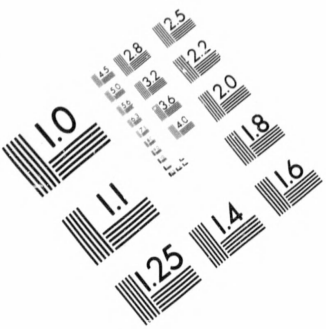

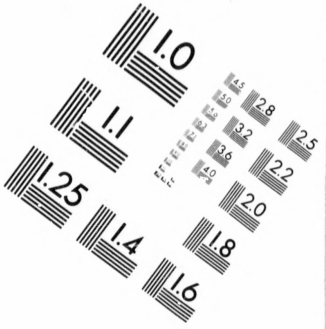

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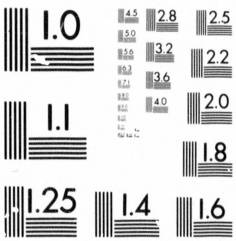

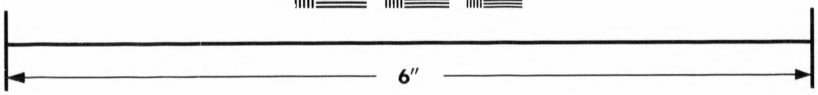

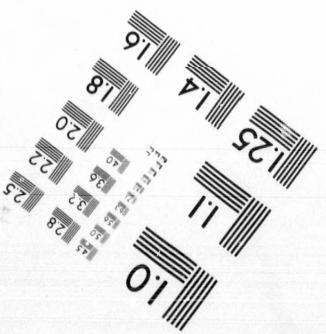

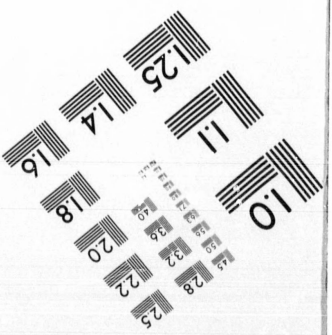

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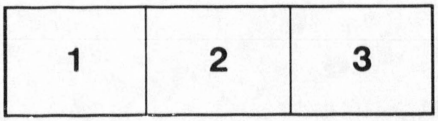

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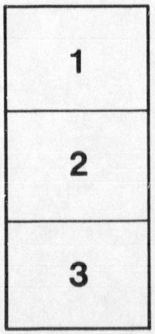

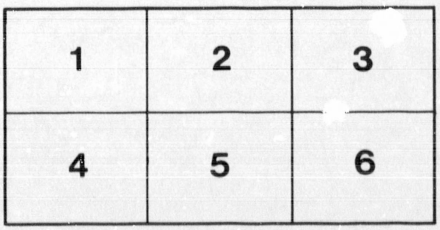

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Some Lake and River Temperatures.

By A. T. DRUMMOND.

In *Nature* and this journal, I have already drawn attention to the fact that the Georgian Bay is, in its main expanse, a large body of cold water whose temperature, at its greater depths, is not much influenced by the heat of summer, whilst, on the other hand, the Central and Southern Basins of Lake Huron, although also receiving surplus waters from Lake Superior, stand in the line of inflow of the warmer waters from Lake Michigan and of their ultimate exit by way of the River St. Clair to the lower lakes, and are consequently somewhat warmer basins.

Staff-Commander Boulton, R N., has been good enough to communicate some further records of temperature made during the season of 1890 in the Georgian Bay and the channel north of the Manitoulin Islands. These, taken in connection with his former results, justify certain conclusions to which reference will be made in this paper.[1]

PARRY SOUND.

In the course of his soundings during 1890 in the deep and wide but land-locked harbor of Parry Sound, on the eastern coast of the Georgian Bay, with its fringe of islands

[1] The readings in this paper are all from Fahrenheit's scale.

