Faulette Mill...	513 acres	Grant#105	Microfilm F...	NULL	1787	http://archives.gnb.ca/Se...	http://gaia.gpe.unb.c...		NULL
RS656-175...	Pawlett Mill...	NULL	Grant#105	Microfilm F...	NULL	1787	http://archives.gnb.ca/Se...	http://gaia.gpe.unb.c...		NULL
RS656-175...	William Spry	NULL	Grant#105	Microfilm F...	NULL	1787	http://archives.gnb.ca/Se...	http://archives.gnb.c...		NULL
RS656-1K...	Ducks Unl...	64ha(a)	69594	Book 293, P...	HENRY ...	1995	None Found	NULL		NULL

Figure 4.11
Attribute data from Digitized Properties shapefile

Giles Tidmarsh 223 -

Nova Scotia &c.
 William Campbell

To all to whom these presents shall come greeting,
 Know ye that I Lord William Campbell, Captain
 general and Governor in Chief in and over His
 Majesty's Province of Nova Scotia or Acadia and its dependences Vice
 Admiral of the same &c. &c. by virtue of the power and authority
 to me given by His present Majesty King George the Third under the
 Great Seal of Great Britain, have given granted and confirmed and do
 by these presents by and with the advice and consent of His Majesty's
 Council for the said Province give grant and confirm unto Giles
 Tidmarsh

Figure 4.12
 Record at PANB Land Grants. Accessed by clicking 'Link to PANB Land Grant' from
 Figure 4.9(d) - available on some records

319
 His Excellency Thomas Carleton Esquire
 Captain general Governor and Commander in
 Chief in and over His Majesty's Province of New
 Brunswick and Territories thereon Depending
 Chancellor and Vice Admiral of the same
 &c. &c.

The memorial of Elijah Eterbrooke
 Ebenezer Eterbrooke & Joseph
 Eterbrooke - most humbly sheweth

Figure 4.13
 Record at PANB Land Petitions. Accessed by clicking 'Link to PANB Land Petition'
 from Figure 4.9(d) - available on some records

4.5. Overlay Historical Maps and Data on Present Day Maps

This section contains a description of the web mapping services used and the details of the web-based map mashup implementation. For more detailed documentation and a further explanation of the web mapping services used, please visit their respective websites.

4.5.1. Web Map Service (WMS)

The Web Map Service (WMS) specification was developed and published by the Open Geospatial Consortium (OGC) [OGC, 2013]. A WMS is a standard protocol for serving georeferenced map images over the internet [OGC, 2013]. These images are generated upon request by a map server (e.g., MapServer) using data from a GIS database or other geospatial dataset - including kml and raster images. WMS may be accessed through a web browser (as used in this research), through a desktop computer using a GIS software package, or with a mobile device [OGC, 2013]. Goals of this research included the ability to generate on-line georeferenced maps and to complete simple data queries: thus WMS was the selected web service.

The Web Map Service is considered part of the OGC web services (OWS) data access services, along with web feature service (WFS), web coverage service (WCS) and

web coverage processing service (WCPS). These data services are all languages for the retrieval and processing of coverages representing sensor, image, or statistic data [OGC, 2013]. Since the implementation of WMS, the use of on-line mapping has dramatically increased [OGC, 2013].

Three operations are offered through WMS requests: get capabilities, get feature info and get map (Figure 4.14). The “GetCapabilities” request indicates the available services, layers and coordinate system of the data, among other items. The “GetMap” request loads the geographic data via the web map service. Users are able to select a feature in the map invoking the “GetFeatureInfo” request function - which requests attribute data of the selected feature via the web map service and returns the attribute data to the web page into a data frame or pop-up for the user to view.

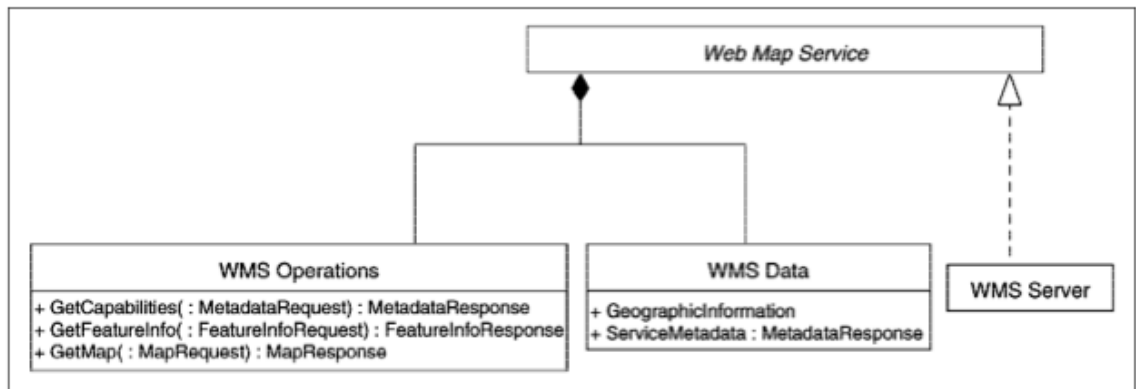


Figure 4.14

WMS UML from OpenGeoSpatial Consortium (OpenGIS Web Map Server Implementation Specification) illustrates the capabilities to retrieve information regarding the services offered, as well as attribute information regarding selected features

4.5.2. WMS with Time Support (WMS-T)

“Geospatial location and time are integral to all aspects of the work in the OGC” [OGC, 2013]. The WMS specification has been extended to include time via WMS-T. As the datasets and images in this research span four centuries, WMS-T was used to be able to view data by specific time periods.

4.5.3. MapServer

In this project MapServer (MapServer, 2013) software has been adopted in the role of map server middleware. The georeferenced images on the website are accessed through a dynamic mapping interface using OpenLayers and a MapServer Mapfile. This Mapfile is considered to be the ‘*heart of MapServer*’ [MapServer, 2013]. This structured text file defines relationships between objects, identifies where the source files are stored, and includes instructions on how to draw elements [MapServer, 2013]. A map file is one of the many components of a MapServer application, with additional components being: geographic data, HTML pages, MapServer CGI and Web/HTTP Server [MapServer, 2013]. An illustration of a standard MapServer application is shown in Figure 4.15. Input to the Mapfile configuration include vector data, raster data, and Web Services. The Web Services utilized for this project are WMS, as discussed in section 4.5.1. A sample Mapfile can be found in Appendix I. The MapServer Common Gateway

Interface (CGI) receives the requests from the application and returns images, data, etc.

[MapServer, 2013]. Additional components for a MapServer application include a Web/

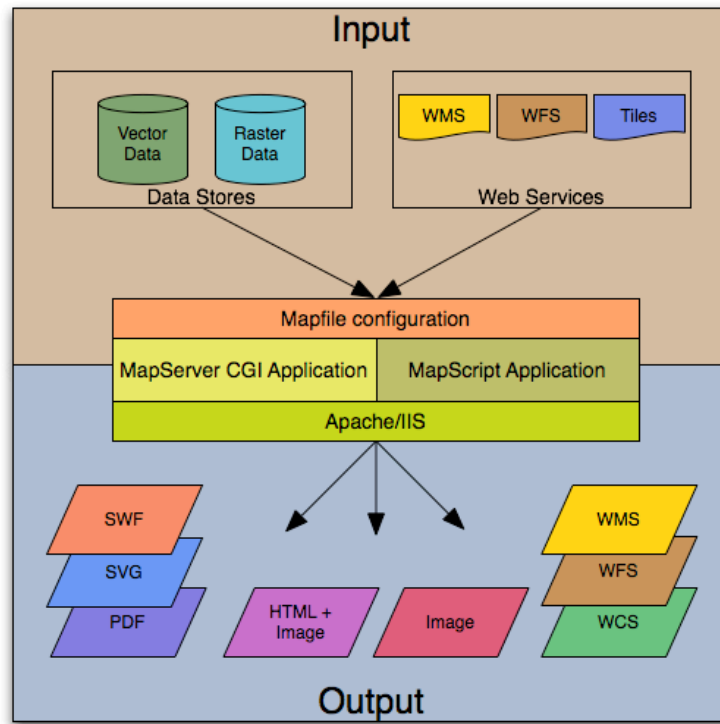


Figure 4.15

Basic architecture of MapServer application. Source: MapServer, 2013

HTTP server.

4.5.4. OpenLayers

OpenLayers is an open source Application Programming Interface (API) designed to consume spatial data and maps from numerous sources [Boundless, 2013]. In addition to being open source, OpenLayers does not utilize server-side dependencies

[OpenLayers, 2013], meaning there is no extra processing required by the host server. Another advantage of using OpenLayers is that it is supported natively by most modern web browsers [OpenLayers, 2013] and therefore the user is not required to install plugins to their computer or tablet in order to view the content.

OpenLayers is similar to Google, Bing, or Yahoo Maps APIs, though it is not tied to any of these [Boundless, 2013]. In addition to the web based map providers (Earth browsers), OpenLayers supports a large variety of file formats for users to access their own data and to create rich dynamic web maps. Data manipulation tasks are also available, such as: digitizing, editing features or attributes, deleting features, etc. Figure

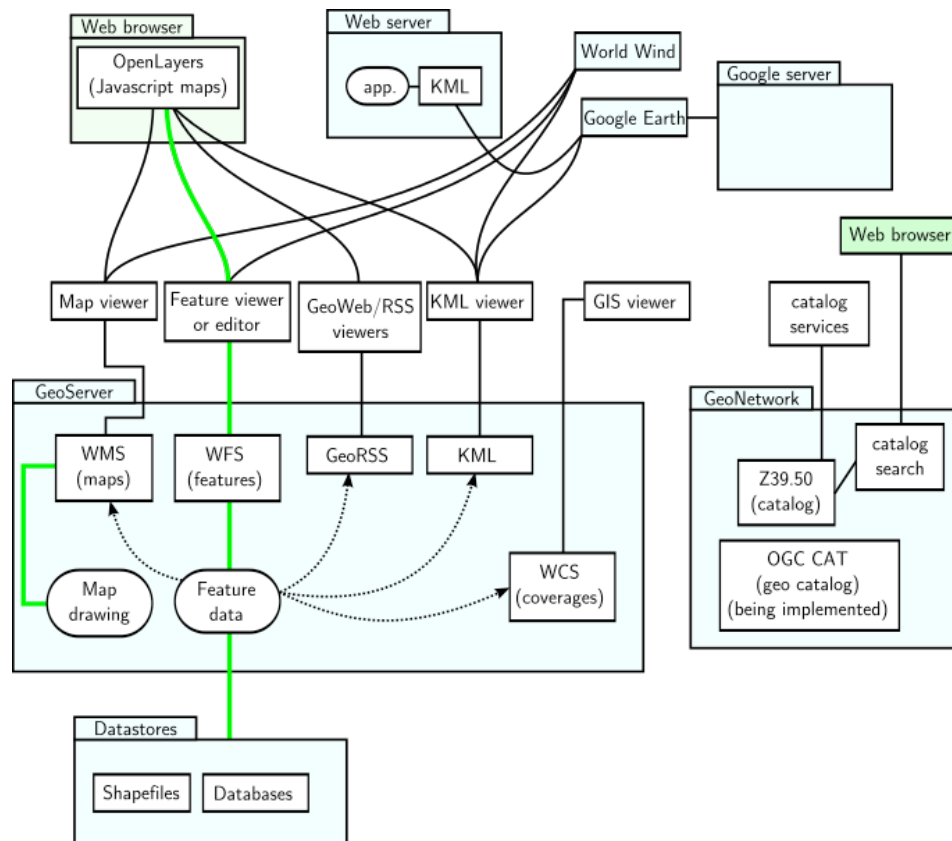


Figure 4.16
GeoServer GeoNetwork with web app. Source SEWilco, 2013

4.16 illustrates protocols and communications available and supported through OpenLayers: further information regarding OpenLayers may be found at OpenLayers.org.

4.5.5. Web Map Mashups

The website is divided into a series of sections based on the type of content. Two sections have been created which display dynamic web maps using OpenLayers and WMS. These two sections are called *Geography* and *Go*. Within the *Geography* section there are four links accessing interactive maps: *Historical Map Overlay*, *Property Boundaries and Wetlands*, *Early Settlers*, and *Coverage area of Historical Map Scans* and there is one link under the *Go* section, *A visual tour* which uses OpenLayers and WMS. A complete description and site-map of the website is found in section 4.6.

4.5.5.1. Raster Overlays

The georeferenced raster images are accessed via the Open Geospatial Consortium (OGC) standards of web coverage service (WCS) and web map service (WMS). The background imagery used on these pages include: Google Satellite,

Toporama Web Map Service (internet service of the Earth Sciences Sector at Natural Resources Canada), and GeoBase Landsat7 satellite imagery.

Once the images were configured for overlay on the web background maps (via the Mapfile and WMS) additional tools which provide the user flexibility and customization of the map display were added.

The default OpenLayers pan and zoom tools were used in the application, while a custom legend was created to enable the user to turn individual images on or off and to modify their transparency. Figure 4.17 illustrates the *Historical Map Overlay* page from the *Geography* section of the website. In the main map window, labeled ‘A’, you have access to the default OpenLayers pan and zoom tools to move around the map. Section ‘B’ controls the visibility and transparency of each raster overlay (historical map). The raster overlays are sorted by century in section ‘B’. By selecting the text *1700s*, *1800s*, *1900s* or *2000s* you are presented with a series of image thumbnails, brief descriptions of the image, and publication date. Multiple rasters may be turned on at a time, and each has its own transparency control. In section ‘C’ you are able to change the background view from the default Toporama map to a Google Hybrid or LandSat7 image by selecting the appropriate button. The final control on this page is in section ‘D’ which allows the user to reset the map to the default map center and zoom level. This ‘reset map window’ returns to the extent of the GLM project boundary area.

To create this custom legend (see Figure 4.17(B)), additional functions were added to the HTML page. The checkbox which sets the elements visibility was configured and accessed via a function called “toggleControl” (see Figure 4.18) this

series of code was replicated for each historical image. The “toggleControl” function is accessed when the user selects or deselects the checkbox. The checkbox is defined using the HTML “Checkbox” object, Figure 4.19 and is related to the “toggleControl” function. An “onClick” event is added to initiate the toggle from checked equals “true” to “false” and vice versa (Figure 4.19). Also added to the HTML script was a function which controls the transparency of each historical image, Figure 4.20: a default visibility setting of ‘75’ has been selected for all layers. On the web page the user has the ability to change the transparency from ‘0’ (transparent) to max ‘100’ (opaque) by moving the slider left or right.

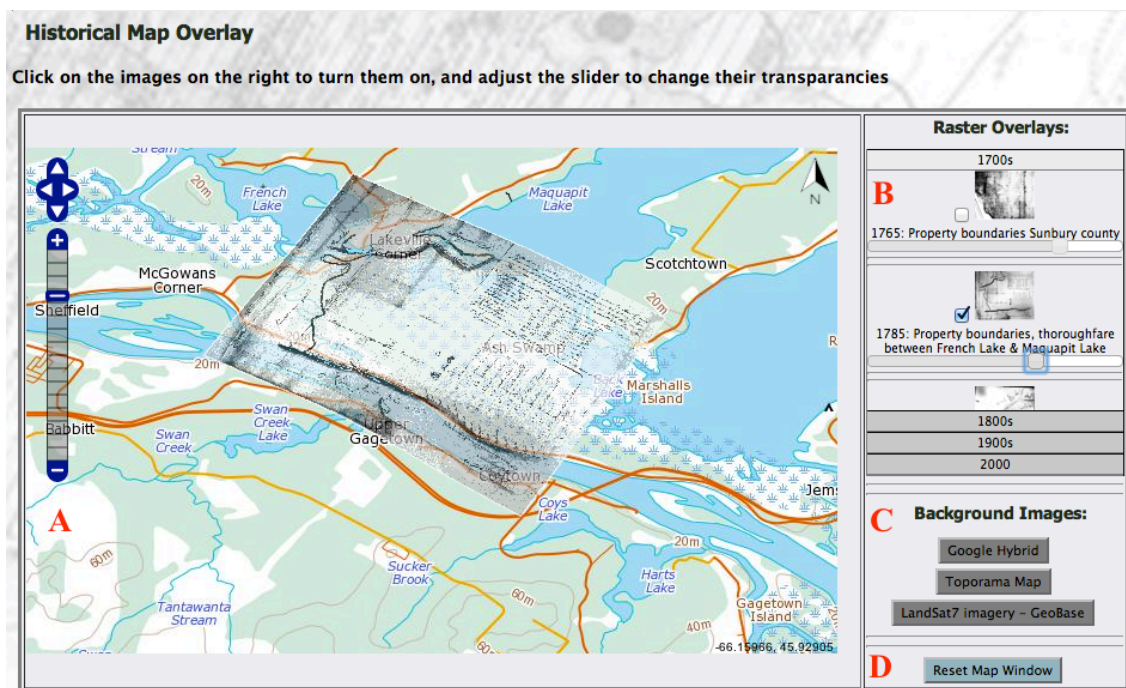


Figure 4.17

Historical map overlays. (a) interactive map with zoom and pan options, (b) menu to turn raster images on and off and change layer transparency, (c) change background imagery, (d) reset map window back to original zoom extent and center

```
function toggleControl(element){
  if(element.value == "ckRS655343"){
    RS655343.setVisibility(element.checked); } };
```

Figure 4.18

HTML code to add in collapsible and toggled layers. 1st argument = Name of the function. 2nd argument= If statement to define action. 3rd argument = Set default visibility of the element (set checkbox to empty)

```
<input type="checkbox" name="overlay" value="ckRS655343"
id="msRS655343" onClick="toggleControl(this);">
  
  <br>1932: French Lake to Maquapit Lake, Land
Ownership
  <div class="slider" id="slidRS655343"></div>
```

Figure 4.19

HTML code: image, thumbnail, checkbox, and description of layer to legend

```
<script>
$(document).ready(function(){
  $( "#slidRS655343" ).slider({
    range: "min",animate: "fast", max: 100, value: 75,
    slide: function(event, ui) {
      RS655343.setOpacity(ui.value / 100);
      $( "#sliRS655343" ).val( ui.value ); }
  }); //end
});
</script>
```

Figure 4.20

HTML code: slider transparency script

The images in the legend (Figure 4.17(B)) are grouped according to century and are enclosed in the Spry Accordion widget. The Spry Accordion widget is a set of collapsible panels which are able to store a large amount of information in a compact space [Adobe Dreamweaver, 2013]. Users are able to select the century (1700, 1800, 1900, or 2000) to see an expanded set of its contents and are able to scroll to view the entire contents of the panel. The accordion widget is comprised of a series of “div” tags: an outer ‘div’ tag which contains all the panels, ‘div’ tags for each of the individual

panels, along with header and content 'div' within the tag of each panel [Adobe Dreamweaver, 2013]. A copy of the complete HTML page can be found in Appendix II.

4.5.5.2. Vector File Overlays

Two types of vector files were used to create vector overlays: shapefile and KML. The shapefiles are accessed via WMS-T in the *Geography* pages of the website under the links: *Property and Wetland changes*, *Early settlers*, and *Coverage area of historical map scans*. The KML file is accessed via WMS and is found under the *Go* section, on the *A visual tour* link. The process of accessing these files is completed through WMS and WMS-T utilizing MapServer Mapfile and OpenLayers API as described in sections 4.5.1 thru 4.5.4.

In the pages *Property and Wetland changes*, *Early settlers* and *Coverage area of map scans* the ability to view records based on an input time period is available through WMS-T. Figure 4.21 is a sample from *Property ownership and wetland changes* page. The page is similar to that created for the historical map overlays, with a few slight changes in the user interface and in the HTML document. In Figure 4.21 section 'A', the main map window, you have access to the default OpenLayers pan and zoom tools to move around the map. Section 'B' controls the viewing time period. The user is able to input a start and end time period of interest to view records. Section 'C' controls the visibility and transparency of each layer, and section 'D' displays the attribute data when

a map feature is selected. Along the bottom of the page the user is able to change the background map from the default Toporama map to Google Hybrid, LandSat7 imagery or Land Cover from GeoBase. The legend displayed for each layer (Figure 4.21(C)) is an image created by the WMS *GetLegendGraphic* request when the page loads.

