Mapping the Gaps: Building a pipeline for contributing and accessing crowdsourced bathymetry data

Aaron Rosenberg[1,2], Jennifer Jencks[1], Adam Reed[3], Krisa Arzayus[1]

[1]NOAA National Centers for Environmental Information, [2]University of Colorado Cooperative Institute for Research in Environmental Sciences, [3]NOAA Office of Coast Survey Integrated Ocean and Coastal Mapping

The IHO and Crowdsourcing Data

Both the Moon and Mars have been more comprehensively mapped than the world's seas and oceans. Contrary to popular belief, less than 15% of the depth of the world's ocean waters have been measured directly and only ~50% of the world's coastal waters have ever been surveyed. Bathymetry underpins the safe, sustainable, cost-effective execution of almost every human activity that takes place at sea, yet most of the seafloor remains virtually unmapped, unobserved, and unexplored.

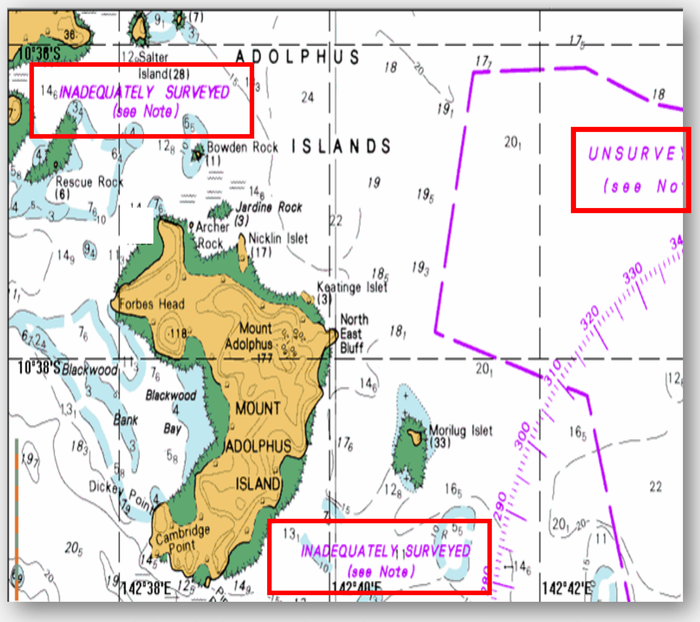
Since 2014, the International Hydrographic Organization (IHO) has been encouraging innovative supplementary data gathering and data maximizing initiatives to increase knowledge of the bathymetry of the seas, oceans, and coastal waters including crowdsourced bathymetry (CSB).

CSB can be used to identify areas where nautical charts are inadequate and proper hydrographic surveys are needed or can be applied to nautical charts when the source and uncertainties of the data are well understood. The key to successful CSB efforts is volunteer observers who operate vessels-of-opportunity in places where charts are poor, where the seafloor is dynamic, or where hydrographic assets are not easily available.

Most ships are inherently capable of measuring and digitally recording depth in coastal waters and an increasing number of vessels are capable of taking measurements in deeper water, both using existing ship's equipment. The vision is to tap into the enthusiasm for mapping the ocean floor by enabling trusted mariners to easily contribute data to fill the gaps in our current bathymetric coverage.

Recognizing the value of CSB, the IHO established a working group comprised of international scientific and hydrographic experts and tasked them with drafting a guidance and standards document to provide volunteer collectors with information about CSB, the installation and use of CSB data loggers, data quality issues, and instructions for submitting the data to the IHO data repository. A working copy of this document is available at https://tinyurl.com/iho-csb-draft.
This document will ultimately become an IHO publication on policy for trusted crowdsourced bathymetry.

Following from the development of CSB policy, the IHO's Data Centre for Digital Bathymetry (DCDB), with guidance from the CSB working group (CSBWG), has pioneered a data pipeline system to collect, archive, and distribute CSB from a variety of unconventional bathymetric data providers.

