

UNIVERSITY OF PRINCE EDWARD ISLAND

**THE WATERMILLS OF
PRINCE EDWARD ISLAND, CANADA
AND
GOTLAND ISLAND, SWEDEN:
AN HISTORICAL SURVEY**

by

JoDee Samuelson

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ABSTRACT

This thesis reviews the development and use of watermills from antiquity to the present, including the economic, environmental and social significance of milling during this time. More specifically, it explores the rise and fall of water-powered technology on two small islands with quite different water resources: Prince Edward Island off the East Coast of Canada, and the Baltic island of Gotland, Sweden. Both islands were once home to hundreds of watermills, yet today waterpower has vanished entirely from the landscape of Prince Edward Island. Gotland, on the other hand, honors the watermill in several regional museums, and one mill site has been refurbished as an electric generating station. Although the community watermill may have been relegated to the pages of history, it is possible that waterpower still has a role to play in the sustainable energy landscape of both of these islands.

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I would like to express my gratitude to the following individuals for sharing their knowledge of the world of watermills. From Prince Edward Island: Mack Dixon, Marjorie Faulkner, Mr. and Mrs. Warren Leard, Annie Leard, Waldron Leard, Mr. and Mrs. Emmett Wisener, Harley Ings, Wally Andrew, Robert Dixon, Guy and Art Rollings, Murdock and Dorothy Buchanan, Margaret Dixon, Pauline Thomson, and Margaret Rix. From the Island of Gotland, sincere thanks to Gustaf Svedjemo and Jan Andréasson-Utas for cheerfully responding to my many questions.

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PREFACE

I grew up in Wetaskiwin, Alberta, in the heart of the Canadian prairies. Although there were no water mills in my childhood, there certainly were windmills. Everyone who lived in the Canadian West in the last century had some experience with windmills, those thin-legged monoliths that were landmarks every bit as proud as those other towering prairie icons, the grain elevators.

After moving to Prince Edward Island in the early 1970s, I became acquainted with a different type of mill: the water mill. At that time many old wooden mill buildings were scattered throughout the countryside, and a few businesses were operational. A person could pick up slabs for the wood stove at Larsen's Sawmill in Rose Valley, or purchase lumber from Bagnall's Sawmill in Hunter River, Wisener's Sawmill in Watervale, or Moore's Mill on the Loyalist Road. Occasionally I accompanied Guy and Arthur Rollings, organic farmers of North Rustico, to the flourmill in Coleman. In early morning, sacks full of fresh sweet hard wheat would be loaded into the pickup truck for the long drive to the Warren Leard's small red-shingled mill south of O'Leary. There we helped carry the sacks of wheat into the dimly-lit flour-dusty mill house, where we were not encouraged to linger, for the miller had work to do.

We would poke around for a few hours drinking tea from a thermos, eating our sandwiches, swatting mosquitoes, and watching men fishing in the millpond, until finally we were given the notice that our flour was ready. The gentlemanly miller, Warren Leard, would brush the flour off his clothes and carefully help us load into the truck large brown paper sacks filled with white flour, shorts and middlings, bulging burlap sacks of bran, and a small bag of cream of wheat. These products would later be sold in the health food store in Charlottetown, and always found a ready market. Little did I know that these trips to the flourmill were part of the closing act of the Island's ritual of self-sufficiency. Leards's Mill (Figure 1) closed in 2002 after 114 years of continuous operation.



Figure 1. Leard's Flour Mill on the Trout River, Coleman, PEI, 2000.

Years later, I lived by the ruins of the Dixon-Scott saw, grist, and flourmill on the Clyde River. (See Figure 2). All the buildings had tumbled down, and Black Angus cattle wandered freely through the ruins, finding shelter behind the old sandstone walls of the kiln. The pond was a lovely spot to fish, meditate, and net smelts in season.

There were places like this all over the Island. Almost every Islander has a story to tell about a mill, for the water mill formed a charming centerpiece to the hallowed lore of the good old days when every community had its local store, church, one room school, post office, and mill.

In 1992 I drew a map called "Old Mills of Prince Edward Island" based largely on information gleaned from the 1880 *Meacham's Atlas*, showing the location, use and ownership of 210 PEI mills. Since that time, using other maps, particularly the Wright and Cundall maps, I located another 160 mill sites. When I showed my mill map to Jan Andréasson-Utas of Gotland, he said, "So many!" We take our history for granted, but to other people it is a source of wonder.



Figure 2. Scott/Dixon Mill on the Clyde River, Bannockburn Road, PEI, 2011. Kiln walls at right.

When I was considering topics for a thesis, the history of Prince Edward Island mills presented itself naturally to me. Then, because this paper has been written for the Island Studies program and because I am of Swedish extraction, I was excited to include the Swedish island of Gotland as an additional part of this research subject. When I traveled to Gotland in the spring of 2012 to investigate that island's experience with waterpower, it was my good fortune to meet scholar and architect Jan Andréasson-Utas who co-authored the book *Väder – och vattenkvarnar på Gotland (Water and Windmills of Gotland)*. I was also given a tour of the southern part of the Island by archaeologist Gustav Svedjemo of the University of Gotland. I learned that, in the early 1800's, there were over two hundred watermills on Gotland Island (GI), and that in 2012 three watermills remained, serving as museums and historical monuments.

In addition to my five-day trip to Gotland, I have relied on facts and figures available on the excellent websites of the Gotland Municipality. Information has also been generously shared with me by my friends Gustaf Svedjemo of Gotland University, and architect Jan Andréasson-Utas. Thanks to everyone who helped me along the way.

During my trip to Gotland and Sweden I visited Östergötland, the province in Sweden that is closest to Gotland. Östergötland was the homeland of my ancestors, and there I found mills, rivers, lakes, canals, boats – and water everywhere. I had not realized how much water there is in Sweden, nor how many thousands of islands there are along its coastline. Some islands are immense grey green boulders rising out of the water, while others host range lights, research stations, windmills, or cottages. There are so many combinations of beauty. It seems as though someone cares about every single island. It was a good feeling.

While researching this project I noticed very clearly that the history of water mills is the history of *men*. Most mill history books never mention a woman or show a single illustration that includes women, and yet women were vitally important in carding mills, cloth mills, shingle mills, and no doubt they helped out as needed even in sawmills. In particular, the wife of the miller acted as hostess to customers waiting for their grain to be ground, while at the same time she had to keep on top of her regular housekeeping duties. As Mr. Warren Leard of Leard's Flour Mill explained in a phone conversation on December 6, 2012:

My wife's a great cook. Oh, she made lovely bread – it would melt in your mouth. Great big fluffy loaves. Her baking was a terrific advertisement for our mill. And she taught other women how to bake bread, cake, puddings, all those sorts of things. She would help in the mill too, sweeping and tidying up at the end of the day, which was a great help. I don't know as how I could have carried on the business without her.

Although such a life might suit some young women today, most would probably not be satisfied with being a miller's wife. Fortunately we have choices. Women's education and work has evolved over the centuries both in Sweden and in Canada, and we welcome the change. Today's women are keeping journals, sharing their thoughts, and writing their own history, so that literature of the future will reflect the accomplishments of the other half of the population. The women below (Figure 3) did not have the same choices. They were born into a world where men and societal expectations largely prescribed a woman's lot.

Mrs. Wisener spent her life in the kitchen acting as hostess to customers of Wisener's Sawmill, while raising a family and being a dutiful member of the

community. Annie Leard ran a busy household, and fed hundreds of men who brought logs to Leard's Sawmill. When the men were short of help in the sawmill, she stacked shingles and piled boards. Marjorie Faulkner was raised at Dixon's Mills, but couldn't wait to get away from the drudgery of working with her mother at the carding mill. She escaped to Boston at the first opportunity.



Figure 3. Left to right: Mrs. Wisener, Wisener's Sawmill, Watervale, PEI. Annie Leard, Leard's Mills, Westmoreland, PEI. Marjorie Faulkner, daughter of John and Edna Dixon of Dixon's Mills, South Melville, PEI.

The lives of these women would almost certainly have been different had they had the opportunities available to young people today. Yet there is pride – balanced by great modesty – in knowing that they contributed to the well-being of their families and communities.

Women and men of the mills, pulling together in a spirit of cooperation and optimism, demonstrated the strong work ethic and community pride that is still evident on both Prince Edward Island and Gotland Island. It has been my privilege to live on PEI during the closing days of this period, and experience in a small way the mystique surrounding Island watermills. It is my hope that this discussion of our milling heritage might result in renewed interest in the care, and use, of our waterways.

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DEFINITIONS

Mill

noun

1. a building equipped with machinery for grinding grain into flour; a piece of machinery for grinding grain; a domestic device for grinding a solid substance to powder
2. a factory fitted with machinery for a particular manufacturing process; a piece of manufacturing machinery.

verb

1. grind (something) in a mill
2. cut or shape (metal) with a rotating tool¹

Mills are used to crush, grind, refine, grate or pound products such as wheat, oats, wool, cotton, iron, quartz, etc. The building that contains such a machine is also called a mill, as in flourmill, mustard mill, paper mill, cloth mill, carding mill, cotton mill, fulling mill, or sawmill. Most people in our society employ various mills on a daily basis, for example, electric coffee grinders and food processors. Or we may use hand-operated food mills such as those pictured below (see Figure 4).

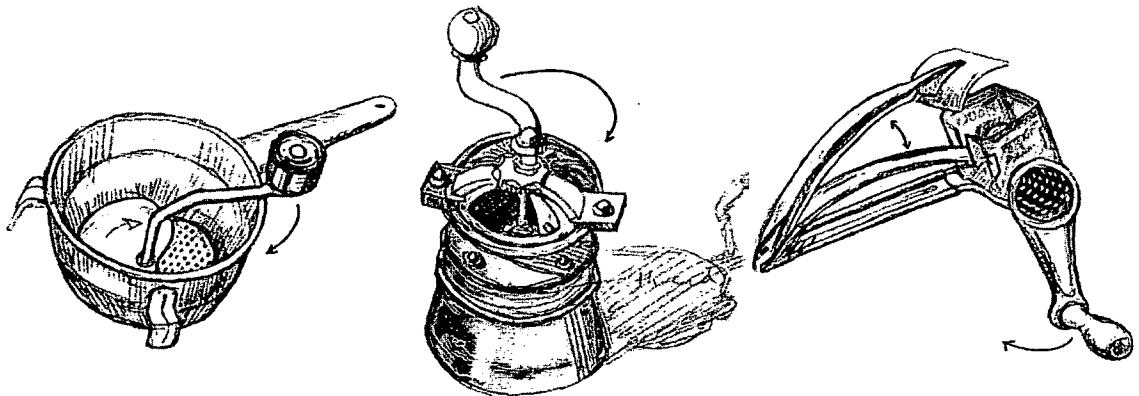


Figure 4. Left to right: “Foley” brand (Minneapolis) food mill for sieving soft fruit and vegetables; coffee mill; and a “Mouli” brand (France) cheese mill.

¹ From *Oxford Dictionary* on-line at <http://oxforddictionaries.com/definition/english/mill>. Retrieved February 6, 2013.

Miller

noun

1. a person who owns or operates a mill, especially a mill that grinds grain into flour.²

The miller is the person in charge of the day-to-day operations of a flour or gristmill. This person is usually a man who might not be the owner of the mill. In medieval times most mills in Europe were owned by the church, city states, or wealthy landlords. In PEI the owner of a sawmill is often also called a miller.

Millwright

noun

1. a person whose occupation is planning and building mills or setting up their machinery
2. a person who maintains and cares for mechanical equipment (as of a mill or factory)³

A millwright is a person, usually a man, who sets up the mill, assembles all the machinery, spindles, etc., makes sure the belts are perfectly aligned so that there is no slippage or unnecessary vibration, and repairs broken parts. This is a trade that was often passed down from father to son.

Waterwheel

noun

1. a wheel made to rotate by direct action of water
2. machine for tapping the energy of running or falling water (hence a prime mover) by means of a set of paddles or buckets mounted around a wheel. The force of the moving water against the paddles, or the weight of water poured into the buckets, rotates the wheel. The resulting power is transmitted to machinery via the shaft of the wheel. This was perhaps the earliest source of mechanical energy to replace that of humans and animals, and it was first used for such tasks as raising water and grinding grain.⁴

² From *Dictionary.com* at <http://dictionary.reference.com/browse/miller>. Retrieved February 12, 2013.

³ From *Merriam-Webster Dictionary* at <http://www.merriam-webster.com/dictionary/millwright?show=0&t=1355838185>. Retrieved February 12, 2013.

⁴ From *Merriam-Webster Dictionary* at <http://www.merriam-webster.com/dictionary/water%20wheel>. Retrieved February 10, 2013.

Waterwheels are divided into two categories: horizontal, or vertical.

Horizontal Waterwheels (See Figure 5.)

Greek or Norse Wheel

The Norse wheel is the earliest . Horizontal blades rotate from a central vertical shaft that turns the runner millstone above by direct drive. This type of waterwheel, which originated in Persia three thousand years ago, was most commonly used in Gotland in early times.

Tub Wheel

A tub wheel is a horizontal wheel enclosed in a hooped wooden barrel, or tub. The tub wheel, which originated in America, captures more of the potential power of the flowing water than a Norse Wheel.

Water Turbine

A water turbine is an all-metal adaptation of the tub wheel. The water swirls through an enclosed space turning specially shaped blades. Water turbines were invented by French engineers in the mid-nineteenth century. They are still in use today, particularly for electric generators.

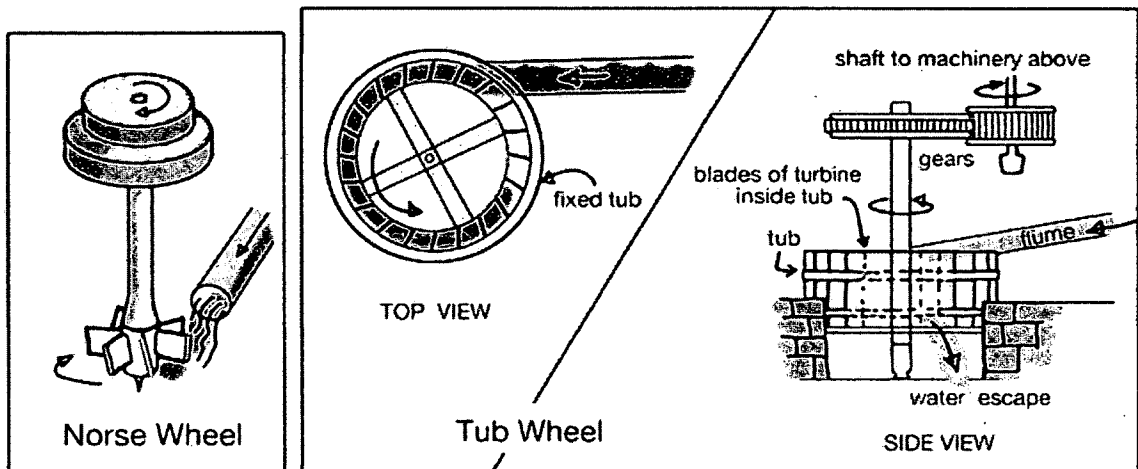


Figure 5. Left: Greek or Norse wheel, left. Right: Tub wheel.

Vertical Waterwheels (See Figure 6.)

Undershot Waterwheel

Water strikes the paddles at the bottom of the vertically positioned wheel, causing the wheel and central horizontal drive shaft to turn. Undershot wheels are used for tidal powered mills, and for floating mills and fixed mills in rivers, where water strikes the blades as it flows by. (See Figure 7.)

Breast Shot Waterwheel

Water strikes the blades at a level near the axis of the waterwheel shaft, causing it to rotate. This vertical wheel is more powerful and efficient than an undershot wheel.

Overshot Waterwheel

Water strikes the blades at the highest point to turn the waterwheel. Overshot wheels can be used near waterfalls where water is directed along a flume to the wheel, or in places where rivers can be dammed to provide a significant “head” or vertical fall of water. This type of waterwheel was popular in the 1800’s on Prince Edward Island. (See Figure 8.)

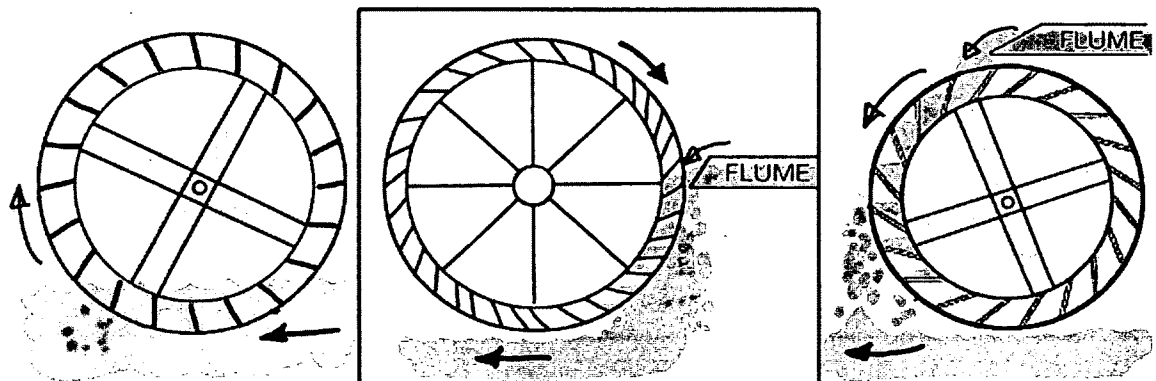


Figure 6. Vertical waterwheels, left to right: Undershot waterwheel, breast wheel, and overshot waterwheel.

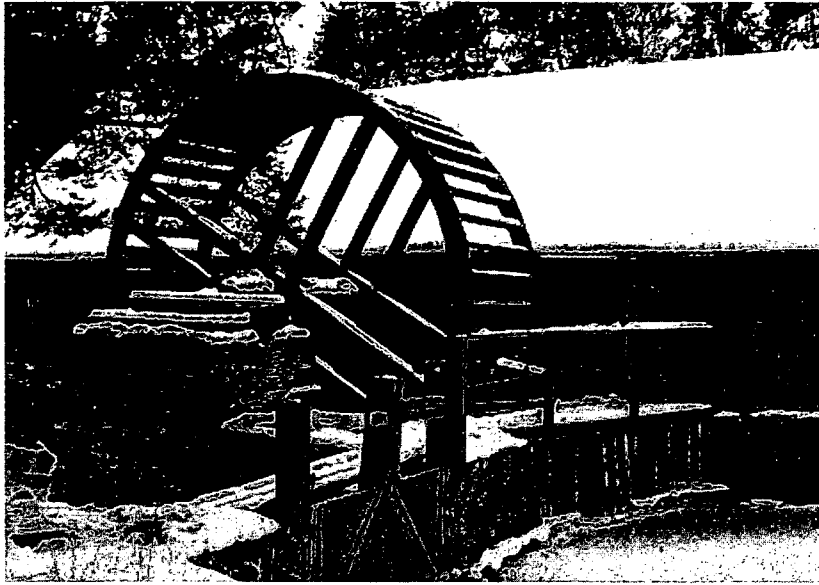


Figure 7. Undershot waterwheel at sawmill in Petarve in Sanda Parish, Gotland. This mill is still in use.⁵ Photo courtesy Jan Andréasson-Utas.

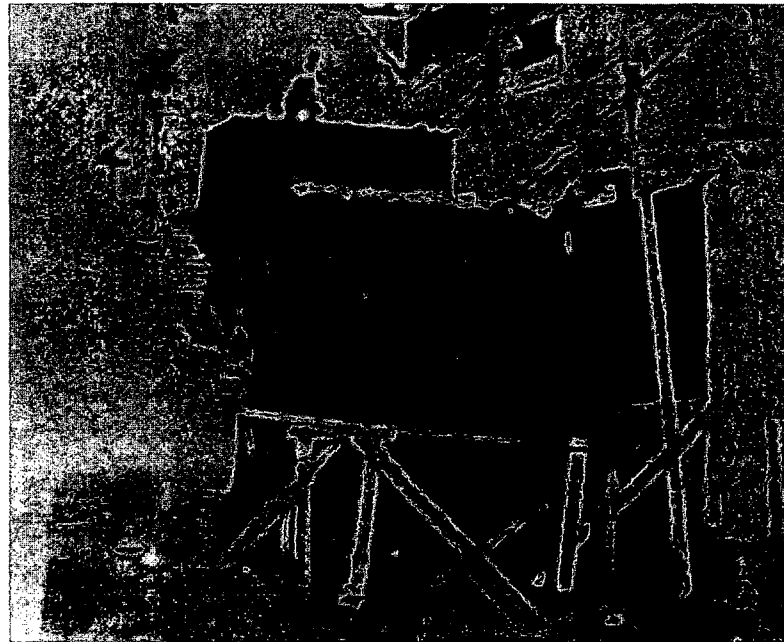


Figure 8. McRae's overshot waterwheel at Heatherdale, PEI, early 1900's. Photographer unknown.

⁵ See Petarve Sawmill working at <http://www.youtube.com/watch?v=m8nGXIF4fWI>. Retrieved January 12, 2013.

Watershed

A watershed is an area of land into which all water flows. It can be likened to a bowl that collects and holds water. All water runs downhill into a lower level, and when the collecting basin or watershed is full, it overflows. Every river has a watershed, each stream flowing into another stream until it reaches the ocean. There are various systems of naming streams according to size and branches (Leopold 1994: 223-229).

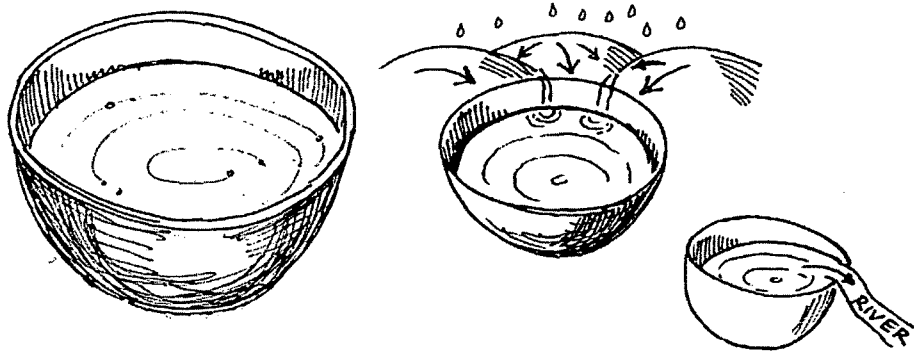


Figure 9. A simplified watershed.

Spring

When water seeps into the ground, it moves vertically until it hits an impenetrable layer of earth. It follows this layer downhill until it encounters a crack, at which point it falls into the crack and continues to flow vertically until it hits groundwater, or another impenetrable layer. A spring is the place on a hillside where this water exits the ground.

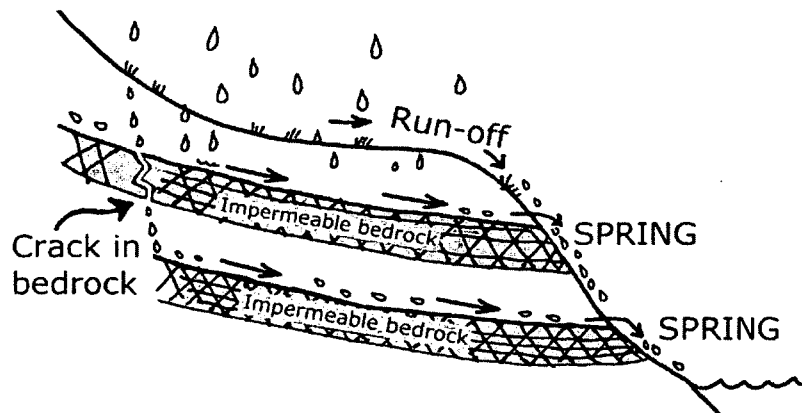


Figure 10. Diagram of a spring.

METHODOLOGY

On Prince Edward Island there is a wealth of data in the local histories written as Centennial projects in the 1960's and 1970's. Most of these documents begin with a chapter titled "The Mill," and provide a firm foundation to the argument that watermills have helped shape Prince Edward Island's past. Information for this thesis came from such varying sources as Clark's *Three Centuries and the Island* (1959), Rayburn's *Geographical Names of Prince Edward Island* (1973), Atlantic Geoscience Society's *The Last Billion Years: A Geological History of the Maritime Provinces of Canada* (2001), Eric Sloane's *Our Vanishing Landscape* (1955), Valentine's *Water in the Service of Man* (1967), and Eileen Power's *Medieval People* (1963). The Provincial Archives provided newspaper ads, trade directories, and censuses.

Gotland mills and history receive less attention than PEI because most of the resources are available only in Swedish. Locations of Gotland mills come from maps drawn by Jan Andréasson-Utas in 1977 for the book he co-authored with Anders Solomonsson, *Väder – och vattenkvarnar på Gotland (Wind and Watermills of Gotland)*.

Locations of PEI mills were sourced from the following maps:

- Holland map (1765) which shows locations of mills (French mills) remaining after the English take-over
- Sartine map (1778) showing French mill sites
- Ashby map (1798) which shows saw, grist and carding mills
- Wright map (1852 & updated to 1874) showing mill locations (types not indicated)
- Wright map updated to 1903 by Cundall
- Plus the *Lake Map* (1863), *Meacham's Atlas* (1880), *Cummins Atlas* (1928), and the *Prince Edward Island Road Atlas* (1963).

There were no formal interviews connected with this investigation, but information was gleaned through conversations with many people associated with PEI mills (see Figure 11): Mack Dixon and Marjorie Faulkner of Dixon's Mills, South Melville; Robert Dixon who built a saw and shingle mill at Glencorrodale; Wally Andrew of Andrew's Mills, East Royalty; Emmett Wisener of Wisener's

Sawmill, Watervale; Allan MacAusland of MacAusland's Woolen Mill, Bloomfield; Warren Leard of Leard's Flour Mill, Coleman; Annie Leard of Leard's Mill, Westmoreland; and many more.

Through books, maps and conversations, I have attempted to answer some of the questions of why waterpower was once so important both on our island and on Gotland Island, and why our watermills have now been relegated to the pages of history. I present this information as a timeline that describes some of the significant breakthroughs in mill technology, plus milestones in the histories of Prince Edward Island and Gotland Island.



Figure 11. Some men involved in watermills of Prince Edward Island, left to right: Allan MacAusland, MacAusland's Woolen Mill, Bloomfield; Emmett Wisener, Wisener's Sawmill, Watervale; and Wally Andrew, Andrew's Mills, East Royalty.

SIGNIFICANCE FOR ISLAND STUDIES

The two islands in our study were formed millions of years ago in a misty past. Prince Edward Island (PEI) off the east coast of North America was once the sandy floor of the Windsor Sea, while Gotland in Northern Europe came into being as a coral reef. Sandstone and limestone: two very different beginnings, two different destinies. People began living on these islands as soon as the ice retreated 10,000 years ago after the end of the most recent Ice Age, and not only survived, but thrived.

What are these islands like? Approaching Prince Edward Island by water, we see a long slender thread of land on the horizon that grows longer as we approach, but not higher. This is an island that lies gently on the waves. There are no imposing mountain peaks or sharp edges here. The road map distributed freely by the government's tourist bureau shows an island that seems small and manageable, but when visitors arrive they find that they cannot see it all in one day.

Gotland Island (GI) also seems conveniently compact on the map, but this too is deceptive, for everything is dense with history. One thing that immediately catches the eye is the old windmill on top of the hill outside the capital city of Visby (see Figure 12). But then more windmill towers appear, and just over the horizon looms a modern wind farm, and it becomes evident that Gotland has had a serious commitment to energy self-sufficiency for a long time.

There are also wind farms on PEI, but there is confusion among the general public over who gets the power. Is it being produced for Island consumption, or is it an exportable commodity? Is PEI becoming more energy self-sufficient by building these windmills, or are we lulling ourselves into complacency? Can we ever provide enough wind power for domestic consumption plus export? And what else can we be doing? What about our waterways? What can we be doing with them?

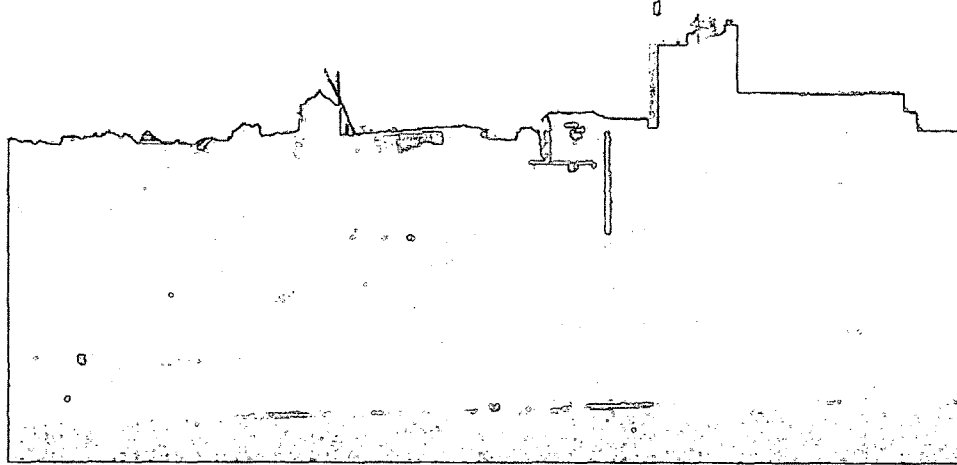


Figure 12. Windmill on horizon, Visby, Gotland, 2012.

Energy sufficiency is a major concern for all jurisdictions, but particularly for islands that rely on imported oil and electricity. Several years ago a freighter off PEI snagged its anchor on the cable that brings electricity from the mainland to the Island, resulting in a serious repair bill for PEI's electricity provider, Maritime Electric, plus inconvenience for customers. With its exposed energy grid, PEI is also vulnerable to hurricane damage. Gotland buried its electric cables to avoid just such natural disasters.

The population of PEI has never been completely self-sufficient since the arrival of Europeans. Right from the start of the settlement period, there were painful shortages of basic foodstuffs, seeds, iron, tools, saw blades, and millstones that could only be supplied by imports from Europe or continental North America. What PEI did have was arable, boulder-free soil and a bountiful sea. Agriculture and fishing were always the basis of the Island's prosperity, and in the mid-1800's PEI was, for a brief shining moment, close to self-sufficiency.

Gotland most certainly was self-sufficient for thousands of years. Far out in the Baltic, its people depended on what they could harvest from the sea, glean from the

shore, and hunt in the forests. The fortunes of Gotland have gone up and down over the centuries, but this has been an island with a mission of independence.

What can these two islands learn from each other? What can we do to make things better? How much time do we have? David Suzuki, visiting PEI in November 2012, warned that humanity could be wiped out within the next one hundred years from famine and natural disasters brought on by climate change and over-population. PEI is already feeling the influence of global warming as tides become higher and winds blow more fiercely, eroding the Island's loosely packed sedimentary sandstone cliffs and pushing cottages back from the shore (see Figure 13). On the south and eastern shores of PEI the average erosion is 0.5 metres per year, while erosion on the north and western shores erosion can be as high as 1.5 metres per year.⁶



Figure 13. Erosion, South Shore of PEI, December 2012.

PEI is not alone in its vulnerability. Even the island fortress of England is susceptible to rising oceans. Madeleine Penney writes in the *LONDON TIMES Eureka* (June 2012, p. 31):

⁶ PEI Department of Environment, Labour and Justice website at <http://www.gov.pe.ca/environment/shoreline-erosion>. Retrieved January 15, 2013.

The East coast of England is disappearing. Made of silt, clay and sand, it shows little resistance to the waves, with the future of many homes and communities under threat. Despite revetments, the cliffs in Happisburgh, Norfolk are receding at up to 12 m per year. A new policy of “managed retreat” will see the village left to its watery fate.

A policy of “managed retreat” is not a very comforting solution, but it is realistic. These are the times we live in, and islands exist at the very forefront of nature. If oceans are rising, then islands are going to notice. However, humans are a resourceful lot and have successfully met the challenges of nature for thousands of years. So while it is evident that Prince Edward Island will experience startling changes to its coastline in the coming years, life on PEI will not come to a crashing halt; and during this period of adjustment, the population will continue to consume energy. Some of this will come from wind, oil, natural gas, and nuclear sources; but one source that is being overlooked is energy from water.

One of humanity’s success stories has been learning how to transform the power of falling water into useful work, whether it is grinding grain, sawing wood, or turning electrical turbines. Not long ago, watermills figured significantly in the industrial and societal landscape of both Prince Edward Island and the island of Gotland. Today, PEI has completely turned its back on waterpower, while the island of Gotland has one small hydro station feeding electricity into the grid. Both islands, lacking locally sourced fossil fuels, are embracing wind power as their renewable energy source of choice.

Meanwhile the rivers of these islands continue to flow, ready and willing to contribute once again to the world’s energy landscape.

CHART 1. TIMELINE OF MILL HISTORY AND DEVELOPMENT

Date	Name of period	Events in world history	Events on Gotland (GI)	Events on Prince Edward Island (PEI)
10,000 to 1800 BCE	Early Antiquity	Stone hand mills used as agriculture, and grain growing, begins.	Ice Age ends. "Settlement Period." Agriculture begins. Stone hand mills.	Ice Age ends. "Settlement Period."
1800 to 500 BCE	Late Antiquity	Stone hand mills (metates and querns) in common use. Irrigation dams in Egypt and Mesopotamia.	"Bronze Age." International trade. Use of stone hand mills.	Mi'kmak hunter-gatherers. Possible use of stone hand mills.
500 BCE to 400 CE	Golden Age of Greece, Roman Empire	Vitruvius describes the vertical waterwheel. Watermills are built throughout the Roman Empire.	"Iron Age." Possible use of horizontal waterwheels to grind grain.	Mi'kmak hunter-gatherers. Possible use of stone hand mills.
400 to 1450	Middle Ages	Watermills, using wooden waterwheels, are common throughout Europe and Asia. They are owned by city states, feudal landlords, and the Catholic Church.	"Age of Migration." Invasion and emigration. / "The Viking Age." Christianity comes to Gotland. / First watermill is built on Gotland ca 1160 CE.	Mi'kmak hunter-gatherers. / Possible European contact ca 1000 CE. / Basque fishermen use Island as summer base. / Stone hand mills.
1450 to 1750	Renaissance and Age of Discovery	Watermills built in the Americas.	Watermills built across Gotland. / Island comes under Swedish rule. / The Island is mapped.	European contact. Native population introduced to metal tools, wheels, horses; also Christianity, and flour.
1750 to 1914 (WW I)	Industrial Revolution	Steam engines begin to replace waterwheels in Europe. / Steel waterwheels and water turbines invented. / Watermills popular throughout North America. / Oil comes into common use in late 1800's. / Electricity. / Watermills converted into hydro stations.	Mid-1800's, bogs drained in centre of Island, rivers dry up. / Many watermills close. Windmills built.	French settlement begins. First watermill built mid- 1700's. / The Island is mapped. / English take-over. Almost 400 watermills built across Island. / Shipbuilding a major economic engine until the late 1800's.
1914 to present	Modern Age	Horses used less after WW I. / Large dams supply water for electric generation. / Small hydropower societies promote hydroelectricity.	Watermills disappear, wind turbines appear. / Gotland University establishes a wind technology program.	Watermills disappear, wind turbines appear.

Please note:

Chapters in the thesis are organized into the time periods used by the Gotlands [sic] Museum, Visby, which reflect the development of the island of Gotland.

CHAPTER 1

Comparison of Prince Edward Island (PEI), Canada, and Gotland Island (GI), Sweden

Our Father who art in heaven, hallowed be thy name.
Thy kingdom come, Thy will be done on earth, as it is in heaven.
Give us this day our daily bread

Humans have always been preoccupied with food. The first request in the Lord's Prayer is "Give us this day our daily bread." Where would this bread come from, if not from a mill? Humans cannot eat grain unless it is boiled, or ground and baked. The earliest mills were two simple stones rubbed together. In Roman times the waterwheel was invented, so that for the past 2000 years the movement of falling water has provided a reliable and renewable energy not only for milling grain, but for other human endeavors as well.

This thesis reviews the development and use of watermills from antiquity to the present, including the economic, environmental and social significance of milling during this time. More specifically, we explore the rise and fall of water-powered technology on two small islands with quite different water resources: Prince Edward Island (PEI) off the East Coast of Canada, and the Baltic island of Gotland (GI), Sweden. (See Figure 14.) In the course of this discussion we will examine the reasons that there were once so many watermills on PEI and Gotland, why they vanished, and what we can learn from this period of our history.

PEI relied on water to power its mills for 300 years; Gotland's water mills reach back in time to the early Middle Ages. PEI had close to 400 water mills, Gotland more than 200. Today both islands have abandoned water as a source of energy, and have embraced energy derived from oil, atomic fuels, and most recently, wind. This "march of progress" is not limited to PEI and Gotland, but is echoed all over the

world on islands and mainlands alike. A water mill is an organic entity, alive and capricious, demanding close attention. As comfort and convenience have replaced physical labour, and mass production has triumphed over artisanal manufacture, so watermills have, perhaps, died a natural death. This thesis examines the reasons for that demise, but it will also propose that energy independence might be enhanced in both PEI and Gotland should waterpower once again find favor with our governments and citizens.

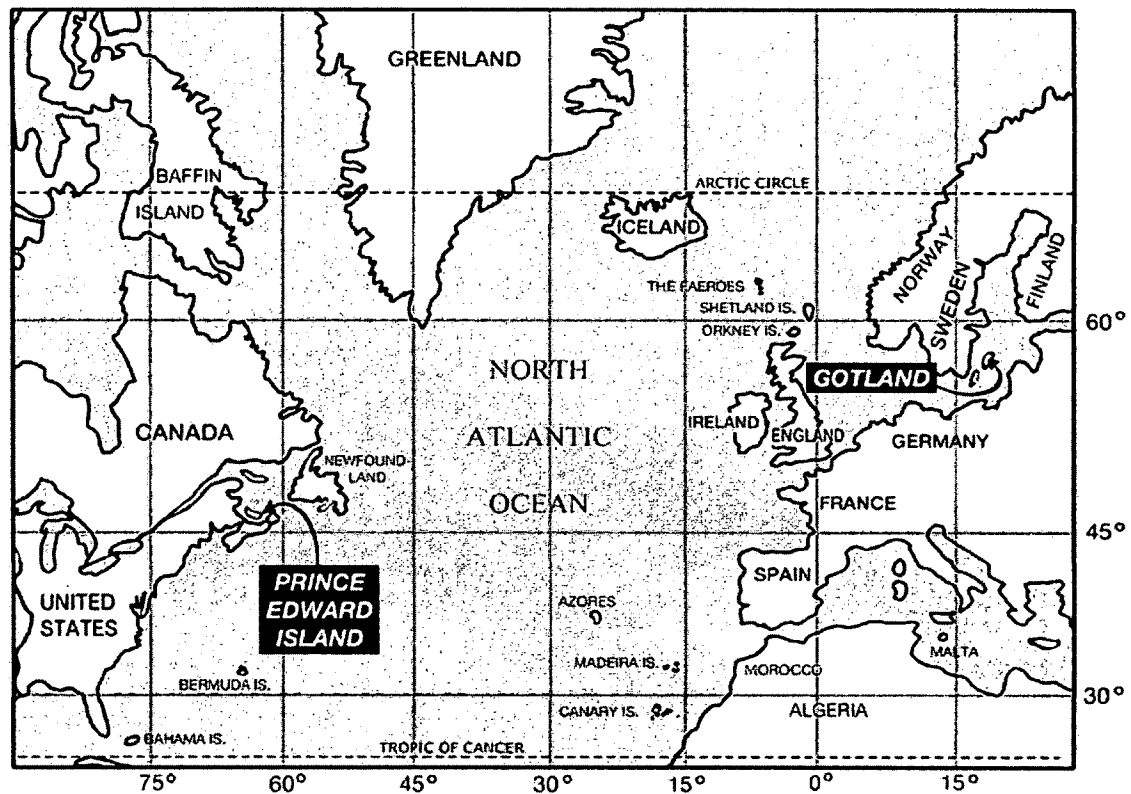


Figure 14. Location of Prince Edward Island, Canada, and Gotland Island, Sweden.

