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C.F.M. Lewis, B.J. Todd, and S.E. Hayward

2018

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Publications in this series have not been edited; they are released as submitted by the author.

Introduction

The 1999 map published by the U.S National Oceanic and Atmospheric Administration (NOAA) is an excellent map of Lake Ontario bathymetry with 2-m contour intervals compiled from the water depth surveys of the U.S. and Canadian hydrographic agencies (Virden et al. 1999). However, the reference elevation for the lake surface in this map is not published, but is thought to be close to the low-water datum used in charts published by the hydrographic survey organizations (K.S. Carignan, NOAA Associate Scientist, pers. comm. 2017). The present study is motivated by the need to know the map datum in order to compute elevations above sea level (asl) of a paleo-barrier beach (informally termed the Grimsby–Oakville barrier beach or formally the Early Lake Ontario barrier beach) discovered beneath the mud of western Lake Ontario during Kelvin Hughes 26B sounding surveys 1968 to 1974.

The approach adopted for estimating/confirming a reference elevation for the NOAA bathymetry map of Lake Ontario is to evaluate true water depth at > 200 station positions in Lake Ontario from the echo sounder records of MV *Martin Karlsen* during its Canada Centre for Inland Waters (CCIW) 74-00-102 cruise on Lake Ontario from 6–16 July 1974. These ship-measured sounder water depths at stations, and the known lake water level (elevation in metres above present sea level, asl) at the time of survey were compared with water depths extracted from the NOAA map to estimate a reference elevation for the NOAA bathymetry map. This estimated lake surface reference elevation was similar to the datum (74.0 m relative to the International Great Lakes Datum of 1955 or IGLD(1955)) of the Canadian Hydrographic charts for western Lake Ontario at the time of surveys of the paleo-barrier beach. For these surveys, it is recommended that elevations for the beach be computed using the IGLD(1955) Lake Ontario datum of 74.0 m.

The paleo-barrier beach is thought to have been constructed when Early Lake Ontario was confluent with the Champlain Sea (Atlantic Ocean) in the upper St. Lawrence River valley. Elevations of the beach are needed to compare with the surface defined by elevations of the Champlain Sea shoreline, now onshore. Because the Champlain elevations (marine limits) were recognized and published in the 1970s and early 1980s, the appropriate bathymetric datum to use in Lake Ontario would be the one established for use in the same period (i.e., 74.0 m asl).

Interpretation of Kelvin Hughes 26B sound pulse travel paths and estimation of true water depths

Outgoing ray paths from a sounder transducer, their reflected incoming ray paths, and their multiple and ghost reflections are those parts of the sound wave fields that are important in understanding reflections recorded by an echo sounder, in this case a Kelvin Hughes 26B sounder (14.25 kHz) operated on MV *Martin Karlsen* during cruise 74-00-102 in Lake Ontario from 6–16 July 1974. Sound wave fronts propagate from a source in all directions. They also travel similar distances in given intervals of time in isotropic media. Although Lake Ontario is stratified horizontally in summer due to temperature differences and is not isotropic, all of the sound travel paths of interest are vertical or close to vertical and thus sound rays approach

water property boundaries at vertical incidence and are assumed to not be affected by refraction, according to Snell's law (SEG Dictionary 2018a). Rays of sound energy can change their direction of travel because all points on a sound wave front can initiate new wave fronts that propagate outward in many directions (SEG Dictionary 2018b). The Kelvin Hughes echograms of cruise 74-00-102 in relatively shallow water (50–100 ft or 15–30 m) record the lakebed reflection (first return), a ghost reflection of the lakebed reflection, a multiple (second) reflection of the lakebed, and a second ghost reflection after the arrival of the lakebed multiple reflection (Fig. 1). Travel paths of the foregoing reflections are interpreted. Like all reflection systems with a combined sound source and receiver, rays must travel a distance twice (down and up) to yield an observable time (and distance) interval. The multiple and its ghost are shown to represent the water depth below the ship's hull, and the depth of the ship's transducer below the air-water interface, respectively. At any sounding site, the sum of these two values is inferred to yield the true water depth.

