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Potential Lock Operations Management Application (LOMA) Hardware Installation Sites along the Ohio River to Improve Automatic Identification System (AIS) Reception and Transmit Range

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PURPOSE: The purpose of this Coastal and Hydraulics Engineering technical note (CHETN) is to propose a list of candidate sites along the Ohio River for the installation of Automatic Identification System (AIS) shoreside towers within the US Army Corps of Engineers (USACE) Lock Operations Management Application (LOMA) program. The LOMA program manages a network of terrestrial (shoreside) AIS sites (Figure 1) and vessel-mounted AIS sites with receive and transmit capability. However, there are known limits to the reception and transmission areas served by existing shoreside towers (referred to as "coverage gaps") along the Ohio River (DiJoseph et al. 2021). Parties interested in improving AIS coverage to enhance maritime domain awareness and navigational safety along the Ohio River may wish to pursue the installation of LOMA program hardware for this purpose.

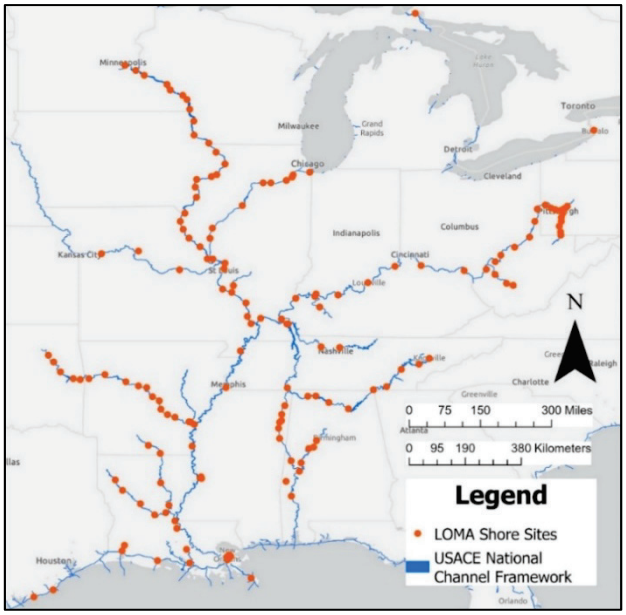

Figure 1. Map of existing Lock Operations and Management Application (LOMA) shore sites in the eastern United States (*orange dots*) with hardware installed. Mobile vessel-mounted systems not shown.

INTRODUCTION: AIS operates on the VHF maritime band and is limited by distance and line-of-sight (USCG, n.d.). AIS was originally developed as an aid to maritime-domain awareness and vessel-collision avoidance. AIS carries a wide range of information regarding dynamic time-stamped vessel operating conditions such as the vessel's current position, course, heading, and speed-over-ground. Static information related to vessel identification is available, including the vessel's name, Maritime

Mobility Service Identity number, dimensions, and type, additional AIS message information can be found from international standard-setting groups (IALA 2008; IEC 2018; ITU-R 2014; USCG-NAVCEN, n.d.). AIS equipment carriage requirements within US territorial waters are governed by 33 C.F.R. § 164.46 (US C.F.R. 2020). The overwhelming majority of vessels engaged in commercial activity are mandated to be equipped with AIS. Real-time AIS data are used for monitoring vessel traffic on waterways through interfaces such as the existing LOMA software package (Kress et al. 2020; USACE-ERDC 2017). Archived AIS information can be utilized to study a multitude of maritime topics including network connectivity (Kress et al. 2021; Young et al. 2022); port resilience (Touzinsky et al. 2018); waterway performance (Mitchell and Scully 2014); or specific incidents.

The Ohio River is historically a heavily trafficked waterway. In calendar year (CY) 2020, over 150 million tons of commercial tonnage utilized the Ohio River for transportation (USACE-WCSC, n.d.). The total tonnage for CY 2015–2020 for the entire Ohio River (the waterway as a whole) and selected ports of varying size on the river is shown in Table 1. In CY 2020, the largest commodity group that traveled on the Ohio River was "Crude Materials, Inedible Except Fuels" with over 49.7 million short tons, followed by "Coal, Lignite, and Coal Coke," which totaled over 49.3 million tons (USACE-WCSC, n.d.).