Prince Edward Island is located off the east coast of Canada. (See Figure 15.) In 1821 missionary Walter Johnstone visited PEI and described the location as follows:

[St. John's Island] lies near the southern boundaries of the Gulph of St. Laurence, between 46 and 47 degrees north latitude, and 61 and 64 west longitude, surrounded by that gulph on all sides, with Newfoundland to the northeast, Cape Breton on the east, Nova Scotia on the south, New Brunswick

and Miramichi to the west, and the Bay of Chaleur and Lower Canada to the north-west. It is, I believe, more than a hundred and forty miles long.¹

Johnstone's description still holds true. PEI consists of one main island divided into three counties, plus 231 minor islands. The North Shore features long sandy beaches and sand dunes, interspersed by numerous bays and harbours that cut deeply into the land. The South Shore consists of a jagged line of red sandstone cliffs, or capes, that at one time were joined to the mainland, but have eroded over thousands of years to their present locations. There are three large bays on the South Shore, and many smaller bays on the east coast. The Western Shore is an almost unbroken line of sharp sandstone cliffs, most of them less than 10 metres high, from the south-west tip of the Island at West Point, all the way to North Cape.

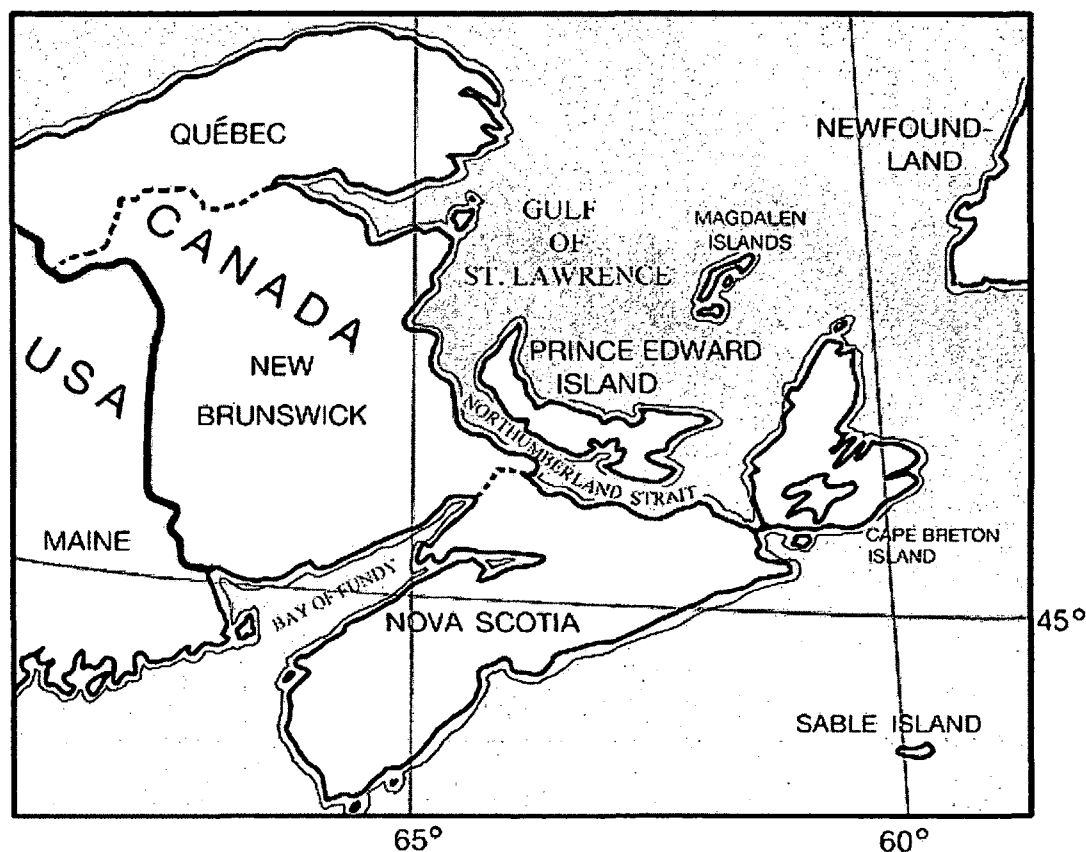


Figure 15. Location of Prince Edward Island on the East Coast of Canada.

¹ Quoted in D.C. Harvey, ed. *Journeys to the Island of St. John* (Toronto: Macmillan of Canada, 1955): 114.

Six thousand kilometres north-east of PEI, on the other side of the Atlantic, in the middle of the Baltic Sea, sits the island of Gotland. (Figure 16). This island, 90 km off the south-east coast of Sweden and 130 km west of the Estonian mainland, is a 3,140 square kilometre plateau of limestone that slopes gradually from west to east. Off the west coast of Gotland is the small island of Stora Karlsö where many Stone Age finds have been made. Fårö Island, off the northern tip of Gotland, is famous as the home of Ingmar Bergman.

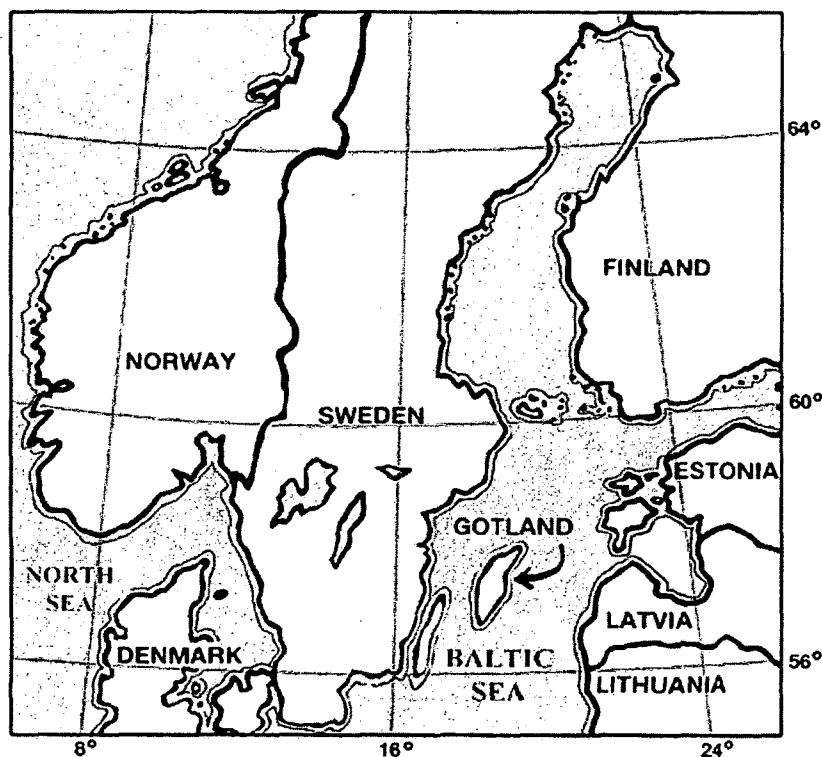


Figure 16. Gotland, Sweden, in the Baltic Sea.

Both PEI and Gotland Island are relatively small islands. PEI has about twice the landmass of GI, and twice the rainfall. It has higher hills and more people. GI has a warmer winter, a cooler summer, and its people make more money than Prince Edward Islanders. People on both islands speak English, as well as other languages. Gotland's tourist information has been translated into English for the convenience of North American visitors, but none of PEI's promotional material is available in Swedish.

PEI is accessible by air, or by driving across the 13 kilometre long Confederation Bridge, or by taking a ferry ride that lasts just over an hour. Looking across the Northumberland Strait from the South Shore, the hills of Nova Scotia can easily be seen, particularly on days when a storm is coming, or so the locals claim.

Gotland can be reached by air, or by two ferries from the Swedish mainland that dock at the capital city of Visby. Neither the Swedish mainland to the west, nor Latvia to the east, are visible from Gotland at any time. Gotland truly is an island stronghold, solidly alone in the Baltic Sea, its white limestone cliffs rising out of the sea like the walls of a mighty citadel. (See Figure 17.)

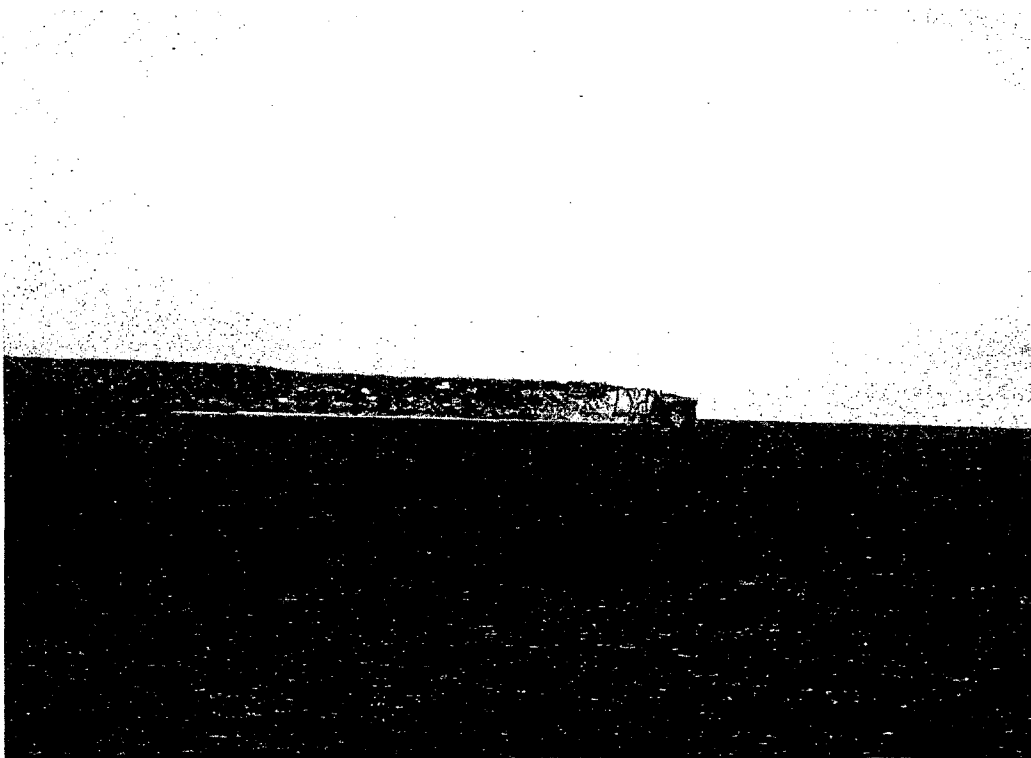


Figure 17. View of western Gotland as seen from ferry.

CHART 2. COMPARISON OF PRINCE EDWARD ISLAND AND GOTLAND ISLAND

	Prince Edward Island ² (PEI)	Gotland Island ³ (GI)
Land area, km ²	5,684	3,140
Length, km	224	176
Width, km	6 to 64	60
Coastline with off-shore islands, km	1260	800
Average yearly rainfall, mm	1125.8	500–600
Average snowfall, cm	318.2	--
Hours of sunshine per year	1900	2000
Average temperature July	20° to 32° C	12° to 20°C
Average temperature January	-3° to -11° C	-2.3° to 1.5°C
Highest elevation, metres	142	82
Latitude of capital city	46.2° N	57.6° N
Longitude of capital city	63.1° E	18.3° E
Population year-round	~139,600 (2008) ~145,800 (2011)	-- ~57,300 (2011)
Life expectancy -- women	82.7 (2007)	83.7 (2010)
Life expectancy -- men	77.6 (2007)	79.3 (2010)
Average income	\$41,500 / family (2011)	\$26,600 /capita (2010)
Net migration, approximate	- 300 (2008) + 2500 (2011)	- 50 (2008) +96 (2010)
Unemployment, %	11.2 (2011)	9.5 (2011)
Languages spoken	English, French	Swedish, Gutniska, English
Churches and museums	Small white churches, one cathedral, a few local museums	Medieval churches, numerous museums, standing stones, runes, hill fortresses, giant's graves, walled city

² Retrieved December 14, 2012 from federal and provincial Canadian government websites, including:
<http://www.gov.pe.ca/infopei/index.php3?number=13495&lang=E>
<http://www.gov.pe.ca/weather/annual.php3> & www.gov.pe.ca/photos/original/pt_pop_rep.pdf

³ Retrieved November 12, 2013 from various Swedish government websites, including:
<http://www.yr.no/place/Sweden/Gotland/visby/statistics.html>;
Gotland in Figures at <http://www.gotland.se/imcms/1354>; and
Gotland Island at <http://hem.passagen.se/jwid0498/GOTLAND.HTM>.

Both PEI and GI are major tourist destinations. In 2010 PEI attracted 1,300,000 visitors, mainly from eastern Canada and the United States, but also from Japan, China and Europe.⁴ Gotland receives 500,000 visitors annually, including some Asian and North American visitors, but it is a particularly desirable summer destination for Swedes and Europeans because of its mild weather, location, small population and history. The *Destination Gotland* ferries carry 800,000 tourists annually from the Swedish mainland to the Island, and many other visitors arrive by air. Both PEI and GI promote themselves as holiday islands with plenty of sun and fun. (See Figure 18.)

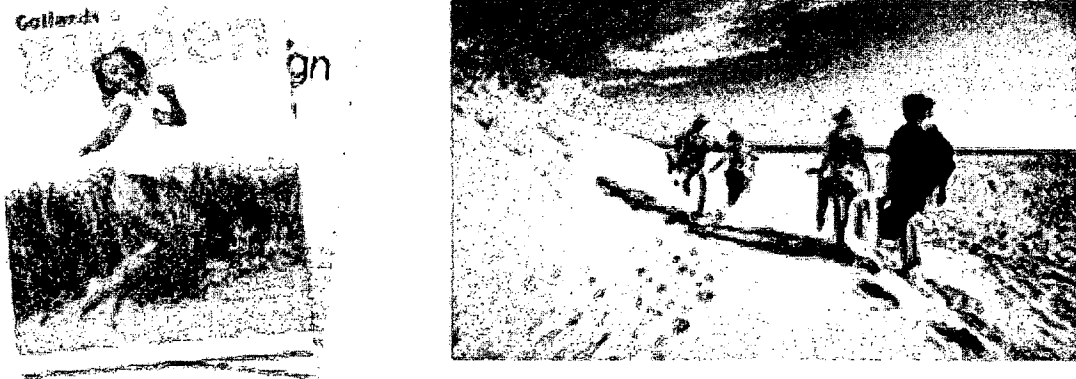


Figure 18. Left: Cover of Gotland tourist guide. Right: Cover of PEI tourist guide.

Our islands share an unlikely literary connection. Red-haired fictional heroines form the basis of major tourist attractions on both PEI and GI. Anne Shirley of L. M. Montgomery's novel *Anne of Green Gables* draws visitors to Prince Edward Island from places as far away as Japan and gift shops across the Island sell "Anne dolls" sporting bright orange braids. On Gotland a modest tourist attraction has grown up around another imaginary red-haired girl, the pig-tailed Pippi Longstocking. Although Pippi Longstocking was written by Astrid Lindgren on the Swedish mainland, the television series was shot on Gotland. At the park in Kneippbyn, Pippi's villa and oak tree and other locations from the films can be seen, and like Anne dolls on PEI, "Pippi dolls" can be purchased in Gotland.

⁴ PEI Budget 2011 at http://www.gov.pe.ca/photos/original/Budget2011_Tour.pdf. Retrieved November 24, 2012.

PEI and GI both possess abandoned railway lines. The Prince Edward Island Railroad came into being in 1875 with narrow gauge rolling stock. It was a highly popular service for both passengers and freight, but in the 1900's, as more cars and trucks started driving on newly improved roads, the railroad system fell into decline. The last train engine on PEI blew its horn in 1989. In subsequent years the tracks and cross ties or "sleepers" were torn up, and the train bed took on a new life as a bike path. On Gotland, the narrow gauge Gotland Railroad was inaugurated by King Oscar II in 1878 and operated until 1960.⁵ Similar economic reasons caused its demise. Both PEI and GI have railway museums and plenty of railroad nostalgia buffs. Gotland has one kilometre of track at Hesselby featuring a steam engine and two cars that offer passengers a short but genuine train ride, while PEI has a few old train cars sitting dolefully on a short strip of track beside the Elmira Museum.

Both PEI and GI export potatoes. In 2010 Gotland organic potatoes accounted for almost a quarter of the KRAV (certified organic) potato fields in Sweden.⁶ Value-added products with the Gotland label are trendy on the mainland. Svedjemo writes (email Oct 27, 2012):

The trend is now that many farmers alone or together develop their own products like cheese, meat, etc in small scale dairies etc. It's still a bit in its infancy, but it's growing. We have a big market in Stockholm and products from Gotland are considered to be of high quality there.

PEI is also trying to break into upscale markets with PEI brand labeling. Organic farming is on the increase, and there are presently thirty farms listed on the website of the PEI Certified Organic Producers Co-op with members producing everything from fall rye to blueberries to beef.⁷ Organic potatoes have not proven easy to grow because of the pervasiveness of pests like Colorado potato beetles, and most recently, wireworms.

Money plays an important part in the story of any island, or country. The paper currency of Sweden is colorful and looks much like Canadian money. (See Figure 19.) Swedish banknotes honor such Swedish cultural heroes as Greta Garbo, Dag

⁵ *Gotland Train Association*, <http://www.gotlandstaget.se/history.htm>. Retrieved November 2012.

⁶ From *Gotland in Figures*, p. 22, <http://www.gotland.se/imcms/1354>. Retrieved February 12, 2013.

⁷ PEI Certified Organic Producers Coop, <http://www.organicpei.com/>. Retrieved January 30, 2013.

Hammar skjöld, Astrid Lingrin, and Ingmar Bergman. Canadian dollar bills feature portraits of male politicians, plus Queen Elizabeth.

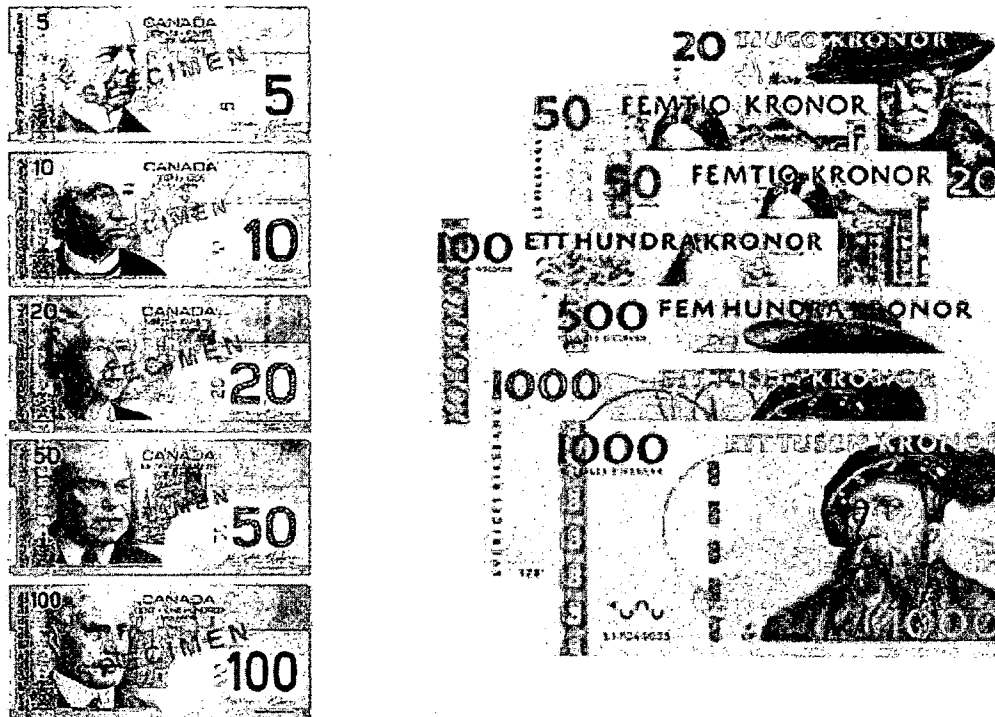


Figure 19. Left: Canadian paper currency. Right: Swedish paper currency.

This is, perhaps, an indication of the different priorities that our two countries have towards the arts. PEI is proud of its numerous musicians and artists, but expects them to be successful without financial support. In 2010-11 the Canada Council provided \$386,468 for arts grants on PEI, or \$2.50 per capita.⁸ By contrast, Gotland's cultural sector is heavily funded by the Swedish government. (See Figure 20.) Sweden even provides a lifetime income guarantee for many of its most successful artists.

⁸ "Canada Council for the Arts Funding to artists and arts organizations in Prince Edward Island, 2010-11," at <http://www.canadacouncil.ca/NR/rdonlyres/14C77888-7F98-4D1E-A2BB-45C23E8013E8/0/PEEN.pdf>. Retrieved November 6, 2012.

ACTIVITIES AND ASSOCIATIONS WITH SUPPORT

- Gotland County Library
- Gotland Arts and Crafts Association
- Gotland Music Foundation
- Gotlands Museum
- Gotland County Theatre
- Gotland Art School
- Gotland School of Music Composition
- Gotlands Dansutbildningar (dance)
- Gotland Bildningsförbund/8 study associations
- Baltic Centre for Writers and Translators
- Baltic Art Centre
- Visby International Centre for Composers
- Galleriföreningen (The Association of Art Galleries)
- Grafikgruppen (The Graphics Group) Visby
- Folkets Bio (cinema)
- Cultural Association Roxy
- Kulturskolan on Gotland
- Bläse Limestone Museum
- Bunge Museum
- The Gotland Train Association
- Gotland Lectures Association
- Gotland Agriculture Museum
- Rural heritage associations/Community groups/Assembly rooms
- The Musical Company
- Medieval Week
- Roma Theatre
- Young Roma

Figure 20. Arts organizations on Gotland that receive Government funding.⁹

It is clear that Sweden is a country where life has settled into distinct rhythms, and where people cherish their place in history and in society. This is demonstrated perfectly on Gotland. Visitors are welcomed as a source of the Island's present-day economic prosperity, but they are kept at arm's length. This could also be said of Prince Edward Island, or any place, in fact, where people survive by servicing that curious transient population known as tourists.

Churches have played an important role in the cultural life of both PEI and Gotland. On PEI, hundreds of little white churches dot the Island, while on Gotland, more than ninety ancient stone and plaster churches enhance the landscape. Gotland's handsome medieval churches are maintained in their solemn dignity by the state, since few people attend church any more. However, those faithful few who do

⁹ From *Gotland in Figures* (2011), p. 43, at <http://www.gotland.se/imcms/1354>. Retrieved February 12, 2013.

attend get to hear music played on beautiful instruments, for every church has a pipe organ. (See Figure 21.) PEI's churches, by contrast, are modest wooden structures with white painted shingles, a steeple, and perhaps one stained window, but almost certainly no pipe organ.



Figure 21. Left: Malpeque United Church, PEI. Right: Stenkumla-Kirche, GI.

Churches and other buildings on both PEI and Gotland have been built to withstand the weather. PEI has a severe gale every few years that causes disruption of power and destruction of coastline. Occasionally a trailer blows over, or an uprooted tree crushes a vehicle, but most of the damage comes from flooding and destruction of the shoreline. On the North Shore, the dune systems have been breached by unusually high tides, particularly in the National Park. Along the South Shore, cottagers see their lawns diminishing every year as rising seas eat away at the capes. In Charlottetown, tidal surges continually threaten, and sometimes destroy, the protective sea wall.

Gotland also experiences severe storms, with winds less powerful than a hurricane, yet strong enough to knock out overhead electric transmission lines. This happened so often that, finally, a decision was made to bury the cables. A sense of peace and order pervades the countryside. Farms, houses, trees, even cows rest naturally on the land as though they belong.

On Prince Edward Island, power and telephone lines crisscross our horizons, so that a vertical pole or a horizontal wire interrupts almost every vista and we are constantly reminded of our dependency on technology. Of course, at one time when electricity was new on PEI, power lines were seen as exciting precursors of better days to come, and there is no turning back. But there is never a year when there is not some electrical crisis on PEI, perhaps only a local outage but still an inconvenient costly interruption.

In the fall of 2012, as Hurricane Sandy visited the USA and winds snapped power poles on Staten Island, Long Island and the island of Manhattan, the vulnerability of a system that is reliant on exposed electric wires and ageing wooden posts was vividly displayed. Although PEI has never experienced a hurricane of these proportions, the danger is present.

Many things set our two islands apart. Gotland has a walled mediaeval city with cobblestone streets, fabulous museums, and old stone windmills. It is overflowing with history. PEI, on the other hand, does not have a single world-class museum, standing stone, hill fortress, or castle; but it does have a world class arts centre, a vibrant democratic political system, a university, trade school, aerospace industry, scientific research community, as well as delicious lobster and some of the tastiest potatoes on earth. And PEI has color. Its red soil is one of its crowning glories. Complement the burnt sienna with blue, green and white and you have a landscape that is truly a feast for the eyes. Gotland has its own colorful palette, but its scenery is painted on a white limestone canvas. The sea floor of the Baltic Sea is also white, so on a clear day the sky is reflected as a true blue. An artist's paint called "Baltic blue" vaguely resembles the color of the Baltic, but "Baltic blue" is a dull opaque grey-blue, whereas the Baltic Sea is sparkling and transparent. The seas surrounding PEI also sparkle, though the water is often tinged with red from the sandstone sea bed.

PEI has color, and it has space. Although it is the most densely populated province of Canada and is far from being a wilderness, the Island feels pastoral, provincial, uncrowded and unspoiled. There are many beaches where a person can walk along for hours and not meet another soul. Visitors notice the manicured lawns,

the fringes of Queen Anne's lace and goldenrod along the roadsides, the tidy farms embraced by calm and order. Of course it is only paradise on the surface. A casual glance does not see that the land is under siege, with sandstone capes eroding, dune systems being broken through by storm surges, and topsoil washing into the rivers after every rain. You only see this side when you live here.

At the heart of this thesis is one special feature that sets PEI apart from Gotland, and that is the amount of fresh water available on each island. Whereas GI lives in a state of chronic water shortage, even drought, PEI is blessed with thousands of springs, and hundreds of brooks and rivers. Every view is a water view. Even before Europeans arrived, humans were using PEI's waterways for food, transportation, and recreation. When the French came in the 1700's, they were thrilled with the bountiful fresh water, and in no time at all someone dammed a river and built a mill. The first water mill was built in the early 1720's, and within the next two hundred years over 300 ponds and dams had transformed the Island landscape.

Gotland has a much longer history of using water to power its mills. The first watermill was constructed in the early thirteenth century, and by 1800 there were at least 228 watermills on their streams. This small-scale industrialization took place in spite of limited fresh water resources, for the prevailing westerly winds that bring rain to Sweden have lost most of their moisture by the time they reach Gotland. So the people of Gotland learned to cherish their fresh water, as well as to live with drought. Prince Edward Islanders, on the other hand, take their water for granted because there is so much and it seems to be everywhere.

The climate and topography of these two islands led to entirely different milling operations. Gotland could be described as a huge limestone plateau. Its limited rainfall was never adequate to gouge out deep rivers or valleys in the hard bedrock. Thus, millers did not have the option of erecting high dams and digging deep ponds, and watermills relied on the limited power afforded by horizontal waterwheels or undershot vertical wheels.

Prince Edward Island, on the other hand, has ample rainfall and snowmelt, and rivers flow bountifully throughout the island. A map of PEI rivers appears almost to be a map of arteries and veins. (See PEI map, p. 116.) Glacial action and erosion

have scoured the landscape until today the Island consists of gentle rolling hills, with steep-banked waterways that invite the construction of dams. Water can be dammed up to create heads of up to 20 feet, as at Long River, and powerful overshot waterwheels were used across the Island.

On both PEI and GI, rivers are short and flow directly to the sea. Mills built closest to the shoreline benefited from the most water flow, and had the possibility of being most successful. Both islands benefited from technology developed elsewhere. Gotland, being connected to Europe via a busy trade route, was able to appropriate milling technology almost as soon as it became available on the European mainland. Prince Edward Island in the New World took another 800 years to arrive at the same point, but once Europeans arrived, they brought state-of-the art milling technology with them. They constructed their mill buildings of wood, since there was no building stone available on PEI; while on Gotland, as throughout Europe, most mill buildings were built of stone.

These two islands, so far apart, so geologically different, learned how to harness the power of water in different ways and at different points in history. This thesis will survey the knowledge and literature that led to this awareness. There will be no attempt to prove that life was better or worse in the “olden days.” Life was merely different. People were not so much obsessed with happiness as they were focused on survival. Hard physical work was the norm. Power provided from the small streams on PEI and GI helped reduce the time and energy required for the very tiresome and repetitive tasks of grinding grain, fulling cloth, and sawing lumber; but this did not mean that life instantly became easy. Anyone who has cut a tree with an axe or crosscut saw knows how long this takes, and getting a tree on the ground is just the beginning of one’s acquaintance with it. And the work involved in the production of grain is simply astonishing. The soil must be prepared by first removing trees, stumps and roots, then plowed and worked repeatedly with a harrow until it is loose, after which the valuable seeds are planted and nurtured until they mature. The work goes on and on until the new seeds are finally in the storage bin, ready to be milled. Milling involves a whole other level of tedium, but without milling the grain, we would have no bread.

Similarly, fulling cloth is an end production that comes after the sheep has been raised, and the wool shorn, cleaned, carded, spun and woven. Fulling consists of scouring and thickening fabric by numerous labor-intensive steps. In Roman times, fulling was carried out by slaves stomping on cloth while ankle deep in tubs of human urine. In Scotland, fulling was women's activity, with women rhythmically thumping the newly woven cloth against a board or tabletop, while singing "waulking songs." (See Figure 22.) These songs were the equivalent of sea shanties, with one woman singing out a line, and the others joining in. Fulling the cloth together in this manner may have inspired a sense of camaraderie and fellowship; nevertheless it was toilsome repetitive work.



Figure 22. Women waulking. Drawing by Keith Henderson, 1928.

Watermills, then, whether fulling mills, carding mills or flourmills, all contributed to the reduction of hard manual labour. Historian Lewis Mumford (1934, p. 118) had this to say about the liberating power of mills:

Thanks to the menial services of wind and water, a large intelligentsia could come into existence, and great works of art and scholarship and science and engineering could be created without recourse to slavery: a release of energy, a victory for the human spirit.

Both PEI and Gotland have experienced this victory of the human spirit. We each have a university; our arts and scientific communities are alive and well; and if we are slaves to work, that work is of our own choosing. Are these successes due to our watermills? Of course not, but waterpower has played an important role in the development of both of our societies, and perhaps it can play an even greater role in the future.

CHAPTER 2

Early Antiquity – The First Hand Mills

And God said, Let the waters under the heaven be gathered together unto one place, and let the dry land appear: and it was so. And God called the dry land Earth; and the gathering together of the waters called he Seas: and God saw that it was good.

Genesis 1:9 and 10

Water has been one of humanity's preoccupations, for water is life. This is reflected in the creation story of the Bible. When earth had both land and water, "it was good." The Bible does not call that early landmass an "island" but that is exactly what it was: one huge island surrounded by a giant sea. Let us move along a few billion years.

Ten thousand years ago the northern world was beginning to recover from the last great Ice Age. (See Figure 23.) Mountains had been ground down, boulders moved, and waterways carved out by the moving ice. Then, as earth entered a warming period, land that had been buried for millennia under ice two kilometers thick now reappeared on the landscape, rising to form new and altered landscapes. It was truly a new world.

Humans were active during this great age of coldness and drought when so much of the earth's water was swallowed up by ice. Some of our ancestors found refuge in the ice-free corridor through the Pyrenees. Their lives as hunter-gatherers are vividly portrayed in the cave paintings of the region,¹⁰ while their cultural lives included not only art, but music.¹¹

¹⁰ Cave paintings, ca 32,000 BCE, are featured in the documentary film *Cave of forgotten dreams* (2010). Directed by Werner Herzog. Produced by Erik Nelson, Adrienne Ciuffo, Dave Harding, Julian Hobbs, David McKillop. France: Creative Differences.

¹¹ Along the Danube River, 42,000 BCE, music was played on bone flutes. Walford, J. (2012), "Flute's Revised Age Dates the Sound of Music Earlier." *New York Times*, May 29, 2012. Retrieved December 20, 2012 from http://www.nytimes.com/2012/05/29/science/oldest-musical-instruments-are-even-older-than-first-thought.html?_r=0

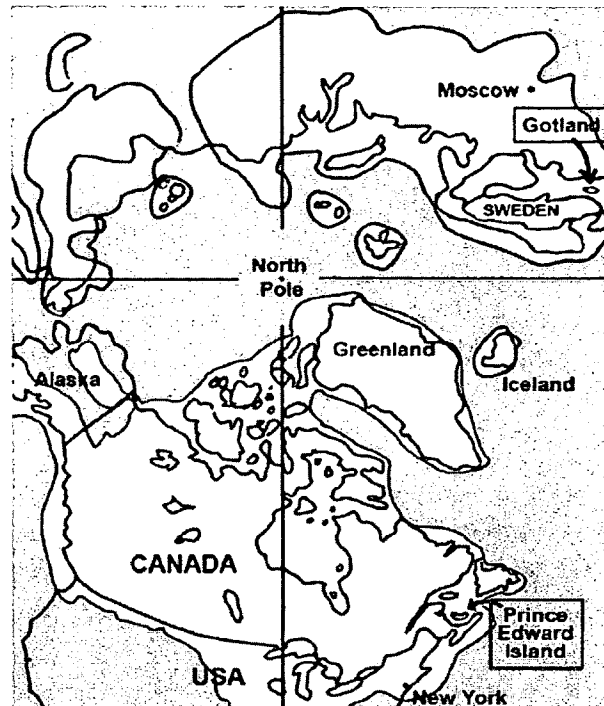


Figure 23. Maximum glacial ice cover of northern world during the Pleistocene Era, approximately 110,000 to 10,000 BCE. After U.S. Geological Survey map.¹²

Others northern people escaped to the warmer south where agriculture was already underway. The earliest grain-grinding implement that has been identified is a *metate* found on the banks of the Euphrates River in modern Syria. (See Figure 24.) This 9000-year old tool looks simple enough, but it weighed 23 kg and was carved out of basalt which is a volcanic rock not naturally occurring in the place where the millstone was discovered. This stone was a serious tool for food processing and represented state-of-the art milling technology.

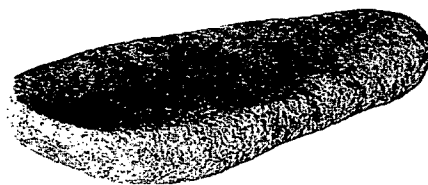


Figure 24. Bottom stone of metate in British Museum.

¹² U.S. Geological Survey map at http://en.wikipedia.org/wiki/File:Pleistocene_north_ice_map.jpg. Retrieved February 14, 2013.

People living in warmer climates during this time were no longer hunter-gatherers but were engaged in sophisticated agricultural and engineering projects. In the Middle East, engineers were experimenting with holding back water for flood control, as well as releasing water for irrigation. The oldest dam in the world is believed to be the Jawa Dam in the Black Desert of Jordan, ca 3000 BC. Constructed of earth and masonry, this embankment was used to hold back a small river for irrigation purposes. Another early dam, built for flood control ca 2700 BCE, was the Sadd el-Kafara dam on the Nile River south of Cairo, over 100 metres long at its base and constructed of squared limestone facing and rubble and rock fill.

Water-based technology was beginning to come into its own.

2-1. Gotland – The Settlement Period

Four hundred million years ago in a period known as the Silurian, before people thought of touring or trading or pillaging in these northern regions, Gotland was a coral reef under warm waters near the equator, part of a great single continent known as Pangaea. The island of Gotland was not formed by breaking off from a larger land mass or by volcanic action, but was created by the accumulation of trillions of seashells mixed with sand and mud that collected and fossilized on the sea bottom to form a solid flat-surfaced land mass.¹³ As Pangaea broke apart and the continents shifted, Gotland found its present home 57 degrees north of the equator.

During the last Ice Age Gotland was crushed under the Scandinavian Ice Sheet, an enormous bed of ice possibly as much as 3 km thick (Lambeck, Smither & Ekman, 1998). Around 14,000 BC, the glacier started to retreat, the weight of the ice decreased, and Gotland slowly began to rise back towards equilibrium. As ice continued to melt and sea levels rose, the Baltic Sea changed from a shallow land-locked fresh water lake, to an open sea (Champion Gamble, Shennan & Whittle, 2009). By 5000 BC the ice sheets had rapidly melted and temperatures reached

¹³ Guteinfo.com website at <http://www.guteinfo.com/?id=3171>. February 21, 2013.

present-day levels, and human settlement commenced in the region. Stone Age skeletons 8,000 years old have been found at Stenkyrka and Lummelunda, so it is known that the island was inhabited shortly after the retreat of the great ice mass.¹⁴

This period from 10,000 BCE to 1800 BCE is known on Gotland as “The Settlement Period.”

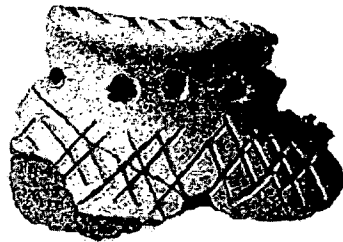
These early Gotlanders survived by hunting, fishing and gathering, and when there was no food, they starved. Life was short and intense. In summer there were blueberries, lingonberries, wild strawberries, raspberries, cranberries, nuts. There were eggs, birds, shellfish along the coast, and seal pups in season (Sjöstrand 2011). Bone fishhooks and fishbones found at Ajvide indicate that by the late Stone Age there was already a specialized deep sea cod fishery in place (Olson, Limburg & Söderblom, 2008). People had not yet set up in permanent dwellings but lived mainly along the coasts. At that time the climate was warm and moist and the winters were mild. The landscape ranged from sparsely covered limestone to verdant forests of deciduous and coniferous trees.

Agriculture came to the region around 4000 BC with the arrival of the Funnel Beaker Culture. These people spread through southern Scandinavia, including Gotland, bringing domesticated cattle, pigs, sheep and goats with them, as well as seeds of wheat, peas, broad beans, and an early version of Gotland Swedish barley (Wiggans 1921). The small blond-maned Gotland pony, called “Russ” or riding horse, and the short-tailed Gotland sheep, “Gotlandsfår,” were likely domesticated during this time. People moved inland away from the sea. Pastures were enclosed and fields created in the midst of the great dark forests, and successful farms produced surplus food for the first time. People needed a way to store their food, and they began to make pottery.