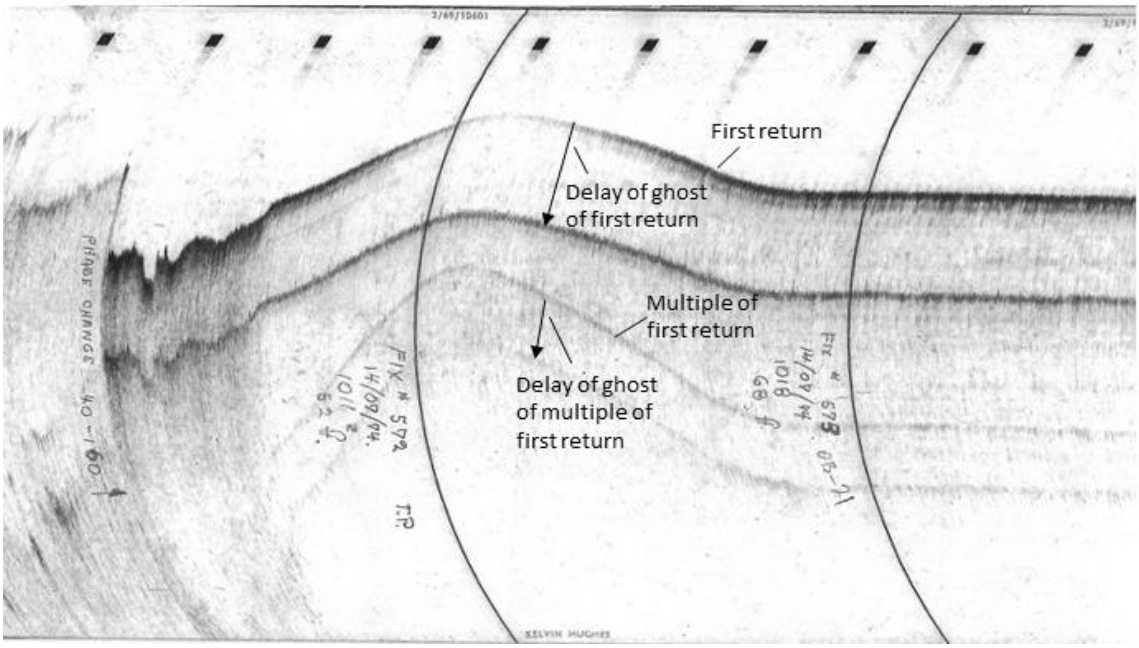

Figure 1. A section of the Kelvin Hughes 26B record from cruise 74-00-102 showing lakebed reflections and ghost reflections at Fixes 572 and 573 (vertical lines concave to the right) and in their vicinity. The record illustrates a range of depths from 40 to 160 ft or 12.2 to 48.8 m. Sounder water depths at fixes were measured during the cruise by the ship's bridge officers.

The database in columns E–K of Table1 is from reflections in Kelvin Hughes 26B records from Canada Centre for Inland Waters (CCIW) cruise 74-00-102 aboard MV *Martin Karlsen*. During this cruise from 6–16 July, 1974, the recorded lake surface elevation was 75.50 m above sea level (asl) according to the website of the Great Lakes Environmental Research Laboratory (GLERL 2017).

Table 1. Reflection data from echograms of cruise 74-00-102 where multiple reflections were visible[1].

E	F	G	H	I	J	K
Fix No	Bridge-read sounder depth ft	First lakebed return ghost delay ft	First lakebed return to multiple ft	Lakebed multiple ghost delay ft	True depth = col H+ col I ft	Bridge-read depth-True depth ft
354	57	23	40.5	14.5	55	2
355	66	25	51	14.5	65.5	0.5
357	85	24	67	14	81	4
361	78	24	61	14	75	3
368	70	24	54	14	68	2
373	74	25	59	15	74	0
375	55	26	41	13.5	54.5	0.5
382	100	22.5	82	13	95	5
387	76	25	59	14	73	3
392	64	23.5	50	13.5	63.5	0.5
393	68	23	52	14	66	2
395	56	25	42	14	56	0
396	62	24	47.5	13.5	61	1
414	76	22	59.5	14.5	74	2
428	72	22	56	13	69	3
437	74	22	57	14	71	3
444	55	22	38	14	52	3
447	85	22	66	13.5	79.5	5.5
448	82	22	62	14	76	6
454	60	21	47	14	61	-1
466	50	22	32.5	14.5	47	3
468	52	22	38	15	53	-1
474	59	22.5	45	15	60	-1
494	93	21	73.5	14.5	88	5
504	59	22.5	44.5	14.5	59	0
515	72	22.5	55.5	14	69.5	2.5
531	55	22	39.5	14.5	54	1
542	54	21.5	39	15	54	0
545	50	22.5	34	14	48	2
546	50	22.5	35	14	49	1
560	66	22.5	48	15	63	3
561	49	22.5	33	14.5	47.5	1.5
572	52	22.5	36	14.5	50.5	1.5
573	68	22.5	51	14	65	3
574	70	22.5	53	14	67	3
653	47	22.5	31.5	14.5	46	1
654	50	22.5	34.5	14.5	49	1
Averages		22.851		14.2		1.932
St'd Dev'ns		1.189		0.5		1.784

[1] Data at one fix that produced an outlier value of 12.5 ft in column K are not listed.