In order to be able to view map data by specific time ranges (Figure 4.21(B)), WMS-T is utilized. This is implemented through a combination of entries in the MapServer Mapfile and a function which was added to the HTML script, shown in Figure 4.22. The function “update_date” is created in the HTML document and reads from the two text boxes in Figure 4.21(B) to determine the “year1” and “year2” values. This in turn updates the layer “DigProperty” to display only those features from the file which have dates between “year1” and “year2”. Three entries are added to the Mapfile

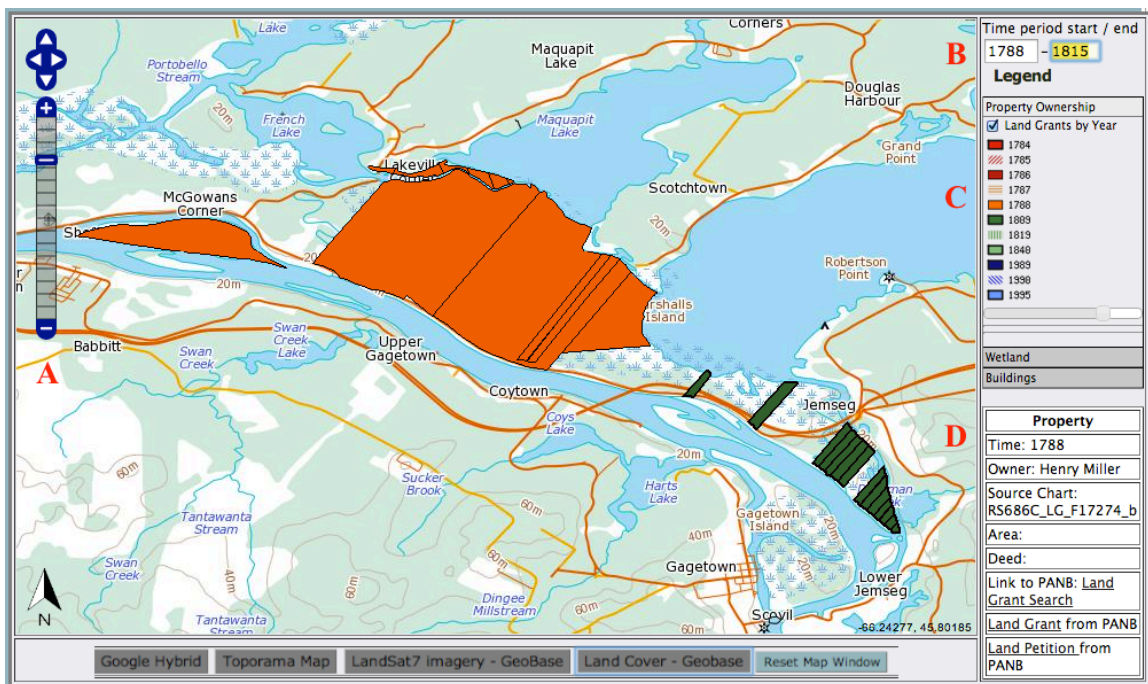


Figure 4.21

Vector overlay maps. Property and wetland changes. (a) map window with pan and zoom tools, (b) set time start and end of viewable layers, (c) turn layers on and off: Property ownership, wetland and building layers, (d) feature identification from map selection

layer metadata to enable time support: *wms_timeitem*, *wms_timeextent*, *wms_timedefault*. The first two items are mandatory, while the latter is optional. A sample illustrating these entries for the Early Settlers layer is shown in Figure 4.23. Additionally, the metadata item '*wms_enable_request*' was added with the quantifier of '*' which fully enables all WMS requests [MapServer, 2013].

To populate the attribute information as shown in Figure 4.21(D) a similar process to that described above was followed: adding a function to the script within the HTML file and a complementary component into the MapServer Mapfile. In the Mapfile a reference to a "template" was included, Figure 4.24. The "template" references an HTML file which produces a simple table based on a subset of attributes of the shapefile (Figure 4.25). An event is created in the HTML script which is activated when a user

```
//update DigProperty file display based on year input
boxes
    function update_date() {
        var string =
OpenLayers.Util.getElement('year1').value + "/" +
OpenLayers.Util.getElement('year2').value;
        DigProperty.mergeNewParams({'time':string});
    }
```

Figure 4.22
HTML Function: for updating feature data based on date

```
#-----layer definition
LAYER
  NAME "DigSettlers"
  METADATA
    "wms_timeextent" "1700/2012"
    "wms_timeitem" "Year"
    "wms_timedefault" "1700"
    "wms_enable_request" "*"
  END
```

Figure 4.23
WMS-T Metadata items required (and optional) for WMS-T support in MapServer Mapfile


```
DATA 'C:\ms4w\Apache\htdocs\glm\Web_HistoricalMaps\shapes
\DigSettlers.shp'
  TEMPLATE "C:\ms4w\Apache\htdocs\glm\Web_HistoricalMaps
\shapes\Settlers.html"
```

Figure 4.24
Link to template file in MapServer Mapfile

Time: [Year]
Settler: [Settler]
Source Chart: [SourceChar]
Comment: [Comment]
Source: [Source]

Figure 4.25
Sample template HTML file which accesses the Shapefiles attribute fields

selects a feature on the map. This calls the WMS *GetFeatureInfo* request, queries the layer, accesses the appropriate template file, and posts the data into the frame (see Figure 4.21(D)), the code for this series of events is shown in Figure 4.26. When the map is ‘clicked’ the layer is first checked for visibility, if the layer is visible, the WMS *GetFeatureInfo* request is posted to the server. The attribute information is returned to the inner HTML document (which is referenced in the feature’s mapfile) and is displayed in section ‘D’ of the web page (see Figure 4.21).

In the *Go* section of the website, a KML file is accessed via OpenLayers and WMS. In the ‘*A visual tour*’ page, the user again has the standard OpenLayers pan and zoom tools and the ability to change the background. This map has the ‘simplest’ interface, there are no layers to turn on or off, no transparencies, and no dates to change. The only user interaction is by clicking on one of purple camera icons in the map. This

opens up a pop-up information window displaying attribute information, and a thumbnail of the view from the selected feature. If the user clicks on the image in the pop-up, a larger image opens in a new window. The images represent the present day view (2013) of what you would see at this location if you were to physically visit the site.

```
//get_feature_info select
  map.events.register('click', map, function (e) {
    if (DigProperty.getVisibility()) {
      OpenLayers.Util.getElement('attr_data').innerHTML =
"Retrieval of data... Please wait...";
      var url = DigProperty.getFullRequestString({
        REQUEST: "GetFeatureInfo",
        EXCEPTIONS: "application/vnd.ogc.se_xml",
        BBOX:
DigProperty.map.getExtent().toBBOX(),
        X: e.xy.x,
        Y: e.xy.y,
        INFO_FORMAT: "text/html",
        FONT: "c:/ms4w/fontlist/times.ttf",
        ENCODING: "utf-8",
        // FEATURE_COUNT: 1,
        QUERY_LAYERS: DigProperty.params.LAYERS,
        WIDTH: DigProperty.map.size.w,
        HEIGHT: DigProperty.map.size.h });
      OpenLayers.Util.getElement('requestp').innerHTML =url; //
to see the URL
      OpenLayers.loadURL(url, '', this, setHTML);
      OpenLayers.Event.stop(e);}
    else
{ OpenLayers.Util.getElement('attr_data').innerHTML = "Data Layer
is not activated"; } });
```

Figure 4.26

Get feature info based on map selection, section of code from HTML document

4.6. Web Application

The web application was created using open source text editor TextWrangler and web authoring software Adobe Dreamweaver. The majority of the web content was written in the text editor, while Adobe Dreamweaver was used for a few tasks including: adding JavaScript (JS) libraries and inserting library items into the HyperText Markup Language (HTML) documents. Technology and services consumed in this web application will be described, followed by a description of the website of including page layout and functionality.

4.6.1. Technology and Services Consumed

This section outlines the technology and services used in the website. Hypertext Preprocessor (PHP), Scalable Vector Graphics (SVG), and jQuery user interface were used to create interactive website content and are described below.

4.6.1.1. Hypertext Preprocessor

Hypertext Preprocessor (PHP) is a widely used open source server scripting language [W3schools, 2013] used for making dynamic and interactive web pages [PHP.net, 2013]. PHP has become increasingly popular: based on a survey by Netcraft in January 2013, is used on over 244 million websites and is installed on 39% of all the servers monitored.

In PHP, the code is enclosed in special ‘start and end’ processing instructions (<?php, ?>) [PHP.net, 2013]. The commands and information, enclosed within the start and end processing instructions are executed on the server. The results are then posted to an HTML file and returned to the client machine [PHP.net, 2013], (see Figure 4.27). The inputs to the web server may be in the form of a data entry form, an uploaded file, a selection from a database, etc. In this web application only data entry forms are used and the inputs are a mixture of text fields, radio buttons, and drop-down menus items.

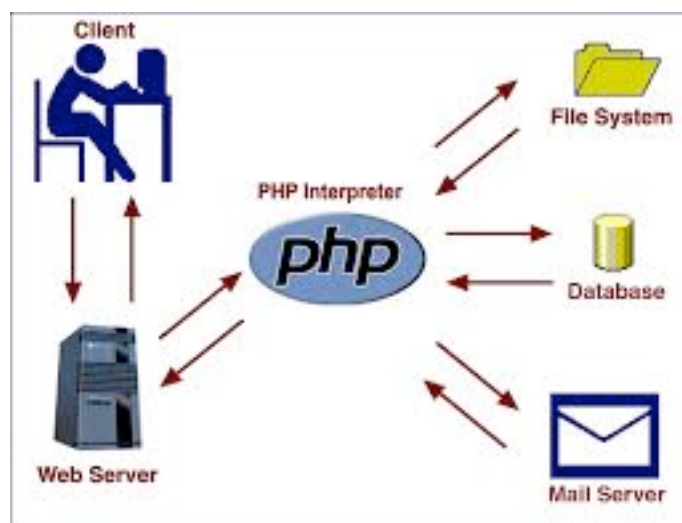


Figure 4.27
How PHP works, from Webucator, Inc. 2013

4.6.1.2. Scalable Vector Graphics

Scalable Vector Graphics (SVG) is an open source markup language for describing two-dimensional graphics applications and images with a set of related graphics script interfaces [W3C, 2013]. SVG is a recommendation of the World Wide Web Consortium (W3C) and has been available since 1999 [W3C, 2013]. The use of SVG adds support for interactivity and animation to images and is natively supported by most modern web browsers. The SVG images and behaviors are described in an extensible markup language (XML) file. SVG functionality used in this web application include: addition of vector shapes to images, setting clickable areas and text, and showing motion along a path.

4.6.1.3. jQuery User Interface

The jQuery user interface is a curated set of user interface interactions, effects, widgets, and themes which are built on top of the jQuery JavaScript Library [jQuery, 2013]. A number of jQuery user interface APIs, including tabs, accordion, and slider, were used to improve the website look, organization, and minimize the amount of scrolling on website pages.

Using the jQuery tabs panel a single content area was created with multiple accessible panels [jQuery, 2013], as shown in Figure 4.28. Selecting a tab, such as ‘Site Organization’ changes the content without reloading the page.

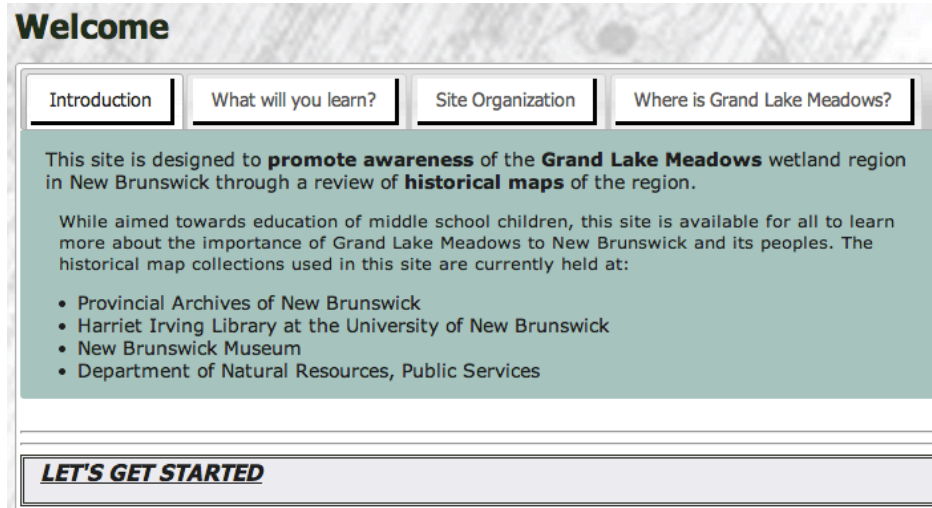


Figure 4.28
jQuery tabs panel

The jQuery accordion is able to display a series of collapsible content panels, which display information in a limited amount of space (see Figure 4.29). In this figure (4.29) there are four content panels: 1700s, 1800s, 1900s, and 2000s. At the right hand side of the figure you see a slider which reveals further content contained in each of the panels.

Figure 4.29 shows the jQuery slider (in addition to the accordion panel) which was added to the map mashups of the Geography section. As discussed in section 4.5.5.1 the default setting for the slider is ‘75’, and users are able to drag the slider left or right to change the transparency of the layer.

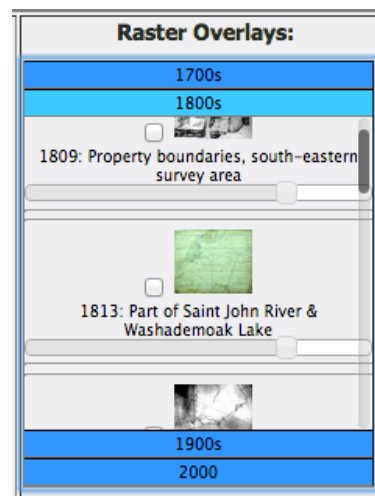


Figure 4.29
jQuery accordion panel

4.6.2. Website Layout

The website is hosted at UNB on the *gaia* server (DNS:gaia.gge.unb.ca).

Relevant software installed on the *gaia* server includes Apache 2.2.21, PHP 5.3.10, and MapServer CGI 6.0.2. Apache HTTP Server is an open source web server application [Apache, 2013]. PHP and MapServer have both been described previously in sections 4.6.1.1 and 4.5.3 respectively.

The website was divided into 5 sections:

- Home
- History
- Geography
- Puzzles
- Go

Additionally, there is a separate login section for teachers to access material geared to towards historical thinking and critical thinking group exercises. Teachers can access this section of the site using a login id of *teacher* and a password of *glm*. A graphical representation of the site map is illustrated in Figure 4.30.

The website uses PHP and SVG to create a series of interactive and dynamic puzzles and quizzes to promote exploration of the web content and education about GLM. The quizzes can be found under both the History and Geography sections. As the quizzes are correctly answered, users collect a series of passkeys which are then used in

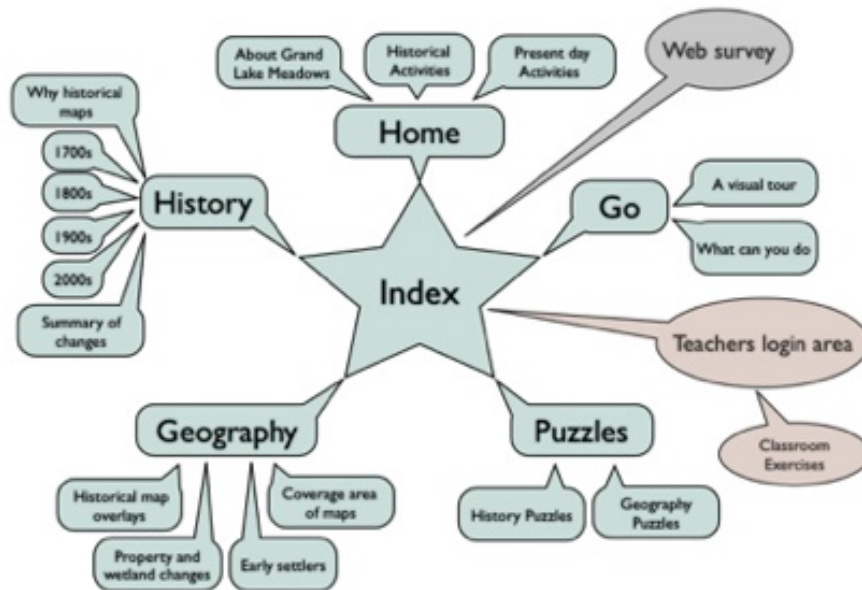


Figure 4.30
Site map for website

the Puzzle section of the website. Appendix V contains an illustrated user guide of the website functionality.

An Adobe Dreamweaver “library” item was used for the main banner in the site and also the page footnotes. A library is a special Dreamweaver file which contains assets such as images, tables, sounds, and AdobeFlash files [AdobeDreamWeaver, 2013]. This library item was inserted into all the pages of the website and any edits made to the library item were then automatically applied to all the pages through Adobe Dreamweaver. The banner and footnote libraries contained items such as unordered lists and hyperlinks to all the individual pages in the site. Additionally, the main banner library item linked to images which display the website title along with UNB and GGE logos. A screen capture of the main banner library item from AdobeDreamWeaver is shown in Figure 4.31, with the web appearance being shown in Figure 4.32. The

difference between these two Figures is attributed to the Cascading Style Sheets (CSS) file - which controls the way the HTML code is implemented in the browser. An unordered list () was created, and five list items () were added to the page: Home, History, Geography, Puzzles, Go. Nested within each of list items is an unordered list and additional list items. This structure, in conjunction with the CSS file creates a series of drop-down menu items in the web page as the user clicks or hovers their mouse/cursor over the main list item, as shown in Figure 4.33. The full the code for the banner library is found in Appendix III.



Figure 4.31
Library file created in AdobeDreamWeaver

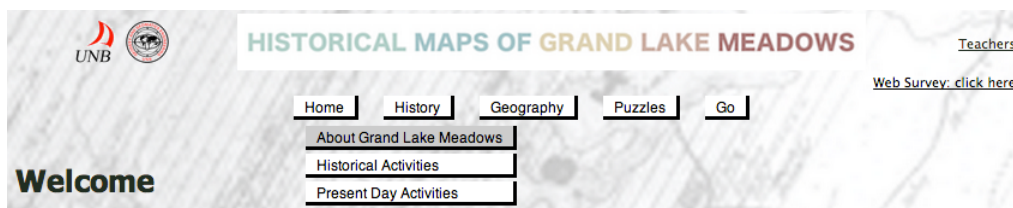


Figure 4.32
Library file created in AdobeDreamWeaver, as implemented in website

```
<ul><li><a href="index_en.html"> Home</a>
<ul><li><a href="about/about_en.html"> About Grand Lake Meadows</a></li>
  <li><a href="about/about_hist_en.html"> Historical Activities</a></li>
  <li><a href="about/about_present_en.html"> Present Day
Activities </a></li></ul></li></ul><ul><ul>
```

Figure 4.33
Sample item list from Library file

A CSS file was created and modified in TextWrangler. A CSS file is used to prescribe style rules which define how to display the HTML elements. The style definitions include dedicated font, font-size, colours, etc.. This CSS file, called *main.css*, is accessed by all web pages in the site to ensure a consistent look and feel, while allowing the ability to change the appearance of the entire site through editing just one file. A copy of the CSS file is available in Appendix IV.

4.6.3. Home Section

In the Home section of the web page an introduction to the website content, layout, and goals of the site are listed, Figure 4.34. Additionally under the Home section, information is included regarding the location of GLM in New Brunswick (NB), its historical importance to NB, as well as descriptions of past and present activities in GLM. This page utilizes HTML and tabs which are implemented via jQuery.

