Impact Assessment Project on Waves Created by Wakeboats on the Shores of Lakes Memphrémagog and Lovering

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SOCIÉTÉ DE CONSERVATION LAC LOVERING
Moi je protège mon lac

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EXECUTIVE SUMMARY

The presence of wakeboats on bodies of water in Quebec has increased in recent years. More and more lakeside residents are concerned about the potential impact of the passage of such boats on the shores of these lakes, including sediment resuspension caused by an increase in the energy present in these waves.

The objective of this research was to develop a scientific framework to validate the existence, magnitude and modalities of the impacts of oversized waves generated by wakeboats on lake environments in Quebec. The research was conducted at lakes Lovering and Memphrémagog, in collaboration with the Société de Conservation du Lac Lovering (SCLL) and Memphremagog Conservation Inc. (MCI), and with the support of Community Service.

Below are the **main results** of the research:

- All wakeboat passages induce a significant increase in the energy contained in the waves that reach the shore, on average by a factor of 4.
- The impact of wakeboat passages is directly and inversely related to the distance between the passage and the shore.
- Of the three different types of waves produced by a wakeboat, wakesurfing waves are the ones that cause the greatest impact when they reach the shore (1.7 times higher than the waves of a boat in normal motion).
- Wakeboat passages have a greater impact on shores with a steep slope than those with a gentle slope.
- Our data show that the energy produced by the wakeboat dissipates completely before reaching the shore (and therefore has no significant effect) when the wakeboat passage is 300 m or more from the shore.

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INTRODUCTION

In recent years, new aquatic sports have emerged on Quebec's water bodies. Notably, the popularity of wakeboats continues to increase on many lakes, including lakes Memphrémagog and Lovering. Located north of the Appalachian region, these two lakes are important recreational and tourism hubs for both shoreline residents and vacationers. The configuration of wakeboats can create a wave high enough to allow enthusiasts to "surf" at the back of the boat, on either a wakesurf or a wakeboard. When wakesurfing, the surfer is not attached to the boat, but the person surfs behind the wake of the boat on a board very similar to a normal surfboard. In the case of wakeboarding, the person surfs behind the boat, remaining attached to it at all times, on a board much more like a snowboard with shoes.

With the exception of a few studies, such as those by Hill, Beachler and Johnson (2002), limited to the Chilkat River in Alaska, and those by Péloquin-Guay (Brief, Université de Montréal 2013) on the Batiscan River, very few experimental studies have been conducted to rigorously and quantitatively assess the potential of boats to accelerate shoreline erosion, and none have been conducted specifically on wakeboat-type boats in lakes. However, shore erosion can be an important nutrient vector to lakes, particularly in deforested areas bordering these lakes (Keenan and Kimmins 1993). To date, there are no regulations governing the use of these boats in relation to their environmental impact. Indeed, the only regulations currently in force are those related to water safety, which limit speed to 10 km/h, when the boat is moving less than 100 m from the shore. On the rest of the lake, the speed limit is 70 km/h (Appendices 2 and 3: Boating regulations map issued by the Government of Quebec, MRC Memphrémagog 2011; MRC Memphrémagog 2013).

However, each wave created by wind or a boat contains a certain amount of energy (turbulent kinetic energy, TKE). Some of this energy will be dissipated quickly, but a certain amount may reach the shore. It is this additional energy that can contribute to the accelerated erosion of shores and the resuspension of sediment in place. Thus far, no link has been made in order to enable quantitative comparison between the energy induced by wave trains produced by boats and those normally observed.

The objective of this project was therefore to develop a scientific framework to validate the existence, magnitude and modalities of the impacts of waves caused by wakeboats on the lake environment in Quebec, based on measurements taken at lakes Lovering and Memphrémagog. Three sites in each lake were each eqipped with instruments to acquire the physical data to quantify the energy induced by the wakeboat wave train reaching the shore. In addition, measurements were taken to assess sediment resuspension.

METHODOLOGY

Sampling plan

In order to properly quantify the effect of wakeboats on the energy received by the shores, we have chosen to proceed with a controlled experimental design, i.e., one where we can impose specific configurations and trajectories on the boat. Our protocol allows us to measure the energy generated by wakeboat waves according to several combinations of three main factors:

1) the type of displacement made by the boat, characterized by the speed of the boat, and thus the type of waves created;
2) the distance from the shore at which the boat passes (100 m, 150 m and 200 m); and
3) the type of shoreline, according to the slope of the shore.

Figure 1 illustrates this sampling plan. For each combination, measurements were taken twice to assess variability between tests of the same configuration.

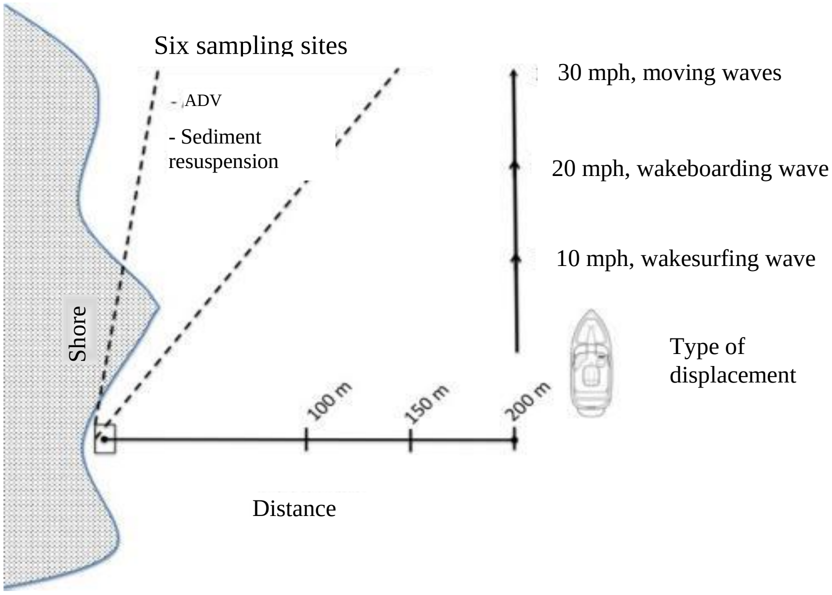


Figure 1. Sampling plan for measuring three different types of displacement at three distances from the shore and six sampling sites.

Types of wakeboat displacement

The displacement of a boat can create different types of waves. In this research, three types of waves were studied: wakesurfing waves, wakeboarding waves and waves caused by the wakeboat moving on the lake. Wakesurfing waves are created by filling only one side of the boat's ballast tanks and sailing at a fairly low speed (10 mph; 16.1 km/h). In the case of wakeboard waves, both sides of the ballast tanks are filled and the boat travels at a speed of 20 mph (32.2 km/h). When the wakeboat moves from one place to another, the average speed of travel is 30 mph (48.3 km/h), but this time, it is moving with these ballast tanks empty. The sampling plan was developed to measure the amount of energy reaching the shore and sediment resuspension at the shore, according to the three different types of displacement (wakesurfing waves, wakeboarding waves and moving waves), at three distances from the shore and at six sampling sites (three per lake; Appendix 1).

Site selection and characterization – Shore type

The purpose of the site selection was to obtain different types of coastal slope, in order to confirm whether the energy reaching the shore and the resuspension of sediments are influenced by the slope of a bank (Sorensen 1997). Lakes Lovering and Memphrémagog were sampled at three different sites on each lake (Appendix 1) in order to obtain a slope gradient representative of the lakes in the region. Sampling was conducted on August 4, 5, and 6, 2013, between 8 a.m. and 8 p.m. For each of the sampled sites, shore slope was calculated from bathymetric maps based on the distance from the shore to the location in the lake where the water reached a depth of 3.05 m (10 feet, bathymetric map units).

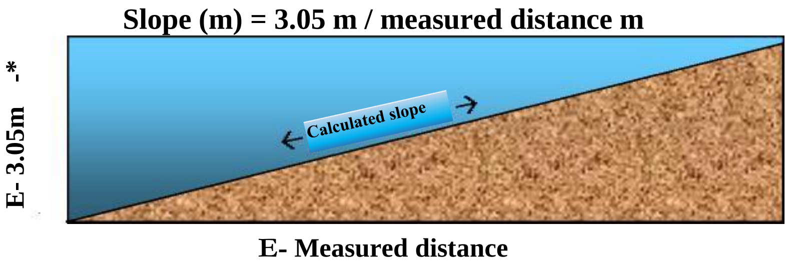


Figure 2. Illustration of the calculation of the shore's coastal slopes at the sampling sites.

Once the slopes were calculated (Table 1), the six sites were separated into sites with a steep ($\geq$0.1 m m^{-1}) or a gentle ($<$0.1 m m^{-1}) slope.

Table 1. Characteristics of the sampled sites.

Lake	Site	Sampling date	Slope of the shore (m m^{-1})	Type of slope
Lovering	LOV1	August 4, 2013	0.096	Gentle
	LOV2	August 5, 2013	0.022	Gentle
	LOV3	August 5, 2013	0.044	Gentle
Memphrémagog	MEM1	August 5, 2013	0.203	Steep
	MEM2	August 5, 2013	0.131	Steep
	MEM3	August 6, 2013	0.299	Steep

Sampling

Sediment resuspension

To measure sediment resuspension, a water sample was taken before (A) and after (B) each vessel passage at each sampling site. Resuspension represents the difference in the amounts of suspended sediment measured between the two samples (B-A). The baseline concentration at each site was established as the first sample collected at that site.

Turbulent kinetic energy

The energy transmitted by the waves of the wakeboats was measured using a micro-ADV (acoustic Doppler velocimeter), which measures the speed of the water in three dimensions at a high frequency (25 times/second; Figure 3).

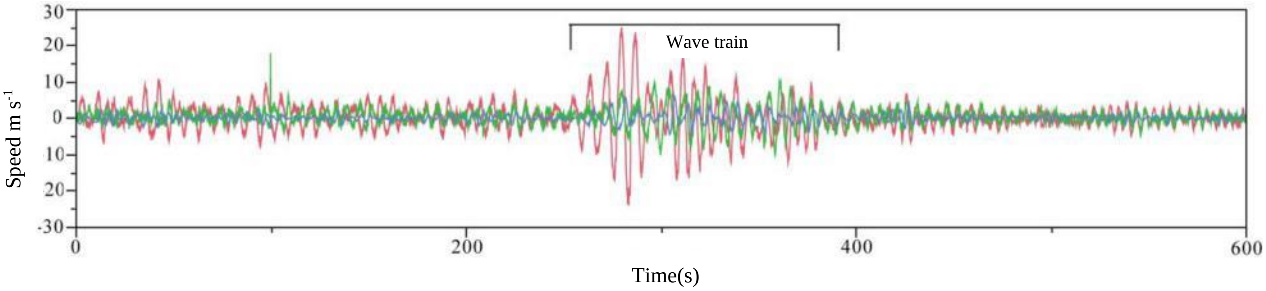


Figure 3. Example representing the velocity (m s^{-1}) of the dimensions x (red), y (green) and z (blue) for a period of normal waves, and during the passage of the boat wave (wave train).

The turbulent kinetic energy (TKE) contained in a wave (created by a boat or otherwise) can be calculated from the three-dimensional velocities of its passage, according to the equation:

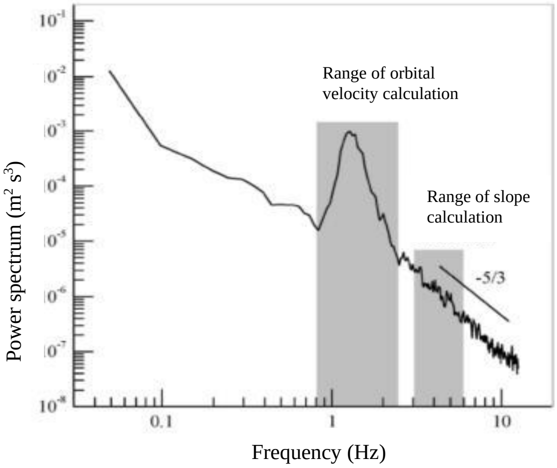
$$TKE = \frac{1}{2}\left(\overline{x^2} + \overline{y^2} + \overline{z^2}\right),$$

where x, y, and z are the velocities of micro-turbulence measured in all three dimensions (Wist 2004).

This type of measurement makes it possible to estimate the energy dissipation rate (ε), which is also a measure of the production of energy when the system is in equilibrium. These three-dimensional velocity measurements are then broken down into a power spectrum (Figure 4), the characteristics of which are predicted by Kolmogorov's theory (1941) according to the equation:

$$S(f) = C_f \varepsilon^{2/3} u_{rms}^{2/3} f^{-5/3}$$

where $S(f)$ is the spectral density at frequency f (Hz), u_{rms} can be considered as the average advective velocity (cm/s), C_f is a constant, and ε is the energy dissipation rate (m2 s-^{3}). Details of this methodology can be found in Vachon, Prairie, and Cole (2010).



(From Vachon, Prairie and Cole 2010)

Figure 4. Example of a power spectrum for calculating the dissipation of energy.

By using the maximum peak of the power spectrum obtained for each wave train and dividing it by the sampling frequency (25/s), we obtain the number of waves present in each wave train. This number of waves is then divided by the length of the wave train (number of waves/wave length) to obtain a number of waves per second for each wave train.

Assessment of normal conditions

Shore impacts under normal conditions, i.e., without the passage of boats, were assessed using the same device used for wakeboat energy measurements. This data made it possible to assess the natural impact of the waves generated by the wind for each of the sites.