The interpretation of the sound travel paths and their recorded reflections is made with reference to parts (i) to (iv) of Figure 2.

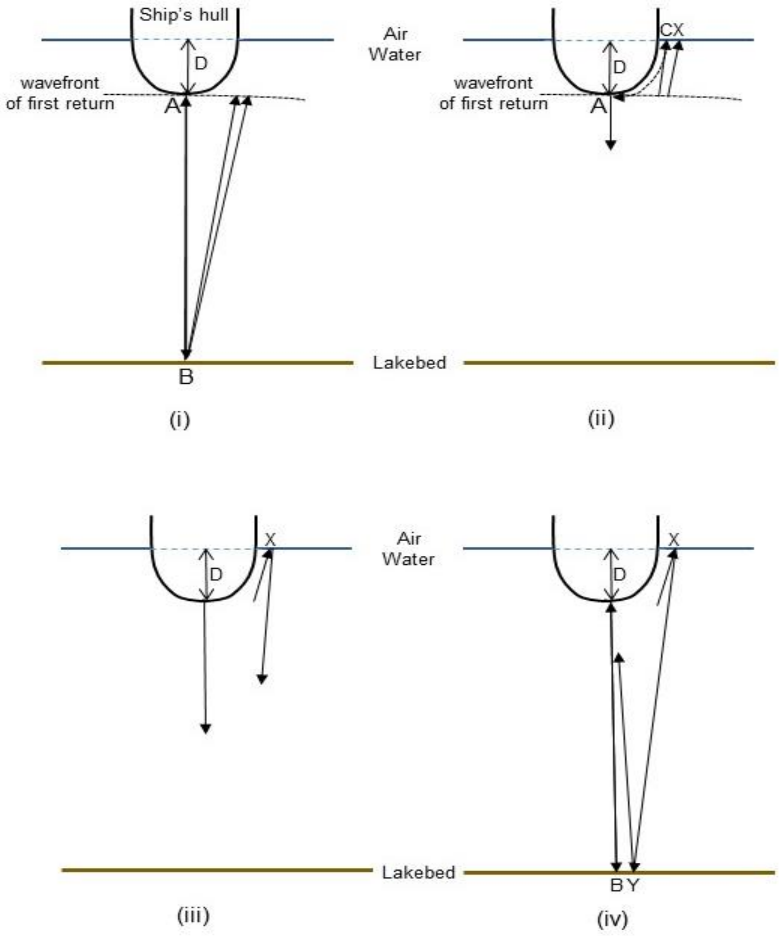

Figure 2. Sketches of progress of a sound pulse from (i) to (iv), comprising initiation at the transducer at base of ship's hull to arrival of a lakebed reflection and its multiple reflections at the transducer. Distance D is the draft of the transducer below the waterline. See text for explanation under paragraphs headed Figure 2i, Figure 2ii, Figure 2iii, and Figure 2iv.

Figure 2i. A sound pulse, emitted from the transducer at the base of the ship's hull (A), is reflected from the lakebed at B and returned to the transducer to produce the first reflection of the lakebed. Other upward-reflected rays are directed beside the ship's hull and will be reflected from the air-water interface above.

Figure 2ii. The first lakebed return is reflected back downward from the base of the ship's hull. At the same time, the other rays continue upward beside the hull to be reflected downward from the air-water interface. One reflected wave front gives rise to other wave fronts and rays that follow the ship's hull and ultimately reach the transducer. This arrival appears later as a ghost lakebed reflection after the arrival of the first return. The measured delays of this ghost reflection are listed in column G of Table 1.

Figure 2iii. While the hull-reflected first lakebed return travels downward, the other upward-moving ray beside the ship has been reflected downward by the air-water interface. The

wave front of this ray has fallen behind the hull-reflected ray because of the extra distance it travelled to reach the air-water interface.

