Navigating Blind: Data Access Challenges in U.S. Inlet Hydrographic Surveys and Their Impact on Recreational Boating Safety

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Abstract

The U.S. Army Corps of Engineers conducts hydrographic surveys of coastal inlets, yet the resulting data is trapped in an archaic distribution system effectively inaccessible to recreational mariners. Through development of a nationwide inlet depth sounding system for Pelagic Insight, we analyzed USACE eHydro survey data across all 12 coastal districts covering 130 tidal inlets from Maine to Texas, achieving 100% processing success across 77 surveyed inlets. We document inconsistent data formats, 30+ incompatible coordinate reference systems, and 53 recreational inlets with no professional survey , many among the most dangerous on the coast. We propose federal standardization, modern API infrastructure, and crowdsourced bathymetry integration as complementary solutions.

1 Introduction: The Hidden Danger at America's Inlets

1.1 What Makes Inlets Dangerous

Tidal inlets, the narrow passages connecting the open ocean to bays, sounds, and estuaries, are among the most hazardous navigational features on the U.S. coastline. The combination of tidal currents, wave action, sediment transport, and confined channels creates conditions that change rapidly and unpredictably. A channel that was 8 feet deep last week may have a 3-foot shoal today.

The United States has approximately 130 significant tidal inlets used by recreational and commercial vessels along its Atlantic and Gulf coasts, plus dozens of smaller passages.

1.2 The Human Cost

The U.S. Coast Guard's Boating Safety Division reports an annual average of approximately 4,168 recreational boating accidents, 613 deaths, and 2,559 injuries nationwide. While not all of these occur at inlets, inlet-related incidents are disproportionately severe. The combination of breaking waves, strong currents, and shallow water means that inlet groundings frequently escalate to capsizings, and capsizings at inlets are frequently fatal.

Notable examples include:

- **Oregon Inlet, NC:** Multiple fatalities over the past decade, widely regarded as one of the most dangerous on the East Coast.
- **Sebastian Inlet, FL:** Currents exceeding 10 knots in a narrow, unmarked , yet no USACE survey coverage.

- **Jupiter Inlet, FL:** Widely considered the most dangerous inlet in Florida, with a shallow bar that breaks across the entire , and no USACE survey coverage.
- **Haulover Inlet, FL:** Famous for standing waves that have capsized vessels, with channel depths of only 12–14 feet and extremely heavy traffic.

1.3 The Information Gap

The core problem is twofold: where professional survey data exists, it is effectively inaccessible to mariners; and where it does not exist, alternative data sources remain underutilized. The 53 inlets without USACE professional survey coverage are disproportionately the natural, unjettied inlets where conditions change most rapidly.

2 Current State of Inlet Survey Data

2.1 The USACE eHydro System

The primary source of inlet hydrographic survey data in the United States is the USACE Navigation and Civil Works Decision Support Center's eHydro system. It provides a web-based map interface, an ArcGIS REST API for metadata, and download links to survey data packages (ZIP files).

A typical eHydro survey download is a ZIP archive containing XYZ sounding files, GEN metadata files, GDB geodatabases, TIN models, and PDF , with composition varying dramatically by district.

2.2 The Eight-Step Access Problem

To access depth measurements, a consumer must: (1) query the API for available surveys; (2) download the ZIP file (potentially 1–189 MB); (3) extract the archive; (4) locate the XYZ file (naming conventions vary); (5) determine the coordinate reference system (method varies); (6) parse the XYZ file (delimiter varies); (7) reproject from local State Plane to a standard CRS; and (8) convert the depth reference datum if necessary.

This eight-step process requires specialized GIS knowledge, programming capability, significant bandwidth, and familiarity with the idiosyncrasies of each USACE district's data conventions.

2.3 Survey Frequency and Coverage

Our comprehensive analysis of 130 tidal inlets found that 77 inlets (59%) have USACE eHydro survey data available, while 53 inlets (41%) have no eHydro survey coverage at all.