Laboratory analysis

Water samples taken before and after each boat passage were analyzed in the laboratory. For each sample, a volume of 250 mL of water was filtered through 934-AH RTU filters (47 mm, pre-washed and pre-weighed, Whatman glass microfibre filters) within 72 hours of being collected in the field. Over the next seven days, the filters were dried for one hour in an oven at 103 °C ± 2 °C, then stored for 30 minutes in a desiccator to remove all traces of moisture. The filters were finally weighed with a microbalance with an accuracy of 0.0001 g, to obtain the amount of dry material and therefore sediment contained in the 250 mL water sample. The result was then converted to mg/L (Gray et al. 2000; Environmental Sciences Section 1993).

Statistical analyses

The BACI (before-after-control-impact) protocol has been used as an experimental design for statistical analyses (Stewart-Oaten, Murdoch and Parker 1986). This type of sampling makes it possible to compare a site before and after a disturbance, for different types of situations. Here we compared the difference between the measurements during the passage of the wakeboat waves and those during normal conditions, for each type of displacement, each distance from the shore and at each sampling site. Analyses of variance (ANOVA), mean comparisons (t-test), and linear regressions were performed with JMP software to analyze the data.

Limitations of study

As part of this study, only two lakes were sampled (Memphrémagog and Lovering) at three sites each. As such, some features of the lakes in the area are likely not represented by the sampling plan. In addition, three typical movements of wakeboat-type boats were used in the sampling plan (wakeboard, wakesurf, moving). In reality, the energy experienced by the shore is probably much more varied, because different types of passage, at varying speeds, ensue over time.

Furthermore, in the case of the sediment resuspension measurement, the results showed lower amounts of sediment than we expected and were very close to the detection limit of the method used. They are therefore not as accurate as desired and should therefore be considered very conservative.

RESULTS AND DISCUSSION

In this study, we analyzed the variations in energy (TKE) and sediment resuspension caused by wakeboat waves upon reaching the shore, by varying the type of movement of the wakeboat, the distance from shore at which it is located, and the slope of these shores. This section opens with the overall results, i.e., the results of all types of crossings, all distances from the shore and all slopes of shore combined, as well as the six sites combined (i.e., the three at Lac Lovering and the three at Lac Memphrémagog). In the following sections, the results are presented according to the type of movement of the wakeboat (wakesurfing, wakeboarding and moving) and therefore the type of waves, according to the distance from the shore (100 m, 150 m, 200 m) and according to the shore's coastal slope. A section also discusses some of the characteristics of the different types of waves produced.

Table 2 shows the average values obtained from the sampling in the two lakes. The results show that the waves created by the wakeboat cause a substantial (on average, four times higher) and still significant increase in the amount of energy (TKE) that reaches the shore, compared to normal conditions (i.e., without boat passage). This general result applies to all types of passages, all distances from the shore and all shore slopes combined.

Table 2. Comparisons of the results in normal conditions and during the passage of a wakeboat: speeds (average, maximum, minimum); turbulent kinetic energy (TKE), horizontal (ε_x) and vertical (ε_z) energy; suspended sediment.

		Normal	Displacement	t-test	n
Average speed	cm s^{-1}	3.04	6.27	<0.0001*	215
Maximum speed	cm s^{-1}	10.58	20.39	<0.0001*	214
Minimum speed	cm s^{-1}	0.08	0.12	0.0003*	214
TKE	m^{2} s^{-2}	7.91	31.81	<0.0001*	209
Suspended sediment	mg L^{-1}	0.57	1.16	<0.0001*	215

Note: Differences were considered significant at $p < 0.05$.

Similarly, the passage of a wakeboat creates waves carrying enough energy to directly induce a statistically significant sediment resuspension, on average two times higher than under normal conditions (Table 2), for all types of displacement, all distances and all slopes combined.

Turbulent kinetic energy (TKE)

Figure 5 shows the TKE results according to the distance between the boat's passage and the shore (100 m, 150 m, 200 m) and according to the type of passage, i.e., TKE measurements for all types of passage combined (Figure 5a), those for wakesurfing (10 mph; Figure 5b), those for wakeboarding (20 mph; Figure 5c) and those for the boat moving (30 mph; Figure 5d).

Our results show that, for each type of boat passage, regardless of the distance, there was always a significant increase in the amount of energy present in the wakeboat wave train (Figure 5) that reached the shore (light grey), compared to normal conditions (dark grey).

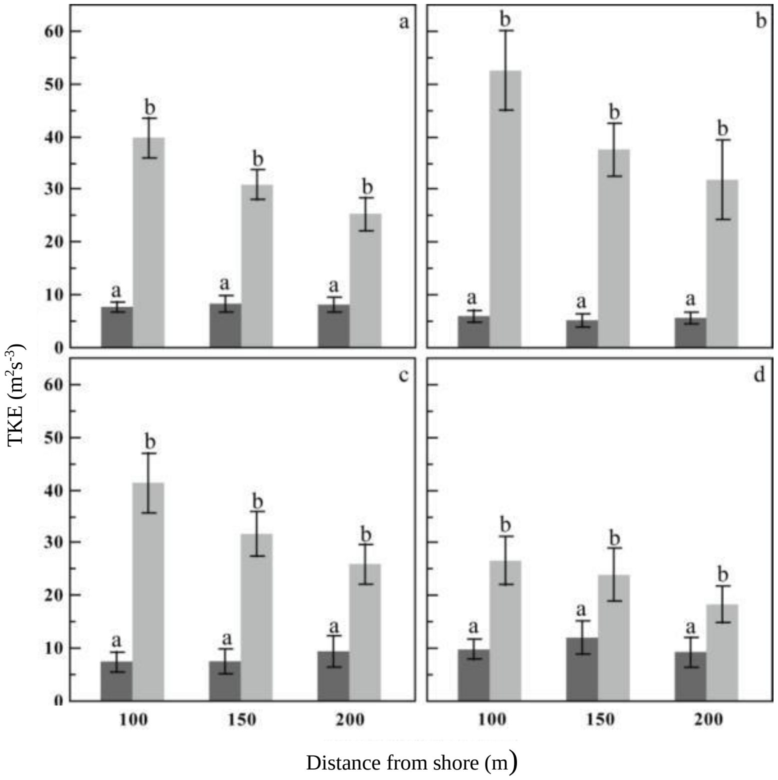


Figure 5. The energy (TKE) present in normal waves (dark grey) and that present in waves following the passage of a wakeboat at 100 m, 150 m and 200 m from the shore, and according to the boat's type of passage (a: all types of passage combined; b: 10 mph; c: 20 mph; d: 30 mph).

Note: The different a and b letters above the columns signify a significant difference ($p<0.05$).

Having thus established that all the passages contain a significantly higher energy than in normal conditions, comparisons will be made between the different types of passages and the different distances from the shore.

Figure 6 shows the additional energy induced by the passage of a wakeboat, i.e., the difference between the energy under normal conditions and that measured during the passage of the wakeboat (wave TKE – normal TKE).

Two types of results are presented here. From one perspective, the additional energy induced is presented according to the use of the boat (wakesurfing, wakeboarding, moving), and therefore according to its speed (10 mph, 20 mph or 30 mph), and according to the distance of the boat from the shore (a: 100 m; b: 150 m; c: 200 m).

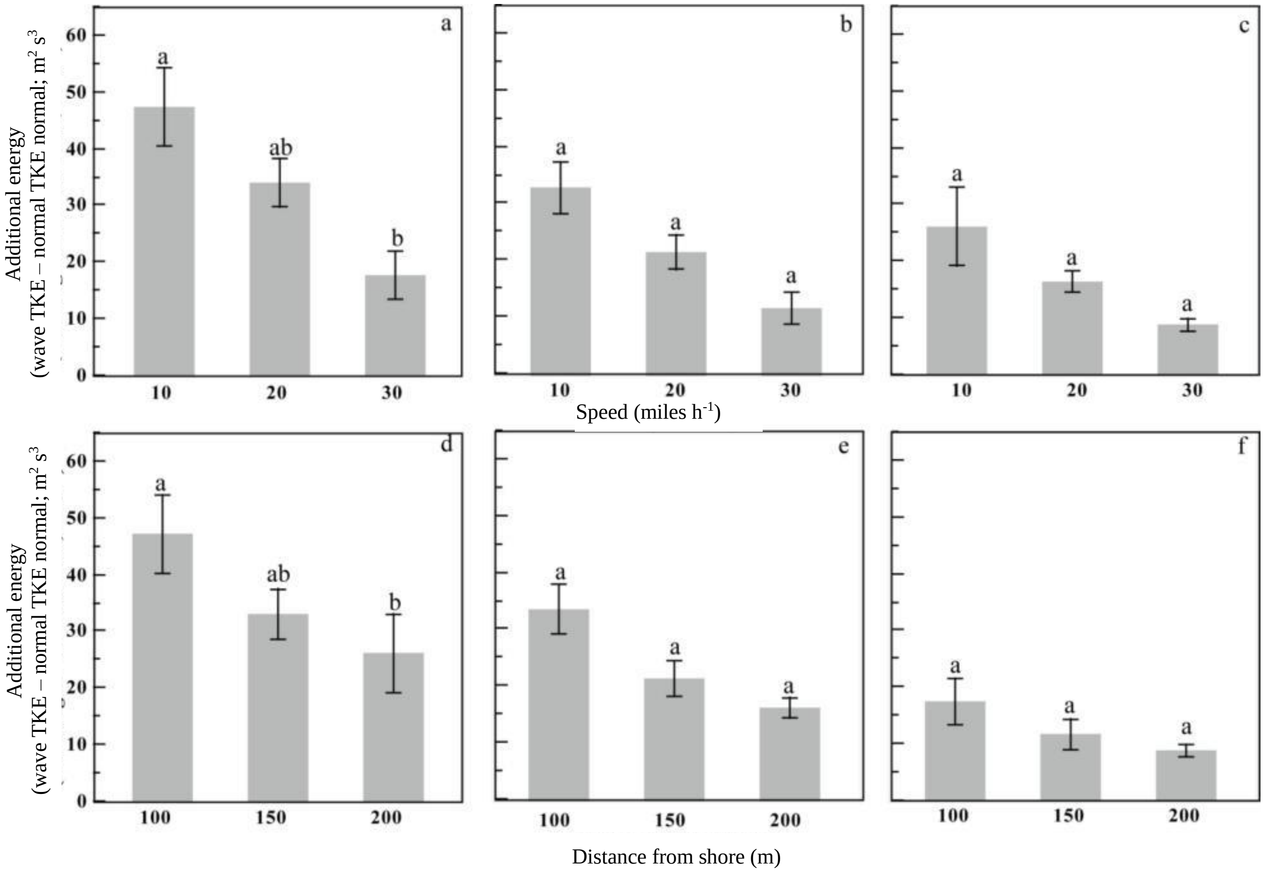


Figure 6. The additional energy induced by the passage of a wakeboat (wave TKE – normal TKE) by type of passage (10 mph, 20 mph and 30 mph) and according to the distance from the shore (a: 100 m; b: 150 m; c: 200 m) and the energy induced by distance from the shore (100 m, 150 m and 200 m) and according to the type of passage (d: 10 mph; e: 20 mph; f: 30 mph).

Note: The different a and b letters above the columns signify a significant difference ($p<0.05$).

This first series of graphs makes it possible to compare the effect of the different uses of the boat for the same distance from the shore: for example, the impact of wakesurfing (10 mph) at 100 m from the shore (Figure 6a) is much greater than that of the boat moving (30 mph). In fact, the energy created by wakesurfing is 1.7 times higher than that produced by the boat moving, despite its speed of 30 mph. For other distances from the shore (Figure b and c), the differences are not significant, although there is a trend between the distances of 300 m and 100 m.

The second set of graphs in Figure 6 allows us to reverse the analysis, i.e., compare the amount of additional energy induced according to the distance from the shore (100 m, 150 m and 200 m) and according to the use of the boat, and therefore according to its speed (d: 10 mph; e: 20 mph; f: 30 mph).

This second set of graphs shows that the additional energy induced when the boat passes 100 m from the shore is two times higher than that induced by a passage at 200 m. This difference according to distance from shore is significant only in the case of wakesurfing waves (Figure 6d), although such a trend can be observed from wakeboarding waves and moving waves (Figure 6e and f).

Sediment resuspension

Figure 7 shows the quantities of sediment resuspended for each distance between the passage of the boat and the shore (100 m, 150 m, 200 m); Figure 7a shows the results for all types of passages; Figure 7b shows the results for wakesurfing waves; Figure 7c shows the results for wakeboard waves; and Figure 7d shows the results for moving waves.

Figure 7 shows that, in general, the passage of a boat creates a significantly higher sediment resuspension than under normal conditions: this is the case for wakesurfing waves (10 mph; Figure 7b) and moving waves (30 mph, Figure 7d), when boats are travelling 100 m or 150 m from shore. When the boat passes at a distance of 200 m, there is no longer any significant change in sediment resuspension. Opposite results are found for wakeboarding passages (20 mph, Figure 7c), i.e., a significant resuspension only at 200 m but not at 100 m or 150 m.