Pottery-making involves many steps: finding the clay, digging it, cleaning, wedging, forming and firing it – all a tedious time-consuming process, and at the end, your pots may break during firing. Yet potters persevere. A group of people called

¹⁴ *gotland.info* website at <http://www.gotland.info/language/eng/gotland-historiska05.php>. Retrieved February 21, 2013.

the Pitted Ware people made pots featuring holes and incised crosshatch (Malmström et al, 2010). Another group, the Funnel Beaker culture, made pots with a strange flared top and widened bottom (Larsson 2009). Thousands of shards of these distinct pottery styles have been found in the same sites on Gotland. (See Figure 25.)



Figures 25. Left: Pitted Ware artifact. Right: Typical shape of Funnel Beaker vessel. Photos in Larsson.

Another important Stone Age breakthrough occurred on Gotland when someone discovered how to make pine tar (a sealant) and pitch (a glue). Making tar was at least as complicated as making pottery. Naval specialist Thomas Gamble (1921) describes tar production as follows:

Suitable roots [of pine trees] must be dug up and cleaned in the autumn and winter, when this raw material can be taken on sledges to the tar "dale" or burning ground. The peasants utilize the roots of trees felled for timber or of trees uprooted by storm. The roots are split at the "dale" and stacked for drying until early spring, when they are split into fine sticks. The "dale" or burning ground is built of logs on a slope in the shape of a funnel, with a spout at the lower end of the slope... leading the tar to the waiting barrel...

Tar and pitch were two products that transformed the boat building industry. And now that fishermen and sailors had reliably waterproof vessels, the horizon was no longer a consideration (Benozzo 2010). Ships from Gotland were ready to travel the high seas and bring back new products and ideas.

2-2. Prince Edward Island – Ice Age to First Human Presence

Like Gotland, Prince Edward Island began its life near the equator. The region that we call the Maritime Provinces was situated deep within the supercontinent of Pangaea 340 million years ago. Seawater from the huge Panthalassic Ocean crept into the continent to form a basin called the Windsor Sea. This was a mineral-rich sea covering a wide area that included the Maritime region. As the sea invaded land and receded repeatedly, it left the oxidized iron-rich red sandstones that form the distinctive bedrock of Prince Edward Island.

The mighty Appalachian Mountain range was formed during the Devonian Period. Freshwater streams flowing from these mountains brought silt, sand and gravel into the body of water now known as the Gulf of St. Lawrence. These deposits eventually settled and hardened under water, forming the sedimentary basin that makes up the Island's foundation (Atlantic Geosciences Society 2001).

The most recent glacier of the Pleistocene was still thick over Prince Edward Island 16,000 years ago, and did not completely retreat for another 5,000 years. With the weight of the ice gone, Prince Edward Island rose from the ocean floor and land life blossomed anew, with new topography, rivers, and hills. The coastline was entirely different from its modern-day profile, for PEI was still connected to the mainland by a low plain that covered much of the present-day Northumberland Strait. PEI became an island only 7000 years ago when rising seawaters broke through the land barrier, named "Northumbria," and washed away PEI's final connection to the continent.¹⁵ By this time the Island's waterways were in place, with rivers like the Hillsborough, West and Dunk already shaping and cutting into the land.

It is known now that there has been an aboriginal presence on the Island approximately since the end of the last Ice Age, thanks to a spear point found in a potato field at North Tryon,¹⁶ and arrowheads and shards of pottery that were

¹⁵ Government of PEI website at <http://www.gov.pe.ca/infopei/index.php3?number=12183&lang=e>. Retrieved February 21, 2013.

¹⁶ PEI Museum and Heritage Foundation receives donation of 11,000 year old artifact. October 29, 2012. Retrieved February 18, 2013 from <http://www.gov.pe.ca/newsroom/index.php3?number=news&newsnumber=8659&dept=&lang=E>

uncovered at the Jones Site in Greenwich in the late 1980's. As layers of the site were excavated, they revealed close to 700 ancient artifacts which have been dated back 11,000 years."¹⁷ Seven hundred artifacts is an impressive number, but there would be many more if the bedrock of PEI were granite rather than sandstone. The coastline has eroded constantly over the past ten thousand years and most historical remains have been washed into the sea.

Archaeologists love to find middens of ancient trash, bones and shells, but these too have disappeared; or perhaps they were eagerly appropriated by early settlers as a source of lime. Clyde River author Margaret Dixon (1979, p. 174) writes about farmwives collecting seashells, then baking and cooling them: "[These shells], broken into bits, like saved bones from meats similarly treated, provided necessary material for the laying hens, which commercially could not be obtained."

The lifestyle of the Paleo-Indian ancestors of PEI's modern Mi'kmak involved periods of travel up and down the East Coast, hunting, trading and visiting. As the rising waters of the Northumberland Strait washed away the land bridge, the Island gradually became more distant from the mainland. Paddling a canoe across the Northumberland Strait to the mainland would have been a serious undertaking, for weather conditions are changeable on the Strait and squalls blow up suddenly and violently.

It is certain that life must have been as interesting and challenging for these early people as it is for us today. They were subject to sickness, hunger, accidents, and difficult childbirth, just as mankind has always been. Prince Edward Island is a gracious provider of wild strawberries, blueberries, raspberries, serviceberries, chokecherries, blackberries and cranberries *in season*, but each season lasts only a few weeks. And although at one time the Island had bear, moose, caribou, deer, fox, seals, walrus, and sea-cows, relying on these animals for food was neither easy nor convenient. The mouths of our rivers were a treasure trove of softshell clam beds. Further out were bar clams, quahogs, oysters, mussels, whelks, lobster; eels, gasperaux, smelts, trout, salmon; kelp, dulse, irish moss; ducks, geese, and possibly

¹⁷ Great Canadian Parks: Greenwich, Prince Edward Island. (2007). Retrieved June 28, 2010 from http://www.greatcanadianparks.com/prince_edward/grnwich/page4.htm.

even turtles. There were passenger pigeons until the mid-1900's, and spruce grouse, now extinct.

These first people were wise in the ways of harvesting their food. Berrill (1956, p. 173), writing about the aboriginal people of Maine, notes that:

[Cormorants] have been eaten by Indians for a long time Hunters used to steal out to the rocky islets where they slept to club what they needed. But being wiser in their ways with wild life than their successors, they took no more than they needed, and would raise a shout to scare the rest of the birds away to safety for the remainder of the night . . . to avoid the risk of another fox raiding what you consider your own.

Our own Island people were equally wise and clever. They were able to survive and prosper for ten thousand years without wheels or horses, or the tools and information on which we are now dependent. People fell in love, fell out of love, played with their children, built canoes, wove baskets (Figure 26), listened at night to the sound of crickets, frogs, and creatures stirring in the forest. Life had its rhythms, its rewards, and its share of suffering.

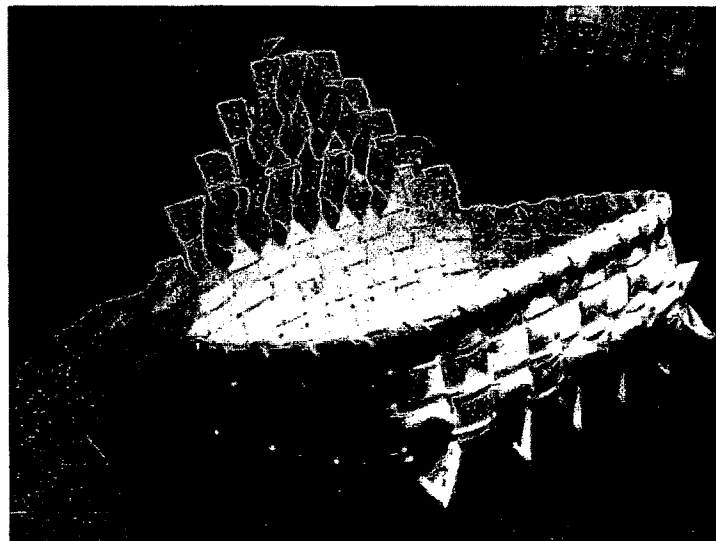


Figure 26. Traditional Mi'kmak basket woven by Marjorie Paul, Canoe Cove, PEI.

Some of the first documents written about the Mi'kmak were reports sent back to France by Jesuit missionaries. In 1634, Father Perrault described the inhabitants of PEI's neighboring island, Cape Breton Island, as follows (Jesuit Relations, p. 207):

As to the people, there is nothing anomalous in their physical appearance; you see well-formed men, good-looking, of fine figures, strong and powerful. Their skin is naturally white, for the little children show it thus; but the heat of the Sun, and the rubbing with Seal oil and Moose fat, make them very swarthy, the more so as they grow older. [...] One sees here old men, of eighty and a hundred years, who have hardly a gray hair. As to their intelligence, if we may judge from their conduct and from their way of dealing with the French, they are not at a great disadvantage.

What an uncertain future these intelligent people were facing, as their island – like Prince Edward Island, and all the islands of North America – was gradually overrun by thousands of Europeans who would change their way of life, their land, and their waterways forever.

CHAPTER 3

Late Antiquity – Mills Enter the Literature

Day in, day out, I work the mill and grind the grain
for wolfish guests who eat their fill and ask for more,
and so I greet the dawn and then I grind again...

MacLaine (2009), p. 87

Women and slaves throughout history have been tied to the “daily grind.” It is hard for us to imagine having to crush grain every day for our bread and porridge, but this has been reality for human beings since we started eating the seeds of grasses thousands of years ago. In the eighth century BCE Homer wrote of women toiling at the mills:

Full fifty female menials serv'd the King
In household offices; the rapid mills
These turning, pulverize the mellow'd grain... (Homer, p. 97)

And again:

A woman, next, a labourer at the mill
Hard by, where all the palace-mills were wrought,
Gave him the omen of propitious sound.
Twelve maidens, day by day, toil'd at the mills,
Meal grinding, some, of barley, some, of wheat... (p. 129)

This work took its toll on a woman's body. (See Figure 27.) The British Museum claims that, “Skeletons found in burials at Abu Hureyra reveal that grinding was women's work. Evidence of osteoarthritis and injuries to the toes, knees, hips and lower back caused by repetitive work in a kneeling position occur almost exclusively on the bones of females.”

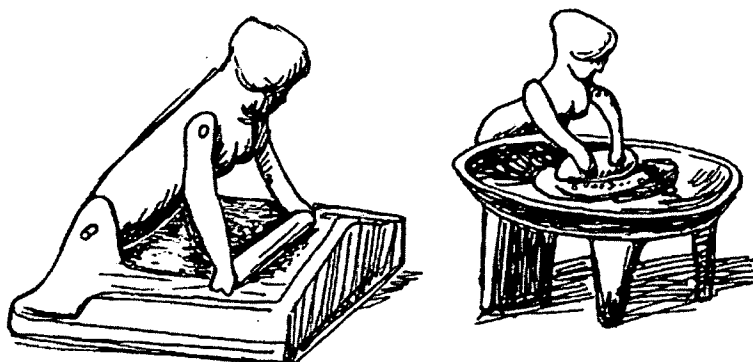


Figure 27. Figurines of women milling grain using grinding stones, or “metates.” After figurines in British Museum.

The first tools that were used for crushing and grinding grain were some of the simplest implements ever invented: two stones rubbed together. They had to be the right kind of stones, however: extremely hard, yet rough. Soft PEI sandstone, for example, would disintegrate and produce sandy tooth-destroying flour and meal.

The quern, (Figure 28), is an improved style of hand-operated grinding mill that features a handle, a central shaft, and a hole on top where the grain is poured in. As the handle turns, the ground meal works its way out. Again, the quality of the stones is important.

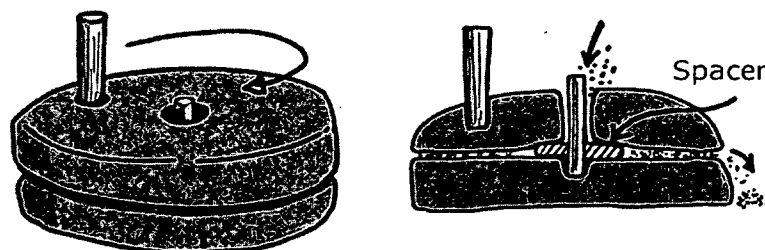


Figure 28. A quern.

It is known that there was a brisk international trade in millstones from Greek islands in ancient times (Williams-Thorpe & Thorpe 1993), and Norway, Sweden, England and France all had their own sources of mill grade stones. The authors of the *Bible* were particularly fond of the millstone as metaphor:

No man shall take the nether or the upper millstone to pledge.
Deuteronomy 24:6 (ca 1600 BC)

His heart is as firm as a stone; yea, as hard as a piece of the nether millstone.
Job 41:24 (ca 500 BC)

Old Testament prophet Jeremiah threatened bad times ahead when the simple pleasures of life would disappear, including the sound of the mill:

Moreover I will take from them the voice of mirth, and the voice of gladness,
the voice of the bridegroom, and the voice of the bride, the sound of the
millstones, and the light of the candle.

Jeremiah 25:10 (ca 600 BC)

Slaves, however, did not appreciate the sound of the millstones. The mighty Samson of the Old Testament (twelfth century BC) was captured, blinded, made a slave and set to the task of turning a millstone. John Milton, the English poet, who was himself blind, interprets Samson's anguish in his poem *Samson Agonistes*:

Designed for great exploits, if I must die
Betrayed, captived, and both my eyes put out,
Made of my enemies the scorn and gaze,
To grind in brazen fetters under task
With this heaven-gifted strength? O glorious strength,
Put to the labour of a beast, debased
Lower than bond-slave! Promise was that I
Should Israel from Philistian yoke deliver!
Ask for this great Deliverer now, and find him
Eyeless in Gaza, at the mill with slaves

In Milton's poem, Samson was turning a stone that might have been a long-handled quern, resembling the water-raising device pictured in Figure 29.

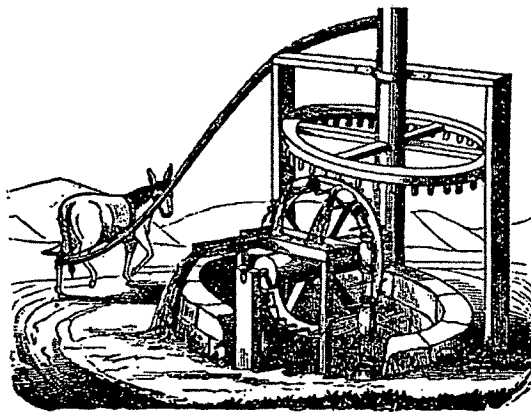


Figure 29. Chain of pots with gears turned by a donkey. In Smith, p. 13.

Thus, for thousands of years, grain was ground and water brought to the surface using the muscles of humans and animals, and increasingly sophisticated devices. Then some early engineers thought to block a waterway with a dam, and water mills were just around the corner.

3-1. Gotland Island – The Bronze Age

The history of watermills on Gotland is closely tied to the ability of Gotlanders to travel abroad and bring back new ideas. Although watermills would not be in use on Gotland until 1000 CE, sailors from Gotland were leaving the farms of Gotland and heading out to sea in waterproof sailboats as early as the sixth century CE (Their, 2003), bringing back booty and new ideas. They were eager to go, for the shiny new metal bronze had come to the Island. Bronze lust had set in. The period on Gotland from 1800 BCE to 500 BCE has come to be called “The Bronze Age.”

Bronze is an alloy of copper and tin (or arsenic) and it makes beautiful jewelry, strong weapons and ship fittings; in addition, it is resistant to saltwater corrosion. There were no tin or copper mines on Gotland or in Scandinavia. Ships had to be built and crews assembled to sail to the Mediterranean in search of bronze objects and prestige goods (Kristiansen & Larsson, 2005, p. 208).

Back home on the farm, the womenfolk minded the crops, raised the children, minded the hired help, tanned the skins, carded the wool, harvested beeswax and honey, and ground the barley with hand querns. Ownership of land, slaves, livestock, ships, metal jewelry and weapons became the new standards of power and influence. The economy was so healthy that Gotland started making its own money (Myrberg, 2010). (See Figure 30.)

During this period, trade was increasing across the whole of Europe. Artifacts found on Gotland include objects imported from many parts of the European cultural area, especially southern Scandinavia. Metals and agriculture changed the entire social structure. Gradually, older more collective settlements were replaced by farms governed by chiefs and powerful families. The family and ownership of land, slaves,

cattle and ships formed the basis of power and influence. Metals too became a symbol of power, since they were so expensive. Agriculture and animal husbandry were the mainstays of Bronze Age society, but specialised craftsmen and traders also began to emerge during this period.

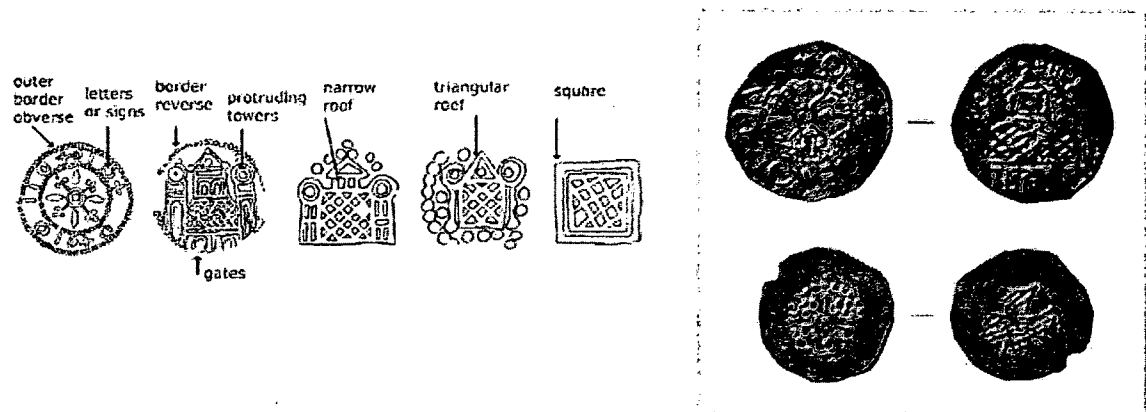


Figure 30. Patterns on Bronze Age coins of Gotland. In Myrberg.

The late Bronze Age saw the manufacture of functional everyday items of bronze, and with the introduction of iron, harder and cheaper tools were being used. The landscape was opening up as the forest was felled to make way for new agricultural land. Fields were enclosed, and pigs and chickens roamed close to the buildings, while sheep, goats, cattle and horses grazed the pastures a little further off.

New burial customs began to appear. The so-called “stone ships” date from this period. There are about 380 known stone ships on Gotland (Wehlin (2010), each one being the burial ground of some wealthy individual, perhaps a chieftain or the captain of a ship, or some other person with high standing in the community. It is not known what these stone ships represent. Perhaps, they represented the journey to the land of the dead; or they might have served as landmarks from the sea in the same way as navigational lights do today; or they may have had some astronomical significance (Bradley et al, 2010).

Because the island of Gotland has a hard limestone coastline which has maintained its integrity over thousands of years, erosion has not destroyed artifacts near the shore. Today the story of the Bronze Age is being pieced together by

scholars and archaeologists, and a rich and complicated story it is.

But this chapter of Gotland's history did not include water mills, though it seems likely that if watermills had been in use anywhere in Europe, Africa or the Middle East, the sea-faring traders of Gotland would have learned about them.

3-2. Prince Edward Island – Pre-European Contact

The only clues about the Prince Edward Island's distant past are various artifacts that have been accidentally uncovered, such as a slate "ulu" or scraper found offshore near North Lake (Keenleyside 1984); a stone "plummet" or fishing weight scraped up from the seafloor at Seacow Head (Keenleyside 2006); pottery shards and arrowheads from the Jones Site at Greenwich; plus, no doubt, other objects that are part of private collections.

It is known that there was a human presence on PEI from 1800 BCE to 500 BCE, the period that on Gotland was called the "Bronze Age"; but it can be said with certainty that there was no Bronze Age on PEI. At this time PEI was in the period called the Maritime Woodland Ceramic Period, characterized by the creation of a variety of stylized decorative pottery (Deal 2001). Agriculture, if any, was in its infancy, so bread was not on the menu and there would have been no need for milling implements other than, perhaps, the simple mortar and pestle.

CHAPTER 4

The Birth of Watermills

All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again.

Ecclesiastes 1:7 (King James version)

Watermills rely on a steady flow of water. But where does that water come from? Philosophers have contemplated the origins of water since ancient times. In 250 BCE, the author of the book of Ecclesiastes puzzled over the ability of water to run continually into the sea without causing the sea to overflow.

Today we would expect scientists to answer such questions, not philosophers. But no question about the natural world was too obscure for philosophers such as Greek scholar Anaxagoras of Clazomenae (500 - 428 BCE) who suggested that rivers were generated by rainfall, and that all of the earth's water was stored in underground caves. (See Figure 31.)

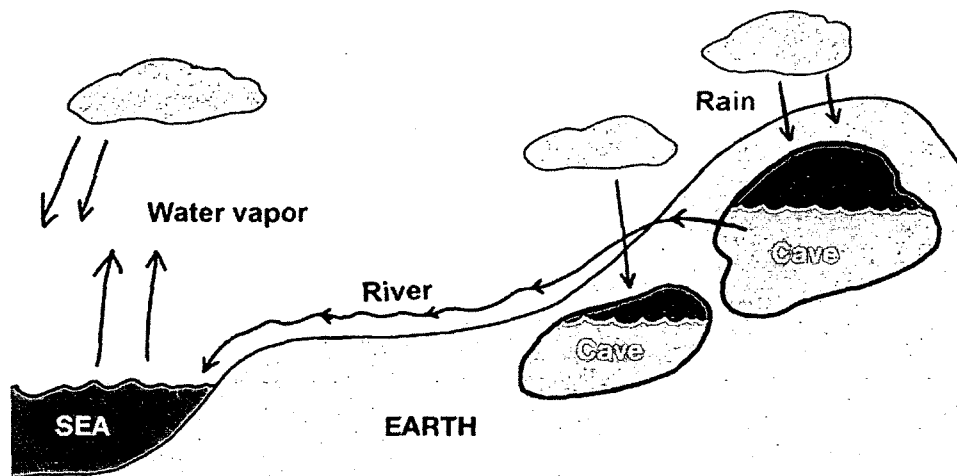


Figure 31. The hydrological cycle as understood by early Greek philosophers.

Plato (428-348 BCE) believed that water was generated in a deep cave underground called Tartarus, and out of Tartarus flowed all the world's rivers and springs. According to Aristotle (c 384-322 BCE), water was stored underground in caves or hollows, and all rivers flowed from this one source. In 55 BCE, the Roman poet Lucretius wrote this lyrical description of the water cycle (p. 179):

As for water, it needs no words to show that sea and river and springs are perennially replenished and the flow of fluid is unending. The evidence confronts us everywhere in the mighty downrush of water. But the vanguard of the flood is perpetually skimmed away, and on balance the surface-level does not rise. The sea is reduced in volume partly by the strong winds that scour its surface, partly by the fiery sun's dissolvent rays, partly because it seeps away in all directions under the ground. The brine is filtered out, and the main bulk of the water flows back and reassembles in full at the fountainhead. Hence it flows underground, a steady column of sweet fluid marching down the highway. . . .

Finally, in the first century BCE, the Roman architect Marcus Vitruvius Pollo (31 BCE - 14 CE) described the water cycle in terms we use today. Vitruvius may have been familiar with the writings of Lucretius, for his ideas are remarkably similar. In *The Ten Books on Architecture* Vitruvius puts forward his thoughts about rain (p. 229):

1. Rainwater ... is liquefied by storms and so returns to the earth. And rainfall is not abundant in the plains, but rather on the mountains or close to mountains, for the reason that the vapour which is set in motion at sunrise in the morning, leaves the earth, and drives the air before it through the heaven in whatever direction it inclines.

2. Wherever the winds carry the vapour which rolls in masses from springs, rivers, marshes, and the sea, it is brought together by the heat of the sun, drawn off, and carried upward in the form of clouds; then these clouds are supported by the current of air until they come to mountains, where they are broken up from the shock of the collision and the gales, turn into water on account of their own fullness and weight, and in that form are dispersed upon the earth.

Vitruvius had the plausible, albeit incorrect, idea that only the lightest thinnest water could evaporate, with the heaviest water staying on the ground (Pfister et al, 2009). Of course, now we now know that is not how water behaves, but how many non-scientists could come up with a better suggestion today?

Vitruvius can also be considered the inventor of the vertical waterwheel. Two thousand years ago, in *The Ten Books on Architecture* (p. 295) he writes:

1. Wheels . . . are also constructed in rivers. Round their faces floatboards are fixed, which, on being struck by the current of the river, make the wheel turn as they move, and thus, by raising the water in the boxes and bringing it to the top, they accomplish the necessary work through being turned by the mere impulse of the river, without any treading on the part of workmen.

2. Water mills are turned on the same principle. Everything is the same in them, except that a drum with teeth is fixed into one end of the axle. It is set vertically on its edge, and turns in the same plane with the wheel. Next to this larger drum there is a smaller one, also with teeth, but set horizontally, and this is attached (to the millstone). Thus the teeth of the drum which is fixed to the axle make the teeth of the horizontal drum move, and cause the mill to turn.

One of the wonders of the ancient world that bore witness to the experience and knowledge of these early Roman engineer philosophers was the flourmill at Barbegal, France. (See Figure 32.) Built in the fourth century CE, this industrial complex had sixteen overshot wheels, and reaffirmed the words of Vitruvius: “They accomplish the necessary work through being turned by the mere impulse of the river, without any treading on the part of workmen.”



Figure 32. The Roman mill complex at Barbegal, Arles, France. After computer-generated image on YouTube.¹⁸

¹⁸ Video of Janiculum mill at Rome and at Barbegal, France, “Ancient Roman Industrial Watermills” can be seen at [youtube.com/watch?v=XE2kOjNqvsW](https://www.youtube.com/watch?v=XE2kOjNqvsW). Retrieved February 18, 2013.

The Barbegal mill was combined with an industrial-sized bakery that provided bread for the Roman army stationed in the south of France (Bakker, 1994). The site bears witness to the expertise of Vitruvius, who was the inventor of the vertical waterwheel, and the Roman engineers who were able to assemble such a monumental manufacturing complex.

Hero of Alexandria, a contemporary of Vitruvius, was the first engineer to calculate the stream flow of water by multiplying velocity times cross section of the pipe or water source. This calculation would be a valuable asset to dam and mill builders for the rest of time.

Slaves, women, horses, and donkeys all must have celebrated the labor-saving properties offered by watermills, for there could have been nothing so tedious as rubbing millstones together by hand, or walking endlessly on a treadmill. or plodding in circles all day. (See Figure 33). In 90 BCE Archias of Rome wrote a poem “On an Old Race Horse” in which an old horse, once so proud, is brought low (Mills 2008, p. 231):

Me, At Alphaeus wreath'd, and twice the theme
Of heralds, by Castalia's sacred stream, –
Me, Isthmus' and Nemeaea's trumpet-tongue
Hailed fleet as winged storms! – I then was young.
Alas! wreaths loathe me now; and Eld hath found
An outcast trundling mill-stones round and round

Roman writer Lucius Apulius (170 CE, p. 113) describes a rotary mill from the point of view of a donkey in *The Golden Ass*:

[The farmer's] stingy and evil-minded wife harnessed me to a mill and made me grind corn for the family by the sweat of my poor hide, which she beat with a leafy branch. Not content with using me as her household drudge, she put me to grind corn for her neighbours as well, and so made money out of me.

It has been argued that waterwheels and windmills would have been used even more extensively in the Roman empire if not for the abundance of slaves (Rouse & Ince, 1957), or donkeys such as the Golden Ass of Apulius.

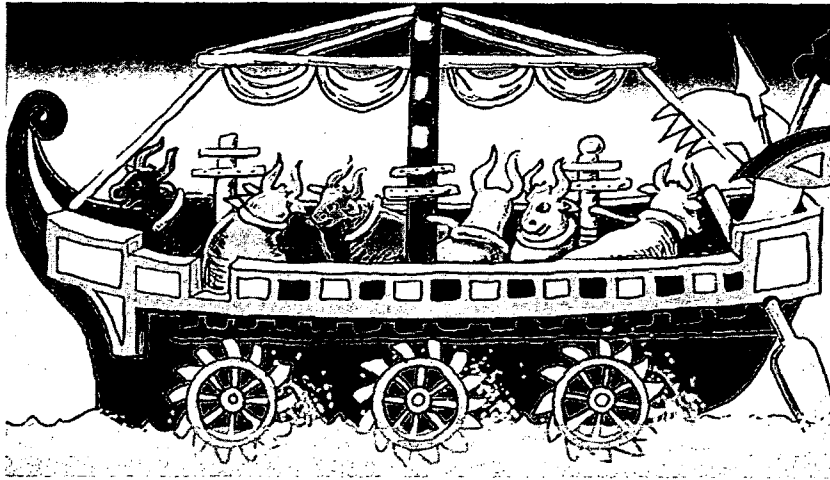


Figure 33. Imaginary ox-powered Roman paddlewheel boat. After a fifteenth century illustration in *De Rebus Bellicis*.

Water was being studied and used not only in Greece and Rome but throughout the ancient world. A six-metre high dam on the Orontes River in Syria was being used for irrigation purposes in 1500 BCE, and is still in use.¹⁹ One of the great engineering marvels of south-eastern India is the Grand Anicut dam which was constructed in the second century BCE. This dam, built of unhewn stones, is over 300 meters long, and for over two millennia it has helped with irrigating a million acres of agricultural land.²⁰

While early engineers were determining how to build dams and divert water, other intellectuals were tackling the question of the shape of our planet. Ptolemy (90-168 CE), the great cartographer of antiquity, lived in Alexandria two thousand years ago, and was convinced that the earth was a globe. He wanted to portray the earth on a flat surface as a map, but a globe cannot be flattened. Ptolemy solved this problem to some extent by changing the globe into a cone. Donald Johnson describes this as follows (1994, p. 63):

[Ptolemy] projected on the globe a cone, with its axis from the peak to the centre of the base aligned with the axis of the earth. When the cone is unrolled and becomes a flat plane, the parallels of latitude are represented as

¹⁹ *Encyclopaedia Britannica* at <http://www.britannica.com/EBchecked/topic/150337/dam>. Retrieved February 21, 2013.

²⁰ Shah, N. (2012). "World's oldest dam is in India; it is still in use." *India Tribute* website at http://www.indiatribune.com/index.php?option=com_content&view=article&id=2450:worlds-oldest-dam-is-in-india-it-is-still-in-use&Itemid=462. Retrieved December 12, 2012.

curved lines maintained equidistant from north to south, while the meridian lines of longitude are widely spaced at the base and converge to a point at the pole.

Ptolemy's concept of the conic projection and his creation of lines of longitude and latitude were breakthroughs for cartography. He was the first mapmaker to use shading to differentiate water from sea, and he also proposed the alignment of north at the top of the map. (See Figure 34.) All these inventions were not truly appreciated for fifteen hundred years, until his maps were rediscovered and used during the great Age of Discovery. New maps, based on Ptolemy's projection, would help with the exchange of ideas and goods around the globe, facilitate the sea voyages of the Gotland traders, and eventually lead Europeans to Prince Edward Island – bringing sophisticated watermill technology with them.

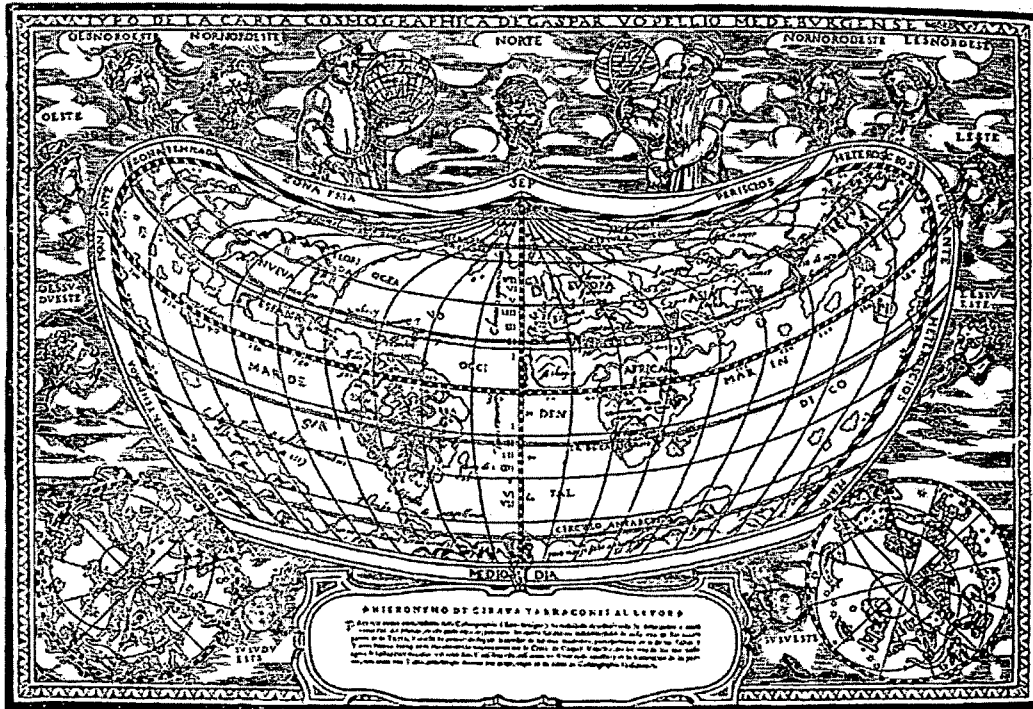


Figure 34. Map of known world, "Typus Orbis Universalis," by Sebastian Münster, 1540. Woodcut after Ptolemy. In Portinaro & Knirsch (1987), p. 60.

4-1. Gotland – The Iron Age

The period between 500 BCE and 400 CE is known on Gotland as the “Iron Age.” Archaeological excavations have shown that there was a brisk trade between Gotland and outposts of the Roman Empire. All along the Baltic coast, furs, skins, salt, glass, wine and other commodities were exchanged for precious metals and other necessities of life. This was a period of prosperity on Gotland, when communal family units started living in longhouses built on solid stone foundations with high roofs, structures that are similar to North American longhouses. These communal dwellings had two parts, the living space for people, and a room for animals or for storage. (See Figure 35.)

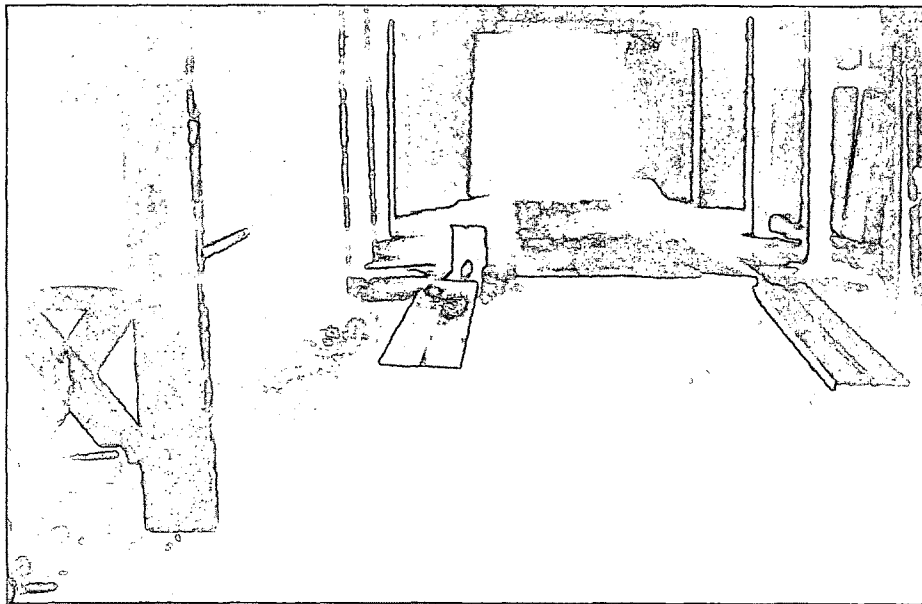


Figure 35. Reconstructed Iron Age longhouse in Gervide, Gotland.

Approximately 1,500 dwelling foundations of this sort, some of them over 50 metres long, have been identified. (See Figure 36.) In days gone by they were called *kämpagravar*, or giants’ graves. Archaeologist Gustaf Svedjemo writes about his research into Iron Age dwellings:

We have many of Iron Age [ca 100AD - 600AD] stone houses left, but many are gone. I'm trying to find the areas where the lost ones lie... I attach a picture of one under excavation (the picture is from the late 1940's), so you can see how they look. They are normally 15-27 meters long and around 7-9 m wide. There are still around 1800 left and there probably were twice as many in the Iron Age.



Figure 36. Foundation of *Kämpgrav* or Iron Age dwelling in Gotland. After photo in collection of Gustaf Svedjemo.

Not all these stone houses were near the shore, which indicates that agricultural pursuits had become the mainstay of many Islanders. They raised livestock, and they planted vegetables, and grains such as barley and rye. These grains needed to be ground for human consumption.

Near the reconstructed Iron Age settlement at Gervide, a hollowed-out millstone lies in an old roadway. (See Figure 37). This stone must have reached the end of its life, and become more useful as a paving stone than a millstone.

Gotland is full of such pleasant surprises.



Figure 37. Kvarn, or metate, half-buried in pathway near Gervide, Gotland. Identified by Gustaf Svedjemo, June 2012.

4-2. Prince Edward Island – Pre-Contact, Continued

There was no Iron Age on PEI, as there was in Gotland in the period between 500 BCE and 400 CE. Iron tools came to North America only in the late fifteenth century with the arrival of European sailors. At the same time, the native people of PEI were skilled in making tools, equipment, clothing and shelter out of materials they had at hand: bone, teeth, quills, shells, clay, wood, roots, bark, and leather, as well as such imported stones as chalcedony and flint. They were able to create comfortable shelter, warm clothing and footwear, shoes for walking on snow (Figure 38), sharp hunting tools, and vehicles for transportation on water. Perhaps it could be said that this was an “Organic Age” on PEI.

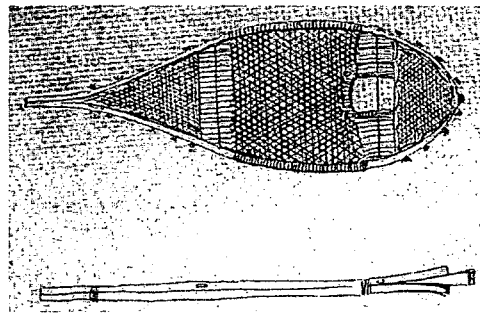


Figure 38. Mi'kmak snowshoe. Drawing by Tappan Adney in C. Behne (2010).

CHAPTER 5

Mills of the Middle Ages

The arable land [of England] was used to grow wheat, barley, oats and beans. *Domesday* records over some 6000 mills to cope with the heavy work of grinding the grain; these were all water mills as windmills did not appear in England until the 12th century A millpond at Stratford in Warwickshire is said to have produced 1000 eels per year.

