Evaluation of Downstream Migration of Silver American Eel in the Susquehanna River Basin

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PROJECT SUMMARY

The U.S. Fish and Wildlife Service (USFWS), in partnership with hydroelectric dam operators, initiated a four-year study of downstream silver eel migration following a consistent trap and transport effort (2008-present) translocating American Eel (*Anguilla rostrata*) upstream of four major hydroelectric dams in the lower Susquehanna River. The purpose of this project was to estimate the timing and duration of downstream eel migration, determine the environmental variables associated with migration events, calculate cumulative survival of eels during passage through the lower Susquehanna River, and describe the impacts of hydroelectric operations on downstream eel passage.

From 2021 to 2023, the USFWS collected eels via electrofishing and implanted acoustic tags in 217 mature American Eels upstream of York Haven Dam. Staff collected most eels from Conodoguinet Creek and the Juniata River, however, collections in Buffalo Creek, Yellow Breeches Creek, Tuscarora Creek, and the Susquehanna River main stem yielded additional eels. USFWS also collected biological information from 1,406 eels not selected for tagging during the study. USFWS and hydroelectric dam owners deployed a series of nine acoustic receiver arrays to monitor the out-migration of tagged eels. The strategically located acoustic receiver arrays documented the arrival and departure of eels from various sections of the river and provided insight into the onset of migration, eel survival, potential migratory delays at hydroelectric projects, and overall escapement rates to the Chesapeake Bay.

As of 31 December 2024, 153 eels initiated downstream migration with 9 in 2021, 47 in 2022, 87 in 2023, and 10 in 2024. On average, the acoustic receiver arrays had a 95% detection rate for migrating eels (range 66-100%). Eel migration past arrays was documented from July until April, however, 99% of migration events occurred between 1 August and 31 December.

Migration peaked in November with 59% of array passage events. The migration season lasted 183 days in 2021, 275 days in 2022, 142 days in 2023 and 129 days in 2024. Fewer eels available for migration in 2021 and 2024 may have influenced the duration of the observed migration season in those years.

Eels that made the complete migration from Harrisburg to Havre de Grace (112.8 rkm), averaged 34 days (median 22 days) with a range of 1.8 to 218 days. Speed of migration ranged from 0.52 rkm/day to 61.1 rkm/day. Eels migrated at a similar speed in river sections that contained a dam compared to those sections that did not contain a dam, suggesting dams did not significantly delay migration. In river sections that contained a dam, speed averaged 1.8 rkm/hr (95% CI 1.6-2.0 rkm/hr) compared to an average of 2.0 rkm/hr (95% CI 1.78-2.21 rkm/hr) in river sections that did not contain a dam. During the study, a total of 63 of 153 tagged American Eels successfully out-migrated from the Susquehanna River. Cumulative survival varied significantly between migration years, with higher survival in 2022 (44%, 95% CI 33-54%) than in 2023 (35%, 95% CI 26-44%). In all years combined, 98% (95% CI 91-100%) of eels survived passage through river sections that did not contain a dam. Survival in river sections that contained a dam ranged from 60% to 100%.

The likelihood of downstream migration past arrays increased with lower water temperature and higher river discharges. In 2022, a high discharge event in November triggered a large migration of eels. However, eel migrations in 2021, 2023, and 2024 were more dispersed and over a wide range of discharge conditions and temperatures. Lunar phase and turbidity were not significantly associated with downstream migration events.

This study was not designed to evaluate route of passage at each hydroelectric dam, through eels could pass downstream of the dams through the project turbines, by spill, and

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potentially through a downstream sluice at York Haven Dam. The York Haven Dam has the lowest hydraulic capacity, and more than half the project flow was spilled over the dam during most of the downstream passage events and apparent project survival at this project met or exceeded 90%. The Safe Harbor Dam has the highest hydraulic capacity, and nearly all the downstream passage events occurred through the project turbines due to lack of spill during eel migration periods. Apparent survival at Safe Harbor Dam ranged from 60% to 79%. Spill occurred at Holtwood Dam during the migration period for three-quarters of the eels passing that dam and apparent survival at that project ranged from 94% to 100%. Operations could not be determined for most eels that passed the Muddy Run Pumped Storage Facility due to the transition daily between pumping, idle, and generation modes and apparent survival ranged from 66% to 100%. All eels passing the Conowingo Dam did so through the project turbines due to lack of project spill during the tagged eel migration periods and apparent survival ranged from 83% to 94%. This study did not account for latent mortality, injury, or tag loss which could have influenced apparent survival rates at any of the individual dams.

Information gained from this project combined with completed and future site-specific studies will inform future mitigation strategies to increase eel escapement from the Susquehanna River.

