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AIS Data Case Study: Identifying AIS Coverage Gaps on the Ohio River in CY2018

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PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) describes a method for evaluating the received coverage from Automatic Identification System (AIS) shore sites and the availability of historic vessel position reports along the Ohio River. The network of AIS shoreside sites installed and operated by the US Army Corps of Engineers (USACE) and the US Coast Guard (USCG) receive information transmitted from vessels; however, reception of these transmissions is generally line-of-sight between the vessel and the AIS site antenna. Reception may also be affected by factors such as the quality of the transceiver installation aboard the vessel as well as the state of the equipment at the receiving site. Understanding how to define and quantify coverage gaps along the inland river system can inform research utilizing AIS data, provide information on the performance of the AIS network, and provide guidance for efforts to address identified coverage gaps.

INTRODUCTION: The ability to access historical vessel position reports through the USCG Nationwide Automatic Identification System (NAIS) archive (USCG 2018) has expanded the tools available for commercial vessel waterway utilization studies (DiJoseph et al. 2019; Mitchell and Scully 2014; Scully and Mitchell 2015) and provided waterways managers with a valuable tool for understanding local navigation traffic and related dredging needs (Kress et al. 2020; Mitchell et al. 2020; Tabbert et al. 2020). AIS is also used for transmitting real-time electronic aids to navigation for navigational safety and security. Since 2016, AIS carriage requirements include most commercial self-propelled vessels on US navigable waters including any vessel over 65 ft[1,2] in length, towing vessels over 26 ft in length with a greater than 600 hp engine, vessels certified to carry 150 or more passengers, dredges in or near a commercial channel, and vessels moving certain dangerous cargo (USCG 2018; US Code of Regulations 2019).

In general, AIS messages are transmitted from vessels and received by both nearby vessels and shoreside AIS sites (shoreside AIS sites may also broadcast messages, but this paper focuses on vessel position reports as received by shoreside AIS sites). The messages received by shore AIS sites are routed to the USCG, where they are archived. AIS operates using the very high frequency (VHF) radio spectrum, operating on 161.975 MHz and 162.025 MHz. VHF transmissions are generally line-of-sight (i.e., the antenna of the transmitting site must have an unobstructed path to the receiving site's antenna). The transmission may be attenuated or blocked by the earth (radio horizon based on antenna

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

[2] For a full list of the unit conversions used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office 2016), 345-7, https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf.

heights, or terrain) or man-made structures. The signal may also be reduced by other factors, such as transmission power, equipment condition, and quality of installation. Therefore, not all AIS signals transmitted by vessels are received by shore AIS sites. AIS technical standards and history can be found online through international associations involved in setting technical standards (IALA 2008; IEC 2001; ITU-R 2014; PIANC 2019). Future studies are planned to measure how different factors affect AIS site reception rate.

Vessels transmit AIS position reports at different time intervals depending on their dynamic condition; the reporting intervals are shown in Table 1. Thus, for the purposes of understanding if sufficient data are available for historical analysis, one measure of AIS coverage is the ability to recreate a historic vessel trackline with fidelity at a specific time interval, such as a 5 min, 1 min, 30 s, or 10 s level (this is a different definition of *coverage* than may be used for other purposes, such as for waterway monitoring for safety or security).

Table 1. Class A shipborne mobile equipment reporting intervals.

Ship dynamic conditions	Nominal reporting interval
Ship at anchor or moored and not moving faster than 3 kn	3 min
Ship at anchor or moored and moving faster than 3 kn	10 s
Ship 0-14 kn	10 s
Ship 0-14 kn and changing course	$3^{1}/_{3}$ s
Ship 14-23 kn	6 s
Ship 14-23 kn and changing course	2 s
Ship >23 kn	2 s
Ship >23 kn and changing course	2 s

Source: ITU-R M.1371-5, 2014, page 8.

