

Ensuring Safety of Navigation: A Three-Tiered Approach



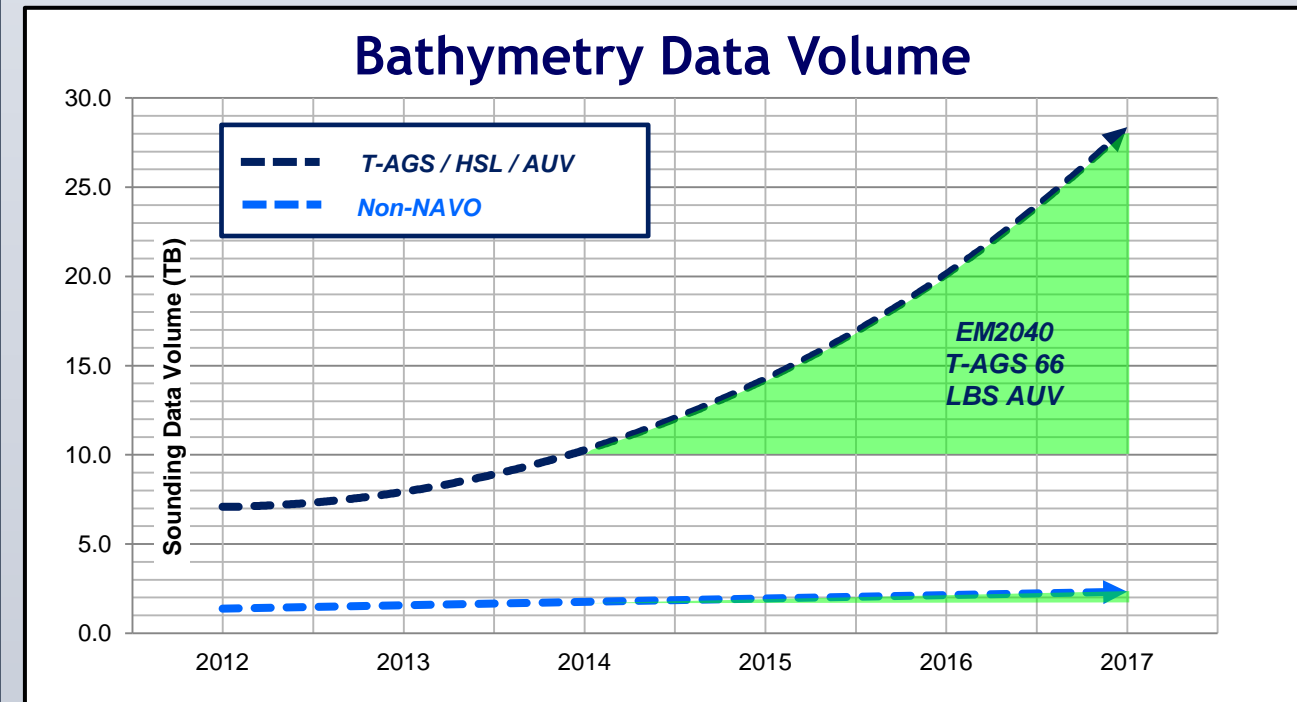
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Introduction

The Naval Oceanographic Office (NAVOCEANO) is responsible for the collection and distribution of hydrographic information to the National Geospatial-Intelligence Agency (NGA) to support the preparation of maps, charts, books, and geodetic products (10 U.S. Code § 7921). For a number of years NAVOCEANO has employed a two-tiered databasing structure to support NGA's production of Digital Nautical Chart (DNC) and Tactical Ocean Data (TOD). The first tier (Data Warehouse, or DWH) provides access to the full-resolution source bathymetry to satisfy product requirements on all scales. The second tier (Digital Bathymetric Database - Variable resolution, or DBDB-V) serves as the final archive for chart scale, gridded products compiled from source bathymetry. The practice of re-visiting source bathymetry for each new production effort has become extremely time consuming due to the volume of information collected using modern surveying technology. In an effort to restore production efficiency, the Bathymetric Databases Branch (NP421) has developed a new capability that decreases the time required to produce and deliver gridded bathymetric products to NGA.