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and comparatively shallow waters in front, some temperatures were taken, at different periods of the summer, which establish the fact that notwithstanding the presence of islands in the sound, and of land on all sides, at no place more than two to three miles distant, the deep depressions or pools in the bottom of the sound, in some places exceeding sixty fathoms in depth, retain their cold water throughout the year. The change observed at the bottom between the beginning of May and the end of August did not exceed 3.5°, whilst in the same period the variation at the surface was 25.5°. The observations have sufficient interest to be given here:—

Time.	Depth.	Air.	Surface.	Bottom.	Sky.
May 2nd, noon....	62 fms.	48°	36 2°	35.7°	Clear
Aug. 23rd, 5 p.m..	48 "	64°	61.7°	39.2°	Some clouds
Oct. 15th, 4.10 p.m.	57 "	57°	53.5°	39°	Overcast

How far the cold waters of these deeper pools in a land-locked harbor like Parry Sound, which is largely free from the direct influence of outside currents, are subject in summer to much change, not merely in temperature but through circulation, is worth considering.

Referring to the Georgian Bay generally, Commander Boulton infers from the temperatures which he has taken that, in the early spring of the year, the whole column of water is at nearly the surface temperature, and that the effect of the summer's heat is to warm up the bottom water to about the temperature of water at its greatest density, viz., 39.2°.

INFLUENCE OF LAKE SUPERIOR WATERS ON GEORGIAN BAY TEMPERATURES.

In considering why the bottom waters in the Georgian Bay retain so low a temperature throughout the summer, regard must be had to the direction of the inflow of the waters from both Lake Superior and Lake Michigan. A reference to a chart of the Great Lakes will help to explain this. The waters of Lake Superior—always cold—find

their outlet to Lake Huron through the River St. Mary. The island of St. Joseph divides the river, as it joins Lake Huron, into two channels, one of which transmits its waters partly through the Detour into the Central Basin of the lake, and partly into what might be termed the Manitoulin Basin, on the north side of the Manitoulin Islands, whilst the other channel guides its waters entirely into this latter basin. It at once suggests itself that the waters of this Manitoulin Basin must be cold, and that the flow of these colder waters, whilst in part to the Central Basin of Lake Huron by the channels between the islands, is more probably largely along the north side of these islands and into the Georgian Bay, thus continuously keeping up the supply of cold water, which is so conspicuous a feature in that bay. Commander Boulton's records seem to me to help this suggestion. Thus, in the Manitoulin Basin, north of Cockburn Island, on June 3rd, 1890, at 10.30 a.m., with a cloudy sky and the air at 54°, the surface water indicated 44.7°, whilst the temperature at 29 fathoms was 39°; and, again, at another point nearer Cockburn Island, at 8.30 a.m., on the next day, when the sky was clear and the air at 66°, the surface of the water was 46.5°, whilst the bottom at 18 fathoms indicated 39.7°.

Again, the preponderating current in the channel between La Cloche Island and the north shore of Manitoulin Island, at the point known as Little Current, is, Commander Boulton informs me, towards the Georgian Bay. As an easterly wind may reverse its direction for the time, he suggests that the easterly current might be merely surface-drift, due to the prevalence of westerly winds. My own impression is that it will be found to be a permanent, deep current, flowing towards the Georgian Bay.

It is, however, also suggestive that the cold waters from Lake Superior which do pass through the Detour, and the channels between the Manitoulin Islands into the Central Basin of Lake Huron, are not immediately incorporated with the warmer Michigan outflow, but trend in an easterly and south-easterly direction towards the Georgian Bay and

Bruce Peninsula, and constitute a barrier to the extension easterly of these warmer Michigan waters. The few surface and bottom readings obtained by the United States Lake Survey would appear to justify the suggestion, as the waters in the broad line of flow from the Straits of Mackinac to Sarnia indicated 10° warmer at the bottom and 6° to 7° at the surface than those in the Central Basin to the east of this general line.

YAMASKA RIVER.

Two or three weeks holiday, spent last August at Yamaska Mountain, on the banks of the Yamaska River, gave me the opportunity of making numerous thermometrical tests of the relations between the water and the overlying air, and, inferentially, of the influence which water in larger bodies must have on the temperature and agricultural capabilities of the neighboring land.

The river here is from 300 to 400 feet wide and from 10 to 15 feet in depth. and flows in a very serpentine course through a broad stretch of level country, the only conspicuous break immediately near being the isolated Yamaska Mountain, which, about half a mile back from the river, rises precipitously to a height of about 900 feet, and is, from summit to base, clothed with pines, spruces, maples and other trees. On the Abbotsford side, the incline is gradual, and affords both room and protection for the extensive orchards which there are laid out with a semblance of mathematical exactitude on the mountain side. Viewed from the mountain, the great plain here has been almost denuded of its woods, and, with the tracery of unsightly fences, is at every point subdivided into cultivated farms. The wind has, therefore, but little to break its force as it sweeps over the great plain and past the mountain sides. Where our headquarters were on the banks of the river, in full view of the sombre mountain which lay about half a mile away, the gales were frequent, sometimes violent. The river, however, flowed in its tortuous course between precipitous banks of from 15 to 20 feet high, and generally

presented a comparatively unruffled surface, which favored the taking of temperatures.