This study examined the availability of AIS data for the entirety of the Ohio River, from River Mile 0, located at the confluence of the Ohio, Allegheny, and Monongahela Rivers to River Mile 981, located at the confluence of the Ohio, Upper Mississippi, and Lower Mississippi Rivers, as shown in Figure 1. This is a heavily traveled portion of US inland waterways; in 2018, the Ohio River carried over 178 million short tons of commodities in the span from Pittsburgh, PA, to the confluence with the Mississippi River (WCSC 2021). Table 2 lists the AIS sites along the waterway installed and operated by both the USCG through the NAIS, and USACE through the Lock Operations Management Application (LOMA). NAIS has four sites along the Ohio River at Pittsburgh, PA; Huntington, WV; Louisville, KY; and Cincinnati, OH (Fort Thomas). USACE has multiple sites located at locks along the Ohio River and various tributaries. Figure 1 shows the locations of LOMA AIS sites, Ohio River navigation locks, and the Ohio River study area (dark blue). The terrain around the Ohio River is quite rolling, and the locks are located in river valleys where surrounding hills may interrupt AIS signal transmission. Because of the combination of terrain and distance between sites, there are coverage gaps between many of these sites.

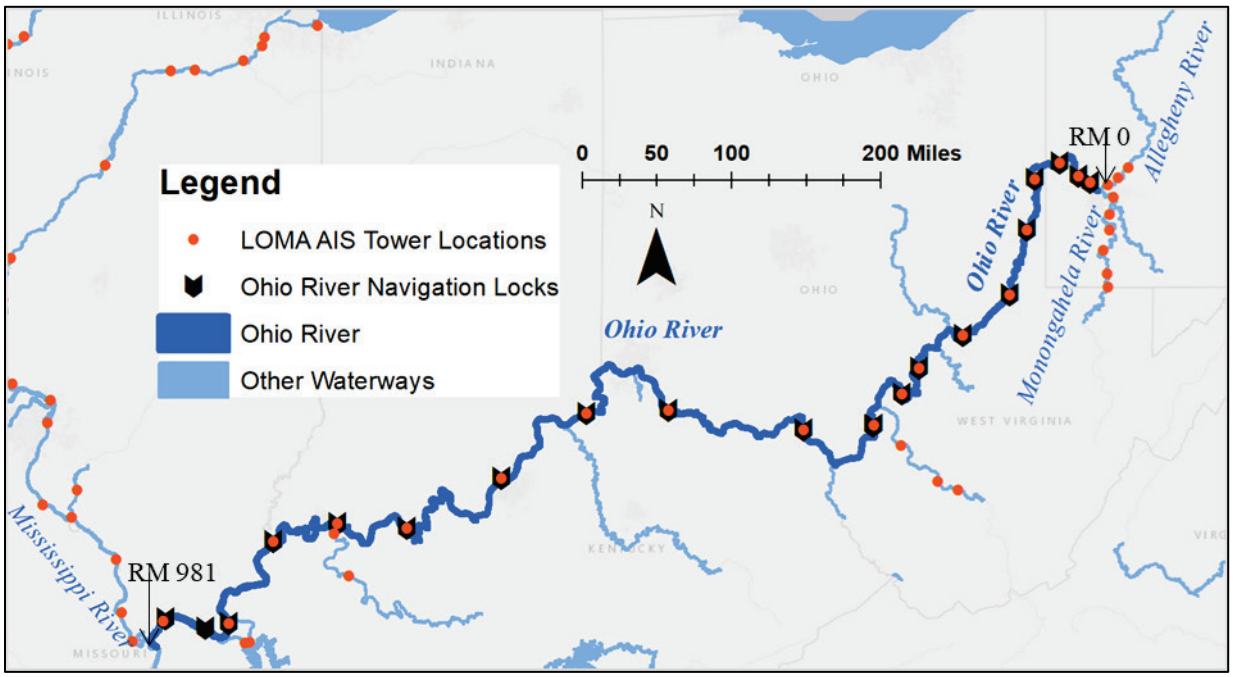

Figure 1. Map of Ohio River (dark blue), navigation locks (black arrows), and USACE LOMA AIS shoreside AIS sites (orange dots) along both the Ohio River and tributaries.

Table 2. AIS site locations providing coverage of the Ohio River (including sites on neighboring rivers that provide overlapping coverage to the Ohio). Sites are listed in the upstream direction from Cairo to Pittsburgh.