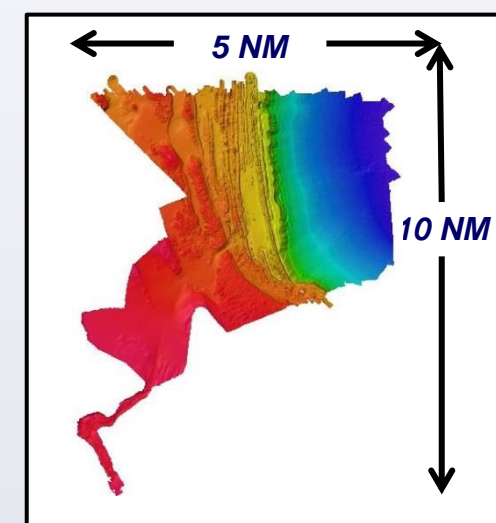


Objectives

In response to department tasking NP421 identified the following objectives:

1. Reduce the requirement to re-visit source bathymetry data
2. Develop the ability to archive high-density bathymetric grids that can be exploited to support multiple bathymetric production efforts
3. Employ Hydrographically sound techniques and processes to combine archived grids of varying resolutions into a single gridded surface.
4. Employ Cartographically sound techniques and processes to generalize gridded surfaces
5. Reduce the time required to produce a final gridded bathymetric product for delivery to NGA.

Objective 1: Address Data Volumes



NAVO HSL EM3002 (21 days of data)

- Source Data: 1.7 Billion Samples
- High Density Gridded Bathymetry
Grid Resolution: 1 Meter
of Depth Estimates: 64,123,708

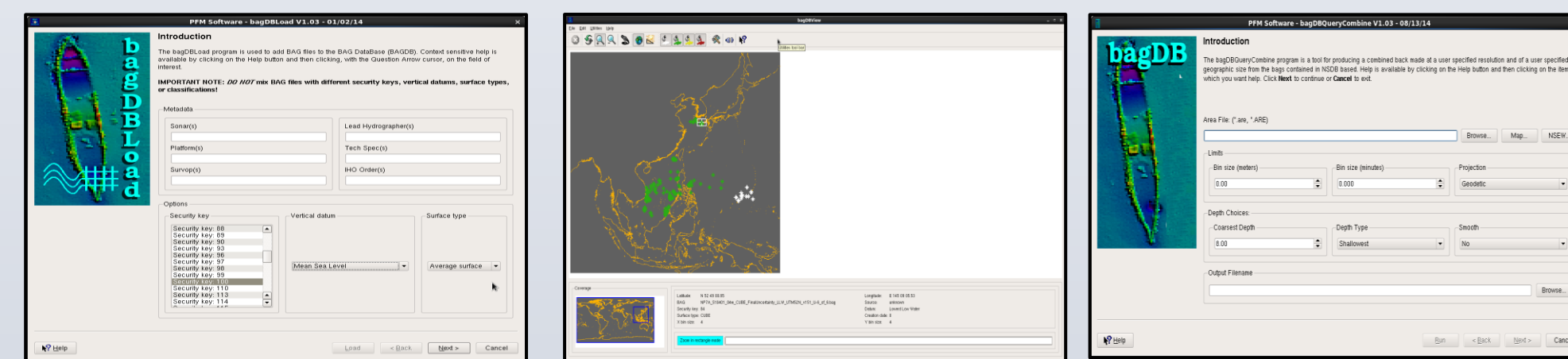
✓ 96% Reduction

Paradigm Shift: "When data density is high, (e.g. for multibeam data) an appropriate bathymetric model (DTM) is an acceptable starting point for a hydrographic product."

