THE COMEDY OF CRYSTAL LAKE: GEOMORPHIC ANALYSIS AND 3D MODELLING OF AN HISTORICAL EVENT USING LIDAR DATA

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IMAGIN 06 JUNE 2017

The Budding GIS Investigator on Crystal Lake (ca. 1944)



Why Did I Run from the Flood?







The "Tragedy" / "Comedy"

The "Tragedy": (Sad Beginning)

- Crystal Lake was 38 ft above Lake Michigan in 1873.
- An attempt was made to construct a slack-water canal to Lake Michigan.
- Whitecap waves washed out a temporary dam.
- Lake level dropped 18 ft (*) as 51 Bgal (*) of water flushed down the Outlet; and
- 1349 A (*) of beach were created = 589 ft (*) beach (avg) around 20.8 mi shore.
- A perceived "failure" of an "ill-conceived" project by an apparent scapegoat ?

The "Comedy": (Happy Ending)

- The founding of the Village of Beulah, the coming of the railroad, installation of telegraph and telephone lines, development of lakeside resorts, construction of 1,100 cottages, all connected by an infrastructure of perimeter roads and trails.
- Property value in 2016 was >\$600,000,000.
- An epochal event that had a permanent bearing on the subsequent development of Benzie County and one of the major incidents of the county's early history.
- An unqualified "success" by a visionary celebrated as a local hero !

(*) Latest estimates of these parameters 06/06/17).



Presentation Outline

- "Tragedy" / "Comedy of Crystal Lake
- Location & Description
- Maps & Data
- Topography & Bathymetry
- Geomorphic Analysis
- 3D Modelling
- Reconstruction of the Historical Event

Greetings from Crystal Lake !



Crystal Lake is like a blue sapphire ring upon the first knuckle of the little finger of the left-hand mitten (palm down) depicting the Lower Peninsula of Michigan.

Lake Algonquin (11,000 YBP)



Larsen, Curtis E., USGS Bull. 1801, 1987, http://pubs.usgs.gov/bul/1801/report.pdf



Winchell, Alexander, Climate of the Lake Region, Harper's New Monthly Magazine 43(254), 275-285 (Jul 1871). Michigan Groundwater Mapping Project, Public Act 148 of 2003, Michigan Lakes,

North End of Lake Michigan



http://www.charts.noaa.gov/OnLineViewer/14902.shtml

Crystal Lake & Environs



Photograph® by Marge Beaver, Photography Plus, 2005.

The Bathtub on the Hill



Crystal Lake (9th largest in MI) (15.40 sq mi) Relatively small watershed area (43.97 sq mi) Former embayment of glacial Lake Algonquin Isolated by dunes at the isthmus of Point Betsie Perched at 600 ft (23 ft higher than Lake Michigan)

Crystal Lake – A Big Footprint

mi

Length

Width Depth

Perimeter

Area

1.9 mi ft (max) 165. ft (mean) 71. 20.838 mi 44.65 sq mi (Total) sq mi (Land) 28.58 sq mi (Lake) 15.40 Acre (34.5%) 9,854. Volume 0.242 Bgal

8.1

Detention 32.

yr WNW to ESE ~25° Orientation

Chicago and

Crystal Lake Watershed



Crystal Lake (Outlet) Watershed HUC 04060104-0305-01-xx, xx = #1 - #17, less #4 (Outlet)

Digital Elevation Model



Crystal Lake is ringed by moraines and terraces.

1838-9 Survey



ARCHIBALD JONES

(1811-1890)

President of the Benzie Co. River Improvement Co.

Responsible for the enterprise that resulted in the lowering of Crystal Lake by 20 ft in 1873.

"The top of Crystal Lake was too far above the beach !"

one

The "Company"

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1,000 shares @ \$25 / share = \$25,000 → " 0 " ! \$25 at 8% compounded for 137 years ~ \$1,000,000 !! 108,778 ft of beach @ \$6,000 / ft = \$652,000,000 !!!

Map Showing Sources & Courses of the PLATTE & BETSEY RIVERS, BENZIE COUNTY, MICH. Together with Some of the Obstructions and Proposed Improvements, DRAWN for the BENZIE COUNTY RIVER IMPROVEMENT COMPANY,

by B.C. Hubbell, DRAFTSMAN, Benzonia, Mich.