Site Name	Antenna Height above Ground (ft)	Latitude	Longitude	River	RM
Prices Landing	20	37.02594	-89.35644	Mississippi	29.5
Olmsted L&D**	75	37.1835883	-89.063833	Ohio	964.6
Barkley L&D	25	37.0192	-88.22498	Cumberland	30.6
Kentucky L&D	15	37.01527	-88.26543	Tennessee	22.4
Smithland L&D	40	37.166449	-88.428196	Ohio	918.5
John T. Myers L&D	50	37.7949	-87.99253	Ohio	846
Green River L&D 1	15	37.85919	-87.40863	Green and Barren	9.1
Newburgh L&D	15	37.9322316	-87.373916	Ohio	776.1
Cannelton L&D	25	37.89969	-86.70638	Ohio	720.7
McAlpine L&D	20	38.279045	-85.79124	Ohio	606.8
*Louisville	549	38.2549017	-85.757235	Ohio	604
Markland L&D	13	38.774345	-84.96612	Ohio	531.5
*Fort Thomas	120	39.0630556	-84.441389	Ohio	462.5
Meldahl L&D	15	38.79734	-84.17253	Ohio	436.2
Greenup L&D	35	38.64795	-82.86117	Ohio	341
*Huntington	172	38.3944444	-82.491389	Ohio	311.7

Robert C Byrd L&D	15	38.6827783	-82.184716	Ohio	279.2
Racine L&D	15	38.9183783	-81.911266	Ohio	237.5
Belleville L&D	20	39.11696	-81.74283	Ohio	203.9
Willow Island L&D	30	39.3602416	-81.321566	Ohio	161.7
Hannibal L&D	5	39.66525	-80.86585	Ohio	126.4
Pike Island L&D	25	40.1480183	-80.701333	Ohio	84.2
New Cumberland L&D	25	40.5258133	-80.62815	Ohio	54.4
Montgomery L&D	30	40.647975	-80.385266	Ohio	31.7
Dashields L&D	25	40.54882	-80.20663	Ohio	13.3
Emsworth L&D	25	40.505	-80.08853	Ohio	6.2
*Pittsburgh	460	40.4719444	-79.994444	Ohio	0

*USCG NAIS site; all other sites USACE LOMA sites.
** L&D = lock and dam

METHOD: The USACE eHydro program National Channel Framework (NCF) has divided the Ohio River into geospatially referenced polygons, known as reaches (USACE-eHydro 2020). The reaches are defined from bank to bank and are continuous for the length of the Ohio River. NCF reaches along inland waterways are generally, but not always, 1 mi in length. This project developed a method for identifying which NCF reaches contain AIS position reports from the NAIS, including reaches with no coverage or partial coverage. AIS data were accessed via the USACE Automatic Identification System Analysis Package (AISAP) software (USACE-ERDC 2018). AISAP enables users to query AIS data from the USCG NAIS at different spatial-temporal scales and data sampling rates. This study requested data from calendar year 2018 for the Ohio River at a 5 min sampling rate interval. The returned AIS position reports were plotted in relation to the NCF reaches that make up the Ohio River using the ArcMap 10.7.1 software program (ESRI 2019). The number of position reports per reach was the output. The count of AIS position report points was normalized by dividing the number of points per reach by the reach's length, resulting in the metric position reports per reach per mile.

Vessel transit counts were acquired from the USACE Lock Performance Monitoring System (LPMS) records (USACE-IWR 2020). These counts were used to determine the minimum number of AIS points per reach expected during 2018. LPMS data are recorded by USACE personnel at lock sites, and each record includes the time of lock transit and vessel identity. Thus, LPMS data can be used to ground truth AIS data and any transit counts derived from AIS data. Recreational vessel lockages were excluded from LPMS records because the authors assumed they did not have AIS transmit capability. Records from neighboring locks were compared to determine each instance when a vessel passed from one lock to the next. This would count as one transit between the locks, and thus, AIS records — if complete — should show the presence of that vessel in any NCF reach located between those locks. This process was repeated for all neighboring locks, for all records, to determine the minimum number of transits per reach. For reaches that did not fall between two locks, which were reaches upstream of Emsworth Lock & Dam and also reaches downstream of the Olmstead Locks and Dam, the number of transits per lock for the nearest lock was used as a proxy for the minimum expected transit count.

