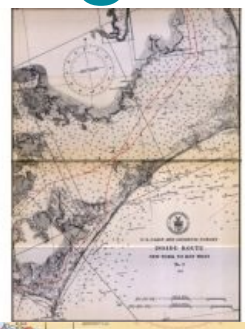
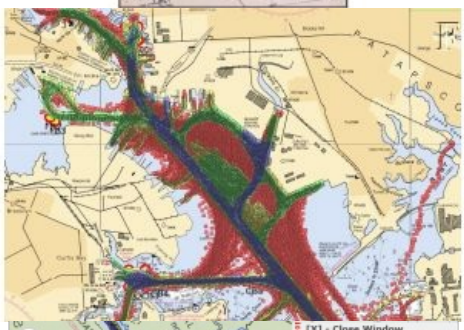
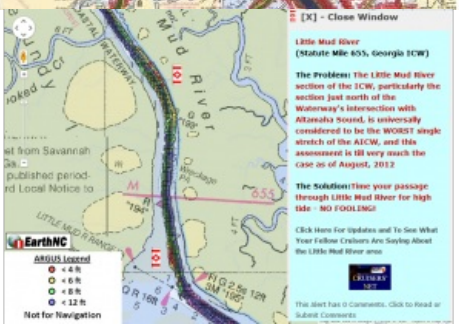
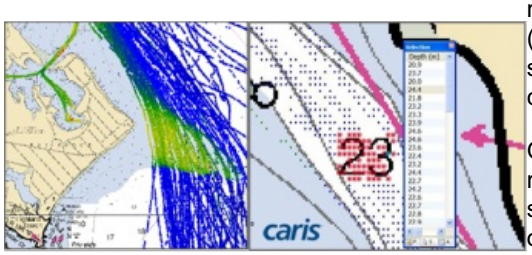
LEVERAGING TECHNOLOGY AND SOCIAL MEDIA FOR INTRACOASTAL WATERWAY RECONNAISSANCE

Crowdsourcing Enhances Navigation Awareness









In this internet age, crowdsourcing is fast providing practical contributions to our understanding of the world around us. Whether it be software developed in an open-source environment, inputs from 'those in the know' to create and maintain wiki pages, or the provision of weather and traffic data through the mobile devices we use every day, society as a whole benefits from what we each 'know' and the ability to communicate that information with today's technology.

Autonomous crowdsourced bathymetry (CSB) is one of the newest tools in the hydrographer's toolbox, leveraging the application of 21st century technology and social media, both now an integral part of our everyday lives. While high-end surveying equipment is still unmatched in precision and accuracy in the hands of a professional hydrographer, very capable surveying technology is now low cost, readily available and already distributed worldwide in the form of standard-equipment vessel electronic charting systems, or chartplotters. Combined with the wireless and cellular networks that we are all constantly connected to, we have the ready means to aggregate and share this distributed coastal intelligence; and with the application of scientific principles rooted in hydrography and big data, we also have the ready means to compute solutions (along with uncertainty estimates) of this data to meet a variety of needs. And thus, the science of autonomous CSB is emerging as a next-generation tool that mirrors the connected mindset of the next generation of hydrographers.

One such purpose for which autonomous CSB is being successfully implemented is as a reconnaissance tool for boaters on the Intracoastal Waterway (ICW) (see Figure 1). Some sections of the waterway consist of natural inlets, saltwater rivers, bays, and sounds, while others are artificial canals. It provides a navigable route along its length without many of the hazards of travel on the open sea. The regional maritime community is taking advantage of CSB as a self-enabling technology through a creative collaboration with industry. Leveraging the public's availability of modern technology and their natural desire to be well informed as well as to benefit society, mariners are providing data that bestow unprecedented insight into conditions and resources along the ICW.

The Salty Southeast Cruisers' Net (SSECN) is an online social media forum focused on the Atlantic ICW, and a treasure trove of useful

reports and articles provided and consumed by the ICW community. The SSECN website informs others via familiar chart displays provided by EarthNC, enhanced with access to information such as fuel prices, marina accommodations, and navigation hazards like misplaced buoys and shoaling. These reports are also enhanced by the millions of water depth measurements made by cruisers during their routine ICW transits, autonomously delivered and processed through the ARGUS™ CSB innovations of SURVICE Engineering and CARIS USA. This virtual, distributed surveying 'vessel' acts as a member of the SSECN cruising community, greatly enhancing condition reports provided through the SSECN website with a continuous flow of physical measurements as portrayed in Figure 2. This model provides the ultimate opportunity to engage the public as it both leverages and supports the public's recreational and commercial interests in the ICW. What was previously a fleeting number on a chartplotter screen has become useful knowledge thanks to this pioneering partnership.

ARGUS Crowdsourced Bathymetry

Autonomous crowdsourcing for maritime applications has been pioneered by SURVICE Engineering and CARIS USA through the innovations of ARGUS. ARGUS is a patented (US Patent 8,417,451) autonomous CSB system that provides continuous, automated acquisition and processing of CSB data. It universally interfaces with vessels' existing GPS and depth-finding systems, automatically processes the GPS and depth signals, and leverages wireless technology and social media for both data aggregation and web dissemination of process outputs. Originally demonstrated as part of a National Oceanic and Atmospheric Administration (NOAA) Small Business Innovation Research (SBIR) grant, ARGUS has processed over 100 million depth soundings from a distributed, international fleet of opportune vessels ranging from 18-foot recreational bass boats to 1000-foot commercial cruise liners (see Figure 3). In the image, vessel traffic is clearly highest in the same coastal zones in which up-to-date reconnaissance is most needed. Studies suggest that ARGUS solutions can meet IHO S-44 Order 2 standards. ARGUS has demonstrated a powerful and practical approach that inexpensively leverages an unlimited, distributed workforce.

