

Bathymetric Mapping of Dells Millpond, calculating sedimentation rate, and locating possible areas for fish crib placement.

Jordan Sell

**Augusta High School
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Background Knowledge of Bathymetric Mapping

Bathymetric mapping falls into the category of cartography, which is making maps. Many occupations fall into this category, from computer programmers, to the actual cartographer. There are schools that specialize in training mapmakers. The training people receive at these schools allows them to become proficient with maps and the tools needed to make them.

The colleges offer specialist programs geared specifically to the training of cartographers. Depending on the period of study (usually two or three years) they lead to qualification as a technician or technologist. Typical programs consist of courses in cartography and the cartographic sciences, as well as courses in support areas such as mathematics, computers, photography and communication. They have a strong practical orientation, and students gain experience with the very latest mapping methods. A student graduating from one of these programs is well equipped to move straight into a job in cartography, though initially of course this is likely to be at a junior level. (http://www.geog.ubc.ca/cca/career_5.html)

The methods employed to make a bathymetric map have improved over time. Before 1960, the technique used was to mark out a grid on the ice in the winter, then to use a string with a weight on it to find the bottom to the water through a hole in the ice. These measurements were then transferred to an aerial photo; the accuracy was quite close, about 2-5 meters. But that was a time consuming process and around 1960 cartographers started using Lowrance Graphing Depth Sounders. Then trying to locate those transect lines on an aerial photo. This didn't make the map any better; in fact the accuracy of the map went from about 3-30 meters. But it was less physical labor than drilling holes in the ice when it is zero degrees outside.

About 1992 the cartographers started using GPS units while using the gameboy technique to locate where they took soundings on a particular map. That was pretty accurate, about 2-10 meters. Now in the past few years' cartographers have been connecting the depth sounder directly to the GPS, and the two machines work together to give sub-meter accuracy.

Bathymetric mapping employs a diverse set of cartographic skills proceeding from the survey of lake depths, to the interpolation of depth contours, and the design and printing of maps that meet DNR standards. Over the past 20 years advances in GPS, GIS and PostScript mapping technologies have reshaped bathymetric mapping methodologies. While the impact of these new technologies is evident in all three stages of bathymetric mapping, knowledge of glacial and fluvial landforms remains a critical asset for accurate mapping. A detailed and thorough lake survey is crucial for the construction of an accurate bathymetric map. With the advent of GPS technologies, free format xy-z point surveys have replaced transect surveys and 'Game Boy' data entry techniques yield a high number of depth points.

The second stage of bathymetric mapping involves using the lake survey to locate depth contours and calculate Lake Statistics. Geographic Information System (GIS) technologies provide fast and accurate coordinate based measurements of lake area and volume, and can accurately locate depth contours for glacial lakes. However, fluvial lake structures are still most accurately mapped manually, using survey data and knowledge of fluvial features to locate contours.

The final stage of bathymetric mapping may be considered “presentation.” The design and production of a bathymetric map should facilitate easy interpretation of lake depths and structures. Post Script map production via *Adobe Illustrator* facilitates the construction of smooth contour lines, with shading applied to clarify the sequencing of depths. To further aid interpretation of locational features, depth contour features may be placed over scanned aerial photographs or DOQ images to create a bathymetric PhotoMap. Post Script graphics support high-resolution image setter printing of Lake Maps and booklets, and PDF files for web display. (<http://www.uwec.edu/hartnesg/>)

Lidar (light detection and ranging) is a laser-ranging technique that can penetrate shallow water to depths as great as 120 feet (36 m) to create precise bathymetric maps that are accurate to within a few inches (15± cm). These maps show details of reef structures and zonation that cannot be revealed using traditional sonar technology, which requires deeper water for successful operations. Lidar data from the island of Molokai, digitally combined with aerial photographs, are resulting in a better understanding of shallow-water coral reef development. Molokai’s reefs, like many reefs elsewhere in the world, consist of near shore inner reef flats that slope toward deeper water fore reefs farther offshore. The reef crest, between the inner reef flat and outer fore reef, lies in extremely shallow water and may be exposed during the lowest tides. Waves commonly crash against or break on the reef crest.

Lidar also reveals details of channels that cross Molokai’s reefs. These channels were originally valleys formed by streams that cut across and eroded the reefs that when sea level was much lower about 18,000 years ago. (<http://www.buss.co.uk/buss/applications-nf.htm>)

Previous studies in the area of Bathymetric Mapping

From what I can tell there has been a lot of mapping done on bodies of water. But much of it has been done on a very large scale on the ocean with huge vessels and very advanced equipment. Although these operations are very different from mine they both have the same general idea of location positions and depths and then putting them together to make a sensible map.