To translate the number of transits to the expected number of AIS data points, some assumptions about vessel speed were made. AIS position reports include speed over ground; the fastest vessel speed recorded in the 2018 data was 8 kn. At 8 kn, a vessel can travel 0.77 mi in 5 min.

Therefore, it was assumed that a 5 min AIS data sampling rate, at least one AIS data point per mile per transit should be returned. Even for a vessel traveling at 10 kn, a data point should be received once every 5 min per mile as a vessel can travel 0.96 mi in 5 min. If a vessel were traveling 5 kn or slower, than there should have been more than one data point per mile. This speed assumption contributes to the possibility of *false positives* for coverage because any vessel traveling under 5 kn would contribute more AIS position reports per reach than expected. However, with this method, if a reach is showing as having less than 100% coverage, it is a *true negative* in terms of not having historical AIS position reports recorded for that reach.

RESULTS: The analysis was conducted for the 530 NCF reaches that make up the 981 river miles of the Ohio River. The results shown in Table 3, indicate that 32 reaches have no coverage (0% of the expected position reports are recorded for the corresponding NCF reach, highlighted in red), 98 reaches have low coverage (1%–25% of expected position reports, highlighted in orange), 37 reaches have limited coverage (25%–50% of expected position reports, highlighted in yellow; 51%–75% of expected position reports, highlighted in light green), and 363 reaches have good coverage (76%–100% of expected position reports, highlighted in dark green). Within the table, reaches are listed from farthest upstream reach (CELRP_OH_LP_EMS_1), starting at Ohio River Mile 0, to farthest downstream reach (CELRL_OH_LD_CAI_1), ending at Ohio River Mile 981, with the corresponding river mile boundaries for each reach. In Table 3 (pages 5, 6, 7, 8), when more than two consecutive reaches have 100% coverage, only the most upstream and downstream reaches with 100% coverage are listed; reaches in between are replaced by a row containing only ellipsis (…).

Table 3. AIS coverage rate by Ohio River reach, 2018.

Reach ID, USACE National Channel Framework	Up-stream River Mile	Down-stream River Mile	AIS Cover-age Rate (%)
CELRP_OH_LP_EMS_1	0	1	100
…			
CELRP_OH_LP_NC2_3	42	43	100
CELRP_OH_LP_NC2_4	43	44	52
CELRP_OH_LP_NC2_5	44	45	100
…			
CELRP_OH_LP_PIK_10	63	64	100
CELRP_OH_LP_PIK_11	64	65	4
CELRP_OH_LP_PIK_12	65	66	1
CELRP_OH_LP_PIK_13	66	67	0
CELRP_OH_LP_PIK_14	67	68	6
CELRP_OH_LP_PIK_15	68	69	49
CELRP_OH_LP_PIK_16	69	70	100
…			
CELRP_OH_LP_HAN_19	102	103	100
CELRP_OH_LP_HAN_20	103	104	1
CELRP_OH_LP_HAN_21	104	105	0
CELRP_OH_LP_HAN_22	105	106	1
CELRP_OH_LP_HAN_23	106	107	0

Reach ID, USACE National Channel Framework	Up-stream River Mile	Down-stream River Mile	AIS Cover-age Rate (%)
CELRH_OH_HD_RAO_19	220	221	3
CELRH_OH_HD_RAO_18	221	222	11
CELRH_OH_HD_RAO_17	222	223	1
CELRH_OH_HD_RAO_16	223	224	5
CELRH_OH_HD_RAO_15	224	225	1
CELRH_OH_HD_RAO_14	225	226	4
CELRH_OH_HD_RAO_13	226	227	22
CELRH_OH_HD_RAO_12	227	228	12
CELRH_OH_HD_RAO_11	228	229	3
CELRH_OH_HD_RAO_10	229	230	81
CELRH_OH_HD_RAO_9	230	231	29
CELRH_OH_HD_RAO_9	230	231	29
CELRH_OH_HD_RAO_8	231	232	100
…			
CELRH_OH_HD_RCB_37	243	244	100
CELRH_OH_HD_RCB_36	244	245	7
CELRH_OH_HD_RCB_35	245	246	2
CELRH_OH_HD_RCB_34	246	247	2
CELRH_OH_HD_RCB_33	247	248	14

Table 3. AIS coverage rate by Ohio River reach, 2018.