Table 1. Commercial tonnage for selected ports and waterway, calendar year (CY) 2015–2020.

Port or Waterway	CY 2020	CY 2019	CY 2018	CY 2017	CY 2016	CY 2015
Ohio River (WATERWAY)[a]	**151,672,665**	**177,040,032**	**178,499,627**	**180,648,735**	**183,057,793**	**151,672,665**
Pittsburgh, PA Port of (PORT)	15,536,051	21,777,395	21,567,015	26,022,535	22,467,462	15,536,051
Mid-Ohio Valley Port, OH and WV (PORT)	35,939,474	46,381,446	41,933,717	43,793,397	42,661,114	35,939,474
Cincinnati-Northern KY Ports of (PORT)	34,476,340	36,560,095	38,534,187	42,676,566	43,050,399	34,476,340
Louisville-Jefferson Port, KY (PORT)	8,069,320	11,151,576	11,260,416	12,304,379	11,516,427	8,069,320
Mount Vernon, IN (PORT)	5,938,469	9,344,185	10,332,103	9,118,896	7,713,026	5,938,469
Paducah-McCracken Riverport, KY (PORT)	5,004,903	3,018,053	1,813,468	1,374,375	2,232,327	5,004,903

Data source: USACE-WCSC, n.d.
Note: Tonnage statistics do not include passenger counts or fisheries landings.
[a] Section included: Pittsburgh, PA, to mouth of river, 981 mi; Maintained depth, 9 ft.

METHOD: This work compared existing LOMA sites with an approximate coverage radius of 18 km* (11.2 mi), to a list of 49 bridges across the Ohio River that could serve as possible LOMA

* For a full list of the spelled-out forms of the units of measure and unit conversions used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office 2016), 248–52 and 345–347, respectively. https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf.

installation sites. Figure 2, *panel A (top)*, shows the existing LOMA sites and approximate coverage radius for each site on the upper Ohio River, note the coverage gap around Cincinnati, Ohio. This coverage gap is of special interest given the curvature of the Ohio River as it passes by Cincinnati, Ohio, one of the major metropolitan areas located along the Ohio River. Figure 2, *panel B (bottom)*, shows the same information with the addition of potential bridge installation locations and the potentially improved coverage radius if a LOMA site were installed on each bridge.

