

A man wearing a straw hat, a white shirt, a red vest, and dark pants is standing in a shallow lake. He is holding a long, dark pole that is curved into a large arc. At the end of the pole, a white bucket is suspended, and water is being poured from it, creating a continuous arc of water that follows the curve of the pole. The background shows a clear blue sky with scattered white clouds and a distant shoreline with trees.

**Inland**  
**Lakes**  
**Levels**  
**Matter**

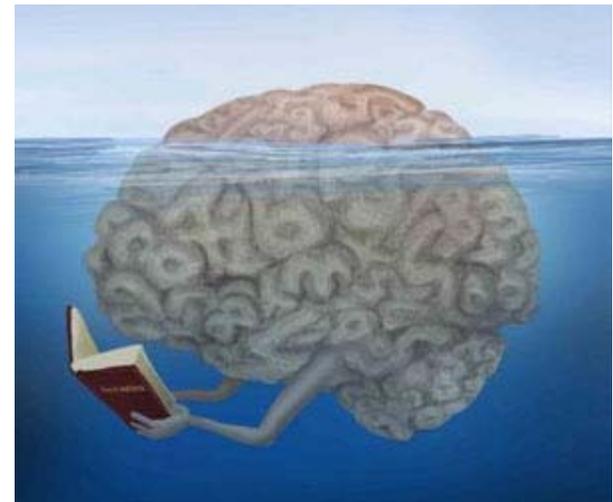
**Dr. Stacy Leroy Daniels**  
**12th Annual MiCorps Conference**  
**Kettunen Center, 03 Nov 2016**

# Inland Lake Levels Matter

- **Lake level is the master variable !**
- **It controls everything in lakes that matter !**
- **What's the *matter* with lake level ?**
- **What is a "Normal" lake level ?**
- **Natural vs. Artificial lake levels ?**
- **How are lake levels be set ?**
- **How are lake levels be controlled ?**
- **Concerns for lake level comprise a classic social dilemma, with semantics and arrant pedantry *not to be put up with* !**

# Confucius Say:

“Man who have water on brain,  
have lake in mind, or mind in lake.”



# **Quiz: “On The Level” ???**

- 1. How many of you live on a lake ?**
  - 2. Is your lake really level ?**
  - 3. Do you know the level of your lake ?**
  - 4. Does your lake have a “normal” level ?**
  - 5. Is your lake too high, too low, or just right ?**
  - 6. Would you “pull the plug”, or “put it back in” ?**
  - 7. How do you and your lake affect each other ?**
  - 8. Do you consider yourself a “littorian”?**
- It all depends ... Right ?**



**“The secret of living is to own a convertible and a lake.  
If the sun is shinning, you can ride around in your  
convertible and be happy. If it starts to rain, it won’t  
spoil your day because you can just say,  
*‘Oh, well, the rain will fill up my lake’.*”  
-- Good Ol’ Charlie Brown.**



<https://nickfalkner.files.wordpress.com/2016/01/amphicar-main-ffm001.jpg>

# How Many Are True/False !/?

- Watching lake level rise and/or fall is
  - (a) boring, like watching grass grow and paint dry;
  - (b) soothing, as the waters are replenished; or
  - (c) alarming, as beach washes away, or fish flop about.
- In the past, there was little concern about surveying, regulating, and maintaining “natural” lake levels.
- Engineered structures were installed as needed to control floods; improve rivers, lakes, and harbors for transport; drain and irrigate land; store and supply drinking waters; and treat wastewaters.
- Changing lake levels affect shoreline, water quality and quantity; animal and plant life; recreational uses; zoning; property values; environment; ... and littorians.
- Littorians and lake levels mutually affect each other.
- Lake level remains the most controversial issue.