From *Domesday Book Online* at
<http://www.domesdaybook.co.uk/life.html>

The period following the collapse of the Roman Empire is often called the Dark Ages, and has been associated with confusion, regression, and even despair. Historians now take a different view of this period of history. The seven hundred years between 500 CE and 1200 CE has even been called a Medieval Power Revolution, as Roman waterwheel technology gradually spread outward from Italy and France to become part of the energy landscape of the whole of Europe, including Sweden (Reynolds 1983, p. 51).

By the eleventh century more than 100,000 small watermills were in use throughout Europe.²¹ Mill historian Terry Reynolds writes (1983, p. 52):

Most small streams in southern and eastern England [in 1086] were covered with mills. In many areas they were placed less than a mile apart; in some areas there were as many as 30 mills in 10 miles. Over all of England there was an average of one watermill for every 50 households. And, since there is no reason to believe that England was technologically ahead of the continent in the eleventh century, it is quite possible that watermills were in even heavier use by that date in some parts of Europe.

France also had its share of watermills. In the ninth century there were at least 59 watermills on property owned by the medieval monastery of Saint Germain-des-Près. Medieval historian Jean Gimpel (1976, p. 10) claims that, “The rate of

²¹ *Small Hydropower in Sweden* website at <http://www.svenskvattenkraft.se/default.asp?L=EN>. Retrieved November 24, 2012.

expansion of the water mills [after 1000 AD] was spectacular. There was nothing comparable in antiquity.” At the beginning of the 12th century, Paris had 60 floating mills on one mile of the Seine (Reynolds, p. 52), with similar numbers noted elsewhere throughout northern France. Some of these were “boat mills,” which consisted of paddlewheels attached to the side of an anchored barge, while other river mills were permanent undershot wheels affixed underneath bridges where the arches of the bridges increased the flow of the water, and therefore, the millstones turned faster. (See Figure 39.) Although floating mills broke loose in times of flooding and interfered with navigation on the rivers, they provided European flourmills with reliable and inexpensive power for hundreds of years.

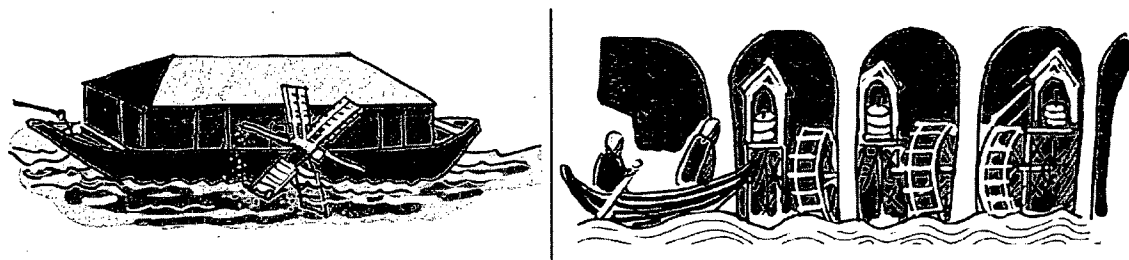


Figure 39. Left: Boat mill. Right: Mills under the arches of bridges in Paris.

As overshot wheels became popular, mill construction became increasingly costly. Only city states, wealthy private citizens, or the church had sufficient resources to build dams and erect large permanent watermills with their stone foundations, timber, various iron and brass fittings, extensive sluices and spillways, hardwood wheels, and cogwheels (Guillerme 1988, Langdon 2004). Once erected, a watermill had continuing expenses such as grease and tallow for daily lubrication, labour costs, and general maintenance.

Significant as all these expenses were, the biggest expenditure for mills was generally for millstones. Langdon writes (p. 162): “Up to a third or more of construction or everyday maintenance costs went towards millstones, while, in any one year, the purchase of a millstone or stones might exceed the revenues for the mill.” In the Middle Ages, transportation options were limited, roads were poor, and heavy loads such as millstones could not easily be transported; thus, mill owners were forced to use inferior or soft millstones that could be sourced locally. Often these

stones contained silica or sand that rubbed off in the milling process. When this sandy flour was eaten over a period of years, the consumer's teeth could be painfully degraded.²² In the Vasa Museum in Stockholm, a skeleton of a drowned sailor is on display. (See Figure 40.) The signage indicates that his teeth were ground down by eating gritty bread.

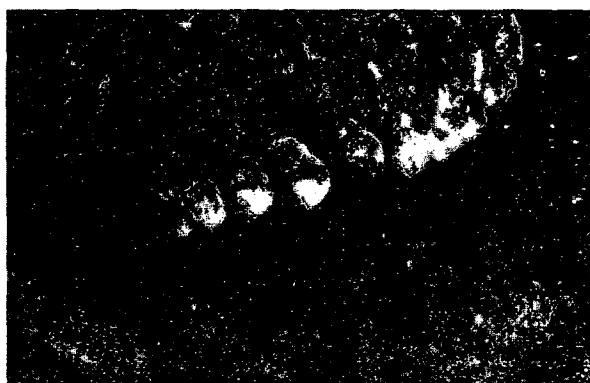


Figure 40. Rounded teeth of sailor “David” on display in Vasa Museum, Djurgården Island, Stockholm.

Millstones used in Western Europe, both for hand grinding and for watermills, came from England, Wales, Scotland, Germany, Hungary, Sardinia, southern Sweden at Lugnås,²³ Malung and Hör; and from the amazing mother lode of millstone rock at Hyllestad, Norway where millstone quarries were scattered over 27 km² of mountains (Hockensmith 2009, p. 172). The website *Millstone* describes the ideal millstone rock:²⁴

All of the main quarrying areas that emerged throughout the Viking Age and the Middle Ages were based on light muscovite-schist with scattered [2-5 mm] crystals of the hard mineral garnet. Such stones kept their grinding attributes during use, because crystals of garnet were worn slower than the relatively softer mica rich matrix. This made the garnets sticking out from the surface, just like very coarse sandpaper. At the same time, the schist was soft enough to be cut from the rock surface with a sharp hack, hammer or chisel.

²² *Mills and Atlas of Mills of France*. Retrieved February 18, 2013 at <http://meuliere.ish-lyon.cnrs.fr/en/millstonequarriesinfrance.htm>

²³ *Qvarnstensgruvan-the Millstone Quarry* website at <http://www.vastsverige.com/en/West-Sweden/products/125987/Qvarnstensgruvan-The-Millstone-Quarry/>. Retrieved February 18, 2013.

²⁴ Rock types used for millstone. <http://millstone.no/en/steintyper-brukt-til-kvernestein.html>. Retrieved January 12, 2013.

Querns of Norwegian origin have been found on Gotland (Carelli & Kresten 1997, p. 124). Millstones were quarried in Gotland out of the soft sandstone along the coast, as Linnaeus noted when he visited Gotland in 1741 (Shaw 2002). Carving millstones must have been a specialized trade, for the Latvia Bank website notes that a brick castle was constructed on Holme Island, Latvia, in 1186 “with the help from millstone cutters from Gotland.”²⁵

Stones suitable for grinding grain were composed of various minerals, some of basaltic lava, others of hard sandstone, limestone, quartz conglomerates, or garnet and mica schist. The best and most expensive “buhr” stones were quarried at La Fertous-Jouarre on the Marne River east of Paris. Made of extremely hard porous quartzite, this stone easily broke through husks of grain without breaking or chipping or leaving flecks of stone in the flour. Many of the Greek islands, such as Milo and Aegina, supplied millstones of volcanic rock that was popular throughout the Mediterranean region (Hockensmith 2009). The island of Milos was famous for its porous quartz-trachite stone that was perfect for grinding barley. During the height of the Roman Empire, Greek millstones were being exported to distant lands as far as 1300 km away (Williams-Thorpe & Thorpe 1993, p. 304).

The peasantry could not afford the set-up cost of a mill with its expensive components, but one religious group that had the means to undertake serious capital ventures was the Cistercian monastic order, founded in 1098 as a branch of the Benedictine Order. The Cistercians believed that by fleeing worldly temptations and living in remote locations, they could become closer to God. Once out in the countryside, these monks were not allowed to sit around all day in silent meditation, but were put to work clearing land, planting crops such as wheat, barley and rye, and building mills to process their grain. Opening areas that had been considered wasteland, they soon became wealthy and powerful.²⁶

One famous mill of the Middle Ages that was not owned by a religious order was located “At Trumpington, not far from Cambridge town.” This is the mill of *The*

²⁵ Latvia Bank website at <http://www.bank.lv/en/money/riga-money-800?pop=1&tmpl=component>. Retrieved November 12, 2012.

²⁶ WaterHistory.org at <http://www.waterhistory.org/histories/s/>. Retrieved February 1, 2013.

Reeve's Tale in Chaucer's *Canterbury Tales* (1396). In this story the greedy miller pulls a trick on two young men who are bringing grain from the monastery to be ground into flour, and in revenge, the disgruntled customers spend a happy night in bed frolicking with the miller's wife and daughter. All of this is great fun, and no one seems surprised that the miller is unscrupulous and wealthy (p. 135):

And thus the bumptious miller was well beaten
 And done out of the supper they had eaten
 And done out of the money that was due
 For grinding Alan's grain, who beat him too.
 His wife was plumbed, so was his daughter. Look!
 That comes of being a miller and a crook.

All millers were not all crooks, but, although they were an important part of medieval society, they did not necessarily rank high on the social scale. Notker, a biographer of Charlemagne, noted that – against popular opinion – two sons of millers were chosen to attend the emperor's famous school; they must have been intelligent, because both became stewards of a monastery (ca 880, p. 102).

It would be wrong to imply that milling technology was limited to Western and Northern Europe. Great empires like China and Turkey had their own milling technology, and knowledge was not limited to a certain group of people. Traders carried trade goods but also brought back ideas. The Crusades, beginning in 1099, must have offered eye-opening experiences to small-town boys, just as World War I changed the outlook of young men and women in the twentieth century. On his great trip to China, 1271 to 1295, Marco Polo admired the fine bridge over the River Pulisanghin (Marco Polo 1295, p. 3):

The fashion of it is this: it is 300 paces in length, and it must have a good eight paces of width, for ten mounted men can ride across it abreast. It has 24 arches and as many water-mills, and 'tis all of very fine marble, well built and firmly founded.

How could this not fail to impress the folks back home? International travel and sharing of knowledge was on-going throughout the Middle Ages, and would soon take another great leap forward. Gutenberg's printing press was about to come on the market, opening the door to the Age of Discovery.

5-1. Gotland – The First Watermill

Watermill technology arrived on Gotland in the twelfth century, at the same time that mills were springing up all over Europe. How could this be? Gotland was far from the technological hubs of Italy, France, and England. The answer must be in the adventurous seafaring nature of the Gotlanders. Traders sailed away and brought back not only merchandise, but also ideas and inventions.

But during this period there were many challenges, for life on Gotland in the early Middle Ages is considered to have been a difficult time. There was prosperity for some, but trouble and violence for others. Historians call the years from 400 to 550 CE the “Age of Migration.” During this period one hundred or more fortresses, called Hill Forts, were erected, such as the fortress of Torsburgen in eastern Gotland. This is the largest ancient stronghold in Northern Europe, covering an area of over one square kilometer. Built at the beginning of the first century CE, it remained in use for a thousand years. It is believed that Torsburgen could have provided refuge to the entire population of Gotland (6,000 to 10,000 people), and that one thousand soldiers would have been needed to defend it. Who were they defending it from? It is unclear. How did they feed themselves? With so much conflict, how were they able to feed themselves?

Gotland has an ancient written history called the *Guta Saga*, which makes reference to the troubles on Gotland during this period (Peel 1999, pp. 3-5):

Gotland was first discovered by a man named Bieluar. At that time the island was so bewitched that it sank by day and rose up at night. That man, however, was the first that brought fire to the island, and afterwards it never sank again . . . From [the original settlers of Gotland], the population of Gotland increased so much over a long period of time that the land was not able to support them all. Then they cast lots to send every third person away from the island. But they were unwilling to move away.

Perhaps the people taking refuge in the hill fortresses were those people who were to be expelled from Gotland. Because the *Guta Saga* was written in the 1100s, during the great period of Scandinavian saga writing, scholars do not consider *Guta Saga* to be historically reliable. However, it is known that there

was social unrest, and as people moved around, they must have carried the necessities of life with them. Did they have grain and hand mills? They must have; but most of the artifacts found in abandoned settlements and graveyards consist of weapons, coins, and glass. These were not Stone Age people any more. The Gotlands Museum in Visby displays tweezers and scissors that have been dated to 550 to 800 CE.

This was also a period when picture stones, and giant's graves or burial sites for wealthy or influential citizens, were erected across the island. The picture stone, Figure 41, bears the following Runic inscription:

Sigmund had this stone raised in memory of his brothers and the bridge built in memory of Sigbjörn. May Saint Michael help his soul and that of Gottraif and Sigraif and Abjörn father of them all, and he lived in the southernmost village. Garvid drew the serpent coils deftly... Sigmund has thus created a memorial stone in honour of the men... Here shall stand the stone as a mark, bright on the rock, and the bridge in front. Rodbjörn cut these runes, and Barleif some of them as well as he knows how

It is apparent that a thousand years ago Gotland enjoyed a highly sophisticated society complete with artists, poets, gods, geographers, stone carvers, and engineers.



Figure 41. Standing stone in the Gotlands [sic] Museum, Visby.

The Viking Age on Gotland began in 800 CE and continued for 250 years. Most men who went to sea were farmers, and the activities of a Viking (fighting and raiding) provided a supplementary income. I met an elderly lady on a park bench in Visby and asked her about the Vikings' reputation for rape and pillage. She replied coyly, "Oh, we like to think of them simply as traders." And traders they were, mostly in the Baltic region, but also traveling northwest to Iceland, northeast to Russia, south around the British Isles and Spain, and east through the Mediterranean past the Black Sea and Constantinople. (See Figure 42.) Drawn to the luxuries and precious metals of the East, Vikings offered iron, tar, wool, fur, and slaves in exchange. They must have been good businessmen, because more than 700 hoards have been found on Gotland consisting of Arabic, German and English coins and unworked silver, suggesting that the traders of Gotland were operating at a substantial profit.

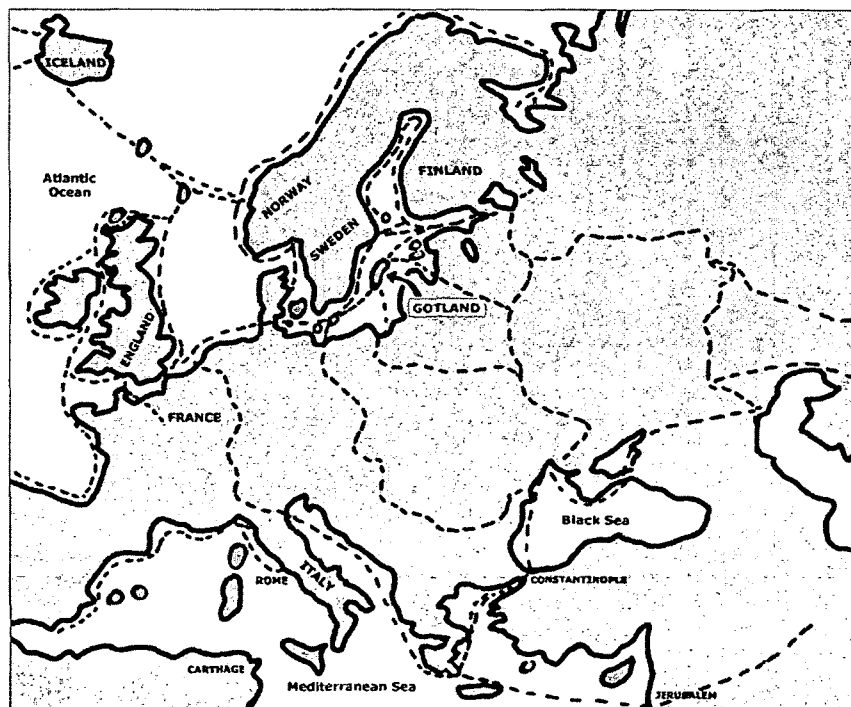


Figure 42. Routes followed by Gotland's traders. After map in Gotlands Museum.

It was both trade and religion that brought watermill technology to Gotland. In 1030, when the exiled St. Olaf of Norway built the first church on the Island, Christianity became the official religion of Gotland. Perhaps, the traders had something to do with this, for as the *Guta Saga* explains:²⁷

Although the Gotlanders were heathens, they sailed with merchants' wares to all lands, Christian and heathen. Then the merchants saw the Christian ways in Christian lands. Then some had themselves baptised, and brought priests to Gotland.

Later that century, in 1086 (the same year that the Domesday Book was completed in England), an epidemic struck the Island and carried off a large proportion of the population. It was in the midst of this physical and spiritual upheaval that the first watermill on Gotland was built at the new Cistercian Abbey, *Beatae Mariae de Gutnalia*, at Roma. (See Figure 43.) Jan Andréasson- Utas writes (e-mail Aug. 31, 2012):

Probably the Cistercian monks at Roma Abbey (in the middle of Gotland) were the first to use watermills (*vattenkvarnar*). The abbey was founded in 1164 but there are no remains of any mill, only a 13th century stone house situated at a place with a contemporary name that indicates that there used to be a watermill there. In a stream just outside Visby we know that watermills have existed at least since early 16th century, but they (there were more than one) are also gone.



Figure 43. Ruins of Cistercian Abbey, Roma, Gotland, 2012.

²⁷ *Guta Saga* at <http://www.northvegr.org/histories%20and%20chronicles/gutasaga/index.html>. Retrieved February 18, 2013.

Roma was also the site of the Allting, Gotland's parliament in the Middle Ages. It seems appropriate that the first of Gotland's several hundred watermills to be established on Gotland should have been established at this venerable site.

5-2. Prince Edward Island – A Simpler Life

After the retreat of the last Ice Age's great glaciers, for ten thousand years Prince Edward Island belonged to the Mi'kmak people. Without horses and without wheels, these resourceful people traveled, traded, lived, and raised their families. During most of the year, food was plentiful, for at one time the Island had bear, caribou, deer, seals, walruses, and sea-cows. Along the shore were millions of soft shell clams, in addition to bar clams, quahogs, oysters, mussels, whelks, and lobster. In season, the rivers teemed with eels, gasperaux, smelts, trout, salmon, and turtles; there were ducks, geese, passenger pigeons, spruce grouse; and for seasoning and thickening of stews, kelp, dulse, and irish moss lay in huge mounds waiting to be harvested.

We can say with some certainty that the Island's first inhabitants did not have watermills, but if they did grind grain such as the wild rice that grows naturally on PEI, they would have used saddlestones (see Figure 44), or a simple mortar and pestle. The Mi'kmak were a nomadic people whose diet primarily involved boiled and roasted dishes of meats, roots, and wild vegetables and herbs (Calvin 1975).

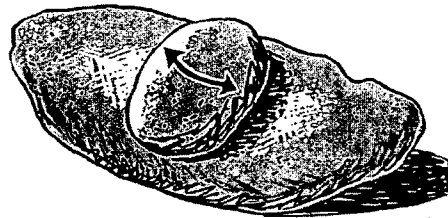


Figure 44. A saddlestone.

It is difficult to imagine this island as it was before European settlement. Canoe Cove on the South Shore, for example, was a destination for Mi'kmac people coming

by canoe from the other side of the Northumberland Strait, for the cove was the start of a portage route inland to the West River. There is now a public park at Canoe Cove, an old church, and a one-room schoolhouse, in addition to the usual houses, farms and roads. There is nothing to remind anyone of what this South Shore area was like six hundred years ago; only the hills and watersheds are the same.

In her volume of poetry, *I am an Island that Dreams*, poet Elaine Harrison imagines Prince Edward Island through the eyes of our first inhabitants (1974, p. 4):

They sheltered
under my red cliffs
in my bays and coves
where they drew up their canoes
and by the fresh cold water springs
they built their fires and camps . . .

In all seasons
the Micmacs walked
through my woods –
when the young ferns
were unfolding
oh so light green
in the first warm days
of April

And on hot summer days
they gathered wild berries
and rested from their travels
in the cool shade of
my pines and birches.

This romantic vision of mankind living in unspoiled nature – living in paradise, as it were – harkens back to mythological creation stories. Yet life was never quite that simple.

CHAPTER 6

The Renaissance and Age of Discovery

The shores of the sea continually increase in soil, towards the middle of the sea; the cliffs and promontories of the sea are continually being ruined and consumed; the mediterranean seas will dry up and all that will remain will be the channel of the greatest river which enters into them; this will flow to the ocean and pour out its waters together with that of all the rivers which are its tributaries.

Leonardo da Vinci
Quoted in Einstein (1906), p. 167

In 1452, the same year that Johann Gutenberg's *Bible* became the first book to be published in volume, Leonardo da Vinci was born. We associate everything about the Renaissance with Leonardo da Vinci, and scholars who study watermills find that da Vinci was interested in everything in the natural world, but especially interested in water. Leonardo (1452-1519) had planned to write a great treatise on the origins and fate of water, believing that water was a force that was constantly shaping the surface of the earth, building it up, and wearing it down. Among other observations, he noted that the faster water flows, the more it wears away its channel; the slower it flows the more silt it deposits (Pfister et al 2009). All these observations had implications for the construction and maintenance of dams and watermills.

Leonardo was just one of many scholars of the day who were experimenting with water, trying to find better ways to harness its energy. By the time of the Renaissance, watermills were in common use from Scandinavia to Asia, and they were not long coming to North America. As Europeans ventured overseas in search of new lands, they carried on their ships, not only slaves, sugar and rum, but also knowledge and experience in building mills. Windmills and watermills were built on

islands in the Caribbean,²⁸ and all the way up the Atlantic coast, and used to crush sugar cane, pump water, grind grain, saw wood, crush rock – any endeavor that required powerful repetitive motion.

The diagram in *De Re Metallica*, (Figure 45 below), shows the increasing complexity of industrial activities of the time. As the known world enlarged, new enterprises unfolded, with waterpower playing an important role in many of them.

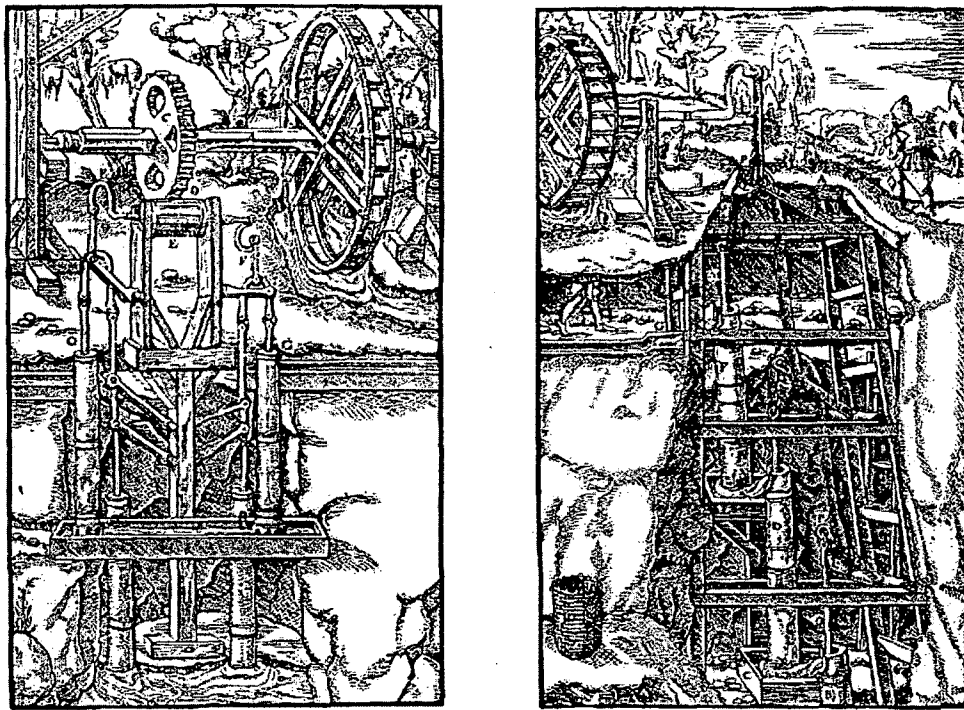


Figure 45. Undershot waterwheels used for pumping water out of mines. In *De Re Metallica* (1556), pp. 186, 198.

²⁸ IUCN: *A sustainable energy future for the Caribbean*. Retrieved February 1, 2013 from http://cmsdata.iucn.org/downloads/iucn_caribbean_energy_concept_note.pdf

6-1. Gotland Island – First inventory of Mills

After the first watermill was built at Roma Abbey in the twelfth century CE, mills were established on almost every major stream in Gotland. The Island was a free republic of peasants where freeholders paid their taxes to the crown, and if possible, each farm had its own mill to ensure its self-sufficiency. There are many questions about land use on Gotland that remain unanswered because the Island was not mapped until the seventeenth century.

Because of its location, Gotland was an island that was always useful to powerful states. It was a largely independent trading state until the early 1300's when it conquered by Denmark. Three hundred years later in 1645, war between Denmark and Sweden resulted in Gotland becoming a Swedish province. Later that century the Island was surveyed, and the first map series of Gotland was created for taxation purposes. (See Figure 46.)

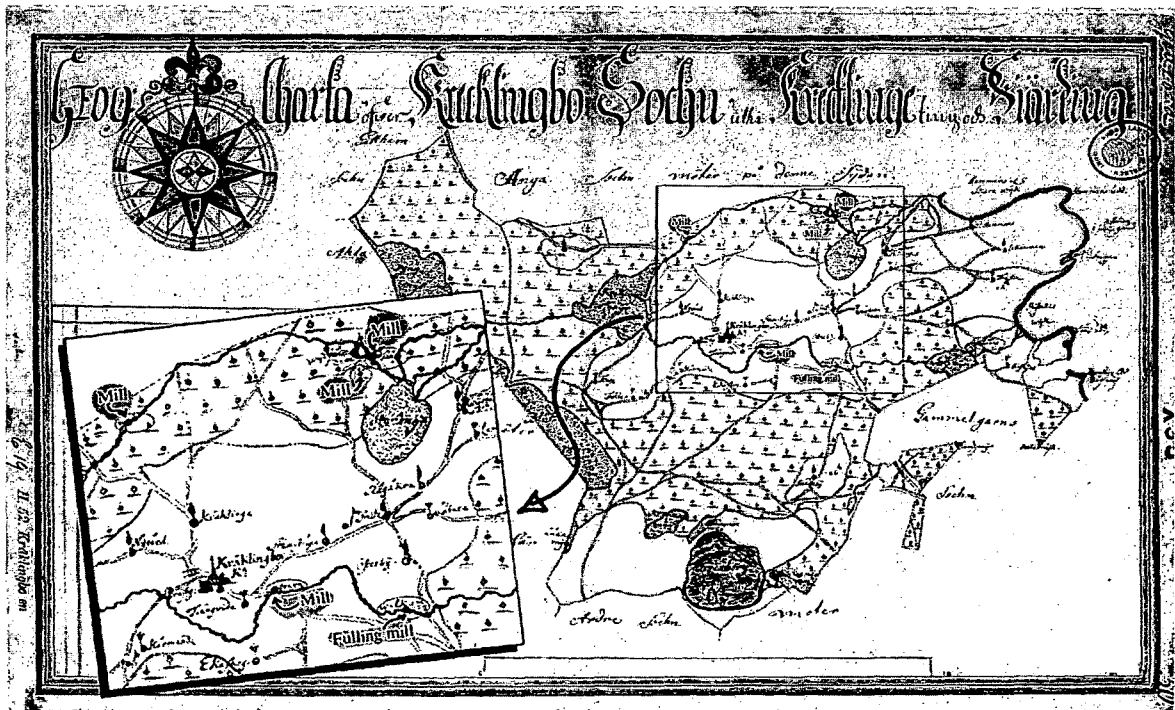


Figure 46. The parish of Kraklingbo, Gotland, its four mills highlighted at left.

Almost every landmark, including mills, was noted on these beautiful maps.

Archaeologist Gustav Svedjemo writes the following about these maps (2007, p. 9):

Since the taxes were mostly based on farming, the infields are best mapped. In addition, other resources closely connected to a rural economy like woods, fishing, mills etc are described, but not as precise as the infields. Roads, hydrology etc are also mapped, because the large-scale maps were also intended as a base for the small-scale map production, where these features were important. In addition much information on land disputes, co-ownership, crops, field rotation, owners and how they acquired their estates and much more, is noted.

No real estate of worth went unnoticed. Some of the categories listed on these large-scale cadastral maps of Gotland included the following:

- Eel fishing
- Enclosed pasture-land
- The place where His Grace wants to build the manor
- Good place with beech, oak and other scanty wood and outlying land
- Mill

The mills shown on these maps would likely have utilized either undershot or horizontal waterwheels, since no ponds are shown. Overshot wheels required a strong flow of water falling from a height or “head,” which could be either from a waterfall or a millpond. GI is a flat island, composed of hard limestone that does not easily erode. It lacks deep ravines and washed-out stream beds. A millpond requires steep hillsides on both sides of the stream that will hold water in a contained area once the stream is dammed. (Prince Edward Island, for example, with its many steep slopes and hilly contours, is the perfect place to build small dams.)

According to Gotland architect Jan Andréasson-Utas (email correspondence August 31, 2012), there were six watermills on Gotland Island in 1653 that could be used year round, and about a hundred smaller ones that had water only a few weeks every year. The largest water mill was at Lummelunda where there were iron works in the seventeenth century, and later, a paper mill. The river at this location flows swiftly and reliably all year long. Svedjemo writes (email October 24, 2012):

Since Gotland is a very flat island (the highest point is only 82 m), the season for most of the mills was short, when the snow was melting in the spring. At some places there were dams and in some areas enough water to run the mills around the year.

Many water mills on Gotland were used both for timber sawing (*vattensågar*), and grinding flour. (See Figure 47.) There were also some cloth mills (*valkor*) in the streams. In many respects, the mills of Gotland were cousins to the mills of PEI.

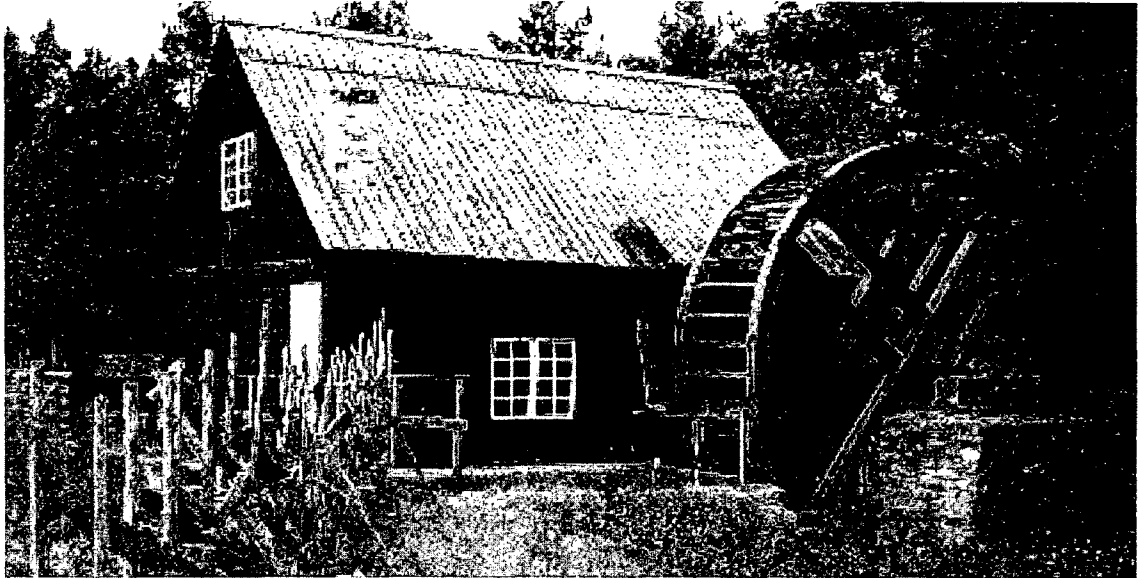


Figure 47. Aner Flour Mill on the Anerån River near Boge, Gotland.²⁹

²⁹ The mill, restored in the late 1800's, is driven by a 6 metre undershot wheel that turns two sets of millstones. Retrieved December 12, 2012, from *Segotland* website at http://www.segotland.se/servlet/GetDoc?meta_id=1145&file_id=6

6-2. Prince Edward Island – Arrival of Europeans

The Renaissance that was beginning in Europe in the middle of the fifteenth century went completely unnoticed on Prince Edward Island. The first Europeans to disturb the tranquility of the Mi'kmak way of life may have been Icelanders if, as some suppose, Vinland was actually Prince Edward Island. *The Vinland Saga* is inconclusive, and it is the only source on which to base this theory. If the Vikings did come, they also went. It is believed that Basque fishermen also used the Island as a fishing base in the sixteenth century,³⁰ but it was not until people from northern France came to the Island in 1720 that a permanent non-native settlement was established on the Island. By this time, the Island was already being mapped and identified with a mixture of native Mi'kmak and French names. (See Figure 48.)

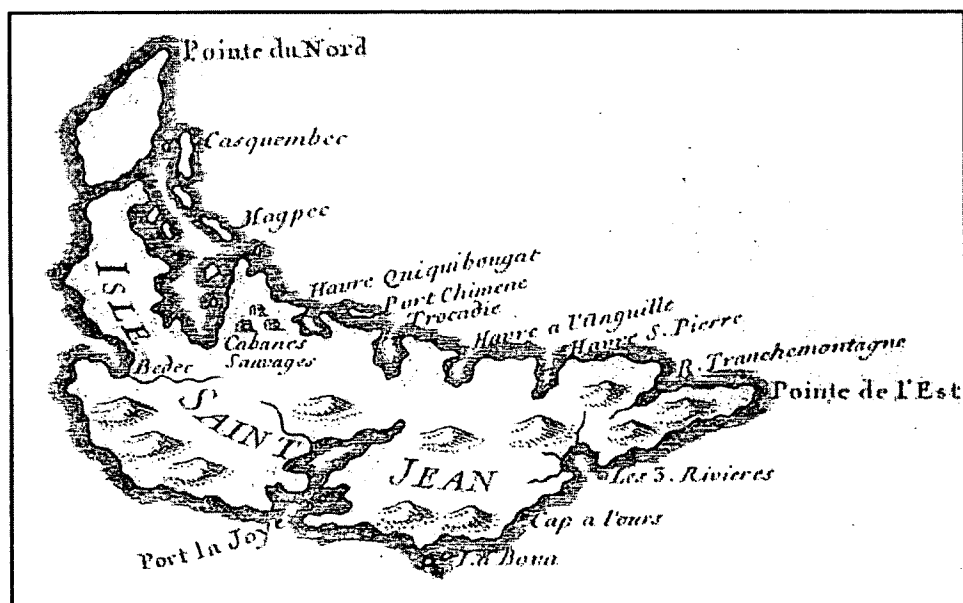


Figure 48. Portion of “Carte de l’Accadie Dressée sur les Manuscrits du Dépôt des Cartes et Plans de la Marine”, by Jacques-Nicolas Bellin, 1744.

Jacques Cartier of St. Malo, France, (Figure 49), is celebrated as being the first European to site the shores of Prince Edward Island, although it is likely that an

³⁰ Parks Canada, “Echoes from the Past.” <http://www.pc.gc.ca/eng/pn-np/pe/pei-ipe/natcul/natcul2.aspx>. Retrieved August 22, 2010.

active European fishery was already established on the North Shore of the Island (Lockerby 2007). Cartier was, at least, the first person to write about what he saw, and in 1534 he described the PEI coastline in flattering terms: *“Toute icelle terre est basse et unie, la plus belle qu’il soit possible de voir et pleine de beaux arbres et prairie.”* His words almost glow on the page: “Everything here is low and united, a most excellent place full of beautiful trees and meadows” (Trudel 1986, p.15). With such an enthusiastic description, it is a wonder that French settlement of PEI did not begin for another two hundred years; although with two new continents awaiting exploration and exploitation, it is not surprising that world leaders should ignore this small but beautiful island.

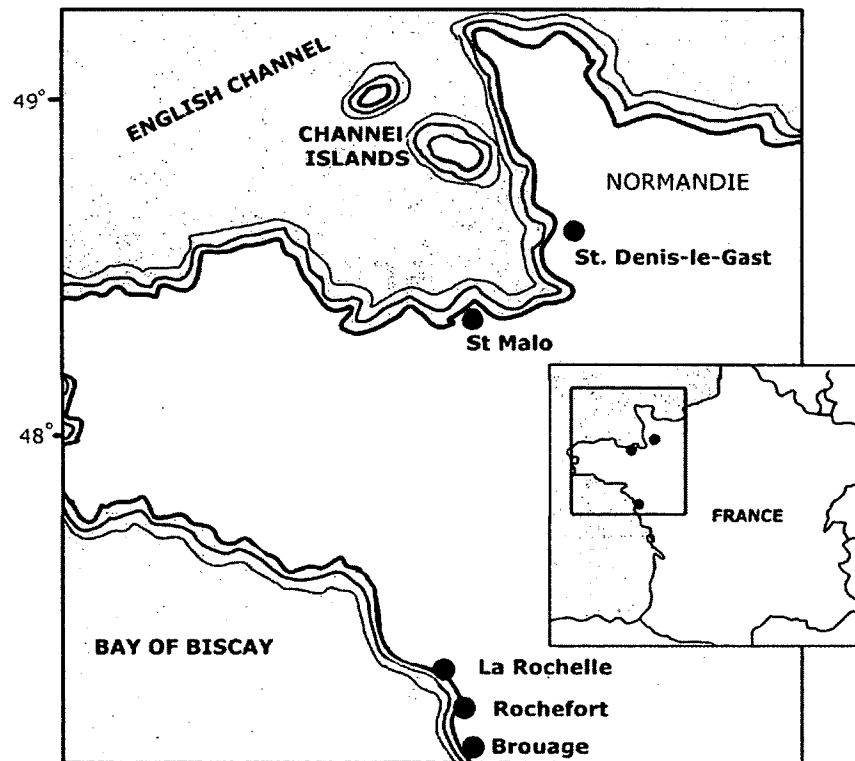


Figure 49. North-west France, home of some of PEI’s earliest settlers and millers.

Two hundred kilometres south of Jacques Cartier’s birthplace of St. Malo is the city of Rochefort. It is from there that three shiploads of French families set out for Île St-Jean in the summer of 1720. Rochefort, on the Bay of Biscay, dates from the era of the great sea explorers. Often called the “Versailles of the Sea,” Rochefort was

built along the River Charente in the seventeenth century on land that had previously been swamps and marshes. In the botanical garden, *Le Jardin des Retours*, world-traveling botanists stored rare plants that they had collected on their voyages. Nearby, the Royal Rope Works of Louis XIV, *Le Corderie Royal*, produced all the rigging for the warships of the Royal Navy. For hundreds of years there were mills along the River Charente, and even today there are working mills that make flour, paper, and nut oils.³¹ The neighboring town of Brouage, famous as a trading centre for sea salt, was the birthplace of Samuel de Champlain.³² Just outside Brouage are salt marshes, criss-crossed with canals and dykes.³³

It is clear that the families who sailed to PEI (Île St-Jean) in 1720 were accustomed to mills, to life on the marshes, and to sea travel. No doubt they had plenty of adventures crossing the Atlantic, but their most serious challenge, when they arrived at Port-la-Joye on August 23, 1720, was confronting the vast Island forest with winter just around the corner. They brought no horses nor dogs with them (Harvey 1926, p.144), they possessed only the barest necessities of life, they were continually short of food, and scurvy was a serious problem (Lockerby 2007). Without help from the native population, they could not have survived.