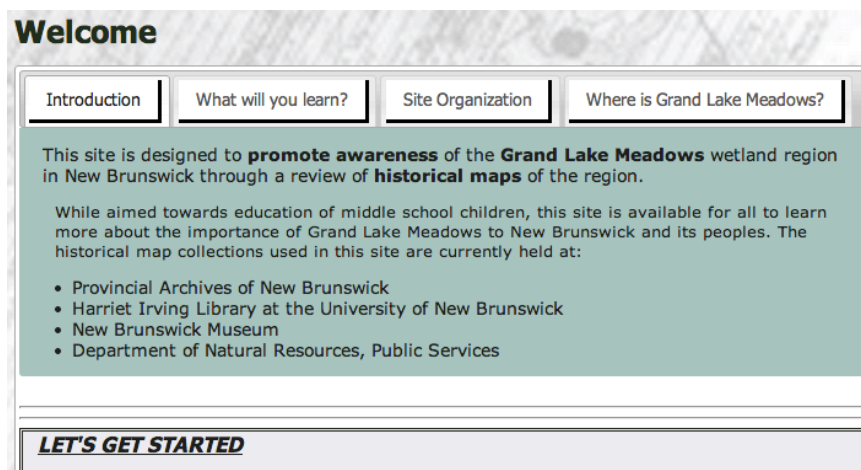


Figure 4.34
Home page of website

4.6.4. History Section

The History section is comprised of six links. The main page *hist_en.html* outlines the content found on the subsequent pages in this section. The links within the History section include: *Why historical maps?*, *1700s*, *1800s*, *1900s*, *2000s*, and a *Summary of changes* found from the 1700s to present day, Figure 4.35. This section contains digital copies of the historical maps, analysis of the map content and changes over time, and quizzes to test comprehension of the content.

The '*Why historical maps?*' link contains content divided over two tabs. The content on the first tab is a series of questions with a submit button, and the second tab contains the answers to the questions - information which explains why historical maps are a valuable.

The five questions on the *Why Historical Maps?* page to answer use a variety of question types including multiple choice, radio button, and text entry (see Figure 4.36). The questions were written using PHP. A simple HTML form was created and when the submit button is pressed, the form and inputs (user's answers to the questions) are sent to the PHP file for processing, and the variables are checked against the correct answers. Three items are returned after submission: first, a 'puzzle piece' which is a jpg image that changes from an all white background to coloured-in puzzle pieces (dependent on the number of correct answers), the second item returned is text indicating

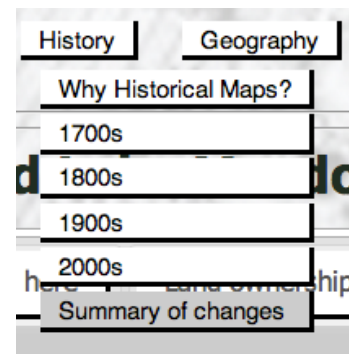


Figure 4.35
Links within History
section

Figure 4.36
 “Why Historical Maps?” page, Passkey tab

to the user the total number correct, and the third is a list of correct answers (see Figure 4.37). The form resets and empties the answers as it reloads. Once all five questions on this page are correctly answered, a “passkey” is revealed (Figure 4.37). There are a total of five passkeys and puzzle pieces to be collected in the *History* section and are all needed to complete the puzzles found under the *History* link of the *Puzzles* page.

The second tab of “*Why Historical Maps*” page is called “*What can historical maps tell us?*”. This tab contains the answers to the questions.

The next four links in the *History* section (see Figure 4.35) are divided by century, with pages for the *1700s*, *1800s*, *1900s* and *2000s*. These pages follow a similar structure to the “*Why historical maps?*” page - with a passkey tab which contains a series of questions, and tabs which contain the answers.

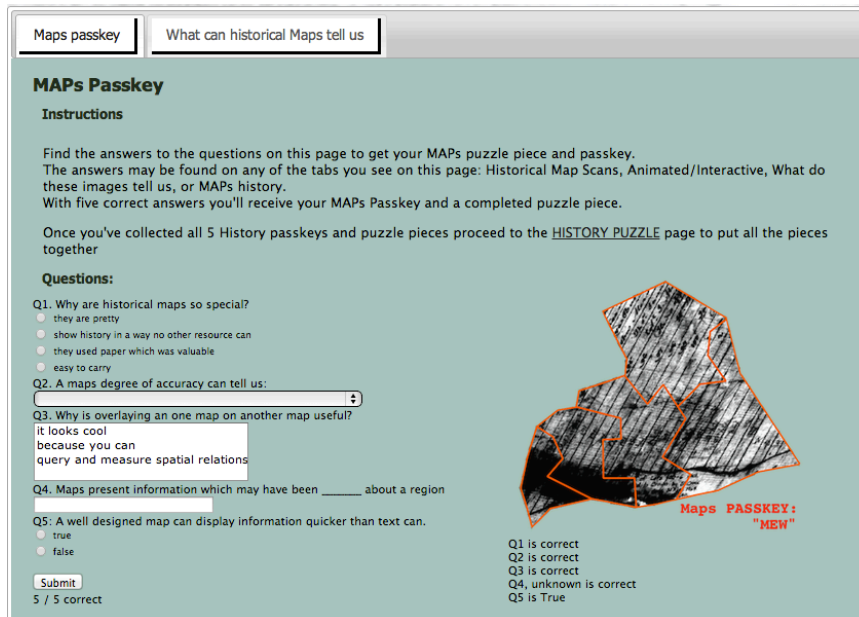


Figure 4.37
 “Why Historical Maps?” page, Passkey tab showing successfully completed puzzle

Users can find thumbnail and full size views of the historical maps from each respective period of time along with the resource location (e.g., PANB: RS687B-Q1/10-Q1/16) on the “*Historical Map Scans*” tab, as shown in Figure 4.38. The images are arranged by date published in an HTML table element.

A tab entitled “*Animated/Interactive*” maps contains an analysis of some of the images from each period of time including animation via SVG. The Animated/Interactive maps tab has a list of four to five different changes we see in GLM or changes to map production for the specified time period. Figure 4.39 illustrates a static capture of the use of SVG. In Figure 4.39 the two canoes in this image are animated routes which follow the assumed paths early settlers used to travel along the waterways.

1700s passkey | **Historical map scans** | Animated/ Interactive maps | What do these images tell us? | 1700s history

Historical Maps found at Provincial Archives N.B.

What can we learn about this time in Grand Lake Meadows from reviewing these historical maps?


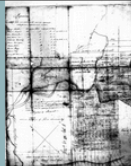
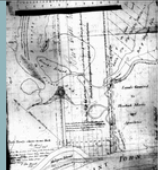

1785	1785
 <p>Geographic Location Full Resolution Image Location at PANB: RS6878/ Q1/10-Q1/16. Property boundaries, thoroughfare between French Lake & Maquapit Lake</p>	 <p>Geographic Location Full Resolution Image Location at PANB: RS686C/ SU/ F17285. Thoroughfare, 'sunken land', and Maquapit Lake</p>
1785	1785
	

Figure 4.38.
Sample from the Historical Maps table, 1700s page

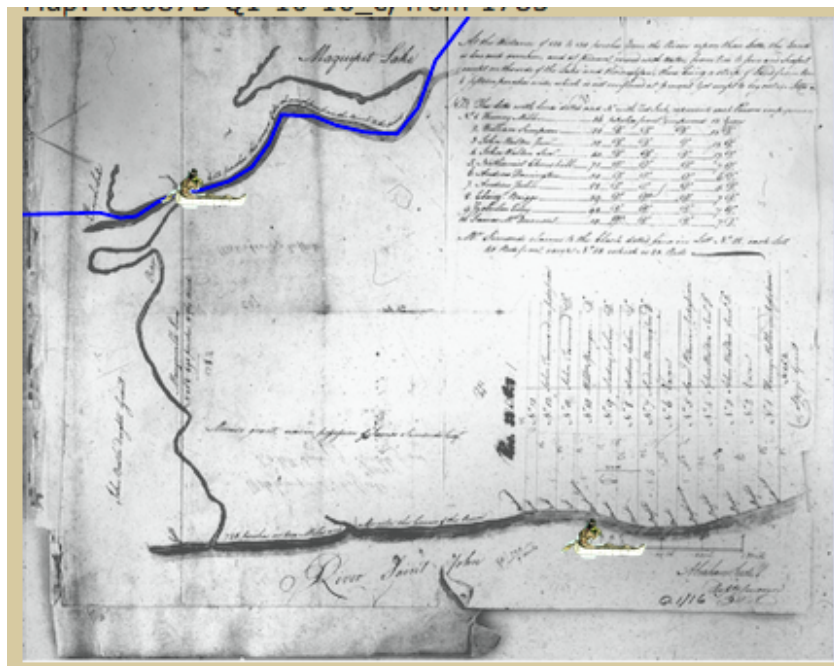


Figure 4.39
Using SVG to create moving objects over historical maps from the 'Animated/Interactive maps' tab of the 1700s page

Another tab within the “*History*” section is a page contains detailed written descriptions of changes seen within each century “*What do these images tell us*” (see Figure 4.40). This tab elaborates on the information and SVG images presented in the preceding tab.

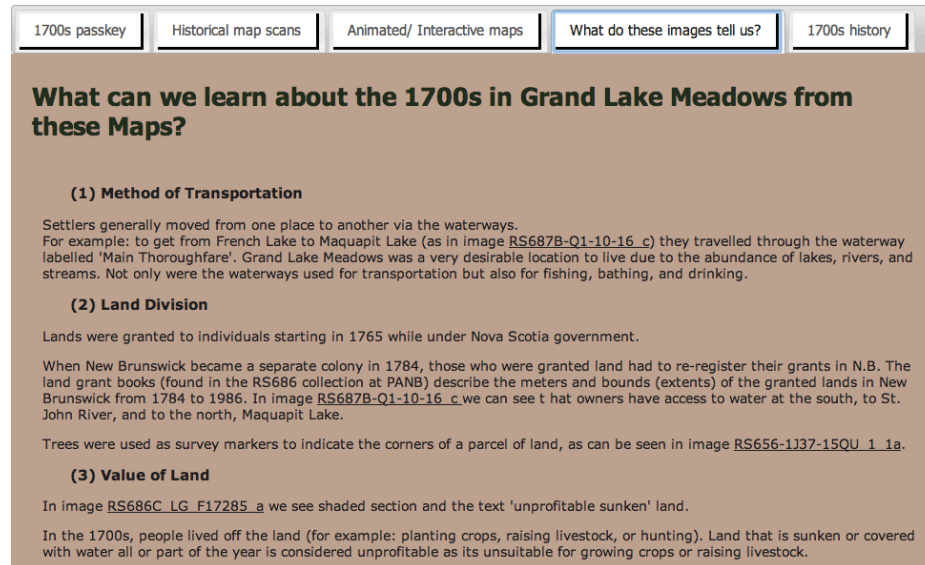


Figure 4.40
Sample of what do these images tell us tab, 1700s page

The final tab, entitled “XXXX” history (e.g., 1700s history) covers a brief historical timeline of events across the province of New Brunswick: these are adapted from the World Atlas, Figure 4.41.

The final link available in the “*History*” section (see Figure 4.35 - Summary of changes) of the website contains a brief summary of the changes found between the 1700s and 2000s in GLM. The summary of changes page includes information regarding how the value of wetlands have changed over time, why settlers settled here, how land parcels were divided, and transportation changes within GLM since the 1700s.

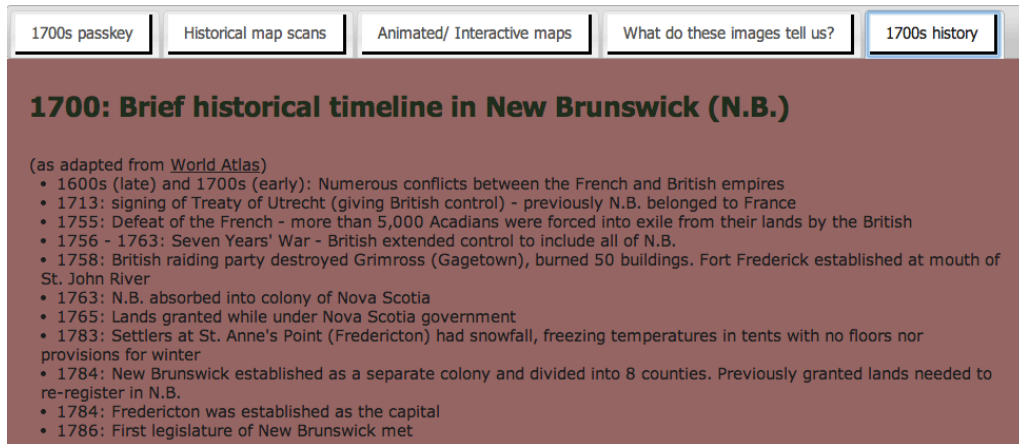


Figure 4.41
Sample XXXXs history tab, from the 1700s

4.6.5. Geography Section

The *Geography* section of the website contains a series of links which display the historical maps overlaid on present day maps. There are four links: *historical map overlays*, *property ownership and wetland changes*, *early settlers*, and *coverage area of historical maps*, Figure 4.42. These links lead to pages that contain dynamic maps and quizzes. The quizzes were designed to encourage the users to explore the maps, learn about GLM, and ask questions about the area. As with the passkeys in the *History* section, the *Geography* passkeys are needed to complete the *Geography Puzzle*.

The process of creating the dynamic map overlays was discussed in section 4.5.

Figure 4.43 shows the *Property Ownership and wetland changes* page and the Property & Wetlands Passkey jQuery tab. Instructions are included on this tab and

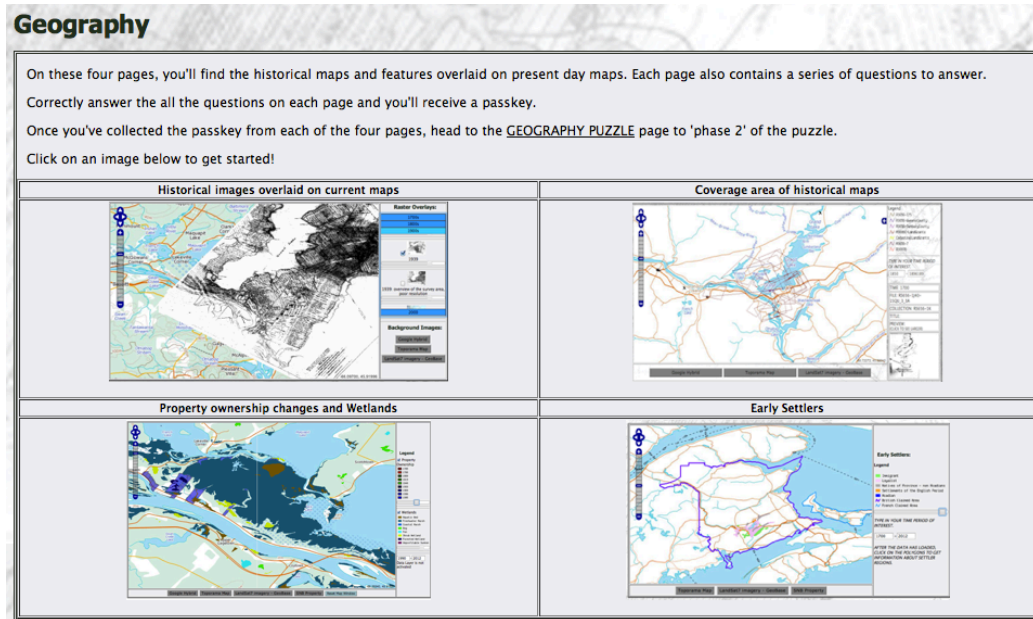


Figure 4.42
Geography home page, with thumbnails and links to the maps/links in this section

indicate to the user that the answers can be found on the *MAP* tab. The user fills in the answers to the questions, presses Submit, and if all answers are correct, they receive the Property & Wetlands Passkey. Each of the four pages contains the same structure.

The process of using the maps to correctly answer the questions is as follows: In Figure 4.43 Question #2 asks: *What type of wetlands are identified in the 1700s?* Open the Map tab (see Figure 4.44). On the right hand side, adjust the “Time period start / end” to include only the 18th century (see Figure 4.45.) Turn on the Wetland layer. At the right hand side of Figure 4.44, Click on Wetland under the Legend to expand the Wetland panel. Click on the checkmark beside wetland classification (see Figure 4.46). The map display updates, and we can see the extent of wetland coverage in GLM during the 1700s as shown in Figure 4.47. Identify the classification type from the legend, or by selecting a feature in the map, and read the classification from the info window below the

Property Ownership & wetlands

Property & Wetland Passkey | MAP - Property ownership & Wetland

Property & Wetland Passkey

Instructions

Answer the questions on this page to get your "Property & Wetland" passkey. The answers will be found on the MAP-Property ownership and Wetland tab. With five correct answers you'll receive your "Property & Wetland" Passkey.

Collect passkeys for each of the four pages in the [Geography section](#). Once you've collected all passkeys proceed to the [GEOGRAPHY PUZZLE](#) page to complete phase 2 of the puzzle.

Questions:

Find the answers to the questions on this page to get your property & wetland puzzle piece and passcode. Proceed to the [GEOGRAPHY PUZZLE](#) page to put all the pieces together

Q1. In the 1785 who owned the largest property:

- ducks unlimited
- harold hunter
- lloyd macfarlane
- morrises grant

Q2. What type of wetlands were identified in the 1700s?

Q3. In 2010 what Wetland types are recorded on Grimmss Island

Q4. What is the deed number of HER MAJESTY THE QUEEN's land in 1989?

Q5: Ducks Unlimited started purchasing land in GLM in the 1800s.

- true
- false

0 / 5 correct

Figure 4.43
Property Ownership and wetlands page, showing two tabs: Property and Wetland Passkey with quiz and MAP

Property & Wetland Passkey | MAP - Property ownership & Wetland

Property ownership changes & wetlands in Grand Lake Meadows

- Turn the layers under legend (Property ownership, buildings, wetland...) on and off with the checkboxes
- Adjust their transparencies by dragging the slider left and right
- Change the years you want to look at by adjusting the Start/End time period
- Click on/select any feature to find out more information about it

Time period start / end: 1700 - 2012

Legend

Property Ownership

- Land Grants by Year
- 1784
- 1785
- 1786
- 1787
- 1788
- 1809
- 1809
- 1848
- 1909
- 1909
- 1995

Wetland

Buildings

Figure 4.44
Map tab of Property Ownership and wetland page

legend. The answer is “unprofitable sunken.” For question #2 on the passkey tab, select Unprofitable sunken from the drop-down menu list.

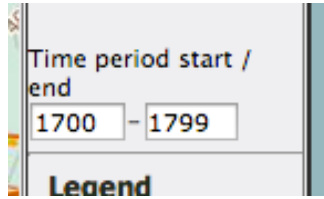


Figure 4.45
Set time period to view maps from 18th century

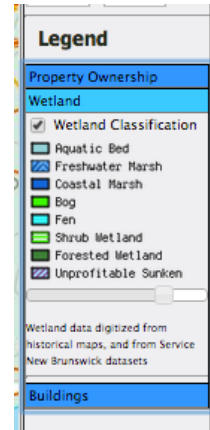


Figure 4.46
Turn on wetland layer

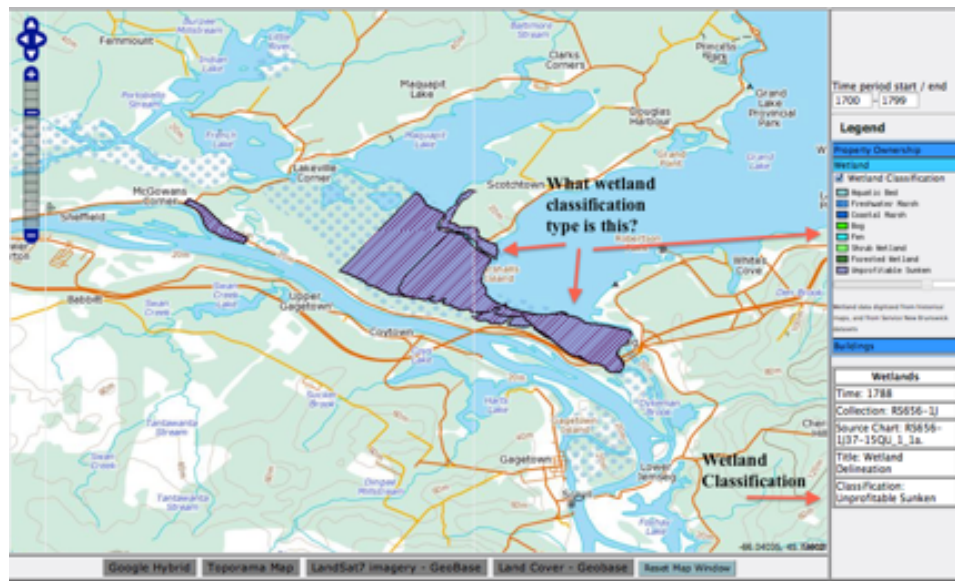


Figure 4.47
Map showing wetlands identified in 1700s

4.6.6. Puzzle Section

The Puzzles section contains secondary puzzles to the *History* and *Geography* quizzes. These puzzles use PHP.