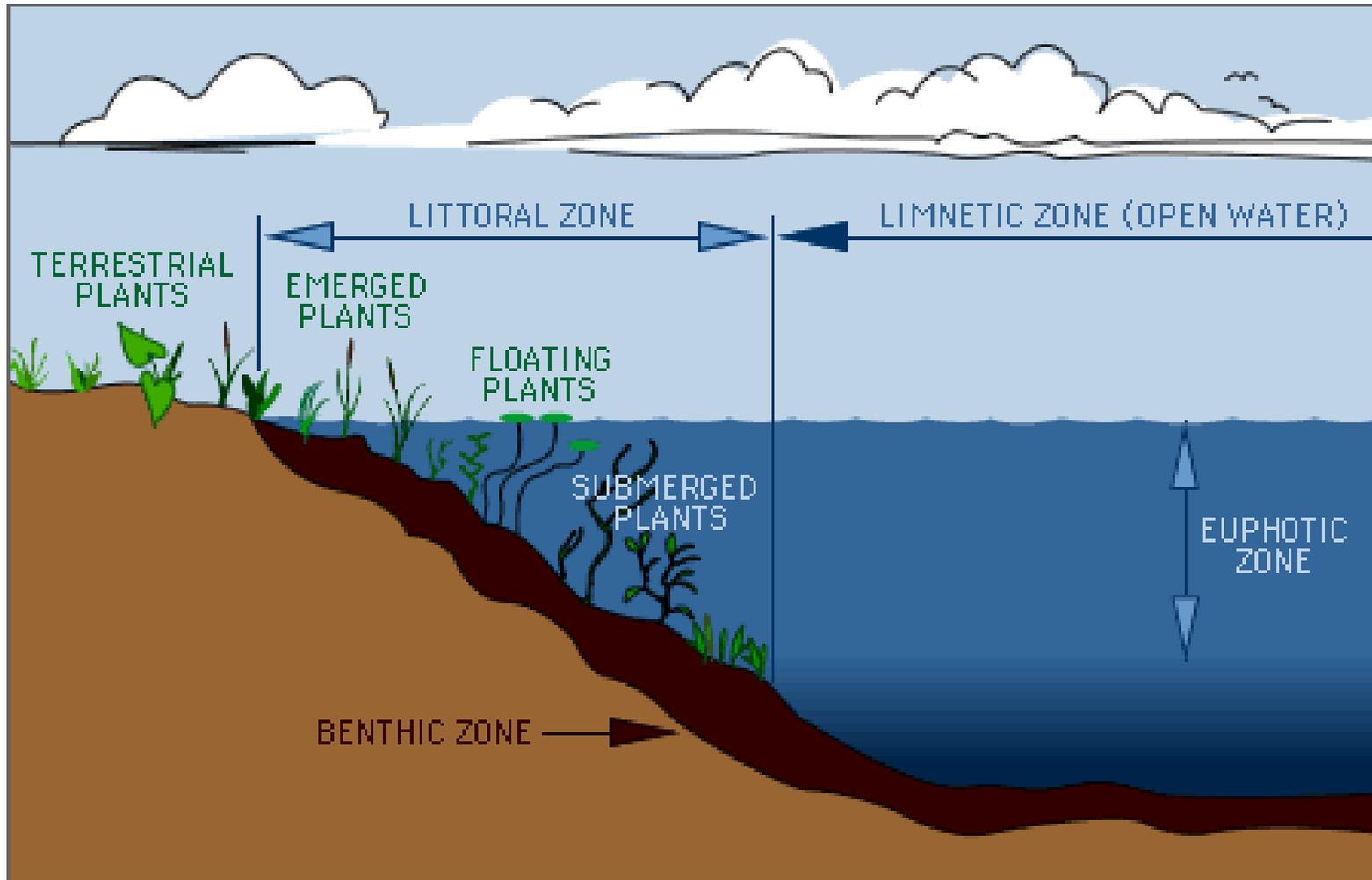
# Goldilocks' Too Much Ado's About Lakes

Too many Lakes it seems, at times, are at too high or too low a level; and contain too much or too little water; and are considered too wet or too dry; too cold or too hot; too windy or too calm; with too many boats; and too few fish; with too many aquatic invasive species; and too few desirable native species; while too many Beaches seem to be too small; too rocky, too muddy, too weedy, too “buggy”, etc. ; with too many irresponsible “litterers”, and too few responsible “littorians”; too many free-loaders and too few tax-payers; and too many (or too few) visitors (two schools of thought); and to boot, too few lakes seem to be on ideally-habitable Goldilocks planets, i.e. too good to be true; or too far away to tout, to or give two too(ts) about (!); and besides, there are too many marginally “limnologically-correct” me-too’ers (!); and too few “just-righter’s” amongst us, besides the two of us; and I’m not too sure about you!