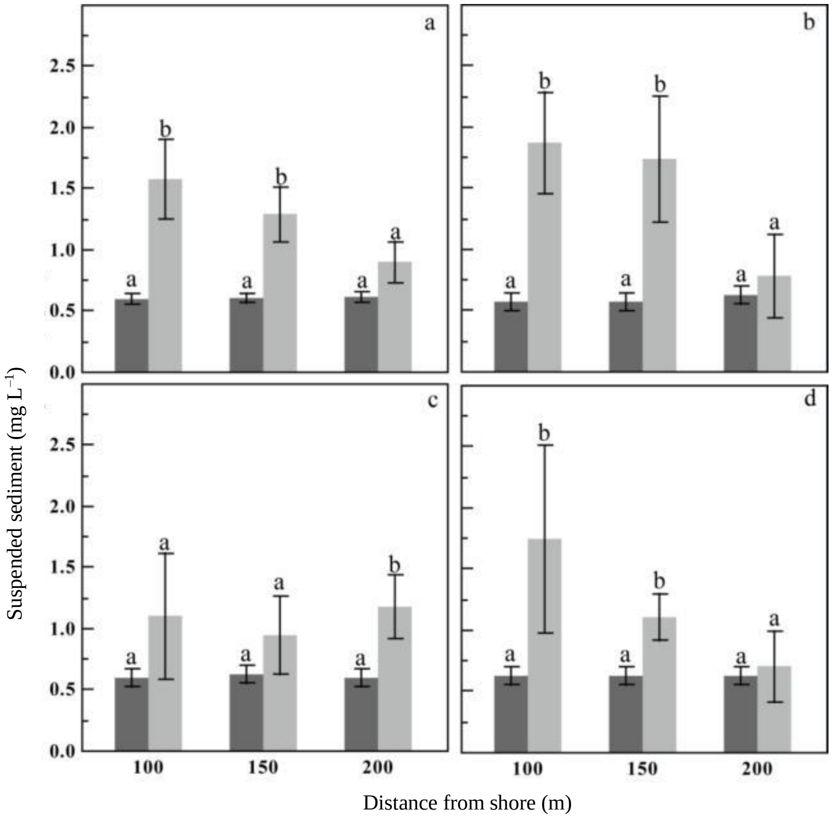


Figure 7. Sediment resuspension caused by normal waves (dark grey) and caused by waves following the passage of a wakeboat at 100 m, 150 m and 200 m according to the type of passage (a: all types of passage; b: 10 mph; c: 20 mph; d: 30 mph).

Note: The same letters above the columns mean that there is no significant difference between the effects of normal conditions and those induced by a wakeboat wave.

Figure 8 (next page) shows the quantities of sediment resuspended in two result formats. The first set of graphs presents the results for each type of displacement (wakesurfing: 10 mph; wakeboarding: 20 mph; moving: 30 mph) for a distance of 100 m (Figure 8a), a distance of 150 m (Figure 8b) and a distance of 200 m (Figure 8c). The second series presents the results according to the distance from the shore (100 m, 150 m and 200 m) according to the type of boat use, i.e., wakesurfing (10 mph; Figure 8d), wakeboarding (20 mph; Figure 8d) and moving (30 mph; Figure 8f).

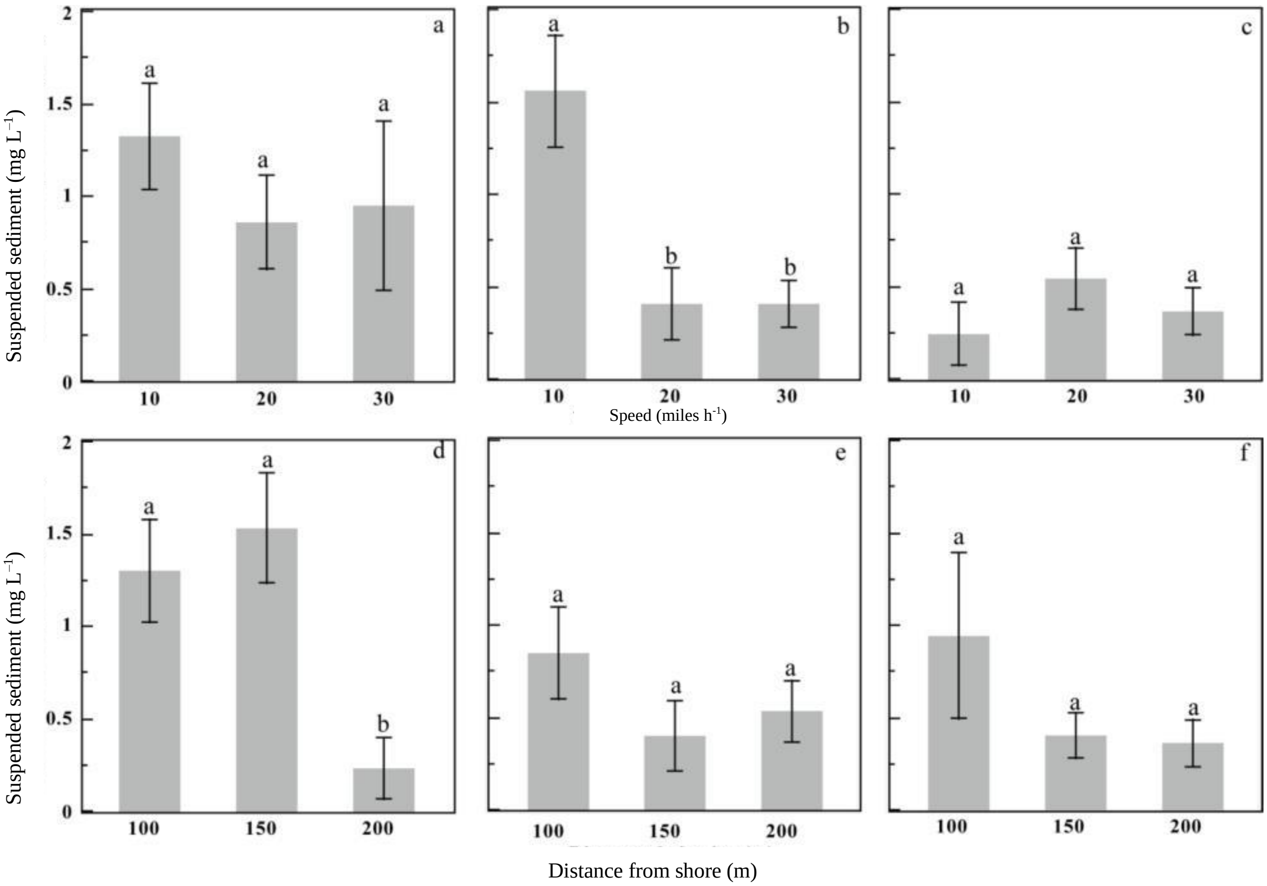


Figure 8. The additional sediment resuspension induced according on the type of passage (10 mph, 20 mph and 30 mph) and according to the distance of passage (a: 100 m; b: 150 m; c: 200 m) and the additional sediment resuspension induced according to the distance from the shore (100 m, 150 m and 200 m) and according to the type of passage (d: 10 mph; e: 20 mph; f: 30 mph).

Note: The different a and b letters above the columns signify a significant difference ($p<0.05$).

The first set of graphs, which compares the resuspension effects between the types of displacement, shows that only wakesurfing waves (10 mph) created at a distance of 150 m from the shore (Figure 8b) produce significantly greater resuspension than the other two displacement types. In the second set of graphs, Figure 8d shows that wakesurfing waves create greater sediment resuspension at 100 m and 150 m from the shore, compared to the distance of 200 m from the shore. The lack of significant differences between the results, despite apparently different mean values, can be explained by the high variability of the data, probably related to the lack of sensitivity of the suspended sediment measurements.

Distance from the shore

As expected, the amount of energy that reaches the shore decreases with the distance of wakeboat passages. Our protocol did not allow us to accurately measure the distance from the shore where no change in energy is visible upon reaching the shore. However, based on the data collected for all types of displacement, if the linear trend observed between the distances studied and the effects measured at the shore (TKE, sediment resuspension) is extended, it is possible to approximate this distance. Figure 9 presents the results of these calculations for each measured effect.

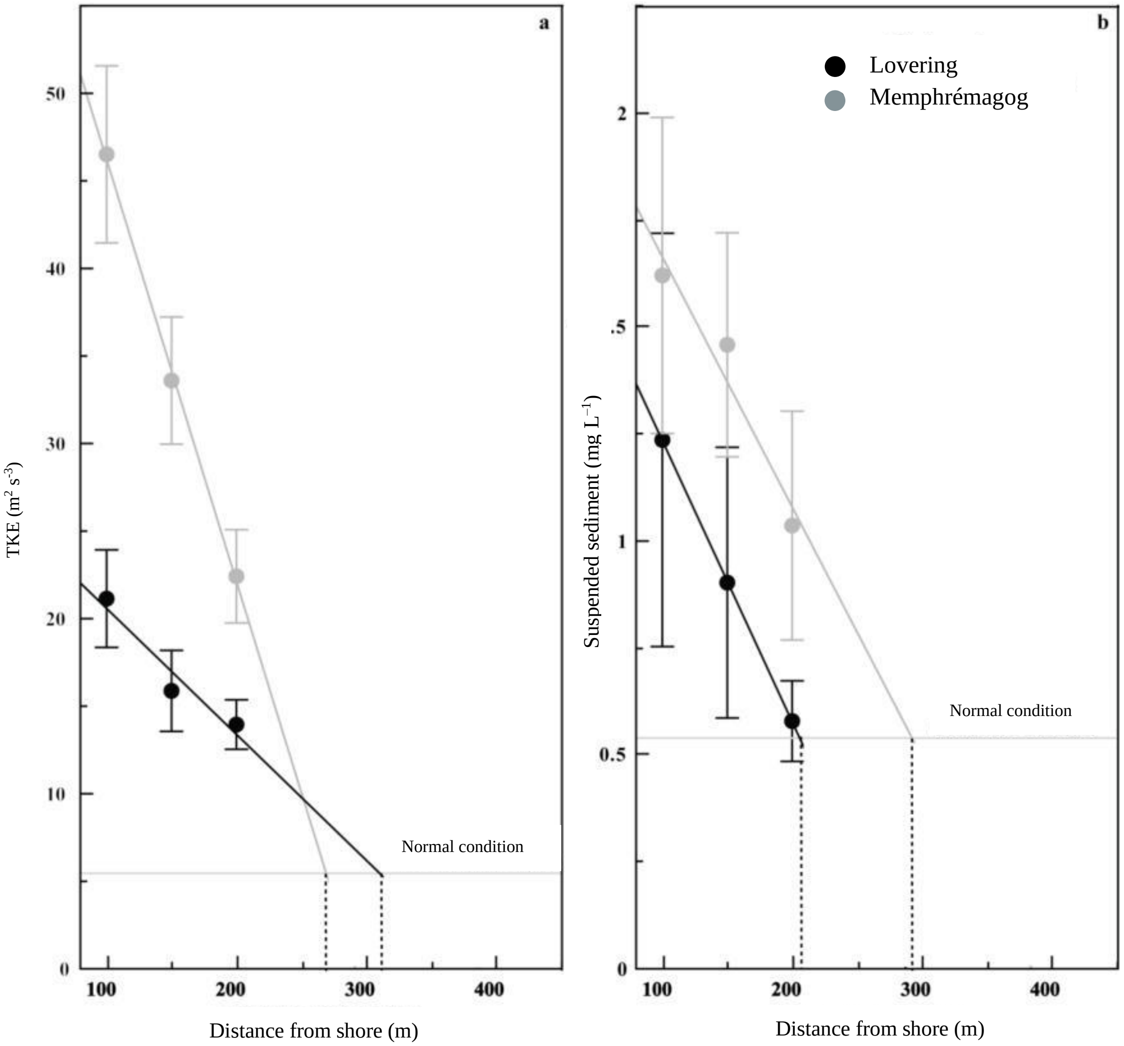


Figure 9. Linear regression of a) energy (TKE) and b) suspended sediment, according to distance from the shore for lakes Lovering (light grey) and Memphrémagog (black).

Note: The grey horizontal line represents the levels of energy (a) and suspended sediment (b), respectively, under normal conditions.

Figure 9 shows the results of the extrapolation of the measurements to estimate the distance at which there would be no measurable effect of energy input (TKE; Figure 9a) or sediment resuspension (Figure 9b). In these figures, the results for Lac Lovering are represented by light grey dots and a light line, and those for Lac Memphrémagog are represented by black dots and lines.

We first assessed the distance at which the wave impact on the shore is equivalent to that of normal conditions, i.e., 5.5 m^2/s^2 for TKE, and 0.57 mg/L for suspended sediment. Normal values of TKE and suspended sediment are represented by a grey horizontal line. Based on energy data (TKE; Figure 9a), the distances of displacement equivalent to normal conditions are 268 m from the shore for Lac Memphrémagog and 312 m from the shore for Lac Lovering. In the case of suspended sediment (Figure 9b), the estimated distances are 286 m (Memphrémagog) and 206 m (Lovering).

According to our calculations, the distance at which wakeboats would have effects similar to those under normal conditions is approximately, on average for the two lakes, 300 m from the shore for energy, and 250 m from the shore for suspended sediment. Based on these results, we assume that 300 m represents a reasonable distance beyond which the waves generated by wakeboats would be largely dissipated before they reach the shore and would therefore have a negligible effect. On this basis, and if the objective is to eliminate any impact on the shoreline that could result from wakeboat passages, we have transposed these results to a map for each lake (next page: Memphrémagog: Figure 10a; Lovering: Figure 10b), to represent the navigable area (in dark grey) for wakeboats, in the case of regulations limiting their use to a distance of 300 m from the shoreline of lakes.

