Flathead Lake Biological Station
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Flathead Lake Tsunami?

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Did you know that a tsunami is possible in Flathead Lake? I did not until I was talking with the Bio Station's physical lake ecologist, Dr. Mark Lorang. Yes, it is in fact possible.

There is a geologic fault on Flathead Lake's east shore along the Mission Mountains. The lake (especially the deepwater trench along the east shore) is due to the lake bottom dropping in relation to the mountains. For this reason, Flathead Lake is geologically considered a "block-drop, graben lake". What a mouthful.

This fault results in periodic earthquakes. Most of these earthquakes are very minor. Bureau of Reclamation studies indicate that the largest "recent" earthquakes along the Mission Fault were Magnitude 7.0 about 8000 and 15,000 years ago. Notable more recent earthquakes were Mag. 3.7 east of Finley Point in 1995, and Mag. 5.5 in 1952 near Bigfork (actually on the Swan Fault) severe enough to damage the Bio Station's original Brick Lab (built in 1912) requiring its replacement in the 1960s.

Back to tsunamis. A tsunami is like throwing a rock into a calm pool – the energy moves out as a ring of waves. They can result from landslides (above or below water) or downdropping, all of which can be associated with earthquakes. The great Lisbon earthquake of 1755 resulted in tsunami waves of 15m (nearly 50ft!) along the Portuguese and Moroccan coasts.

If there were major movement along the Mission Fault resulting in landslides or sudden lake bottom downdropping, waves of water would travel across the lake (West Shore problem?), and then slosh back and forth (everyone's problem). The size of the earthquake, downdropping or landslide would determine the size of the waves. In the ocean, this would be called a tsunami. In the lake, it would technically be considered a seiche, one of the wave types discussed in a previous article (Local Ocean in Motion).

How would the effects of an earthquake-caused tsunami/seiche differ from storm waves? Again we need to look at some of Mark Lorang's research, as in 2010 he wrote a scientific paper about this. As complex as physics seem to me (a biologist), they can also be quite straightforward. Larger waves (height) are able to move larger rocks and to move them higher in elevation and therefore further inland. Large tsumami waves are larger than storm waves.

Using data from around the Pacific Ocean (particularly from beaches in Hawaii), Mark examined the characteristics of waves, size of rocks, rock elevations and distances from the shoreline. From this he developed techniques to determine the wave characteristics and power necessary to move the rocks, and was able to show whether tsunamis or storm waves had put them there.

This research ties back to Flathead Lake because Mark has also done extensive research on waves, wave power and their ability to move sediments and erode the lake's shoreline. We get our strongest storms and largest waves with the most power in the late summer and early fall (late August and September). Given that the lake is at full pool during this time frame, this is when most of the shoreline erosion takes place.

Property owners do not much like shoreline erosion, and so many different preventative techniques have been used over the years. Traditional methods such as sea walls and rip rap of large rocks (or old car bodies once upon a time) may stop erosion locally, but they do not solve the overall problem. This is because hard structures such as sea walls, do not dissipate or eliminate the wave energy that causes erosion, they just reflect that energy back across the lake to the opposite shore. Or the waves continue along the sea wall until they encounter a neighbor's natural shoreline which then erodes (at times dramatically).

Mark's experience on ocean beaches and his research on Flathead Lake have provided an alternative: constructed beaches. Soft structures such as beaches provide both shoreline protection and ecological benefits. Beaches are able to decrease the erosive power of waves, because as a wave breaks on a beach, the wave energy moves the particles (sand, gravels and cobbles), dissipating erosive energy. Scientifically determining the size, direction and power of the waves allows for the proper design (particle size, beach orientation) of constructed “dynamic equilibrium beaches”.

For decades now, Mark has worked with a variety of cooperators (including US Fish and Wildlife Service, MT Fish, Wildlife & Parks, Confederated Salish and Kootenai Tribes, City of Polson, Flathead Lakers, and private landowners) to design, construct and examine the success of these dynamic equilibrium beaches to protect shoreline and also restore fish and wildlife habitat. Thousands of feet of sea walls have been replaced with dynamic beaches on all of Flathead Lake’s shoreline types and wave climates.

Before and after: Old sea wall (left) replaced with dynamic equilibrium beach (right) on Flathead Lake.

A prominent example is Flathead Lake’s North Shore. Since the construction of Kerr Dam in 1938, higher than natural lake levels in the late summer resulted in the erosion and retreat of the shoreline by nearly 2 miles. Managed primarily as a wildlife refuge and waterfowl production area, state and federal agencies wanted to prevent further erosion and protect remaining habitat. To do this, at one point during the 1990s, there was a plan to build a sea wall across 3+ miles of the North Shore. Not only would this have just bounced the erosive power of waves back across the lake, but a sea wall would have eliminated any natural connections between aquatic and terrestrial organisms and ecosystems.

Instead, after seeing the success of the North Shore’s first experimental beach, constructed by Mark in 2005 for Bigfork residents and business owners Bob and Suzi Keenan who were willing to take the risk on an untested idea to stop erosion on their property, in 2008 the management agencies asked Mark to help them construct 2.5 miles of gravel beaches. Since then beaches have prevented further erosion, trapping wood, debris and sediments, and restoring wetland, aquatic and terrestrial habitats. On top of that, it was $6 million less expensive than building a sea wall across the North Shore.

At a conference I recently saw a scientist from the National Oceanic and Atmospheric Administration issue a plea for new soft structure research and approaches to prevent coastal erosion. Turns out that during recent hurricanes (such as Sandy in the New York City area), soft structures were more successful and fared better than traditional hard structures. So from that agency’s perspective, soft structures are the future in protecting coastal residents and cities from intense storms and rising sea levels. And we have some ground-breaking, leading research on this important topic right here on our lake.

Yet, none of this even takes into account aesthetics or human enjoyment. Personally, I prefer to sit on a beach, getting my feet wet and tossing rocks into the lake than sitting perched up on a sea wall or a large rip rap boulder. Beaches are an inviting transition between land and water as opposed to an obstacle or barrier. But you should look for yourself. Go visit the North Shore, or Finley Point State Park, or Salish Point in Polson, as these are all public areas where Mark has constructed dynamic equilibrium beaches.