-- Stacy Leroy Daniels: 11/11/2016

# Littoral Zone: Tween Land & Lake



<http://www.lakeaccess.org/ecology/art/lakezones.gif>

# The Littoral Zone

- **The littoral zone of large lakes is the interface of the land and water extending from a high water mark onshore, which is rarely inundated, to a low shoal mark offshore, that is permanently submerged.**
- **The erosive power of moving water creates particular landforms like dunes and bars.**
- **The littoral zone supports a great variety of plant and animal life among wetlands.**
- **Human activity can coexist in, on, and near a lake.**

[https://en.wikipedia.org/wiki/Littoral\\_zone](https://en.wikipedia.org/wiki/Littoral_zone)

**The difference between walking on water and treading on thin ice is a matter of degree.**



**[http://www.redbubble.com/people/slblevins/works/6770325-walking-on-water?grid\\_pos=26&p=framed-print](http://www.redbubble.com/people/slblevins/works/6770325-walking-on-water?grid_pos=26&p=framed-print) (463 results)**

# “Littorian” or “Riparian” ?

- A **“Littorian”** : Someone who inhabits or frequents the edges of large freshwater lakes and rivers.
- A **“Riparian“** : Someone who is associated with the interface between land and a river or stream.
- One is “high-and-dry”; the other is “low-and-wet”.
- A “littorian lives beside, not on a lake, or by a river.
- (A littoral zone is littered with *Littorina littorea* (snails).
  
- Heaven save us from the “*literal littering littorian*”, who, having a concern for a specific issue involving a lake, creates a character, assumes attributes, and plays a role, spreading the word.

# What Affects Lake Levels - 1 ?

- **Season**
- **Climate (Short- and long-term)**
- **Waves (Waves) Transverse, Longitudinal, Surface)**
- **Precipitation (Rain and snow)**
- **Evaporation (Into the air)**
- **Percolation (Into the ground)**
- **Surface water Inflow (Supply) and Outflow (Discharge)**
- **Groundwater (Flows in/out)**
- **Watershed (Land/water ratio)**
- **Surface runoff (From impervious surfaces)**
- **Engineered structures (Dams, sediment basins)**
- **Gravity (Tides)**
- **Curvature of the earth (Line of sight)**

# What Affects Lake Levels - 2?

- **Temperature (Thermal expansion and contraction, fall and spring overturns.)**
- **Absolute pressure (Water is relatively incompressible.)**
- **Phase changes (Liquid water vs. solid ice)**
- **Disturbances:**
  - Things moving into the lake - swimmers, dogs, birds, rocks, sediment.
  - Things moving out of the lake - fish.
  - Things moving thru the lake - fish, ducks, boats.
  - Forces acting on the lake - earthquakes, moon's gravity.
- **Effects:**
  - Range from a few millimeters to several feet.
  - Last from a few seconds to several months or years.
  - Occur repeatedly or only very infrequently.

# What Is Affected by Lake Level?

## Habitat

Hypoxia  
Ports  
Lights  
Marinas  
Shipping  
Hardening  
Piers  
(Canals)  
Dams  
Dredging\*  
Pipelines\*

## Withdrawals

Inland Lakes\*  
Great Lakes\*

## Development

Coastal  
Mines  
Power plants  
Recreation  
Roads

## Fisheries

Aquaculture  
Commercial  
Stocking(native)  
Stocking(other)  
Recreational\*  
Food Chain\*

## Invasives

Ballast  
Gobies  
Mussels  
Phragmites  
Lamprey  
Fish Disease\*  
Algae\*  
Plankton\*