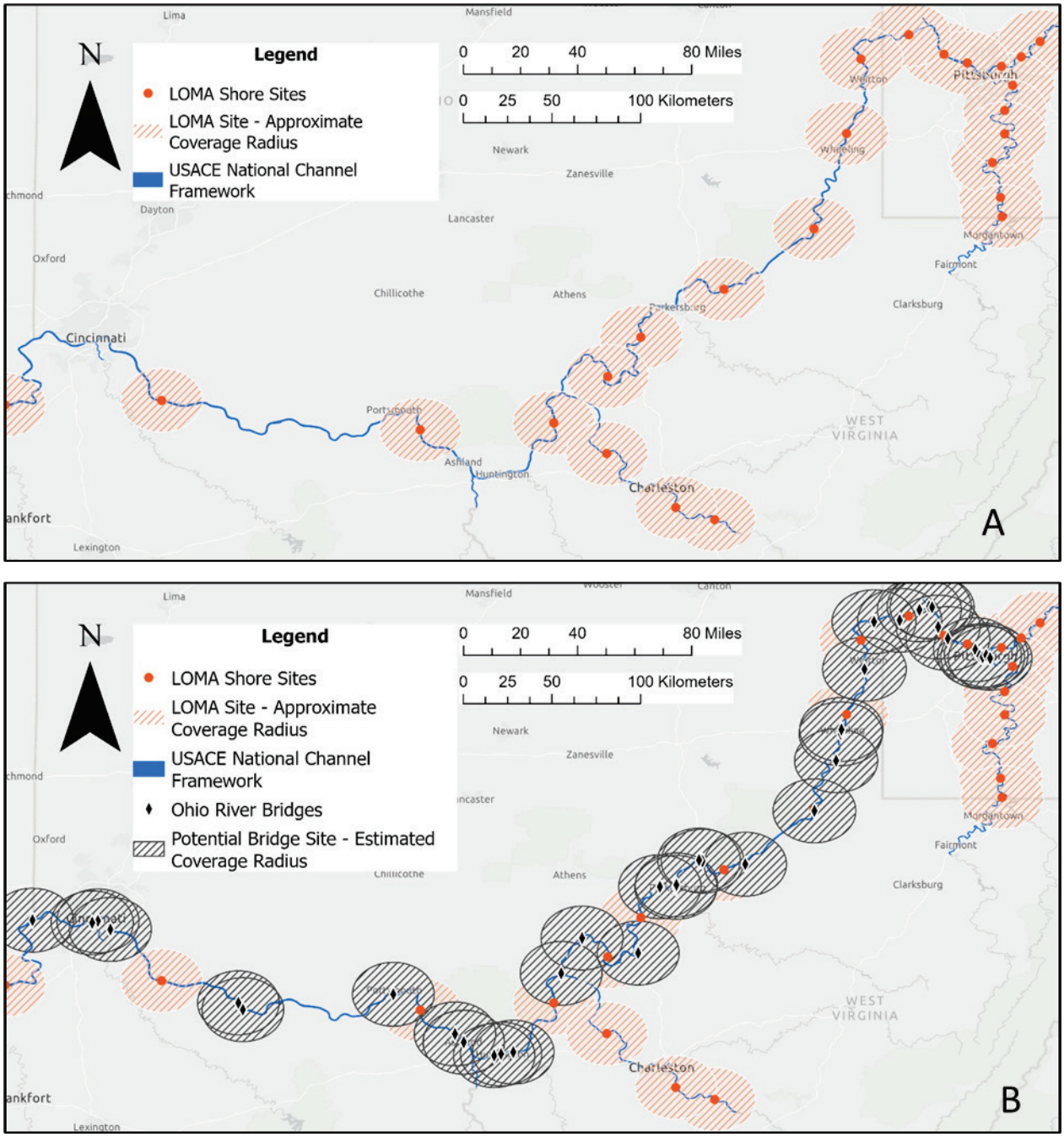

Figure 2. *Panel A (top)*, LOMA sites *(orange dots)* on the upper Ohio River with approximate coverage radius (18 km). *Panel B (bottom)*, same as *Panel A* with the addition of bridge sites (*black diamonds*) and their potential coverage radius *(black diagonal lines)*.

Figure 3, *panel A (top),* shows the existing LOMA sites and approximate coverage radius for each site on the lower Ohio River; note the multiple coverage gaps between lock sites. Figure 3, *panel B (bottom)*, shows the same information as *panel A*, with the addition of potential bridge installation locations and the potential improved coverage radius if a LOMA site were installed on select bridges.