INTRODUCTION

History and stocking

Historically, American Eels (*Anguilla rostrata*) occupied the majority of the Susquehanna River Basin, supporting commercial fisheries in Pennsylvania and New York (Dittman et al., 2010; Pennsylvania State Commissioners of Fisheries, 1883). In the early 1900s, the construction of four major hydroelectric dams in the lower Susquehanna River Basin eliminated access to most of the American Eels' historic habitat. In 1928, construction of Conowingo Dam, the first barrier blocking upriver immigration, restricted eel migration to the lowermost 16 kilometers of the river. Stocking efforts translocated 17.2 million eels into various locations of the Susquehanna River Watershed from 1936-1980 (SRAFRC, 2013). In the early 2000s, fisheries surveys conducted by the Pennsylvania Fish and Boat Commission (PFBC) documented few to no American Eel in the Susquehanna River Basin. Dam blockages preventing the upstream migration of juvenile eels, discontinuation of eel translocations, and maturation and downstream migration of previously relocated eels to their spawning grounds in the Sargasso Sea largely contributed to the absence of eels in most of the basin. In 2008, the USFWS initiated a trap and transport program to reestablish eels in upstream portions of the Susquehanna River Basin. Constellation Energy has maintained this program since 2016. The trap and transport program has stocked nearly 3 million elvers from 2008 – 2024 (Table 1). Eels have been stocked primarily in the basin upstream of the hydroelectric dams in the lower basin.

Ecological role

The absence of natural American Eel migration in the Susquehanna River Basin has deprived the river of vital ecosystem services and eliminated a once thriving fishery. American

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Eels are a dominant freshwater predator and exert top-down control on a variety of other species due to their size and long residency times (Lookabaugh and Angermeier, 1992; Ogden, 1970; Stranko et al., 2014). Additionally, elver and yellow life stage eels are important forage fish for other species (Facey and Van Den Avyle, 1987; Walter and Austin, 2003). American Eels are a primary host for Eastern elliptio (*Elliptio complanata*) larvae, a Unionid mussel that is abundant in many Atlantic slope drainages (Lellis et al., 2013). Prior to the re-initiation of the American Eel stocking program in 2008, Eastern elliptio populations were biased towards older individuals and were notably sparse throughout the Susquehanna River Basin (Blakeslee et al., 2018; Galbraith et al., 2018). Galbraith et al. (2018) demonstrated the reintroduction of American Eel to a Susquehanna River tributary substantially increased recruitment of juvenile Eastern elliptio. Water quality in the Susquehanna River could indirectly benefit from the restoration of the American Eels given the considerable filtration capacity of healthy elliptio populations (Galbraith et al, 2018; Kreeger et al., 2018).

Anthropogenic impacts on migration

Little information is available regarding the timing and duration of American Eel out-migration, survival of downstream migrants, or the environmental factors that influence migratory behavior within the Susquehanna River. Dams present significant challenges to downstream migration through interactions with turbine blades and dam spill infrastructure. Eels navigating through turbines may be subject to blade or guide vane strikes, barotrauma, and disorientation (Larinier, 2001). The elongate morphology of the American Eel increases the occurrence of hydroelectric turbine injuries. Most dam-related eel injuries and mortalities are likely caused by direct contact with turbines (Plugrath et al., 2021). Mortality rates of eels

passing through hydropower structures can reach 100% but vary widely based on turbine type (Carr and Whoriskey, 2008; Dainys et al., 2018; Debowski et al., 2016; Larinier, 2001). Eels navigating over the dam crest during spill conditions may experience shearing forces, abrasion, blunt force trauma against spill surfaces, and rapid velocity and pressure changes in the dam tailrace (Larinier, 2001). Additionally, disorientation of eels passing dams may result in indirect mortality by increasing their susceptibility to predation (Larinier, 2001).

American Eels migrating downstream in the lower Susquehanna River must navigate past four large hydroelectric dams and the Muddy Run Pumped Storage Facility. Research conducted in 2011 using out-of-basin eels has provided some information about eel survival at the Muddy Run Pumped Storage Facility and Conowingo Dam (Normandeau Associates and Gomez and Sullivan Engineers, 2012; USFWS, 2012). Researchers released 146 tagged eels upstream of the Muddy Run Pumped Storage Facility under various operational conditions. Eels successfully passed the project with a median time of 9.65 hours. Researchers estimated an entrainment rate of 7%, equating to 93% survival for the population passing the project (Normandeau Associates and Gomez and Sullivan Engineers, 2012). During the Muddy Run study, the USFWS deployed a monitoring station near Havre de Grace, Maryland to detect eels that successfully passed the Conowingo Dam, which is located downstream of the Muddy Run Pumped Storage Facility (USFWS, 2012). Staff considered eels detected at the Havre de Grace monitoring station downstream of Conowingo Dam to be alive due to the 14 rkm distance from the dam. Eighty-eight tagged eels that passed Muddy Run could have attempted passage at Conowingo Dam. The Havre de Grace array detected 79 of those eels resulting in an apparent survival rate of 90% for eels passing the Conowingo Dam. The limited receiver coverage at Conowingo Dam prevented researchers from determining the route of passage or the mortality rate associated with the

turbines. Most eels likely passed the project via the turbines, as spill at the dam only occurred for only a short time while tagged eels were available to pass during that study. American Eels took an average of 6.8 days to arrive at the downstream Havre de Grace array after release upstream of Muddy Run. Although this study provided information on eel survival and duration of passage past two projects, it did not assess more natural migration patterns of out-migrating, American Eels in the Susquehanna River Basin.