## Climate

Water level  
Ice Cover  
Temperature

## Pollution

CSOs  
Nitrogen  
Phosphorus  
Sediments

## **Chemicals**

AOCs  
Hg  
Cu  
PCBs  
New Toxics\*  
Drugs\*  
Pesticides\*

(\*) Not weighted. <http://www.pnas.org/content/110/1/372.full.pdf>

AOCs – Areas Of Concern ( *not appellation d'origine contrôlée* )

CSOs – Combined Sewer Overflows

# Biblical Level Control



# **“Normal Lake Level ?”**

**“It seems to me that the matter of defining or arbitrarily determining the normal lake level is very nearly of the same order as determining a normal stream flow. I don’t believe anyone can do it.”**

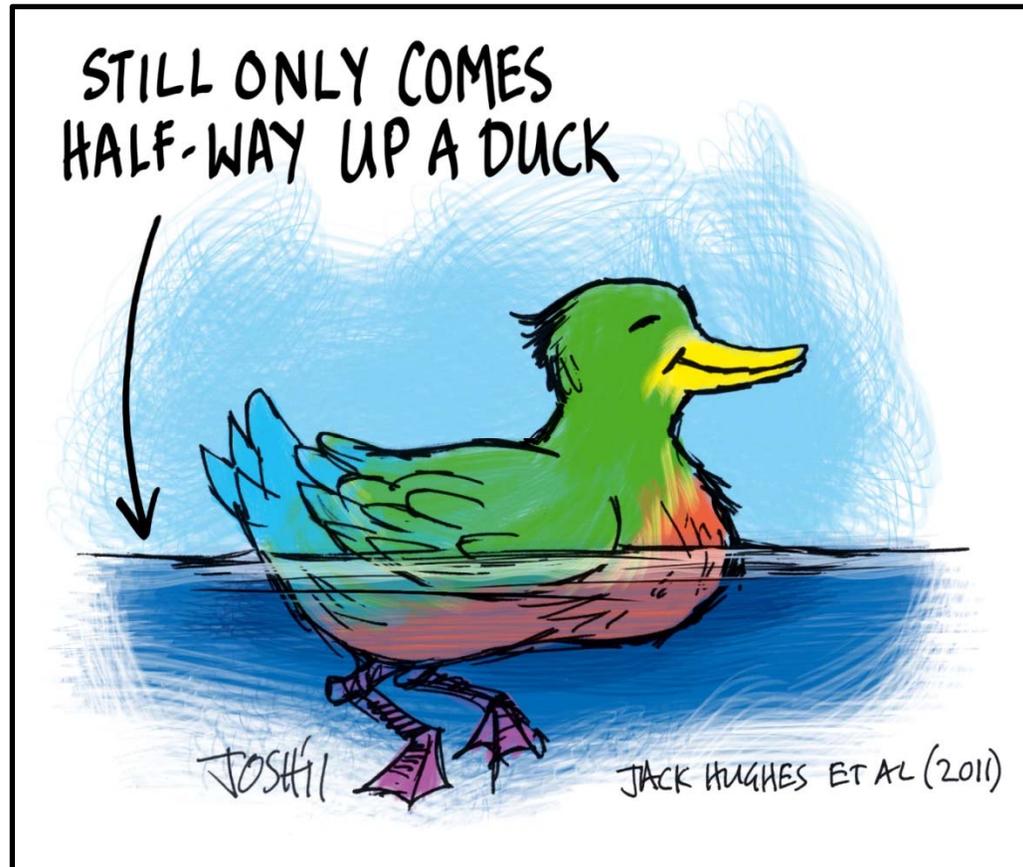
**“It would be possible within certain limits to fix lake levels, but we could not be arbitrary beyond factors which are entirely beyond man’s control. So let us not think we can by any legal device determine a normal lake level.”**

**-- Robert Letts McNamee, (\*)**

**(\*) Discussion of “Water in Its Relation to Inland Lake Level Control”, Michigan’s Water Problems, Lansing, MI, 28 Jan 1944.**

**Robert Letts McNamee, founder of McNamee, Porter & Seeley, consulting firm, conducted the first bathymetric survey of Crystal Lake beginning in 1935. His dissertation for a CE degree was entitled, “The Surface Waters of Michigan, Hydrology and Quantitative Characteristics and Purification for Public Use”.**

# The Level of Crystal Lake



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

# Legal Actions for the Times

## **River & Harbor Improvements**

Legal requirements for the formation of companies to construct canals or harbors, and improve the same, were first approved for the State of Michigan in 1861 and revised in 1871.