(Larry Mayer, Data Processing Pipeline, 58th Multibeam Sonar Training Course, JAN 2012)

- High data density allows NP4 to produce gridded bathymetric surfaces at the highest resolution that the collection sensor system and the environment can support.
- Completed surfaces contain nodal estimates for depth and depth uncertainty, along with datum separation values and a complete metadata record.

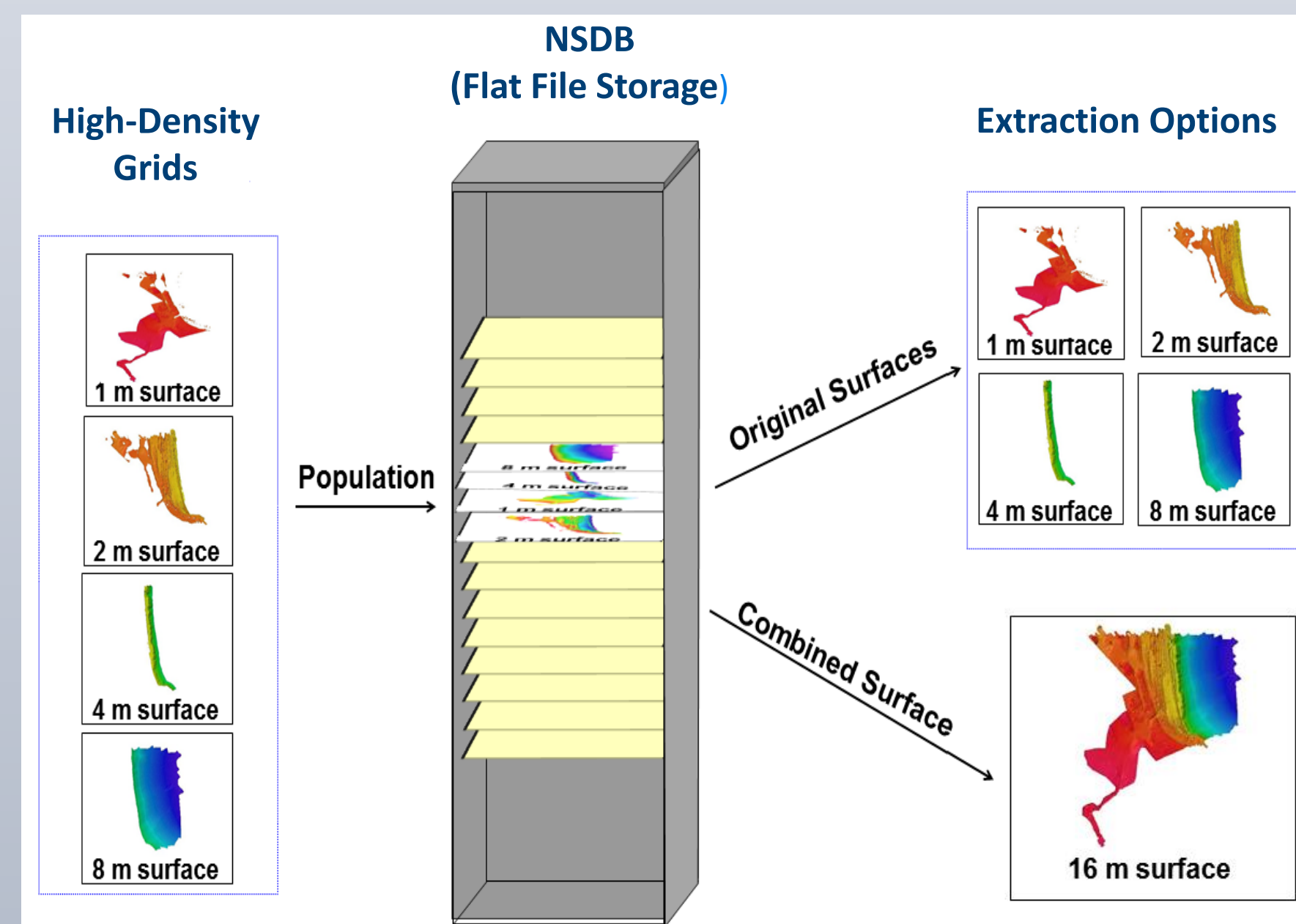
Objective 2: Develop capability to archive high-density gridded surfaces



NSDB makes use of a file server and a relational database to store high-density surfaces and associated metadata.