Table 1: Survey frequency among the 77 surveyed inlets

Frequency	Count	Examples
Monthly or more	8	Oregon Inlet NC, Hatteras Inlet NC
Quarterly	12	Murrells Inlet SC, St. Augustine FL
Annually	20	Various harbors and channels
Less than annually	37	Various

2.4 The 53 Unsurveyed Inlets

The unsurveyed inlets cluster into distinct categories:

- **North Carolina (9 inlets):** Ocracoke, Drum, Bogue, Browns, Rich, Mason, Lockwoods Folly, Shallotte, and , among the most morphologically active in the country.
- **Florida East Coast (7 inlets):** Sebastian, Jupiter, Haulover, Boynton, Boca Raton, Hillsboro, and , several notorious for dangerous conditions.
- **Florida Gulf Coast (13 inlets):** From Marco Island to Steinhatchee River, serving active recreational and commercial fleets.

- **Georgia sounds (5 inlets):** Wide tidal sounds with shifting channels.
- **South Carolina (4 inlets):** Bulls Bay, Stono, North Edisto, and St. Helena Sound.
- **Other:** Wachapreague (VA), Nassau Sound (FL), San Luis Pass (; controlling depth just 0.5 feet).

3 Data Format and Access Challenges

3.1 File Format Inconsistencies

The most fundamental challenge is the absence of a standardized data format specification. Each USACE district has developed its own conventions.

3.1.1 Delimiter Variation

XYZ sounding files use different field delimiters depending on the originating district: CESAW (Wilmington, NC) uses comma-delimited CSV; CESAC (Charleston, SC), CESAJ (Jacksonville, FL), and most others use space-delimited formats; CENAE (New England) and CENAN (New York) use mixed formats. There is no metadata field indicating the delimiter used.

3.1.2 Coordinate Reference System Fragmentation

USACE surveys use the State Plane Coordinate System, which divides the United States into over 120 zones. Our analysis identified more than 30 different SPCS zones in active use. The method for determining a survey's zone varies by : some include it in GEN files, others only in API metadata with non-standard formatting. We developed a lookup table with over 60 entries to handle the variations.

3.2 District-Level Summary

Table 2: Format characteristics across all 12 USACE coastal districts

District	**Code**	**Delim.**	**GEN**	**ZIP Size**	**Inlets**
New England	CENAE	Mixed	Mixed	5–120 MB	21
New York	CENAN	Mixed	Mixed	Variable	5
Philadelphia	CENAP	Space	Yes	5–25 MB	5
Baltimore	CENAB	Space	Yes	Variable	1
Norfolk	CENAO	Space	Yes	Variable	2
Wilmington NC	CESAW	Comma	Yes	1–15 MB	6
Charleston SC	CESAC	Space	**No**	10–40 MB	5
Savannah GA	CESAS	Space	Yes	10–30 MB	1
Jacksonville FL	CESAJ	Space	Yes	5–30 MB	14
Mobile AL	CESAM	Space	Yes	Up to 189 MB	7
New Orleans LA	CEMVN	Space	Yes	20–60 MB	5
Galveston TX	CESWG	Space	Yes	62–83 MB	7

3.3 Absence of Modern Data Delivery

The eHydro system provides no GeoJSON API, no OGC Web Services, no tile services, no real-time streaming, and no lightweight endpoints. The only access method is downloading a ZIP , a 1990s paradigm applied to a safety-critical application in the 2020s.

4 Navigational Safety Implications

4.1 The Data-to-Decision Gap

For a recreational boater relying on NOAA charts or chart-based apps, the effective latency from survey to usable information can exceed 6 months to 2 years. At a dynamic inlet where the channel shifts weekly, this means chart data may be catastrophically wrong.

4.2 Who Is Affected

The populations most affected are those with the least technical capacity to work around it: 12 million registered recreational vessels, charter fishing operations, small commercial vessels, and transient boaters on the Intracoastal Waterway.

5 Case Studies

5.1 Oregon Inlet, NC: Best-Surveyed, Still Dangerous

Oregon Inlet is among the most frequently surveyed inlets in eHydro, with approximately 4,880 depth sounding points per survey. Yet the data delivery system fails to connect survey results to mariners in time. The inlet migrates southward at approximately 70 feet per year, and sandbars shift weekly.