Figure 2iv. The hull-reflected first return has been reflected from the lakebed back to the transducer to be recorded as the lakebed multiple reflection. The measured depth interval between the first return reflection and the multiple reflection of the first return appears in column H of Table 1. The other reflected ray from the air-water interface has also been reflected from the lakebed, but has been delayed relative to the lakebed multiple reflection. This other ray will arrive at the transducer and be recorded later as a ghost of the lakebed multiple reflection. This delay is seen, by reference to Figures 2ii and 2iii, to be caused by the extra distance travelled up and down beside the ship's hull, a distance that approximates the draft (D) of the transducer below the waterline. The measured delays of this ghost reflection are listed in column I of Table 1.

From Table 1, column I, the transducer draft, D, equals 14.2±0.5 ft or 4.3±0.2 m, the delay of the ghost of the lakebed multiple reflection after the arrival of the actual lakebed multiple reflection. The sum of this delay and the depth of the multiple lakebed reflection below the first return of the lakebed signal equals the true water depth, and the summed values are listed in column J of Table 1. In column K of Table 1, the true water depth is subtracted from the depth read by the ship's bridge officers. All differences in column K reveal that the bridge-read depths are 1.93±1.78 ft or 0.59±0.54 m greater than the true water depths, on average.

The bridge-read depths would be 'correct' if lake level was 0.59±0.54 m higher at an elevation of 75.50+0.59±0.54 = 76.09±0.54 m asl.

Relation of NOAA bathymetry and water depths at stations on CCIW cruise 74-00-102

The water depths at 210 'on' and 'off' positions of stations of cruise 74-00-102 from both the ship's sounder and the Lake Ontario NOAA bathymetry map appear in Table 2. The difference of MV *Martin Karlsen* sounder depths and NOAA depths was determined, on average, to be 2.41±3.23 m, neglecting one extreme value of 17.9 m that lies far beyond the central mode of the 'Sounder minus NOAA depth' distribution (Fig. 3).

Table 2. Comparison of Kelvin Hughes sounder depths with NOAA bathymetry map depths at stations of CCIW cruise 74-00-102 on Lake Ontario.

Station	Latitude N	Longitude W	Bridge-read Sounder Depth m	NOAA map m	Sounder minus NOAA
on P21A	43.38	-78.73	72.24	73.21	-0.97
off P21A	43.38	-78.73	71.63	72.81	-1.18
on P21 B	43.38	-78.72	71.32	67.91	3.41
off P21**B**	43.38	-78.72	74.07	67.91	6.16
on P21C	43.38	-78.71	69.19	65.61	3.58
off P21C	43.38	-78.71	68.58	65.61	2.97
on P21D	43.38	-78.75	73.76	74.91	-1.15

Station	Latitude N	Longitude W	Bridge-read Sounder Depth m	NOAA map m	Sounder minus NOAA
off P21D	43.38	-78.75	74.07	74.91	-0.84
on 21E	43.38	-78.76	77.42	78.91	-1.49
off P21E	43.38	-78.76	77.72	79.91	-2.19
on P21F	43.39	-78.75	85.95	85.71	0.24
off P21F	43.39	-78.75	85.65	85.71	-0.06
on P21G	43.39	-78.73	83.52	83.21	0.31
off P21G	43.39	-78.73	83.21	83.21	0.00
on P21H	43.39	-78.72	82.30	82.21	0.09
off P21H	43.39	-78.72	81.69	82.21	-0.52
on P21I	43.38	-78.72	53.64	52.61	1.04
off P21I	43.38	-78.72	53.04	52.61	0.43
on P21J	43.38	-78.73	57.91	55.71	2.20
off P21J	43.38	-78.73	57.61	55.71	1.90
on P21K	43.38	-78.73	65.23	64.31	0.92
off P21K	43.38	-78.73	65.53	64.31	1.22
on P21L	43.38	-78.73	68.28	67.41	0.87
off P21L	43.38	-78.73	73.76	74.31	-0.55
on R1	43.44	-78.84	130.15	126.42	3.73
off R1	43.44	-78.84	127.41	126.42	0.99
on R2	43.52	-78.84	143.26	141.02	2.24
off R2	43.52	-78.84	145.39	142.02	3.37
on R3	43.75	-78.86	82.30	78.72	3.58
off R3	43.75	-78.87	81.99	76.72	5.28
on P25A	43.66	-78.71	124.36	121.71	2.65
off P25A	43.65	-78.70	128.63	126.51	2.11
on P25B	43.65	-78.69	130.45	129.61	0.84
off P25B	43.65	-78.69	129.24	129.61	-0.38
on P25C	43.65	-78.68	129.84	128.91	0.93
off P25C	43.65	-78.68	128.02	125.71	2.31
on P25D	43.66	-78.68	126.80	124.81	1.99
off P25D	43.66	-78.68	124.66	123.81	0.85
on P25E	43.65	-78.71	128.63	128.11	0.51
off P25E	43.65	-78.71	126.80	128.01	-1.21
on P25F	43.63	-78.68	135.64	134.71	0.92
off P25F	43.64	-78.68	133.50	131.01	2.49
on T1	43.58	-79.38	72.54	69.14	3.41
off T1	43.57	-79.38	76.81	75.34	1.47
on T2	43.52	-79.35	103.02	99.74	3.29
off T2	43.52	-79.35	103.02	100.14	2.89
on T3	43.43	-79.31	118.87	120.14	-1.27
on T4	43.33	-79.27	96.01	90.54	5.47
on PC4	43.36	-79.63	77.72	68.76	8.97
on OB1	43.87	-78.07	65.23	64.80	0.43
off OB1	43.86	-78.07	65.84	64.30	1.53
on OB2	43.85	-78.07	70.10	67.80	2.30
off OB2	43.85	-78.07	70.41	67.80	2.61
on PC6	43.77	-78.06	99.36	100.70	-1.34
off PC6	43.77	-78.05	89.31	85.40	3.90
on PC7	43.65	-78.00	163.98	164.70	-0.72
off PC7	43.65	-78.00	164.90	164.70	0.19
on OB3	43.81	-77.78	87.17	80.40	6.77
off OB3	43.81	-77.73	85.95	76.10	9.85