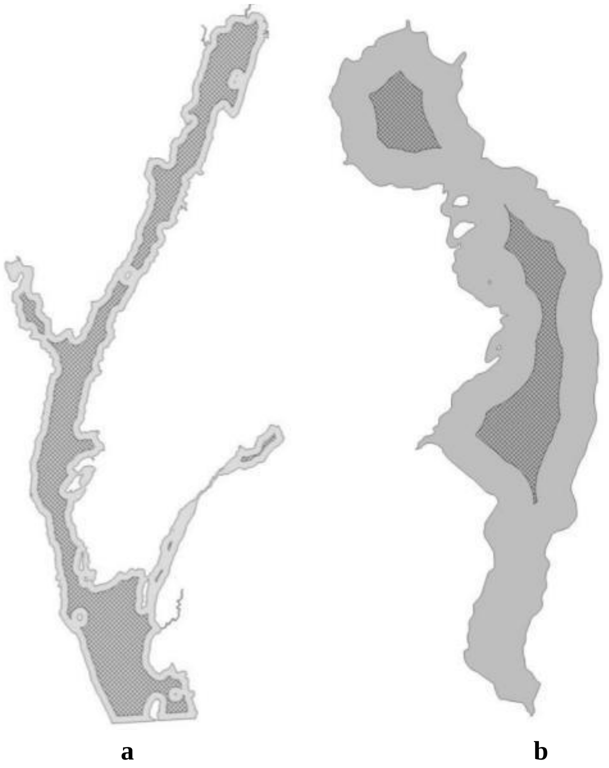


Figure 10. Map of the area navigable by wakeboats (dark grey) following a regulation limiting their activity to more than 300 m from the shores of lakes Memphrémagog (a) and Lovering (b).

Impact of the coastal slope on the energy reaching the shore

Based on the literature, the level of energy that reaches the shore is expected to be a function of the coastal slope. We wanted to assess this hypothesis by linking the coastal slopes of each site with the energy (TKE), measured under normal conditions and then during the passage of a wakeboat, all types of displacement and all distances combined.

Our results show that, under normal conditions, the level of energy that reaches a shore with a steep slope (steep: ≥ 0.1 m m^{-1}) is not significantly different from that reaching the shore with a low slope (gentle: <0.1 m m^{-1}). This is shown in Figure 11a, which shows the energy values (TKE) under normal conditions with a gentle slope (light grey) and a steep slope (dark grey).

However, when the energy that reaches the shore is increased (with the passage of a wakeboat), the steep slopes receive a significantly higher level of energy (Figure 11b). Indeed, when a coastal slope is steep, the wave encounters the bottom of the coastline less quickly and the energy of the wave dissipates less quickly. The energy that reaches the shore is then much higher, leading to a greater impact on sediment resuspension and eventually shore erosion.

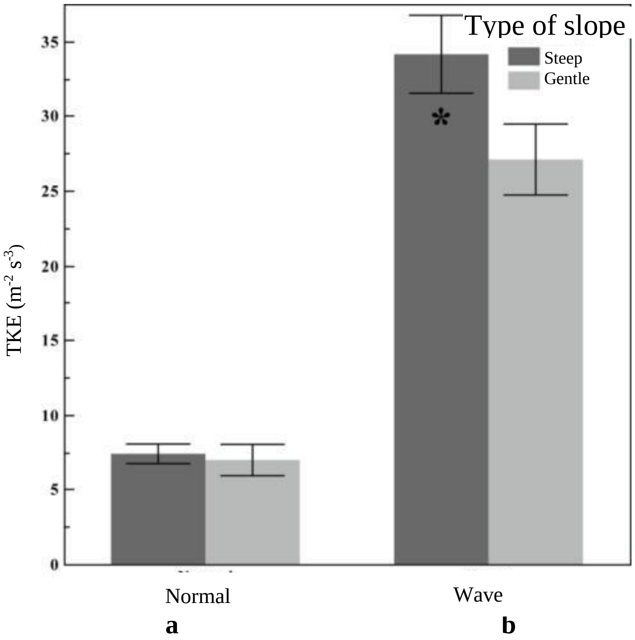


Figure 11. Energy (TKE) that reaches the shore based on sites with a steep (dark grey) or gentle (light grey) coastal slope for normal waves (a) and wakeboat waves (b).

Note: The asterisk (*) represents a significant increase ($p<0.05$).

We used the coastal slope and TKE data to relate them in a regression analysis (next page: Figure 12), under normal conditions (Figure 12a) and during the passage of a wakeboat (Figure 12b). As seen previously, under normal conditions (Figure 12a), there is little difference between the energy that reaches a gentle coastal slope (first point at the bottom, in Figure 12a) and the energy that reaches a steep coastal slope (last point at the top, same figure). However, with the large amount of energy present in the waves caused by the passage of a wakeboat (Figure 12b), the impact of the coastal slope is much greater. The effect of wakeboat waves on energy (TKE) at the site with the steepest coastal slope (last point at the top, Figure 12b) is much greater than for the site with the lightest coastal slope (first point at the bottom, same figure).

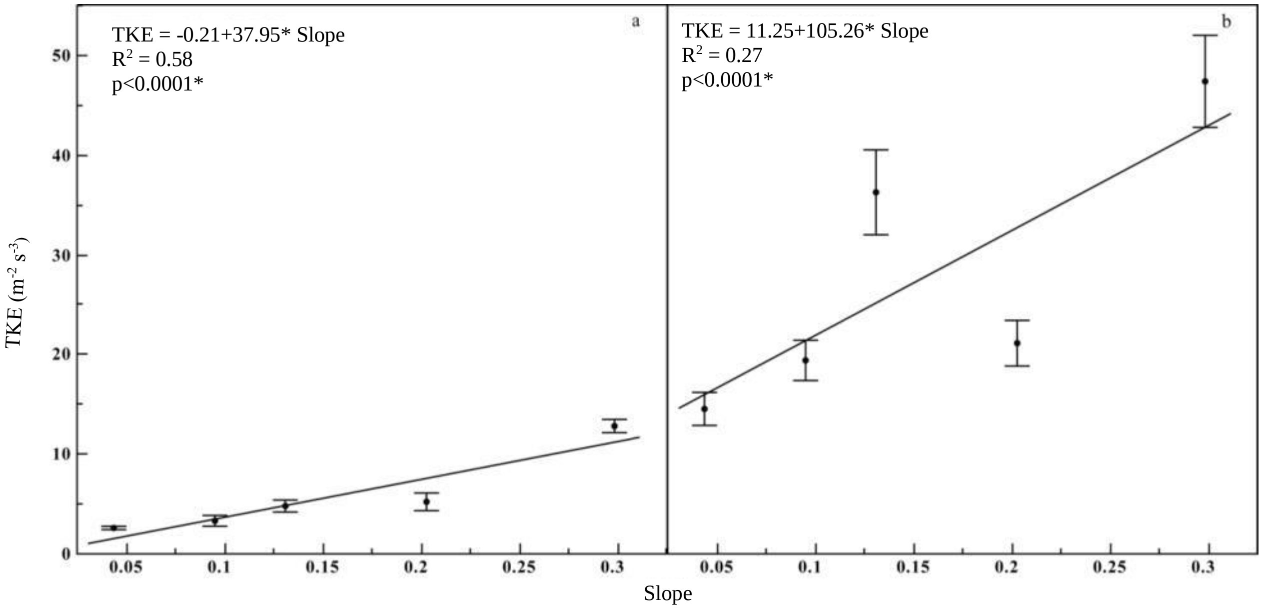


Figure 12. Linear regression between energy (TKE) and coastal slope: a) under normal conditions and b) during the passage of a wakeboat wave train for five sampled sites.

Note: LOV2 has been eliminated from coastal slope analyses because its very low slope and very long length eliminates the trends observed here.

Wave characteristics

In addition to the previous information, we have characterized waves and wave trains to assess their impact on the shore. According to our results, the very short and intense wave train created by wakesurfing is the one that has the most impact when it reaches the shore, as it contains much more energy (Figures 5 and 6). Indeed, despite a shorter average wave train duration (52.5 s) and a lower number of waves per second (0.54 wave s^{-1}), the maximum wave speeds reached are the highest (25.0 m s^{-1}), causing significant sediment resuspension during the passage of these waves (Table 3). This is because the higher energy is concentrated in a low number of waves, giving it more power.

The wakeboarding wave train is much longer in duration (71.8 s) but, despite a fairly large increase in energy (Figure 5) and maximum speed (21.1 m s^{-1}), we were not able to detect significant sediment resuspension. The wave train would become too extensive to have a major impact on the sediment.

Table 3. Average wave train duration (sec), number of waves per wave train length and maximum speed (m s^{-1}) according to different distances from the shore (100 m, 150 m, 200 m) and the types of wakeboard displacement.

	Distance	All combined	Wakesurfing	Wakeboarding	Moving
Wave train duration (s)	All combined	--	52.47	71.79	65.46
	100 m	47.64	40.42	54.03	48.6
	150 m	62.83	52.36	69.96	64.64
	200 m	80.63	64.63	89.92	83.13
Number of waves per length (wave s^{-1})	All combined	--	0.54	0.60	0.65
	100 m	0.59	0.52	0.59	0.67
	150 m	0.60	0.55	0.61	0.64
	200 m	0.60	0.59	0.59	0.64
Maximum speed (m s^{-1})	All combined	--	25.04	21.07	15.94
	100 m	22.17	29.3	23.16	16.7
	150 m	20.18	25.46	20.27	15.97
	200 m	17.99	20.36	19.96	15.14

The moving wave train is intermediate in duration (65.5 s); contains less energy and has a lower maximum speed (15.9 m s^{-1}) than the other two types of wave trains, but it still has a considerable impact on the shore (Table 3 and Figures 7 and 8). This trend for each of the three wave types remains the same depending on the distance from the shore (Table 3). Thus, the number of waves per wave train duration is not a function of the distance from the shore ($p>0.05$). However, the wakesurfing wave train contains significantly fewer waves, regardless of the distance from the shore ($p<0.0001$*, for the three distances and all the distances combined: Table 3).

The power of a wave train is therefore strongly influenced by the intensity that each of the waves of which it is composed has the capacity to accumulate.

CONCLUSION

Based on this experimental study, it is possible to establish that the passage of wakeboats causes a considerable impact on the shore when it passes 100 m from the shore and that all passages within 300 m add significant energy to the waves naturally present (Figure 9). In addition, the waves created by a wakeboat for wakesurfing (one side of the ballast tanks filled) are the ones that have the greatest impact when they reach the shore, given the large amount of energy contained in their short wave train, which contains few waves. Because of their much longer wave train containing a greater number of waves, wakeboarding waves (two sides of the ballast tanks filled) and the displacement of the wakeboat (empty ballast tanks) have a less severe impact on the shore, as the energy is distributed throughout the duration of the wave train. Nevertheless, it should be noted that all the boat passages observed in this study carry a significantly higher amount of energy to shore than under normal conditions.

The energy present in the wave train created by wakeboats leads to sediment resuspension and probably also accelerated erosion of the shores.

Based on the conclusions of this research, and in order to eliminate any additional impact on the shore caused by wakeboat passages, we suggest that regulations limit the passage of wakeboat-type boats on lakes to at least 300 m from the shore in order to prevent their erosion (Figure 9). The navigable areas illustrated by the maps in Figure 10 were established on the basis of this distance of 300 m from the shore, for the two lakes under study (Memphrémagog: Figure 10a; Lovering: Figure 10b).

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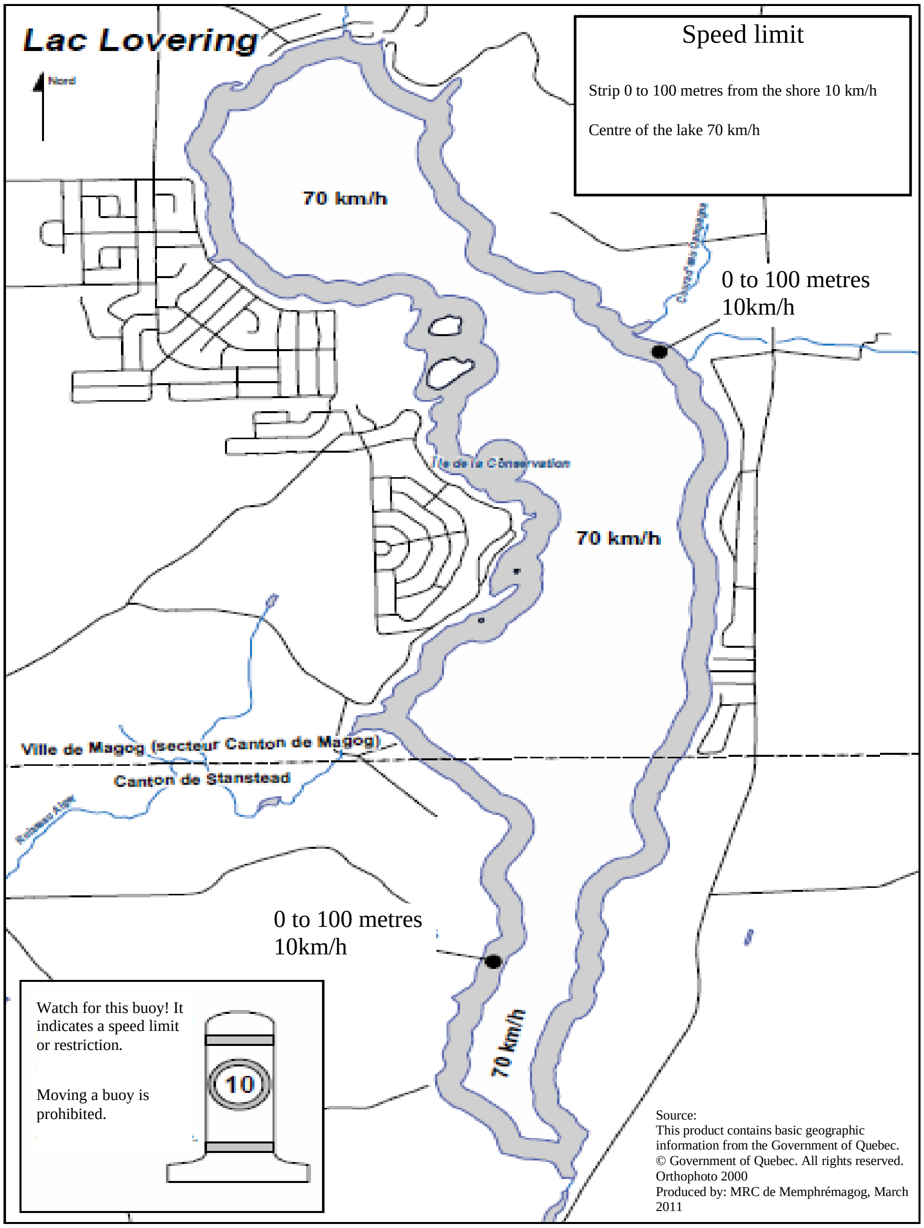
APPENDICES

Appendix 1. Sample Sites in Lac Lovering and Lac Memphrémagog

EN	FR
LOV3	LOV3
LOV2	LOV2
LOV1	LOV1
MEM1	MEM1
MEM2	MEM2
MEM3	MEM3

Appendix 2. Lac Lovering Boating Regulations Map

EN	FR
Lac Lovering	Lac Lovering
Nord	North
Centre du lac 70 km/h	Centre of the lake 70 km/h
L'île de la conservation	Île de la Conservation
Ville de Magog (secteur Canton de Magog)	City of Magog (Magog Township area)
Canton de Stanstead	Stanstead Township



Speed limit

Strip 0 to 100 metres from the shore 10 km/h

Centre of the lake 70 km/h

Watch for this buoy! It indicates a speed limit or restriction.