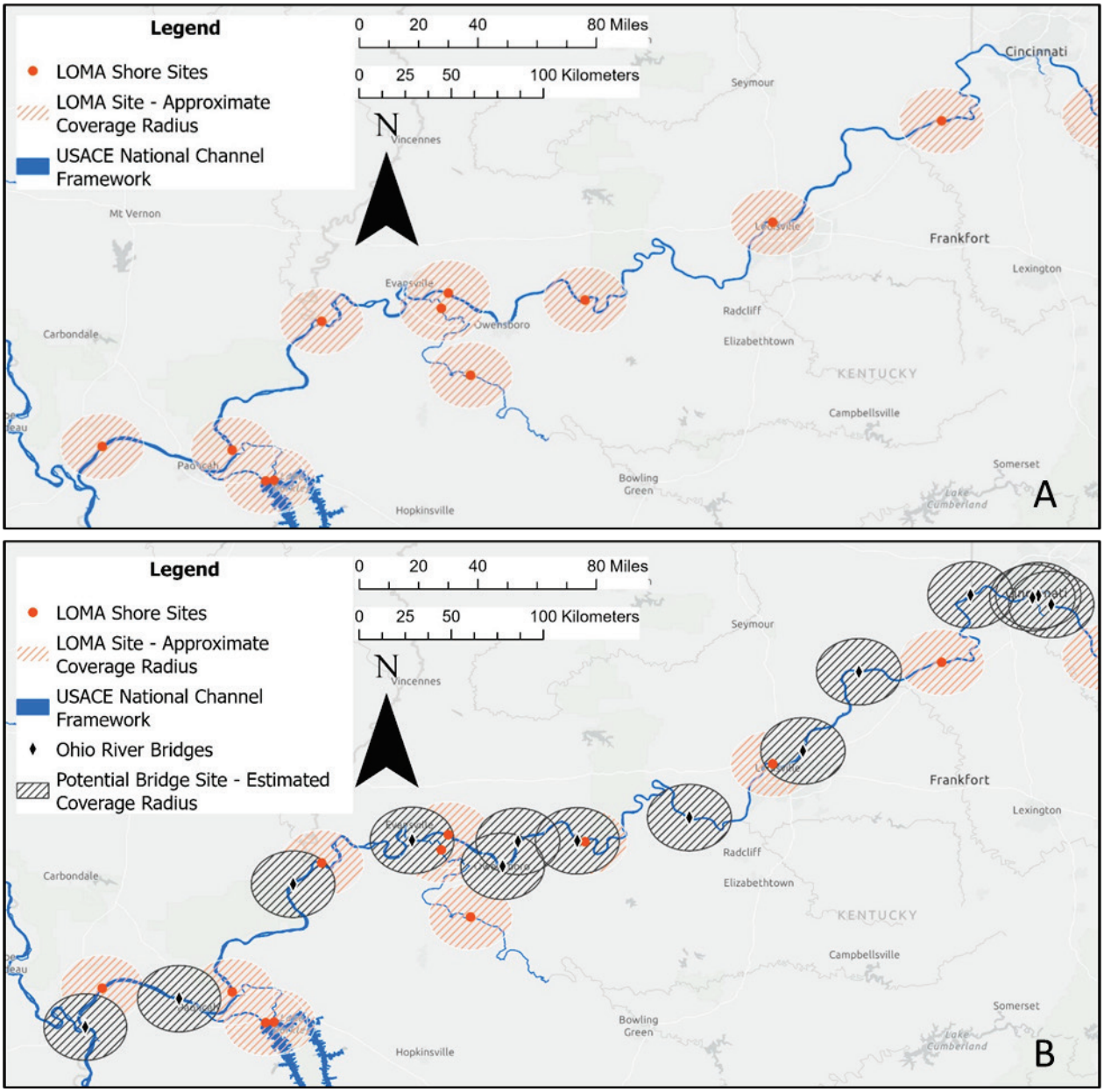

Figure 3. *Panel A (top)* LOMA sites (*orange dots*) on the lower Ohio River with approximate coverage radius (18 km). *Panel B (bottom)*, same as *panel A* with the addition of potential bridge sites *(black diamonds)* and their potential coverage radius *(black diagonal lines)*.

RESULTS: As shown in Figure 2 and Figure 3, there are multiple bridges crossing the Ohio River. Some of the coverage gaps between existing LOMA coverage areas contain bridges capable of supporting LOMA hardware. Figure 4 shows a total of 10 bridges in areas that currently lack LOMA coverage on the Ohio River and the expected coverage radius if a LOMA box were to be installed on those selected bridges. The same 10 example bridges (and others nearby) are listed in Table 2. This list does not constitute a solicitation for specific sites but is provided for example and discussion purposes only.