The *Geography* puzzle uses the passkeys collected in the *Geography* section of the website. This *Geography Puzzle* page uses SVG which is implemented in the form of a word search (see Figure 4.48). The goal of the puzzle is to find the four passkeys (a total of nine words) hidden in the image. As the user finds the words hidden in the image, clicking on them turns the words red. In Figure 4.48 three of the nine words have been found: *valuable*, *unprofitable*, and *marsh*. The remaining six words that have not been selected include: *area*, *sunken*, *freshwater*, etc. The contents of the SVG code include a canvas and fence, and the pixels which represent the selectable areas. Figure

4.49 shows how the hidden word “valuable” is defined in SVG and reference to the “ChangeColor” event is called then the mouse is clicked in this series of pixels. The “ChangeColor” function, is self describing - it changes the background colour of a series of pixels as the user clicks on

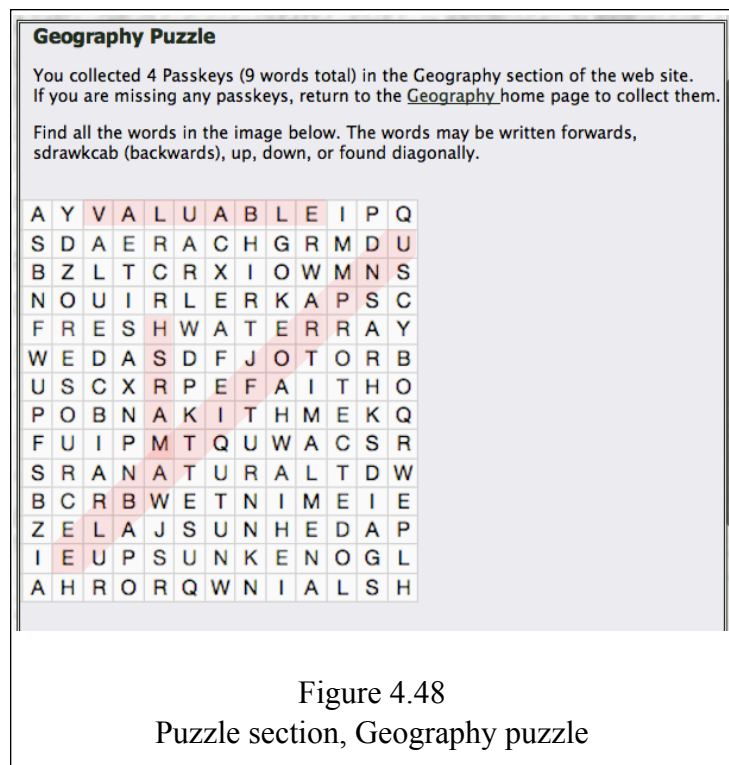


Figure 4.48
Puzzle section, Geography puzzle

any of the hidden words (Figure 4.50).

```
<!--Draw the polygon for hidden word "valuable"-->
  <polygon id="valuable" points="53,0 257,0 257,22
53,22 "
style="fill-opacity:0.1;" fill="white"
onmousedown="ChangeColor(evt);"
onmouseup="ChangeColor(evt);"/>
```

Figure 4.49
Geography Puzzle: SVG hidden word sample

```
<script>
function ChangeColor(evt){
  if (evt.type == "mousedown")
    evt.target.setAttribute("fill", "black");
  else if (evt.type == "mouseup")
    evt.target.setAttribute("fill", "red");
    evt.target.setAttribute("fill-opacity", "1");
  }
}</script>
```

Figure 4.50
Puzzle section, function ChangeColor event

The *History Puzzle* page is comprised of two interactive forms. The first, “Part 1” uses PHP and keyin fields. Enter the five passkeys collected from the *History* section of the website: *mew*, *ark*, *sleds*, *dog*, and *panama*. Press submit with all five correct entries loads a video which shows the assemblage of the puzzle pieces, Figure 4.51. A suggestion to improve this video, such that it launches a 5-10 minute video describing the region with interviews from local residents and historians, would be more effective and informative than the present video.

History Puzzle: Part 2 again uses PHP and keyin fields. This puzzle is an anagram where the user has to unscramble the letters in the passkeys to solve a phrase. A “hint” is supplied if an incorrect answer is submitted: this hint fills in some of the

letters to make the anagram easier to solve. The hint uses the JavaScript rollover event: when the mouse is rolled over the image a series of letters appear (see Figure 4.52).

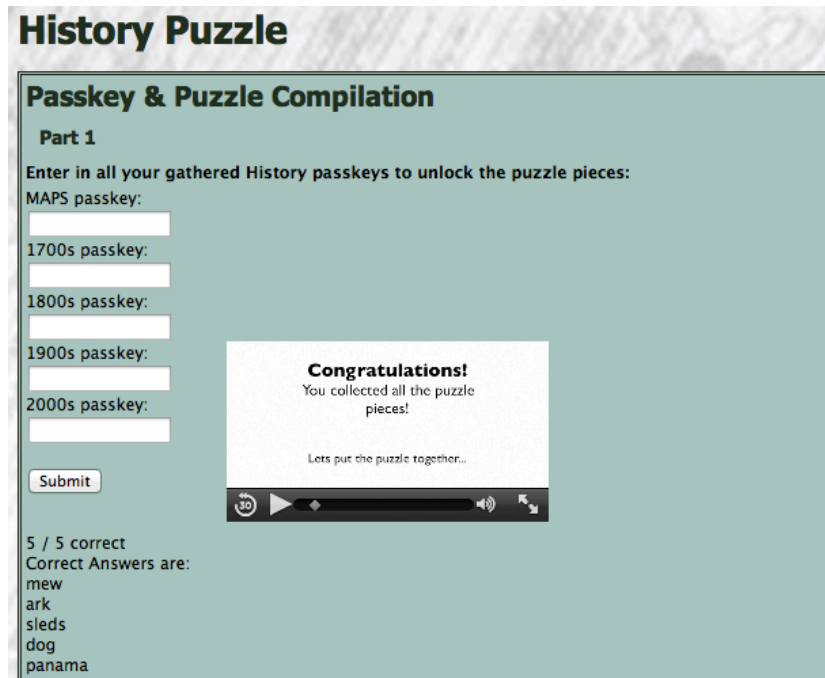


Figure 4.51
History Puzzle, Part 1.

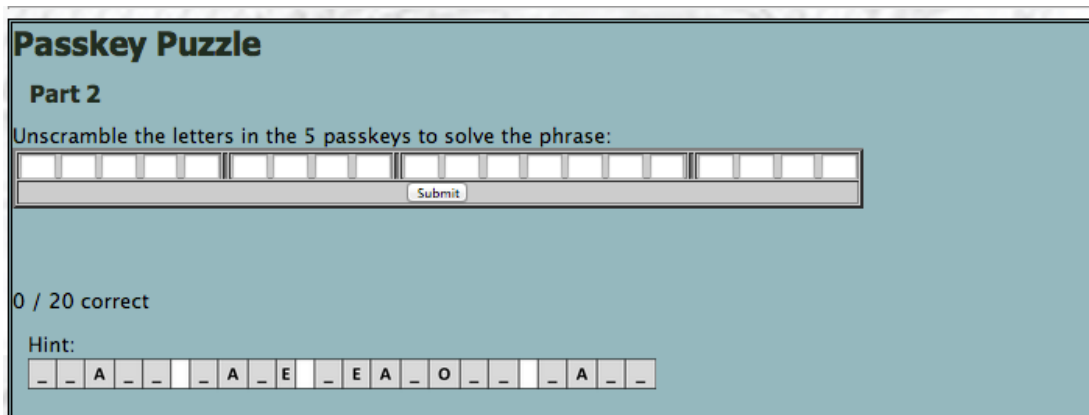


Figure 4.52
History Puzzle, Part 2. Anagram

4.6.7. Go Section

In the *Go* section, there are two links, *A visual tour* and *What can you do?* *A visual tour* page uses OpenLayers API and loads a KML file via WMS which contains point locations and links to photos as described in section 4.5. In the ‘*What can you do?*’ page activities presently available to the public at GLM are shown, including hyperlinks to pages created by local and government organizations (see Figure 4.53).

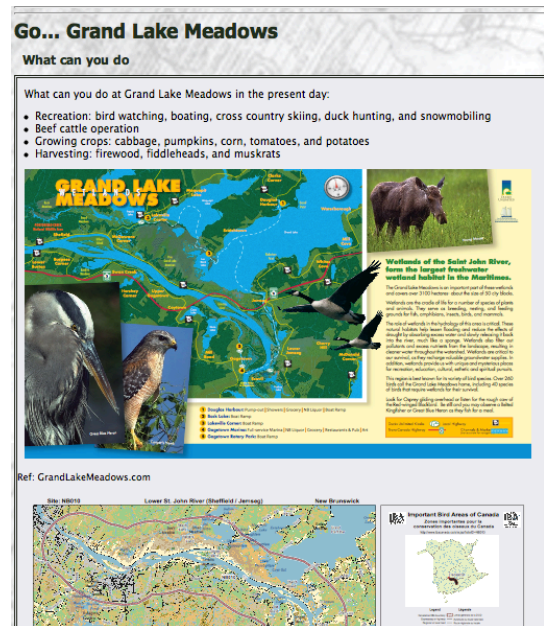


Figure 4.53
Go: What can you do?

4.6.8. Educational Component

Until recently, history and geography instruction in elementary schools had focused on memorization and recitation [Libbee and Stoltman, 1988; Sharma and Elbow, 2000; Halvorsen, 2009; McCall, 2011]. In the past few years changes have been made to school curriculum with the aim of encouraging critical thinking skills in students [Edmonds et al., 2005; McCall, 2011]. Instead of memorizing where a location is and

who settled there, students are increasingly being encouraged to analyze maps and ask questions such as:

- When was the map made?
- What does it have to say?
- Who was the cartographer?
- What were they trying to accomplish by creating this map?
- Did they succeed?
- Does the map tell us something we didn't know before about the area?
[Barrett and Erling, 2009]

This encourages critical thinking skills and is often referred to as 'historical thinking' or 'visible thinking'. As students engage their minds in inquiry, evaluation, problem solving, judgement, and synthesis, they may experience an 'a-ha' moment and become inspired to further analyze, evaluate, and think critically [Edmonds et al., 2005]. The five 'w's are taught to students to develop these critical thinking skills: who, what, where, when, and why [Edmonds et al., 2005]. Exercises incorporating these historical thinking concepts are included in the *Teachers* section of the website.

A generic login of '*teachers*' with the password of '*glm*' is needed to enter the *Teachers* section of the website. This section differs from the main website content, as it is meant to be delivered in a classroom - with time for the students to interact and discuss the historical maps and their ideas and opinions. The exercises within this section were developed based on the core framework put forth by Heritage Canada in its The Historical Thinking Project [Canadian Heritage, 2013]. Clicking on the *Teachers* link from the right hand side of the banner loads the Teachers Resources page, Figure 4.54. This form utilizes PHP and the HTML "Include" element. Upon successfully entering the User ID and Password, the teachers HTML content is loaded into this page. Sample

exercises geared towards grade 5 - 6 students have been developed. These exercises could be expanded to include exercises for all grades of elementary and middle school students.

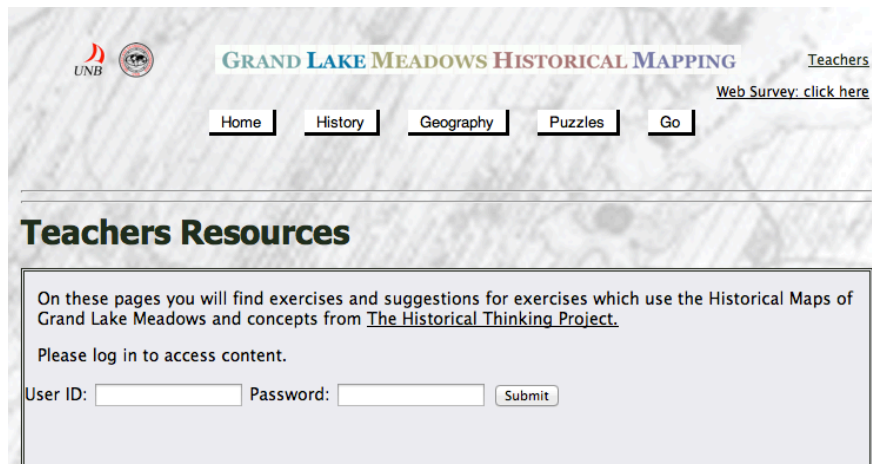


Figure 4.54
Teachers resources area

5. PERFORMANCE, VALIDATION, AND ASSESSMENT

To determine the performance and robustness of the website many tests were conducted which measured page load speed, found broken links, appraised cross-browser tests, and provided analytics.

5.1. Validation

All of the pages were run through the W3C Markup Validation Service (<http://validator.w3.org/>). This markup validation test offered by W3C is able to scan through web documents (e.g., HTML, XHTML, SVG, etc.) to validate specific content and to find broken links [W3C, 2013]. The validator is able to find erroneous tags, content that is obsolete in the HTML document (and should be included in CSS), and ‘bad values’ for attributes. An example of the results of the W3C Validation from the page *index_en.html* page is shown in Figure 5.1. Some errors relating to obsolete HTML entries were left within the pages, instead of migrating them to the CSS as was recommended. The

Errors found while checking this document as HTML5!	
Result:	44 Errors, 1 warning(s)
Address :	<input type="text" value="http://gaia.gge.unb.ca/glm/en/index_en.html"/>
Encoding :	utf-8 <input type="button" value="(detect automatically)"/>
Doctype :	HTML5 <input type="button" value="(detect automatically)"/>
Root Element:	html
Root Namespace:	http://www.w3.org/1999/xhtml

✘ **Line 35, Column 35: The align attribute on the td element is obsolete. Use CSS instead.**

```
<td width="10%" align="right" > <a href="http://www.unb.ca/"><img style wid...
```


✘ **Line 35, Column 127: Bad value 42% for attribute width on element img: Expected a digit but saw % instead.**

```
...nb.ca/"></a></td>
```

Syntax of non-negative integer:
One or more digits (0–9). For example: 42 and 0 are valid, but -273 is not.

Figure 5.1
Results from W3C Validation of index_en.html page

5.2.Performance

Page speed testing was completed using Google Developers PageSpeed Insights (<https://developers.google.com/speed/pagespeed/insights/>). The purpose of PageSpeed Insights is to analyze the content of a web page and generate suggestions to improve the load time of the page [Google Developers, 2013]. While the network connection performance of different machines vary, PageSpeed Insights only considers the network independent components of the page: server configuration, HTML structure, and use of external resources such as images and JavaScript [Google Developers, 2013]. Pages are

scored with a value between 0 and 100, with higher scores representing better performance. In addition to the overall performance indicator, suggestions for improvement are ranked based on a 'red-yellow-green' exclamation point system. A red exclamation mark indicates a fix would result in a measurable (positive) impact on page performance), the yellow is a suggestion to fix (if fixing it wouldn't be a substantial amount of work), and green indicates no significant issues found [Google Developers, 2013]. The results of PageSpeed Insights tests indicated many images could be compressed or modified to improve page performance, Figure 5.2. On these pages the images were compressed and thumbnails were used instead of the full-size image, while the ability to load the full-size image was available through a page link. Further PageSpeed Insight runs indicated "Losslessly compressing" the images would save many bytes of data [Google Developers, 2013]. Image processing programs, available for Mac or PC, are available to complete this compression and reduce file size and webpage load time. Additionally, suggestions to leverage browser caching by setting "cache lifetimes" of a week improve page performance. By setting a 'cache lifetime' value equal to one week this allows the browser to use the cached resource without checking to see if a newer version is available from the web server: thus improving page load times [Google Developers, 2013]. Addition of HTML keyword tag and associated keywords (e.g., Grand Lake Meadows, history, maps, wetland, etc.) in the HTML metadata header allow the page to be more visible: as this metadata tag is used to identify content by some search engines [W3C, 2013].

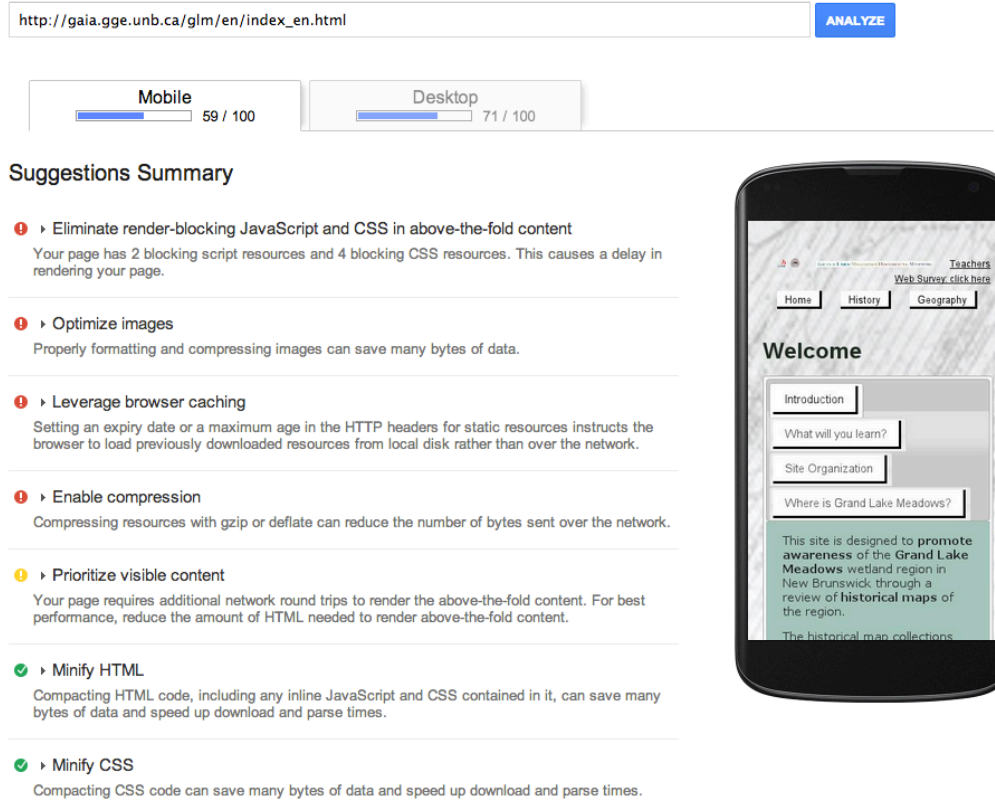


Figure 5.2
Sample Google Developers Pagespeed Insights result

5.3.Cross-browser

Moreover, the web content was tested in various browsers to ensure consistency and conformance. The desktop browsers tested were: Safari (version 6.0.5), Chrome (version 30.0.1599.101), Firefox (version 22.0), and Internet Explorer (version 10.0). All of these browsers were successfully able to display the content, the maps, and interactive quizzes and puzzles. Safari running on iPhone and iPad mobile devices was tested (in

both iOS6 and iOS7) and was also successful at loading the pages and map content.

While not optimized for viewing on an iPhone, the pages are legible and the map content is able to be viewed and interactive content selected.

5.4. User Assessment

A link to the website was sent to many individuals to review and comment on the design, content, and functionality.

5.4.1. Design, Content, and Functionality

A link to the website was sent out to approximately 30 individuals asking for review and comments on the design, content, and functionality of the links. A one-page document which briefly describes the website and content was included in the email, and is found in Appendix VI. The individuals selected to review the website included Geodesy and Geomatics Engineering (GGE) faculty, graduate students, family, educational professionals, and middle school students in Fredericton, NB. Of the 30 individuals 15 of them were grade 5-7 teachers in the Fredericton school system. The request asked for their review of the site and teachers were asked to share the link with

their students. Additionally social media was used to promote the site, encourage visitors, and to elicit a greater number of survey responses. Since one of the goals was to deliver this content to middle school students and educate them on the history and importance of GLM, their comments were the highest valued responses. An online survey, created with Survey Monkey, is linked to the website and was used to acquire feedback regarding the functionality, educational content, and fun. The questionnaire can be found in Appendix VII.