Station	Latitude N	Longitude W	Bridge-read Sounder Depth m	NOAA map m	Sounder minus NOAA
on PC9	43.62	-77.52	129.84	129.70	0.14
off PC9	43.63	-77.53	131.67	131.00	0.67
on PC10	43.60	-77.24	142.65	140.90	1.74
off PC10	43.60	-77.26	145.69	147.80	-2.11
on PC11	43.67	-76.96	142.95	135.40	7.55
off PC11	43.67	-76.96	142.95	132.60	10.35
on PC12	43.75	-76.64	79.25	80.40	-1.15
off PC12	43.75	-76.63	84.43	80.90	3.53
on PC13	43.79	-76.58	58.83	56.70	2.12
off PC13	43.73	-76.63	101.80	92.60	9.20
on E30	43.51	-76.91	231.04	224.50	6.54
off E30	43.51	-76.91	230.43	224.80	5.63
on PC14	43.99	-76.51	30.48	28.20	2.28
off PC14	44.00	-76.50	32.31	39.40	-7.10
on PC15	44.00	-76.49	49.07	49.10	-0.03
off PC15	44.00	-76.46	30.48	29.90	0.58
on OB4	43.97	-76.44	36.58	32.61	3.97
off OB4	43.97	-76.44	35.36	32.61	2.75
on OB5	43.96	-76.37	23.47	20.81	2.66
off OB5	43.96	-76.37	23.16	20.21	2.96
on OB6	43.96	-76.34	27.43	24.01	3.43
off OB6	43.96	-76.34	27.43	24.01	3.43
on OB7	43.96	-76.31	24.38	20.81	3.58
off OB7	43.96	-76.31	23.47	20.81	2.66
on PC16	43.90	-76.54	56.39	53.00	3.39
off PC16	43.90	-76.53	54.56	51.00	3.56
on PC17	44.12	-76.55	28.65	26.30	2.35
off PC17	44.11	-76.55	28.65	26.00	2.65
on OB10	44.15	-76.34	10.97	9.31	1.66
on OB11	44.15	-76.33	32.31	30.01	2.30
on PC19	44.08	-76.43	27.43	23.81	3.63
off PC19	44.08	-76.43	27.43	28.81	-1.37
on PC20	44.16	-76.65	20.42	13.60	6.82
off PC20	44.16	-76.65	20.12	13.60	6.51
on OB12	44.09	-76.78	12.50	9.70	2.79
off OB12	44.09	-76.78	12.50	9.70	2.79
on PC21	43.99	-76.53	30.18	26.40	3.77
off PC21	43.99	-76.52	34.75	28.60	6.14
on PC22	44.04	-76.14	15.24	7.79	7.45
off PC22	44.04	-76.14	10.67	7.79	2.88
on PC23	43.97	-76.10	10.36	7.81	2.56
off PC23	43.97	-76.10	10.36	7.81	2.56
on PC24	43.88	-76.61	41.45	39.20	2.25
off PC24	43.88	-76.60	41.45	42.00	-0.55
on OB13	43.91	-76.63	15.24	13.20	2.04
off OB13	43.91	-76.63	15.24	13.20	2.04
on OB14	43.88	-76.64	31.09	29.00	2.09
off OB14	43.88	-76.63	35.36	31.70	3.65
on OB15	43.87	-76.63	45.72	42.90	2.82
off OB15	43.87	-76.63	46.63	43.80	2.83
on OB16	43.79	-76.64	61.26	59.60	1.66
off OB16	43.79	-76.64	61.26	59.70	1.56

