



# **The Petitcodiac River Tidal Bore 250 Years of Anecdotes**

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## *Pet-Kout-Koy-ek*

In the beginning was the Great Spirit, who created everything in the sky, in the ocean and on the earth. He created the first man, whose name was Glooscap. And he created Pet-Kout-Koy-ek, the River That Bends Like a Bow.

Today the water of Pet-Kout-Koy-ek is brown like chocolate. But in ancient times it was clear and fresh. One day a monster Eel swam down the river, pushing all the fish and fresh water into the salty bay.

Turtle told Glooscap about the wicked Eel's misdeeds and the harm he had inflicted upon the river and its creatures. So Glooscap gave great powers to Lobster, who grew gigantic and strong enough to fight the Eel.

Their battle stirred up the mud of Pet-Kout-Koy-ek, turning the water brown, and sent waves far up the river. They fought long and hard, until Lobster prevailed and Eel was killed.

Even today, however, the battle takes place twice a day on the river now called the Petitcodiac. The wave, which forms as Lobster pushes Eel back inland, is known to most as the tidal bore.

*Legend told by the late Micmac artist Michael Francis from Big Cove, whose parents were originally from Beaumont on the Petitcodiac River.*

## **THE PETITCODIAC TIDAL BORE**

The Petitcodiac River's claim to fame is its tidal bore, forming twice a day as the tides from the Bay of Fundy push upriver towards Moncton. A tidal bore occurs in areas of the world where tidal amplitudes are strong (at least 6 m), as is the case in the Bay of Fundy region. The phenomenon is created and influenced by a number of factors including river slope, downstream flow, river basin morphometry, the phases of the moon, the seasons and winds.

Twice a day as the tides rise in the Bay of Fundy, the current channels itself into a narrower body of water in Chigecto Bay. The tide is then forced into Shepody Bay, and finally into the mouth of the Petitcodiac, which becomes progressively narrower as the water moves forward. Entering the Petitcodiac River, the tide increases in height until an accompanying wave or vertical front, a tidal bore, forms as it moves upriver against the downstream flow.

Depending on the amplitude of the phenomenon, the wave or tidal bore in the Petitcodiac River will vary today from a few centimeters in height to as much as 75 cm (formerly as high as 2 m), rising at speeds ranging from a few km/hour to 13 km/hour.

## **PETITCODIAC – 250 YEARS OF ANECDOTES**

The Petitcodiac River Tidal Bore in southeastern New Brunswick has fascinated people for centuries. Numerous written testimonies, going back as far as 250 years ago, describe the passing of the Tidal Bore in various settings, with the unique perspective of its observers. The following section lists fifteen quotes and anecdotes on the Petitcodiac River tidal bore, collected throughout the centuries.

### **1750 – de Léry, French Officer**

De Léry's account of the bore is the oldest written account of Petitcodiac that has so far been traced, dating back to 1750.

“The Petitcodiac River goes up six leagues and fills the creeks, one hundred-ton ships can go up the river but can't anchor in it. However there are anchorages two leagues from its mouth, at Larosette's one league upriver, and right at the mouth, where we don't run aground at low tide.

In these various anchorages, up to thirty vessels can be accommodated and up to twenty can run aground in the creeks. If a vessel ran aground anywhere along the six leagues where they can go upriver, the great strength of the current would silt it up, as has already happened. The current flows up the river with such speed that, as the tide begins, it builds up a volume of water two or three feet thick that a galloping horse can't keep up with. The current is just as fast at rising and at falling tides.”

Excerpts from the *Rapport de l'Officier de Léry*, published in the Acadian newspaper *L'Évangéline* on October 2<sup>nd</sup>, 1924.

### **1758 – George Scott, English Officer**

In 1758, George Scott tells how the Tidal Bore created problems for his ships.

"The Tide is the most rapid of any of the rivers in the Bay of Fundy, the Bore (or first of the Tide) running five or six feet high and sometimes seven at Spring Tides, which makes it extremely dangerous for Vessells grounding in the River (...) when we went up, and the Bore came in it drove two of our Vessells foul of each other, did them much damage and I was greatly afraid would have wrecked them both."