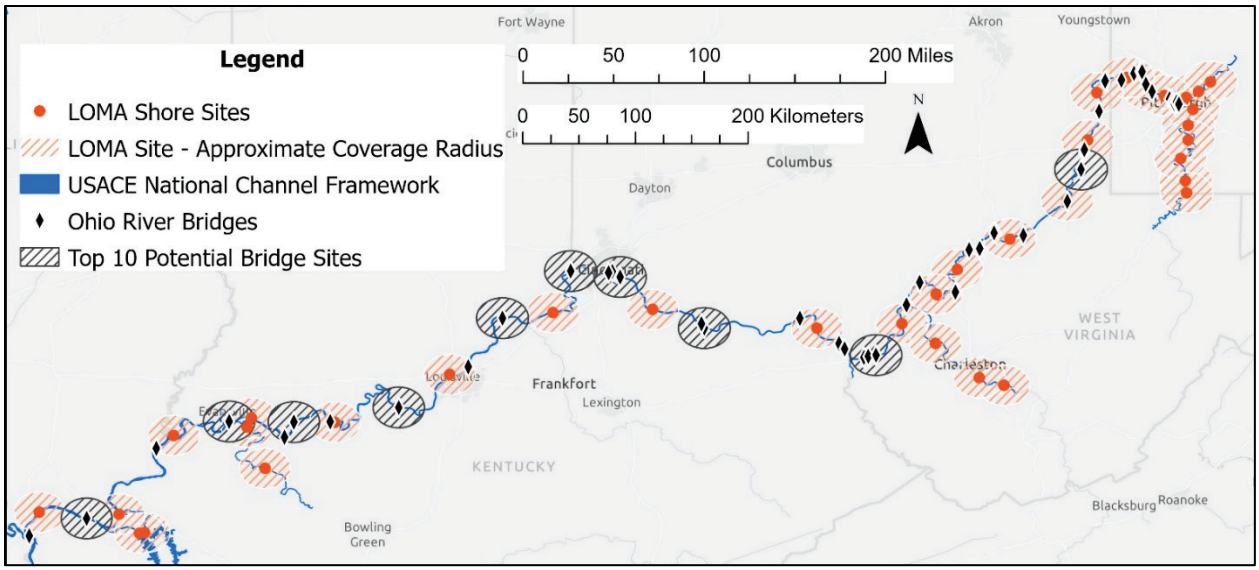

Figure 4. View of existing LOMA sites *(orange dots)* on the entire Ohio River with approximate coverage radius (18 km), along with 10 example bridge sites *(black diamonds)* and their estimated coverage radius (18 km).

Table 2. List of 10 bridge locations for consideration of LOMA hardware installation to improve Automatic Identification System (AIS) signal coverage along the Ohio River.

Ohio River Mile	Potential Bridge Name	Nearby Alternate Bridge(s)
102	Hwy 2	—
305	Hwy 7	Hwy 527, Hwy 52
408.5	Hwy 62	Hwy 68
462	I-275	I-471, I-71
492	I-275	—
557	Hwy 421	—
648	Hwy 79	—
756	Hwy 231	Hwy 161
787	Hwy 41	—
941	I-24	—

SUMMARY: Multiple bridges cross the Ohio River, providing potential capability for increased LOMA coverage. Bridges in general are desirable sites for AIS hardware installation due to their location high off the water's surface, allowing them to "see" both upriver and downriver. However, a variety of factors would need to be considered in assessing suitability for any given bridge, including the willingness of the bridge owner to participate and the accessibility of an installation location on the bridge itself.

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REFERENCES

DiJoseph, P. K., B. J. Tetreault, and M. M. Kress. 2021. *AIS Data Case Study: Identifying AIS Coverage Gaps on the Ohio River in CY 2018*. ERDC/CHL CHETN-IX-57. Vicksburg, MS: US Army Engineer Research and Development Center. *http://dx.doi.org/10.21079/11681/40886*.

IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities). 2008. *G1062 Establishment of AIS as an Aid to Navigation.* *https://www.iala-aism.org/product/establishment-of-ais-as-an-aid-to-navigation-1062/*.