Reach ID, USACE National Channel Framework	Up-stream River Mile	Down-stream River Mile	AIS Cover-age Rate (%)
CELRP_OH_LP_HAN_24	107	108	0
CELRP_OH_LP_HAN_25	108	109	0
CELRP_OH_LP_HAN_26	109	110	0
CELRP_OH_LP_HAN_27	110	111	18
CELRP_OH_LP_HAN_28	111	112	4
CELRP_OH_LP_HAN_29	112	113	4
CELRP_OH_LP_HAN_30	113	114	1
CELRP_OH_LP_HAN_31	114	115	0
CELRP_OH_LP_HAN_32	115	116	1
CELRP_OH_LP_HAN_33	116	117	66
CELRP_OH_LP_HAN_34	117	118	100
…			
CELRH_OH_HD_WIO_30	133	134	100
CELRH_OH_HD_WIO_29	134	135	0
CELRH_OH_HD_WIO_29	134	135	0
CELRH_OH_HD_WIO_28	135	136	81
CELRH_OH_HD_WIO_27	136	137	88
CELRH_OH_HD_WIO_26	137	138	48
CELRH_OH_HD_WIO_25	138	139	29
CELRH_OH_HD_WIO_24	139	140	22
CELRH_OH_HD_WIO_23	140	141	7
CELRH_OH_HD_WIO_22	141	142	4
CELRH_OH_HD_WIO_21	142	143	1
CELRH_OH_HD_WIO_20	143	144	1
CELRH_OH_HD_WIO_19	144	145	0
CELRH_OH_HD_WIO_18	145	146	0
CELRH_OH_HD_WIO_17	146	147	0
CELRH_OH_HD_WIO_16	147	148	1
CELRH_OH_HD_WIO_15	148	149	0
CELRH_OH_HD_WIO_14	149	150	0
CELRH_OH_HD_WIO_13	150	151	1
CELRH_OH_HD_WIO_12	151	152	0
CELRH_OH_HD_WIO_11	152	153	1
CELRH_OH_HD_WIO_10	153	154	0
CELRH_OH_HD_WIO_10	153	154	0
CELRH_OH_HD_WIO_9	154	155	0
CELRH_OH_HD_WIO_9	154	155	0
CELRH_OH_HD_WIO_8	155	156	1
CELRH_OH_HD_WIO_7	156	157	12

Reach ID, USACE National Channel Framework	Up-stream River Mile	Down-stream River Mile	AIS Cover-age Rate (%)
CELRH_OH_HD_RCB_32	248	249	12
CELRH_OH_HD_RCB_31	249	250	28
CELRH_OH_HD_RCB_30	250	251	61
CELRH_OH_HD_RCB_29	251	252	100
CELRH_OH_HD_RCB_28	252	253	48
CELRH_OH_HD_RCB_27	253	254	27
CELRH_OH_HD_RCB_26	254	255	100
…			
CELRH_OH_HD_CAM_80	358	359	100
CELRH_OH_HD_CAM_79	359	360	39
CELRH_OH_HD_CAM_78	360	361	76
CELRH_OH_HD_CAM_77	361	362	37
CELRH_OH_HD_CAM_76	362	363	95
CELRH_OH_HD_CAM_75	363	364	76
CELRH_OH_HD_CAM_74	364	365	74
CELRH_OH_HD_CAM_72	365	367	12
CELRH_OH_HD_CAM_73	365	366	64
CELRH_OH_HD_CAM_71	367	368	48
CELRH_OH_HD_CAM_70	368	369	55
CELRH_OH_HD_CAM_69	369	370	100
…			
CELRH_OH_HD_CAM_66	372	373	100
CELRH_OH_HD_CAM_65	373	374	89
CELRH_OH_HD_CAM_64	374	375	29
CELRH_OH_HD_CAM_63	375	376	13
CELRH_OH_HD_CAM_62	376	377	11
CELRH_OH_HD_CAM_61	377	378	28
CELRH_OH_HD_CAM_60	378	379	11
CELRH_OH_HD_CAM_59	379	380	15
CELRH_OH_HD_CAM_58	380	381	25
CELRH_OH_HD_CAM_57	381	382	26
CELRH_OH_HD_CAM_56	382	383	16
CELRH_OH_HD_CAM_55	383	384	22
CELRH_OH_HD_CAM_54	384	385	38
CELRH_OH_HD_CAM_53	385	386	50
CELRH_OH_HD_CAM_52	386	387	36
CELRH_OH_HD_CAM_51	387	388	36
CELRH_OH_HD_CAM_50	388	389	54
CELRH_OH_HD_CAM_49	389	390	27