The NSDB software utilizes archived metadata to visualize, load, modify, delete and query surfaces within the database.

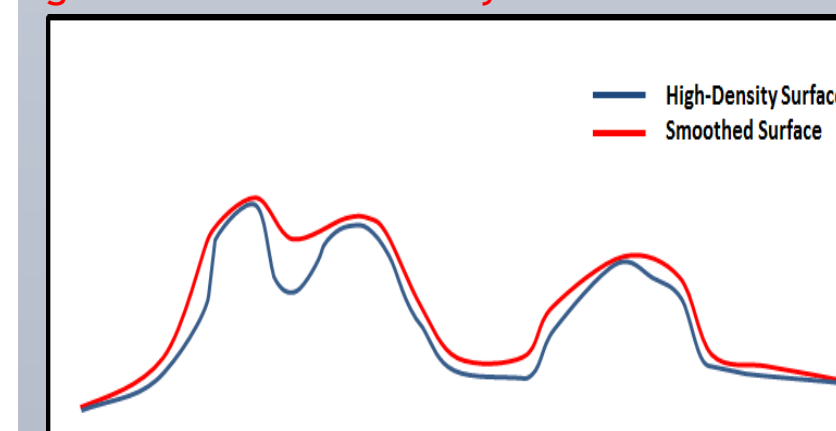
Objective 3 and 4: Exploitation of Gridded Surfaces using NSDB



NSDB provides the following capabilities:

- 1) Extract the original high-density surface(s).
- 2) Extract a combined surface (shoal or resolution) generated at the coarsest resolution of the input surfaces.
- 3) Extract a combined and smoothed surface generated at a user defined resolution.

The NSDB smoothing algorithm is based on a proposed solution identified by Shepard Smith². We attempt to further answer his solution's remaining questions by defining our own solution to generalized uncertainty.



Objective 5 : Production Time

A single survey can easily produce billions of samples (see Data Volume example) when you take into consideration the collection system, the depth range of the survey area, and the timeframe of the project. As a result, the time required to generate usable high-density gridded bathymetric surfaces from full resolution data can be extensive (> 1 day) and counterproductive because the department is forced to repeat the process multiple times. With the addition of NSDB, primary surfaces are archived and made available for future exploitation, thus eliminating the requirement to revisit source data for each production effort. Subsequent use of archived data requires less deconfliction and post processing and provides the ability to rapidly generate, within the timeframe of a workday, a product surface that can support the production of DNC, TOD and future navigation charting products.

Way Forward

Current:

1. Fully populate NSDB with relevant high-density surfaces to support current and future production.
2. Continue to refine existing tools and develop new capabilities to combine and exploit the contents of NSDB.
3. Promote the use of open source formats and contribute to international geospatial data standards development.

Future:

1. Develop a common user interface for consolidated access to the NAVOCEANO bathymetric databases including the Data Warehouse, the Navigation Surface Database, and the Digital Bathymetric Database - Variable resolution (DBDB-V).
2. Improve bathymetric and hydrographic data discovery, visualization, and geo-processing.

References

1. 10 United States Code § 7921 - Safety and effectiveness information; hydrographic information
2. Shepard M Smith; THE NAVIGATION SURFACE: A MULTIPURPOSE BATHYMETRIC DATABASE, Masters Thesis, University of New Hampshire, May 2003
3. Larry Mayer; Data Processing Pipeline, 58th UNB-OMG / UNH-CCOM Multibeam Sonar Training Course, New Orleans, January 2 to 7, 2012.