Pincombe, C. Alexander, Larracey Edward W., *Resurgo: The History of Moncton, City of Moncton*, vol. 1, p. 40-41.

### **1812 – Mgr. Plessis, Québec Bishop**

Mgr Plessis, during his stay in Acadia in 1812, describes how he saw the Tidal Bore at that time:

"It is known that the Bay of Fundy is famous for the rapid rise of the tide, as well as for the enormous difference between the height of low and high waters. The rivers that empty into the bay participate in this extraordinary flow, which the locals identify as the "refoul" In Memramcook, the flow raises the water by twenty feet. At Peticoudiac, it can be heard coming from very far away, making a loud noise. It is a furious torrent, rising six to ten feet above the level of the river, running up with a rolling motion and terrible smashing sounds. Misfortune awaits any rowboat, or any schooner for that matter, found in its path. When the wave arrives at the location where the Creator has destined it to stop, then the water level rises as a single body until the tide reaches its height."

Plessis, Mgr Joseph-Octave, *Le journal des visites pastorales en Acadie de Mgr Joseph-Octave Plessis*, Les Cahiers, Société historique acadienne, vol. 11 no. 1-2-3, 1980, p. 114-115.

### **1825 – Peter Fisher, Historian**

In 1825, Peter Fisher describes in his historical writings his view of the phenomenon:

" The tides at the head of the Bay rise to a great height. They come in with successive swells of the water called the Boar, which at spring tides roll in with amazing velocity in waves about three feet perpendicular. The noise of the Boar is heard a great distance, and animals immediately take to the highland, and manifest visible signs of terror if near it."

Fisher, Peter, *The First History of New Brunswick*, Woodstock, Larsen's Printing, 1980, p. 70.

### **1844 – James Brown, School Commissioner**

Commissioner Brown, while on visit at "The Bend" (Moncton) in 1844, describes in his journal his sighting of the Tidal Bore.

" Went out in the afternoon and looked at the tide coming up the Petitcodiac River. It came rolling over the flats with immense fury carrying stones and mud before it and making a fearful noise. I stood on the wharf and saw it coming. The water behind was several feet high above the level of the water and flats within the Banks of the River and the whole body moved forward with immense force the front bank foaming and tumbling down in an indescribable manner. When it passed the point where I stood the River presented one entire rapid current running upwards red and thick with mud and clay."

Brown, James, *NB School Commission Report, 1844-45*, P.A.N.B.

### **1861 – British Hydrographic Chart**



A British hydrographic chart of the Petitcodiac River, published in 1861, refers to the Tidal Bore as follows:

"A bore with a breaking face occurs about every three hours before high-water in the Petitcodiac River between Stoney Creek and Moncton. At Moncton 8 miles above Stoney Creek, its rate of progress at Springs (extremely high tides) is about 8 ½ miles an hour, its average height being about 3 ¼ feet. After its passage the rise of the tide is very rapid until high water is attained.

During Neaps (lowest tides) the Bore still appears but its broken front usually is only a few inches high."

Larracey Edward W., *Chocolate River: A story of the Petitcodiac River*, Moncton, 1985, p. 36.

### **1869 – Daily Times, Moncton**

The height of the Tidal Bore during the "Saxby Gale", a hurricane that affected the Moncton area the night of October 4th, 1869, was apparently even greater:

"That day, October 4th 1869 ... during the night, the tide, which was high due to the full moon, came in just as the winds sprang up and quickly increased to gale strength. The Tidal "Bore" on that night must have been something to see. The Bore, according to various sightings, was estimated to have been between seven and nine feet in height and the roar as it came up the river could be heard for over a mile ..."

Pincombe, Alexander C., *The history of Monckton township (ca 1700-1875)*, M.A. Thesis UNB, 1969.

### **1887 – l'abbé Casgrain de Québec**

While visiting l'Acadie, l'abbé Casgrain describes the bore in this fashion in 1887 :

"In this part of the Bay of Fundy, the tide rises extremely rapidly, and can reach a perpendicular height of seventy feet. It comes rolling in on an enormous wave that scrapes a thick layer of mud or silt off the bottom of the Bay, which is deposited as the tide goes down."