Fundamentally, ARGUS processes every GPS position and corresponding water depth measurement that is output from the chartplotter. The system operates autonomously with no operator interaction required other than turning on the chartplotter. Backend processing includes the application of vessel offsets, tide and other environmental corrections, various stages of quality control, and CSB-specific data aggregation methods. Output from the process can be managed through CARIS' Bathy DataBASE (BDB), which is used to compile survey data with appropriate metadata that can be used for searching. CARIS' Spatial Fusion Enterprise (SFE) then can be used to serve out the data via the web. CARIS BDB and SFE provide powerful post-processing and visualisation platforms for the web-served ARGUS solution sets, robust and scalable storage and analysis for the ever-expanding volumes of data, high-resolution graphics, industry standard bathymetric processing modules, and simple yet powerful end-user interfaces.

CSB Application on the ICW

ARGUS has been in operation since 2010, acquiring over 100 million soundings from a distributed fleet of vessels navigating US and international waters. Over 20 million of those soundings have been processed over the 1000+ miles from Norfolk to Key West, thanks to long-time contributors like Sea Tow, M/V *Altair*, M/V *Chez Nous*, Trawler Beach House, and Reality Check Sailing, and the data solution set is continually being refreshed. Figures 4 and 5 show two of the classic ICW trouble spots highlighted for SSECN readers: Georgia's Jekyll Creek and Little Mud River, respectively. These are typical examples of ARGUS data providing a real 'visual' of the conditions and of the best route of travel through these trouble spots.

Clearly evident in the case of the ICW, an especially hard-to-reach area for official survey assets, the swath of CSB data provides the partnership with a great opportunity to update the magenta line, or preferred route of travel, as currently represented on official charts. The magenta line was last comprehensively surveyed in the 1930s and desperately needs updating. Figure 6 shows one of many examples where the swath alone indicates the preferred route of travel, yet without consideration for which is the deepest part of the swath. Endorsed by the Atlantic Intracoastal Waterway Association, this project will add a continuously updated magenta line as a layer in the SSECN chart windows.

Since the CARIS-led introduction of autonomous CSB to the international hydrographic community in 2010, CSB's potential value has been noticed and is rapidly moving to leverage its benefits. Among others, the development of CSB has since been endorsed and encouraged by the United Kingdom Hydrographic Office, the International Hydrographic Organization and the Hydrographic Services Review Panel in the United States. The application of inevitable hardware improvements along with scientific expertise promise to only make CSB solutions better—in fact magnitudes better than the pre-1940s 'soundings' that are the basis for the majority of modern charts.

Who Benefits?

Crowdsourcing provides an opportunity to apply innovative technologies while engaging partners from academia, the public and commercial entities. It also attracts populations that are currently underrepresented in the hydrographic science workforce. The continuous flow of coastal environmental information promotes stewardship and informs decision making by stakeholders, educators, students, and the public who are interested in science. Crowdsourcing is an effective engagement of key stakeholders and the public that can enhance literacy of our coastal environments.

Through this pilot application, SSECN readers are getting the benefit of a reconnaissance tool that keeps them best informed about the journey that lies ahead. The chart windows and layers allow planning for tomorrow's journey while in a slip or on the anchor with a look-ahead view of current attractions, alerts, and trouble spots. Information is bolstered by local knowledge of the SSECN community as the readers monitor local solution updates, make local chart comparisons, and identify areas of interest (e.g., shoaling), which are then reaffirmed by and for the community. Reader testimonials indicate wide approval of these SSECN reports.

The general public benefits from a reduced need to tax current observing systems, which are already 100 years behind schedule and with growing requirements. Steadily decreasing resources have reduced the number of hydrographic survey platforms worldwide to about 65% of what it was 15 years ago. This is in the face of commercial maritime trade that has increased three-fold since the 1970s. Especially in hard-to-reach areas such as the ICW, crowdsourcing can be used as a supplement to mission planning for official surveys requiring controlled measurements as shown in Figure 7.

Resource-challenged hydrographic offices realise that they must rely not only on their own capabilities, but that they must also engage stakeholders and the public at multiple levels in order to build capacity and accomplish their missions. As demonstrated in other application areas such as the Chesapeake Bay, Antarctica, coastal New York and New Jersey, and the ports of Baltimore, New York, and Pittsburgh, one can see additional CSB networks being established to support local interests while complementing the work of hydrographic services and surveyors. Combined with the availability of the internet and wireless connectivity, remote sensing far beyond the capacity of all the world's hydrographers combined is being realised. With the challenge of reduced resources, the use of CSB and other nontraditional methods for collecting data will grow to support the ever-increasing needs and uses for hydrographic data. The newest members of the hydrographic workforce—the commercial and recreational vessel captains that value the waterways—are bringing the fruit of their efforts to the benefit of the entire ICW community.

More Information

- Van Norden, M., P. Cooper, and J. Hersey. "Crowdsourced Bathymetry: One Solution for Addressing Nautical Chart Data Deficiencies." US Hydro 2013.
- Sedaghat, L., J. Hersey, and M. McGuire. "Detecting Spatio-Temporal Outliers in Crowdsourced Bathymetry Data." GEOCrowd 2013.
- SURVICE Engineering ARGUS Website, http://argus.survice.com/.
- The Salty Southeast Cruisers' Net (SSECN) Website, http://cruisersnet.net/.
- The Atlantic Intracoastal Waterway Association (AIWA) website, http://www.atlanticintracoastal.org/.