These settlers arrived at the new settlement of Porte-la-Joye, at Rocky Point across the harbour from present-day Charlottetown. It is there that the Island's first mill may have been established. (See Figure 50.) Was it a mill built by the military or by the crown, or as a private venture? Perhaps we will never know. It was likely a flourmill for there are no remains of a dam on this small stream, and a sawmill requires significant water flow to power its machinery.

³¹ *Discover Poitou Charentes* website. Retrieved November 24, 2012 from <http://www.discover-poitou-charentes.com/food-drink/mills-in-poitou-charentes.htm>

³² *France Travel Guide* at <http://www.france-travel-guide.net/Rochefort.html>. Retrieved November 26, 2012.

³³ "In the marsh of Brouage." http://www.bernezac.com/Brouage_marais_uk.htm. Retrieved November 26, 2012.

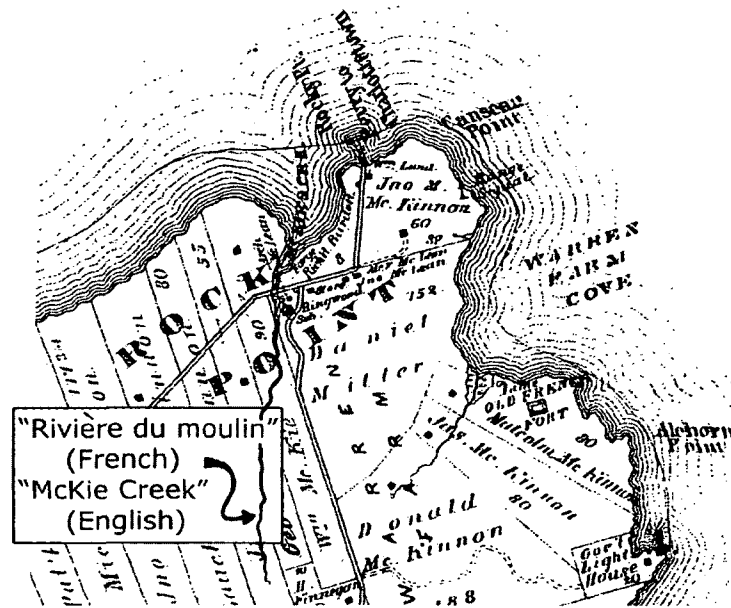


Figure 50. Rocky Point, PEI. Selection from Lot 65, *Meacham's Atlas*, showing "McKie's Creek," formerly named Rivière du Moulin (Rayburn 1973, p. 82).

Other mills quickly sprang up on the Island as other settlers brought mill expertise with them from France. One of these knowledgeable individuals was François Douville who came from the mill town of St Denis-le-Gast which is situated in Normandie on la Rivière Sienne. (See Figure 51.) This is an area famous for its Camembert cheese, sandy beaches, off-shore islands, salt marshes (*marais*), and rich farmland.



Figure 51. Moulin Saint-Denis-le-Gast, Le Manche, Normandie, in 1907.³⁴

³⁴ *Le journal de l'association régionale des amis des moulins de Basse-Normandie* (2009), No. 36, p. 7, at <http://www.moulinsdefrance.org/moulins/BN/CAD36.pdf>. Retrieved December 9, 2012.

Salt marshes, mills, water – François Douville was familiar with all of it.

The census of 1752 paints a clear picture of the success of the Douville family on Île St-Jean.³⁵

Le Sr. Francois Douville, fisherman, navigator and ploughman, native of St. Denis Le Gatz, bishopric of Coutance in Normandy, aged 62 years, he has been in the country 35 years. Married to Dame Marie Rogé, native of La Rochelle, aged 42 years.

They have four sons and three daughters:

Jacques, aged 24 years.

François, aged 17 years.

Philippe, aged 11 years.

Pierre, aged 9 years.

Françoise, aged 18 years.

Louise, aged 16 years.

Margueritte, aged 3 years.

In live stock they have eight oxen, eight cows, four heifers, eight calves, one horse, twenty-two ewes, nine pigs, four geese, fifty fowls or chickens and twenty turkeys or young turkeys. The land where they are settled is situated at Nigeagant, on which they have made a clearing and sown sixty bushels of wheat, where they have fallow land for as much more.

They have another piece of land, situated at the place called le fond des Etangs, on which there is a flourmill. The said land where the flour mill is placed was given to them under a permit from Monsieur de Bonnaventure, dated 1750.

It is not known whether François Douville was a miller himself, or simply a mill owner. He was sufficiently well-connected to receive a permit to establish a mill, and perhaps the income from this enterprise was part of the secret of his economic success.

François Douville was married to Marie Rogé (or Roger) who was born in La Rochelle, France. La Rochelle is just north of Rochefort. It is possible that Marie was one of the children with those first immigrants who sailed from Rochefort in 1720. She must have been an excellent helpmate for Monsieur Douville and a successful mother to their numerous children. It is unfortunate that no written records

³⁵ Census from *Island Register* website at http://www.islandregister.com/1752_page4.html#top. Retrieved January 5, 2013.

have come down to us about her life except that she was married at the tender age of thirteen, and that she and her husband had eleven children. Did Marie help out in the ? Could she bake good bread from the “sixty bushels of wheat” that were sown on the family land? How did she provide clothing for her eleven children? We will never know.

The obituary below, written by Georges Arsenault, reveals the affection that the people of St. Peters felt for this family:

On January 30, 1757, the people of Havre-Saint-Pierre, on the Island’s North Shore, gathered in the parish church to bid farewell to a distinguished member of the community, Sieur François Douville, who had passed away the previous day at the age of 72. “First inhabitant of the said Island,” carefully noted in the church register Rev. De Biscarret who presided at the funeral service.

When François Douville died, he was the most prosperous resident of the area. In the census taken five years earlier, he is identified as a fisherman, a navigator and a farmer. He owned three properties, he had the largest herds and he was the owner of a boat and two fishing shallops. He was also the proprietor of a flour mill located at the “fond des Étangs” (head of St. Peters Lake) where Bristol is located today.

Around 1722, when he was about 38 years old, François Douville married a 13 year-old girl by the name of Marie Roger who was the daughter of Gabriel Roger, a pioneer merchant in Havre-Saint-Pierre. The couple had eleven children.³⁶

The first settlements on Île St Jean were Port-la-Joye and Havre St-Pierre (St. Peters Harbour). As more immigrants arrived, people spread out in search of lowlands where they could harvest marsh hay for their livestock. They settled mainly along the Hillsborough River system where marsh grass, wild rice and wild fowl abounded. But marsh grass also grows at the mouth of most of the Island’s rivers including, for example, the DeSable River on the Island’s South Shore. There is agreement in the district that there was an historic Acadian presence in DeSable. Local historian C.C. Ince writes in his book, *Old DeSable* (1982, p.1):

³⁶ *Acadian & French Canadian Ancestral Home* website at <http://www.acadian-home.org/George-Francois-Douville.html>. Retrieved September 18, 2012.

DeSable remains today as one of the surviving names of the old French regime on Prince Edward Island. It is recorded both by French Census of 1752 and a later report of T. Pichon, French Army Officer and traveler, that here several families totaling 30 people were found settled on the banks and upper reaches of a tidal river which they had named “The Sable” or “Rivière de Sable” – River of Sand.

In the Census of 1752, several families are listed as living at the neighboring rivers to the west of DeSable at la Rivière des Crapaux (Westmoreland River) and at Rivière des Blonds (Tryon River) for a total of forty-nine persons. One wonders why these hardy and independent people left the larger group to the east in St. Pierre and along the Rivière de Nord-Est (Hillsborough River) to establish their own community seventy kilometres away. Perhaps it is simply that they appreciated the excellent tidal marshes found all along the South Shore. Ince continues:

The Acadian French settler always diked the marshland along the rivers to provide pasture in summer and hay for livestock in winter. Even today in 1975, the remains of dikes can plainly be seen on the eastern bank of the main Sable River above the Trans Canada road and bridge; these earthworks were named “The Frenchman’s Banks” by the early British settlers.

The work involved in building these dikes staggers the mind. Constructed with the simple tools and using only sleds and oxen, dikes would be built about 3 metres above high water mark. The Nova Scotia Department of Agriculture, which maintains 43,000 acres of dike land in Nova Scotia, describes the original dike construction as follows:

The dikes were built by cutting blocks of sod with sharp, flat shovels or spades. These sods were piled on top of each other and reinforced with spruce bows to add strength and rigidity to the structure. The outer (seaward) side of the dike was also lined with logs or rocks in some cases. The top and inner side of the dike was covered with soil and grass was planted. The grass roots provide structure and strength to hold the soil in place.³⁷

Although the dike system is alive and well in Nova Scotia, and original Acadian dikes can still be seen across the Northumberland Strait in Nova Scotia between Wallace and Tatamagouche, on the Prince Edward Island side of the Strait, the dikes at the mouth of the De Sable River are no longer visible. Local resident Mack Dixon

³⁷ Colchester dike system being questioned. *Truro Daily News*, Sept. 22, 2012, p. 4.

remembered the DeSable marshlands and bay as being entirely different fifty years ago, with deep channels and clean sandbars, and he blames run-off from farmer's fields as being the culprit. The main crop in the tidal estuary these days seems to be sea lettuce.

Whenever French families arrived in the DeSable area, they would have found plentiful marsh hay for the animals but no cleared land for house or garden. One tree at a time these plucky Acadians hewed their way into the forest, some trees being easier to deal with than others. In 1820 the observant Scotsman Mr. Walter Johnstone visited the Island to prepare a report for future Scottish emigrants and noted the following (p. 102-103):

The land where [beech] abounds is the easiest cleared both as to the cutting, burning and rotting of the stumps. [Whereas] hemlock, a kind of fir, is found of an amazing size, being from two to three and one-half feet in diameter. These trees are exceedingly heavy to cut and pile and very difficult to burn. The stumps will stand undecayed in the ground twenty or thirty years before they can be easily eradicated.

Once the trees were chopped down, cut in sections and moved to the side to await a future of providing winter fuel, the land formerly hidden under trees and shrubs could be loosened with a hoe, and seeds – peas, beans, barley, rye – carefully dropped in with not a grain to waste. Then if everything went well and there was no flooding, no drought, no blight, no mice, no grasshoppers, no sickness nor outside troubles; if fortune smiled and good health abounded, if there were many children to help and cheer, if people could stay in love, why, then, life was bearable and the seeds and the future stood a chance.

It was all right eating porridge and pea soup for a time, but eventually a diet of boiled grains and legumes wore a bit thin. Europeans were accustomed to eating bread on a daily basis, and bread was what they craved. A flourmill was needed. Was there an Acadian mill in DeSable? Although no French mill is shown on the first maps, there is a hint that there might have been one in DeSable. When the doorstep of a house at the DeSable corner was being excavated, a small millstone 2.5 feet in diameter was found underneath. (See Figure 52.)



Figure 52. Sandstone millstone found in DeSable.

On Bell's Creek, near this property, there was an old mill, locally called the "pioneer mill." It is possible that the millstone in Figure 52 could be from this mill, and that it could be of Acadian origin. Oral history also relates that ruins of an early mill were found at Holms corner on the eastern branch of the DeSable River.³⁸ It is possible, then, that a mill did exist in the area.

This was an ambitious time for the French colonists. In 1721 French officer Denys de la Ronde reported (Gaudet 1979: 2):

The timber that covers the Island is abundant in quantity and excellent in quality. The streams that water the interior of the Island are well suited for the erection of saw mills, which could provide constant and profitable employment cutting pine and oak planks for ship building.

His words proved true. Thirty years later, there were four flourmills and two sawmills in the colony (Harvey 1926, p. 171). Some of the flourmills might have used millstones similar to the granite millstones that are on display at Fort Beauséjour, New Brunswick, across the Northumberland Strait. (See Figure 53.) These stones might have come over as ballast, but would have been precious cargo nonetheless.

³⁸ Cindy Newson. Interview with author, telephone, 30 June 2010.



Figure 53. Granite millstones on lawn at Fort Beauséjour, New Brunswick.

Everything seemed to be in place for a successful future as a French colony. People were steadily coming to the Island, they had boats, they were catching fish, they had livestock both large and small, and they were growing grain. (See Chart 3 below.)

CHART 3. EARLY CENSUS STATISTICS FROM ÎLE ST-JEAN IN 1700's³⁹

Date	Population	Houses	Saw-mills	Flour mills	Bushels (80 lb) grain	Various boats	Quintals (100 kg) of cod	Various large livestock
1728	297 (plus 125 fishermen not listed)	54				8 schooners, 19 shallops	4874	
1732	325					27		
1734	573					1 schooner and 37 fishing boats, 6 boats for commerce		332 cattle, 119 sheep
1735	563				676	30 shallops for fishing, 8 boats for commerce		433 (undefined)
1748	735							
1752	2223		2	4				
1755	~3500							
1758	~4700							
1765	~1400							

³⁹ PEI censuses at <http://www.islandregister.com/> and Statistics Canada website at <http://www.statcan.gc.ca/pub/98-187-x/4064810-eng.htm#part1>. Both accessed February 19, 2013. The huge increase in population in the census of 1752 was a result of mainland Acadians fleeing to PEI.

But in 1758 everything changed. The English took possession of the Island. And what a place they took over: houses, barns, animals, roads, rivers, and mills. (See Figure 54.) Québec license plates read: *Je me souviens* (I remember). The same motto could be used for the surviving French, Acadian, and Mi'kmak people of Prince Edward Island.

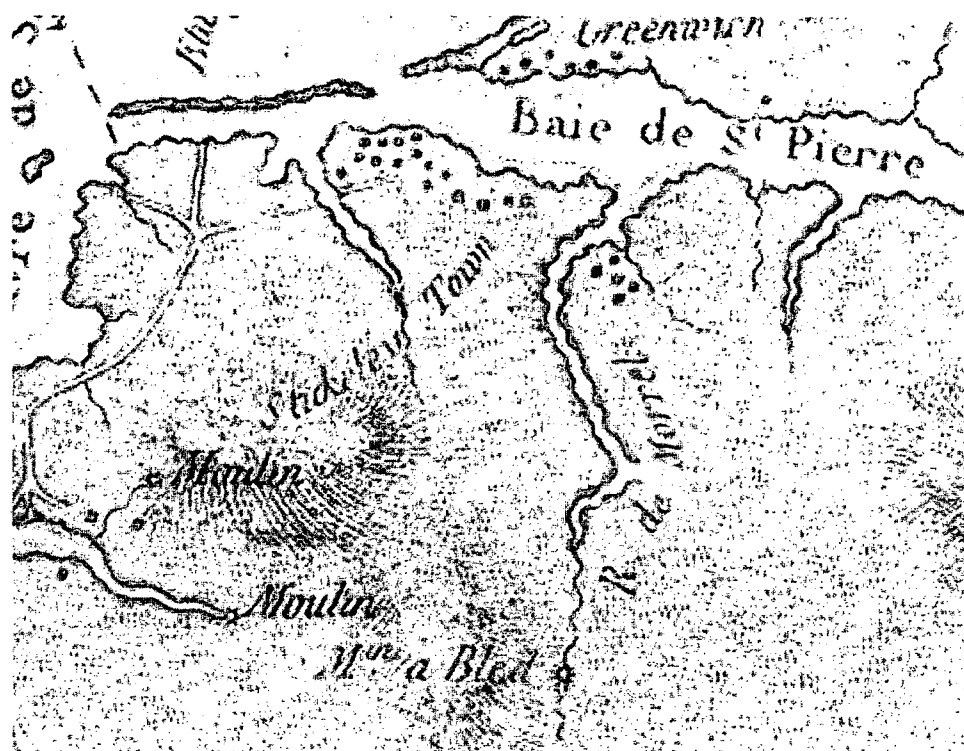


Figure 54. Section of map, "Plan de l'Île de St. Jean. Par Ordre de M. de Sartine, Conseiller d'Etat, Ministre et Secrétaire d'Etat au Département de la Marine." (1778). Retrieved February 16, 2013 from *Island Imagined* website at <http://www.islandimagined.ca/fedora/repository/imagined%3A209156>

CHAPTER 7

Industrial Revolution to World War I

In the price of flour or meal, we must add to the price of the corn, the profits of the miller, and the wages of his servants; in the price of bread, the profits of the baker, and the wages of his servants; and in the price of both, the labour of transporting the corn from the house of the farmer to that of the miller, and from that of the miller to that of the baker, together with the profits of those who advance the wages of that labour.

Adam Smith (1776: 45)

In 1750, while Ile St.-Jean (PEI) was still a virtual wilderness populated by 1550 hardy souls,⁴⁰ and Gotland remained a sleepy outpost of the Swedish empire, Adam Smith was thinking about capitalism, using as an example, the common flourmill.

King George II on the throne of England was setting the stage for the Seven Years War that would see England win North America, including Île St.-Jean (PEI), from the French. Samuel Johnson was writing *A Dictionary of the English Language*; the Gregorian calendar was about to be officially adopted by the British Empire, and thus, by the world, and the British Museum would soon open. In Leipzig, Germany, Johann Sebastian Bach was having an eye operation to cure his blindness, which would result in his death. Sweden's King Frederick I was also at the end of his life and would go down in history for the modest achievement of having banned duelling in Sweden.

All the great powers of Europe, including Sweden, were profiting from the slave trade and would continue down this road for another hundred years. Slaves helped to grow cotton that was processed in some of the largest water-powered industrial complexes the world had ever seen. Slaves also provided cheap labour for sugar plantations, so that sugar, molasses, and rum became new staples of European diets.

⁴⁰ Figures do not include the native population. From *Historical Atlas of Canada* online at www.historicalatlas.ca/website/..42/..jacadian_pop_1750_1803.xls. Retrieved September 18, 2012.

In the city of Linköping on the Swedish mainland, west of Gotland, ninety per cent of the adult population had dental caries in the 1700's as a result of the novelty and availability of sugar (Rönnbäck 2007).

Across the Atlantic in Philadelphia, Ben Franklin was carrying out experiments with electrical charges and lightning rods that would eventually lead to a complete energy revolution. No one at the time could have imagined that, by the end of the next century, electricity would be generated at watermills all over the world.

In the year 1750, wealthy individuals had reasonably good prospects for survival – although it would be wrong to imagine that life for the upper classes was anything close to comfortable or convenient. Catherine the Great, Queen of Russia, described her existence in the cold and drafty winter palace (1796, p. 183): “I remained the whole winter [of 1755] in this miserable little narrow room, about five to six feet long and four across, with its two windows and three doors.” Toilets, running water and central heating were a long ways off.

While life for the wealthy may have been tedious or inconvenient, for the European poor it was a terror. Those with enough resources to find a spot on a ship heading for the New World counted themselves lucky, even though the dangerous passage from European to North American ports left many of them destitute.⁴¹ “It was the best of times, it was the worst of times.” The novel *A Tale of Two Cities* lays out the plight of the impoverished classes of London and Paris in the years before the French Revolution (Dickens 1859, p. 26):

[These were] samples of a people that had undergone a terrible grinding and re-grinding in the mill, and certainly not in the fabulous mill which ground old people young The mill which had worked them down, was the mill that grinds young people old; the children had ancient faces and grave voices; and upon them, and upon the grown faces, and ploughed into every furrow of age and coming up afresh, was the sign, Hunger.

In the midst of the turmoil that was the eighteenth century, with wars and bad roads and poor dental care, the watermill reigned supreme. Until steam arrived, no

⁴¹ "Passage To America, 1750." *Eye Witness to History* at www.eyewitnesstohistory.com. Retrieved October 12, 2012.

source of energy was known that could compare to the power of a swiftly flowing stream, or even better, a dammed river.

At the height of the Roman Empire, engineer and philosopher Hero of Alexandria tinkered with steam engines. Seventeen hundred years later, steam technology became the force behind the Industrial Revolution thanks to James Watt's steam engine with a separate condenser. Steam engines of his design began pumping water out of coal mine shafts in 1769 and quickly proved that they could pump much better than horses or mules. Watt coined the term "horsepower" to calculate the number of horses his steam engine would replace, and we use this power designation to this day. Watt was so highly regarded by industrialists and scientists that the electrical unit, the watt, was named in his honor.

Powerful reliable steam was not only also superior to the weak muscles of animals, but also to the vagaries of water and wind. Steam engines could be used anywhere, any time, as long as there was fossil fuel and water available. As industry developed in Europe, the need for power increased rapidly and much of it was supplied by steam engines using coal or wood as fuel. Steam itself was a renewable resource, but wood and coal were not. The renewable resources of water and wind were about to take a back seat to fossil fuels for the next two centuries.

At the same time, it was evident that a steam engine was a costly machine with voracious appetite for fuel, whereas water was free. So inventors came up with designs for better waterwheels, with wider blades, thinner blades, or cups instead of blades. In the 1850's metal waterwheels were developed (see Figure 55), and it was quickly realized that they were superior to wooden wheels:

Metal waterwheels keep on working during harsh winters. The metal fins of the buckets act as a heat conductor of the warmer water and allow the wheel to operate at lower temperatures than a wooden waterwheel. Wooden waterwheels would stop due to icing. Even if a wooden wheel did not ice up, it soaks water into the wood and goes out of balance, decreasing its efficiency. Out of balance wheels require more maintenance due to the wheel jumping around causing undo stress on the bearings and structure.⁴²

⁴² *Water Wheel Factory* website at <http://www.waterwheelfactory.com/wood.htm>. Retrieved April 3, 2013.

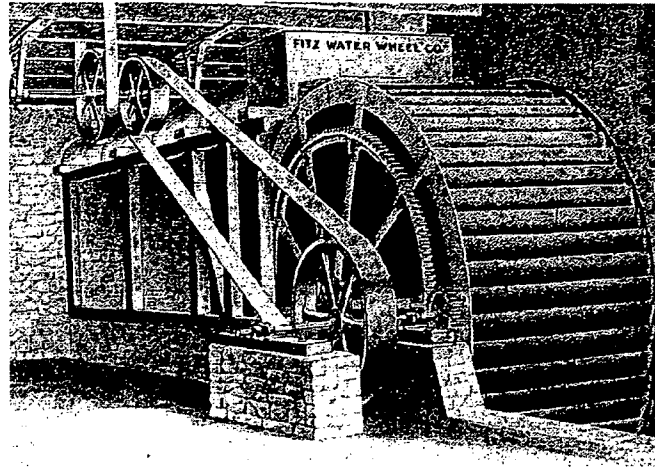


Figure 55. Metal “Fitz” waterwheel. In B. Dedrick, *Practical Milling* (1924), p. 460.

The success of metal waterwheels and steam engines was partly due to the reduced cost of the metal components, for the price of steel was reduced more than tenfold during the reign of Queen Victoria. According to Gordon (1968, p. 17): “The cheapening and improvement of iron and steel during the eighteenth and nineteenth centuries was the most important event of its kind in history – or perhaps just the most important event in history.” At the end of the nineteenth century, iron and steel began to replace wood in every sphere of industry, from waterwheels to the hulls of ships.

The water turbine, developed in France around 1830, was one invention that benefited from steel components. A turbine is a highly efficient metal waterwheel, enclosed in a compartment from which water cannot escape, thus utilizing most of the energy of the rushing water. The water is directed by blades of various design (see Figure 56). Poncelet, Fourmeyron, Francis, Kaplan, and Pelton are just some of the men who were instrumental in developing the modern water turbine.

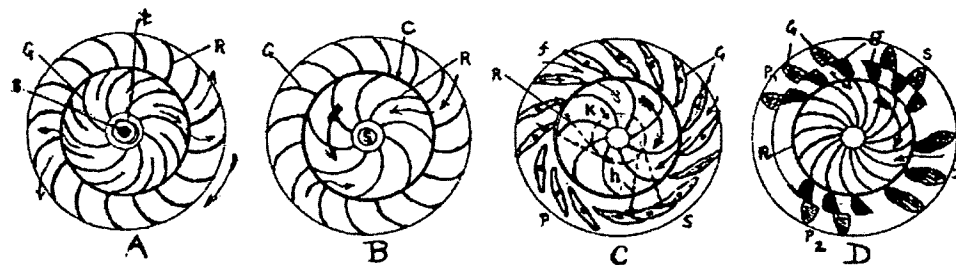


Figure 56. Various profiles of water turbine blades. In Dedrick (1924), p. 455.

The Pelton turbine with metal cups, (see Figure 57), proved ideal for use on small streams for driving a saw gear, threshing, or for any purpose that required a belt drive. Being a semi-portable device, it could directly power a saw or a grinding mill on site. Water was directed against the cups from the nozzle at the bottom, where a shut-off valve could control the flow.

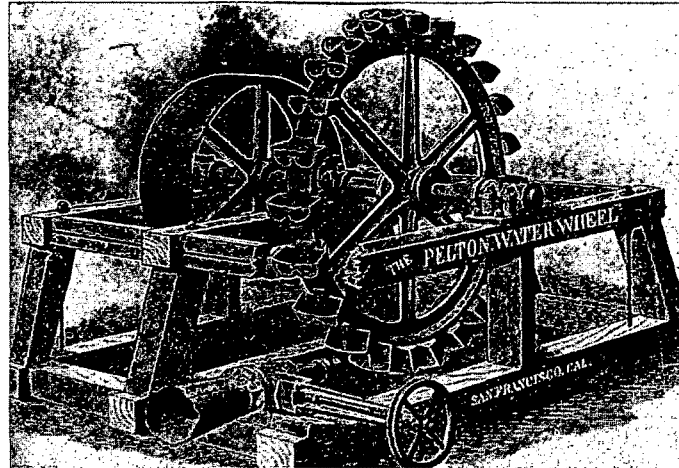


Figure 57. A Pelton water turbine of the 1890's. In N. Smith (1975), *Man and water: a history of hydro-technology*.

News traveled fast in the nineteenth century, and the first water turbine on PEI was installed at Gordon's Saw and Gristmill on the Montrose River, Prince County, in 1852 (Bell 1989, p. 55).

When electricity made its appearance on the world stage in the mid-1800's, efficient water turbines soon started a new era in hydropower. Mills and dams were modified to provide power for populations hungry for new laborsaving lights and gadgets. In Sweden, watermills with turbines began generating electricity around 1840,⁴³ while in Canada hydro generation began in 1881 with a waterwheel at Chaudière Falls on the Ottawa River, that provided electricity for new streetlights in the nation's capital. PEI's first hydro station was built at Valleyfield in 1899 (Bell 1989, p. 85). The first dam designed specifically for electric generation was built at Craigside, England, in 1878.

⁴³Swedish hydropower Association website at <http://www.svenskvattenkraft.se/default.asp?L=EN>. Retrieved January 15, 2013.

In the late 1800's, three-phase electricity was developed, allowing transfer of electricity over long distances. Much of this electricity was created using water turbines. Electricity opened the door to technologies that would, in the past, have been reserved for the wealthy. One of the most popular electric appliances was the washing machine. Women were desperate for anything that would reduce the drudgery of manual clothes washing, even when they had such enlightened gadgets as the manual washing machines shown below. (See Figure 58.) Electric lights and water pumps quickly became necessities for rich and poor alike, with refrigerators and radios not far behind.

AGENTS WANTED. **A WOMAN** Can buy a **World's Washer**



ON TRIAL and no money paid until it is perfectly satisfactory. Washes easy. Clothes clean, sweet and white as snow. Child can use it. Circulars free. I pay freight. **C. E. ROSS**, 12 Clean St., **Lincoln, Ills.**

HAVE YOU SEEN
The New
Vandergrift Rotary Washer?



Guaranteed to run easier and do better work than any Machine ever placed on the market. A good machine for Agents to handle. Write for circular, price, etc. Owned and made exclusively by **THE VANDERGRIFT MFG. CO., JAMESTOWN, N. Y.**

Figure 58. Ads for manual washing machines in *The Farm Journal*, 1901

It seemed that in the 1800's, even with steam engines and new inventions speeding up industry, travel, and communications, watermills were here to stay. Mills, as part of the culture and landscape, were commonly mentioned in the literature of the day. Writers appreciated the many metaphors that mills could offer, for example, Thoreau writes in *Walden* (1854, p. 159):

[The gossips] are the coarsest mills, in which all gossip is first rudely digested or cracked up before it is emptied into finer and more delicate hoppers within doors.

James Cook, describing sailing conditions at the Great Barrier Reef, writes (1768, p. 167):

To our surprise we found the Tide of Ebb gushing out like a Mill stream so that it was impossible to get in; we however took all the advantage possible of it and it carried us out to about a $\frac{1}{4}$ of a Mile from the breakers...

Mill stories abound in the collection of German folklore known as *Grimm's Fairy Tales* (1812). The young maiden aided by "Rumpelstiltskin" is a miller's daughter. "Puss in Boots" is the story of a son of a miller who is left destitute when the miller dies. In "The Bremen Town Musicians," a donkey who had spent his whole existence carrying sacks to the mill, is getting old and useless and fears for his life.

George Eliot's *The Mill on the Floss* (1860) is, in many ways, more about the repression of women in the Victorian age than about the family mill; but the story revolves around on-going competition for water rights on a river. The miller, Mr. Tulliver, is damned if he will allow "his" water to be siphoned off for irrigation up-river (p. 135)

Water's a very particular thing – you can't pick it up with a pitchfork. . . It's plain enough what's the rights and wrongs of water, if you look at it straightforrard; for a river's a river, and if you've got a mill, you must have water to turn it; and it's no use telling me, Pivart's erigation and nonsense won't stop my wheel: I know what belongs to water better than that. Talk to me of what the engineers say! I say it's common sense, as Pivart's dykes must do me an injury. . .

We do not associate Oscar Wilde with children's literature, or with mills, but in *The Happy Prince and Other Stories* (1888), Wilde tells the tale of an unscrupulous miller and naive little Hans in the highly sentimental story "The Devoted Friend." Everyone in nineteenth century Europe and North America was acquainted with a mill. It would have seemed inconceivable that water mills would soon be museums.

But the energy landscape took an abrupt about-face in 1859 when oil was discovered in Titusville, Pennsylvania. Gasoline, kerosene, and diesel fuel all helped power the mighty engines of commerce and war. World War I saw the end of horses being used on the battlefield, and the birth of aeronautics and tank warfare.

Waterpower could not hope to fuel such machines or endeavors.

7-1. Gotland Island – The Demise of Watermills

Historically, the great swamps and shallow lakes in the centre of the Island fed the rivers of Gotland. Here was stored the valuable rainfall and snowmelt that stored moisture and released it gradually over the summer. In the mid-1800's there was a great drive all over Europe to drain wetlands and convert them into "productive" farmland. Gotland followed this trend and built canals to encourage water to flow from the interior marshes to the coast. As a result, many of the streams dried up, and watermills could no longer operate.

If there is one lesson to learn from a study of Gotland and PEI, it is this: wetlands are indispensable to rivers.

Gotland turned to wind power out of necessity, building circular stone tower mills with tops that could be turned into the wind. (See Figure 59.) These mills were fine for grinding grain on windy days, but there was not enough power in wind to saw wood.

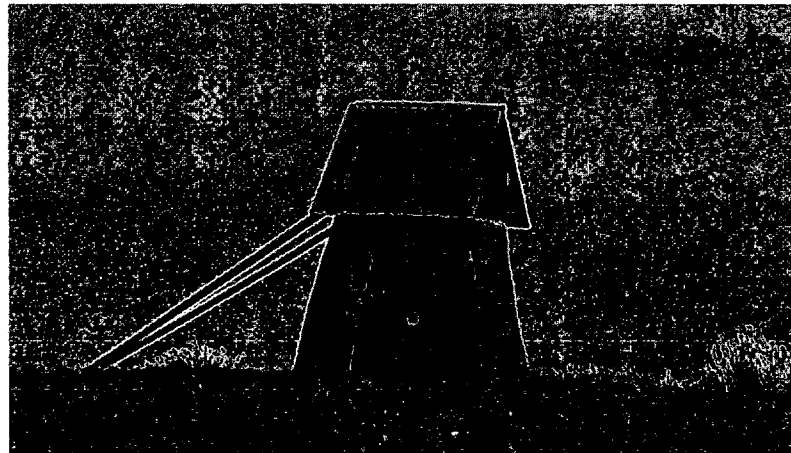


Figure 59. Old stone "Hollander" type windmill tower in a field, Gotland.

The maps in Figure 60 show the changing landscape of Gotland in the 1800's as the Island changed from waterpower to wind power – a trend that has continued to this day. In 1807 there were at least 258 water mills on the Island; in 1888 there were 70 (Andréasson-Utas & Salomonsson 1977). People on Gotland repeat time after time, with a touch of melancholy, "It happened when they drained the marshes."

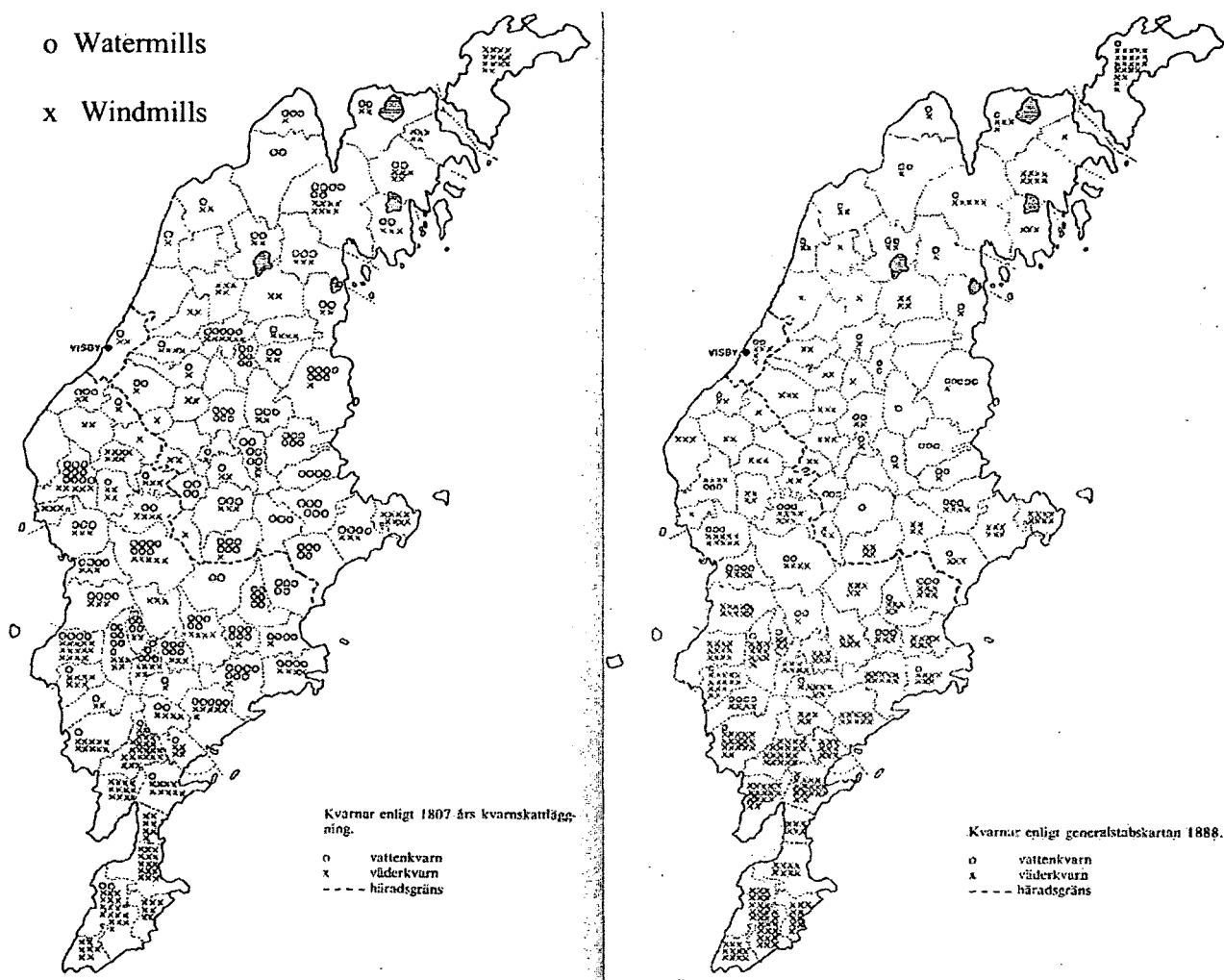


Figure 60. Left: Map of Gotland, 1807, before drainage of the inland marshes. Right: Map of Gotland, 1888, after drainage of the inland marsh. Maps courtesy Jan Andréasson-Utas (1977), pp. 29 & 34.

In the 1800's roads improved on Gotland, and transportation underwent a huge change with the inauguration of the Gotland Railway in 1878. On the other side of the Atlantic, PEI had built its railroad network a few years earlier and the PEI Railway began operations in 1875. Both islands had tracks laid almost tip-to-tip, and neither railroad survived the economic challenges of the twentieth century. (See Figure 61.)

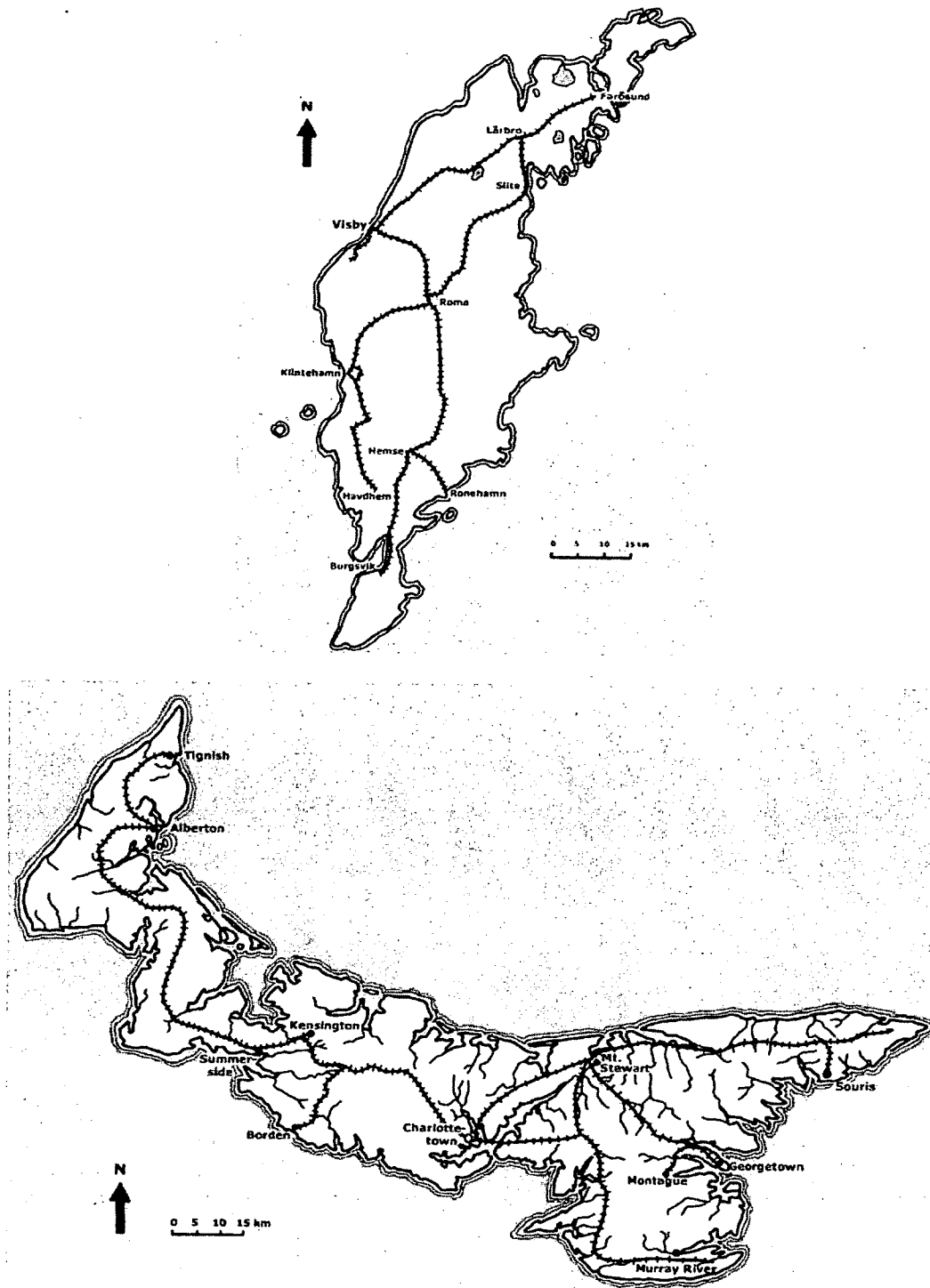


Figure 61. Top: Railway lines of Gotland, 1878 to 1964. Bottom: Railway lines of Prince Edward Island, 1875 to 1989.