More recently, studies conducted at York Haven Dam sought to evaluate turbine survival and route of passage at that project. In 2022, York Haven Power Company (YHPC) conducted a turbine survival study where out-of-basin eels were forced through a representative Francis and propeller turbine at the project and recovered to evaluate for injury and mortality (YHPC, 2023). Most of the tested eels were smaller than the mature eels that occur in the Susquehanna River, which may have inflated survival estimates through the turbines in that YHPC study. YHPC found that 90% of the eels that passed through the Francis unit were injury-free, immediate survival was 100%, and survival after 96 hours was 96%. Passage though the propeller unit resulted in higher injury and mortality, with 56% of eels being injury-free, and immediate and 96-hour survival of 85% and 77%, respectively. In 2023, YHPC conducted a telemetry study to determine what routes eels used to pass the project (YHPC, 2024). Although passage by spill at this project is assumed to be safe, two-thirds of the tagged eels passed the project through the turbines. Results suggest that 3 of the 56 telemetered eels (5%) that passed the project were killed while passage through the propeller turbines. These studies provide context on how eels move past the project and survival rate estimates for passage between different types of turbines. However, they are not sufficient to evaluate project survival over a range of discharge and operational conditions present during the fall migration period. To determine actual project

survival, the results from the turbine survival study and route of passage study will need to be combined and evaluated against the range of discharge and operational conditions that occur during the eel downstream migration season, as established by this study.

Cumulative impacts to downstream migrants from dam-related injuries and mortalities, entrainment into the pumped storage facility, and migratory delays may reduce successful escapement from the Susquehanna River and subsequent spawning in the Sargasso Sea. The Susquehanna River Anadromous Fish Restoration Cooperative's American Eel Restoration Plan (SRAFRC, 2013) recommends an 85% downstream passage survival target at each of the main stem dams and the pumped storage facility, equating to 44% cumulative survival over all five facilities. The Federal Energy Regulatory Commission (FERC) Licenses for York Haven Hydroelectric Project, Muddy Run Pumped Storage Facility, and Conowingo Hydroelectric Project incorporated this survival target as a requirement. The relicensing of Holtwood and Safe Harbor Dams in 2030 will also consider downstream out-migration survival targets for eels.

Recent downstream migration events

In 2013, strainer screens at Safe Harbor Dam collected the first silver American Eel following the re-initiation of stocking efforts in 2008. Several projects in the Susquehanna River conduct strainer and traveling screen sampling from October through November to evaluate timing of juvenile American Shad (*Alosa sapidissima*) downstream migration and, more recently, American Eel. Between 2013 and 2024, from late September through early December, Safe Harbor Dam strainers and Peach Bottom Atomic Power Station traveling screens have collected nearly 100 mature (silver) eels. However, strainer sampling is typically not conducted outside the fall season, so downstream eel migration may occur during other times of the year

and go unreported. In addition to strainer and traveling screen collections, eel mortality events were documented at York Haven Dam during the fall of 2019, 2020, 2022 (PFBC, 2020; USFWS, 2021, 2022a). Low discharge conditions prevailed in the lower Susquehanna River during these events and discharges generally remained below station generating capacity at York Haven Dam. Downstream migrating eels experienced injury and mortality while passing through the York Haven powerhouse turbines. In October 2019, the public and PFBC staff reported a mortality event of over 100 eels after a rain event that resulted in a moderate increase in river discharge. In 2020, resource agencies conducted periodic surveillance of the York Haven tailrace and recovered more than 250 dead eels from September through November. Public reports noted additional eel mortalities during this time. In 2021, USFWS received only one public report of a dead eel from the York Haven Dam tailrace. High discharge conditions resulted in greater water flow via spill rather than through turbines potentially reducing eel turbine mortality. Alternatively, during the fall 2021 season, the high discharge conditions may have precluded public observations of dead eels in the tailrace. In September and October 2022, resource agencies collected over 110 dead or mortally injured eels and observed many other dead and injured eels after prevailing low discharge conditions. No public reports or agency surveillance of eel mortalities occurred downstream of York Haven Dam in 2023 or 2024. Other hydroelectric dams on the lower Susquehanna River have not observed or reported dead eels in their tailraces, though no directed surveys have been conducted at these dams. Accessibility and water depth in the tailraces of the other projects may have precluded observation of dead eels.