Casgrain, l'abbé, H.R., *Un pèlerinage au pays d'Évangéline*, Imprimerie de L.J. Demers et Gréerie, Québec, 1887.

### **1899 – Daily Transcript, Moncton**

In 1899, the Daily Transcript of Moncton talks about the Tidal Bore's height:

"It is said that formerly the bore used to be higher than at present, owing to changes that have taken place in the bars in the river, which now obstruct the channel at low water and interfere with its development. No very definite information could be obtained as to this. [...] On the 22<sup>nd</sup>

August, 1892, a good photograph of the bore was obtained, which has been published in a report of the Geological Survey. Its height, as then measured, was 5 feet 4 inches. In quoting this figure, it is to be noted that the rise of the water immediately after the bore passes, is so rapid that a few minutes delay in taking a reading on a graduated staff would greatly increase the height which would be observed. From the observation above tabulated, it is clear that in 3 to 4 minutes after the bore passes, the water has already risen an extra foot. The greatest height which was measured in the above observations was 3 feet 3 inches, although it would be a little higher at the middle of the river."

The Petitcodiac Bore, Official report on the Tidal Phenomenon, The Daily Transcript, Tuesday Evening, April 11, 1899.

### **1910 – Illustrated London News**

A remarkable photo of the Petitcodiac Tidal Bore, taken in 1902, appears in the front page of the *Illustrated London News*, December 10, 1910, along with a photo of China's Qiantang River Bore, the world's largest tidal bore.

" The result of a sudden flow of the tide into the estuary of a river close to the sea: the tidal bore (on the Petitcodiac) near the Bay of Fundy."

### **1925 – George-Nester Tricoche, Traveller**

A Frenchman by the name Tricoche gives his perspective of the Tidal Bore in 1925:

"My purpose is to see the famous Bore (in English in original account), the front of water created on the Petitcodiac River. For tourists, the Bore is Moncton's raison d'être. At least that's the opinion one young Loyalist farmer's daughter:

- Open a local daily newspaper and you'll see the Bore Time Table, showing the time of the bore's arrival within half a minute. And look in this bookstore's display window, the Time of Bore advertisement practically jumps out at you.

And then in an affected tone, she makes a pun on Bore, which has more than one meaning in English:

- Truly, it is a Bore!

But that is not my opinion: there are several points of interest in this local curiosity. Today is Sunday, and besides tourists, many residents with not much to do are gathered in the small square that overlooks the river. The scene reminds me of Caudebec-en-Caux, where so many foreigners come to the promenade along the Seine to contemplate the bore at the rising tide.

The illusion is even greater because all around me I hear French being spoken. Indeed, there are numerous Acadians living in Moncton, and a large proportion of them live in this neighborhood.

The front does not reach the height of the bore in Caudebec, not to mention that of the wave in the Brahmapoutra. But it is remarkable, nevertheless, in that it is strongly felt more than 40 kilometres away from the Ocean, and as it rises swiftly over the mud flats, its effect is that of a sudden flood.

As I watch the Acadian women and girls gaily chatting while they look at the bore, I reflect that some of them no doubt had ancestors that did the very same thing in the little Norman town, totally oblivious of the expatriation and tribulations which awaited their descendants."

Ticoche, Georges-Nester, *Au Maine et au Nouveau-Brunswick*, Paris, Librairie Pierre Roger, 1925, p.134-135.

### **1951 – Keith Dalton, Scientist**

In November of 1951, an article entitled *Fundy's prodigious tides and Petitcodiac's tidal bore* is published in the *Journal of the Royal Astronomical Society of Canada*:

"As it moves further, towards Moncton and the right angle bend of the Petitcodiac River, the Tidal Bore develops a foaming and breaking front, and its average height is from 3 to 3 ½ feet (1m). Its height can also increase above 5 feet (1.5 m) if a storm occurs. The Tidal Bore moves at a speed of 8 miles per hour, and travels a distance of 13 miles once it has passed Moncton. After the passing of the Tidal Bore, the river's water level rises quickly, then more gently, all within 3 hours. Then, the river is about 30 feet deep and is half a mile wide. Some vessels take advantage of the bore's passage to move upstream and downstream along with the river current."