Island Studies scholar Godfrey Baldacchino writes (2008, p. 225): “The railway has been a clear champion of modernity. It was, certainly in the nineteenth century, synonymous with development and the opening of erstwhile frontier sites to both settlement and industrialization.” Between 1750 and 1900, the population of Gotland increased from 24,000 to 53,000,⁴⁴ but this might have been due to the Island becoming a popular tourist destination in the 1800’s, rather than the opening of untamed frontiers. However, trains in the 1800’s were a status symbol and a clear sign of prosperity.

Gotland, with its ability to adapt to changing conditions and realities, continued to be on the leading edge of modernity. This adaptability included the shift from waterpower to wind power following the draining of its marshes. (See Chart 4.)

CHART 4. RISE AND FALL OF WATERMILLS AND WINDMILLS ON GOTLAND⁴⁵

	1697 Mill Commission	1807 Inventory	<i>Mid-1800's Draining of marshes</i>	1888 Inventory	1971 Inventory
Watermills	159	259		72	21 (includes ruins)
Windmills	56	334		399	233 (includes ruins)

Today (2013) Gotland is once more demonstrating how to live within its means, using the resources at hand. One of those resources is wind. The University of Gotland offers a Masters Degree in Wind Power Project Management, with the following mandate:⁴⁶

The focus of the Wind Power Project Management program is to provide progressive, contemporary education for professionals who design, develop, implement, and manage wind farms in the global economy. It is equally beneficial for those responsible for the external economic, social or legal environments within which a wind farm is located and operates such as local and national regulatory bodies, infrastructure and supply-chain organizations.

⁴⁴ *Historical Atlas* at <http://www.tacitus.nu/historical-atlas/population/counties.htm>. Retrieved January 30, 2013.

⁴⁵ Inventories listed in Utas & Salomonsson (1977), pp. 91-174.

⁴⁶ Gotland University at <http://www.hgo.se/wpmaster/1257-hgo.html>. Retrieved February 21, 2013.

This wind program plays into Gotland's *Sustainable Society*⁴⁷ project:

In 1996 the municipality of Gotland set a target that the island should become a sustainable society by 2025. Sustainability will play a growing part in our everyday life not only on Gotland but also across the globe, as more and more governments, communities and individuals realise that we cannot continue draining the Earth of its natural resources.

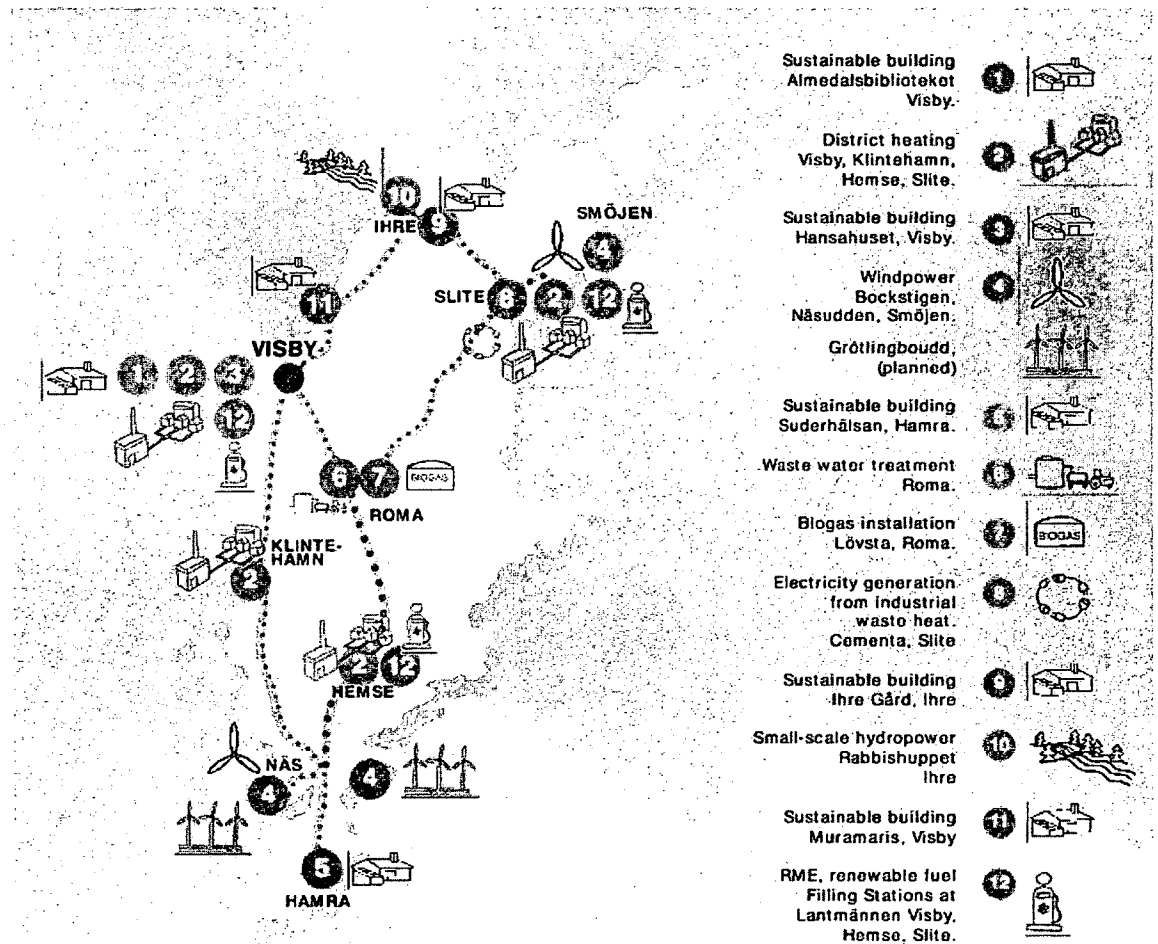


Figure 62. Location of renewable energy installations in Gotland.

The island of Gotland is a hard act to follow. Of course GI has been working at sustainability for 10,000 years, while PEI is just opening its eyes to the realities of the twenty-first century.

⁴⁷ Quote and Figure 62 taken from *The Sustainable Society* website at <http://www.gotland.se/imcms/3883>. Retrieved February 21, 2013.

7-2. Prince Edward Island – The Heyday of Watermills

The 1700's are sometimes called "The Long Eighteenth Century" because of the wars that plagued this period, including the following:

- 1689-97: Nine Years War
- 1702-13: War of Spanish Succession
- 1739: War of Austrian Succession
- 1756-63: Seven Years War
- 1775-83: American War of Independence
- 1793-1801: French Revolutionary War
- 1803-15: Napoleonic Wars

All the soldiers and sailors involved in these wars needed to be fed, which put a huge demand on the grain supplies and flourmills of Europe and North America.

In Europe, the Industrial Revolution was underway, new inventions were changing the face of industry, ships were plying the seas transporting slaves, sugar, cod, wine, rum and molasses, and all was in a state of flux. Meanwhile, on Prince Edward Island (Île St-Jean), no one was setting out to be clever or innovative. The French and Acadian colonists were busy enough trying merely to survive and to remain unnoticed as the British were beating the war drums just over the horizon. Finally in 1758, their already difficult lives took a turn for the worse as the British took over PEI / Île Saint-Jean for a final time. Pawns in a game, their lives and hard work considered worthless by distant powers, these pioneers who had been through so much now had to start life over in other strange new worlds. They were forcefully rounded up and evicted from the Island in the late summer and fall of 1758, from Port-la-Joye, the very place where the first French settlers had landed in 1720. Of the estimated 3,000 Acadians deported from Île Saint-Jean, more than half perished in shipwrecks or died of disease (Jobb 2008). Their land, houses, barns and mills were now in the hands of new British settlers.

And what of the native population? They had experienced thirty years of co-existence with the French, with not much more than a few metal pots and pans to show for it. The Mi'kmak, too, had been trying to survive and keep out of the way of trouble. It is well documented that North American aboriginal people experienced confusion and despair as, slowly but surely, their land and water resources were

slipping away from them as Europeans moved in and shouldered them aside.

Europeans also brought with them sicknesses previously unknown on North America: smallpox, measles, whooping cough, scarlet fever, typhus, pleurisy, tuberculosis. John Tanner, living with the Ojibwa in Ontario, wrote poignantly of their distress (Tanner 1830, p. 95):

While we were engaged in collecting and preparing [the wild rice], many of us were seized with a violent sickness. It commenced with cough and hoarseness, and sometimes bleeding from the mouth or nose. In a short time many died, and none were able to hunt. This disease was entirely new to the Indians, and they attempted to use few or no remedies for it.

Prince Edward Island's Mi'kmak were not immune to the troubles of the mainland, but managed to escape the trials of co-existence with white men for two hundred years longer than their native brethren along the Atlantic coast to the south.

Saskatchewan farmer Sharon Butala describes the feeling of walking on land that had been the sole domain of native people (Butala 2000, p. 116):

Despite paying lip service to the understanding that all this land had belonged once to Amerindian people, I had failed to have a sense of that as something real and practical and everyday – real people, real land that they walked on. . . and were born and died on, and knew and understood, and had given names to, and had loved and revered as the great gift to them from their Creator. Then it hit me, with the force of true comprehension at last, what we had done when we settlers had claimed this land for our own.

Even today our governments continue to take native rights for granted. A Prince Edward Island government water policy data briefing note from 2011 states: “First Nations rights to water are not yet explicitly and legally acknowledged in any provincial or federal legislation. The 1987 Federal Water Policy (Environment Canada, 1987) acknowledges Native interests in water but this has not generally been reflected in provincial allocation decisions.”⁴⁸ Travel writer Isabella Bird, on a sightseeing visit to the Indian village at Rocky Point in 1856 noted that: “[The natives] are not represented in the Legislative Assembly” (p 49). The same holds true in 2012.

⁴⁸ <http://www.waterpolicy.ca/prince-edward-island-water-policy>. Retrieved February 10, 2012.

So it was that with British invasion of 1758, the Mi'kmak and Acadian population of PEI faded, for a time, into the shadows, and had to shift for themselves as best they could. The watermills that had been located and built with such labour now became the property of the British. (See Figure 63.)

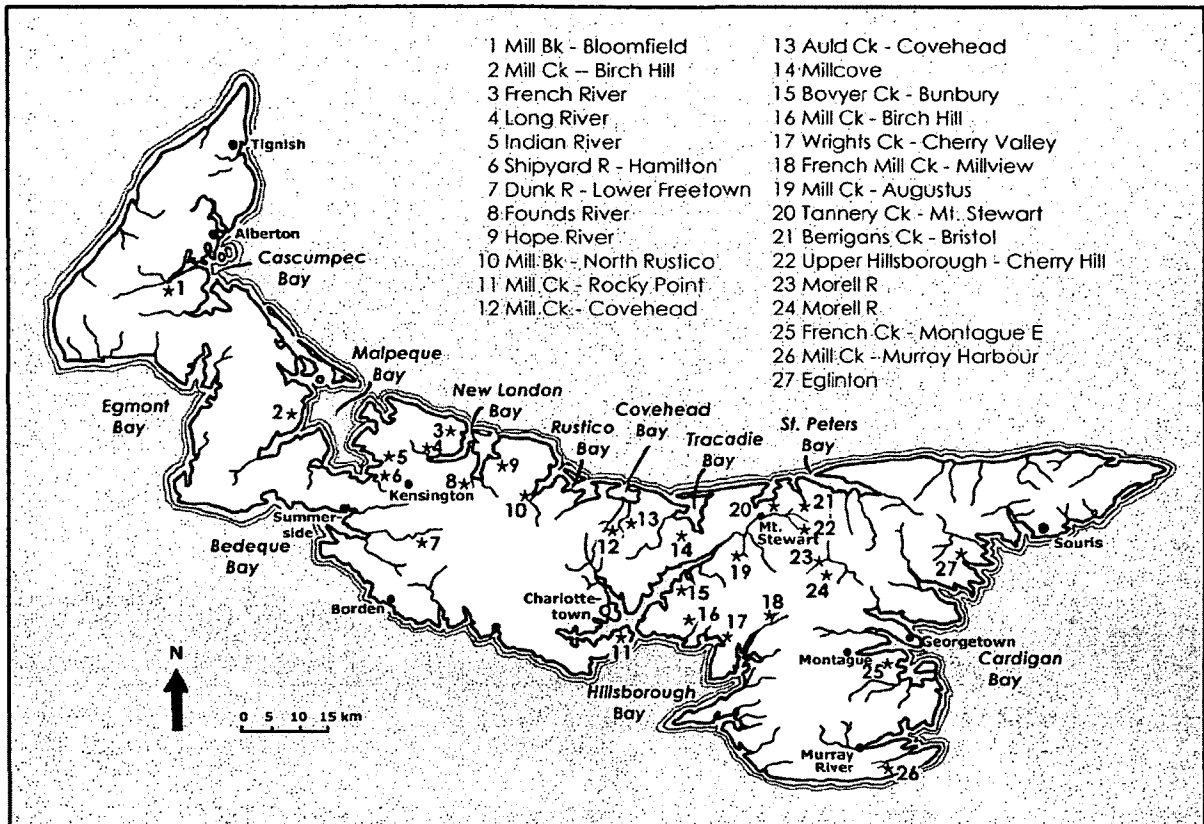


Figure 63. Earliest [French] watermills on PEI, as shown on the Holland map of 1775 and the Sartine map of 1778.

As the eighteenth century progressed, a steady stream of British settlers began to transform the very landscape of the Island, building roads, bridges, dams, ponds and mills, and converting the forests into firewood and lumber.

Thomas Curtis was a young sawyer who worked in a sawpit in England. After hearing the glowing report of land agent Robert Clark, he decided to head for St. John's Island to seek his fortune. He recalled Robert Clark's very words (Curtis 1777, p. 10):

[He said that] Sawyers were better paid for their labour, than in England, that the Rivers abounded with fish & the Country with game which were free for any one, that Deer & Turkeys were so plentiful that a person might shoot them some times from the Windows, & when at work in the woods might shoot enough to serve his family without loss of time – in short any man could live much more comfortable there, than in England.

Curtis did make it to St. John's Island, and was one of the first persons to write about the Island's mills. He visited the sawmill in New London and was impressed with the employment opportunities this mill provided for the area, but not by the output (p. 42):

My curiosity led me once to see a Saw mill that was Erected for R Clarks use at a considerabl [sic] Expense, it being about 6 or 7 Miles from new London up the River on a convenient Spot and the finest Timber growing round it ever Was. The mill was calculated to Work only one Saw at a time. I was inform^d by Respectable people that there were upwards of Seventy men one Winter employed to keep this Saw at Work in cutting Boards &c. From this circumstance I think the Boards must be very dere [sic] if they were sold for their cost, as the Mill was not half its time at Work with all those hands. From what I could learn, one pair of Sawyers if they had their Work pitted would have been able to cut as mutch [sic] Boards in the coarse [sic] of the Winter as this Mill.

Curtis had the makings of an astute businessman. Even as he was admiring the fine timber, he was calculating how it could be more efficiently turned into lumber if the sawmill was looked at as an economic rather than a social venture. The questions he asked in 1777, about low-paid employment for many versus high-paid employment for a few, are still unanswerable.

At New London, Thomas Curtis met Benjamin Chappell who was one of the Island's first British millwrights. Chappell was a true Renaissance man who could cut firewood, square timbers, make beds, chairs, desks, trays, dressers, coffins, ax handles, pot lids, mallets, stools, chests, doors, wood sleighs, spinning wheels, rudders, oarlocks and masts. In his *Daybook* he kept track of his activities at the Island's early mills, including such interesting entries as the following (Chappell 1998):

January 1775 Wednesday January 20

No logs at y^e Saw pit for boards nor can we get aney for want of horses the Sawyers go home for want of logs

February Thursday February 9
 a General discharge amongst y^e French men
 No Sawyers at Work

March Tuesday March 21
 Six fishermen Grinding wheat at the mill

May Wednesday May 24
 News came of the Destruction of lawsons Corn mill

May Monday May 29
 Mr Allen {blank} with three labourers & two more from M^cDonalds
 Went up to Repair y^e mill dam
 Which we Repair'd all a Cross y^e river by Saturday night

Chappell and his family moved to Charlottetown and carried on with his millwright activities at various locations including New London, Cape Traverse, and Murray River. In terse prose, Chappell's *Daybook* reveals the hardships associated with mills, and he bemoans the death of two valuable fellow millwrights:

December 1780

Bartlet Coffin Came, and the Millwright Drownd'd!

August 10, 1810

Died the boy at the mill

August 1, 1815

Died about the midel of July Mr Renton in the Bay at Marymahche he was going up in a Moderate Breize, the Boom Jibe'd knock't him over. he rose once, but no more. he was a Good English ~~Wright~~ Mill Wright, a Real Loss.

April 14, 1818

Dead at Bedecque a poor man who was Prosicuted for Stealing a little flour out of the Mill. He took it so to heart that he Mournd until he died left a widow & 8 children.

In 1780 Benjamin Chappell helped set up a windmill in Charlottetown for Governor Patterson on property close to the present day Charlottetown Yacht Club. Patterson's Windmill was a landmark along the waterfront but unfortunately it is not recorded just what happened at the mill. It almost certainly was not a sawmill, for windmills lacked sufficient power to cut through timber. In 1815 this wooden structure was destroyed in a terrifying gale, as Chappell relates:

August 1, 1815

Tuesday this morning Just past 12 O'Clock a Thunder Storm most Sharp I Ever saw here. the Great Clap Struck y^e Windmill shater'd it to pieces the Stroke made a Sising noise. Dredfull. it passed on upon the River or it had Laid y^e town in ashes but it Rain'd hard.

August 3, 1815

Thursday at One O'Clock the Windmill was hew'd Down by [blank] it was a fine day, and Son Richard buys the Shatter'd Remains of M^r Nelson.

Some time during the life of this windmill, a hotel was built in Charlottetown called the "Wind-Mill Hotel." It is recorded that in 1820 the Bell family, arriving in Charlottetown from Scotland with seven of their children, found temporary shelter at the Wind-Mill Hotel (Robinson 1992, p. 2). There would have been no windmill by 1820; but neither are there any oak trees these days at the Charlottetown mall named "Oak Tree Place."

Life on Prince Edward Island in the early 1800's was not luxury living. Thomas Curtis concluded his narrative about his voyage to PEI with the heartfelt declaration (Curtis 1777: 65): "I cant [sic] express The Joy I Felt when I got on my native Country the 2d of Feb. 1777."

Travel writer Walter Johnstone's description of the Island in 1820 was equally unsympathetic. He simply advised his fellow English countrymen not to go there (144-45):

I have, in the most attentive manner, examined the circumstances of a great number of the settlers, so as to know who had a prospect of doing well, and who had not, I shall proceed to give advice upon the subject. *I would advise none to go there, even though their friends should invite them*, who can, by their earnings at home, obtain the common supports of life, though it should be in a homely way...

Johnstone bemoaned the Island's lack of wheat and barley mills, although he did praise the flour, oat and barley mill complex of Mr. Wright in East Royalty, (Figure 64), whose progressive establishment also featured a threshing machine, a brewery, and a distillery.

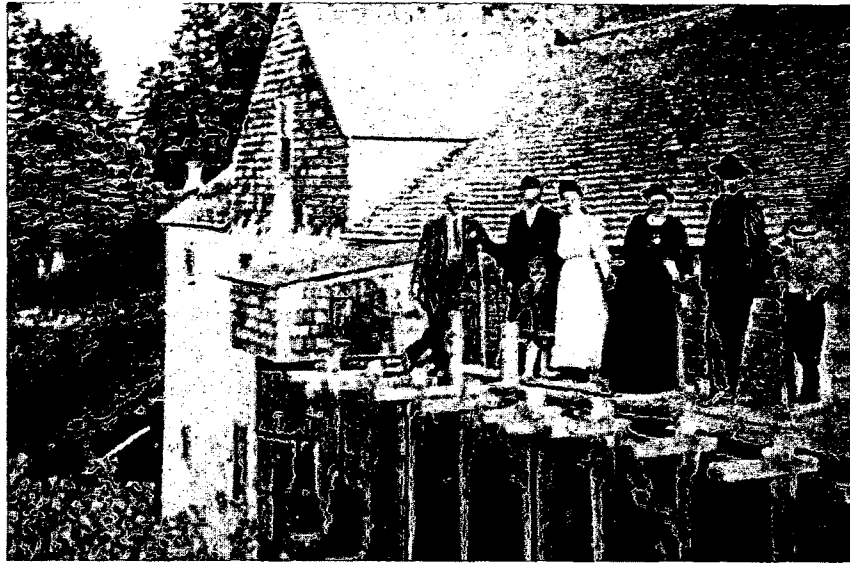


Figure 64. The flume of the Wrights/Andrews Mill in West Royalty, PEI, early 1900's. Photo courtesy Wally Andrew.

Indomitable world traveler and author Isabella Bird, visiting Prince Edward Island in 1856, reported on the very harsh nature of Island life (1856, p. 46):

Such things as duels, but of a very bloodless nature, have been known: people occasionally horsewhip and kick each other; and if a gentleman indulges in the pastime of breaking the windows of another gentleman, he receives a bullet for his pains.

As well, she noted that political and religious divides were rampant in PEI: "I never saw a community in which people appeared to hate each other so cordially." And (p. 40): "This island metropolis has two or three weekly papers of opposite sides in politics, which vie with each other in gross personalities and scurrilous abuse."

Critchlow Harris was the son of a prosperous family in Wales whose estate included a big house named "Millbank" and a corn (grain) mill. In spite of the relative comforts of life in the Old Country, Harris decided to immigrate to Canada with his young family in 1856. Fortune did not smile on Harris in the New World, however, and in numerous letters he gives vent to his discontent (Tuck 1983, p. 75):

Sept 20, 1858

The well-conducted part of the Inhabitants [of PEI] are endeavouring to get away, but the great difficulty with them is to get rid of their property. I only wish I could get out of the miserable place.

His wife was of much the same mind for she could not get serving girls to suit the needs of her large family, and she lived with a dissatisfied husband. All the same, she raised two sons, William and Robert, who grew up to be PEI's most famous architect (William) and artist (Robert).

Looking on the brighter side, C. Birch Bagster visited PEI in 1860 and cheerfully reported that things were going along as well as could be expected (Bagster 1861 p. 13):

From 1799 to 1861, PRINCE EDWARD ISLAND has struggled through vicissitudes of management and mismanagement; the cares of privation and plenty; the anxieties of failure and success; the chances of unfavourable and prolific seasons; and more than all, the animose encounters of good and bad opinion; and she has borne herself bravely, -- for at the present time there is more power, benevolence, religion and loyalty, and less pauperism, crime and misery, in this tight little Island, than perhaps in any other portion, the same in size and population of all our gracious Queen's dominions.

In the 1800's PEI was almost self-sufficient. Most people lived on farms, grew their own food, sheared their sheep and took the wool to the carding mill for processing, had their grain ground into flour or animal feed at the local gristmill, and their trees turned into lumber in a local sawmill. Prince Edward Island was trading with the United Kingdom, United States, Bermuda, West Indies, Newfoundland, New Brunswick, St. Pierre, and Nova Scotia, selling such perishables as butter, oats, barley, hams and bacon, oatmeal, cheese, wool, sheepskins, potatoes, herring, mackerel, scale, alewives, dried cod, oysters, turnips, eggs, beef, turnips, fish oil, eggs, and lard. In 1860 PEI exported to UK 3,424 tons timber, 52 spars, 152 cords lathwood, and 1,241,767 feet of deals⁴⁹; as well as 796 bushels barley⁵⁰, 281,116 bushels oats, and 550 bushels wheat. Metals had to be imported to the Island, as did millstones. The following statistics from the middle of the nineteenth century reveal a highly productive, and horse-centred, society:

⁴⁹ A "deal" is sawed pine or fir lumber, 9 inches or wider, and 3, 4 or 5 inches thick.

⁵⁰ One bushel equals 80 lb.

CHART 5. EXPORTS FROM PEI IN THE MID-1800'S (From Bagster 1861, Appendix)

Exported from PEI	1829	1859
Barrels of flour & meal	527	4135
Bushels of oats	47,797	1,111,970
Bushels of barley	4,471	97,935
Bushels of wheat	219	-----

Business was booming on the Island partly because of a successful shipbuilding industry, and partly thanks to the Reciprocity Treaty of 1854 with the United States that reduced customs duties on trade items (Bolger 1973, p. 136). People were also resourceful, used everything and wasted nothing. Women gardened, baked their own bread, sewed their own clothes, knitted socks and mitts. Farmers practiced mixed farming so that, if one crop failed, another took its place. They dug mussel mud and spread it on the fields to add calcium to the soil. They harvested seaweed after storms to use as fertilizer. (See Figure 65).



Figure 65. Seaweed lying thickly along Prince Edward Island's South Shore.

Thoreau wrote the following passage about a shipwreck on Cape Cod, where the people paid no attention to the wreck but went after the seaweed (1854, p. 463):

[The shipwreck was buried in water] several feet deep, and here and there was a bonnet or a jacket on it. In the very midst of the crowd about this wreck, there were men with carts busily collecting the seaweed which the storm had cast up, and conveying it beyond the reach of the tide, though they were often obliged to separate fragments of clothing from it, and they might at any moment have found a human body under it. Drown who might, they did not forget that this weed was a valuable manure.

This passage could just as easily have been written about PEI. But it would be wrong to suppose that the early settlers were all environmentalists or totally in tune with nature. The forests of the Island were so dense and immense, that as land was cleared for houses, barn and fields, trees were merely piled up and burnt. Was this waste, or practicality? Walter Johnstone, visiting in 1850, noted miles and miles of burnt woods and despaired of the devastation, fearing that the Island would soon be short of firewood. Mrs. Critchlow Harris also suggested the same possibility.

Writing to her old mother in England in 1859, Mrs. Harris wrote (Tuck p. 79):

An old MacDonald gave us his opinion on farming in this Island. He has been a farmer here for 50 years, but he was never satisfied with it as an agricultural country. Instead of improving it by clearing, that only causes it to deteriorate in value, for as the woods are cut down the springs dry, and when the firewood is cleared out from the back farms there must be great destitution.

It is interesting to realize that these early settlers were already thinking of how things would turn out in the future. The farmer, "old MacDonald" mentioned above, believed that springs were valuable. And so they were considered, for in *Meacham's Atlas* (1880) "Springs" are clearly indicated on every map. (See Figure 66.)

Isabella Bird visited a spring in St. Eleanor's in 1856, and after scrambling through the woods she finally arrived at her destination (p. 55):

At last we reached the spring. It was such a scene as one might have dreamed of in some forest in a fabulous Elysium. It was a large, deep basin of pure white sand, covered with clear water, and seven powerful springs, each about a foot high, rose from it... And here it lay in lonely beauty, as it had done for centuries, probably known only to the old people and to the wandering Indians. In enterprising England a town would have been built round it, and we should have had cheap excursions to the "Baths of St. Eleanor's."

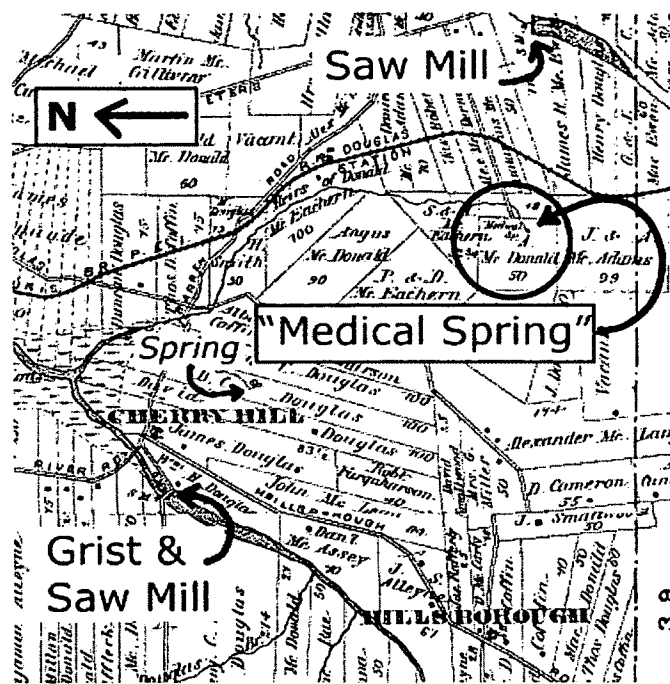


Figure 66. The “Medical Spring” or “Healing Spring” near Cherry Hill, PEI. In *Meacham’s Atlas*, p. 91.

Bird paints a lovely picture of a primeval world that had already started to disappear. There are still springs today, hundreds of them, but perhaps they are not cherished in the way they should be. On Prince Edward Island water is a resource that was always taken for granted, and few people realize that some of the Island’s drinking water is millions of years old (Atlantic Geoscience Society 2001, p. 171):

Water that originated as rainfall and is stored in an appropriate aquifer provides one of the best sources of drinking water in areas where there are no large, pollution-free surface reservoirs or lakes. Prince Edward Island, for example, obtains all of its drinking water from aquifers in Carboniferous to Permian sandstones.

Ample rainfall, plenty of snow and hundreds of springs all contributed to making PEI the perfect place for small watermills. Between 1720 and 1900, hundreds of mills were constructed at almost 400 mills locations. The following chart (Charts 6) reveals that there were more sawmills than any other type, with gristmills close behind. Because no flour mills are listed in these censuses, it becomes evident that “grist” refers to crushed animal feed, as well as wholewheat flour, buckwheat flour, or oatmeal. The Holland map shows some mills as “corn mills,” while Sartine shows

several written as “Moulin à bled,” and perhaps these were mills that strictly ground wheat. The high number of mills listed in the Census of 1871, as with the other censuses, reflects mill sites with multiple mill functions; but there are not 515 mill sites on PEI.

CHART 6. Mills of PEI as shown on earliest maps and listed in censuses.⁵¹

Source	Grist Mills	Flour Mills	Saw Mills	Shingle Mills	Carding Mills	Woolen Mill	Cloth Mill	Fulling Mills	Mill type not shown	Population ⁵²	Total Mills
Holland map ⁵³ 1765	11 (corn and grist)		6						4, plus 1 windmill		21
Sartine map ⁵⁴ 1778	4		1						6		11
1798										4,327	
1810										9,462	
1833										32,292	
Census 1841	87		83		11					47,034	181
Census 1848	116		139		27					62,678	282
Census 1855	79		88		25			4		71,496	196
Census 1861	141		176							80,857	317
Census 1871	145		181	130	47			13		94,021	515 ⁵⁵
Census 1881										108,891	

⁵¹ PEI Public Archives website states: “Census records from 1881, 1891, 1901 and 1911 are fully nominal, listing the name, sex and age of each person living in the household, whether immediate family member or other. Containing considerably less land and agricultural information, they give more detail regarding place of birth, education, and family relationships.” Retrieved April 3, 2013 from <http://www.gov.pe.ca/archives/index.php3?number=1019766&lang=E>

⁵² PEI Public Archives and Records Office. Retrieved February 19, 2013 from <http://www.gov.pe.ca/archives/census/info1841.php3>.

⁵³ From *Island Imagined*, Identifier 1174: Plan of the Island St. John in the Gulf of St. Lawrence in the Province of Nova Scotia in North America from a survey made by Samuel Holland in 1765. <http://www.islandimagined.ca/fedora/repository/imagined%3A209165>. Retrieved February 16, 2013.

⁵⁴ From *Island Imagined*, Identifier Map3: Plan de l’Ile de St. Jean. Par Ordre de M. de Sartine, Conseiller d’Etat, Ministre et Secrétaire d’Etat au Département de la Marine. The map shows the province of Prince Edward Island and its three counties, Kings, Queens, and Prince, bodies of water, towns, and cities. Retrieved February 16, 2013 from <http://www.islandimagined.ca/fedora/repository/imagined%3A209156>.

⁵⁵ This high number reflects mill sites with multiple milling operations. There are not 515 mill sites on PEI. This is true for all the listings above.

Advertising directories are another source of mill listings. The following chart reveals that from 1870 to 1909 the number of mills on PEI remained relatively stable. Sawmills consistently outnumbered all other mills, but dropped off sharply after 1909, possibly due to the end of shipbuilding. Carding mills too had their day, before cotton replaced wool as the fabric of choice in the early 1900's.

CHART 7. Mills as listed in PEI Directories

Source	Grist Mills	Flour Mills	Saw Mills	Shingle Mills	Carding Mills	Woolen Mill	Cloth Mill	Fulling Mills	Mills (type not listed)	Steam Mill	Electric	Total
<i>Hutchinson's Directory 1864</i>	38		45	3								86
<i>McAlpine's Directory 1870</i>	54		54				2		81			191
<i>Teare's Directory 1880-81</i>	16		15	5	5		5	1	21			68
<i>Meacham's Atlas 1880</i>	20		37	18	1	1	4	1	63	3		158
<i>McAlpine's Directory 1880-81</i>	54	1	54		1	5	2					117
<i>McAlpine's Directory 1900</i>	37	1	54	7	10	2	1	1	64	4		181
<i>McAlpine's Directory 1904</i>	27		44		3			1	5			80
<i>McAlpine's Directory 1909</i>	60	3	101		15		1			3		182
<i>McAlpine's Directory 1914-15</i>	40	2	40		8							90
<i>McAlpine's Directory 1924-25</i>	19	1	19	1	3				18			61
<i>Cummins Atlas 1928</i>	1		14		1				6	4		26
<i>Might's PEI Directory 1929-30</i>		20	5									25
<i>Trade Directory of PEI 1935</i>		13	6			1						20
<i>PEI Directory 1950</i>			18				1		45		1	65

All mills are not listed in directories. Perhaps the mill owner felt that advertising was too expensive or a waste of money. Some years there were different multiple directories vying for the same business. For example, *Teare's Directory* of 1880-81 and *McAlpine's Directory* of 1880-81 came out around the same time as *Meacham's Atlas* (1880). Some patrons might have chosen to advertise in one and not in the other. In the above chart, mill listings dropped off in 1914, but bounced back in 1909. The reasons for this are unclear. But after 1909 there is a steady decline in numbers.

Directories revealed that millers had achieved high social standing on the Island. Most of them operated farms, but some were shipbuilders, merchants, blacksmiths, Justices of the Peace, and Postmasters. One miller, Stanislaus Perry of Tignish, was both a Justice of the Peace and a Member of the Provincial Parliament.

CHART 8. Millers with second jobs

Source	Miller & Justice of the Peace	Miller & Postmaster	Miller & M.P.P.	Miller & Farmer
<i>McAlpine's Directory</i> 1870	7			
<i>Teare's PEI Directory</i> 1880-81	5	1	1	11
<i>Meacham's Directory</i> 1880	1	3		89
<i>Frederick's Directory</i> 1889-90	1	5	1	39

The watermills of PEI reached their pinnacle of success in the period between 1850 and 1910, at a time when the whole world was in economic and social transition. The Island could not escape outside forces that threatened both its sense of independence, and its desire to maintain the status quo. PEI historian Ed MacDonald writes (2000, p. 4):

Prince Edward Island of 1900 was the antithesis of the popular image of Canada. The young Dominion sprawled across the North American continent, boundless and wild and empty; Prince Edward Island was a tiny garden fenced in by the sea. . . . Canada's gaze was fixed firmly on the far horizon; Prince Edward Island glanced wistfully over its shoulder at a past that seemed considerably more golden than it probably was.

At the turn of the twentieth century, Prince Edward Island was a scrambling, hustling, busy world of farms and horses, small halls and one-room schools, large

families, country stores, and watermills. It was a confusing time for rural people especially, as they struggled to keep in step with changing realities. Portable gas-powered sawmills were making inroads into the profitability of the old saw gear powered by water; and who could argue with the convenience of setting up your personal mill in the field near the woodlot. (Figure 67.)

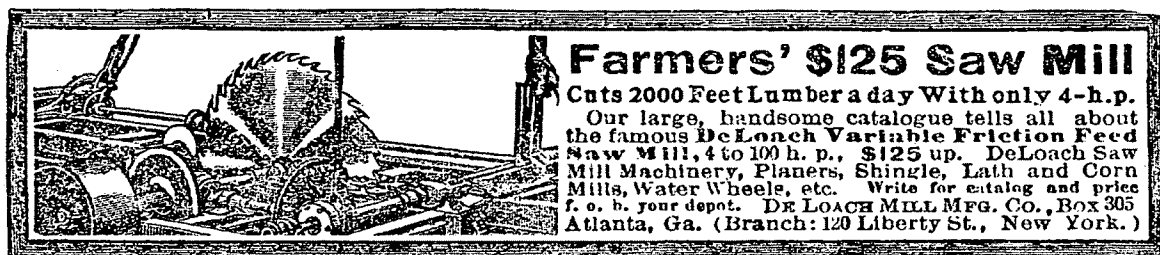


Figure 67. Ad in *The Farm Journal*, May 1902.

And there was the question of horses, which had been indispensable since time immemorial. Gas engines promised to do the work of a team of horses, but these new gadgets cost money, and money was hard to come by. In Figure 68 below, the horses turning the treadmill (left), have a hard time competing with the efficiency and power of the stationary engine (right).