Table 3. AIS coverage rate by Ohio River reach, 2018.

Reach ID, USACE National Channel Framework	Up-stream River Mile	Down-stream River Mile	AIS Cover-age Rate (%)
CELRH_OH_HD_WIO_6	157	158	100
…			
CELRH_OH_HD_BEL_40	165	166	100
CELRH_OH_HD_BEL_39	166	167	3
CELRH_OH_HD_BEL_38	167	168	0
CELRH_OH_HD_BEL_37	168	169	0
CELRH_OH_HD_BEL_36	169	170	0
CELRH_OH_HD_BEL_36	169	170	0
CELRH_OH_HD_BEL_35	170	171	0
CELRH_OH_HD_BEL_35	170	171	0
CELRH_OH_HD_BEL_34	171	172	1
CELRH_OH_HD_BEL_33	172	173	6
CELRH_OH_HD_BEL_32	173	174	10
CELRH_OH_HD_BEL_31	174	175	7
CELRH_OH_HD_BEL_30	175	176	3
CELRH_OH_HD_BEL_29	176	177	0
CELRH_OH_HD_BEL_29	176	177	0
CELRH_OH_HD_BEL_28	177	178	6
CELRH_OH_HD_BEL_27	178	179	32
CELRH_OH_HD_BEL_26	179	180	1
CELRH_OH_HD_BEL_25	180	181	2
CELRH_OH_HD_BEL_24	181	182	1
CELRH_OH_HD_BEL_23	182	183	1
CELRH_OH_HD_BEL_22	183	184	1
CELRH_OH_HD_BEL_21	184	185	2
CELRH_OH_HD_BEL_20	185	186	1
CELRH_OH_HD_BEL_19	186	187	1
CELRH_OH_HD_BEL_18	187	188	0
CELRH_OH_HD_BEL_18	187	188	0
CELRH_OH_HD_BEL_17	188	189	0
CELRH_OH_HD_BEL_17	188	189	0
CELRH_OH_HD_BEL_16	189	190	7
CELRH_OH_HD_BEL_15	190	191	5
CELRH_OH_HD_BEL_14	191	192	5
CELRH_OH_HD_BEL_13	192	193	1
CELRH_OH_HD_BEL_12	193	194	2
CELRH_OH_HD_BEL_11	194	195	2
CELRH_OH_HD_BEL_10	195	196	1
CELRH_OH_HD_BEL_9	196	197	13

Reach ID, USACE National Channel Framework	Up-stream River Mile	Down-stream River Mile	AIS Cover-age Rate (%)
CELRH_OH_HD_CAM_48	390	391	21
CELRH_OH_HD_CAM_47	391	392	38
CELRH_OH_HD_CAM_46	392	393	25
CELRH_OH_HD_CAM_45	393	394	14
CELRH_OH_HD_CAM_44	394	395	4
CELRH_OH_HD_CAM_43	395	396	2
CELRH_OH_HD_CAM_42	396	397	2
CELRH_OH_HD_CAM_41	397	398	1
CELRH_OH_HD_CAM_40	398	399	2
CELRH_OH_HD_CAM_39	399	400	1
CELRH_OH_HD_CAM_38	400	401	1
CELRH_OH_HD_CAM_37	401	402	1
CELRH_OH_HD_CAM_36	402	403	38
CELRH_OH_HD_CAM_35	403	404	100
…			
CELRH_OH_HD_CAM_33	405	406	100
CELRH_OH_HD_CAM_32	406	407	39
CELRH_OH_HD_CAM_31	407	408	21
CELRH_OH_HD_CAM_30	408	409	17
CELRH_OH_HD_CAM_29	409	410	3
CELRH_OH_HD_CAM_28	410	411	2
CELRH_OH_HD_CAM_27	411	412	26
CELRH_OH_HD_CAM_26	412	413	100
…			
CELRH_OH_HD_CAM_24	414	415	100
CELRH_OH_HD_CAM_23	415	416	5
CELRH_OH_HD_CAM_22	416	417	16
CELRH_OH_HD_CAM_21	417	418	100
…			
CELRL_OH_LD_MCA_6	540	544	100
CELRL_OH_LD_MCA_5	544	556	38
CELRL_OH_LD_MCA_4	556	565	100
…			
CELRL_OH_LD_CAN_7	625	639	100
CELRL_OH_LD_CAN_6	639	659	4
CELRL_OH_LD_CAN_5	659	664	4
CELRL_OH_LD_CAN_4	664	680	11
CELRL_OH_LD_CAN_3	680	700	23
CELRL_OH_LD_CAN_2	700	720	100