At present, it's been two months since contacting local teachers. I hypothesized that this would be plenty of time to collect user responses and analyze feedback. I've received numerous responses from UNB students, faculty, family and friends, however, none from local middle school teachers or middle school children. It is possible teachers have visited the site and have failed to complete the survey. I definitely underestimated the ability to collect such responses from local educators and more thought and research will need to go into the creation, distribution, and promotion of future surveys to elicit a greater numbers of responses. Including a specific reference to how this material could fit into provincial curriculum or contacting the NB Department of Education could have been attempted to improve responses from educators.

5.4.2. Recommendations for Improving the Website

The overall response from GGE students, friends and family was quite positive, noting that inclusion of the passkeys and puzzles made the pages interactive and users

were apt to spend longer on the site. Users found the layout and structure of the site easy to understand and navigate. They liked the clear headings and sections as well as the consistent layout of the pages in the *History* section. In the *Geography* section the page which allows for turning on and off multiple historical maps and the ability to show individual transparencies has been commented as “really cool.” Users liked that historical image thumbnails and short description of the maps were available, noting it made it easy for them to identify which image they wanted to turn on and off.

Recommendations for improvements include:

- Review of quiz questions: Some of the questions asked on the site are not as specialized or focused directly on the significance of each era and their importance in time. A review and possible revision of some of these questions may be undertaken to focus the learning on the changes or significance of each century in Grand Lake Meadows.
- Passkey tracking: Another suggestion was to have a page or frame to keep track of the passkeys that each user successfully collects on each page. At present, users collect these passkeys which are required for the secondary puzzles, but they need to remember them or note them down. Additionally, having the pages save and reload the correct answers instead of resetting the form was also requested.
- Improving the anagram: Presently, the user collects 5 passkeys under the *History* section, these are: *panama*, *dog*, *mew*, *ark*, and *sleds*. While these alone don't offer much value, if you unscramble the letters, they spell out the phrase:

“Grand Lake Meadows Maps”. Selecting different passkeys, ones that summarize the significance of each century, for example: settlement, land-division, or conservation may be more poignant.

- Video improvement: The History Puzzle, Part 1: when completed launches a short video where the “puzzle pieces” are put together. It has been suggested that a more interesting video which includes historical photographs, interviews with local residents, and voice-over would be more effective and would shed more light on the region.
- Search capabilities: Including the ability to search using keywords such as last name, PID, or grant would enhance the users’ experience on this website. This would allow them to narrow down information to a specific individual or plot of land and acquire further information about it.

6. CONCLUSIONS AND RECOMMENDATIONS

This section contains conclusions of the present research and recommendations for future research.

6.1. Conclusions

Grand Lake Meadows and the surrounding region has been inhabited since Aboriginal times, with evidence dating back 10,600 years (GNB) and is a vital component in the social, political, and economic development of New Brunswick [Queens County Heritage, 2013]. Making this region especially valuable and significant are: rich soil for planting, animals for hunting and trapping, ease of transportation along the rivers and waterways, and resources for making tools and medicines [Queens County Heritage, 2013]. The aboriginals were first to recognize the value in this region and to live and work here [GLM, 2013]. During the 18th century many settlers including the Dutch, French, English, and Loyalists came to this area and vied for the rich resources along with the aboriginals [Queens County Heritage, 2013]. As these settlers arrived the resources in GLM quickly became exploited.

The Province of New Brunswick has long recognized the importance of this area, primarily due to its contributions to maintaining a clean environment for a wide variety of flora and fauna, its historical significance to the people of New Brunswick, and its

environmental sensitivity [Queens County Heritage, 2013]. In the late 1900s a number of provincial acts were passed which aimed to protect GLM, including: Clean Environment Act, the Historic Sites Protection Act, the Protected Natural Areas Act, and the Endangered Species Act [Queens County Heritage, 2013].

The results of this research have found that a number of historical maps exist for this project area. Primarily, these historical maps are in the form of Land Grants registered in New Brunswick in the late 1700s: when New Brunswick was established as a separate colony [World Atlas, 2013]. While the Land Grant maps contain information regarding how the land was divided, they do not contain details pertaining to land use (such as crops farmed) nor do they contain information regarding structures which may be built on the land. It was predicted that the historical maps found at PANB would be able to provide a better understanding (than currently exists) of land use and farming practices in the region from this period; however the map resources found were unable to fulfill this prediction.

On a number of the historical maps from the 1700s and 1800s there exist shading and boundaries labeled “unprofitable sunken land” or “sunken land” (Figure 6.1). These represent areas which today are considered freshwater marsh [SNB, 2013]. Areas labeled as “unprofitable sunken land” or “sunken land” are found south of the Lower Thoroughfare and along the northeastern edge of the survey area (bordering Grand Lake) all the way to Jemseg River (Figure 6.2). Once these maps with wetland delineation were found, it was hypothesized that a comprehensive picture of the extent of the wetland over the period studied may be created and evidence of growth of the wetland

over time may have been found. Unfortunately, however, there were not a significant number of maps with enough variation of the mapped wetland extents to be able to make any claims regarding growth or diminishment of the wetlands over time.

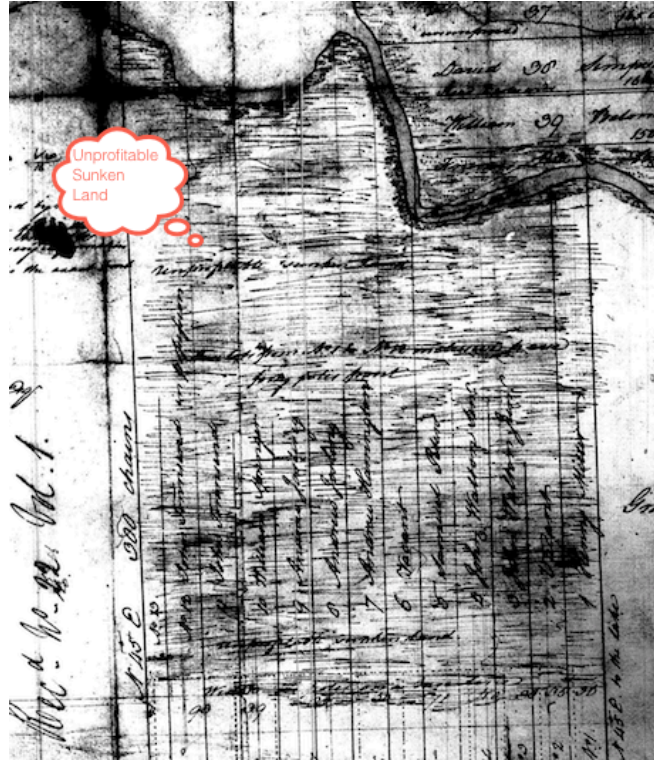


Figure 6.1
Snapshot of historical map identifying unprofitable sunken
land. PANB collection: RS686C, microfilm: F17285

The St. John River banks along the GLM project area are primarily low relief alluvial floodplain [Papoulias et al., 2006] and flooding during the spring freshet occurs seasonally. The flow of the river and the influence of tides make this an area of erosion and deposition. While this is a very active area for sediment movement, analysis of the historical maps in the project area, have been unable to positively identify any significant changes along the riverbank of the St. John River.

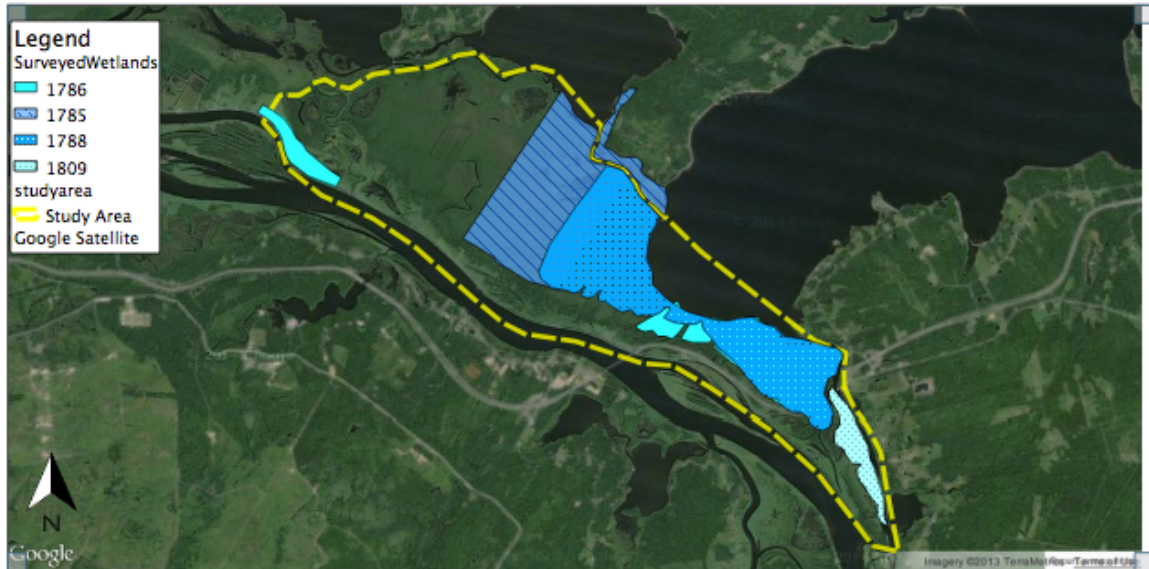


Figure 6.2
Wetlands (unprofitable sunken lands) identified from PANB land grant maps

The creek running through the northwestern section of the project area, called Loder Creek was previously named Simmonds creek. Analysis of this river through a series of maps identify conflicting routes which transport water in this creek between the St. John River and the Main Thoroughfare. It is suspected that this may be due to lack of precise equipment, or interest in mapping the meandering curves of this creek, and may not be due to significant changes in the actual watercourse (see Figure 6.3).

Reviewing the content and types of maps from the 1700s to present day, we see many changes. The maps found from the 1700s display primarily lands granted to individuals. In the 1800s we start to see maps with some more detail regarding land classification, and in the 1900s we see a large number of maps with varying content. A large number of maps produced in the 1900s were created by the provincial or federal government and depict specialized information such as: river bathymetry, origins of the



Figure 6.3

Meanders of Loder (Simmonds) Creek. The present day mapped location of Loder Creek, and overlain are two historical maps also displaying Loder Creek

people, and magnetic surveys. Additionally, aerial photography collection began in the 1900s. The earliest photographs were taken from mountain tops, and by the 1920s the Canadian government (via the Royal Canadian Air Force) had established regular aerial photography flights across the country [NRCAN, 2013]. Aerial photography for the entire project area was not purchased, and there may be existing aerial photos of the project area earlier than 1934. As we entered the 2000s, the precision and availability of a wide array of survey equipment has further expanded mapping capabilities. We continue to find a wide variety of maps which are highly detailed and thematic such as: wetland classifications, protected natural area zoning and classes, and ecosites to name a few.

Great changes in society have occurred since the 1700s with respect to housing, transportation, hunting and gathering, as well as general technological advancements. In

the present day, very few of us live off the land (as our ancestors did) and plant a garden or hunt for our own food. This is a stark contrast to the living conditions of the 1700s and 1800s. Permanent housing structures were not as prevalent in the late 1700s as they have become today. Based on aerial photo interpretation, the largest number of buildings are found in the 1950s [Paponnet-Cantat and Black, 2003] (see Figure 6.4). This corresponds to what some refer to as ‘the end of farming’ in GLM [Shalala D’Aoust, 2013]. This ‘end of farming’ is considered a result of the Canadian government looking for a location to establish a suitable Canadian Army training facility and a general population decline as a result of World War II. In the early 1950s expropriation of lands commenced as the construction of the base facilities for Canadian Forces Base (CFB)

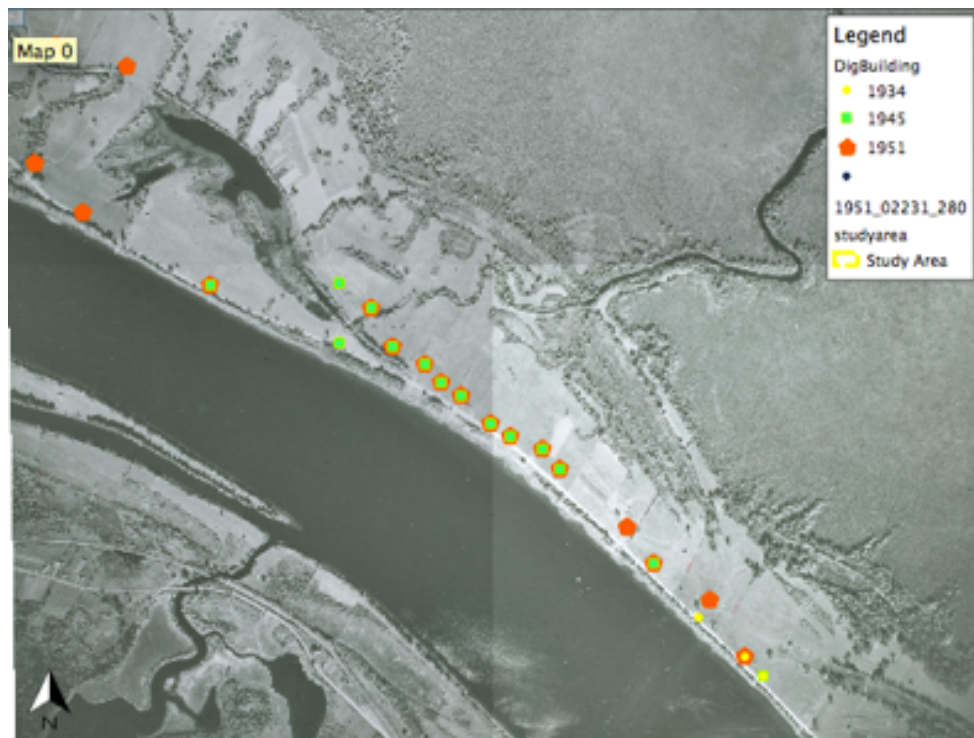


Figure 6.4
Buildings in Grand Lake Meadows in the 1900s (as interpreted from aerial photography provided from DNR, Public Services)

Gagetown began in the village of Oromocto [GovCda, 2013]. While a few structures and some farming practices still exist in GLM today, land use and occupancy is much lower than was recorded in the 1940s.

Land based transportation routes have grown considerably since the 1800s. Initially called Route 2, this two-lane highway was defined in 1927 and connected Quebec's Route 2 terminous to Nova Scotia, spanning New Brunswick via Edmonston, Grand Falls, Woodstock, Fredericton, Saint John and Moncton [FoundLocally, 2013]. In 1950 the route of the Trans-Canada Highway was defined, largely following Route 2. In the mid-1960s a bridge was constructed over Jemseg River which became part of Route 2 (Trans-Canada Highway). By the end of the 20th century, to accommodate growing transportation needs, the Trans-Canada Highway route through GLM was revised and a



Figure 6.5
Google maps image and street view illustrating new four lane bridge and 1960s bridge crossing Jemseg River

four-lane highway was constructed along with a new bridge, approximately 100m upstream from the previous bridge, Figure 6.5. The growing transportation network and its impact, while increasing accessibility to transport, reduced the available land in GLM (by approximately 55 ha [Blair, 2003]) for farming, residence, and wildlife.

In summary, while unable to illustrate specific changes with respect to geomorphological changes within GLM through historical map analysis, societal changes have been identified and a comprehensive history of the area has been created by combining historical maps, research, and historical knowledge into an educational website, which may be found at: http://gaia.gge.unb.ca/glm/en/index_en.html. This lack of geomorphological information may be, in part, due to the map makers of the day not recognizing the importance or future value of documenting such things. As we've moved into a modern era, the agendas of human interest in the area have been balanced with more information on the nature and ecology of GLM itself, and this has been increasingly studied and documented. As far as the educational aims of the website go, our growing awareness and appreciation of GLM ecology is an historically 'new' development, and an important one. Promoting the educational website towards young students may plant the seeds of historical and ecological awareness and appreciation in their minds, which will hopefully continue to grow into the future – the 'history' we have yet to write.

6.2. Future Research

This research was based primarily on reviewing and analysis of historical maps available at the Provincial Archives of New Brunswick (PANB) to identify geomorphological and societal changes in GLM. During the course of this project, additional research topics were identified, and are as follows:

- Discussions with members at Queens County Heritage indicated additional reading resources which could further enrich the map content and add historical context to the maps by illustrating land use. Linking the information from these reading lists could aid in ‘painting a picture’ of early life in GLM.
- Aerial photographs of the project area are available from the Department of Natural Resources, Public Service. The collection of aerial photographs owned by the province date back to the 1920s [DNR, 2013]. Additional years are available for purchase for the remainder of the 20th century, and for the remainder of the project area. From these images, we can identify buildings, farmed land, rivers, existing roads, and clear-cut lands. Future research could focus on aerial photo interpretation to get a better understanding of land use and habitation in the region from the 1900s to present day.

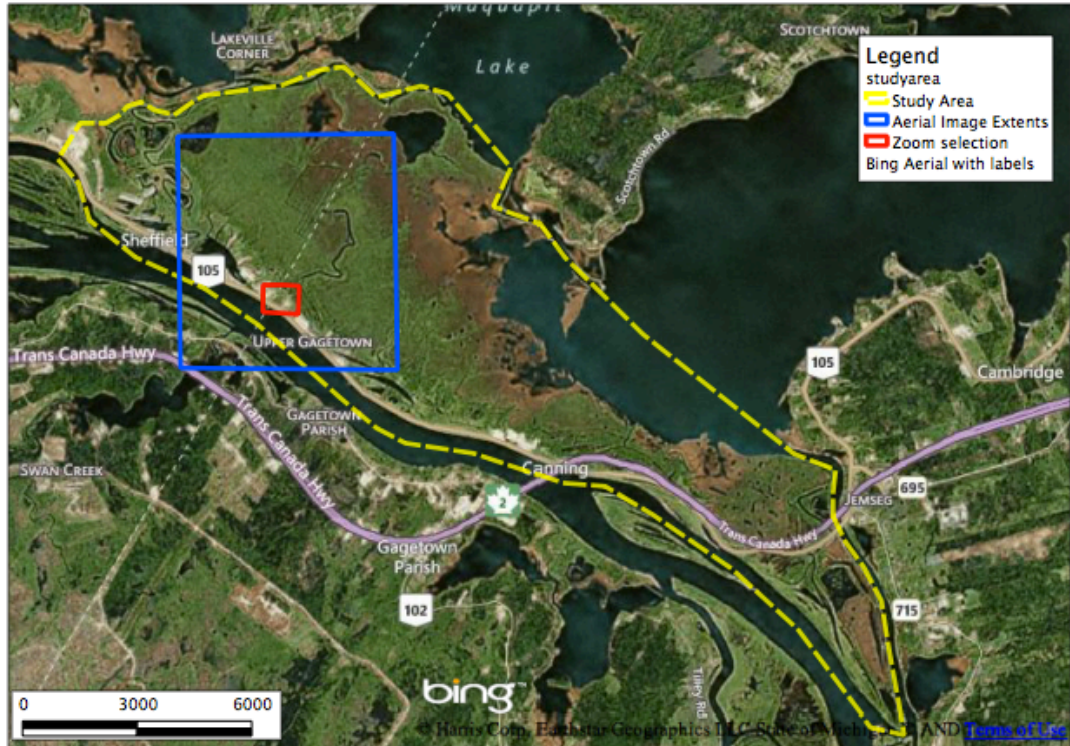


Figure 6.6

Bing aerial map indicating project area in dashed yellow line, and aerial image extents. Full image coverage blue square, and zoom section red square