Moving a buoy is prohibited.

Source:
This product contains basic geographic information from the Government of Quebec.
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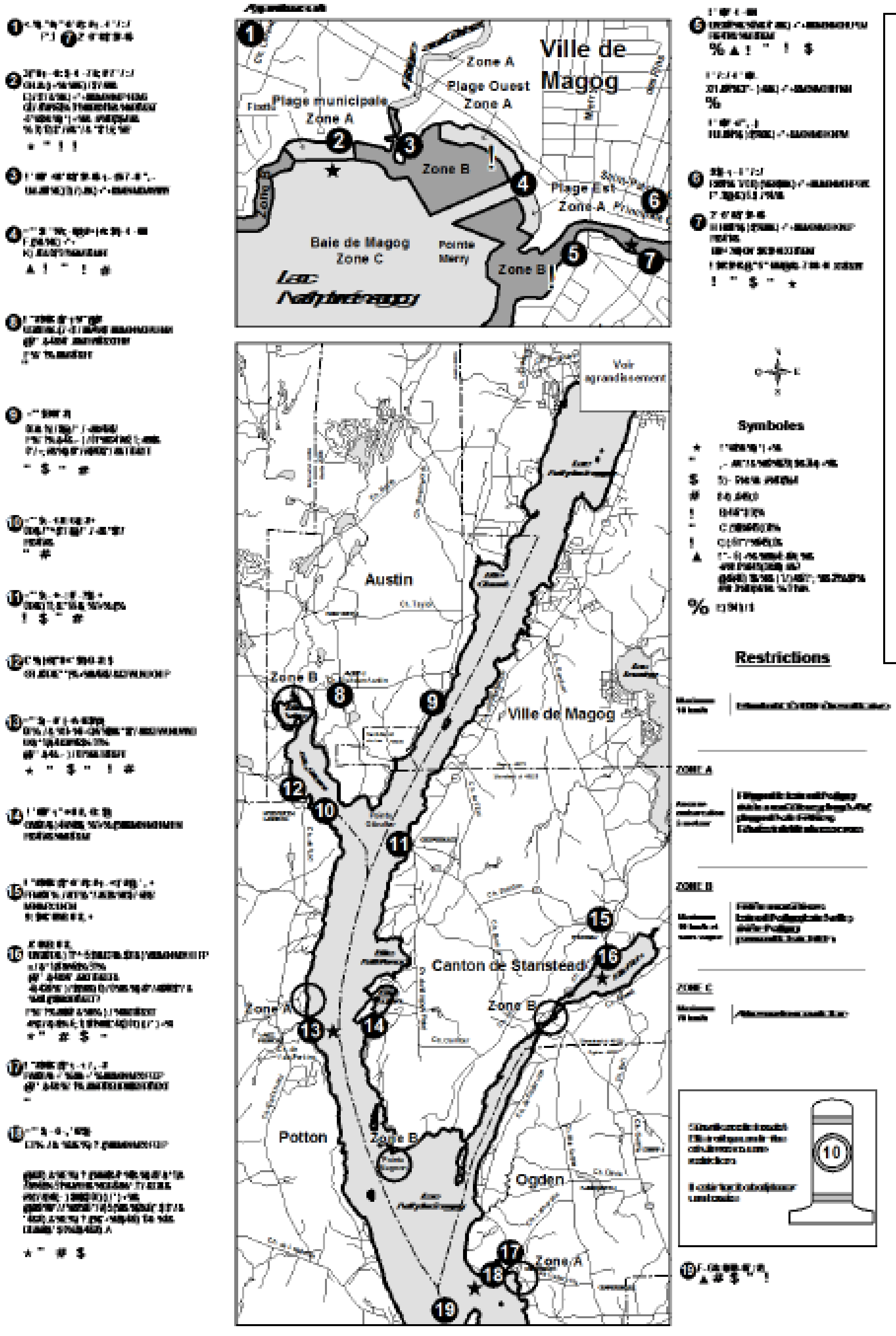
Orthophoto 2000
Produced by: MRC de Memphrémagog, March 2011

(MRC Memphrémagog 2011)

Appendix 3. Lac Memphrémagog Boating Regulations Map

Lac Memphrémagog Regulations



EN	FR
Ch. Levesque	Lévesque Rd.
Plage municipal Zone A	Municipal beach Zone A
Fisette	Fisette
Zone B	Zone B
Baie de Magog Zone C	Baie de Magog Zone C
Zone A	Zone A
Plage Ouest Zone A	West beach Zone A
Ville de Magog	City of Magog
Des Pins	Des Pins
Plage Est Zone A	East beach Zone A
Pointe Merry	Pointe Merry
Saint Patrick	Saint Patrice
Ch. North	North Rd.
Voir agrandissement	See enlarged image
Austin	Austin
Ch. Nicolas Austin	Nicholas Austin Rd.
Pointe Gilbraltar	Pointe Gibraltar
Canton de Stanstead	Stanstead Township
Potton	Potton
Ogden	Ogden
Restriction	Restriction
Symboles	Symbols

(MRC Memphrémagog 2013)

Appendix 3. Physical Parameter Raw Data Tables

Sampling date	Lake	Site	Period	Speed (miles/h)	Distance from shore	Average speed (m s^{-1})	Maximum speed (m s^{-1})	Minimum speed (ms^{-1})	TKE (m^2 s^{-2})	Epsilon z (m^2 s^{-3})	Number of waves per train	Wave train duration	Number/ Length (waves s^{-1})
4/8/2013	Lovering	LOV1	Normal	10	100	2.41	21.52	0.04	4.38	3.8E-08			
4/8/2013	Lovering	LOV1	Wave	10	100	6.49	25.81	0.10	33.07	2.2E-07	29.46	62.20	0.47
4/8/2013	Lovering	LOV1	Normal	10	150	1.13	17.33	0.02	0.96	2.2E-08			
4/8/2013	Lovering	LOV1	Wave	10	150	6.02	25.32	0.05	29.52	1.4E-07	43.69	78.88	0.55
4/8/2013	Lovering	LOV1	Normal	10	150	1.23	4.82	0.03	1.12	6.7E-08			
4/8/2013	Lovering	LOV1	Wave	10	150	5.75	19.65	0.12	23.54	6.7E-08	31.83	67.64	0.47
4/8/2013	Lovering	LOV1	Normal	10	200	2.85	10.21	0.06	5.96	6.0E-08			
4/8/2013	Lovering	LOV1	Wave	10	200	5.46	17.09	0.02	21.06	3.3E-08	29.49	53.04	0.56
4/8/2013	Lovering	LOV1	Wave	10	100	6.82	20.54	0.10	33.45	1.6E-07	25.37	51.80	0.49
4/8/2013	Lovering	LOV1	Normal	10	100	1.89	8.53	0.07	2.54	3.3E-08			
4/8/2013	Lovering	LOV1	Wave	10	200	5.03	14.77	0.13	16.87	1.7E-08	43.11	74.84	0.58
4/8/2013	Lovering	LOV1	Normal	10	200	2.28	7.64	0.12	3.89	1.5E-07			
4/8/2013	Lovering	LOV1	Normal	20	200	1.91	8.52	0.02	3.11	1.5E-07			
4/8/2013	Lovering	LOV1	Wave	20	200	4.99	18.88	0.14	18.53	8.0E-08	51.66	90.40	0.57
4/8/2013	Lovering	LOV1	Normal	20	150	2.09	12.40	0.11	3.37	2.1E-07			
4/8/2013	Lovering	LOV1	Wave	20	150	5.48	17.55	0.02	21.90	1.3E-07	38.01	63.36	0.60
4/8/2013	Lovering	LOV1	Normal	20	200	2.01	8.02	0.04	3.12	2.5E-07			
4/8/2013	Lovering	LOV1	Wave	20	200	4.67	19.31	0.07	16.57	1.1E-07	58.45	96.60	0.61
4/8/2013	Lovering	LOV1	Normal	20	100	2.66	7.05	0.04	4.74	2.5E-07			
4/8/2013	Lovering	LOV1	Wave	20	100	6.30	19.08	0.34	29.20	2.1E-07	27.76	51.28	0.54
4/8/2013	Lovering	LOV1	Normal	20	100	1.58	6.38	0.05	1.81	5.4E-08			
4/8/2013	Lovering	LOV1	Wave	20	100	5.84	20.49	0.04	26.12	1.4E-07	37.14	59.84	0.62
4/8/2013	Lovering	LOV1	Wave	20	150	4.47	17.06	0.11	14.98	1.7E-07	66.39	103.28	0.64
4/8/2013	Lovering	LOV1	Normal	20	150	2.38	12.37	0.06	3.86	1.1E-07			
4/8/2013	Lovering	LOV1	Normal	30	150	1.59	5.03	0.07	1.72	9.9E-08			
4/8/2013	Lovering	LOV1	Wave	30	150	3.17	9.14	0.03	6.92	5.0E-08	53.36	81.52	0.65
4/8/2013	Lovering	LOV1	Wave	30	200	3.83	11.47	0.10	10.25	3.3E-08	26.28	38.32	0.69
4/8/2013	Lovering	LOV1	Normal	30	200	1.26	5.64	0.02	1.10	4.4E-08			
4/8/2013	Lovering	LOV1	Normal	30	100	1.61		0.05	10.50	2.4E-07			
4/8/2013	Lovering	LOV1	Wave	30	100	3.78	13.32	0.01	10.26	5.2E-08	22.27	33.40	0.67
4/8/2013	Lovering	LOV1	Normal	30	150	1.55	5.18	0.04	1.62	9.5E-08			
4/8/2013	Lovering	LOV1	Wave	30	150	3.14	11.06	0.04	7.13	9.9E-08	52.16	79.68	0.65
4/8/2013	Lovering	LOV1	Wave	30	100	5.06	14.41	0.08	18.49	8.7E-08	39.36	59.04	0.67
4/8/2013	Lovering	LOV1	Normal	30	100	1.94	8.15	0.00	2.78	9.3E-08			
4/8/2013	Lovering	LOV1	Wave	30	200	3.70	11.51	0.04	10.04	5.8E-08	67.91	99.04	0.69
4/8/2013	Lovering	LOV1	Normal	30	200	1.54	5.75	0.05	1.68	6.1E-08			
5/8/2013	Lovering	LOV2	Normal	10	200	3.95	16.21	0.15	11.76	9.4E-07			
5/8/2013	Lovering	LOV2	Wave	10	200	6.70	21.41	0.05	34.65	3.5E-07	53.90	89.84	0.60