Study objectives

In partnership with hydroelectric dam operators, the USFWS studied the downstream migration of American Eel in the Susquehanna River from August 2021 through December 2024. Previous reports contain 2021, 2022, and 2023 study year information (USFWS, 2022b; USFWS, 2023; USFWS, 2024). This report compiles information from all four study years. The project objectives are to determine the: 1) seasonal timing of silver eel migration in the Susquehanna River including the proportion of annual migrants by month during each study year, 2) environmental variables associated with silver eel migration including water temperature, lunar phase, time of day, river discharge, and generated river flow at the respective hydroelectric dams, 3) potential for hydroelectric dams to delay downstream migration by evaluating the speed of downstream migration in sections of river containing hydroelectric dams versus open river sections, 4) total yearly duration of silver eel migration out of the lower Susquehanna River watershed and, 5) cumulative survival of silver eels leaving the Susquehanna River.

METHODS

Eel collection and tagging

USFWS biologists collected American Eels by electrofishing from 2 August to 13 October in 2021, 8 June to 22 September in 2022, and 6 June to 19 September 2023 in the Susquehanna River Basin. All eel collections occurred upstream of the uppermost acoustic monitoring array. Staff conducted backpack electrofishing in all creeks and sampled the Juniata and Susquehanna rivers with boat electrofishing. Backpack electrofishing focused on Buffalo and Conodoguinet Creek, with additional sampling in Yellow Breeches, Fishing (West and East),

Middle, Sherman, Tuscarora, Penns, Wiconisco, Armstrong, and Clark creeks (Figure 1). The

use of low frequency (30hz) electrofishing minimized the potential for injury to eels (Reynolds

and Holliman, 2004). While visible injury was infrequent, injured eels were not tagged. Staff

focused on acoustically tagging large eels that appeared to be silver (mature) or in the process of

becoming silver. Silver American Eels are differentiated from immature (yellow) eels by their

thicker abdominal musculature, larger lateral line pores, relatively larger eyes, and lighter

margins on the pectoral fins (McGrath et al., 2003). Staff assigned individuals showing

characteristics of both silver and yellow eels to the pre-silver phase (Eyler et al., 2016). USFWS

staff used Pankhurst's eye index to further classify the maturity of collected American Eels

(Equation 1), where A is horizontal eye diameter, B is vertical eye diameter, and L is total body

length. A calculated eye index (I) of 6.5 indicates a maturing individual (Pankhurst, 1982).

Equation 1.

$$I = \left[\frac{\left(\frac{A + B}{4} \right)^2 \pi}{L} \right] \times 100$$

Field crews 1) sedated all eels with no obvious physical injuries using Aqui-S 20E (10% eugenol

solution) according to the Aquatic Animal Drug Approval Partnership Program's (AADAP)

Investigational New Animal Drug Program (INAD) protocols; 2) collected total length (mm),

eye height (mm), eye width (mm), and weight (g); 3) assigned individuals a color phase (yellow,

pre-silver, or silver) according to the previously listed criteria; and 4) surgically implanted

Innovasea (Vemco) model V13-1x pulse position modulation telemetry tags in selected pre-

silver and silver eels. We adjusted Aqui-S 20E concentrations in the field from initial

concentrations of 60 mg eugenol/ L of water to account for incomplete sedation at water

temperatures below 18°C. The surgery consisted of a lateral incision on the ventral surface of the

eel approximately 5 cm anterior to the anal opening. Following insertion of the tag, staff closed the wound using 2-3 sutures. In 2021, pre-silver eels exclusively received low power tags with a 20-40 second ping rate and an estimated 518-day battery life. An additional three silver eels received low power tags, and five silver eels received high power tags with a 33-57 second ping rate and an estimated 265-day battery life. During 2022 collections, staff inserted surplus low or high-power tags from the 2021 pilot study into six silver eels and the remaining silver and pre-silver eels received low power tags with a 33-57 second ping rate and an estimated 726-day battery life. In 2023, all tagged eels received low power tags with identical ping rates and battery life to tags used in 2022. In the 2021 pilot study, receiver arrays recorded no difference between low and high-power tag detection rates, supporting use of low power tags in 2022 and 2023 due to their longer battery life. Tags measured 13 mm in diameter, 30 mm in length, and 9.2 g in air. We used total length to determine the sex of mature American Eels. USFWS considered all silver individuals over 400 mm as female (Krueger and Oliveira, 1997; Newhard et al. 2021), silver eels under 400 mm as male, and non-silver eels under 400 mm as undetermined sex. After processing and tagging, staff moved all sedated eels to an aerated container of fresh water for recovery prior to release within one hour of tagging near their capture location.