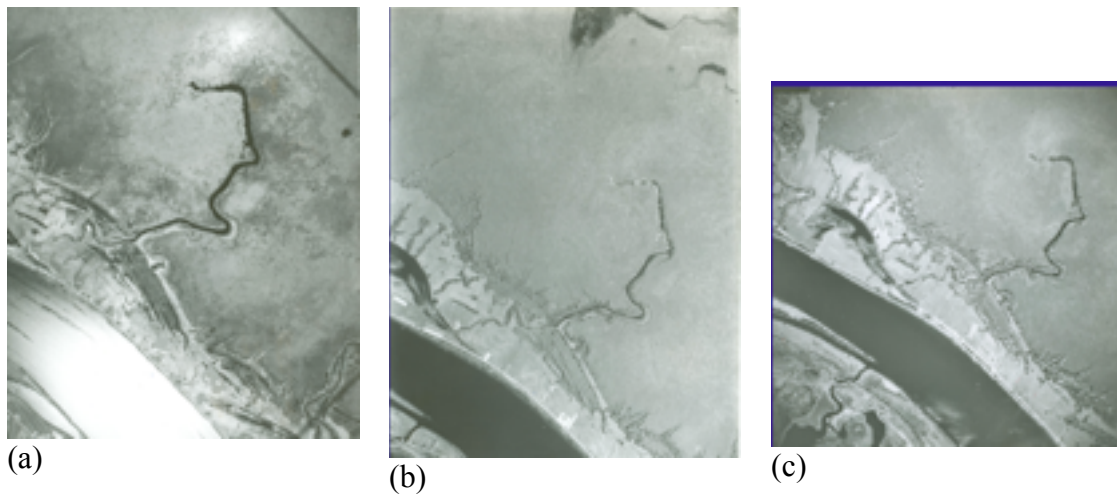


Figure 6.7

Three band colour image, aerial photographs from Department of Natural Resources, Public Services. PID: 60080462. (a) 1934, (b) 1945, (c) 1951

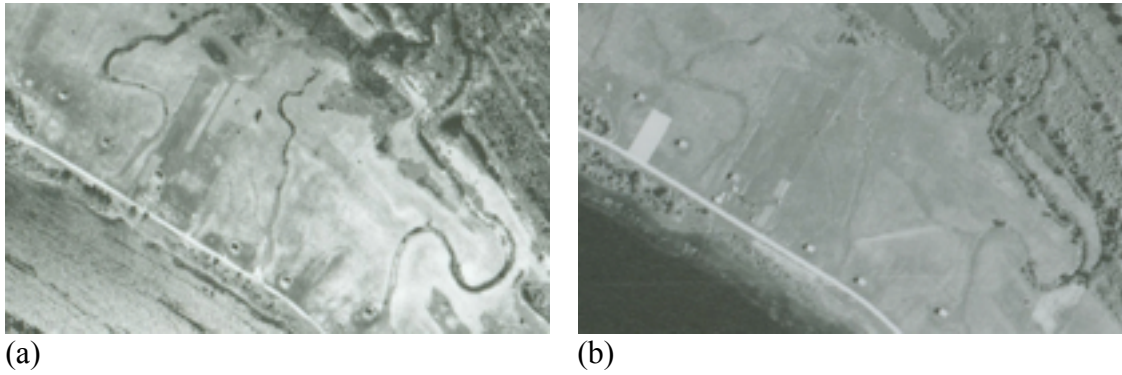


Figure 6.8

Three band colour image, aerial photographs from Department of Natural Resources, Public Services. PID: 60080462. (a) 1934, (b) 1945

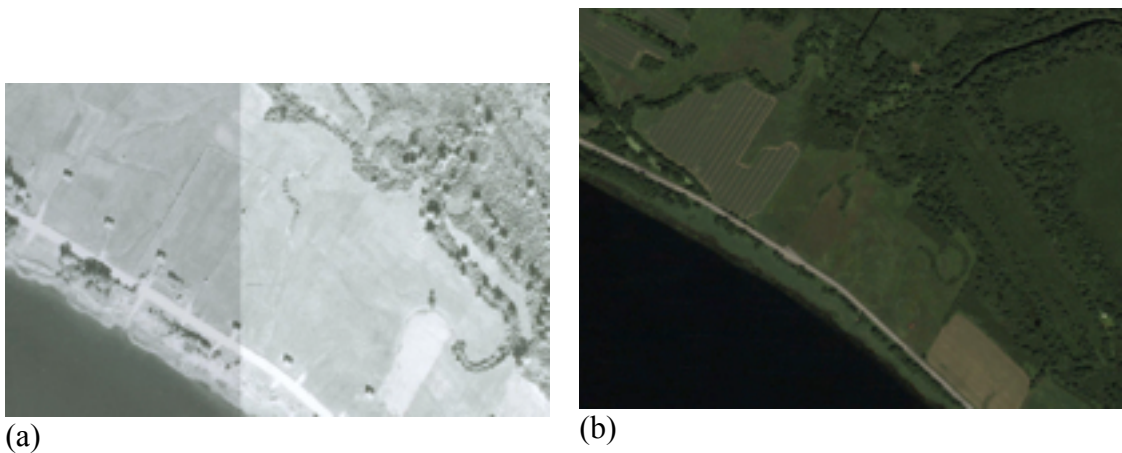


Figure 6.9

(a) Three band colour image, aerial photographs from Department of Natural Resources, Public Services. PID: 60080462. (b) Google Satellite image from 2013

- In addition to the gray scale or three band colour images, we can view the images using pseudocolour. Using pseudocolour for display, as shown in Figure 6.10, additional details in the image become evident as the perceived difference in colour space is greater than that of the gray scale [Schowengerdt, 2007]. These pseudocolour images are derived from the grayscale through a process of mapping the intensity values at each cell based on a defined table or function

[Schowengerdt, 2007]. Using the pseudocolour images is also an effective way to look at volume flows of water and may identify geomorphological changes. Specifically, in Figure 6.10 we can see in the 1951 image, the St. John River is clearly displayed in blue, which is typical of locations below sea level. However, in the 1939 image the St. John River is red in the southern and central section of the image. Further analysis into these, and other anomalies would be very informative.

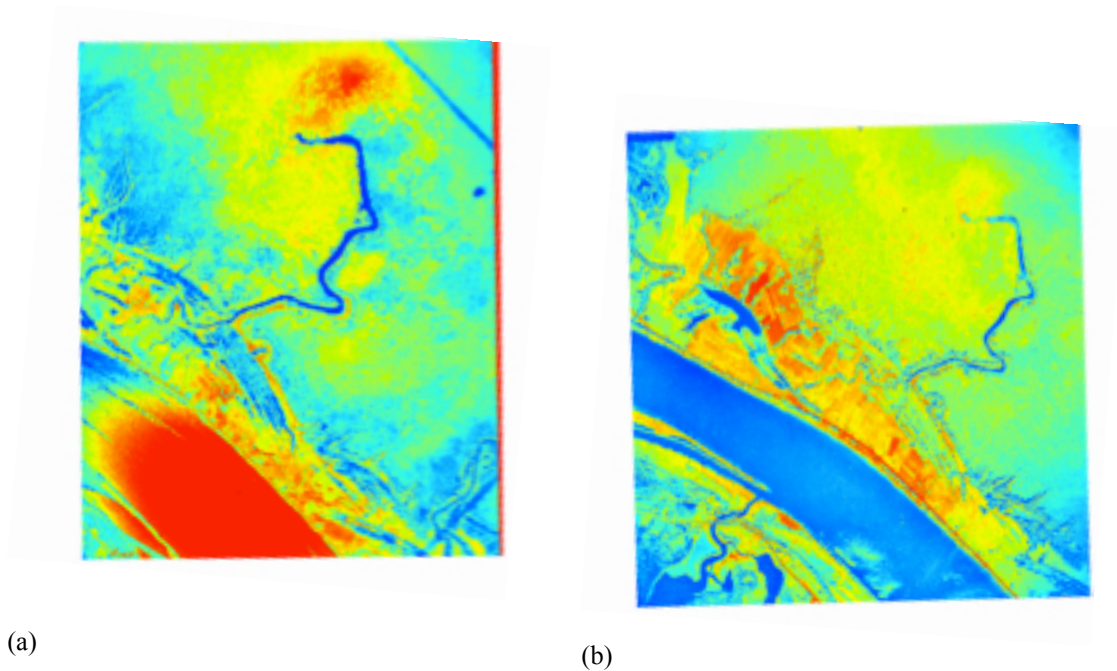


Figure 6.10
Pseudocolor images: aerial photographs from Department of Natural Resources, Public Services. PID: 60080462. (a) 1934, (b) 1951

- Beyond aerial images, additional future topics for research could include developing a website (or expanding the present one) which further intertwines the resources available at PANB. For example, having a map which would link land grant petitions to the land grants and also to the historic map scans in a geographic

viewer, Figure 6.11. This could provide an all-in-one solution, where a user could: select a plot of land, view the recorded history of it, along with any sketches and petition letters which were submitted for that particular parcel of land.

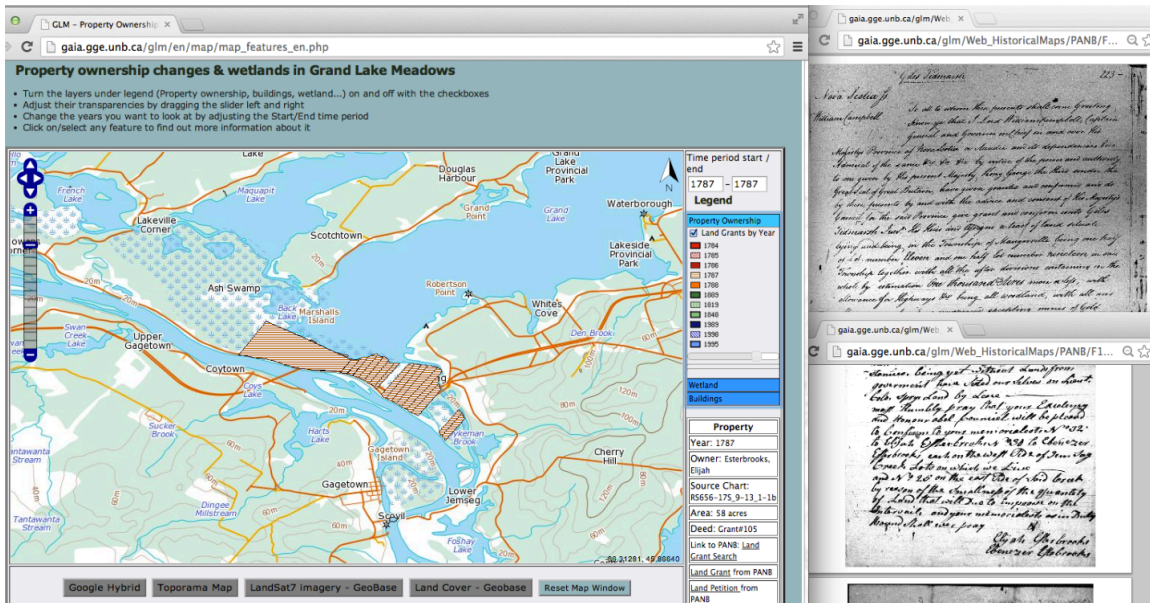


Figure 6.11

Integrated map. Viewing polygon property boundaries over BING map. Select a property, and the attributes link to land grant information and a digital copy of the original petition and grant for the parcel

- To enhance this mapping application, one could add keyword searches to view available resources to load onto the map. Additionally, merging all available resources onto one page may also be useful. Currently, the website has separate links for the historic map scans, for settlers, and for land grants and wetland delineation. Merging all resources into one page could be a nice enhancement and provide an all-in-one map resource for users
- Studies on genealogy could also provide more information regarding early settlers, family connections, and patterns.

With respect to the educational component, suggestions for improvement and future research include:

- Expansion of the education content to include more exercises geared towards critical thinking. Creating a greater number of exercises and expanding the content to include a greater range of age groups.
- Including providing links of the current NB curriculum to the provided exercises. This would give the teachers a clear idea how the provided exercises can fit into the mandated curriculum, and provide digital access to the resources.
- By working in conjunction with the New Brunswick Department of Education to aid in the development of provincially approved content, adhere to the education departments standards, and align with current curriculum.
- Expansion of the visual tour to a full virtual tour would allow the site visitors to get a better representation of present day. Setting up capabilities in a virtual tour that would allow for the overlay of historical maps so users could view the environment in both present and past would be a really fun activity and a great learning tool.
- Enabling the site to work with the new Google Glass technology, could allow users to toggle between the present day view and historical views.
- Presenting this material at a public meeting at Queens Country Heritage or in middle school classrooms is also of interest. Presently (Oct, 2013) this is being pursued, though no dates for such presentations have been set.

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Appendix I: MapServer MapFile

```
MAP

NAME imagekey_wms
STATUS ON
SIZE 800 600
EXTENT 2487881 7409565 2556927 7445916
UNITS DD
IMAGECOLOR 234 238 244

PROJECTION
    "init=epsg:2953"
END

WEB
    IMAGEPATH "C:\ms4w\Apache\htdocs\tmp"
    IMAGEURL "/tmp/"
    METADATA
        "wms_title" "imagekey"
        "wms_onlineresource" "http://gaia.gge.unb.ca/cgi-bin/mapserv.exe?map=/ms4w/Apache/htdocs/glm/Web\_HistoricalMaps/shapes/imagekey\_wms.map&SERVICE=WMS&VERSION=1.3.0&REQUEST=GetCapabilities"
        "wms_timeformat" "YYYY"
        "wms_feature_info_mime_type" "text/html"
        "wms_srs" "EPSG:2953 EPSG:4326"
    END
END

#-----legend definition
LEGEND
    STATUS ON
    KEYSIZE 16 10
    TRANSPARENT ON
    LABEL

    COLOR 1 1 1
    END
END

#-----layer definition

LAYER
    NAME "imagekey"
    METADATA
        "wms_title" "imagekey"
        "wms_description" "image key of historical maps"

        "wms_timeextent" "1700/2012"
        "wms_timeitem" "Year"
        "wms_timedefault" "1700"
        "wms_enable_request" "*"
    END

    TYPE POLYGON
    STATUS ON
    TOLERANCE 20
```

```

PROJECTION
  "init=epsg:2953"
END
DATA 'C:\ms4w\Apache\htdocs\glm\Web_HistoricalMaps\shapes\imagekey.shp'
TEMPLATE "C:\ms4w\Apache\htdocs\glm\Web_HistoricalMaps\shapes\imagekey.html"
CLASSITEM "source"
  CLASS
    NAME "RS656-17S"
    EXPRESSION "RS656-17S"
    STYLE
      OUTLINECOLOR 113 91 10
      WIDTH 1
    END
  END
  CLASS
    NAME "RS656-1J "
    EXPRESSION "RS656-1J"
    STYLE
      OUTLINECOLOR 75 0 130
      WIDTH 1
    END
  END
  CLASS
    NAME "RS656-1K "
    EXPRESSION "RS656-1K"
    STYLE
      OUTLINECOLOR 151 34 159
      WIDTH 1
    END
  END
  CLASS
    NAME "RS686C"
    EXPRESSION "RS686C"
    STYLE
      OUTLINECOLOR 151 34 0
      WIDTH 1
    END
  END
  CLASS
    NAME "RS656-7"
    EXPRESSION "RS656-7"
    STYLE
      OUTLINECOLOR 100 0 50
      WIDTH 1
    END
  END
  CLASS
    NAME "RS687B"
    EXPRESSION "RS687B"
    STYLE
      OUTLINECOLOR 250 50 20
      WIDTH 1
    END
  END
  CLASS
    NAME "LandGrants"
    EXPRESSION "PANB_web"
    STYLE

```


OUTLINECOLOR 232 245 139
WIDTH 3

END

END

END
END

Appendix II: Historical Map Overlays HTML

```
<!doctype html>
<html>
  <head>
    <meta http-equiv="Content-Type" content="text/html; charset=UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0, maximum-scale=1.0, user-
scalable=0">
    <meta name="apple-mobile-web-app-capable" content="yes">
    <title>GLM - Map Overlays</title>
    <!--main.css my custom stylesheet-->
    <meta http-equiv="Content-Type" content="text/html; charset=UTF-8">

    <link rel="stylesheet" href="../../main.css" type="text/css">
    <!--needed for OpenLayers.loadURL-->
    <script src="http://gaia.gge.unb.ca/GGE6408/OpenLayers/lib/deprecated.js"></script>
      <script src="http://openlayers.org/dev/OpenLayers.js"></script>
      <link href="../../SpryAssets/SpryAccordion.css" rel="stylesheet" type="text/css">
      <script src="../../SpryAssets/SpryAccordion.js" type="text/javascript"></script>

    <!-- google temp key -->
    <script src="http://maps.google.com/maps?
file=api&amp;v=2&amp;key=AlzaSyCJE2KT21whf6YM65BnMhImN-eAwwUNsZ0"
      type="text/javascript"></script>

    <script type="text/javascript">
      var lon = -66.16;
      var lat = 45.842194;
      var zoom = 10;
      var map, RS687B2, RS687B1, RS687B3, toporama;
      var RS687B4,RS687B5, RS687B6;
      var RS655341, RS655342, RS655343;
      var RS6561J1, RS6561J2, RS6561J3, RS6561J4;
      var RS6561K1, RS6561K2, RS6561K3, RS6561K4, RS6561K5;
      var RS65671, NBFedNat1, PNA1, PNA2,PNA3;
      var RS65617S1, RS65617S1, PANBw1, PANBw2, PANBw3, PANBw4;
      var RS686C1, RS686C2, RS686C3, RS686C4, RS686C5, RS686C6, RS686C7;
      var landsat, g_hybrid;
      var GLMWebmaps1, GLMWebmaps2, GLMWebmaps3, GLMWebmaps4, GLMWebmaps5;

    //to add in collapable and toggled layers
    function toggleControl(element){
      if(element.value == "ckRS687B1"){
        RS687B1.setVisibility(element.checked);
      }
      if(element.value == "ckRS687B2"){
        RS687B2.setVisibility(element.checked);
      }
      if(element.value == "ckRS687B4"){
        RS687B4.setVisibility(element.checked);
      }
    }
    ...
    ....
```

```

}

//to resize map with window size
function resizeMap() {
    var container = document.getElementById('map');
        container.style.height = Math.round((document.documentElement.clientHeight) * 0.75) +
'px';
        container.style.width = Math.round(document.documentElement.clientWidth * 0.85) + 'px';
    }

    function init() {
        var options = {
            projection: new OpenLayers.Projection("EPSG:2953"),
            displayProjection: new OpenLayers.Projection("EPSG:2953"),
            units: "m", };

        resizeMap();
//define map
    map = new OpenLayers.Map( 'map', { controls: [] } );

//geogratis Toporama NRCAN
        toporama = new OpenLayers.Layer.WMS("Toporama", "http://wms.ess-
ws.nrcan.gc.ca/wms/toporama\_en", {layers:
'vegetation,builtup_areas,hydrography,designated_areas,hypsography,water_saturated_soils,landforms,wate
r_features,road_network,structures,feature_names'});

//my map file    to load raster images from RS687B
//6 images
        RS687B1 =    new OpenLayers.Layer.WMS("1785:", "http://gaia.gge.unb.ca/cgi-bin/
mapserv.exe?map=/ms4w/Apache/htdocs/glm/Web\_HistoricalMaps/PANB/RS687B/RS687B\_wms.map",
{layers: 'RS687B1',transparent:"true",format:'image/gif', visibility: 'true'},
    {singleTile: true},
    {isBaseLayer:false}
    );
//set visibility to false.. user can toggle on
RS687B1.setVisibility(false);

        RS687B2 =    new OpenLayers.Layer.WMS("1788: ", "http://gaia.gge.unb.ca/cgi-bin/
mapserv.exe?map=/ms4w/Apache/htdocs/glm/Web\_HistoricalMaps/PANB/RS687B/RS687B\_wms.map",
{layers: 'RS687B2',transparent:"true",format:'image/gif', visibility: 'true'},
    {singleTile: true},
    {isBaseLayer:false}
    );
//set visibility to false.. user can toggle on
RS687B2.setVisibility(false);
    ....
    ....

//set projection of raster layers..
    RS687B1.projection = new OpenLayers.Projection("EPSG:2953");
    RS687B2.projection = new OpenLayers.Projection("EPSG:2953");
    ...
    ...

//Google Base mapping