Sampling date	Lake	Site	Period	Speed (miles/h)	Distance from shore (m)	Average speed (m s^{-1})	Maximum speed (m s^{-1})	Minimum speed (m s^{-1})	TKE (m^2 s^{-2})	Epsilon z (m^2 s^{-3})	Number of waves per train	Wave train duration	Number/ Length (waves s^{-1})
5/8/2013	Lovering	LOV2	Wave	10	100	10.17	28.68	0.13	79.82	1.5E-06	16.06	36.80	0.44
5/8/2013	Lovering	LOV2	Normal	10	100	3.98	12.77	0.09	11.78	3.1E-07			
5/8/2013	Lovering	LOV2	Normal	10	100	3.44	11.16	0.00	8.91	1.9E-07			
5/8/2013	Lovering	LOV2	Wave	10	100	10.65	30.38	0.30	89.23	1.1E-06	16.93	31.04	0.55
5/8/2013	Lovering	LOV2	Normal	10	150	3.26	10.82	0.07	7.86	2.9E-08			
5/8/2013	Lovering	LOV2	Wave	10	150	8.40	28.02	0.04	51.91	4.8E-07	27.26	49.04	0.56
5/8/2013	Lovering	LOV2	Normal	10	200	3.27	11.53	0.09	8.14	5.9E-08			
5/8/2013	Lovering	LOV2	Wave	10	200	8.20	25.64	0.09	49.81	8.2E-08	24.29	46.56	0.52
5/8/2013	Lovering	LOV2	Wave	10	150	7.71	25.43	0.09	43.57	3.0E-07	25.92	46.44	0.56
5/8/2013	Lovering	LOV2	Normal	10	150	3.72	10.84	0.09	9.76	2.1E-07			
5/8/2013	Lovering	LOV2	Wave	20	150	8.10	28.32	0.10	48.36	2.7E-07	31.67	50.80	0.62
5/8/2013	Lovering	LOV2	Normal	20	150	5.00	15.52	0.10	18.12	1.6E-07			
5/8/2013	Lovering	LOV2	Wave	20	200	7.82	31.55	0.23	47.66	1.9E-07	36.85	64.48	0.57
5/8/2013	Lovering	LOV2	Normal	20	200	6.20	20.47	0.09	29.09	1.3E-07			
5/8/2013	Lovering	LOV2	Wave	20	150	8.32	29.10	0.13	52.70	1.8E-07	24.47	41.12	0.60
5/8/2013	Lovering	LOV2	Normal	20	150	5.09	19.96	0.04	19.49	2.2E-07			
5/8/2013	Lovering	LOV2	Normal	20	200	6.09	19.47	0.04	27.84	1.9E-07			
5/8/2013	Lovering	LOV2	Wave	20	200	7.86	25.67	0.14	46.30	2.1E-07	35.13	58.56	0.60
5/8/2013	Lovering	LOV2	Normal	20	100	4.51	16.30	0.07	15.42	6.7E-08			
5/8/2013	Lovering	LOV2	Wave	20	100	8.07	28.93	0.16	50.20	5.4E-07	31.75	50.92	0.62
5/8/2013	Lovering	LOV2	Normal	20	100	4.76	14.83	0.17	16.29	1.8E-07			
5/8/2013	Lovering	LOV2	Wave	20	100	8.51	30.62	0.25	53.98	4.2E-07	24.60	40.40	0.61
5/8/2013	Lovering	LOV2	Normal	30	100	4.94	14.93	0.19	17.60	1.8E-07			
5/8/2013	Lovering	LOV2	Wave	30	100	7.63	19.41	0.36	39.06	1.0E-07	30.23	34.96	0.86
5/8/2013	Lovering	LOV2	Normal	30	200	5.77	17.92	0.04	23.59	1.1E-07			
5/8/2013	Lovering	LOV2	Wave	30	200	6.98	24.98	0.09	35.83	1.0E-07	48.65	74.32	0.65
5/8/2013	Lovering	LOV2	Normal	30	100	5.36	20.25	0.00	21.36	1.3E-07			
5/8/2013	Lovering	LOV2	Wave	30	100	6.85	18.78	0.13	33.32	9.9E-08	47.36	68.08	0.70
5/8/2013	Lovering	LOV2	Normal	30	150	6.92	21.01	0.09	34.48	1.1E-07			
5/8/2013	Lovering	LOV2	Wave	30	150	8.27	22.49	0.05	48.24	1.2E-07	36.15	56.24	0.64
5/8/2013	Lovering	LOV2	Normal	30	150	6.61	22.47	0.04	31.59	1.8E-07			
5/8/2013	Lovering	LOV2	Wave	30	150	8.65	28.30	0.11	55.08	1.4E-07	41.85	65.32	0.64
5/8/2013	Lovering	LOV2	Normal	30	200	6.61	24.82	0.23	31.69	1.0E-07			
5/8/2013	Lovering	LOV2	Wave	30	200	7.68	23.44	0.08	43.63	2.1E-07	31.60	47.40	0.67
5/8/2013	Lovering	LOV3	Wave	10	100	6.18	18.59	0.08	27.96	3.7E-07	35.70	57.52	0.62
5/8/2013	Lovering	LOV3	Normal	10	100	2.55	6.79	0.13	4.50	4.5E-07			
5/8/2013	Lovering	LOV3	Wave	10	150	4.49	17.16	0.04	16.05	1.8E-07	51.30	82.28	0.62
5/8/2013	Lovering	LOV3	Normal	10	150	1.80	6.23	0.02	2.83	1.4E-07			
5/8/2013	Lovering	LOV3	Wave	10	100	5.87	16.87	0.09	25.17	2.0E-07	34.01	54.56	0.62
5/8/2013	Lovering	LOV3	Normal	10	100	1.96	6.67	0.03	2.80	2.2E-08			
5/8/2013	Lovering	LOV3	Wave	10	200	5.19	17.27	0.08	20.14	1.2E-07	50.02	87.88	0.57

Sampling date	Lake	Site	Period	Speed (miles/h)	Distance from shore (m)	Average speed (m s^{-1})	Maximum speed (m s^{-1})	Minimum speed (m s^{-1})	TKE (m^2 s^{-2})	Epsilon z (m^2 s^{-3})	Number of waves per train	Wave train duration (sec)	Number/ Length (waves s^{-1})
5/8/2013	Lovering	LOV3	Normal	10	200	1.97	6.36	0.05	2.94	2.5E-08			
5/8/2013	Lovering	LOV3	Wave	10	200	4.05	16.29	0.05	13.29	2.0E-07	50.08	91.80	0.55
5/8/2013	Lovering	LOV3	Normal	10	200	1.86	6.30	0.09	2.56	8.7E-08			
5/8/2013	Lovering	LOV3	Normal	10	150	1.94	6.56	0.07	2.84	8.7E-08			
5/8/2013	Lovering	LOV3	Wave	10	150	5.24	18.21	0.02	20.82	2.1E-07	45.76	73.08	0.63
5/8/2013	Lovering	LOV3	Wave	20	150	5.01	14.61	0.15		3.6E-07	52.57	84.32	0.62
5/8/2013	Lovering	LOV3	Normal	20	150	1.87	6.58	0.04		1.0E-07			
5/8/2013	Lovering	LOV3	Normal	20	100	2.13	6.10	0.15	2.94	1.8E-07			
5/8/2013	Lovering	LOV3	Wave	20	100	5.15	17.75	0.18	20.19	7.1E-07	44.88	74.80	0.60
5/8/2013	Lovering	LOV3	Wave	20	200	4.24	15.01	0.03	13.16	1.1E-07	66.14	109.32	0.61
5/8/2013	Lovering	LOV3	Normal	20	200	1.88	24.26	0.03	2.73	3.0E-08			
5/8/2013	Lovering	LOV3	Wave	20	150	4.73	17.76	0.04	17.04	3.7E-07	58.45	96.60	0.61
5/8/2013	Lovering	LOV3	Normal	20	150	1.83	5.88	0.08	2.29	2.0E-07			
5/8/2013	Lovering	LOV3	Normal	20	100	1.65	6.68	0.09	1.97	3.2E-08			
5/8/2013	Lovering	LOV3	Wave	20	100	4.52	17.25	0.11	15.78	4.9E-07	53.12	85.20	0.62
5/8/2013	Lovering	LOV3	Normal	20	200	1.79	5.57	0.09	2.35	2.4E-08			
5/8/2013	Lovering	LOV3	Wave	20	200	4.18	15.79	0.04	13.53	9.3E-08	74.75	116.28	0.64
5/8/2013	Lovering	LOV3	Normal	30	150	1.65	5.10	0.03	1.98	4.9E-08			
5/8/2013	Lovering	LOV3	Wave	30	150	3.29	11.33	0.09	7.81	8.2E-08	75.53	110.16	0.69
5/8/2013	Lovering	LOV3	Normal	30	200	1.69	6.33	0.10	2.08	7.9E-08			
5/8/2013	Lovering	LOV3	Wave	30	200	3.07	9.87	0.08	6.96	2.7E-08	86.92	112.40	0.77
5/8/2013	Lovering	LOV3	Wave	30	150	3.37	10.84	0.04	8.26	6.0E-08	73.45	107.12	0.69
5/8/2013	Lovering	LOV3	Normal	30	150	1.93	5.97	0.03	2.81	4.6E-08			
5/8/2013	Lovering	LOV3	Wave	30	100	2.92	8.40	0.02	5.92	5.7E-08	61.34	84.36	0.73
5/8/2013	Lovering	LOV3	Normal	30	100	1.54	6.73	0.01	1.54	2.5E-08			
5/8/2013	Lovering	LOV3	Wave	30	200	3.01	10.27	0.06	6.33	1.7E-07		135.96	
5/8/2013	Lovering	LOV3	Normal	30	200	1.59	4.88	0.02	1.79	9.2E-08			
5/8/2013	Lovering	LOV3	Wave	30	100	3.17	9.69	0.01	7.37	5.6E-08	73.41	91.76	0.80
5/8/2013	Lovering	LOV3	Normal	30	100	1.60	5.28	0.04	1.90	3.1E-08			
5/8/2013	Memphrémagog	MEM1	Normal	10	200	2.07	5.75	0.06	2.83	4.2E-07			
5/8/2013	Memphrémagog	MEM1	Wave	10	200	5.23	22.64	0.06	24.28	1.5E-07	27.87	54.20	0.51
5/8/2013	Memphrémagog	MEM1	Wave	10	150	4.92	16.36	0.07	19.56	4.4E-08	26.33	46.08	0.57
5/8/2013	Memphrémagog	MEM1	Normal	10	150	1.84	6.37	0.02	2.38	1.9E-07			
5/8/2013	Memphrémagog	MEM1	Wave	10	100	5.39	19.46	0.05	23.74	8.2E-08	19.18	41.76	0.46
5/8/2013	Memphrémagog	MEM1	Normal	10	100	2.24	5.82	0.09	3.52	4.0E-07			
5/8/2013	Memphrémagog	MEM1	Normal	10	150	2.50	8.27	0.06	4.20	6.0E-08			
5/8/2013	Memphrémagog	MEM1	Wave	10	150	6.61	22.79	0.25	37.38	5.3E-07	26.89	52.28	0.51
5/8/2013	Memphrémagog	MEM1	Wave	10	200	3.59	12.91	0.06	10.41	1.8E-08	52.11	95.52	0.55
5/8/2013	Memphrémagog	MEM1	Normal	10	200	1.54	7.29	0.01	1.86	3.6E-08			
5/8/2013	Memphrémagog	MEM1	Wave	10	100	7.04	34.66	0.20	49.27	4.2E-07	17.07	33.60	0.51
5/8/2013	Memphrémagog	MEM1	Normal	10	100	1.78	5.94	0.03	2.20	2.1E-07			

Sampling date	Lake	Site	Period	Speed (miles/h)	Distance from shore (m)	Average speed (m s^{-1})	Maximum speed (m s^{-1})	Minimum speed (m s^{-1})	TKE (m^2 s^{-2})	Epsilon z (m^2 s^{-3})	Number of waves per train	Wave train duration	Number/ Length (waves s^{-1})
5/8/2013	Memphrémagog	MEM1	Normal	20	150	1.81	4.58	0.02	2.25	1.6E-06			
5/8/2013	Memphrémagog	MEM1	Wave	20	150	5.17	16.32	0.26	18.67	4.2E-07	47.87	80.44	0.60
5/8/2013	Memphrémagog	MEM1	Normal	20	200	2.62	11.22	0.19	5.06	1.5E-07			
5/8/2013	Memphrémagog	MEM1	Wave	20	200	4.38	12.65	0.04	13.16	5.0E-07	75.03	116.72	0.64
5/8/2013	Memphrémagog	MEM1	Wave	20	150	5.03	12.38	0.03	17.54	3.8E-07	39.72	64.00	0.62
5/8/2013	Memphrémagog	MEM1	Normal	20	150	3.18	8.80	0.16	7.03	4.2E-07			
5/8/2013	Memphrémagog	MEM1	Normal	20	200	2.12	14.69	0.04	3.01				
5/8/2013	Memphrémagog	MEM1	Wave	20	200	4.48	14.64	0.11	13.97	4.3E-07	72.79	121.32	0.60
5/8/2013	Memphrémagog	MEM1	Normal	20	100	2.32	6.19	0.12	3.70	1.2E-06			
5/8/2013	Memphrémagog	MEM1	Wave	20	100	6.07	19.55	0.11	27.64	1.3E-06	29.39	51.44	0.57
5/8/2013	Memphrémagog	MEM1	Wave	20	100	5.88	22.33	0.07	28.07	6.2E-07	37.69	65.96	0.57
5/8/2013	Memphrémagog	MEM1	Normal	20	100	1.73	6.66	0.08	2.28	8.9E-07			
5/8/2013	Memphrémagog	MEM1	Normal	30	200	3.00	11.38	0.02	6.73	4.6E-07			
5/8/2013	Memphrémagog	MEM1	Wave	30	200	4.78	12.78	0.07	16.14	7.8E-07	37.68	62.80	0.60
5/8/2013	Memphrémagog	MEM1	Wave	30	100	5.01	13.38	0.25	17.21	1.3E-06	22.22	44.44	0.50
5/8/2013	Memphrémagog	MEM1	Normal	30	100		9.66						
5/8/2013	Memphrémagog	MEM1	Wave	30	100	4.63	13.01	0.13	15.64	2.0E-07	32.87	54.32	0.61
5/8/2013	Memphrémagog	MEM1	Normal	30	100	3.27	12.84	0.10	8.98	1.7E-08			
5/8/2013	Memphrémagog	MEM1	Wave	30	150	5.20	14.01	0.17	18.83	7.9E-07	19.05	30.16	0.63
5/8/2013	Memphrémagog	MEM1	Normal	30	150	4.38	9.93	0.12	12.63	3.4E-07			
5/8/2013	Memphrémagog	MEM1	Normal	30	200	2.47	9.36	0.03	4.96	9.4E-07			
5/8/2013	Memphrémagog	MEM1	Wave	30	200	4.13	15.55	0.09	12.74	5.6E-07	52.82	84.72	0.62
5/8/2013	Memphrémagog	MEM1	Normal	30	150	4.58	10.63	0.34	13.89	6.7E-07			
5/8/2013	Memphrémagog	MEM1	Wave	30	150	4.46	12.74	0.11	14.73	5.8E-07	28.17	44.60	0.63
5/8/2013	Memphrémagog	MEM2	Normal	10	100	2.09	6.99	0.08	3.27	2.7E-07			
5/8/2013	Memphrémagog	MEM2	Wave	10	100	8.15	36.25	0.06	67.82	2.4E-06	16.05	29.88	0.54
5/8/2013	Memphrémagog	MEM2	Wave	10	150	8.12	32.63	0.14	61.86	3.1E-07	18.08	35.60	0.51
5/8/2013	Memphrémagog	MEM2	Normal	10	150	2.07	6.72	0.08	3.08	2.5E-07			
5/8/2013	Memphrémagog	MEM2	Normal	10	200	2.16	6.16	0.02	3.18	6.8E-08			
5/8/2013	Memphrémagog	MEM2	Wave	10	200	3.48	11.71	0.02	8.86	9.1E-09	38.78	62.48	0.62
5/8/2013	Memphrémagog	MEM2	Normal	10	200	2.13	8.43	0.04	3.45	3.1E-08			
5/8/2013	Memphrémagog	MEM2	Wave	10	200	6.50	20.04	0.04	35.24	2.1E-08	29.54	48.24	0.61
5/8/2013	Memphrémagog	MEM2	Wave	10	100	7.56	35.70	0.24	62.72	2.5E-06	19.15	36.56	0.52
5/8/2013	Memphrémagog	MEM2	Normal	10	100	1.78	4.34	0.08	2.12	2.4E-07			
5/8/2013	Memphrémagog	MEM2	Wave	10	150	6.71	33.51	0.05	48.93	4.4E-07	20.70	40.32	0.51
5/8/2013	Memphrémagog	MEM2	Normal	10	150	1.90	6.56	0.00	2.60	3.4E-07			
5/8/2013	Memphrémagog	MEM2	Normal	20	150	2.61	6.81	0.04	4.62	7.3E-07			
5/8/2013	Memphrémagog	MEM2	Wave	20	150	7.04	22.82	0.36	36.89	3.2E-07	30.95	51.16	0.61
5/8/2013	Memphrémagog	MEM2	Wave	20	200	6.60	25.18	0.22	33.21	3.6E-07	38.47	67.32	0.57
5/8/2013	Memphrémagog	MEM2	Normal	20	200	2.67	7.50	0.08	4.82	9.3E-07			
5/8/2013	Memphrémagog	MEM2	Normal	20	200	1.50	5.48	0.03	1.69	9.3E-08			