We did not directly assess tag loss or tag-related mortality in this study. Previous research suggests that surgical implantation of acoustic tags is the preferred method of tracking eels due to negligible tag loss and mortality associated with the procedure. Cottrill et al. (2006) demonstrated that surgical implantation of acoustic tags resulted in 100% tag retention after 12 weeks and did not affect swimming ability in American Eels. Additionally, tagging of the closely related European eel (*Anguilla anguilla*) with Vemco V9 or V13 acoustic transmitters had no impact on mortality status after 10 weeks of monitoring (Simon et al. 2012). These tag retention

studies did not expose eels to turbine passage during healing, and tag shedding due to turbine passage has not been assessed.

Telemetry monitoring

USFWS and the hydroelectric companies deployed a total of nine receiver arrays to track eel movements through the lower Susquehanna River (Figure 2). Deployment strategy and duration of deployment varied by location according to river discharge, depth, and potential hazards to equipment. Most receivers operated while anchored to the river bottom and oriented to the surface. USFWS staff conducted range testing using Innovasea (Vemco) model V13-1x (69 kHz) transmitter that alternated pinging at high and low power at 20 second intervals to ensure a complete acoustic monitoring gate across the river at all four USFWS arrays. Similar array testing was conducted by YHPC and Constellation at their respective arrays. Both Innovasea VR2Tx (69 kHz) and VR2W (69 kHz) receiver models were used during the study and the two types of receivers demonstrated identical detection capabilities during range testing. Details on specific array deployment locations and dates can be found in Appendix A.

Array 1: Harrisburg - The USFWS managed a four-receiver array at City Island in Harrisburg, Pennsylvania. This array consisted of two receivers deployed on either side of the island and was continuously deployed from 2 August 2021 to 9 July 2025. Staff exchanged initially deployed VR2W receivers with VR2Tx receivers on 13 October 2021. Three of the four receivers had a battery failure that occurred in mid- to late November 2024, precluding additional eel detections from date of failure to 31 December 2024. Tagged eels encountered the Harrisburg array first during their downstream migration.

Array 2: York Haven Upstream – The YHPC managed this array located on either side of Sassafras Island, near the airport in Harrisburg, Pennsylvania. This array consisted of four receivers with two VR2Tx receivers deployed on either side of the island. YHPC removed the receiver arrays from the river before ice formed in the winter to prevent entanglement of marking buoys with ice flows or river debris. The array was deployed from 31 August 2021 to 21 December 2021, 1 June 2022 to 21 December 2022, and 24 May 2023 to 10 January 2024. No hydroelectric dams are located between this array and the Harrisburg array.

Array 3: York Haven Downstream – The YHPC managed this array located near Marietta, Pennsylvania. This array consisted of two VR2Tx receivers. Initially deployed on 30 August 2021, a high discharge event on 2 September 2021 displaced the west side receiver about 60 m downstream. YHPC repositioned the receiver on 5 October 2021. The array broke a second time after the 5 October 2021 repositioning effort when both receivers went missing. YHPC retrieved one of these receivers on 25 August 2022. Subsequent fall 2021 migration data from one receiver were lost. The remaining deployments occurred from 24 May 2022 to 21 December 2022 and 24 May 2023 to 10 January 2024. Like the York Haven Upstream array, YHPC staff removed this array over the winter to prevent loss or damage from ice and high river discharge. The York Haven Hydroelectric Dam is located between this array and the upstream array at York Haven Upstream.

Array 4: Safe Harbor Upstream - The USFWS managed this array. Originally deployed near Columbia, Pennsylvania on 31 May 2022, USFWS moved this three-receiver array 9 rkm upstream of Safe Harbor Dam on 30 June 2022 to allow for better detection ranges with deeper water. This array of VR2Tx receivers was continuously deployed until 28 March 2025 when two

of the receivers were removed. The final receiver was removed 10 July 2025. No hydroelectric dams are located between this array and the upstream array at York Haven Downstream.

Array 5: Holtwood Upstream - The USFWS managed this array located in Lake Aldred, an impoundment created by Holtwood Dam. The original array of three VR2Tx receivers was deployed on 1 June 2022 near Pequea, Pennsylvania on either side of Weise Island. On 30 June 2022, USFWS staff removed the array and redeployed it downstream as a two-receiver array with each receiver on either side of Duncan Island. The redeployment of this array at a location further downstream decreased the potential for detection of dead, drifting eels killed during passage through Safe Harbor Dam. This array remained continuously deployed until 13 March 2025. This array served as both the downstream array for Safe Harbor Dam and the upstream array for Holtwood Dam. The Safe Harbor Hydroelectric Dam is located between this array and the upstream array at Safe Harbor Upstream.

Array 6: Muddy Run Upstream - Constellation managed this array located 1 rkm upstream from the Muddy Run Pumped Storage Facility. This array consisted of three VR2W receivers, with the receivers later replaced with a VR2Tx receiver in 2024. This array was continuously deployed starting 16 June 2022. Constellation replaced the East station VR2W receiver on 26 February 2024 with a second VR2W after the original receiver could not be recovered. Additionally, the West and Middle station VR2W receivers were lost after downloads on 20 April 2023. Constellation replaced the lost receivers with VR2W model receivers on 5 July 2023. Receivers in this array were removed on 30 January and 10 February 2025. This array served as both the downstream array for Holtwood Dam and the upstream array for Muddy Run. The Holtwood Hydroelectric Dam is located between this array and the upstream array at Holtwood Upstream.