Station	Latitude N	Longitude W	Bridge-read Sounder Depth m	NOAA map m	Sounder minus NOAA
on OB17	43.67	-76.22	14.94	11.90	3.03
off OB17	43.67	-76.22	14.94	12.40	2.53
on OB18	43.67	-76.26	31.39	30.30	1.09
off OB18	43.67	-76.26	31.09	30.30	0.79
on OB19	43.67	-76.32	45.72	43.40	2.32
off OB19	43.67	-76.32	45.42	43.40	2.01
on OB20	43.66	-76.28	36.58	34.00	2.57
off OB20	43.66	-76.28	36.58	34.00	2.57
on OB21	43.54	-76.35	20.73	18.60	2.13
off OB21	43.54	-76.35	21.34	19.80	1.54
on OB22	43.55	-76.36	31.39	30.50	0.89
off OB22	43.55	-76.36	31.70	29.90	1.80
on OB23	43.56	-76.35	43.59	35.00	8.59
off OB23	43.56	-76.35	41.45	35.60	5.85
on OB24	43.57	-76.37	54.86	49.10	5.76
off OB24	43.57	-76.37	55.17	50.90	4.27
on OB25	43.67	-76.36	64.92	58.30	6.62
off OB25	43.67	-76.36	64.92	58.30	6.62
on PC25	43.64	-76.63	165.20	163.60	1.60
off PC25	43.64	-76.63	155.45	164.40	-8.95
on PC26	43.51	-76.63	140.21	138.20	2.01
off PC26	43.52	-76.63	142.95	139.50	3.45
on OB26	43.50	-76.63	125.27	114.20	11.07
off OB26	43.50	-76.63	125.58	114.20	11.38
on OB27	43.49	-76.62	100.58	104.20	-3.62
off OB27	43.49	-76.63	105.16	104.20	0.96
on OB28	43.49	-76.62	74.68	83.90	-9.22
off OB28	43.49	-76.62	89.31	83.90	5.41
on OB29	43.48	-76.62	75.29	68.20	7.08
off OB29	43.48	-76.62	74.07	68.20	5.87
on OB30	43.47	-76.63	61.87	60.40	1.47
off OB30	43.47	-76.63	57.91	60.40	-2.49
on OB31	43.45	-76.63	42.67	40.90	1.77
off OB31	43.45	-76.63	42.06	40.90	1.16
on OB32	43.44	-76.63	30.78	29.80	0.98
off OB32	43.44	-76.63	29.87	29.80	0.07
on OB33	43.42	-76.63	15.24	10.50	4.74
off OB33	43.42	-76.63	14.02	10.50	3.52
on OB34	43.31	-76.92	13.41	12.70	0.71
off OB34	43.31	-76.92	13.41	12.70	0.71
on OB35	43.32	-76.91	31.09	30.10	0.99
off OB35	43.32	-76.91	31.09	30.10	0.99
on OB36	43.34	-76.92	45.72	45.10	0.62
off OB36	43.34	-76.92	42.67	45.10	-2.43
on OB37	43.36	-76.92	61.26	60.70	0.56
off OB37	43.36	-76.92	60.35	60.70	-0.35
on OB38	43.37	-76.92	75.90	70.30	5.59
off OB38	43.37	-76.92	71.93	69.80	2.13
on OB39	43.39	-76.92	98.15	91.70	6.44
off OB39	43.39	-76.92	93.27	88.70	4.57
on OB40	43.39	-76.92	107.90	103.20	4.70
off OB40	43.39	-76.92	106.07	102.50	3.57