Table 3. AIS coverage rate by Ohio River reach, 2018.

Reach ID, USACE National Channel Framework	Up-stream River Mile	Down-stream River Mile	AIS Cover-age Rate (%)	Reach ID, USACE National Channel Framework	Up-stream River Mile	Down-stream River Mile	AIS Cover-age Rate (%)
CELRH_OH_HD_BEL_8	197	198	97	…			
CELRH_OH_HD_BEL_7	198	199	79	CELRL_OH_LD_NBG_10	731	733	100
CELRH_OH_HD_BEL_6	199	200	100	CELRL_OH_LD_NBG_9	733	738.5	32
…				CELRL_OH_LD_NBG_8	738.5	741.2	67
CELRH_OH_HD_RAO_31	208	209	100	CELRL_OH_LD_NBG_7	741.2	745	100
CELRH_OH_HD_RAO_30	209	210	59	…			
CELRH_OH_HD_RAO_29	210	211	0	CELRL_OH_LD_SMT_11	862	865	100
CELRH_OH_HD_RAO_28	211	212	1	CELRL_OH_LD_SMT_10	865	868.6	60
CELRH_OH_HD_RAO_27	212	213	44	CELRL_OH_LD_SMT_9	868.6	872.8	17
CELRH_OH_HD_RAO_26	213	214	95	CELRL_OH_LD_SMT_8	872.8	877.1	3
CELRH_OH_HD_RAO_25	214	215	8	CELRL_OH_LD_SMT_7	877.1	884	2
CELRH_OH_HD_RAO_24	215	216	16	CELRL_OH_LD_SMT_6	884	891	5
CELRH_OH_HD_RAO_23	216	217	10	CELRL_OH_LD_SMT_5	891	898	7
CELRH_OH_HD_RAO_22	217	218	23	CELRL_OH_LD_SMT_4	898	903	100
CELRH_OH_HD_RAO_21	218	219	12	…			
CELRH_OH_HD_RAO_20	219	220	3	CELRL_OH_LD_CAI_1	979.5	981	100

The presence or absence of AIS signals within an NCF reach appears dependent upon the terrain, rather than a predictable distance from an AIS site. Figure 2, below, shows a map of expected vs. received position reports for the reaches covering River Miles 0 to 74. Figure 2 shows that from River Mile 0 through 64, there is good coverage, but then coverage declines across River Miles 65 through 69, which corresponds to a sharp bend in the river valley.