5.2 Sebastian Inlet, FL: Extreme Danger, No Survey Data

Sebastian Inlet produces tidal currents exceeding 10 knots. It has **no USACE eHydro professional survey coverage**. Dozens of recreational boats transit daily with active depth , data that NOAA's Crowdsourced Bathymetry program could potentially capture.

5.3 Jupiter Inlet, FL: Most Dangerous, No Survey Data

Jupiter Inlet is widely considered the most dangerous inlet in Florida, with a shallow bar (often 4–6 feet) that breaks across the entire entrance in swells of 3 feet or more. It has **no USACE eHydro professional survey coverage**.

6 Crowdsourced Bathymetry: A Complementary Data Source

6.1 The CSB Landscape

Every vessel with a depth sounder is a potential survey platform. The ecosystem includes NOAA's Crowdsourced Bathymetry (CSB) program, Navionics SonarChart, C-MAP Genesis, and Garmin , but only NOAA provides truly open, programmatically accessible data.

6.2 Accuracy Comparison

Table 3: Crowdsourced bathymetry vs. professional surveys

Factor	CSB	USACE Survey
Vertical accuracy	0.5–2 m	0.1–0.3 m
Horizontal accuracy	3–5 m	<1 m
Tidal correction	Usually none	Corrected to MLLW
Temporal coverage	Continuous	Periodic
Cost per survey	Near zero	$50K–$500K+

The key value proposition is *temporal frequency over point accuracy*. For the 53 unsurveyed inlets, the choice is not between CSB and professional ; it is between CSB and *no data at all*.

7 Proposed Solutions

7.1 Federal Policy Recommendations

Standardized eHydro data format: USACE HQ should mandate CSV format, UTF-8 encoding, consistent naming, WGS84 coordinates as primary output, and MLLW vertical datum across all districts.

Real-time data API: GeoJSON endpoints, OGC-compliant WFS, vector tile services, webhook notifications, and lightweight query endpoints (e.g., “What is the minimum depth at Oregon Inlet?”).

Survey frequency mandate: High-dynamic inlets monthly; moderate quarterly; stable annually. Initiate professional surveys at the highest-risk unsurveyed inlets (Sebastian, Jupiter, Haulover, Ocracoke).

7.2 Technology Recommendations

GeoJSON API standard: A standardized schema for sounding data with explicit quality and source fields distinguishing professional from crowdsourced data.

Mobile-first delivery: Lightweight payloads, offline capability, visual depth overlays, and integration with existing marine navigation apps.

7.3 Pelagic Insight: A Proof of Concept

The Pelagic Insight platform demonstrates these solutions are feasible today at national scale:

- Covers 130 tidal inlets from Maine to Texas
- 100% success rate processing all 77 USACE-surveyed inlets across all 12 districts
- Handles 30+ State Plane coordinate zones, mixed delimiters, encodings, and archives up to 189 MB
- Delivers depth information in lightweight GeoJSON accessible from any device

8 Implementation Roadmap

- **Phase 1 (Year 1, $1.5–3M):** Format standardization, pilot with 3–4 districts, CSB integration baseline
- **Phase 2 (Years 1–2, $3–5M):** API development, change detection algorithms, Trusted Node partnership
- **Phase 3 (Years 2–3, $10–20M):** Professional survey expansion to highest-priority unsurveyed inlets, CSB monitoring for remainder
- **Phase 4 (Years 3–5, $5–10M):** Full integration, IHO S-102 alignment, mobile deployment

Total estimated investment: $19.5–38 million over 5 , modest relative to the $170+ billion recreational boating economy it supports.

9 Conclusion

The United States possesses world-class hydrographic survey capability, but that data is locked behind a distribution system never designed for recreational mariners. For 53 inlets, professional data does not , yet vessels transit them daily with active depth sounders, generating data currently discarded.

The solutions are neither speculative nor prohibitively expensive. Pelagic Insight’s nationwide platform proves the technical barriers are surmountable. What is needed is institutional will to modernize eHydro data delivery, modest federal investment in standardization and API infrastructure, integration of crowdsourced bathymetry, and state-federal coordination to ensure monitoring of all critical inlets.

The professional survey data exists for 77 inlets but cannot reach mariners. For 53 inlets, it does not , but the vessels transiting carry the instruments to fill the gap. The technology is proven. The need is urgent. What remains is the decision to act.