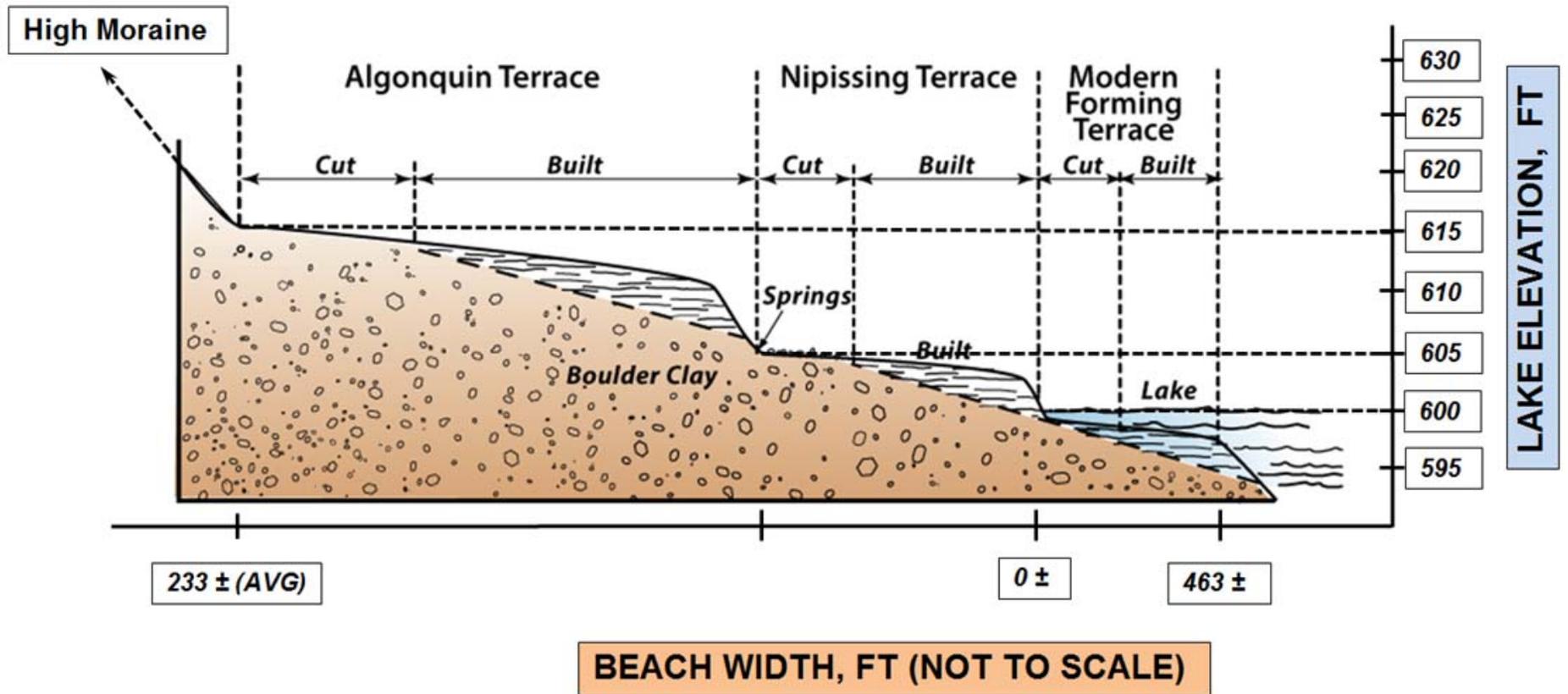
(The Benzie Co. River Improvement Co. was formed in 1873.)

## **Natural Lake Levels**

A subsequent State action authorized boards of supervisors to determine the natural level of the waters in navigable inland lakes, to maintain the level, and to build dams and embankments (1911).