The Sea-Floor Mapping Group at the Woods Hole Field Center interprets high-resolution seismic data to delineate the shallow geologic framework of a survey area. Recent advances in computer processing and software allow for processing, interpretation, and analysis of the seismic stratigraphy within a suite of programs designed for this task. The Landmark SeisWorks interpretation software enables the visualization, interpretation, and to some extent, the modeling of a large quantity of data within a study area. Alternatively, paper records can be interpreted and the stratigraphy digitized. We use the DigiRule Seismic Suite and Geocad mapping software for this purpose. Stratigraphic data and surface models are displayed within a GIS and can be integrated with other data types, such as sidescan-sonar and sediment samples. (<http://woodshole.er.usgs.gov/operations/sfmapping/interp.htm>)

Work has also done with universities cooperating with state and national agencies to create maps that are used by both parties, for education and nature preservation.

The U.S. Geological Survey (USGS) is working closely with academic institutions and state and Federal agencies to assess the factors that affect the health of Hawaii's and our nation's coral reefs. In order to establish a basis from which scientists can objectively detect changes in reef health, the USGS and its cooperators are applying many new techniques to the mapping and monitoring of coral reefs in Hawaii. Mapping of coral reefs provides important information about a number of reef characteristics, such as overall structure and morphology, abundance and distribution of living coral, and distribution and types of sediment. No single approach is effective for evaluating the overall health of a reef. It is only through combining techniques that scientists can establish the most complete view of a reef, one that can be used for evaluating reef health and for future monitoring. (<http://geopubs.wr.usgs.gov/fact-sheet/fs084-01/>)

The project that I took on was not an easy one; I knew this when I started. I wanted something that would be challenging and helpful to me in some way. When I originally started this program I was a freshman. I had some trouble and quit for a while but then I got back to it this year and completed it. The use of GPS to make maps is somewhat of a new idea; there have been other ways to map bodies of water but none that come close to the accuracy of these techniques. Using grids on the ice, or transect lines and soundings. These were all previous ways of mapping. One must have a working knowledge of GPS, computers, boats, motors, and the depth locating equipment that must be used in this area of study.

Mapping a body of water can be supported by several reasons. With the finished map several options can be put into action. First, the amount of knowledge that can be gained from reading a map is unlimited. Any fisherman who knows that the perch are suspended three feet above the bottom in ten feet of water can pinpoint locations where fish might be holding, thus giving him more time fishing and less time searching. It could also be used to help locate positions for placing fish cribs. This could be of interest to people who want to improve ice fishing or improve habitat for fish.

Also, the option of calculating sedimentation rates in the body of water is easily within reach. There are several reasons for this. First, it will tell that at the current rate of the life of the body of water will last so long. A far-fetched usage of this information would be helping people decide whether or not to build on a lake by figuring how long before the lake becomes a stream again. Another reasonable usage for this data would be in presenting to a lake association the importance of putting forth money for dredging. If there were a strong interest, the information would be very helpful in getting this plan into action. Without these calculations, there would be no sound information on what is happening and how fast.

I also wanted to do a project that might help me to decide upon a career that I would be interested in. Now that I have worked on this project, I have come to the conclusion that I would not like to do this for a job. But, none the less, I enjoyed it and found it to be a good learning experience for me.

Hypothesis

The outcome of my project should be a completed map of the body of water. It will contain information that will assist in determining the rate of sedimentation. It will also be

easily worked with to someday include the vegetation of the lake and other structure on the bottom of the lake such as fish cribs, rocks, or brush piles. As a whole, the map is designed to help people who wish to enjoy a day of fishing on the lake to improve their chances of success. Finally, I wish that this map would be available to anybody who wishes to use it for whatever purpose they wish.

Process

In the spring of 2001 I had to decide what classes I would like to take my senior year in High school. One that I chose was Field Research. The topic that would take me through the first semester and then some was to create a Bathymetric Map of Dells Pond.

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The first step in my long process is to accumulate the necessary materials. In my project I used a 10-foot Bass Hound boat, equipped with a 3 horse Johnson outboard, a depth finder and a 36 lb. thrust Minnkota Trolling motor. Also needed is a Global Positioning System (GPS). For my use I had a Trimble GeoExplorer.

The Global Positioning System (GPS) is a worldwide radio-navigation system formed from a constellation of 24 satellites and their ground stations. GPS uses these "man-made stars" as reference points to calculate positions accurate to a matter of meters. In fact, with advanced forms of GPS you can make measurements to better than a centimeter! In a sense it's like giving every square meter on the planet a unique address. GPS receivers have been miniaturized to just a few integrated circuits and so are becoming very economical. And that makes the technology accessible to virtually everyone. These days GPS is finding its way into cars, boats, planes, construction equipment, movie making gear, farm machinery, even laptop computers.