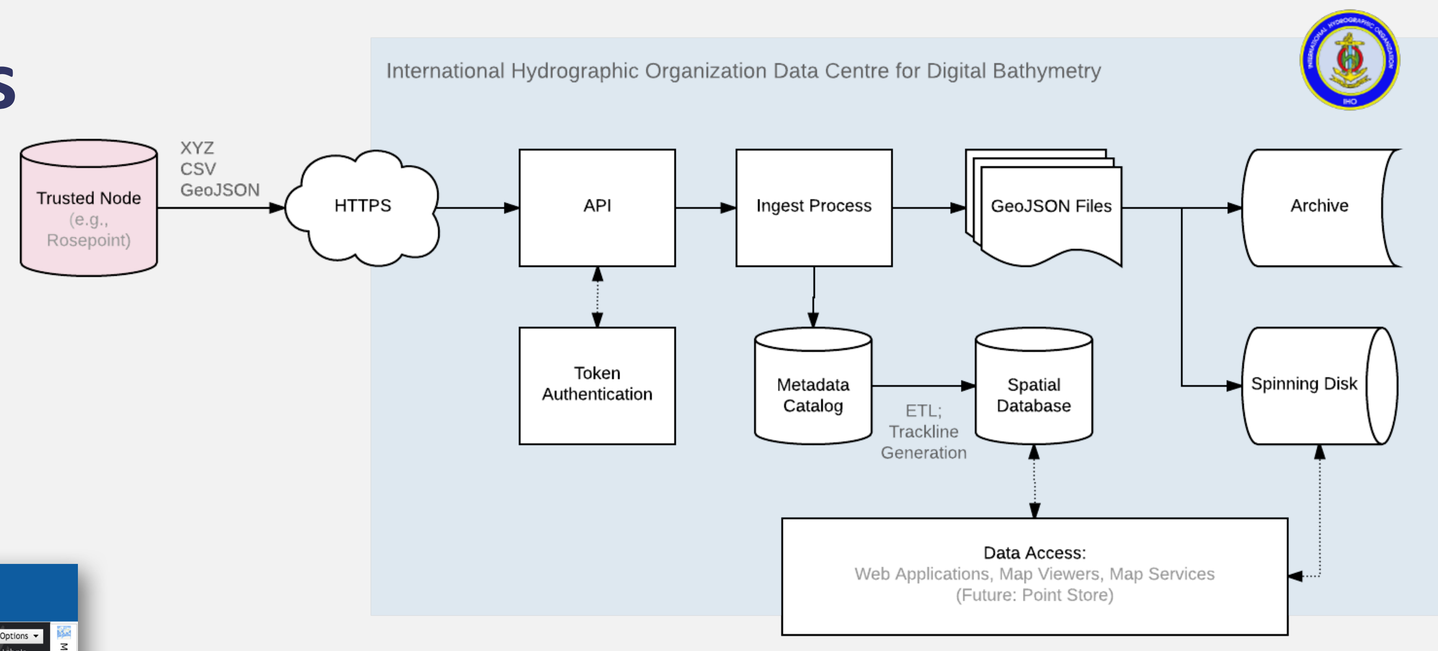


Nautical Chart displaying inadequately surveyed and unsurveyed regions (red boxes) surrounding the North Australian Coast.