Sampling date	Lake	Site	Period	Speed (miles/h)	Distance from shore (m)	Average speed (m s^{-1})	Maximum speed (m s^{-1})	Minimum speed (m s^{-1})	TKE (m^2 s^{-2})	Epsilon z (m^2 s^{-3})	Number of waves per train	Wave train duration	Number/ Length (waves s^{-1})
5/8/2013	Memphrémagog	MEM2	Wave	20	200	5.19	20.95	0.04	22.22	1.1E-07	45.81	79.52	0.58
5/8/2013	Memphrémagog	MEM2	Wave	20	100	7.66	25.91	0.24	48.80	1.2E-06	21.41	37.16	0.58
5/8/2013	Memphrémagog	MEM2	Normal	20	100	2.19	8.47	0.04	3.73	7.2E-07			
5/8/2013	Memphrémagog	MEM2	Wave	20	150	6.61	21.87	0.16	33.50	4.2E-07	33.86	56.44	0.60
5/8/2013	Memphrémagog	MEM2	Normal	20	150	2.68	7.33	0.14	5.35	1.4E-06			
5/8/2013	Memphrémagog	MEM2	Normal	20	100	2.00	6.56	0.03	3.23	1.2E-06			
5/8/2013	Memphrémagog	MEM2	Wave	20	100	8.06	28.34	0.18	52.53	1.2E-06	20.02	35.04	0.57
5/8/2013	Memphrémagog	MEM2	Normal	30	150	3.97	9.94	0.08	10.56				
5/8/2013	Memphrémagog	MEM2	Wave	30	150	5.31	15.05	0.09	19.51	6.1E-08	30.07	47.60	0.63
5/8/2013	Memphrémagog	MEM2	Normal	30	150	2.74	7.81	0.09	5.12	1.3E-06			
5/8/2013	Memphrémagog	MEM2	Wave	30	150	6.00	14.18	0.10	24.58	9.8E-08	25.06	40.20	0.62
5/8/2013	Memphrémagog	MEM2	Normal	30	100	2.95	8.82	0.05	6.15	1.6E-07			
5/8/2013	Memphrémagog	MEM2	Wave	30	100	6.77	15.11	0.15	30.53	7.4E-07	20.81	30.84	0.67
5/8/2013	Memphrémagog	MEM2	Normal	30	200	3.02	9.98	0.13	6.51	2.9E-07			
5/8/2013	Memphrémagog	MEM2	Wave	30	200	4.11	11.70	0.07	11.86	1.5E-07	54.98	91.64	0.60
5/8/2013	Memphrémagog	MEM2	Wave	30	100	7.43	24.18	0.23	40.52	1.1E-07	16.86	29.04	0.58
5/8/2013	Memphrémagog	MEM2	Normal	30	100	3.81	13.95	0.09	10.86	1.3E-06			
5/8/2013	Memphrémagog	MEM2	Normal	30	200	2.66	6.73	0.14	4.66	1.1E-06			
5/8/2013	Memphrémagog	MEM2	Wave	30	200	4.01	13.25	0.06	11.77	5.1E-07	63.09	94.64	0.67
6/8/2013	Memphrémagog	MEM3	Wave	10	200	11.09	35.95	0.39		4.5E-07	15.15	29.88	0.51
6/8/2013	Memphrémagog	MEM3	Normal	10	200	3.63	12.52	0.03	9.32	1.0E-07			
6/8/2013	Memphrémagog	MEM3	Normal	10	200	3.73	13.26	0.08	10.30	6.4E-08			
6/8/2013	Memphrémagog	MEM3	Wave	10	200	7.35	28.59	0.04	42.18	2.0E-07	22.03	41.24	0.53
6/8/2013	Memphrémagog	MEM3	Normal	10	150	3.65	14.11	0.07	10.67	2.1E-07			
6/8/2013	Memphrémagog	MEM3	Wave	10	150	8.89	26.88	0.08	58.74	1.1E-06	20.33	33.68	0.60
6/8/2013	Memphrémagog	MEM3	Normal	10	100	4.34	12.23	0.02	13.07	5.5E-07			
6/8/2013	Memphrémagog	MEM3	Wave	10	100	11.79		0.25			10.99	24.04	0.46
6/8/2013	Memphrémagog	MEM3	Normal	10	100	3.95	11.26	0.09	11.15	5.1E-07			
6/8/2013	Memphrémagog	MEM3	Wave	10	100	10.32	30.13	0.09	83.96	4.8E-06	14.27	25.32	0.56
6/8/2013	Memphrémagog	MEM3	Normal	10	150	4.21	16.18	0.09	12.52	4.7E-07			
6/8/2013	Memphrémagog	MEM3	Wave	10	150	12.09	39.60	0.21		1.7E-06	11.11	22.96	0.48
6/8/2013	Memphrémagog	MEM3	Normal	20	100	5.06	16.63	0.28	18.94	1.5E-06			
6/8/2013	Memphrémagog	MEM3	Wave	20	100	11.28	23.66		81.75	2.1E-06	6.00	9.60	0.63
6/8/2013	Memphrémagog	MEM3	Normal	20	150	6.81	18.52	0.23		1.7E-06			
6/8/2013	Memphrémagog	MEM3	Wave	20	150	8.26	22.45	0.27	47.69		32.59	55.44	0.59
6/8/2013	Memphrémagog	MEM3	Normal	20	150	6.01	19.64	0.18		1.2E-06			
6/8/2013	Memphrémagog	MEM3	Wave	20	150	7.16	23.02	0.19	37.53	3.6E-07	55.48	92.48	0.60
6/8/2013	Memphrémagog	MEM3	Normal	20	200	4.73	12.86	0.09	16.05	1.9E-06			
6/8/2013	Memphrémagog	MEM3	Wave	20	200	6.92	19.41	0.16	32.54	1.1E-06	46.44	93.04	0.50
6/8/2013	Memphrémagog	MEM3	Normal	20	200	4.22	12.14	0.04	12.62	4.4E-07			
6/8/2013	Memphrémagog	MEM3	Wave	20	200	7.47	20.46	0.15	38.93	9.5E-07	37.39	65.44	0.57

Sampling date	Lake	Site	Period	Speed (miles/h)	Distance from shore (m)	Average speed (m s^{-1})	Maximum speed (m s^{-1})	Minimum speed (m s^{-1})	TKE (m^2 s^{-2})	Epsilon z (m^2 s^{-3})	Number of waves per train	Wave train duration	Number/ Length (waves s^{-1})
6/8/2013	Memphrémagog	MEM3	Wave	20	100	9.32	24.54	0.05	60.35	9.4E-07	23.62	42.40	0.56
6/8/2013	Memphrémagog	MEM3	Normal	20	100	4.29	12.59	0.03	13.00	8.5E-07			
6/8/2013	Memphrémagog	MEM3	Wave	30	150	7.79	25.95	0.16	45.06	5.6E-07	28.71	50.24	0.57
6/8/2013	Memphrémagog	MEM3	Normal	30	150	4.25	8.81	0.14	12.89	2.4E-06			
6/8/2013	Memphrémagog	MEM3	Normal	30	100	4.38	16.56	0.19	14.48	3.8E-07			
6/8/2013	Memphrémagog	MEM3	Wave	30	100	8.18	25.11	0.04	47.33	1.2E-06	21.28	36.20	0.59
6/8/2013	Memphrémagog	MEM3	Normal	30	200	3.74	10.22	0.24	9.55	7.3E-07			
6/8/2013	Memphrémagog	MEM3	Wave	30	200	6.41	18.95	0.10	27.01	4.2E-07	46.96	78.28	0.60
6/8/2013	Memphrémagog	MEM3	Normal	30	200	4.99	23.96	0.22	15.81	6.4E-07			
6/8/2013	Memphrémagog	MEM3	Wave	30	200	6.15	17.90	0.19	25.59	1.0E-06	40.03	77.84	0.51
6/8/2013	Memphrémagog	MEM3	Normal	30	100	3.76	10.94	0.08	10.04	3.0E-07			
6/8/2013	Memphrémagog	MEM3	Wave	30	100	8.35	25.62	0.34	51.91	1.4E-06	23.35	35.76	0.65
6/8/2013	Memphrémagog	MEM3	Normal	30	150	4.20	11.85	0.15	13.45	2.8E-06			
6/8/2013	Memphrémagog	MEM3	Wave	30	150	6.64	16.61	0.14	29.18	7.0E-07	41.87	62.80	0.67

Appendix 4. Suspended Sediment Value Raw Data Tables

Sampling date	Lake	Site	Period	Speed (miles/h)	Distance from shore (m)	T0 sediment (A) (mg L^{-1})	T1 sediment (B) (mg L^{-1})	Resuspension (mg L^{-1})
8/4/13	Lovering	LOV1	Normal	20	200	0.4	1.6	1.2
8/4/13	Lovering	LOV1	Wave	20	200	0.4	1.6	1.2
8/4/13	Lovering	LOV1	Normal	20	150	0.4	2.8	2.4
8/4/13	Lovering	LOV1	Wave	20	150	0.4	2.8	2.4
8/4/13	Lovering	LOV1	Normal	30	150	0.4	0.4	0
8/4/13	Lovering	LOV1	Wave	30	150	0.4	0.4	0
8/4/13	Lovering	LOV1	Normal	20	200	0.4	0.4	0
8/4/13	Lovering	LOV1	Wave	20	200	0.4	0.4	0
8/4/13	Lovering	LOV1	Normal	20	100	0.4	0.4	0
8/4/13	Lovering	LOV1	Wave	20	100	0.4	0.4	0
8/4/13	Lovering	LOV1	Wave	30	200	0.4	0.4	0
8/4/13	Lovering	LOV1	Normal	30	200	0.4	0.4	0
8/4/13	Lovering	LOV1	Normal	10	100	0.4	0.4	0
8/4/13	Lovering	LOV1	Wave	10	100	0.4	0.4	0
8/4/13	Lovering	LOV1	Normal	30	100	0.4	0.4	0
8/4/13	Lovering	LOV1	Wave	30	100	0.4	0.4	0
8/4/13	Lovering	LOV1	Normal	20	100	0.4	2.4	2
8/4/13	Lovering	LOV1	Wave	20	100	0.4	2.4	2
8/4/13	Lovering	LOV1	Normal	10	150	0.4	-2.4	-2.8
8/4/13	Lovering	LOV1	Wave	10	150	0.4	-2.4	-2.8
8/4/13	Lovering	LOV1	Normal	30	150	0.4	2	1.6
8/4/13	Lovering	LOV1	Wave	30	150	0.4	2	1.6
8/4/13	Lovering	LOV1	Normal	10	150	0.4	3.2	2.8
8/4/13	Lovering	LOV1	Wave	10	150	0.4	3.2	2.8
8/4/13	Lovering	LOV1	Normal	10	200	0.4	0.4	0
8/4/13	Lovering	LOV1	Wave	10	200	0.4	0.4	0
8/4/13	Lovering	LOV1	Wave	30	100	0.4	0.4	0
8/4/13	Lovering	LOV1	Normal	30	100	0.4	0.4	0
8/4/13	Lovering	LOV1	Wave	20	150	0.4	0.4	0
8/4/13	Lovering	LOV1	Normal	20	150	0.4	0.4	0
8/4/13	Lovering	LOV1	Wave	10	100	0.4	0.4	0
8/4/13	Lovering	LOV1	Normal	10	100	0.4	0.4	0
8/4/13	Lovering	LOV1	Wave	10	200	0.4		
8/4/13	Lovering	LOV1	Normal	10	200	0.4		
8/4/13	Lovering	LOV1	Wave	30	200	0.4	0.4	0
8/4/13	Lovering	LOV1	Normal	30	200	0.4	0.4	0
8/5/13	Lovering	LOV2	Normal	30	100	0.6	8.2	7.6
8/5/13	Lovering	LOV2	Wave	30	100	0.6	8.2	7.6
8/5/13	Lovering	LOV2	Wave	20	150	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	20	150	0.6	0.6	0