Soon GPS will become almost as basic as the telephone. The next thing to be done in the process is to get the GPS set up. Along with the obvious, charging the battery one must also get the GPS to find its position. This must be done if the GPS has not been used for an extended period of time. To do this the unit must be left out side with an unobstructed view of the sky. This is necessary so the satellites, which it works off of, can be located.

A data dictionary is a list and setting for the different types of information one wishes collect with the GPS. For this the GPS is connected to a computer with ArcView installed on it. The Data Dictionary is created in ArcView then transferred to the unit. There are several different choices such as having numbers, which are scrolled through and chosen. Or the numbers can each be a different setting. The second is the one I chose for my project, and it seemed to work the best. Also I had to get a setting for a line, which I used for the shoreline.

Now it is time for the dirty work. I got in my boat and started up the motor and started around the shore with the GPS on and collecting data. All seemed to go smooth until I noticed that I was no longer collecting data points, but I continued to the finish. I had lost

contact with the satellites and needed to redo the shoreline. Then came the job of getting depth contours. I started at the north end of the lake and crossed back and forth working my way south. Every time I crossed the pond I would cross different depths. I started by shore and went out until I found two feet of water on my depth finder. I would then use the GPS to record "2" feet at that position. Then I would move on to four feet, six feet, eight feet and so on. Every time I had a depth change of two feet I would record it, I did this all the way down the pond. The collection process took about a month, but it could have been less because I ran into some trouble. This method is known as the gameboy method; pushing buttons just like on the hand held game.

As I mentioned above I ran into some trouble, I had collected about a third of the data, I decided that I would take it off of the GPS and put it onto the computer at school. I had just transferred the files from the unit to the computer through ArcView, and was going to open them. I found that the points had not been recorded properly and that the depths weren't saved. So back out to the lake I went and finished the collection process and this time it worked.

Transferring the data is pretty easy, but there is still more work. The data that the GPS collects is not correct; the government has GPS satellites scramble information so that the information is off by about five meters. To correct this correction files are collected from this web site www.ngs.noaa.gov/cgi-cors/ufcors2.prl to get these some information must be filled out, such as the date for which the information is needed, time, and location. These files are sent as a zip file and must be unzipped to get the information in a usable format for ArcView. This is easily accomplished by using WinZip to unzip them and then it is ready to go to the next step of exporting.

Exporting is just moving them to another program. For the mapping project I chose to use pathfinder, then the creating of the map can begin. First I found all the data that I needed to use to create my map and got it in one folder so I knew where it was. Then I had to reproject it, this means adjusting it so that it matches up with the Department of Natural Resources data. The computer can do this for you also.

Now all that must be done is to organize the data in the fashion with which you wish it to appear on your final map and do some touch up work. Finally the map is exported to Adobe where the final touch up work can be preformed. In this program I made changes such as: cleaning up depths that ran into each other, adding keys and titles, and finally printing. In this program the map can be used to make several different things, print shops can print maps on different size pieces of paper, or even make it into a poster.

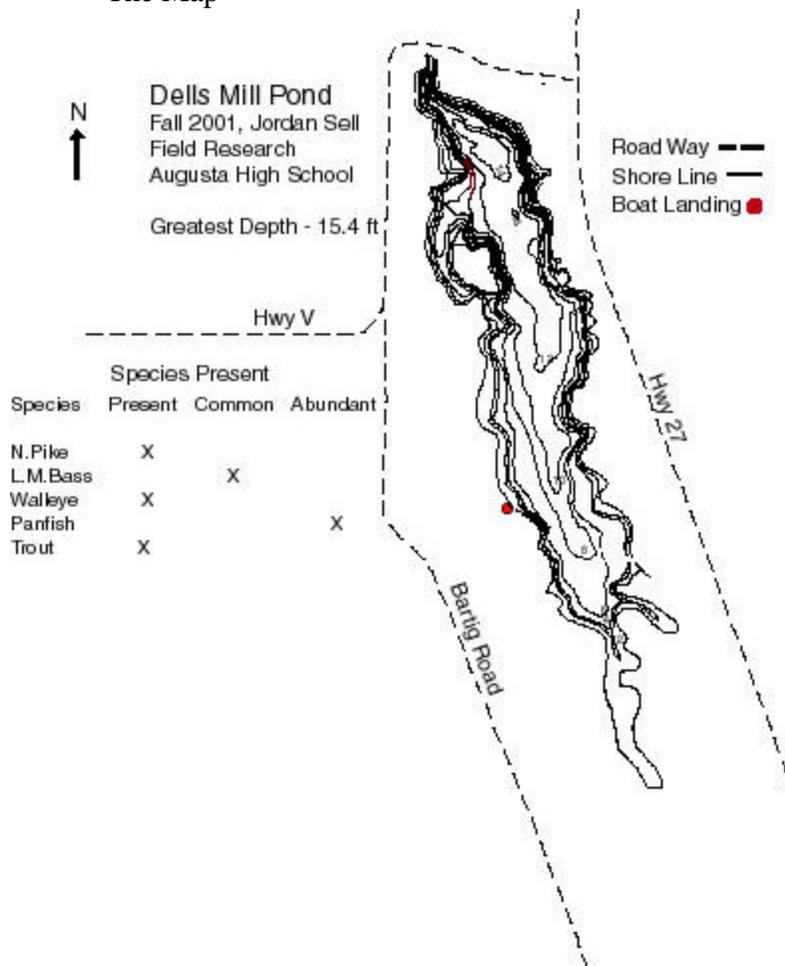
The map that I created could be used for many things. I have considered using it and adding to it the vegetation of the lake. Possibly I could add more than vegetation, by locating fish cribs or brush piles. Fish locations throughout the year and why could also be research using this map.