Dalton, F.K., 1951, *Fundy's prodigious tides and Petitcodiac's tidal bore*: *Journal of the Royal Astronomical Society of Canada*, v. 45, no. 6, p. 225-230.

### **1960 – Jacques Bouteloup, Scientist**

Bouteloup, 1960

"All rivers that have a mouth that is not too deep nor obstructed on a sea with strong tides present this phenomenon; the most intense are those of the Petitcodiac River (Bay of Fundy), the Qiantang River (southern China) and the western mouth of the Amazon (reaching 6 meters)."

Bouteloup, Jacques, *Vagues, marées courants marins*, Paris, Coll. « Que Sais-je ? », Presses Universitaires de France, 1960, p. 110.

### **1965 – R.A.R. Tricker, Scientist**

One of the first scientific works on the tidal bores of the world, Tricker's *Bores, breakers, waves and wakes - An introduction to the study of waves on water*, was published in 1965.

"Tidal bores occur widely in other parts of the world. There is a large one, of some 4 or 5 feet in height, in the Petitcodiac River in New Brunswick."

Tricker, R.A.R., 1965, *Bores, breakers, waves and wakes - An introduction to the study of waves on water*: New York, Elsevier, 250 p.

## **1982 – David Lynch, Scientist**

Lynch 1982

"North America has several notable tidal bores. The most striking is the one on the Petitcodiac River in Nova Scotia, which empties into the Bay of Fundy."

Lynch, D. K., 1982, Tidal Bores: Scientific American, v. 247, no. 4, p. 146-156.

### **Analysis and Observations**

The description of these fifteen anecdotes on the Petitcodiac River tidal bore, taken during the course of the past 250 years, allows us to suggest the following analysis and observations:

1. The Petitcodiac tidal bore (pre-1968) is recognised as one of the most important in the world (1910, 1925, 1951, 1960, 1965, 1982)
2. The Petitcodiac tidal bore is internationally renowned since many years (1910)
3. That this bore had an average height of between 1 and 1.5 m, and that it exceeded 1.5 m in height during the year's strongest tides (1951, 1965)
4. The largest tidal bore recorded in the Petitcodiac seems to have taken place during the Saxby Gale of 1869, where it reached between 2 and 3 m (1899)
5. That during conditions of low tides, the bore reached an average height of only a few centimetres (1861, 1951)
6. The arrival of the Petitcodiac tidal bore was accompanied by a furious torrent and a remarkable noise (1758, 1812, 1825, 1844)
7. The bore arrived rapidly (a galloping horse – 1750, 1899, 1951)
8. The Petitcodiac tidal bore fascinates its observers since centuries (1750)
9. The phenomenon is recognised and appreciated as a tourist attraction since many years (1899, 1925)

## **PETITCODIAC – THE BORE IN THE YEAR 1951**

One of the most famous descriptions of the Petitcodiac River tidal bore appeared in the *Journal of the Royal Astronomical Society of Canada* in November of 1951. Written by F. Keith Dalton, the article is entitled *Fundy's Prodigious Tides and Petitcodiac's Tidal Bore*.

While these observations go back approximately 50 years, it remains one of the last scientific accounts of this very rare Canadian natural phenomenon before the completion of the construction of the Petitcodiac causeway in 1968. The Dalton description allows us to better understand the original conditions of the Petitcodiac River tidal bore (pre-1968), and also helps us imagine what the Petitcodiac tidal bore could look like with the restoration of these conditions.

### **Extracts from the Dalton article**

"The tides of the oceans and their effects on the shores and rivers are probably the most interesting natural phenomenon to observe on this planet. The highest tides in the world that have been noted are those at the Minas Basin, at the eastern end of the Bay of Fundy, between the provinces of New Brunswick and Nova Scotia, in Canada. In this area, extreme effects occur.

In the Petitcodiac River, which flows into the Bay of Fundy through Shepody Bay and Chignecto Bay, can be found a very impressive tidal bore which can be observed, as it rolls up the river, from a park set up along the river for this purpose, in Moncton.