Station	Latitude N	Longitude W	Bridge-read Sounder Depth m	NOAA map m	Sounder minus NOAA
on OB41	43.41	-76.92	122.53	124.00	-1.47
off OB41	43.41	-76.92	121.92	123.40	-1.48
on OB42	43.29	-77.33	16.76	10.70	6.06
off OB42	43.29	-77.33	18.29	10.70	7.58
on OB43	43.30	-77.33	31.70	30.70	1.00
off OB43	43.30	-77.33	32.61	31.60	1.01
on OB44	43.31	-77.33	46.63	45.10	1.53
off OB44	43.31	-77.33	47.55	45.10	2.44
on OB45	43.33	-77.33	62.79	63.30	-0.52
off OB45	43.33	-77.33	63.09	63.20	-0.11
on OB46	43.34	-77.34	76.81	73.00	3.81
off OB46	43.34	-77.33	77.42	73.10	4.32
on OB47	43.34	-77.33	93.88	89.50	4.37
off OB47	43.34	-77.33	94.79	89.30	5.49
on OB48	43.35	-77.33	107.29	102.60	4.69
off OB48	43.35	-77.33	107.90	102.60	5.30
on OB49	43.29	-77.62	14.33	11.31	3.02
off OB49	43.29	-77.62	12.80	11.31	1.50
on OB50	43.32	-77.61	30.78	27.31	3.48
off OB50	43.32	-77.61	31.09	27.31	3.78
on OB51	43.34	-77.59	46.33	47.81	-1.48
off OB51	43.34	-77.59	46.63	47.81	-1.17
off OB52	43.36	-77.60	64.01	66.51	-2.50
on OB53	43.37	-77.60	78.03	83.41	-5.38
off OB53	43.37	-77.60	78.64	83.41	-4.77
on OB54	43.37	-77.59	92.66	91.61	1.05
off OB54	43.37	-77.59	93.27	91.61	1.66
on OB55	43.38	-77.59	108.51	107.21	1.30
off OB55	43.38	-77.59	109.73	107.21	2.52
on OB56	43.39	-77.59	122.83	118.71	4.13
off OB56	43.39	-77.59	124.66	118.71	5.96
on OB57	43.40	-77.58	138.07	136.61	1.47
off OB57	43.40	-77.58	140.82	136.61	4.21
on OB58	43.40	-77.58	152.40	144.31	8.10
off OB58	43.40	-77.58	153.92	144.31	9.62
on PC27	43.46	-77.62	153.62	149.40	4.22
off PC27	43.46	-77.61	160.32	150.40	9.92
on PC28	43.53	-77.42	178.00	176.40	1.60
off PC28	43.52	-77.41	181.36	177.60	3.75
on PC29	43.50	-77.19	198.73	194.90	3.83
on OB59	43.50	-77.55	157.28	160.00	-2.73
off OB59	43.50	-77.55	158.80	160.20	-1.40
on PC30	43.60	-77.75	156.97	152.70	4.27
off PC30	43.60	-77.76	157.89	147.30	10.58
on CB	43.55	-78.17	195.07	185.20	9.87
on PC31	43.59	-79.28	89.61	88.00	1.61
off PC31	43.60	-79.27	91.74	88.03	3.71
				Count	210
				Average	2.41
				St'd Dev'n	3.23

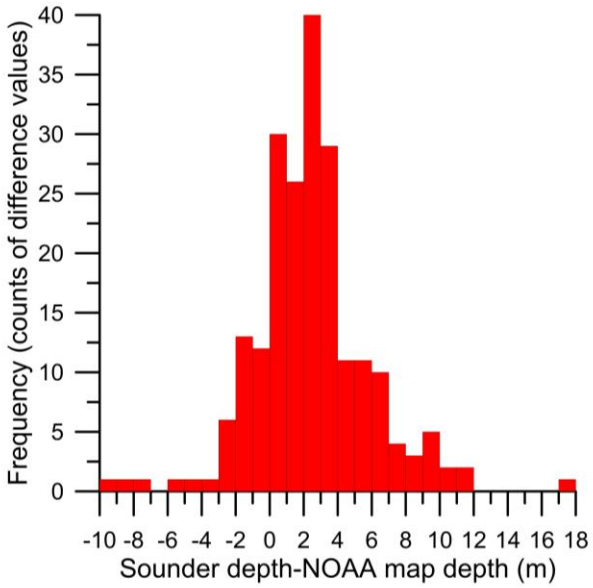

Figure 3. Frequency histogram of 'Sounder depth minus NOAA water depth' values for cruise 74-00-102 in Lake Ontario 6-16 July 1974. The value between 17 and 18 was neglected.