```

```

G_HYBRID_MAP });
    g_hybrid = new OpenLayers.Layer.Google( "Google Hybrid" , {type:
//g_hybrid.projection = new OpenLayers.Projection("EPSG:4326");

//my map file - study area
    // studyarea = new OpenLayers.Layer.WMS("studyarea", "http://gaia.gge.unb.ca/cgi-bin/mapserv.exe?map=/ms4w/Apache/htdocs/glm/Web\_HistoricalMaps/study.map",
    {layers:"studyarea",transparent:true,format:'image/gif'});

        // Geobase      landsat layer
        landsat = new OpenLayers.Layer.WMS("LANDSAT7(Geobase)", "http://ows.geobase.ca/wms/geobase\_en", {layers: 'imagery:landsat7'});

//add layers to map
    map.addLayers([toporama, RS687B1,RS687B2,RS687B4, RS687B3, RS687B5, RS687B6, landsat,
g_hybrid]);
    map.addLayers([RS655341,RS655342,RS655343, NBFedNat1, PNA1, PNA2, PNA3]);
    map.addLayers([RS6561J1,RS6561J2,RS6561J3,RS6561J4, PANBw1, PANBw2, PANBw3,
PANBw4]);
    map.addLayers([RS6561K1,RS6561K2,RS6561K3,RS6561K4,RS6561K5]);

map.addLayers([RS65671,GLMWebmaps1,GLMWebmaps2,GLMWebmaps3,GLMWebmaps4,GLMWeb
maps5]);
        map.addLayers([RS65617S1,RS65617S2, RS686C1, RS686C2, RS686C3,
RS686C4, RS686C5, RS686C6, RS686C7]);

//center map on lat lon as above
map.setCenter(new OpenLayers.LonLat(lon, lat), zoom);
//add zoom bar and pan arrows and layer switcher
    map.addControls([
        new OpenLayers.Control.Navigation(),
        new OpenLayers.Control.PanZoomBar(),
    ]);
        //add mouse cursor to bottom of screen
        map.addControl(new OpenLayers.Control.MousePosition());
    }

// resize window
window.onresize = resizeMap;
</script>

<!--sliders for each layer -->
<script>
$(document).ready(function(){

    $("#slidRS687B2").slider({
    range: "min",animate: "fast", max: 100, value: 75,
slide: function(event, ui) {
    RS687B2.setOpacity(ui.value / 100);
    $("#sliRS687B2").val( ui.value );
    }
    });
});

```

```

        $( "#slidRS687B1" ).slider({
        range: "min",animate: "fast", max: 100, value: 75,
        slide: function(event, ui) {
        RS687B1.setOpacity(ui.value / 100);
        $( "#sliRS687B1" ).val( ui.value ); }
        });

        ...
        ...

//end
    });
</script>
</head>

<body onLoad="init()">
<!-- add to 'top of page' reference -->
<a id="top" accesskey="t"></a>

<!-- site navigation menu --><!-- #BeginLibraryItem "/Library/2.lbi" -->
<!-- as previously viewed in earlier Appendix -->

<!-- title-->
<h1 id="title"> Historical Map Overlay</h1>
<table width="60%" cellspacing="1" cellpadding="1" align="left">
<tr>

<td width="15%" bgcolor="white"><a><h3><a href="#PK">Map Overlay Passkey</h3></a></td
><td width="19%" bgcolor="white"><a><h3><a href="#HM">Historical Map Overlay</h3></a></td></
table>

<br><br><br>
<!-- add section to have Q&A and answer key -->
<div style=" background-color:#94B8BD; border:#272920 double" >
<table width="80%" border="1" align="center">
<tr><th colspan="2" align="left">
<a id="PK" accesskey="PK"></a>
<h3>Map Overlay & General Geography Puzzle</h3>

Find the answers to the questions on this page to get your Map Overlay puzzle piece and passcode.<br>
Proceed to the <a href=" ../quiz/geo_quiz_en.php" target="_self">GEOGRAPHY PUZZLE</a> page to put
all the pieces together </td></tr>
<tr><td width="40%">General Geography</td><td width="40%">Map Overlay</th>
</tr>
<tr>
<td>
<form action="map_hist_overlay_en.php" method="post">
Q1. The old name for Loder creek was?<br>
<input type="radio" name="q-1-a" id="q-1-a-C" value="C" />
<label for="q-1-a-C">Harrison Creek</label>
<br>
<input type="radio" name="q-1-a" id="q-1-a-B" value="B" />
<label for="q-1-a-B"> Simmonds Creek</label><br>
<input type="radio" name="q-1-a" id="q-1-a-D" value="D" />
<label for="q-1-a-D"> Otter Creek</label><br>

Q2.Fulton Island is between:<br />
<select name="q-2-a">

```

<option value="E"></option>
<option value="D">'Blind' and 'Main' Thoroughfares</option>
<option value="A">'Apple' and 'Gilbert' Island</option>
<option value="B">'Jemseg' and 'St. John' River</option>
<option value="C"></option>'Coys' and 'Harts' Lake</select>

Q3. What lake is not found in Grand Lake Meadows:

<select name="q-3-a" size="4">
<option value="A">Black Lake</option>
<option value="B">Upper Timber Lake</option>
<option value="C">Maquapit Lake</option>
<option value="D">Lower Tower Lake</option></select>

Q3. Which Highway does not enter Grand Lake Meadows:

<select name="q-4-a" size="4">
<option value="D">Hwy 2</option>
<option value="A">Hwy 102</option>
<option value="C">Hwy 105</option>
<option value="B">Trans Canada</option>
</select>

</td>
<td>

Q6. In the 1785: Property boundaries chart, how many acres of land are granted?

<input type="radio" name="q-6-a" id="q-6-a-A" value="A" />
<label for="q-6-a-A"> 3000</label>

<input type="radio" name="q-6-a" id="q-6-a-C" value="C" />
<label for="q-6-a-C">4050</label>

<input type="radio" name="q-6-a" id="q-6-a-B" value="B" />
<label for="q-6-a-B"> 1000</label>

<input type="radio" name="q-6-a" id="q-6-a-D" value="D" />
<label for="q-6-a-D"> 5000</label>

Q7. In 1786 who has been granted the land which borders Loder Creek?

<select name="q-7-a">
<option value="C"></option>
<option value="D">Morrises Grant</option>
<option value="A">Capt. Paulette & others</option>
<option value="B">John Dight</option></select>

Q8. In the 1933 hydrographic chart, wetland/swamp areas are identified

<select name="q-8-a" size="2">
<option value="A">True</option>
<option value="B">False</option>
</select>

Q9. In the 2006 NB Federation of Naturalists chart, "RED" represents:

<select name="q-9-a" size="4">
<option value="D">Low Shrub Meadow</option>
<option value="A">High Shrub Meadow</option>
<option value="C">Swamp</option>
<option value="B">Small Ponds</option>
</select>

</td>
<tr><td colspan="2" align="center">
<input type="submit" />

```

</form>

<?php

$answer1 = $_POST['q-1-a'];
$answer2 = $_POST['q-2-a'];
$answer3 = $_POST['q-3-a'];
$answer4 = $_POST['q-4-a'];
    $answer6 = $_POST['q-6-a'];
$answer7 = $_POST['q-7-a'];
$answer8 = $_POST['q-8-a'];
$answer9 = $_POST['q-9-a'];

$totalCorrect = 0;

if ($answer1 == "B") { $totalCorrect++; }
if ($answer2 == "D") { $totalCorrect++; }
if ($answer3 == "D") { $totalCorrect++; }
if ($answer4 == "D") { $totalCorrect++; }
    if ($answer6 == "A") { $totalCorrect++; }
if ($answer7 == "D") { $totalCorrect++; }
if ($answer8 == "A") { $totalCorrect++; }
if ($answer9 == "A") { $totalCorrect++; }

echo "<div id='results'>$totalCorrect / 8 correct</div>";
?>

</td></tr>
<td align="center" colspan="2">
<!-- add image to indicate how many correct -->
...

</td></tr></table>
</div>
<!-- end quiz questions -->
<br>
<hr><hr>
<a id="HM" accesskey="HM"></a>
<h3>Historical Map Overlay</h3>

<h4 id="title"> Click on the images on the right to turn them on, and adjust the slider to change their
transparancies </h4>

<!-- map and info window put into a table-->
<table border="3" width="99%" bgcolor="#EFEFF1" align="center">
<tr><td width="76%">
    <div id="map" class="smallmap"></div>
</td>
<th width="24%" height="100%" valign="top"><h3>Raster Overlays:</h3>

<!-- add collapsible panel(spry accordian) for 1700s -->
    <small>
        <div id="Accordion1" class="Accordion" tabindex="0">
            <div class="AccordionPanel">
                <div class="AccordionPanelTab">1700s</div>
                <div class="AccordionPanelContent">

<!-- add image, checkbox and short description of layers to add -->

```

```

<!-- RS656-17S -->
  <input type="checkbox" name="overlay" value="ckRS65617S2" id="msRS65617S2"
onClick="toggleControl(this);" autocomplete="off">
  
  <!--desc -->
                                <br> 1765: Property boundaries Sunbury county
                                <div class="slider" id="slidRS65617S2"></div>

    <hr><hr>
  <!-- RS687B -->
  <input type="checkbox" name="overlay" value="ckRS687B1" id="msRS687B1"
onClick="toggleControl(this);" autocomplete="off">
  
  <!--desc -->
                                <br> 1785: Property boundaries, thoroughfare between French Lake &
Maquapit Lake
                                <div class="slider" id="slidRS687B1"></div>

    <hr><hr>
  ...
  ...
</div></div>
<!--begin accordian panel for 1800s -->
<div class="AccordionPanel">
  <div class="AccordionPanelTab">1800s </div>
  <div class="AccordionPanelContent">

<!-- add image, checkbox and short description of layers to add -->
<!-- RS656-17S -->
  <input type="checkbox" name="overlay" value="ckRS65617S1" id="msRS65617S1"
onClick="toggleControl(this);" autocomplete="off">
  
  <!--desc -->
                                <br> 1809: Property boundaries, south-eastern survey area
                                <div class="slider" id="slidRS65617S1"></div>

  ...
  ...
</div></div>

<!--begin accordian panel 1900s -->
  <div class="AccordionPanel">
    <div class="AccordionPanelTab">1900s</div>
    <div class="AccordionPanelContent">

<!-- add image, checkbox and short description of layers to add -->

    <input type="checkbox" name="overlay" value="ckRS655343" id="msRS655343"
onClick="toggleControl(this);" autocomplete="off">
    
    <br>1932: French Lake to Maquapit Lake, Land Ownership
    <div class="slider" id="slidRS655343"></div>

```



```

        <hr><hr>
...
...
    </div></div></div>
    <script type="text/javascript">
var Accordion1 = new Spry.Widget.Accordion("Accordion1");
    </script>
    </small>
<hr><hr>

<h3>Background Images:</h3>
<!-- add buttons to toggle web based layers visibility -->
<input type=button style="font-size: 8pt; width:200; text-align=center; background:#7F7F7F"
value="Google Hybrid"
onClick="map.setBaseLayer(g_hybrid);clearALL();">
<br>
<input type=button style="font-size: 8pt; width:200; text-align=center; background:#7F7F7F"
value="Toporama Map"
onClick="map.setBaseLayer(toporama);clearALL();">
<br>
<input type=button style="font-size: 8pt; width: 200; text-align=center; background:#7F7F7F"
value="LandSat7 imagery - GeoBase"
onClick="map.setBaseLayer(landsat);clearALL();">
<br>
<hr><hr>
<input type=button style="font-size: 8pt; width: 200; text-align=center; background:#94B8BD"
value="Reset Map Window"
onClick="map.setCenter(new OpenLayers.LonLat(lon, lat), zoom);">
<br>
</td></tr></table>

    <br><hr><hr>
    <!-- add footer --><!-- #BeginLibraryItem "/Library/footer.lbi" -->

<!-- link to home and top of page -->
<div>
    <p align="right">
        <a> Return to the <a href="#top"> top of page</a>
    </p>
    <table align="center" width="65%">
        <tr><td align="center">
<a href="../../Library/contactform.htm"> Contact us </a>
        </td><td align="center">
<a href="http://www.grandlakemeadows.com/"> Grand Lake Meadows </a>
        </td>
        <td align="center"> <a href="http://www.queenscountyheritage.com/"> Queens County
Heritage</a>
        </td></tr></table>
<hr>
<p align="center">
    <small>Content last updated 2013. <a href="http://www.unb.ca/">University of New Brunswick</a>, <a
href="http://gge.unb.ca/HomePage.php"> Geodesy and Geomatics Engineering Department</a>
    </small> </p>
</div></div>
</div><!-- #EndLibraryItem -->
</body>
</html>

```

Appendix III: Library Item for Website Banner

```
<meta http-equiv="Content-Type" content="text/html; charset=utf-8">
<!-- add glm logo -->

<p>&nbsp;</p>
<div align="left">
  <table width="100%" border="0" cellspacing="0" cellpadding="0">
    <tr>
      <td width="10%" align="right"> <a href="http://www.unb.ca/"></a></td>
      <td width="12%" align="left"> <a href="http://gge.unb.ca/HomePage.php"></a></td>
      <td bordercolordark="#666666" width="70%">
    </td>
    <td align="right" width="8%"><a href="../fr/index_fr.html" target="_self">Francais</a></td>
  </tr>
</table>
</div>

<!-- site navigation menu -->
<table align="center">
  <tr><td>
    <ul><li><a href="../en/index_en.html"> Home</a>
    </ul>
  </td>
  <td>
    <li><a href="../en/about/about_en.html"> About Grand Lake Meadows</a></li>
  </td>
  <td>
    <li><a href="../en/about/about_hist_en.html"> Historical Activities</a></li>
  </td>
  <td>
    <li><a href="../en/about/about_present_en.html"> Present Day Activities </a></li>
    </ul></li></ul>
  </td><td>
    <ul>
      <li><a href="../en/hist/history_en.htm" title="History" target="_self"> History</a>
      </ul>
      <li><a href="../en/hist/map_special_en.php"> What is special about Historical Maps? </
a></li>
      <li><a href="../en/hist/1700_en.php"> 1700s </a></li>
      <li><a href="../en/hist/1800_en.php"> 1800s </a></li>
      <li><a href="../en/hist/1900_en.php"> 1900s </a></li>
      <li><a href="../en/hist/2000_en.php"> 2000s </a></li>
      <li><a href="../en/hist/hist_changes_en.htm"> Summary of changes </a></li>
    </ul></li></ul>
  </td>
  <td>
    <ul>
      <li><a href="../en/map/map_en.html"> Geography</a>
      </ul>
      <li><a href="../en/map/map_hist_overlay_en.php"> Historical Map Overlays </
a></li>
      <li><a href="../en/map/map_features_en.php"> Property & Wetland Changes </
a></li>
      <li><a href="../en/map/map_settlers_en.php"> Early Settlers </a></li>
      <li><a href="../en/map/map_imagekey_en.php"> Coverage Area of Historical Map Scans </a></li>
    </ul></li></ul>
```

```

                </td><td>
                <ul>
                <li><a href="../en/quiz/quiz_en.php"> Puzzles</a>
<ul>
<li><a href="../en/quiz/quiz_en.php"> History Puzzle </a></li>
    <li><a href="../en/quiz/geo_quiz_en.php"> Geography Puzzle </a></li>
</ul></li></ul>
            </td>
<td>
                <ul>
                <li><a href="../en/visit/go_en.html"> Go</a>
<ul>
<li><a href="../en/visit/map_go_en.html"> A virtual tour</a></li>
    <li><a href="../en/visit/go_do_en.html"> What can you do? </a></li>
</ul></li></ul>
            </td>
</tr>
</table>

```

Appendix IV: Main CSS

```
body {
    padding-left: 0.8em;
    font-family: "Lucida Sans Unicode", "Lucida Grande", sans-serif;
    color: black;
    font-size: 14px;
    background-image: url('../images/bkg.png');
    background-color="#D6D6D6";
}

label {
    font-family: "Lucida Sans Unicode", "Lucida Grande", sans-serif;
    color: black;
    font-size: 10px;
    text-transform: lowercase;
}

legend {
    font-family: Tahoma, Geneva, sans-serif;
    color: black;
    font-size: 11px;
    text-transform: uppercase;
}

ul {
    font-family: Tahoma, Geneva, sans-serif;
    color: black;
    font-size: 12px;
    margin: 3;
    padding: 0.5em;
    list-style: none;
}

ul li {
    display: block;
    position: relative;
    float:left;
}

li ul {
    display: none;
}

ul li a {
    display: block;
    text-decoration: none;
    background-color:white;
    border-top: 1px solid #ffffff;
    border-color: black;
        border-style: none solid solid none;
    padding: 0.3em;
    margin:0.2em 0.4em ;
    margin-left: 4px;
    white-space: nowrap;
}

ul li a:hover {
background: #D4D7DA;
}
```

```

li:hover ul {
  display: block;
  position: absolute;
}
li:hover li {
  float: none;
}
li:hover a { background: #D4D7DA; }
li:hover li a:hover {
  background: #D4D7DA;
}
li { margin-left: 11px}

a:link {
  color: black }
a:visited {
  color: #black }
a:hover {color:#black }
}

address {
  margin-top: 1em;
  padding-top: 1em;
  border-top: thin dotted }

h1 {
  font-family: Tahoma, Geneva, sans-serif;
  font-size: 2em;
  font-weight: heavy;
  color: #1F2D22;
  margin: 0 0 .5em 0;
}
h1#page-title { text-align: center; text-transform: uppercase;
}
h2 { font-size:1.7em; font-weight:heavy; color: #1F2D22; margin: 0 0 .5em 0; font-family: Tahoma,
Geneva, sans-serif;
}
h3 {
  font-size: 1.2em;
  font-weight: 900;
  color: #1F2D22;
  margin: 0 0 .7em 0.7em;
  font-family: Tahoma, Geneva, sans-serif;
}

p {
  font-size: 14px;
  padding-left: 0.8em;
}

sm {
  font-size:.8em; font-weight:normal;
}
sm.hover{
  font-weight:bold}

```

```

a {color:#1F2D22;}
em {
    text-transform: uppercase;
}

small {
    font-size:.8em; font-weight:normal;
}
input:focus{
    background-color:#FBFBEB;
    border-width:0.2px;
}

table {
    font-family: "Lucida Sans Unicode", "Lucida Grande", sans-serif;
    color: black;
    font-size: 12px;
}

#tabs-1 {
    background-color:#A6C7BE;}
#tabs-2 {
    background-color:#94B8BD}
#tabs-3 {
    background-color:#D7CAA5;}
#tabs-4 {
    background-color:#C1A194;}
#tabs-5 {
    background-color:#996666;}

.ui-widget-content { border: 1px solid #ccc; background: #ff9900 url(images/ui-
bg_flat_100_ff9900_40x100.png) 50% 50% repeat-x; color: #222222; }
.ui-widget-header { border: 1px solid #aaaaaa; background: #797979 url(images/ui-bg_highlight-
soft_75_797979_1x100.png) 50% 50% repeat-x; color: #222222; font-weight: bold; }

.ui-slider { position: relative; text-align: left; }
.ui-slider .ui-slider-handle { position: absolute; z-index: 2; width: 1.2em; height: 1.2em; cursor: default; }
.ui-slider .ui-slider-range { position: absolute; z-index: 1; font-size: .7em; display: block; border: 0;
background-position: 0 0; }

.ui-slider-horizontal { height: .8em; }
.ui-slider-horizontal .ui-slider-handle { top: -.3em; margin-left: -.6em; }
.ui-slider-horizontal .ui-slider-range { top: 0; height: 100%; }
.ui-slider-horizontal .ui-slider-range-min { left: 0; }
.ui-slider-horizontal .ui-slider-range-max { right: 0;}

#myMenu ul {
    list-style-type: none;
    position: relative;
    margin: 0;
    padding: 0;
}
#myMenu ul li {
    float: left;
}
#myMenu ul ul {

```

```
position: absolute;
  z-index:1;
}
#myMenu ul li a {
  display: block;
  padding: 3px 10px 1px;
  background-color: white;
  color: black;
  font-family: sans-serif;
  font-size: 1.1em;
  text-decoration: none;
}
#myMenu ul li a:hover {
  color: #black;
  background-color: #CCC;
}
#myMenu li ul li {
  float: none;
}

#myMenu table.center {
  margin-left:auto;
  margin-right:auto;
}

#myContent {
  clear: both;
  padding: 10px 0;
}
```

Appendix V: Website User Guide

(Website address: http://gaia.gge.unb.ca/glm/en/index_en.html)

Grand Lake Meadows Historical Mapping - Website User Guide

This website is designed to promote awareness of the Grand Lake Meadows wetland region in New Brunswick through a review of historical maps of the region

1. What can you expect to learn?	2
2. How is the site laid out?	2
3. What's in each section?	2
4. What's a Passkey?	3
5. Where can you get the passkeys?	3
6. How to collect History Passkeys?	3
7. How to use History Passkeys for the History Puzzle	4
8. Part 1: History Puzzle	4
9. Part 2: History Puzzle	5
10. How to collect Geography Passkeys?	6
11. Example: Question	6
12. Example: Answer:	7
13. How to use Geography Passkeys for the Geography Puzzle	9

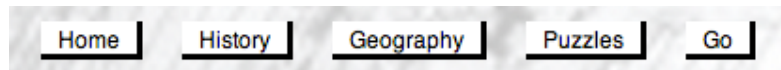
(Website address: http://gaia.gge.unb.ca/glm/en/index_en.html)

What can you expect to learn?