The rivers most known for their tidal bores are the Severn and Trent Rivers, both in England; the Seine River in France; the Qiantang River in China; the Amazon in Brazil and the Petitcodiac River in Canada.

The tides that affect the Bay of Fundy begin by a westward movement of ocean waters in the Indian Ocean, west of Australia. This movement proceeds along, as it becomes more intense, until it passes around South Africa and then rushes to the north, up the Atlantic Ocean.

The effect of the tides on the shores of bays and basins are the erosion of rocks as well as the shifting or washing away of fine materials. These effects have already produced beaches and splendid sites worth seeing. An example of erosion of rocks by waves is at Hopewell Cape, at the mouth of the Petitcodiac River, where a series of "flower-pot rocks" can be found, which were shaped by the tides of the Bay of Fundy. According to the rocks' curved shape and height, It is possible to notice the maximum height reached by the tides across time and how frequent certain water levels used to be.

An example of the shifting of fine materials is at the northern shore of the Minas Basin, at Parrsboro, where a steep gravel beach, consisting of washed up materials by waves and tides, can be found.

The Tidal Bore of the Petitcodiac River, in south-eastern New Brunswick, is an impressive tourist attraction for both amateurs and professionals. For them, it is proof that there exists a gravitational pull between the moon and the Earth, which moves ocean waters and produces this bore. The Bore is caused by the anomalistic tides of the Bay of Fundy, when these tides vary according to the distance between the moon and the Earth. It is a wave that forms as it moves up the Petitcodiac River, when the incoming tide is forced into it. As the incoming tide usually flows against the outgoing current of the river, a wave is formed and is followed by the high waters.

Two conditions must be met so that a tidal bore can occur. The tide at the mouth of a river must rise rapidly. Also, the river must have a gradually sloping bottom, so that the depth of the water decreases as the waves moves up the river. The river must also become gradually narrow. The height of the bore depends upon the rate of rise of the tide. Should a storm or a hurricane force the tide to rise more rapidly, the tidal bore would also be higher.

The Petitcodiac River is joined to the Bay of Fundy by an estuary 32 miles long. When the rising tide enters at Hopewell Cape, it has a height of about 46 ½ feet and becomes a tidal wave 10 miles further as it moves up the river. It has a softer appearance, as its ends break against the shores, thus it can be heard from a great distance.

As it moves further, towards Moncton and the right angle bend of the Petitcodiac River, the Tidal Bore develops a foaming and breaking front, and its average height is from 3 to 3 ½ feet. Its height can also increase above 5 feet if a storm occurs. The Tidal Bore moves at a speed of 8 miles per hour, and travels a distance of 13 miles once it has passed Moncton. After the passing of the Tidal Bore, the river's water level rises quickly, then more gently, all within 3 hours. Then, the river is about 30 feet deep and is half a mile wide. Some vessels take advantage of the bore's passage to move upstream and downstream along with the river current.

When the moon is nearest to the Earth, even during Spring Tides, the Tidal Bore is high enough. When the moon is further from the Earth, during neap tides, the Tidal Bore has the character of a ripple and is hardly discernible when winds blow to the same direction.

In order to predict the height of the Tidal Bore when it passes near Moncton, and to avoid the deception of observing no more than a ripple, it is possible base the height of the bore on that of the rising tide near Saint John, New Brunswick, as indicated in the Atlantic Tide Tables, available upon request. These tables indicate that when the tide's height is expected to be about 28 feet high at Saint John, the Tidal Bore will be more pronounced at Moncton. If the tide's height is expected to be no more that 21 feet, the Tidal Bore will appear as a small ripple. One can also use these tables to predict the time of passage of the bore. It passes every 12 hours and 30 minutes, and most of the time, there are two bores flowing the river each day. The Tidal Bore's height can also vary from one passage to another.”