Sampling date	Lake	Site	Period	Speed (miles/h)	Distance from shore (m)	T0 sediment (A) (mg L^{-1})	T1 sediment (B) (mg L^{-1})	Resuspension (mg L^{-1})
8/5/13	Lovering	LOV2	Normal	30	200	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	30	200	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	10	200	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	10	200	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	30	100	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	30	100	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	10	100	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	10	100	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	20	200	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	20	200	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	20	150	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	20	150	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	30	150	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	30	150	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	10	100	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	10	100	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	20	200	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	20	200	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	20	100	0.6	3.4	2.8
8/5/13	Lovering	LOV2	Wave	20	100	0.6	3.4	2.8
8/5/13	Lovering	LOV2	Normal	20	100	0.6	1.8	1.2
8/5/13	Lovering	LOV2	Wave	20	100	0.6	1.8	1.2
8/5/13	Lovering	LOV2	Normal	10	150	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	10	150	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	10	200	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	10	200	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	30	150	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	30	150	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	30	200	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	30	200	0.6	0.6	0
8/5/13	Lovering	LOV2	Wave	10	150	0.6	0.6	0
8/5/13	Lovering	LOV2	Normal	10	150	0.6	0.6	0
8/5/13	Lovering	LOV3	Normal	30	150	0.3	0.3	0
8/5/13	Lovering	LOV3	Wave	30	150	0.3	0.3	0
8/5/13	Lovering	LOV3	Normal	30	200	0.3	0.3	0
8/5/13	Lovering	LOV3	Wave	30	200	0.3	0.3	0
8/5/13	Lovering	LOV3	Wave	30	150	0.3	0.3	0
8/5/13	Lovering	LOV3	Normal	30	150	0.3	0.3	0
8/5/13	Lovering	LOV3	Wave	10	100	0.3	1.9	1.6
8/5/13	Lovering	LOV3	Normal	10	100	0.3	1.9	1.6
8/5/13	Lovering	LOV3	Wave	20	150	0.3	0.3	0
8/5/13	Lovering	LOV3	Normal	20	150	0.3	0.3	0
8/5/13	Lovering	LOV3	Normal	20	100	0.3	0.3	0
8/5/13	Lovering	LOV3	Wave	20	100	0.3	0.3	0
8/5/13	Lovering	LOV3	Wave	10	150	0.3	3.5	3.2

Sampling date	Lake	Site	Period	Speed (miles/h)	Distance from shore (m)	T0 sediment (A) (mg L^{-1})	T1 sediment (B) (mg L^{-1})	Resuspension (mg L^{-1})
8/5/13	Lovering	LOV3	Normal	10	150	0.3	3.5	3.2
8/5/13	Lovering	LOV3	Wave	30	100	0.3	0.3	0
8/5/13	Lovering	LOV3	Normal	30	100	0.3	0.3	0
8/5/13	Lovering	LOV3	Wave	30	200	0.3	0.3	0
8/5/13	Lovering	LOV3	Normal	30	200	0.3	0.3	0
8/5/13	Lovering	LOV3	Wave	20	200	0.3	1.5	1.2
8/5/13	Lovering	LOV3	Normal	20	200	0.3	1.5	1.2
8/5/13	Lovering	LOV3	Wave	20	150	0.3	0.3	0
8/5/13	Lovering	LOV3	Normal	20	150	0.3	0.3	0
8/5/13	Lovering	LOV3	Wave	10	100	0.3	1.5	1.2
8/5/13	Lovering	LOV3	Normal	10	100	0.3	1.5	1.2
8/5/13	Lovering	LOV3	Wave	30	100	0.3	0.3	0
8/5/13	Lovering	LOV3	Normal	30	100	0.3	0.3	0
8/5/13	Lovering	LOV3	Wave	10	200	0.3	0.3	0
8/5/13	Lovering	LOV3	Normal	10	200	0.3	0.3	0
8/5/13	Lovering	LOV3	Wave	10	200	0.3	0.3	0
8/5/13	Lovering	LOV3	Normal	10	200	0.3	0.3	0
8/5/13	Lovering	LOV3	Normal	20	100	0.3	-1.7	-2
8/5/13	Lovering	LOV3	Wave	20	100	0.3	-1.7	-2
8/5/13	Lovering	LOV3	Normal	20	200	0.3	0.3	0
8/5/13	Lovering	LOV3	Wave	20	200	0.3	0.3	0
8/5/13	Lovering	LOV3	Normal	10	150	0.3	1.5	1.2
8/5/13	Lovering	LOV3	Wave	10	150	0.3	1.5	1.2
8/5/13	Memphrémagog	MEM1	Normal	30	200	1	2.2	1.2
8/5/13	Memphrémagog	MEM1	Wave	30	200	1	2.2	1.2
8/5/13	Memphrémagog	MEM1	Normal	10	200	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	10	200	1	1	0
8/5/13	Memphrémagog	MEM1	Normal	20	150	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	20	150	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	30	100	1	1	0
8/5/13	Memphrémagog	MEM1	Normal	30	100	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	10	150	1	1	0
8/5/13	Memphrémagog	MEM1	Normal	10	150	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	10	100	1	4.2	3.2
8/5/13	Memphrémagog	MEM1	Normal	10	100	1	4.2	3.2
8/5/13	Memphrémagog	MEM1	Normal	10	150	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	10	150	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	10	200	1	1	0
8/5/13	Memphrémagog	MEM1	Normal	10	200	1	1	0
8/5/13	Memphrémagog	MEM1	Normal	20	200	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	20	200	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	30	100	1	1	0
8/5/13	Memphrémagog	MEM1	Normal	30	100	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	20	150	1	1	0
8/5/13	Memphrémagog	MEM1	Normal	20	150	1	1	0

Sampling date	Lake	Site	Period	Speed (miles/h)	Distance from shore (m)	T0 sediment (A) (mg L^{-1})	T1 sediment (B) (mg L^{-1})	Resuspension (mg L^{-1})
8/5/13	Memphrémagog	MEM1	Wave	30	150	1	1	0
8/5/13	Memphrémagog	MEM1	Normal	30	150	1	1	0
8/5/13	Memphrémagog	MEM1	Normal	30	200	1	-0.2	-1.2
8/5/13	Memphrémagog	MEM1	Wave	30	200	1	-0.2	-1.2
8/5/13	Memphrémagog	MEM1	Normal	20	200	1	3	2
8/5/13	Memphrémagog	MEM1	Wave	20	200	1	3	2
8/5/13	Memphrémagog	MEM1	Normal	30	150	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	30	150	1	1	0
8/5/13	Memphrémagog	MEM1	Normal	20	100	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	20	100	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	20	100	1	1	0
8/5/13	Memphrémagog	MEM1	Normal	20	100	1	1	0
8/5/13	Memphrémagog	MEM1	Wave	10	100	1	2.2	1.2
8/5/13	Memphrémagog	MEM1	Normal	10	100	1	2.2	1.2
8/5/13	Memphrémagog	MEM2	Normal	20	150	0.4	-0.8	-1.2
8/5/13	Memphrémagog	MEM2	Wave	20	150	0.4	-0.8	-1.2
8/5/13	Memphrémagog	MEM2	Normal	10	100	0.4	2.4	2
8/5/13	Memphrémagog	MEM2	Wave	10	100	0.4	2.4	2
8/5/13	Memphrémagog	MEM2	Wave	10	150	0.4	4	3.6
8/5/13	Memphrémagog	MEM2	Normal	10	150	0.4	4	3.6
8/5/13	Memphrémagog	MEM2	Wave	20	200	0.4	2.4	2
8/5/13	Memphrémagog	MEM2	Normal	20	200	0.4	2.4	2
8/5/13	Memphrémagog	MEM2	Normal	20	200	0.4	0.4	0
8/5/13	Memphrémagog	MEM2	Wave	20	200	0.4	0.4	0
8/5/13	Memphrémagog	MEM2	Normal	10	200	0.4	0.4	0
8/5/13	Memphrémagog	MEM2	Wave	10	200	0.4	0.4	0
8/5/13	Memphrémagog	MEM2	Normal	30	150	0.4	0.4	0
8/5/13	Memphrémagog	MEM2	Wave	30	150	0.4	0.4	0
8/5/13	Memphrémagog	MEM2	Normal	10	200	0.4	-0.8	-1.2
8/5/13	Memphrémagog	MEM2	Wave	10	200	0.4	-0.8	-1.2
8/5/13	Memphrémagog	MEM2	Normal	30	150	0.4	1.6	1.2
8/5/13	Memphrémagog	MEM2	Wave	30	150	0.4	1.6	1.2
8/5/13	Memphrémagog	MEM2	Normal	30	100	0.4	1.6	1.2
8/5/13	Memphrémagog	MEM2	Wave	30	100	0.4	1.6	1.2
8/5/13	Memphrémagog	MEM2	Normal	30	200	0.4	1.6	1.2
8/5/13	Memphrémagog	MEM2	Wave	30	200	0.4	1.6	1.2
8/5/13	Memphrémagog	MEM2	Wave	30	100	0.4	0.4	0
8/5/13	Memphrémagog	MEM2	Normal	30	100	0.4	0.4	0
8/5/13	Memphrémagog	MEM2	Wave	20	100	0.4	2	1.6
8/5/13	Memphrémagog	MEM2	Normal	20	100	0.4	2	1.6
8/5/13	Memphrémagog	MEM2	Wave	20	150	0.4	2.4	2
8/5/13	Memphrémagog	MEM2	Normal	20	150	0.4	2.4	2
8/5/13	Memphrémagog	MEM2	Normal	30	200	0.4	1.6	1.2
8/5/13	Memphrémagog	MEM2	Wave	30	200	0.4	1.6	1.2
8/5/13	Memphrémagog	MEM2	Normal	20	100	0.4	0.4	0

Sampling date	Lake	Site	Period	Speed (miles/h)	Distance from shore (m)	T0 sediment (A) (mg L^{-1})	T1 sediment (B) (mg L^{-1})	Resuspension (mg L^{-1})
8/5/13	Memphrémagog	MEM2	Wave	20	100	0.4	0.4	0
8/5/13	Memphrémagog	MEM2	Wave	10	100	0.4	4.4	4
8/5/13	Memphrémagog	MEM2	Normal	10	100	0.4	4.4	4
8/5/13	Memphrémagog	MEM2	Wave	10	150	0.4	3.2	2.8
8/5/13	Memphrémagog	MEM2	Normal	10	150	0.4	3.2	2.8
8/6/13	Memphrémagog	MEM3	Wave	30	150	0.7	1.9	1.2
8/6/13	Memphrémagog	MEM3	Normal	30	150	0.7	1.9	1.2
8/6/13	Memphrémagog	MEM3	Normal	20	100	0.7		
8/6/13	Memphrémagog	MEM3	Wave	20	100	0.7		
8/6/13	Memphrémagog	MEM3	Wave	10	200	0.7	3.1	2.4
8/6/13	Memphrémagog	MEM3	Normal	10	200	0.7	3.1	2.4
8/6/13	Memphrémagog	MEM3	Normal	30	100	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Wave	30	100	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Normal	30	200	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Wave	30	200	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Normal	30	200	0.7	-0.9	-1.6
8/6/13	Memphrémagog	MEM3	Wave	30	200	0.7	-0.9	-1.6
8/6/13	Memphrémagog	MEM3	Normal	10	200	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Wave	10	200	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Normal	30	100	0.7	3.1	2.4
8/6/13	Memphrémagog	MEM3	Wave	30	100	0.7	3.1	2.4
8/6/13	Memphrémagog	MEM3	Normal	20	150	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Wave	20	150	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Normal	20	150	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Wave	20	150	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Normal	10	150	0.7	2.7	2
8/6/13	Memphrémagog	MEM3	Wave	10	150	0.7	2.7	2
8/6/13	Memphrémagog	MEM3	Normal	10	100	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Wave	10	100	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Normal	30	150	0.7	1.5	0.8
8/6/13	Memphrémagog	MEM3	Wave	30	150	0.7	1.5	0.8
8/6/13	Memphrémagog	MEM3	Normal	20	200	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Wave	20	200	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Normal	20	200	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Wave	20	200	0.7	0.7	0
8/6/13	Memphrémagog	MEM3	Wave	20	100	0.7	-1.7	-2.4
8/6/13	Memphrémagog	MEM3	Normal	20	100	0.7	-1.7	-2.4
8/6/13	Memphrémagog	MEM3	Normal	10	100	0.7	3.1	2.4
8/6/13	Memphrémagog	MEM3	Wave	10	100	0.7	3.1	2.4
8/6/13	Memphrémagog	MEM3	Normal	10	150	0.7	1.9	1.2
8/6/13	Memphrémagog	MEM3	Wave	10	150	0.7	1.9	1.2