Array 7: Conowingo Upstream - Constellation managed this array located near Broad Creek, Maryland. This array consisted of three VR2W receivers with two of the receivers being replaced with VR2Tx receivers in 2024. This array remained continuously deployed from 27 June 2022 to 10 February 2025. The Middle station receiver went missing, resulting in a gap in coverage at this location from 23 November 2022 to 30 January 2023. The same station lost a receiver a second time, leaving a gap between 15 April 2024 to 19 July 2024. Finally, Constellation replaced the West station receiver on 29 May 2024 after it could not be located after a download event on 9 February 2024. This array served as the downstream array for the Muddy Run and upstream array for Conowingo Dam. The Muddy Run Pumped Storage Facility intakes are located between this array and the upstream array at Muddy Run Upstream.

Array 8: Conowingo Downstream - Constellation managed this array located near Port Deposit, Maryland, which consisted of three continuously deployed VR2W receivers initially deployed on 17 June 2022. However, staff added a fourth receiver on 30 June 2022 after range testing to complete the gate. Constellation reported several losses of receivers including two receivers lost after 5 December 2023 leaving a gap in the East station deployment between 5 December 2023 to 19 July 2024 and West station between 5 December 2023 to 29 May 2024. Additionally, the Middle station receiver was lost after a download date of 20 April 2023 and restored on 14 July 2023. Finally, Constellation replaced the Far West station on 29 May 2024 after it went missing after a 3 January 2024 download date. Constellation replaced all lost receivers with VR2Tx models except the Middle station, which remained a VR2W model. Constellation removed all receivers from this array on 30 January 2025. This array served as the downstream array for the Conowingo Dam. The Conowingo Dam was located between this array and the upstream array at Conowingo Upstream.

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Array 9: Havre de Grace - The USFWS managed this array located at Havre de Grace, Maryland consisting of two VR2Tx receivers that were continuously deployed from 20 September 2021 (second receiver deployed 29 September 2021). Originally, staff deployed this array by anchoring it in the river. However, during the 2022 season, USFWS moved the array, suspending one receiver from a Coast Guard buoy in the river channel and attaching the other receiver to a bulkhead piling on the western shore. The array remains deployed for other studies, but the last download for this study occurred 10 March 2025. There are no hydroelectric dams between this array and the upstream array at Conowingo Downstream. The Havre de Grace array marks the final array in the Susquehanna River.

Mobile Tracking

In 2022 and 2023, the YHPC conducted mobile hydrophone monitoring in the York Haven Dam tailrace to the Brunner Island discharge. YHPC monitoring efforts occurred over eight days from 9 September to 21 December 2022 and over seven days from 8 September to 22 November 2023. The USFWS conducted two mobile tracking efforts in the York Haven Tailrace on 5 October and 1 November 2022. The USFWS did not conduct any additional mobile tracking of tagged eels at any other locations in the Susquehanna River through the duration of the study.

Detections Beyond the Susquehanna River

USFWS cooperated with the Atlantic Cooperative Telemetry Network (ACT) by using the Mid-Atlantic Acoustic Telemetry Observation System (MATOS), a network of researchers using acoustic telemetry technology that promotes collaboration among users. Participation in the MATOS expands the range over which tagged eels from the Susquehanna River may be

detected and provides additional telemetry data for projects within the ACT network. Telemetry receivers in the MATOS/ACT network that detected tagged eels after leaving the Susquehanna River are depicted in Figure 3 (Appendix B).

Data screening and analysis

The USFWS, YHPC, and Constellation Energy conducted periodic data downloads at the receiver arrays throughout the study. This report covers data available through 31 December 2024 for all arrays except for the York Haven upstream and downstream arrays that were removed on 10 January 2024. USFWS staff managed the database and conducted data cleansing prior to analysis to remove false-positive detections. Detections at adjacent arrays or receivers within the array helped determine the validity of single detections. Staff eliminated single detections not validated by surrounding arrays. We combined all data from receivers in a single array to evaluate eel passage at a particular location. Analyses assumed all eel detections indicated downstream migration.

Demographics of migrating eels

We used two-tailed t-test assuming unequal variances (alpha 0.05) to compare lengths, weights, and *I* across eels that migrated the year tagged compared to those that migrated the year after tagging as well as pre-silver and silver eels within the eels that migrated the same year as tagging.