## **Analysis and Observations**

The 1951 Dalton description, one of the last scientific accounts of the Petitcodiac River tidal bore prior to the construction of the causeway (1968), allows us to suggest the following analysis and observations:

1. The Petitcodiac tidal bore was one the most important natural phenomena of its kind in the world
2. The Petitcodiac tidal bore had an average height of 1 m, and that it exceeded 1.5 m in height during the year's strongest tides (8.5 m tides)
3. That during conditions of low tides, the bore reached an average height of only a few centimetres (6.5 m tides)
4. The arrival of the Petitcodiac tidal bore was accompanied by a very impressive torrent that could be heard from a distance
5. The Petitcodiac tidal bore moved at an average speed of 8 ½ miles per hour, and travelled a distance of 13 miles beyond Moncton (20 km – up to nearby Salisbury)
6. That after the passing of the tidal bore, the river's water level rose quickly, then more gently, all within 3 hours
7. That after the water levels rose, the river was about 30 feet (9 m) deep during high tide conditions
8. The Petitcodiac tidal bore arrives approximately every 12 hours and 30 minutes, and that most of the time, there are two bores flowing up the river each day
9. The Petitcodiac tidal bore is influenced by the tides of the Bay of Fundy, which vary proportionately with the distance between the Earth and the Moon
10. The highest tides occur in the Spring and Fall of every year, and during the days following the New and Full Moon
11. The Petitcodiac tidal bore is an impressive tourist attraction for amateurs and professionals alike
12. That aside from Cook Inlet in Alaska and the Minas Basin in Nova Scotia, the Petitcodiac River is the only other know estuary in North America where the phenomenon takes place

## TIDAL BORES OF THE WORLD

The natural phenomenon of the tidal bore occurs in areas of the world where tidal amplitudes are strong (more than 6 m). It is found in approximately sixty rivers and estuaries around the world and on all continents except Antarctica (Catalog of Worldwide Tidal Bore Occurrences and Characteristics, S. Bartsch-Winkler and D. K. Lynch, 1988).

In North America, the phenomenon of the bore is found in the Bay of Fundy and in Cook's Inlet, Alaska. Among the best known are the bores in the Petitcodiac River (1 m + pre-1968) which passes by Moncton, in New Brunswick, called *refoul* by the Acadians, in the Shubenacadie River (1 m +) and Salmon River (1 m) in Nova Scotia. These bores are all based on the tides of the Bay of Fundy. As for the bores on the Turnagain Arm and Knik Arm Rivers, both originate in Cook's Inlet, Alaska.

In Europe, nowadays, tidal bores mainly occur in England (Severn River – 1 m +) and in France (Dordogne River – 1 m +). The largest bores in the world occur in the Qiantang River in China (2 m +) and the mouth of the Amazon River in Brazil (2 m +).

The Qiantang River tidal bore, called *Black Dragon*, attracts over 250,000 visitors every fall to its most impressive onslaught of the year. A people's festival takes place in the city of Hangzhou and prayers are offered by the inhabitants to placate the spirit of Black Dragon.

Each spring, the tidal bore in the Amazon, called *pororoca*, spreads across several branches of the mighty river's estuary. One of the unique features of this remarkable bore is that it forms at sea. It can reach up to 20 km in width and over 4 metres in height.

In England, surfing adepts and some professionals have been creating a sensation over the past ten years by riding the wave of the Severn tidal bore for a distance of several kilometres, attracting thousands of observers each spring as well as national television channels. In Nova Scotia, some thirty people are employed in a tourism operation that uses Zodiacs to transport thousands of visitors per year over the waves of the Shubenacadie Tidal bore. The economic spin-offs from this new industry amount to several million dollars yearly.

It may be difficult to establish the exact order of importance and popularity of the world's various tidal bores, but here is a suggested list of the 10 best-known tidal bores:

1. Qiantang, China (2 m +)
2. Amazon, Brazil (2 m +)
3. Seine, France (1 m + - pré-1963)
4. Petitcodiac, Canada (1 m + – pré-1968)
5. Severn, England (1 m +)
6. Dordogne, France (1 m +)
7. Shubenacadie, Canada (1 m +)
8. Turnagain Arm, United States (1 m +)
9. Salmon, Canada (1 m)
10. Hoogly, India (1 m +)



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