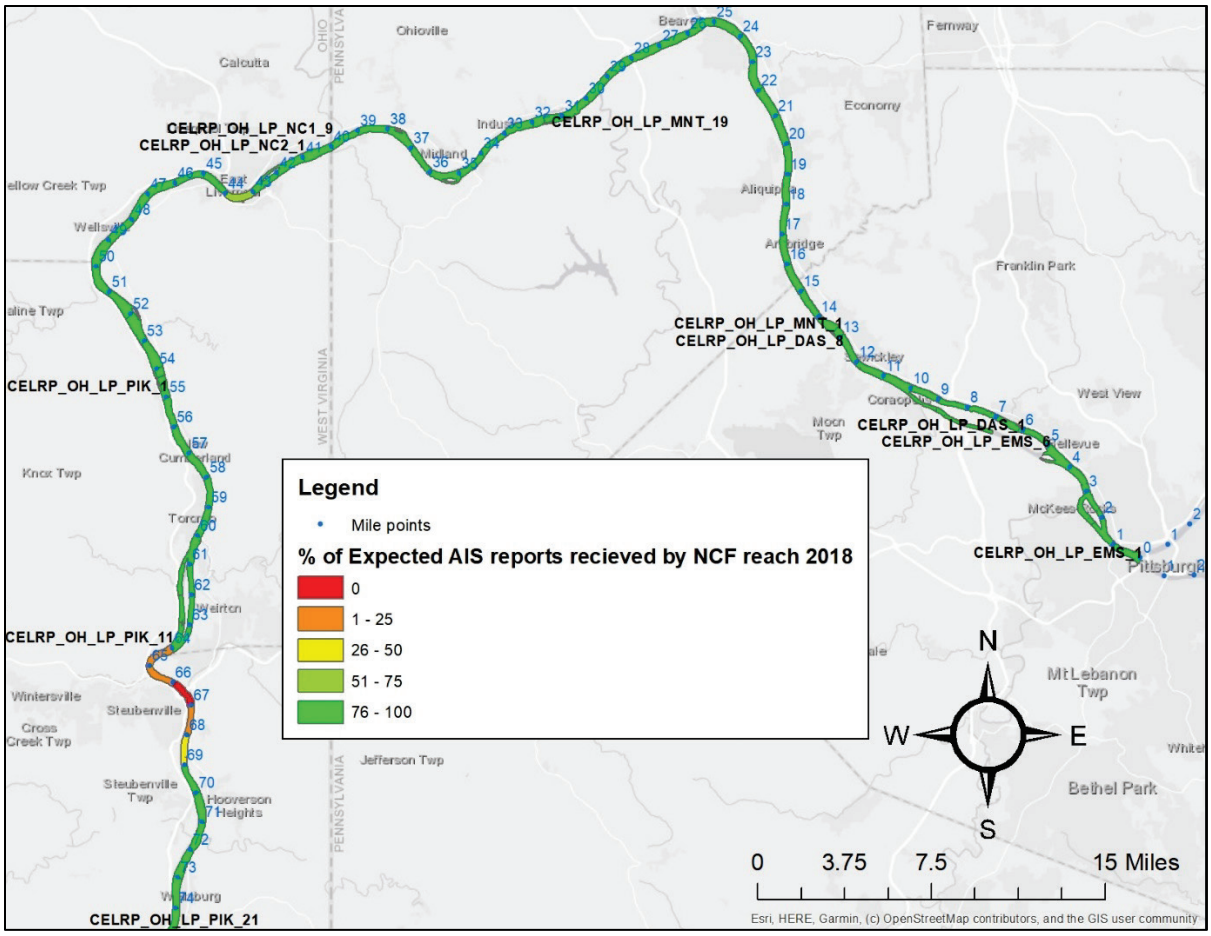

Figure 2. Map of expected vs. received AIS position reports for reaches covering Ohio River Miles 0 to 74 in year 2018.

One drawback to this method is the possibility of false positives, where a reach may appear to have full spatial coverage along its entire length when in fact it does not. Despite this limitation, the method described here identifies reaches that have no coverage and are thus potential candidates for improving coverage. There are several ways to fill coverage gaps, including improving existing sites, installing new sites, using repeaters, and possibly purchasing data from a commercial source. Users of historic Ohio River AIS data should be alerted to the presence of these data gaps, which may limit the scope of other waterway investigations. Future work in the area of AIS coverage analysis may include the following approaches: removing AIS reports with zero speed to look at only moving vessels; examining years beyond 2018; utilizing a different sampling rate; or developing measures that better reveal the extent of partial coverage. In addition, the coverage analysis can be correlated to characteristics of the surrounding area and closest AIS site locations to determine any dependencies, such as with antenna height, AIS site features, distance to nearest site, and topography. Finally, this method can be applied to additional navigable rivers to expand the sample size and also to inform waterway stakeholders.

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