IEC (International Electrotechnical Commission). 2018. *EC 61993-2: 2018 Maritime Navigation and Radiocommunication Equipment and Systems—Automatic Identification Systems (AIS)—Part 2: Class A Shipborne Equipment of the Automatic Identification System (AIS)—Operational and Performance Requirements, Methods of Test and Required Test Results.* *https://webstore.iec.ch/publication/34277*.

ITU-R (International Telecommunication Union-Radiocommunication Sector). 2014. *Technical Characteristics for an Automatic Identification System Using Time Division Multiple Access in the VHF Maritime Mobile Frequency Band*. Recommendation ITU-R M.1371-5. Geneva, Switzerland: International Telecommunication Union. *http://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.1371-5-201402-I!!PDF-E.pdf*.

Kress, M. M., B. J. Tetreault, K. N. Mitchell, M. Balazik, and M. C. Booton. 2020. *AIS Data: Real-Time Operation Support, Incident Investigations, and Waterway Use Analysis*. ERDC/CHL CHETN-IX-53. Vicksburg, MS: US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory. *http://dx.doi.org/ 10.21079/11681/36395*.

Kress, M. M., D. L. Young, K. F. Chambers, and B. M. Scully. 2021 *AIS Data Case Study: Quantifying Connectivity for Six Great Lakes Port Areas from 2015 through 2018*. ERDC/CHL CHETN-IX-56. Vicksburg, MS: US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory. *http://dx.doi.org/10.21079/11681/40720*.

Mitchell, K. N., and B. N. Scully. 2014. "Waterway Performance Monitoring via Automatic Identification System (AIS) Data." *Transportation Research Record: Journal of Transportation* 2426 (1): 20–26. *https://doi.org/10.3141/2426-03*.

Touzinsky, K. F., B. M. Scully, K. N. Mitchell, and M. M. Kress. 2018. "Using Empirical Data to Quantify Port Resilience: Hurricane Matthew and the Southeastern Seaboard." *Journal of Waterway, Port, Coastal, and Ocean Engineering* 144 (4): 05018003. *https://ascelibrary.org/doi/10.1061/%28ASCE%29WW.1943-5460.0000446*.

USACE-ERDC (US Army Corps of Engineers, US Army Engineer Research and Development Center). 2017. *Lock Operations Management Application (LOMA)*. *https://loma.usace.army.mil*. Requires login and is unavailable to the public.

USACE-WCSC (United States Army Corps of Engineers, Waterborne Commerce Statistics Center). n.d. "Ports and Waterways Page." Accessed 23 March 2023. *https://ndc.ops.usace.army.mil/wcsc/webpub/#/*.

US C.F.R. (US Code of Federal Regulations). 2020. *Navigation and Navigable Waters*, 33 C.F.R. § 164.46 "Automatic Identification System." *https://www.ecfr.gov/current/title-33/chapter-I/subchapter-P/part-164/section-164.46*.

USCG (United States Coast Guard). n.d. "Nationwide Automatic Identification System." Accessed 23 March 2023. *https://www.dcms.uscg.mil/Our-Organization/Assistant-Commandant-for-Acquisitions-CG-9/Programs/C4ISR-Programs/nais/*.

USCG-NAVCEN (United State Coast Guard, Navigation Center). n.d. "USCG AIS Encoding Guide v.25." Accessed 23 March 2023. *https://www.navcen.uscg.gov/sites/default/files/pdf/AIS/AISGuide.pdf*.

Young, D. L., M. M. Kress, K. F. Chambers, and B. M. Scully. 2022. "Analysis of the US Port Network Using AIS Data: Metrics for the Caribbean." In *16th Triennial International Conference. COPRI PORTS '22*, September 17–22, 2022, Honolulu, HI, 438–448. *https://www.researchgate.net/publication/363600535_Analysis_of_the_US_Port_Network_Using_AIS_Data_Metrics_for_the_Caribbean*.