In a shallow river like the Yamaska, whose waters are readily swollen by very heavy rains, and whose course is broken here and there by milldams, the temperature of the water is necessarily somewhat uniform, excepting so far as the surface may be influenced by the sun's rays by day or by the coolness of the night air. Thus, on days when the sky was continuously overcast, this uniformity was frequently observable, whilst in the bright sunshine of early August, the surface would indicate from 1° to 2° higher than at about four feet depth. The general temperature of the water at that depth in the earlier part of the month was about 77°, but by September 8th it had fallen gradually to 68°.

INFLUENCE OF TEMPERATURE OF WATER ON THE IMMEDIATELY OVERLYING AIR.

The temperature of the river water was about 6° to 7° higher than Lake Ontario waters at about the same depth and the same period in August would be, but the protection which the river banks afforded from the wind, and the, at oft times, comparatively unruffled surface, aided in rendering the tests made here more definite than, on the open lake, they could generally have been. The readings were taken (1) at one inch below the surface of the water, (2) in the air one inch above the surface, (3) at one foot and one foot and a-half above the surface, and (4) on the top of the bank at about sixteen feet above the river level. Cloudy days were selected, though some tests were made at sunset.

The features of interest which from the first presented themselves were, as might be expected, the much higher temperature of the surface water over the immediately overlying stratum of air, and the extreme variation in this difference of temperature. It was not uncommon to find this difference amounting to 6° @ 8°, although it sometimes was as low as half a degree, and on one occasion, at 7.45 p.m. on the 13th August, rose to nearly 18°, and was then accom-

panied by a light vapour over the water. In the ascent from this stratum of air directly in contact with the water, to the top of the bank, there was a constantly varying but gradually lower temperature. At one and a-half feet above the water the readings fluctuated between .5° and 3° lower than at one inch above the water, and on the top of the bank these fluctuations ranged from .5° to 4.5° lower than at one inch. In only one case was the reading on the top of the bank higher in range. Four illustrations are here given to show the relative temperatures (1) during a continuous dense fog, (2) and (3) at different hours on the same cloudy day, and (4) at sunset on a cloudy cool day:

	(1) 9 a.m. Aug. 16. dense fog.	(2) 4 p.m. Aug. 31, cloudy.	(3) 7 p.m. Aug. 31, cloudy—water absolutely calm.	(4) 7.15 p.m. Aug. 28, cloudy—cool.
Water at 3 ft.....	71.75°	68°	.....	67.2°
Water at 1 in.....	71.75°	68°	68.25°	66.5°
Air 1 in. above water..	68.5°	66°	66.25°	57°
" 1 ft. " " ..	66.75°	63.5°	61.5°	55.5°
" 8 ft. " " ..	.....	63°	.....	....
" 16 ft. " " ..	65.75°	62°	60.25°	55°

In the case of the second illustration, when the thermometer at 8 ft. up the bank was placed upon the moist ground there, the mercury rose from 63° to 64.5°. On the top of the bank, about 300 ft. inland in the fields away from the woods, it remained at 62°, but in the woods 200 ft. nearer the bank of the river it fell to 60.5°, the thermometer in each case being placed at about 18 in. above the ground.

CONCLUSIONS.

The readings are suggestive of the condition of probably most of the tributaries, from the south, of the St. Lawrence and Great Lakes during the hot months of summer. The tests were not sufficiently varied, as to place and time, to warrant definite deductions, but it may be said, in general terms, that these rivers, which in winter are paved with two

or three feet of ice, have in early August a general temperture of 76° to 77°: that the air in direct contact with the warm surface of the water has, in that month, its temperature raised to from 1° to 5° above that of the air directly above but in more exposed positions: and that this increase of temperature, which is greatest at the point of contact, is, at one foot above the surface of the water, already to a considerable extent lost.