(The “natural” level of Crystal Lake was also determined in 1911.)

# Crystal Lake: Its Many Levels



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

# Setting the Ideal Lake Level

“In regard to the question of lake level, I personally do not feel that it will work out practically to have the level dropped a portion of the year with any dependence upon its being satisfactory the remaining portion of the year, for what is everybody’s business is nobody’s business,

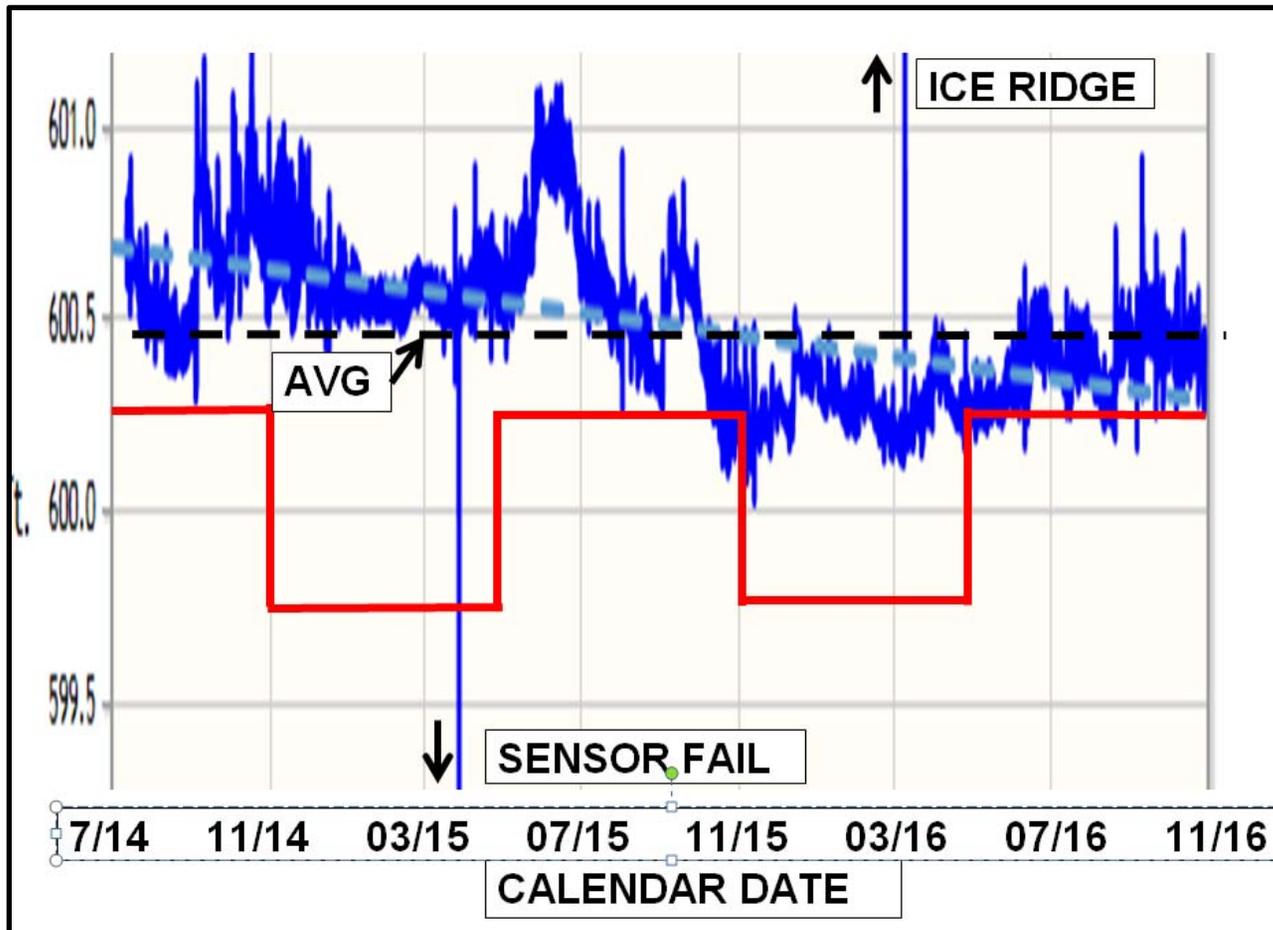
...