Migration timing and duration

We converted all dates and times downloaded from the receivers from Coordinated

Universal Time (UTC) to Eastern Standard Time (EST). Passage time of day is reported in

Daylight Savings Time where appropriate (14 March to 7 November 2021; 13 March to 6

November 2022; 12 March to 5 November 2023; 10 March to 3 November 2024). We used

arrival date and time at arrays to determine timing of migration at each array. We used the

elapsed time between the arrival of the first annual migrating eel at Harrisburg to the departure of

the last eel detected at Havre de Grace to calculate duration of downstream eel migration out of

the lower Susquehanna River. The association of time of day with eel arrivals at an array was

described using the R package actel (Flávio and Bakoft, 2021).

Speed of migration

We calculated the speed of downstream migration for the lower Susquehanna River by

determining the elapsed time from the first detection at the Harrisburg array to the last detection

at the Havre de Grace array divided by the distance traveled (112.8 rkm). We calculated speed of

migration in each discrete river section for all eels that had successive detections in the upstream

and downstream arrays by taking the elapsed time (hours) between the departure of an eel from

an upstream array to its arrival at the immediate downstream array and dividing that by the

distance traveled in kilometers (see Table 2 for distances between arrays). We compared the

speed of migration in river sections with and without hydroelectric dams using a random effects

analysis of variance to account for individual eel variation in migration speeds between different

river sections. The river section containing Muddy Run Pumped Storage Facility was considered

a river section with a dam even though that dam does not extend across the main stem of the

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Susquehanna River. Note that for these analyses, we treated the receiver arrays as line across the river and did not account for the distance of the receiver's detection ranges upstream and downstream of the array. The detection distances for the arrays were variable and likely changed with changing river conditions. By assigning all detections to a single line for the array, we likely underestimated migration times and overestimated migration speeds because first detections were likely upstream some distance from the array and last detections were some distance downstream of the array. Finally, we determined time spent within the detection range of an array by subtracting the date and time of first detection from the date and time of last detection at a single array.

Total survival/escapement

The survival of eels passing through all four dams, past the pumped storage facility and ultimately escaping into the unimpeded waters of the Chesapeake Bay provided information on cumulative project impacts and background mortality on mature eels emigrating from the Susquehanna River. A Cormack-Jolly-Seber (CJS) model was used to estimate survival during eel out-migration through discrete sections of the Susquehanna River as well as overall survival for migrating eels traveling from Harrisburg to Havre de Grace. In this application of the CJS model, space (i.e., river section) was substituted for time as in a typical CJS model because downstream migration occurred in a systematic, linear fashion as eels migrated downstream past dams and there were no instances where an individual reversed direction during migration.

The CJS model focused on telemetry data collected in 2022 and 2023. These two years had complete coverage by acoustic telemetry arrays and the greatest number of migrating silver eels available for analysis. Data from 2021 had limited eel movement and incomplete receiver

deployments, which prohibited inclusion in the analysis. Data collected in 2024 were analyzed with a CJS model, but receiver coverage did not include arrays upstream and downstream of York Haven, so analysis was restricted to the area of the river from Safe Harbor to Havre de Grace. Detections of migrating silver eels beyond the Havre de Grace array came from data provided by MATOS beyond the Susquehanna River. Inclusion of these detections allowed estimation of survival beyond the Havre de Grace array.

Four alternative CJS models were fit with data from 2022 and 2023. Model 1 assumed survival (φ) and detection probability (p) were constant across years and space (i.e., constant detection at receiver arrays and constant survival between receiver arrays). Model 2 assumed φ and p varied across years but were constant across space. Model 3 assumed φ and p varied across both years and space. Finally, Model 4 assumed φ and p were constant across years but varied across space. Models were fit using the RMark package (version 3.0.0) in R (version 4.5.0) and performance of each was compared by corrected Akaike Information Criterion (AIC_c). The model with the lowest AIC_c was deemed the most appropriate model.

Data from 2024 only included 10 individuals and a single CJS model was fit to these data assuming φ and p varied across space.

Cumulative survival of silver eels from upstream of York Haven Dam through Havre de Grace was estimated by bootstrap simulation. Cumulative survival equaled the product of river section-specific survival estimates. In each simulation, a random value of survival for a river section was drawn from a normal distribution with a mean equal to the point estimate (logit scale) and standard deviation equal to the standard error for that river section. A total of 10,000 simulations were conducted for 2022 and 2023 separately.

Bootstrap simulations were also conducted to gain an estimate of survival of migrating

eels through undammed sections of river. Here, estimates of survival and associated standard

errors from the Harrisburg to York Haven upstream array, York Haven downstream array to the

Safe Harbor array, and from the Conowingo downstream array to the Havre de Grace array from

2022 and 2023 were used given a total of six estimates (and standard errors) from which to draw

random samples. In each bootstrap iteration, a single survival point estimate and associated

standard error (logit scale) was randomly selected, and then a random survival was generated

based upon the selected survival estimate and standard error. This process was repeated 10,000

times to generate a final distribution of possible silver eel survival through undammed river

sections that provided maximum values for natural background mortality in the lower

Susquehanna River.