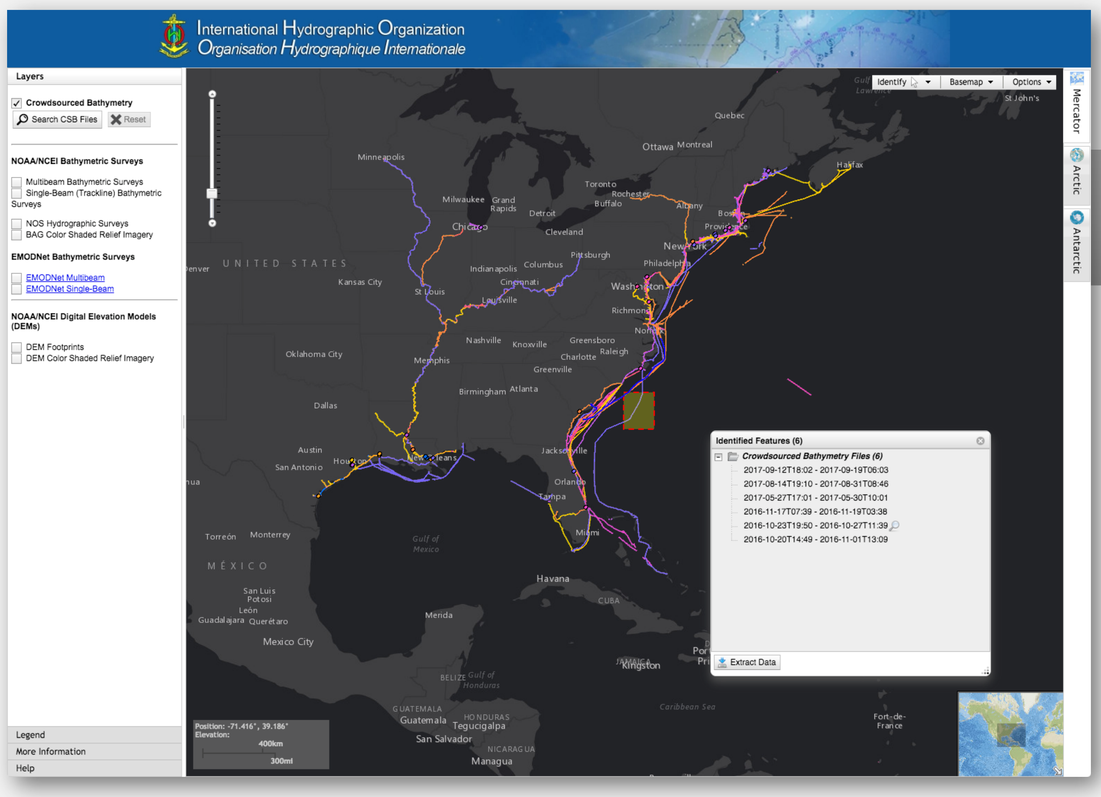
CSB Pipeline Enhancements

NOAA's National Centers for Environmental Information (NCEI) has been working to enhance the infrastructure and interface of the DCDB to provide archiving, discovery, display, and retrieval of CSB contributed from mariners around the world. CSB, in CSV, XYZ, or GeoJSON formats, can now be sent to the DCDB through the web to an HTTPS endpoint, where the data are picked up and processed into the discovery and archive systems.

The contributed depth measurements are integrated into a map service which is accessed through an interactive map viewer and data discovery tool, hosted at the DCDB (https://maps.ngdc.noaa.gov/viewers/csb/). The contributed files, converted to GeoJSON, can be downloaded through the map viewer.



Process for chart for ingesting CSB from a trusted data provider.



CSB Map Viewer, hosted at the IHO DCDB

Enabling **ALL** mariners to *map the gaps*!

Pilot Project

The current pipeline relies on trusted data providers who are issued unique tokens to post CSB over the web directly to an API endpoint, hosted at the IHO DCDB. This token, stored in the transferred metadata, is validated before the bathymetric data is allowed to enter the automated ingest system.

The DCDB collaborated with NOAA's National Ocean Service (NOS) and Rosepoint Navigation Systems to develop and implement a pilot production system. Rosepoint, through its Coastal Explorer Electronic Navigation System, and NOS give mariners an option to enable CSB logging, allowing a modified electronic charting system log file to record position, depth, and time. Mariners can choose to be anonymous or to submit metadata describing their vessel and equipment. The modified log file and JSON metadata string are then submitted via HTTP post.

Once received at the DCDB, data are ingested and incorporated into the CSB map service and discovered on the CSB map viewer. The current data holdings represent 78 million soundings from vessels of opportunity at sea.

Future Work

Future work for the IHO DCDB includes the expansion of the project from a pilot phase into a full production environment. This includes outreach and coordination with numerous potential trusted data providers and the parallel scaling of data ingest and services to mirror the expected growth.

An integral part of this development is the implementation of new underlying technologies which will give additional functionality for search and discovery, such as dynamic scaling and aggregation of data on the map viewer and the ability to download sounding subsets from a point store database.

"If we got 1% of all seagoing vessels logging data, and on average they spent half their time at sea, then that's about 5 billion data points a day."

- Tim Thornton, TeamSurv

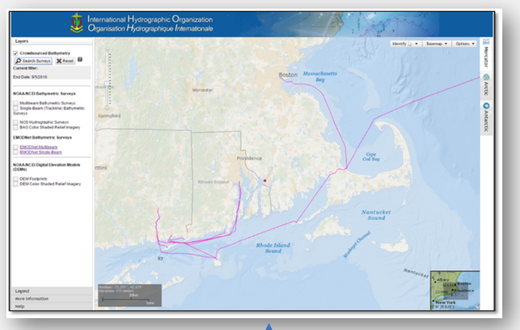
Comments or questions:

Jennifer Jencks
IHO CSB Project Lead
Director of the IHO DCDB
jennifer.jencks@noaa.gov

Aaron Rosenberg
IHO DCDB Technical Lead
aaron.rosenberg@noaa.gov

Crowdsourced data log file

Data uploaded via a trusted data provider



Data discovery and access via the DCDB portal