Thus, water depths from the NOAA bathymetry map are estimated to be 2.41±3.23 m below the apparent 'corrected' lake elevation during cruise 74-00-102, and the resulting reference elevation for the NOAA map is 76.09±0.54 - 2.41±3.23 = 73.68±3.77 m asl. The correlation of NOAA map depths and sounder depths is quite close (R^2 = 0.995) as shown in Figure 4 despite the dispersion of data shown in Figure 3.

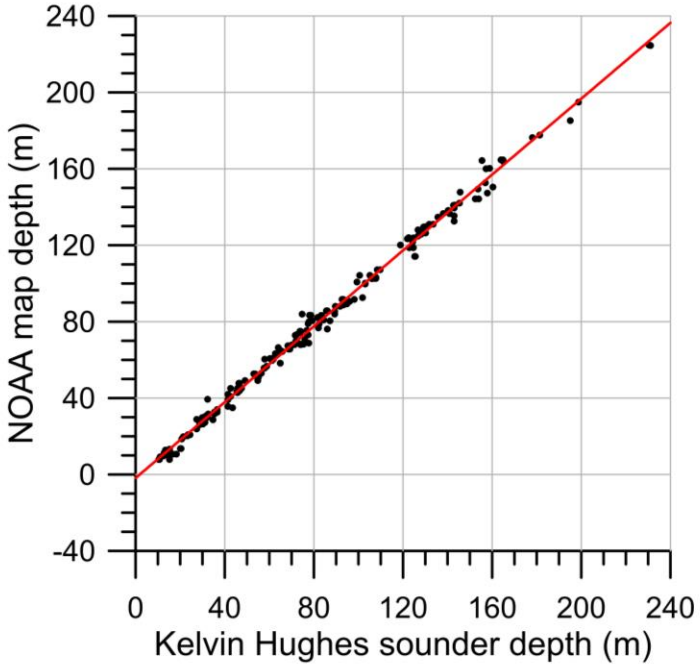

Figure 4. Correlation of NOAA map depths and Kelvin Hughes sounder depths for station positions of CCIW cruise 74-00-102 in Lake Ontario, 6-16 July 1974. $R^2 = 0.995$. Red line is linear fit to data with equation Y = 0.9927440629 * X - 1.840139791.

This last result, rounded to 73.7±3.8 m asl, is the estimated reference datum for the NOAA Lake Ontario bathymetry map for the 1968–1974 survey period. This estimated value is similar to the reference elevation (74.0 m asl) for Canadian Hydrographic Service (CHS) charts of Lake Ontario of the same era. Thus a reference elevation datum of 74.0 m asl is probable for the NOAA Lake Ontario bathymetry map at the time of cruise 74-0-102, a value close to the estimated reference datum here, and well within the standard deviation range of the estimate.

Datums in the Great Lakes are established relative to a benchmark near Rimouski QC on the St. Lawrence River Estuary. During the 1968–1974 surveys the datum was dated to 1955 and referred to as International Great Lakes Datum (1955) or IGLD(1955). Because the lake basins are subject to differential isostatic uplift relative to Rimouski, the reference datums for the lakes are re-examined about every 30 years. Although differential uplift raises each basin and increases the lake chart datums, the values of water depths in each basin beneath the datums remain the same. The mean of benchmark elevations around Lake Ontario were increased for IGLD(1985) by about 15 cm (Coordinating Committee 1995). This change is the basis for the present IGLD(1985) chart datum of 74.2 m for CHS chart 2077 for western Lake Ontario.

For investigations in which elevations above sea level of Lake Ontario lakebed and subsurface features are to be computed from bathymetric data, and compared with elevations of onshore features, we conclude that the appropriate chart datum is the one established in the same period as for the measurement or adjustment of elevations of the onshore features. Thus for computation of elevations of the subsurface Early Lake Ontario barrier beach from sounder depths acquired 1968–1974, and for comparison of these elevations with surface elevations of the Champlain Sea marine limits in the upper St. Lawrence River valley determined in the same era, it would be appropriate to employ the IGLD(1955) 74.0 asl value as a datum for the NOAA bathymetric map. However, if the marine limits had been determined after the IGLD(1985) datum was established, it would be appropriate to use the IGLD(1985) Lake Ontario datum of 74.2 m asl. In cases where elevations of lakebed features only are being made without comparison to other data, it would be appropriate to use the current IGLD datum. This datum choice should always be stated, however.

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