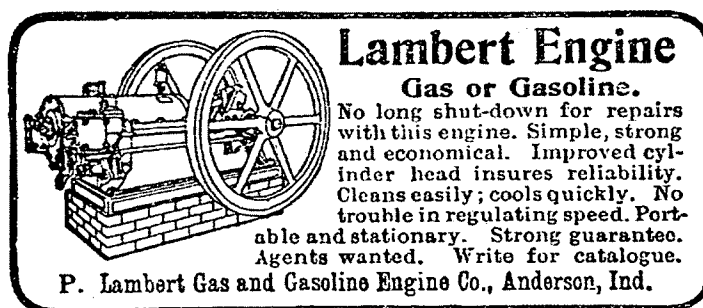
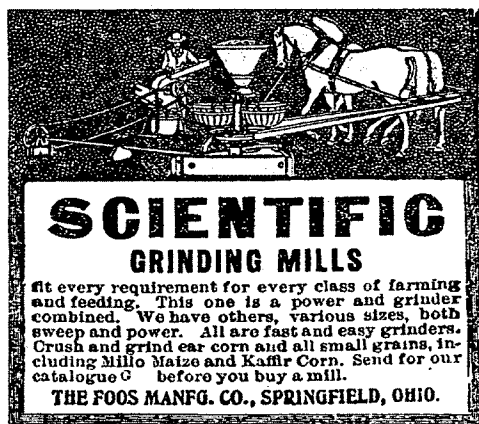


Figure 68. Ads in *The Farm Journal*, Philadelphia, April and May 1902. *The Farm Journal* was a popular source of farming news and ideas for PEI farmers.

The changing times were being discussed in every public forum, from newspaper editorials, to the pulpit, to the “funny papers.” Consider the following cartoons in *Li'l Orphan Annie*:

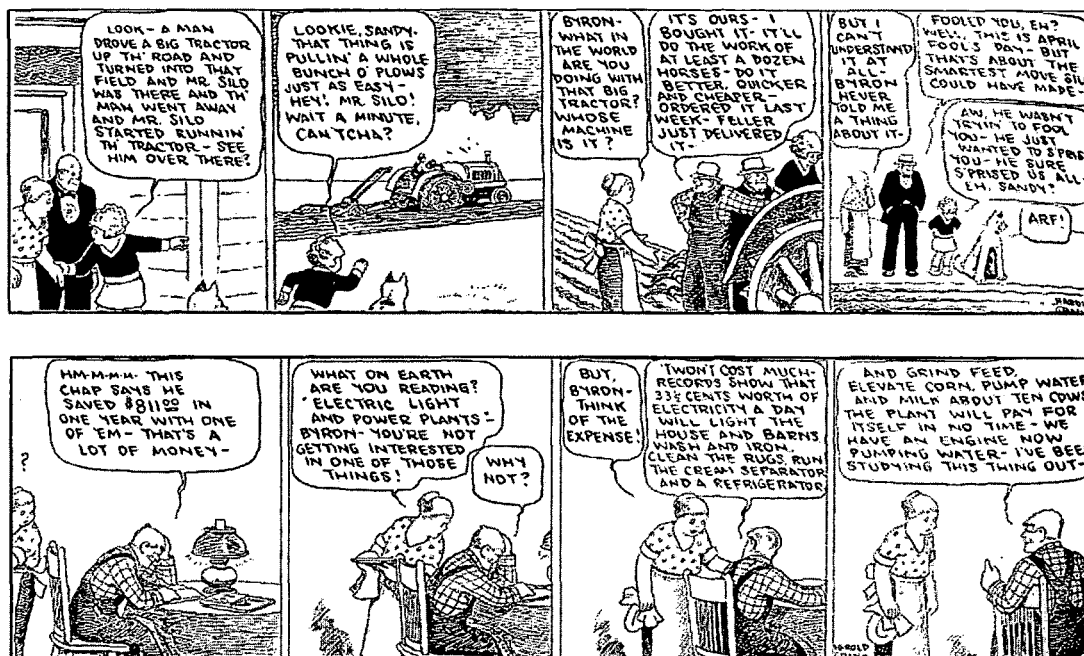


Figure 69. Daily strips in *Little Orphan Annie*, April 1 and 3, 1929.

The clash of forces at work in the early twentieth century – the natural world versus mechanization – can still be heard reverberating across the Island and around the globe.

7-3. Profiling a Prince Edward Island River:

THE DE SABLE RIVER

Having discussed mill history, technical innovations and other generalities, let us digress for a moment to try and put a face on all this information. It is not possible to write about every mill and every river, nor is it necessary, for most stories are similar. One Prince Edward Island river – the DeSable River – will show what has happened along its lovely watercourse in the years since Europeans began to transform the Island landscape.

The DeSable River is, in many ways, typical of many Island rivers. Though not as long as the West, Morell, or Valleyfield Rivers, it is nevertheless a substantial waterway, fed by numerous streams and brooks, and augmented by hundreds of springs along its watercourse that contribute to its volume year-round. Because it originates at a high altitude – high for the Island at 115 metres – and flows between steep hillsides, it has more springs than some of the Island's small rivers that begin at lower elevations. Island rivers that are roughly the same length as DeSable River, but flow through flatter terrain, could support only one mill. Examples include Cow Creek, Schooner Pond Run, Little Miminegash, and Black River. The DeSable River, on the other hand, with its abundant water flow, had several mills, similar to the Clyde River, Orwell River, Priest Pond Creek, or Huntley River.

Like other Island rivers, the DeSable River was shaped first by glacial action, and later by erosion of the Island's sandy topsoil and substrata. By the time Europeans arrived, forces of nature had created steep riverside slopes that permitted – even invited – damming. Astute immigrants with milling experience took note of the perfect conditions for erecting watermills, and within one hundred years there were mills from one end of the Island to the other.

On all PEI rivers, the dam closest to the shore was situated just above high tide mark, or slightly further inland. Occasionally, high spring tides would bring seawater up to the dam and push against the waterwheel, thus stopping its motion. On the DeSable River, the first mill upstream from the shore was Dixon's Mill. According

to Marjorie Faulkner, daughter of the last miller, high tides did shut down the mill from time to time, creating a great nuisance.⁵⁶ This was one of the problems of operating a mill along a seacoast, in this case, on an island.

The mills on the DeSable River were, like all Island mills, constructed of wood. Because of this, most mills have disappeared over time, whether through fire, vandalism, or simple neglect and disintegration. Dixon's Mill, which will be discussed in this chapter, is one building that has survived, largely through the efforts of the last miller, John Dixon, who installed steel roofing on his mill before he died.

The DeSable River has steep sandy banks, it is spring-fed, it empties into the sea, it is surrounded by forest and farmland. It seems a suitable model to represent other Island rivers. Let us examine it further.

The DeSable River is situated approximately halfway between North Cape and East Point on what is called Prince Edward Island's South Shore. It comes to life in the highlands north of Kelly's Cross, flows south through the communities of Kelly's Cross, South Melville and DeSable, and empties into the Northumberland Strait. There is an eastern branch called Greens Brook that begins in the hills of picturesque Appin Road and joins the DeSable River in the salt marshlands. There, joined as one, these two bodies of water form a channel and head boldly out to sea.

A river can be defined as "a large natural stream of fresh water flowing along a definite course, usually into the sea, being fed by tributary streams,"⁵⁷ or more simply as "a natural stream of water of considerable volume."⁵⁸ There are many rivers of considerable volume on Prince Edward Island, perhaps a hundred or more. Various internet sites list their names but suggest that because their freshwater portions are so short they don't deserve to be called rivers. Prince Edward Islanders have always called them rivers and continue to do so.

Most of these rivers are indeed short, less than twenty kilometers long. All of them are fed by springs all year round, and most of them go about their business of bringing water from our modest highlands to the sea without fanfare or much mention

⁵⁶ Conversation with Marjorie Faulkner, Charlottetown. October 5, 2011.

⁵⁷ *Collins English Dictionary* 5th Edition (Harper-Collins 2000). Accessed February 19, 2013.

⁵⁸ *Webster's Ninth New Collegiate Dictionary* (Merriam-Webster 1983). Accessed February 19, 2013.

– except when a heavy rain causes the river to run angry and red, which happened as long ago as 1850 when *The Examiner* reported on September 14, 1850 (p. 3): “We are sorry to hear that the heavy rains of Saturday and Sunday have done considerable damages... carrying away Bridges, Mills, Mill Dams.” Or a spring freshet might cause a dam to burst, which happened as recently as April 4, 2009 on the Dunk River: “The dam at Scales Pond failed Saturday, sending a large volume of water, ice and silt into the Dunk River. Rains and rapid snow melt are believed to have contributed to the dam’s failure.”⁵⁹

The Dunk River is one of the Island’s longest and most important rivers. By contrast, the DeSable River is short and unpretentious. It flows approximately ten kilometers from spring to salt sea, for the most part hidden from public view as it winds its way through private property. It is only fishermen who spend much time on its banks, clambering over dead trees, pushing aside fallen branches and avoiding wild roses. Though no singers or poets have set this river to verse, the DeSable has its own voice, its own history and its own distinct loveliness. It is blessed with dozens, perhaps hundreds, of springs whose sweet water keeps the river cool and fresh. Today it would not appear to have been an industrial river, yet at one time there were four mills plus one tannery on the west branch. (See Figure 70.)

To examine this Island waterway I am relying on my own observations of the river as it is today; on a small body of literature about De Sable and Kelly’s Cross; on historical maps of Lot 29; and on conversations with Mr. Mack Dixon, son of the miller, John Dixon, who owned and operated a mill on the De Sable River. Mack helped in the mill as a boy, but his true love was farming and raising Clydesdale horses. He passed away in 2011, but up until the time of his death he was happiest at any time of the day regaling visitors with stories about Dixon’s mills.

The western branch of the De Sable River begins its life as a spring in Maplewood in the northeast corner of Lot 29, approximately 350 feet or 107 meters above sea level. Without any fanfare the clear water burbles out of the ground in a

⁵⁹ PEI Department of Environment, Energy & Forestry press release, “Community Government to Plan Future of Scales Pond,” Monday, 6 April 2009. Retrieved October 30, 2012, from <http://www.gov.pe.ca/news/getrelease.php3?number=6241>.

hollow beside the barn on the farm of Ian Nantes, beef farmer and school bus driver. “There are actually three springs, but the other two disappear in dry weather,” says Ian. “The cattle used to love it down there.”⁶⁰ We gaze down at the buttercups, marsh marigolds and jewelweed tangled happily together in the cool darkness of the spring.

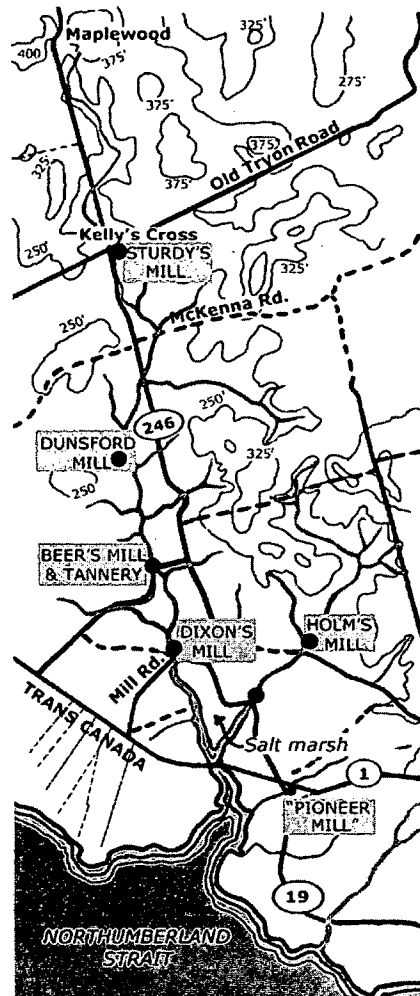


Figure 70. The DeSable River watershed.

The youthful waterway leaves the farmyard and gracefully dances past ripening wild strawberries and nodding hawkweed before disappearing into a mixed spruce and hardwood forest. There, its small presence is strengthened by other spring-fed

⁶⁰ Ian Nantes, interview with author, Maplewood, PEI, 21 June 2010.

brooks. As a single body of water it ducks under unpaved Route 246, makes a gentle turn, crosses back under the road just before the Kelly's Cross intersection, flows under Route 13, and continues its southerly flow beside pink and white dame's rockets that fill the undergrowth. The stream is now approximately four kilometers from its source and substantial enough to be termed a river.

Up to this point the De Sable River has had no demands put on it. In bygone days, livestock would drink from it year round. In the hot summer they would wade in it, congregate on its banks and mill about just for the pleasure and comfort that cool water afforded. These days, legislation prohibits such activity, and the De Sable River, like all Island waterways, is fenced off to protect humans from the bacteria and silt which farm animals unconcernedly strew about when they have their way. The old maps show that at Kelly's Cross the potential might of the DeSable river was called upon historically for the first time. There was a mill here.

Kelly's Cross is so named because at one time four Kelly families lived at each corner of the intersection (O'Grady 1983, p. 64). According to *A History of Kelly's Cross Parish* (Nantes et al, 1974, p. 63), Kelly's Cross in the "De Sable back lot" was full of heavy timbers needing to be cut. Wm. W. Lord of Tryon, "inn and tavern keeper, merchant, property-owner, shipbuilder and exporter" went to Ireland in search of cheap labour and brought out young Irish people. The history goes on to say:

[These settlers] took up their farms at one shilling per acre and went into business cutting timber for Mr. Lord who sold it in the Old Country. The timber was cut in the winter, hauled out to Sturdy's mill, with spring tides, small rafts of the timber were pulled below the Bridge and then made into one big raft which was then rolled out into the [DeSable] basin. In spare time they cleared the land, and hoed in potatoes and grain in the burnt over place.

One wonders how much spare time they actually had. Yet they must have enjoyed their new lives and freedom for this local history goes on to say: "The Irish people had very sweet voices, were good singers, and the best of neighbors." The Lake Map of 1863 reveals a school at the Kelly's Cross intersection, as well as McMurray's Tavern, a blacksmith shop, a parsonage, St. Joseph's Roman Catholic Church, and a sawmill. The sawmill seems to be under the ownership of an L. Sturdy. Local history states that James Cairns opened a sawmill here in 1865 and operated it

until 1880 until he sold the equipment to Mr. John Stordy (or Sturdy) and that this location has always been called the “saw-pit.” Mr. Cairn’s mill used an up-and-down saw, which predated the circular saws (Nantes 1974, p. 145). This mill began operations early in the nineteenth century and was owned at that time by Mr. Duncan Matheson. During its long and busy life, this mill crushed grain, ground buckwheat, made flour, sawed boards and made shingles. Would its millstones have come from England, France, or North America? Millstones were available from New Brunswick quarries on the Petitcodiak and Memramcook Rivers⁶¹ or from the Wallace quarries just across the Strait.⁶² Notices such as this one in *The Examiner*, May 30, 1856 remind us that mill business was booming, but that millstones must be procured off-Island:

As the Subscriber will leave Charlottetown, about the mid of April next, for Canso, for the purpose of obtaining Mill Stones, he desires to acquaint millers that he is now ready to receive orders for such Mill Stones as they may require.

John Cairns

This John Cairns might be the same Cairns who carved gravestones across the Island, some of which bear his signature in the Kelly’s Cross graveyard.

The mill at Kelly’s Cross closed around 1930 (Nantes 1974, p. 144). Today the slope down to the river is filled with lupins, and the riverbank is lined with spruce trees, willows and speckled alders. The descendants of the Irish settlers live on: the Kellys, Monaghans, Quinns, Duffys, and Doyles. Molyneaux’s General Store at the corner is closed for business, but St. Joseph’s Roman Catholic Church up the road is alive and well.

Leaving Kelly’s Cross, the DeSable River meanders through the forests of South Melville, joined along the way by brooklets from the numberless springs that dot the hillsides plus several substantial streams coming from east and west. Eight kilometers from the sea, the river makes a swing to the east where there is a second

⁶¹ *Historic Places* website at <http://www.historicplaces.ca/en/rep-reg/place-lieu.aspx?id=14263>. Retrieved February 19, 2013.

⁶² Email correspondence with Tom Flynn, owner of Wallace Quarries, October 12, 2012: “There were millstones produced in the Wallace Quarries. The only reason I know this for sure is that we have excavated 3 or 4 partially finished ones over the years.”

millsite. This is the location of the old Dunsford mills, noted in *Meacham* (p. 76) as “Wm. Dunsford Saw and Grist mills.” The PEI Census of 1881 (Lot 29) lists the Dunsfords as being English origin, with five millwrights in one family. Mr. Theodore Hazen (2001), one of America’s leading experts on mill history, states that:

One problem with being a miller is that many millwrights would not share their information or knowledge among others. If they had one or two apprentices, one would be taught one thing and the other something totally different. So in this way they would not be able to connect their information for years. Millwrights were considered such powerful people or creatures that it was thought for a long time that their spit could kill a toad.

Whether or not any of the Dunsfords did indeed spit at toads is a question that need never be resolved. But the ability to set up and maintain mill equipment was a special skill possessed by only a few persons; thus, in those days when the Island boasted hundreds of mills, the Dunsford family with five experts in one family must have been assured of a good livelihood.

According to Mack Dixon, the first Mrs. Dunsford was a “real lady,” a city woman from the heart of London, England. Her husband William came out from England first and got everything ready as much as he could and then he sent for her. When she arrived and saw where she was to live, she wept! “Well,” says Mack, “can you imagine a city woman out there in the middle of that forest?” No doubt Mrs. Dunsford had the same feelings about Prince Edward Island as Susanna Moodie had about Upper Canada when she wrote in 1832 (p. 73):

Dear, dear England! Why was I forced by a stern necessity to leave you?
What heinous crime had I committed, that I, who adore you, should be torn
from your sacred bosom, to pine out my joyless existence in a foreign clime?

John Dunsford of South Melville describes his Great-Grandmother as being “devastated” when she confronted the wilderness. Yet in spite of her misgivings Mrs. Dunsford stayed, and all the Dunsfords on the Island are said to come from the family she and her husband started. John Dunsford describes the pond as being “of a terrific size, running the whole width of the farm.” Today part of the dam is still visible, although the empty pond has grown up in weeds and spotted alders, and the old house is in bad repair. It is hard to imagine what life was like a hundred years ago when mill customers were coming and going, the mill was roaring, a dog was barking,

harnessed horses were stamping their feet, and supper was on the stove.

Meacham's Atlas (1880) indicates that, if we continue two kilometers downstream, there was another pond with a sawmill belonging to Wm. Beer. There is nothing left to show of this enterprise. The Lake map of 1863 does not quite define the activity at this location. *J. Beer*, *G. Beer* and *W. Beer* are shown with a gristmill and tannery in the midst of their names. It is interesting to speculate on what might have been tanned at this tannery: cowhides and horsehides, no doubt, for harness, belts, hinges, and shoe repair. Tanneries were usually on waterways because the tanning process uses a lot of water and puts out a good deal of undesirable effluent. One can imagine that the neighbors downstream, including the operators of the next mill, might not appreciate the debris that floated by. At the same time farmers needed hides tanned, so a compromise must have been reached. The production of tannic acid used in the process might have been a sideline for local residents. The Island had plenty of trees that would yield tannin, including oak, chestnut, and sumac. Mill historian Jon Sass (1990, p. 59) writes that, "In Colonial America, the gathering of tanning bark was a sideline of lumbering and clearing of land for farming." The same held true in Prince Edward Island, and the bark of the Island's giant hemlock trees was shipped away for the tanning industry on the mainland.

The Beer's Saw and Grist Mills were advertised for sale in *The Islander* in 1857:

<p>Saw and Grist Mills for Sale.</p> <p>CONSISTING of a SAW MILL, with one pair of Mill Stones, propelled by the same water wheel, with a piece of LAND, chiefly covered with hard wood, and a NEW DWELLING HOUSE thereon. The above machinery being completed by a mechanic of the first class, and having a powerful stream of water, renders it a desirable property. For further particulars, apply to the Subscriber on the premises.</p> <p style="text-align: right;">WILLIAM BEER. if</p> <p>De Sable, Lot 29, Dec. 8, 1856.</p>

Figure 71. Ad in *The Islander*, 27 March 1857, p. 4.

William Beer must have had no offers on his mills, because in *Meacham's Atlas* (1880) William Beer is still shown as owning the mill property.

There was one more mill on this branch of the DeSable River. Two kilometres further south from Beers Mills, just above the high tide mark, was the Johnstone-Marchbank-Dixon gristmill, carding mill, cloth mill, and sawmill. Today although the pond is gone, the sturdy mill building still stands on the banks of the DeSable as it has for over one hundred years. (See Figure 72.) This is the only remaining mill of its kind on the Island, a multi-purpose mill housing a sawmill on its first floor, a gristmill on the second, with further flour milling operations on the third.

Since it was the mill farthest downstream on the DeSable River, the Dixon's mill had the most water and, thus, the most power. This property was often referred to locally as the Old Marchbank Mill. The original enterprise was started by James Johnstone, then sold to John Marchbank, and finally taken over by John Dixon in the late 1800's.



Figure 72. The Johnstone-Marchbank-Dixon gristmill and sawmill on the DeSable River, South Melville, PEI. A separate building housed the carding and cloth mill.

Business directories were popular and Prince Edward Island had its share. Not every enterprise advertised its commerce in every directory – frugality was the order of the day – but the Marchbank-Dixon mill in DeSable does appear occasionally:

Patron's Directory in Meacham's Atlas [1880], Lot 29:

Marchbank, David. De Sable Mills (Hampton) Farmer and Millowner.
Birthplace PEI.

McAlpine Directory of 1900. Saw, Grist, Flour, Carding, Planing, etc:

Dixon, John, DeSables

McAlpine Directory of 1924-25. Mills, Saw Grist & Carding:

Dixon, J H B, De Sable

Cummins Atlas Rural Directory [1928] Lots 29 and 30:

Dixon, John. Wife Edna. Children Dorothy, Marjorie, John, Mack, Gordon

Trade Directory of PEI 1935: Sawmills:

Dixon, J. De Sable

Originally, the mill stood on the other side of the river, but one hundred years ago for reasons unknown, miller John Dixon decided to move it to across the river to its present location. This dangerous but successful venture was carried out by a certain Matthew Callbeck of Crapaud, and we can only imagine, looking at this imposing structure, how tricky this operation must have been. At that time John Dixon decided to replace the old millstones and invest in modern milling equipment, so an order was put in to the Wm. and J.G. Greey Mill Furnishing Firm of Toronto for a roller mill and all necessary components. (See Figure 73.) Mack Dixon, son of miller John Dixon, recalls (in conversation, June 10, 2010):

The new equipment was shipped by train in the wintertime, it was all in pieces in big heavy crates. Twenty horses and sleighs left our yard to haul it home from the station at Breadalbane. The Greey company sent a man along to set it up, but he needed someone to help him so we got our neighbor Bill Ferguson to come along. Bill was a pretty good carpenter and that Greey man thought so much of him that he took him everywhere with him afterwards.

Mack Dixon remembers a second mill building housing a carding and cloth mill where both his mother and his grandmother worked. His mother, Edna (John) Dixon, kept a diary, and in her later years, wrote a short autobiography for her family entitled "Memoirs of Mrs. John Dixon, De Sable." She writes that the mill not only ground wheat, but also, using various pieces of equipment, made buckwheat flour, oatmeal, and pearl barley. Rather than being paid in cash, which was in short supply, millers were allowed by law to take one bushel in twelve as toll.



Figure 73. One of three Greey roller mills that was installed in Dixon's Mills in the early 1900's.

The Dixons were suitably conscious of their rights and responsibilities, for Mrs. Dixon proudly notes that, "Jack had a proper half-bushel measure, which was always used – imperial measure, and government approved." Thus, they avoided any run-ins with the Assayer of Weights and Measures who ran this stern notice in *Haszard's Gazette*, August 22, 1855:

Notice to Millers in Queen's County:

The Assayer of Weights and Measures intends shortly to inspect their weights, and that those who shall not be provided with such as the Mill Act requires them to have, may expect to be fined.

John Bovyer, Assayer of Weights and Measures

Marjorie Faulkner is a sister of Mack, and daughter of the miller and his wife, John and Edna Dixon. Marjorie remembers that her mother did not like to use flour from their own mill. She recalls (interview May 17, 2012):

Farmers would bring Father bad wheat. Maybe it was damp or full of weed seeds. Of course he had to grind it but it made poor flour. Father would clean everything properly before grinding the next customer's wheat, and he would give the bad flour that he cleaned out of the mill to Mother to use in the house. She would have liked to buy her flour from town! Mother baked almost every day because there were so many men who came from far away and it wasn't worth their while to go home and come back so they'd wait for their grists, and naturally Mother would have to feed them.

Marjorie's mother, Edna Dixon, might not have minded so much. Mrs. Dixon was clearly a proponent of pastoral life, and in her memoirs she paints a very attractive picture of activities at the mill in the early 1900's:

In the wintertime, when the pond was frozen over, and the ice a foot or more thick, many neighbours came to get their summer's supply of ice. They cut it into large cubes with long cross-cut saws, and hauled load after load, packing it with sawdust from the mill to save it from thawing in the icehouse Sometimes there was good skating and it was nice to see a lot of young people having so much fun. I have seen the pond so clear at times that one could see the bottom of the pond quite easily. The millpond was bordered by trees, which made a very striking picture. In the summertime we used to raise ducks, and when a large flock was swimming in the pond it was a very pretty sight.

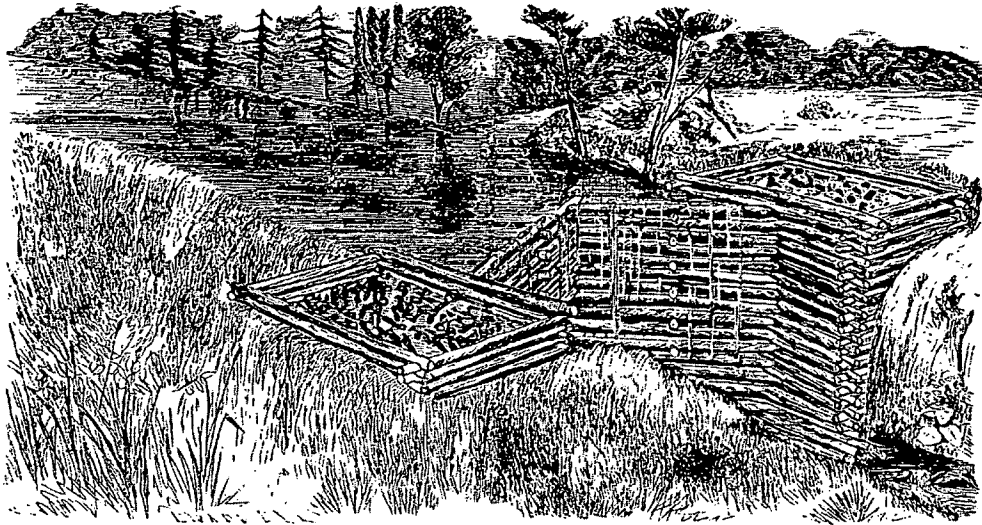
The mill dam was once washed away in a spring freshet and the water quickly drained out of the pond. "Many eels were in evidence," writes Mrs. Dixon, "and the men caught their quota very quickly."

According to Mack Dixon, his father said, "The more dams the better." After the mill would be closed for the night, the flume would be closed to allow the water to build up in the pond overnight. Each mill started operating about the same time of the morning, so that the stored water, released gradually, would keep things going all day. When tides were highest, and when salt water came right up to the two millwheels, they would stop turning.

Perhaps Mack's father had a copy of James Leffel's masterpiece on the construction of mill dams which contained such important counsel as the following (Leffel 1881, p. 146):

The almost invariable tendency of earth to lose its stability in some measure when subjected to the action of water, and the fact that its impermeability cannot be depended upon with certainty, render it necessary that the nature as well as the breadth of the foundation should be carefully attended to.

The soft clay of the Island would limit the types of dams that it was possible to construct. Here are two types of dams that might have been built on PEI:



*Figure 74. Crib dam. Logs of dam interlocked with logs in the “crib,” which is a tall rectangular tower of logs filled with rubble. Image in J. Leffel (1881), *Leffel’s construction of mill dams*, p. 22.*

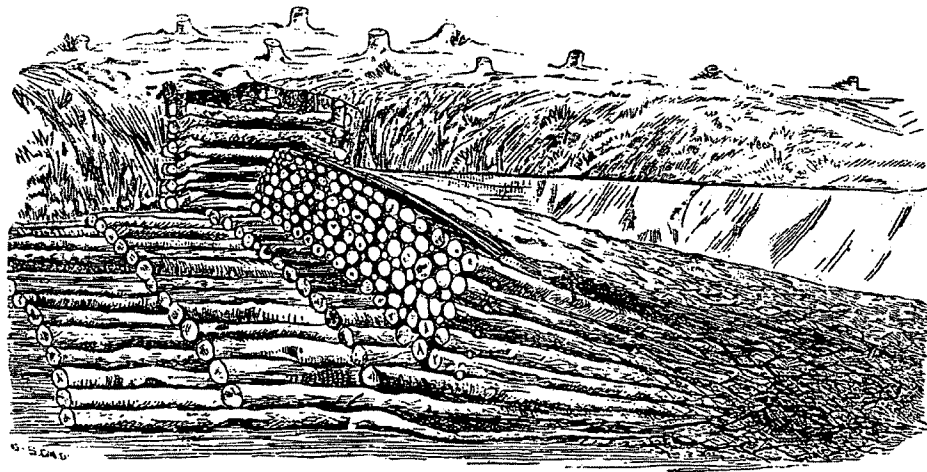


Figure 75. Log dam for streams with sandy bottoms. Image in Leffel p. 9.

Much knowledge was needed to build a dam, operate a mill, or to farm, fish, repair machinery, build a log cabin – to do all the things our ancestors did without fanfare or sophisticated equipment. However, with all this knowledge, accidents happened. Dixon’s Mill closed about sixty years ago when a spring freshet washed out the dam. According to Mack, there were still two grists of wheat in the mill waiting to be ground that were never ground:

A lot of mills closed about that time, including Crosby's Mill [on the West River] in Bonshaw. Their dam was destroyed in that same freshet. It was pretty discouraging when your dam went out. But it wasn't just that. People were buying cheap flour from Western Canada so it wasn't worth a farmer's while to grow wheat and haul it to the mill. And there were certain diseases of wheat on the go, like rust. Farmers stopped growing so much wheat and got more into other crops, like potatoes.

After the big freshet of 1950, the Dixon's Mill dam was never repaired. Mack's father retired from milling, though he kept farming. So ended the working life of the Dixon mill. Dixon descendants still live on the property and a millstone is set into the lawn. Their drinking water, plus water for their cattle, comes from a powerful spring above the former pond. The mill building is in good shape thanks to Mack's father's insistence on putting a steel roof on before he died. "When he got that roof on, Father said, now we've got 'er," said Mack. The first and third floors of the mill still contain miscellaneous milling equipment, including a "bran duster" that gave the bran a final shake to remove valuable flour. (See Figure 76.) A large circular saw blade – a "solid tooth saw" – lies in the middle of the first floor. Moldy belting is strewn about in heaps. On one wall is a drawn pattern for dressing the millstone.

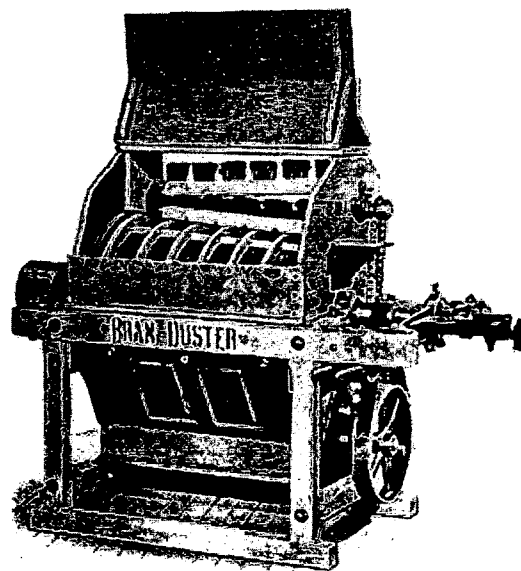


Figure 76. Bran duster similar to one in Dixon's Mill. Image in B.W. Dedrick (1924), *Practical Milling*, p. 179.

There is a musty but friendly smell in the air. Visitors close the door carefully and thoughtfully behind them as they leave. Outside, the DeSable River rushes on. In the days when the dam held it back, this river was a force to be reckoned with. During spring (extra high) tides, the sea would come all the way up to the dam, and the mill would have to be shut down because the tide would push against the wheel and stop it. Today the river seems to have no memory of the times when it was a centerpiece of the community. Around the bend from Dixon's Mill is the salt marsh. It is a special place where freshwater mingles with salt, where cord grass, salt marsh asters, rushes and sedge put down roots, and where the blue heron stalks its prey. Here, even today canoes can pull in safely, and it is easy to imagine that this marshy cove was once a destination of choice for our first Islanders.

The Dixon's Mill site features one of the few remaining mill buildings from the 1800's. No one plans to turn this handsome building into a museum, and it may already be too late, for the signs of decay are everywhere. This may also be true for Leard's Flour Mill in Coleman, the last remaining flourmill on PEI, which still stands with all its milling machinery intact.

One building that has been saved is Bagnall's Sawmill in Hunter River, which has been purchased and renovated by private contractor Dwight Parkman. This mill was established some time after 1841 by James Patterson of Norwich, England, who established a grist and lumber mill operation. When electricity made its appearance on PEI, various mills around the province installed generators, and the Hunter River mill was one of these pioneers. In 1944, Reagh Bagnall purchased the mill and started a business manufacturing doors and windows. When the business wound down in 2000, the mill building was vacant for several years until the current owner, Mr. Parkman, purchased the property and began rehabilitation of the site, including the installation of two waterwheels. (See Figure 77.) Neither wheel is turning, although the goal is to eventually produce electricity. This is one site that is standing by, ready to assume a new life as both a tourist attraction, and an electric generating station.



Figure 77. The Patterson-Bagnall Mill on the River Clyde in Hunter River, 2012.

Another historic mill building that dates from the mid-1800's is the Dawson/Ives Upper Mill on the northwest branch of the Tryon River in North Tryon. This mill in its long life was at various times gristmill, sawmill and feed mill. As a gristmill, it became famous in 1902 for having some of the first steel rollers in the area – although some of the patrons preferred their wheat ground by stone, so the millers kept both systems working for a few years (Robinson 1993). The mill itself was powered by one of the Island's first water turbines and operated under various guises until 1985. In 1990 the property was purchased by Joey Tobin to become a woodworking shop. This old mill is a lovely sturdy building and a credit to its many owners over the years.

The one working mill on PEI is the fabulous MacAusland's Woolen Mill in Bloomfield, PEI. The dam washed out years ago, so this mill is no longer powered by water, but it still makes yarn and blankets as it has for 100 years. (See Figure 78.) Tourists can wander through the building, take photos, and talk to the employees. MacAusland's Woolen Mill is a provincial treasure.

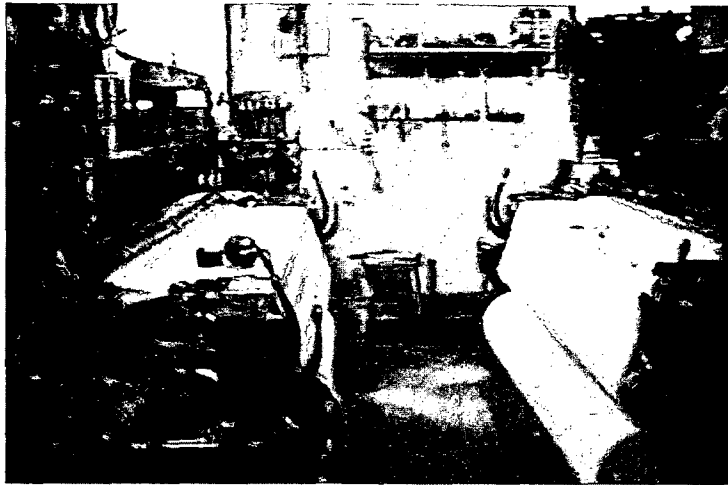


Figure 78. Blanket weaving machines at MacAusland's Woolen Mill, 2002.

One other fabric mill worthy of mention is the Belfast Mini Mills in Eldon, PEI. This enterprise produces yarn and does custom cleaning and carding of exotic “wools” (or hairs) from such species as musk ox and angora rabbits. They also sell their mini mills worldwide. Run by a mother and twin daughter team, Belfast Mini Mills has customers all over the world.

MacPherson's Sawmill (Figure 79) operated until the 1990's but has since ceased operation. A sawmill always had open doors. Mrs. Margaret Dixon of Clyde River used to tell her children, “Close the door. You weren't born in a sawmill!” How many people these days would know what she meant?



Figure 79. MacPherson's Sawmill, Eldon, PEI, 1996.

Other remnants of PEI's milling days can still be found along rivers all across on PEI: an old turbine buried in the mud down by a washed out dam; a tumbled-down building (see Figure 80); some belting rotting in a stream; some metal mesh from a drying kiln curled up in a pile; even a millstone or two, although most of these have been hauled away for lawn ornaments. There are some ponds, too, perfectly good ponds with dams, but no one tending a mill beside the dam. The mills on PEI had a good season, but those days are over.



Figure 80. Larsen's Sawmill, Rose Valley, PEI, 2012.

Chapter 8

Modern Times – End of an Era

How 'ya gonna keep 'em down on the farm,
After they've seen Paree?

Sam Lewis and Joe Young (1919)

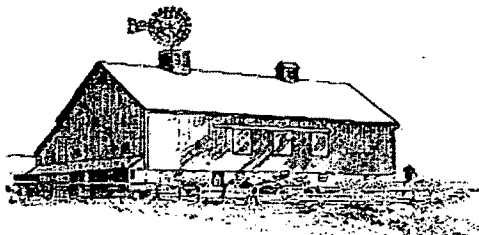
The past century was not kind to the watermills of Gotland and Prince Edward Island. We assume that our institutions will last forever but change is the nature of the universe. Who would have thought that Kodak shares would become practically worthless? That people would stop going to church? That small farms would disappear? The small local mill was an enterprise that was a part of daily life in communities all around the world. But water could not compete with oil as an energy source.

On Prince Edward Island the writing was already on the wall before World War I. A big part of the sawmill industry on PEI had involved supplying lumber for the shipbuilding industry. This ended in the late 1800's as steel hulls and steam engines replaced wood and sail. By the twentieth century, the Island's forests were already depleted, so one by one, water-powered sawmills closed or converted to steam engines. When the young lads went off to war in 1914, there were not many work opportunities on the Island besides farming. This was a problem that no one knew how to solve. School superintendent O. J. Kern pondered the question (1906 p. 12):

Is the continued migration to the city unavoidable? The trouble has been that too often the country child in his education has been led to believe that agriculture does not furnish sufficient intellectual development and financial success to warrant a longer stay on the farm. Many a boy has quit the farm, not because of the hard work only, but because day after day, month after month, he experienced only hard work.

The ad for windmills, (Figure 81 below), echoes these sentiments: "It is that kind of drudgery that drives boys away from the farm." (Apparently girls were still quite happy with their lot in life.)

LET THE WIND WORK FOR YOU



Don't do work that the wind can do for you. A windmill isn't for pumping alone; that is but a tenth of its possible service. Let us send you our 40-page book showing the dozens of things that a power Aermotor can do. The hardest part of your work can be saved by it.

Wind power costs nothing. It is almost always available, if you have the right windmill. The first cost is small; the running expense almost nothing. Its efficiency is marvelous.

Take feed-grinding, for instance. We make a simple and inexpensive grinder, which, in connection with the 12-foot Aermotor, will, in a fair wind, grind from 12 to 15 bushels of feed per hour.