Crystal Lake Canal System



Daniels, Stacy Leroy, "The Comedy of Crystal Lake", 2015 (Centerfold)

Features & Areas of Interest

Feature

- Great Lake
- Riverine watershed
- Inland lake watershed
- Major inlet
- Major outlet (surface water)
- Major outlet (ground water)
- South canal
- North canal
- West canal

Area of Interest

- Lake Michigan
- Betsie River
- Crystal Lake
- Cold Creek
- Outlet Creek
- Pt. Betsie
- Outlet
- Round Lake
- · CSA

Michigan Statewide Authoritative Imagery & LiDAR (MiSAIL), 04-24-30/2015.

Topographic/Bathymetric Map



Crystal Lake Watershed 3D



South Canal (Outlet Dam)





South Canal (Outlet) 3D



North Canal (Round Lake)





North Canal (Round Lake) 3D



West Canal (CSA)





West Canal (CSA) 3D



Crystal Lake: Its Many Levels



(Adapted after I.D. Scott, Inland Lakes of Michigan, 1921.)

Crystal Lake Watershed Hypsograph (Topo-Bathy)



Crystal Lake Water Levels



High-to-Now Level (Δ 15 ft) ~ 3 x Now-to-Low (Δ 5 ft) Level ("I came; I saw; I (allegedly 'pulled the plug'" !

"Life is a <u>tragedy</u> when seen in close-up, but a <u>comedy</u> in long-shot." -- Charlie Chaplin



References

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- Daniels, Stacy L., Crystal Lake Commonality and Uniquity: A Century of "Ups & Downs" in Lake Level, ML&SA, 01 May 2015; Michigan Riparian 50(3), 20 (Summer 2015). <u>http://www.mi-riparian.org/wp-content/uploads/archives/summer2015.pdf</u>
- 3. Daniels, Stacy Leroy, Schaetzl, Randall J., and Michalek, Michael, The Physiographic Rearrangement of Crystal Lake after Its Historic Lowering, MASAL, 04 Mar 2016.
- 4. Daniels, Stacy Leroy, Lake Levels How Ups and Downs Affect Everything We Littorians Do With Our Lakes, ML&SA, 30 Apr 2016. <u>http://michiganlakes.msue.msu.edu/uploads/files/2016_Convention_Docs/Presentations/Saturday/Daniels_Lake_Levels.pdf</u>
- 5. Daniels, Stacy Leroy, The Comedy of Crystal Lake: GIS Analysis of an Unique Historical Event Using Original Survey and Project Maps, IMAGIN, Mapping the Mitten, Map Gallery, 16 May 2016.
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- 7. Daniels, Stacy Leroy, A Map; A Plan; A Canal: The "Tragedy" / "Comedy" of Crystal Lake!, American Canals, Bull. American Canal Soc., 45(3), 6-10 (Summer 2016).
- 8. Larsen, Curtis E., Geological History of Glacial Lake Algonquin and the Upper Great Lakes, U.S. Geol. Sur. Bull. 1801, 1987. <u>https://pubs.usgs.gov/bul/1801/report.pdf</u>
- 9. Schaetzl, Randall J., et al., Measurement, Correlation, and Mapping of Glacial Lake Algonquin Shorelines in Northern Michigan, AAAG 92(3), 399-413 (2002).

Changes in Crystal Lake (Net)

- $1873 \rightarrow 1895 \rightarrow 2017$
- Water level dropped 17 ft
 - $612 \rightarrow 595 \rightarrow 600 \text{ ft}$
- Surface area:
 10,426 A → 8721 → 9,843 A
- Volume
 - ~ 272 \rightarrow 205 \rightarrow 221 Bgal
- Water surface lost = beach gain = 1,470 A
- Length of beach: 21 mi perimeter
- Depth of beach: 589 ft (avg)

The Level of Crystal Lake



Elevation: 600 +/- 0.25 ft (IGLD1985) (Summer: 01 May - Oct 31; Winter: 01 Nov - 30 Apr 30