Where is Grand Lake Meadows, why is this area considered so valuable, who lived here, when did they arrive, are there still people living off the land, what was the role(s) of government, and what historical maps can tell us about the past.

How is the site laid out?

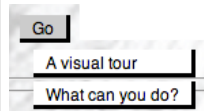
There are 5 sections:



What's in each section?

<p>Home</p> <ul style="list-style-type: none"> Home About Grand Lake Meadows Historical Activities Present Day Activities 	<p>Outlines the site objectives and organization, where Grand Lake Meadows is, and a description of historical and present day activities</p>
<p>History</p> <ul style="list-style-type: none"> History Why Historical Maps? 1700s 1800s 1900s 2000s Summary of changes 	<p>Describes why maps are such valuable resources and what we can learn from them. Each of the links: <i>1700s</i>, <i>1800</i>, <i>1900s</i>, and <i>2000s</i> contain a table with the historical maps found, animations and interactive maps which show us information about the maps or life during that time, text describing life and activities during the century, and a brief history of New Brunswick in that period. The <i>Summary of changes</i> outlines changes from 1700s to present day. **Passkeys to collect on 5 of these pages!</p>
<p>Geography</p> <ul style="list-style-type: none"> Geography Historical Map Overlays Property & Wetland Changes Early Settlers Coverage Area of Historical Map Scans 	<p>Maps, maps and more maps. You can overlay the historic maps on present day maps, you can view properties and wetlands as recorded at different time periods and find information about the map features. **Passkeys to collect on these 4 pages!</p>
<p>Puzzles</p> <ul style="list-style-type: none"> Puzzles History Puzzle Geography Puzzle 	<p>Use the Passkeys you collected in the History and Geography sections to complete puzzles. The puzzles include a word search and an anagram.</p>

(Website address: http://gaia.gge.unb.ca/glm/en/index_en.html)

<p>Go</p> 	<p>The <i>A visual tour</i> page loads a map, and if you click on the camera icons you will see what the meadows looks like in 2013. <i>What can you do?</i> Links you to current activities you can partake in at Grand Lake Meadows</p>
--	---

What's a Passkey?

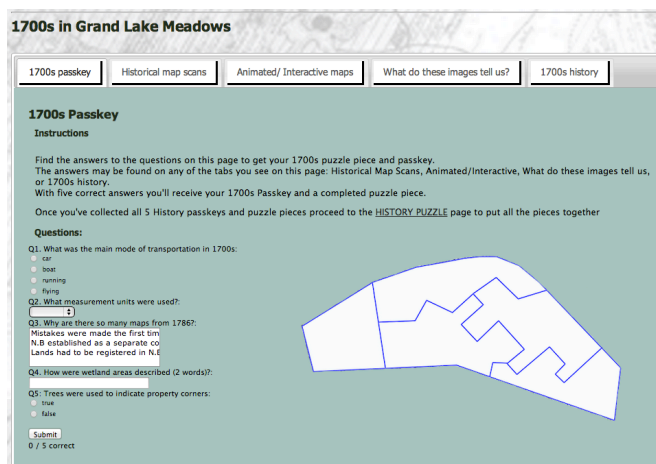
A passkey can be a word, group of words or a puzzle piece. You collect these by correctly answering a series of questions.

Where can you get the passkeys?

In the History and Geography Sections.

How to collect History Passkeys?

The History pages: *1700s*, *1800s*, *1900s* and *2000s* are laid out in the same format: Shown is an example from the 1700s.



1700s in Grand Lake Meadows

1700s passkey | Historical map scans | Animated/Interactive maps | What do these images tell us? | 1700s history

1700s Passkey
Instructions

Find the answers to the questions on this page to get your 1700s puzzle piece and passkey. The answers may be found on any of the tabs you see on this page: Historical Map Scans, Animated/Interactive, What do these images tell us, or 1700s history. With five correct answers you'll receive your 1700s Passkey and a completed puzzle piece. Once you've collected all 5 History passkeys and puzzle pieces proceed to the [HISTORY PUZZLE](#) page to put all the pieces together

Questions:

Q1. What was the main mode of transportation in 1700s:
 car
 boat
 running
 flying

Q2. What measurement units were used?

Q3. Why are there so many maps from 1786?
Histories were made the first time
N.B established as a separate co
Lands had to be registered in N.E

Q4. How were wetland areas described (2 words)?

Q5. Trees were used to indicate property corners:
 true
 false

Submit
0 / 5 correct

1. On the first tab, 1700s passkey, there are a series of questions about the maps from the 1700s.
 - You need to correctly answer all 5 questions to complete the puzzle piece and collect your Passkey.
- The ANSWERS to these questions can be found on the tabs in this page:
 - The answers may be on any of the tabs: *Historical map scans*, *Animated/Interactive maps*, *What do these images tell us?* or the *1700s history* tab

(Website address: http://gaia.gge.unb.ca/glm/en/index_en.html)

- When you successfully answer all questions, the puzzle piece fills in, and you receive the passkey from this page:

1700s in Grand Lake Meadows

1700s passkey | Historical map scans | Animated/ Interactive maps | What do these images tell us? | 1700s history

1700s Passkey

Instructions

Find the answers to the questions on this page to get your 1700s puzzle piece and passkey. The answers may be found on any of the tabs you see on this page: Historical Map Scans, Animated/Interactive, What do these images tell us, or 1700s history. With five correct answers you'll receive your 1700s Passkey and a completed puzzle piece. Once you've collected all 5 History passkeys and puzzle pieces proceed to the HISTORY PUZZLE page to put all the pieces together

Questions:

Q1. What was the main mode of transportation in 1700s:

- car
- boat
- running
- being

Q2. What measurement units were used?

Q3. Why are there so many maps from 1780? Mistakes were made the first time N.B. established as a separate colony Lands had to be registered in N.S.

Q4. How were wetland areas described (2 words)?

Q5. Trees were used to indicate property corners:

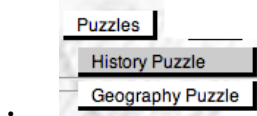
- true
- false

5 / 5 correct

1700s PASSKEY: "ARK"

Q1: Boat is correct
Q2: Chains is correct
Q3: is correct
Q4: unprofitable sunken is correct
Q5 is True

- Collect passkeys and puzzle pieces from each of the pages:
 - 1700s, 1800s, 1900s and 2000s & Why Historical Maps.
 - Once you have all 5 passkeys proceed to the History Puzzle



How to use History Passkeys for the History Puzzle

There are two puzzles on this page: Part 1 & Part 2.

Part 1: History Puzzle

- In Part 1, enter in the passkeys in each of the appropriate text boxes.
- Press Submit.
- If all are entered correctly, a video appears on the right hand side of the screen, press Play to start the movie.

History Puzzle

Passkey & Puzzle Compilation

Part 1

Enter in all your gathered History passkeys to unlock the puzzle pieces:

MAPS passkey:

1700s passkey:

1800s passkey:

1900s passkey:

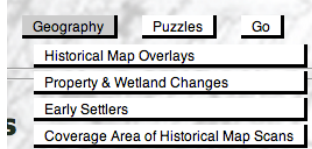
2000s passkey:

0 / 5 correct
Correct Answers are:

(Website address: http://gaia.gge.unb.ca/glm/en/index_en.html)

How to collect Geography Passkeys?

In the Geography section, there are 4 passkeys to collect, one on each of the pages.



On each of the pages pages in the Map section, there are two tabs:

(a) the passkey tab, and the (b) Map tab

The ANSWERS to the questions asked on the Passkey tab are found on the MAP tab.

Property Ownership & wetlands

Property & Wetland Passkey | MAP - Property ownership & Wetland

Property & Wetland Passkey

Instructions

Answer the questions on this page to get your "Property & Wetland" passkey. The answers will be found on the MAP-Property ownership and Wetland tab. With five correct answers you'll receive your "Property & Wetland" Passkey.

Collect passkeys for each of the four pages in the [Geography section](#). Once you've collected all passkeys proceed to the [GEOGRAPHY PUZZLE](#) page to complete phase 2 of the puzzle.

Questions:

Find the answers to the questions on this page to get your property & wetland puzzle piece and passcode. Proceed to the [GEOGRAPHY PUZZLE](#) page to put all the pieces together

Q1. In the 1785 who owned the largest property:

- ducks unlimited
- harold hunter
- lloyd macfarlane
- morrises grant

Q2. What type of wetlands were identified in the 1700s?

Q3. In 2010 what Wetland types are recorded on Grimross Island

Aquatic Bed & Freshwater Marsh
Aquatic Bed & Bog
Freshwater Marsh & Fen

Q4. What is the deed number of HER MAJESTY THE QUEEN's land in 1989?

Q5: Ducks Unlimited started purchasing land in GLM in the 1800s.

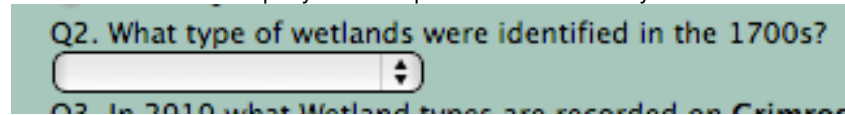
- true
- false

0 / 5 correct

(Website address: http://gaia.gge.unb.ca/glm/en/index_en.html)

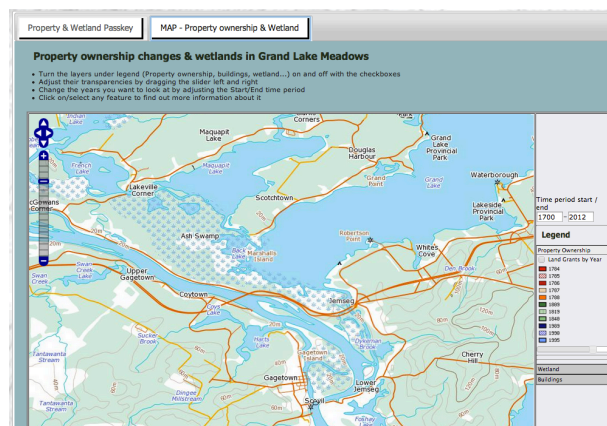
Example: Question

Question #2 from the Property Ownership and Wetland Passkey:

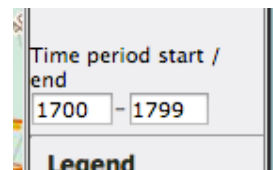


Example: Answer:

1. On the MAP tab

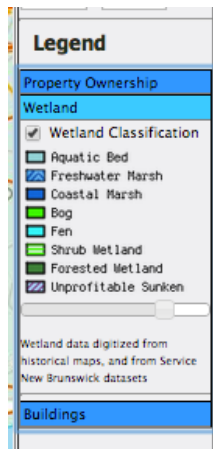


2. On the right hand side, adjust the Time period start/ end to include only the 1700s.

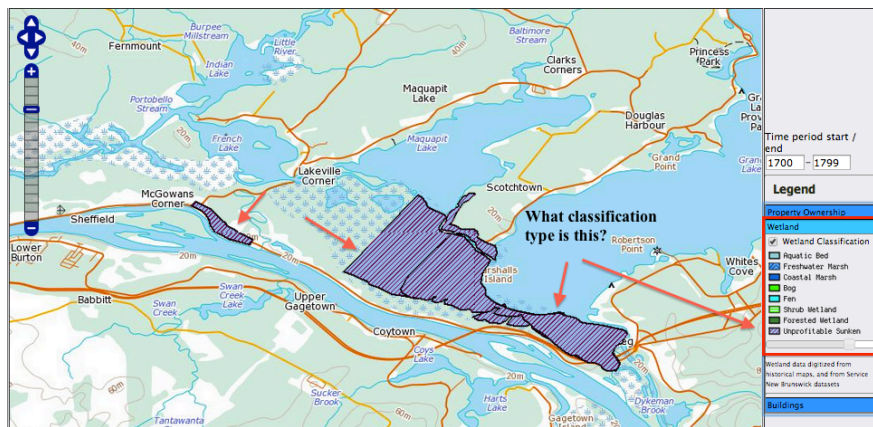


3. Turn ON the WETLAND Layer
 - Click on Wetland under the Legend
 - Click the Checkmark beside Wetland Classification

(Website address: http://gaia.gge.unb.ca/glm/en/index_en.html)

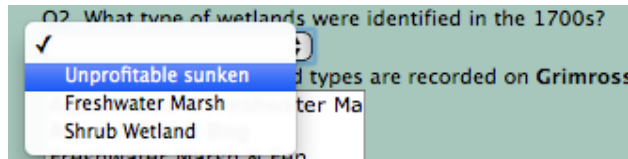


4. Look at the Map and the Symbology used... look in the legend to see which classification this matches



- The colours and lines represent the 'Unprofitable Sunken' classification.
- So the answer to Question #2 is Unprofitable Sunken.

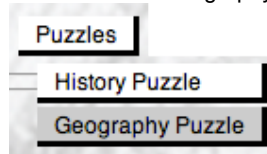
(Website address: http://gaia.gge.unb.ca/glm/en/index_en.html)



Continue this process to answer all the questions on this page and the other pages in the Geography section.

Once you've collected all 4 passkeys (a total of 9 words):

Proceed to the Geography Puzzle page to complete the puzzle and use your passkeys



How to use Geography Passkeys for the Geography Puzzle

On the Geography puzzles page, there is a graphic with words hidden in it.

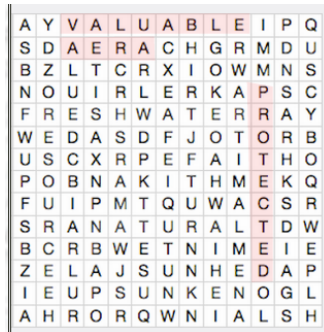
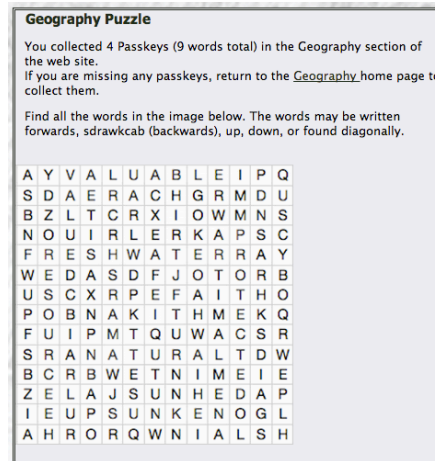
Find the Geography Passkeys in the image.

The words may be written:

- Forwards
- Backwards
- Up
- Down
- diagonally

•As you find words in the image, click on them, and the words will turn red

•There are a total of 9 words to find in this word-search image.

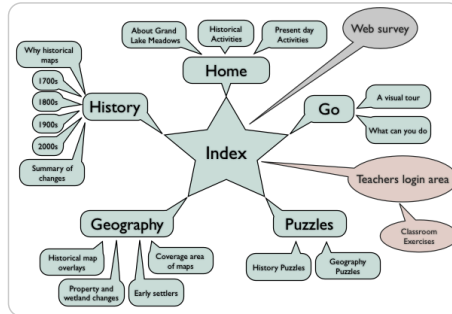


Appendix VI: One-page Website Leaflet

Grand Lake Meadows Historical Mapping Website

Heather McGrath: heather.mcgrath@unb.ca

Website structure



Website address: http://gaia.gge.unb.ca/glm/en/index_en.html

Site goals:

This site is designed to promote awareness of the Grand Lake Meadows wetland region in New Brunswick through a review of historical maps of the region

What can you expect to learn?

Where is Grand Lake Meadows, why is this area considered so valuable, who lived here, when did they arrive, are there still people living off the land, what was the role(s) of government, and what historical maps can tell us about the past.

** There are quizzes in the History & Geography sections, and puzzles in the Puzzle pages **

History

- **6 links**
 - 5 passkeys to collect
 - With each passkey you also collect a puzzle piece
 - *You need to remember the passkeys (you'll use them later)
 - Once all 5 passkeys and puzzle pieces have been collected, proceed to the Puzzles > History Puzzle page
- **Puzzles > History Puzzle page**
 - Phase I: Enter in all the 5 passkeys to unlock a video which assembles the puzzle pieces
 - Phase II: Unscramble the letters in all the passkeys to get a phrase about this site

Geography

- **4 links**
 - 4 passkeys to collect
 - *You need to remember the passkeys (you'll use them later)
 - *The passkey may be one word or multiple words
 - Once all 4 passkeys have been collected, proceed to the Puzzles > Geography Puzzle page
- **Puzzles > Geography Puzzle Page:**
 - Find all the passkey words in the word finder image
 - Click on the word and it will turn **red**
 - The words may be forwards, backwards, or diagonal
 - *Hint: there are 9 words to find

With support of Grand Lake Meadows Project Management Committee

Appendix VII: SurveyMonkey Website Survey

10/25/13

[SURVEY PREVIEW MODE] Grand Lake Meadows Historical Mapping - web survey

Grand Lake Meadows Historical Mapping - web survey

Thanks for taking a few minutes to fill in this survey about the Grand Lake Meadows Historical Mapping website.

1. How old are you?

<= 13 years old

>= 14 years old

2. General Web Site Questions

1. No 2. 3. 4. 5. Yes

Were the learning objectives clearly outlined?

Did the menu items (Home, History, Geography, etc.) make sense?

Did you experience any problems with web pages not loading?

Was it easy to find what you were looking for?

3. General comments about the website layout or suggestions for improvement.

4. How many pages did you visit?

5. Questions about the content of the website

1. No 2. 3. A little bit 4. 5. Yes

Was the information interesting?

Was the information useful?

www.surveymonkey.com/s.aspx?PREVIEW_MODE=DO_NOT_USE_THIS_LINK_FOR_COLLECTION&sm=viH81hqSzhysGtCGvqUYqimynywD%2b7lwMB... 1/2

Grand Lake Meadows Historical Mapping - web survey

This series of questions asks about the History, Geography and Puzzles sections.

6. Quizzes and Puzzles

	Yes	No
Did you complete any of the quizzes?		
Did you complete any of the puzzles?		

7. Please answer the questions below with respect to the puzzles and quizzes.

	Way to hard	A little bit difficult	Just right	A little bit easy	Way to easy	N/A
The History quizzes were ...						
The Geography quizzes were ...						
Unscrambling the letters in the History puzzle was ...						
Finding words in the Geography puzzle was ...						

8. Did you visit the Geography section?

Yes
No

9. Questions about the Geography Pages.

	No	Kind of	Yes
Was it clear how to turn map layers on and off?			
Did turning images/layers on and off work?			
Did the transparency sliders work?			
Were you able to			

Curriculum Vitae

Heather McGrath

Born: Goderich, ON, Canada

Universities attended

2012 - present, MScE. University of New Brunswick, NB, Canada

2000, B.Sc.. Geography, McMaster University, ON, Canada

Publications:

McGrath, H., and Stefanakis, E.. (2013) Grand Lake Meadows since the 18th Century: A Mapping and Awareness Project. In the Proceedings of the Annual Canadian Institute of Geomatics Conference, Toronto, Canada (Master's work).

Conference Presentations:

McGrath, H., and Stefanakis, E.. (2013) Grand Lake Meadows since the 18th Century: A Mapping and Awareness Project. In the Proceedings of the Annual Canadian Institute of Geomatics Conference, Toronto, Canada (Master's work) Poster presentation.