and it would not be properly attended to, and if it should be placed in reliable hands, who knows whether the season is going to be wet or dry, and what dependence can be placed upon the sluiceway, or whatever means is used to drop the level, being closed in time to bring it up to the desired point to maintain the level at its present height from May 1st to November 1st, which is a compromise in the bench mark, as will be found upon the records of the County Board, and about an inch below the agreed compromise with the Ann Arbor Railroad.”

-- Frank E. Herdman, Resident civil engineer and overseer of the Crystal Lake dam construction, 10 Aug 1916.

# Crystal Lake Level

- ~78,000 data (15 min) 840 da (7/2014 – 11/2016)
- Actual (Avg): 600.48 ft (Period of record) (----)
- Target (Set): 600+/-0/25 ft [Summer / Winter] (-----)



# Pulling the Plug

When should littorians be put in an old-folks home ?

Fill up their lake. Offer a teaspoon, teacup, and bucket.



Ask them to empty their lake.

A normal littorian would use the bucket.

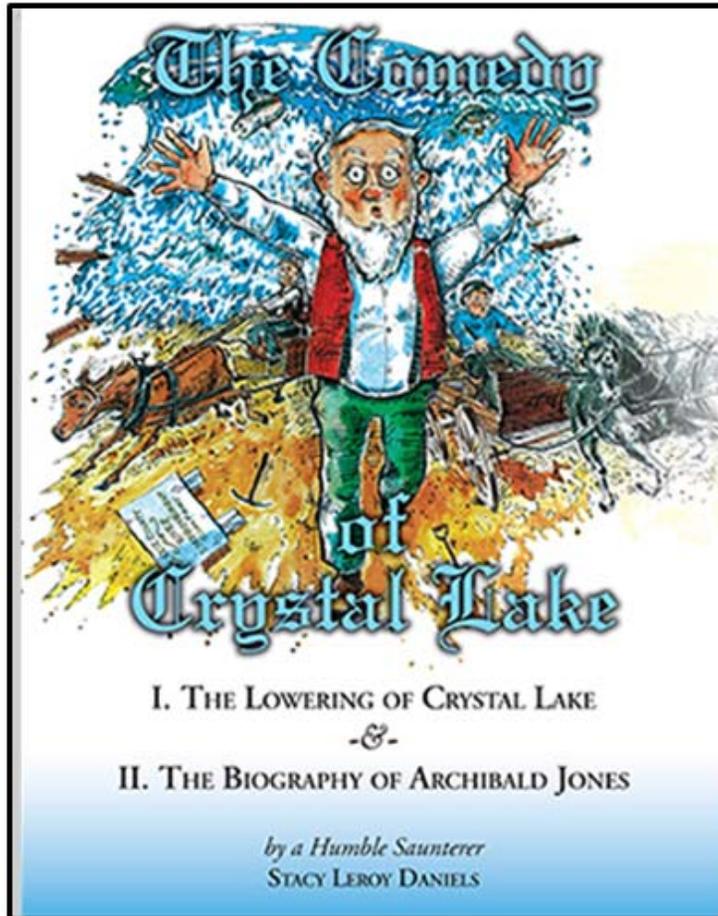
It's bigger than the spoon or the teacup. Right ?

No. A normal littorian would just pull the plug !

Do you want a bed near a window overlooking the lake ?

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## The Comedy of Crystal Lake

Stacy Leroy Daniels

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A sequel to the classic booklet, "*The Tragedy of Crystal Lake*" (1922), being a summary chronicle with many more sidelights, of a tale written in two parts, describing a seemingly ill-fated historical event, so epochal in its nature as to have had a permanent bearing upon the development and future of Benzie Co., Northwest Lower Michigan, together with myriad viewpoints of its diverse characters and sundry locales, &c, &c.

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