Besides doing his own work, many a farmer has paid for his power Aermotor the first season by doing custom grinding for the neighbors. Many are clothing themselves and their boys every year with what it earns.

Then there is feed to cut, corn to shell, and wood to saw. The grindstone must be turned; the churn must be operated; the machinery in your tool room needs to be driven.

No need of doing these things by hand.

If you hire this work done, it may cost you as much every season as an Aermotor would cost.

If you or your boys do it you are wasting as much. And it is that kind of drudgery that drives boys away from the farm.

These very boys like mechanics. The operation of a power mill is fun for them. And they will find a score of ways to make it help in the farm work.

Let them do it. They will save all the dollars that you pay the miller and blacksmith. They will make more dollars by doing the same work for others.

You are using farm machinery that serves you but a few weeks in the year, and it pays. No modern farmer would think of doing without it.

Figure 81. Ad in *The Farm Journal*, October 1901, p. 323.

The reality was, that when soldiers came home from war, they did not all return to the farm. By this time farms on PEI were already changing. With many of the young men and women gone, farmers had to establish different priorities. One farm crop that suffered was wheat production. The Crow's Nest Pass agreement of 1897 encouraged east-west rail traffic and the bulk production of grain (Hill & Vaisey 1995, Tothstein 1989) so that it became cheaper to buy wheat from Western Canada than to grow it on the Island. Large, fully mechanized flourmills on the mainland, such as the mill shown in Figure 82, supplied grocery stores with a high quality homogenous product at a reasonable price, which suited housewives perfectly, and thus the small flourmills were squeezed out.



Figure 82. Five Roses Flour Mill on the island of Montréal, 2013.

The era of home knitting, and the need for woolen mills and carding mills, came to a gradual close in the 1900's. Although the Tryon Woolen Mills (powered by steam) temporarily found a niche knitting undergarments for soldiers during World War I (MacQuarrie 1994), the demand for woolen products was on the decline. Cotton was in, wool was out, so farmers stopped raising sheep. Today the only mills left on PEI that process wool are the MacAuslands Woolen Mill in Bloomfield, and the Belfast Mini Mills, a welcome newcomer.

The map (Figure 83) shows the locations of 386 watermills built on PEI in the past three hundred years, whether sawmill, gristmill, carding mill, or hydro plant. These small mills serviced a local community, that is, the area that could be comfortably reached by horse and wagon. Once automobiles appeared on the Island and roads improved, people began to travel farther a field to do their shopping, and even farmers could take their logs to the sawmill of their choice. Fraser writes (1991, p. 46):

Once postwar production was under way, the automobile allowed the farmer, wife, and children to visit their trading center or other, larger towns with relative ease and efficiency. The entire family could be offered products of the rapidly expanding economy tantalizing array of carefully designed inducements.

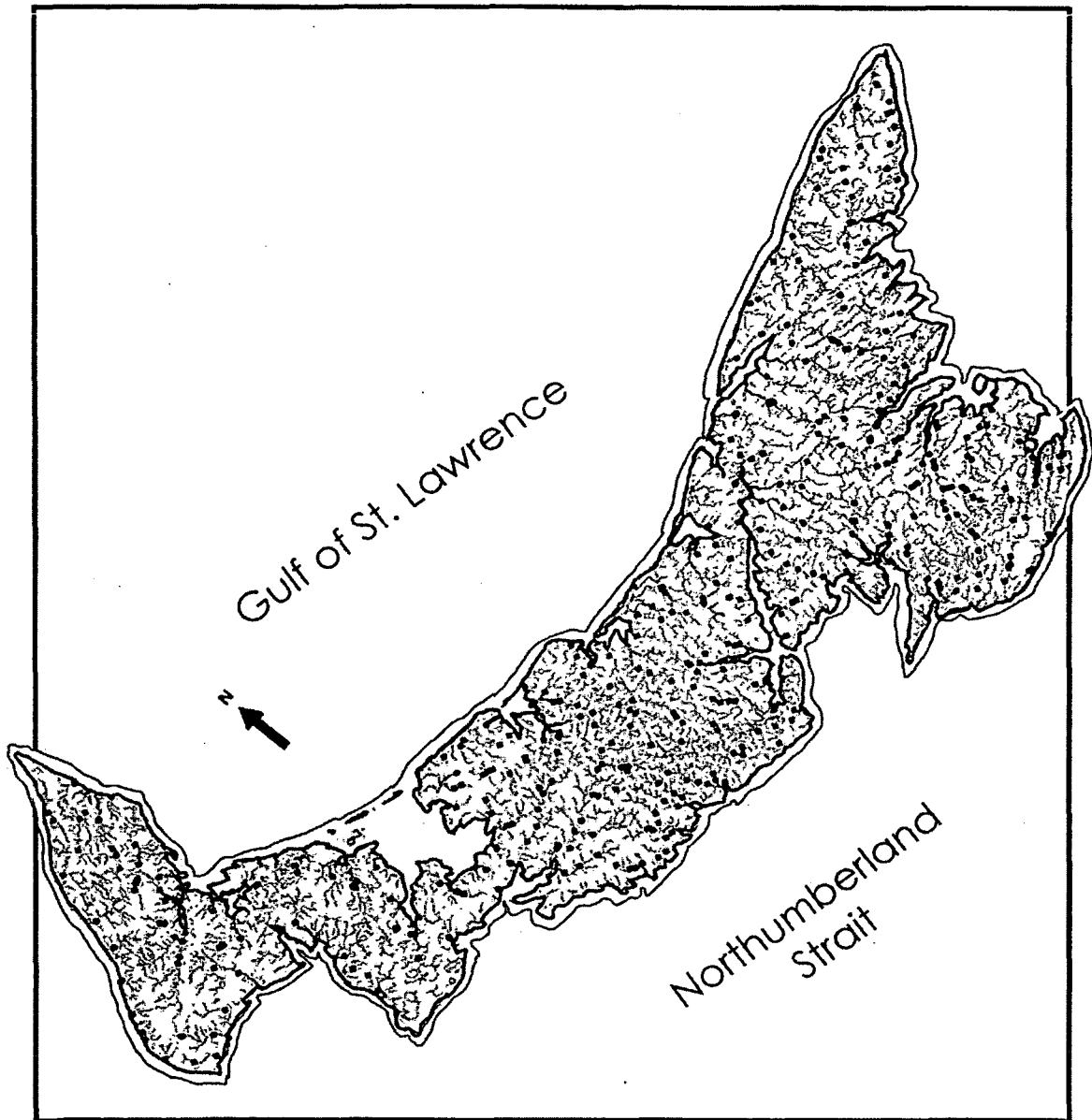


Figure 83. Mill locations on Prince Edward Island. Map created on a GIS system by Bill Glen, with information supplied by author. (See Appendix V, pp. 133-135.)

Some water mills survived temporarily by installing electric generators, which kept the lights on for a number of years in villages such as Hunter River, Breadalbane, Mount Stewart and Valleyfield (Bell 1989). (See Figure 84.)

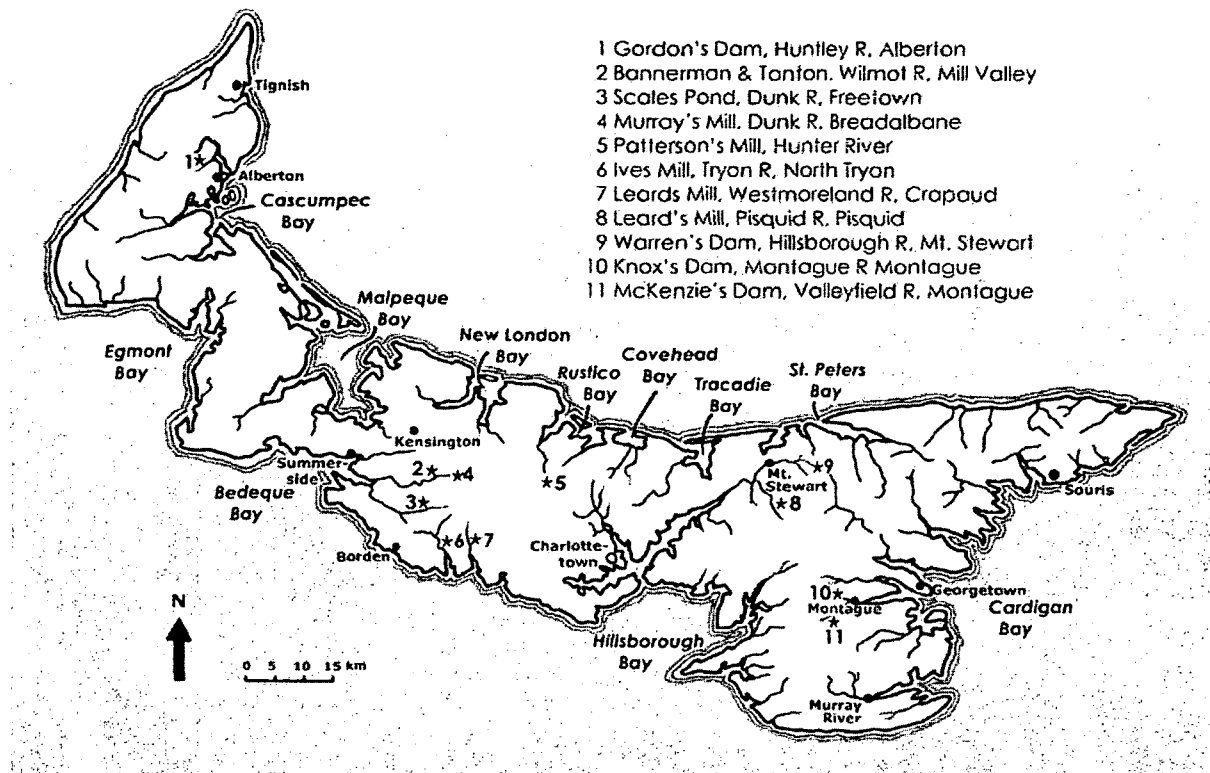


Figure 84. Locations of early electric plants on PEI. From information in Kenneth Bell, *Getting the Lights* (1989).

Yet, as water mills disappeared from the landscape, authors kept writing about them. The poet O'Henry (1920) celebrated the happy flour miller in "The Song of the Wheel":

The wheel goes round,
 The grist is ground,
 The dusty miller's merry.
 He sings all day,
 His work is play,
 While thinking of his dearie.

Another flourmill became a children's rhyme in *Mother Goose* (Fisher-Wright 1916, p. 94):

Margaret wrote a letter,
 Sealed it with her finger,
 Threw it in the dam
 For the dusty miller.

The Miller of Old Church (Glasgow 1911) was a romance novel of the early 1900's that featured not a doctor and nurse, or a lawyer and a secretary, but a virtuous young miller. In *Anne of Windy Poplars* (1926) by PEI's most famous author, L. M. Montgomery, the novel's ubiquitous cat was named "Dusty Miller."

Even playwrights made use of mills. Prince Edward Island has a major piece of literature set at a gristmill in the eastern part of the Island in the play *Johnny Belinda* (Harris 1940). *Johnny Belinda* was made into feature film that won an Oscar for its lead actress, and later became one of the most popular musical productions for locals and tourists alike at Confederation Centre of the Arts. This play stars a churlish miller, his deaf but endearing daughter, a nasty villain, and a heroic doctor who saves the day. The author touches on themes of small-mindedness, the destructive power of gossip, the community rapist, outsider versus community, the healing power of love – and all within the unlikely confines of a flourmill.

Why is it that people still love mills? In an abandoned cottage on the South Shore, the porch wall is covered with jigsaw puzzles, half of them featuring pictures of mills. It cannot be that these people especially love mills; in fact, they may never even have visited a mill. What is there about a mill, then, that is so appealing? The image of a quiet millpond or millwheel evokes a gentle sense of the past. Yet, nostalgia is often misplaced. Mills were not necessarily pleasant places. A gristmill might have been tidier than a sawmill, but it was filled with highly explosive dust, and many people who worked in flourmills developed lung diseases. A sawmill made an alarming mess of a river.

At the Scott-Dixon Mill in Clyde River, the miller was cleaning sawdust from under the circular saw blade when something distracted him. He lifted his head suddenly – into the saw blade – split his head open, and died shortly thereafter. In Millvale, a man caught his head in a whirling belt and lost his life. At a mill in Forest Hill a woman got her long hair caught in the spindle of a saw gear, which pulled off every bit of her scalp, even her eyebrows. (She lived!)⁶³

A History of Long River lists under "Accidents" (Long River W.I. 1967, p. 25):

⁶³ Conversations with Murdock Buchanan, Clyde River, 1980.

John Johnstone killed in saw mill Indian River, Oct. 3rd, 1874, age 27
 James Found killed in saw mill Long River, 1884, age 16

It continues with “DOUBLE DROWNING ACCIDENT NARROWLY AVERTED”:

Anna and Jim Cousins were used to coasting down their hill and across the two bridges at the mill, this morning the sleigh went out of control and both children landed in the brook. Dan Johnstone had a full head of water and was using both waterwheels so there was a big brook running. Anna grabbed Jim who was trying to stand waist deep in the water and screaming at the top of her voice Uncle Hugh! Uncle Hugh! Come and fish us out we're drowning...

In Clinton, Alexander Smith had both legs broken while working in the mills, and died from the effects of the accident (Clinton W.I. 1973, p. 53).⁶⁴ At a mill in Dock, a girl got her hair entangled in the carding machine, and subsequently died (Three Rivers Historical Society, p. 24).⁶⁵

A mill was a dangerous place. Still, the benefits and joys of the mill outweighed the troubles: skating and sledding on the pond in winter, and fishing in summer; bringing home a winter's supply of sweet nutty flour; building a shed made of freshly sawn lumber; knitting a sweater with wool from your own sheep.

Neither the people of PEI nor the people of Gotland can go back. We can only imagine what those days were like when small mills provided such comfort to so many (Pearson 1956, p.16):

It is quiet now along the streams. The old mills have collapsed and green moss grows on the rotting timbers that framed the buildings. Dams are broken and the ironwork of the great waterwheels rusts among the stones of the brook. Time marches on and the handicrafts of yesteryear disappear. But he who is sensitive to history still finds the ruins of the old mills a good place to dream dreams of what life was like a century and more ago.

⁶⁴ *History of Clinton 1770 – 1973*. (Clinton W.I. n.p. n.d), p. 53.

⁶⁵ *Wandering Back*. (Alberton: Three Rivers Historical Society), p. 24.

Chapter 9

CONCLUSION

For every smile in the world
There's someone out there crying
And each time something is born
There's something dying
Still the river keeps on flowing
But we don't know what it is
And we don't know where we're going

By Barry DeVorzon, Perry Botkin, Jr.
Sung by Melanie Safka (1972)

There are no clear answers to the questions of why we are here on earth, or what we are supposed to accomplish in our brief lives. Yet there is a compulsion to establish meaning and order, and to understand our universe and our past.

This thesis has examined the history of watermills on two islands that lie on opposite sides of the Atlantic Ocean: the island of Gotland, in the Baltic Sea, and Prince Edward Island, on the east coast of Canada. Millions of years ago, Prince Edward Island was created out of the sandy sea floor, while Gotland began its life as a coral reef. As the last Ice Age ended, melting glaciers sculpted the waterways of both islands. Prince Edward Island's soft sandstone was deeply carved by the retreating ice into rolling hills and gentle valleys, while its numerous rivers were fed by thousands of springs, and by plentiful rainwater and melted snow that was stored in swamps and marshes inland. Gotland, composed of hard limestone and sandstone, withstood the scouring action of the moving glaciers, and emerged from the Ice Age as a plateau. In the centre of this flat terrain were shallow depressions, such as the Tingstäde Marsh, that collected scarce rainwater and snow melt, and fed the Island's meandering streams. The inhabitants of both PEI and Gotland used their waterways for domestic purposes, travel, and fishing, but watermills were not a feature of the ancient landscape.

Meanwhile, in the area around the Mediterranean Sea, curious philosophers and

engineers were learning how to hold back the rivers on their downward rush to the sea, and turn the force of falling water into energy for human enterprise. Thus was born the watermill. The first large-scale mills, using vertical overshot waterwheels, were flourmills, built ca 400 CE, to grind wheat for the Roman citizens.

After the fall of the Roman Empire, mills continued to be built on rivers throughout Europe, and across Asia. Mills provided power for a variety of enterprises, such as grinding grain, sawing wood, crushing oil seeds, producing paper, and fulling cloth. Two islands that relied on mills for their industrial development were Gotland Island, in the Baltic Sea, and Prince Edward Island, off the east coast of Canada. These islands, on opposite sides of the Atlantic Ocean, both benefited from technical innovations developed elsewhere.

It is thought that Cistercian monks built the first watermill on Gotland in the thirteenth century CE. In the years that followed, more than 200 watermills were established across GI, most of them flourmills that utilized either small horizontal wheels, or undershot wheels. In the mid-1800's, the swamps and shallow lakes in the centre of the Island were partially drained during a land reclamation program. Consequently, many of Gotland's rivers were affected, and the reduced volume of water caused the demise of many watermills. After this energy crisis, Gotland turned to wind to supply energy for its milling needs.

The rivers of Prince Edward Island were not utilized for watermills until European settlers arrived in the eighteenth century, at which time the waterways of the Island were quickly appropriated for milling purposes. More than 386 watermills were built on PEI between 1720 and 1990.⁶⁶ Using only the force of gravity in the form of falling water, watermills provided clean renewable energy for small-scale industrial enterprises.

They also served as social hubs. Together with the church, school, and village store, watermills were the cornerstone of almost every Island community, easing labour, offering meaningful employment, and serving as meeting places. They were even, apparently, polling stations. *A History of Long River* (1967, p. 53) states: "In the early days the mill was the center of community life, here the people went to cast

⁶⁶ In the late 1980's, Robert Dixon of Glencorrodale built a shingle mill on Priest Pond Brook.

their votes on election day the 1st poll in the 1st district of Queens County”

Marjorie Faulkner, born in 1920 to the last milling family on the DeSable River, observed first-hand the mill’s heyday, and its decline. She claims: “The mill was everything. Everyone came there. The people had nothing, and the mill gave them everything. What would they have done without it? Oh my, but that was before my time.”⁶⁷

PEI’s Age of the Watermill came to an end for various reasons, including: the depletion of the Island’s forests, the end of wooden shipbuilding, the emergence of electricity, the introduction of gasoline engines, and a population shift from rural to urban. While the closure of small watermills was inevitable, it was nonetheless poignant. Everyone who grew up in North America in the 1900’s knew the words to “Down by the Old Mill Stream,” one of the most popular songs of the times, that evoked longing, nostalgia, a sense of history, and innocence:

Down by the old mill stream, where I first met you,
With your eyes so blue, dressed in gingham too,
It was there I knew that you loved me true.
You were sixteen, my village queen,
By the old mill stream.

Tell Taylor, 1910

How many children today have any idea what an old millstream is?

Today PEI, like Gotland, is embracing wind as its renewable energy resource of choice. At the same time, there are over three hundred abandoned mill sites on Prince Edward Island, with streams that are still able to provide small but significant amounts of energy, as they did in the past.

Gotland, with its limited water resources, has one small hydro plant nicknamed “Rabbishuppet” or Rabbit Hut. (See Figure 81.) This hydro station is situated on the Ihre River, one of the largest rivers in northern Gotland, draining approximately 150 square kilometres, including Lake Tingstäde swamp. Since the early 1600’s, there were at least seven mills on this waterway, so Rabbishuppet follows a fine tradition. It uses two refurbished turbines dating from the early 1900’s, to produce 100MWh per

⁶⁷ Conversation with Marjorie Faulkner, Charlottetown, April 2, 2013.

year. This may seem like a small amount of energy, but it is renewable energy providing enough electricity for 33,000 homes for one hour.⁶⁸



Figure 85. Hydro station “Rabbishuppet” on River Ihre, Gotland. Photo from Region Gotland website at <http://www.gotland.se/imcms/2229>.

PEI has many more rivers than Gotland, and a little “Rabbit Hut” would fit nicely into the Island’s landscape.

Natural Resources Canada promotes small-scale hydropower systems in its brochure *Introduction to Micro-Hydropower Systems*:

Micro-hydropower systems are small hydropower plants that have an installed power generation capacity of less than 100 kilowatts (kW). Many micro-hydropower systems operate “run of river,” which means that no large dams or water storage reservoirs are built and no land is flooded. The majority of these systems only use a fraction of the available stream flow to generate power, and this has little environmental impact.⁶⁹

This promotional pitch by Canada’s federal government seems to be aimed directly at jurisdictions like Prince Edward Island.

Micro hydro projects are already underway on many of the world’s islands, including: Nias Island (North Sumatra); Fiji Islands; islands of Malaysia, Japan, and the Philippines; Eigg (Scotland); St. Lucia; Newfoundland; Vancouver Island;

⁶⁸ 1 megawatt hour (Mwh) = 1,000 Kilowatt hours (Kwh) = 1,000 kilowatts of electricity used continuously for one hour = electricity used by about 330 homes during one hour. From *Clean Energy* website at <http://www.cleanenergyauthority.com/solar-energy-resources/what-is-a-megawatt-and-a-megawatt-hour/>. Retrieved February 21, 2013.

⁶⁹ http://canmetenergy.nrcan.gc.ca/sites/canmetenergy.nrcan.gc.ca/files/files/%20pubs/Intro_MicroHydro_ENG.pdf. Retrieved February 19, 2013.

Hawaii; Borneo; the Solomon Islands; Sumatra; Yapen Island and Sumba Island (Indonesia); Stewart Island (New Zealand); Sri Lanka; and more. Any island with plentiful fresh water, such as Prince Edward Island, can easily get involved in the vibrant small hydro movement. Small hydropower is discussed at numerous international conferences, such as *Hydroenergi*, the International Congress and Trade Fair on Small Hydropower, which is a European conference that began in 1989 with the goal of providing a platform for the small hydropower players to meet and discuss future directions. Other conferences, such as *Renewable Energy World* and *HydroVision International*, offer interested parties the chance to compare notes.

The *HydroWorld* website has a section called “small hydro” which discusses the challenges of tapping small hydro sources around the world. Contributors note that one of the biggest obstacles to moving ahead with projects is the unwillingness of governments to allow “tinkering” with waterways, which, to an entrepreneur, is both a blessing and a curse. Ferris (2012) writes about the situation in America where only 3% of the 80,000 dams currently produce electricity:

Small hydro entrepreneurs name one towering obstacle to building the smart dam: government paperwork. In essence, small hydro projects that involve tinkering with existing dams are held to standards developed for the massive, landscape-altering dams of the 20th century and their tendency to destroy fish migrations.

Fear of interfering with the life cycle of fish need no longer be a consideration, for French engineers have developed a fish-friendly “hydro turbine generating set for very low head,” generating from 100 to 500 kW.⁷⁰ This turbine, which was partially funded by Natural Resources Canada, is completely submersible, well suited for variation in stream flow, and advertised as “simple, reliable and silent.” It is easy to envisage such a turbine being used in Prince Edward Island streams.

Of course, small hydro can only supplement the energy needs of a modern state. One hurdle that accompanies the quest for sustainable energy is the need to educate and encourage consumers to limit their energy usage. Electrical engineers on Gotland have been working on a five-year project to develop a “smart grid” that integrates a

⁷⁰ Paper presented at *hydroenergia 2010* conference by MJ2 Technologies. Retrieved December 12, 2012 from <http://2010.hydroenergia.eu/pdf/3B.07.pdf>.

steady flow of wind energy into the electrical grid. To encourage customer acceptance of the project, they offer monetary rewards:

Another element of the five-year project will focus on the demand side: testing whether Gotland's 54,000 residents can be persuaded to alter their consumption depending on whether the wind is blowing or not. Hourly metering will be introduced, and a system of tariffs will reward those who consume less energy when wind speeds are low.⁷¹

Gotland has a target of 100% renewable energy by 2025, as outlined in *Energy 2010: Energy Plan for the Municipality of Gotland*.⁷² Their program includes a variety of initiatives, including wind power, energy efficient buildings, better water treatment, renewable fuels, electrical generation from industrial waste heat, and small hydro plants. Prince Edward Island could also benefit from such a strategy. The people of PEI would be wise to be talking about what kind of society they envisage, and begin planning for it, as the people of Gotland are doing.

Our two islands, Prince Edward Island and the island of Gotland, have much in common. They are both small islands that came into being at the bottom of the ocean floor. Their destinies were shaped by water, with the sea sculpting their shores, and the rain shaping their hills, valleys and watercourses, washing and refreshing the earth, forming rivers, lakes and marshes. Water, irresistibly drawn to the sea, has played a crucial role in the history of both islands, and watermills have been part of that history. The story is not yet over.

⁷¹ *Recharge* website at http://www.rechargenews.com/business_area/innovation/article300258.ece. Retrieved January 24, 2012.

⁷² *Energy 2010* website at <http://www.gotland.se/imcms/37135>. Retrieved February 19, 2013.

APPENDIX I – A Few Mill Owners of Note

Here are a few noteworthy people in North America with connections to mills:

- The first President of USA, George Washington, had a gristmill at Mount Vernon, Virginia.
- The father of Sir John A. MacDonald, Canada's first Prime Minister, operated a flourmill at Glenora, Ontario.
- Simon Fraser, the Canadian explorer, owned a sawmill and gristmill in Cornwall township, Ontario.
- Seven feet nine inch Giant MacAskill of Cape Breton had a gristmill at St. Ann's, N.S.
- On Prince Edward Island, Sir Andrew MacPhail's father operated a gristmill at Orwell.
- Critchlow Harris, the father of PEI's famous Harris brothers (Robert the painter and William the architect), came from a family in Wales that owned mills (Tuck 1983).
- Many young Island men left to seek their fortune in California during the California Gold Rush. The Gold Rush began in 1848 when gold was discovered at the sawmill of John Sutter in Coloma, California.
- Charles Stanfield and Samuel Dawson founded Tryon Woolen Mills in Tryon, P.E.I. in 1856. This enterprise transformed over time into Stanfield's Underwear, which continues making fine quality undergarments to the present time. Stanfield's is now located in Truro, N.S.
- Today on PEI there is a mill founded and operated for the past twenty years by a mother and her twin daughters. The Belfast Mini Mills is a local success story, although it is not powered by water.

APPENDIX II – PEI Mill Ads

MILLER WANTED!

AN EXPERIENCED person in Millering is wanted by the subscriber to work his Grist Mill for a shorter or longer time, as may be agreed upon. The mill is in good order, having burrs and all necessary machinery, with plenty of water and in a good stand.

GEO. CLARK.

Wilmot Valley, July 3, 1884.—2w

MILL VALLEY Woolen Mills

For Sale or to Rent.

THIS well known Cloth Factory will be Sold or Rented on reasonable terms. This is a One Set Mill complete with steam and water power complete for manufacturing all kinds of Cloth. In connection there is a good GRIST MILL, lately improved and repaired, and now in first class running order. Adjoining above property there is a Large Dwelling House and New Barn, and Outbuildings that will be let or sold with the Factory. The Customs

Carding and Grist Mills

In connection with above Factory will be run during this summer.

CATHERINE JOHNSTON.

Mill Valley, June 14, 1883.—tf

New Rotary SAW AND SHINGLE Mills,

AT MILL RIVER, LOT 5.

I HAVE just started my New Saw Mill at above place, with complete facilities for sawing all kinds of

Spruce and Hardwood Lumber,

Spruce Shingles, &c., &c.

Those wishing anything in my line will find it to their advantage to communicate with me as I am in the centre of one of the best Lumber Districts in this Province, which places me in a position to quote the

Very Lowest Rates.

G. H. CARRUTHERS,

Mill River Lot 5.

March 28, 1885.—3m

Newspaper ads from the late 1800's reveal a milling landscape that was full of contradictions. Some mills were for sale, others were starting up, still others were trying to keep staff. Ads above in *Prince Edward Island Agriculturist*. "Miller Wanted" ad, July 10, 1884; Mill Valley and Carruthers Mill ads, July 26, 1883.

APPENDIX II continued - PEI Mill Ads



Tryon Woolen Mills!

June, 1886.

Cloth and Wool.

TO OUR CUSTOMERS.

IT is just twelve years since we re-built the Woolen Mill. We then resolved to manufacture the best cloth that could be produced from

P. E. ISLAND WOOL.

That our efforts have been successful and appreciated we are warranted in concluding from the fact that hundreds of the same people who patronized us in 1874 are our customers in 1886. During the past year we have added many improvements particularly in the dyeing and finishing departments. Although we have not reached perfection, yet we feel justified in saying that no better tweeds or greater variety of patterns are made in any other establishment in the Lower Provinces. We do not propose to compete against the cheap shoddy and cotton mixtures, that are sold as ALL-WOOL goods, but quality and durability considered we claim ours to be the CHEAPEST CLOTHS in the market. If you want good value for your

WOOL OR CASH,

please call at the Factory or on either of the following Agents:

HON. H. J. CALNECK, Charlottetown.
 REID BROS., Charlottetown.
 BEER & SPRAGUE, Montague.
 WILLIAM MINTO, Cardigan.
 WILLIAM REID, Summerside.
 CHARLES E. PRATT, St. Peter's Bay.
 A. D. J. McDONALD, Pisquid Station.
 JOHN T. HUGH, Murray Harbor South.
 BOWNESS & ANDERSON, Kensington.
 HIRCH & DYER, Alberton.
 COLIN WHITT, Bedquo.
 WRIGHT BROS., Victoria.

May 27, 1886. - 4w

NEW ROTARY SAW -AND- Shingle Mill

-AT-

Pierre Jacques, Lot 8.

THE undersigned has just started his New Saw Mill with complete facilities for sawing all kinds of lumber.

On Hand and for Sale,
 a large quantity of good Spruce and Cedar Shingles. Write for quotations.

HUMPHREY GORRELL,

Lot 8 P. O., April 16, '85. - 1f

For Sale Water Power Mill Site AT BRAE.

THIS VALUABLE POWER with 80 acres of first class Land, and a Head of 12 feet of water, which will furnish Power the year round to run Shingle, Woollen and Grist Mill, situate on the line of Railway, within half a mile of Railway Station, in the midst of plenty good

Spruce, Hemlock & Cedar Lumber,

and surrounded by a flourishing Farming Country, will be sold Cheap to the right man.

The Railway Authorities have agreed to lay a track to the Mill when required. Apply to or address,

HUGH MCPHEE.

Brae Station, P. E. I., Aug. 27, 1885. - 1f

All ads above are from the *Prince Edward Island Agriculturist*. Tryon Woolen Mills, June 10, 1886; Gorrell's Mill at Pierre Jacques, July 16, 1885; McPhee's Mill at Brae, Sept 17, 1885.

APPENDIX III – Changing Times



SAMSON
Galvanized Steel
Wind Mills...
Strongest and Best.

This is our new factory. Its erection was made necessary by the unprecedented demand for Samson Wind Mills. We are hoping that we shall now be able to keep up with the trade. This new factory covers 64 acres of ground. It is the most modern in every particular. Electrically equipped throughout—light, power, ventilation, etc. The annual capacity is 75,000 wind mills. Undoubtedly the largest and best equipped wind mill factory in the world.

Remember. The Samson is a Samson all over—in the extra strength of all its parts, in power and in lifting ability, particularly in deep well pumping. It is sold under a most positive guarantee. Write us for our handsome Illustrated Catalogue. Mailed Free.

THE STOVER MFG. CO.
529 River Street, Freeport, Ills.

Windmills dotted the landscape of PEI all during the 1800's. This ad in *The Farm Journal*, March 1902, shows the importance of windpower.

Work in Progress in Fore River Yard, April 1, 1902

BATTLESHIP—NEW JERSEY, 15,000 tons.
BATTLESHIP—RHODE ISLAND, 15,000 tons.
CRUISER—DES MOINES.
TORPEDO BOAT DESTROYER—LAWRENCE.
TORPEDO BOAT DESTROYER—MACDONOUGH.
SEVEN-MASTED STEEL SCHOONER—(11,000 tons displacement). The largest sailing vessel in the world.

FORGINGS for steamships now being built in other yards.

STEEL BRIDGE, 800 feet long, over Weymouth Fore River.

SEVENTY-FIVE SETS FORGINGS for rapid fire guns.

MISCELLANEOUS STRUCTURAL WORK.

The above, with other work in hand, will bring the total amount of contracts up to \$8,907,000.

Ad in *The Farm Journal*, May 1902, p. 192. While steel hulled ships had taken over from wooden vessels, sailing vessels were having their last hurrah. The Fore River Yard, Quincy, Mass, boasted of building a seven masted schooner, "the largest sailing vessel in the world." The largest ship built on PEI was the 1,796-ton full-rigged ship Ethel, in 1858.

APPENDIX IV – Photos of Some Old PEI Mills



Ruins of Warren's Grist and Sawmill on Warren Creek, Warren Grove, PEI. Winter 1986.



Johnston's Sawmill on the Winter River, Suffolk, PEI. Winter 1986.

Appendix IV continued – Photos of Some Old PEI Mills



Ruins of Ramsay / Marchbank / Livingstone / Currie / Betts Sawmill on Little Pierre Jacques River, Glenwood, PEI, ca 1990. Photo courtesy Click Stewart.

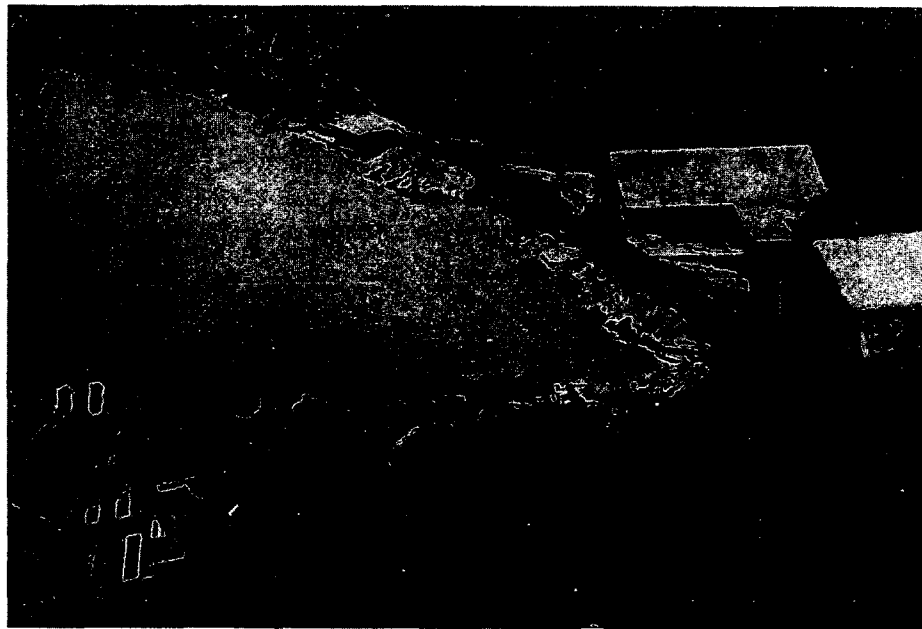


Figure 65. Leard's Mill, Westmoreland, ca 1950. Photo courtesy Annie Leard.

Appendix V – GIS Map of PEI

The mill sites shown as dots on the print-out GIS map of PEI (p. 116) were identified over many years using old maps of PEI. This process began previous to 1996 when I published a map titled *Old Mills of PEI* which shows 210 mill sites. These sites were located using *Meacham's Atlas*. (Copy of *Old Mills Map* is included in binder at end.)

At that time I also began creation of a database, which has been up-dated as further information became available. It included the following categories in the header:

Old: Mill sites as numbered on the *Old Mills* map
 New: New mill site identified after 1996 when *Old Mills* map was drawn
 Millers or mill owners
 Name of river
 Name of community and lot
 Name of pond
 Type of mill: S = saw Sh = shingle
 G = grist E = electricity
 C = carding
 Coded identifiers reveal source of information. For example, ^S refers to
 "Sawmill" as shown in *Meacham's Atlas*.
 Page number where mill is shown in *Meacham's Atlas*
 Page number where mill is located in my copy of the *PEI Road Atlas*

While writing this thesis, I have been importing this database into an Excel document that will accompany the GIS map. I have, in addition, consulted the following maps:

Holland 1765	Lake Map 1863
Sartine 1778	Wright & Cundall 1874
Ashby 1798	Meacham 1880
Wright 1852	Wright & Cundall updated to 1903

Each location, with relevant database information, can be accessed by anyone using a GIS mapping system. Possibilities for this map and database include:

- Mills can be color-coded according to type
- Dates of construction and demise can be noted
- Various layers can reveal topographic information
- Other layers can include roads, towns, bridges, forest cover, and so on.

The Excel database is not complete, but once finished, should prove useful to molinologists who are curious to learn more about PEI's milling history. On the next page is a random selection from the original database [1996] containing information on mills numbered 48 to 50 on the *Old Mills* map, plus additions.

APPENDIX V, Continued: *Old Mill Map* database from 1996 with additions

Year	Lot	Owner	Water	Location	Notes	Map	Scale	Year	Notes
	48	Yeo/ Collum	Carr's Ck/ Shemody Ck	Miscouche (Lot 17)		AS	52	21	" "
	48A	Waugh? Nicholson?	Reads Ck	Reads Corner (Lot 19)		AC (*) QC		25	Lake map
	48B	Tilton? Rayner	Jiltos Ck/ Rayner's Ck	Travelers Rest (Lot 19)		AS "oakmill" (*) QG		25	Lake map
	48C		Reads Ck	Reads Corner (Lot 19)		AG Q		25	
	48D	Green: George, Spencer, William		West end Summerside (Lot 17)		AG Flour Q			Prowse Chappell: "This was called the ice pond" <u>Roads to S. Side</u> p.14: name of Greens, flour mill
	48E			River Platte (Lot 17)		(*)? S QS	85	24	
	49	Carr	Baltic R	Baltic (Lot 18)		*G	85	24	<u>Hist of Baltic:</u> "One of the first 6 grist mills on PEI" (also Hamilton, Long R, Bustico) -1820 - -1965
	49A			(Lot 20)	Adams	*G		24	
	50	Beacista: Geo, Thomas/ Riley, Geo/ Bernard, James/ Burt, Chas/ MacKenzie, Gordon/ MacKenzie, Alex/ Hunter, Wm	Hunter's Ck	Spring Valley/ Baltic (Lot 18)	Hunters	AG S *G	85	24	<u>Hist of Baltic/ Seaview</u> p. 25-26 <u>McAlpine 1900 Dir:</u> Thomas Beacista, Baltic (G)
	51	Wallace, Wm/ Clark, John/ Morrison, Rich, Adams/ Madderson	Shipyard R	Hamilton or Malpasque (Lot 18)		AG S *G QG S	85	24	early "Richmond Mills" info <u>Baltic History</u> Map of 1859 <u>Pathways to the Present: Hamilton</u> <u>Hutchinson's 1864 Dir:</u> Richard W. Morrison, Malpasque, lot 18 (G) (S)
	52	McLellan, Angus/ Juplin, John, James	Indian R	Indian River (Lot 18)		AS G Sh (*) Q7	85	24	<u>Hutchinson's 1864 Dir:</u> Angus McLellan, Indian Riv, lot 18 (S) (G) <u>McAlpine 1900 Dir:</u> John G. Juplin, Indian River

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