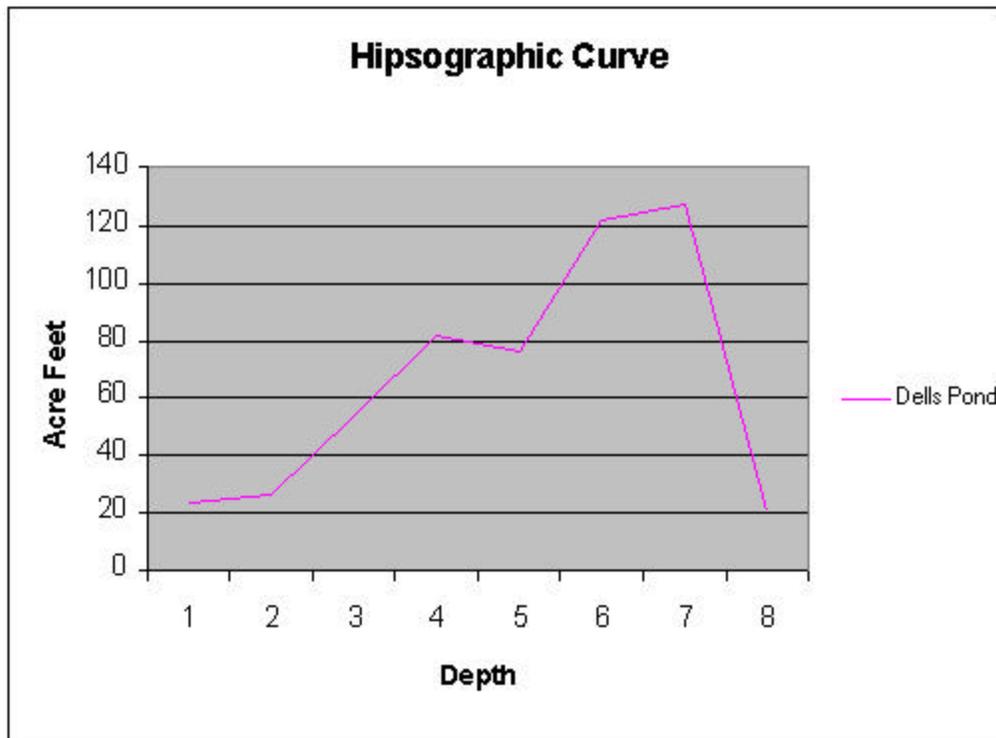
Another use for the map would be to figure the volume of water that is contained within the basin. This is accomplished by determining the amount of water, which is at each depth zone. Then figuring the volume the same way for the map that was from the nineteen sixties. Comparing the two maps would give a number, which tells how fast the lake is silting in. This could be useful in showing that the pond may use dredging or how it changes over time.

Results

My final outcome was a finished map. The map that I made can be used to help people with several different problems. Fishermen can use it to find a likely place to catch fish. People who want to improve habitat for fish and wildlife can have a place to start. Or somebody who is just interested in the body of water can have something to look at. Another interesting fact that I found was that even though the total surface area has decreased from 74.8 acres in 1968 to 70.4 acres in 2001 the total volume has increased over time. In 1968 the volume was 409.4 acre feet and now it has gone up to 531.32 acre feet. That shows a pretty big increase in volume considering that the surface area has decreased. The reason for this could be explained by the idea that possibly the bottom of the pond has actually been scoured by one of the several floods that happened in the 1990's.

The Map





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Jordan Sell

Field Research 2001-02
Augusta High School
Augusta Wisconsin