Environmental covariates

We compared all array passage events that occurred from 1 August to 31

December to environmental covariates including water temperature, river discharge,

lunar phase, and turbidity. A temperature monitor in the East Channel Fishway at York

Haven Dam provided mean daily water temperature for 01 July 2021 through 16

December 2021 and 31 March 2022 through 16 August 2022. The U.S. Geological

Survey (USGS) monitoring station 01579550 at Darlington, PA (USGS, 2023) provided

daily mean water temperature for 17 December 2021 through 30 March 2022 and daily

mean turbidity data from 01 July 2021 through 16 August 2022. The USGS monitoring

station 01576003 at Columbia, PA (USGS, 2023) provided daily mean water temperature

and turbidity data starting 17 August 2022 for the remainder of the study. The USGS

gauging station 01570500 at Harrisburg, PA (USGS, 2023) provided river discharge data. In instances where gage data were missing for a given day, data were interpolated from dates immediately before and after the missing date(s). The US Navy Astronomical Application Department (https://aa.usno.navy.mil/data/MoonFraction) produced lunar phase data.

We used a random effects logistic regression model to evaluate the effects of environmental covariates on eel movement. If an eel passed a telemetry array on a given day, it was considered to have moved (coded as a 1), otherwise it was considered to have remained stationary (coded as a 0). We also examined all environmental covariates as well as the change in discharge (increasing or decreasing) over the prior 2, 3, and 5 days. We fit eel movement data to a total of 20 possible models and models were ranked according to AIC values. The model with the lowest AIC was considered the best fitting model. The random effect in each fitted model was the individual acoustic tag numbers representing individual eels.

Project operations during fish passage

We evaluated the timing of dam passage for eels that passed through both the upstream and downstream receiver arrays of each hydroelectric dam. We assigned the arrival time at a dam using the departure date/time from the upstream receiver array and the departure time from the dam using the arrival date/time from the downstream receiver array where fish were detected at both upstream and downstream arrays (arrays listed in Table 2). Subtracting the departure time at the upstream receiver array from the arrival time at the downstream receiver array provided the time an eel took to pass a dam. If a passage event between upstream and downstream arrays

occurred during the transition to daylight savings time, we added one hour to the passage duration between arrays to account for the time change. For all eel passage events, we described the proportion of flow through the project that occurred by spill versus through turbines. For the eels that passed a dam in less than 24 hours, we described the total project flow, unit flow, spill flow, percentage of spill and description of units running during each event in which an eel passed. We considered only project operations that occurred from the date/time of departure from the upstream array until the date/time of arrival at the downstream array. We based project flow data on the sum of spill and generation flows by hour for all dams except for hourly project flows provided by the USGS Harrisburg Gage (#01570500) for York Haven. Constellation, Brookfield, and York Haven Power Company provided their operational data in hourly increments.

RESULTS

Eel collection and tagging

USFWS collected a total of 1,623 eels over 60 sampling days during the project. Although electrofishing effort was not always recorded, USFWS field crews performed at least 95 hours of electrofishing effort during collections with just over two recorded hours in 2021, 35 in 2022, and 57 hours of in 2023 (Table 3). Staff tagged 217 silver and pre-silver eels with 16 tagged in 2021, 101 in 2022, and 100 in 2023 (Table 4).

During the study, USFWS staff tagged 98 silver and 119 pre-silver eels. Silver eel total length measured 777 ± 5 mm (mean ± SE; range = 667 – 902 mm) (Figure 4). Pre-silver eel total length measured 729 ± 3 mm (mean ± SE; range = 675 – 872 mm) (Figure 4). Silver eels weighed 1189 g ± 25 g (mean ± SE; range = 790 – 1,850 g) (Figure 5), while pre-silver eels

weighed 947 g ± 15 g (mean ± SE; range = 620 – 1,640 g) (Figure 5). The average silver eel *I*

value measured 6.75 ± 0.1 (mean ± SE; range = 4.35 – 9.38) (Figure 6), and the calculated pre-

silver *I* average measured 6.65 ± 0.08 (mean ± SE; range = 4.63 – 9.76) (Figure 6).

We collected biological information from 1,406 additional untagged eels. Untagged eel

total length averaged 493 ± 4 mm (mean ± SE; range = 140 – 891 mm; n = 1,406) (Figure 7).

Approximately 71% of non-tagged eels exceeded the maximum male total length of 400 mm

indicating that they were females (Krueger and Oliveira, 1997; Newhard et al., 2021). Field

technicians did not observe silver male eels during sampling collection efforts.

Eel Migration

Eels included in migration assessment

A total of 160 of the 217 tagged eels were detected by receiver arrays during the study.

Six eels were removed from analysis because they were only detected at the Harrisburg receiver

and no downstream arrays. An additional eel was removed from analysis because it did not

initiate migration until March 2025 and most of the receiver arrays had been removed by that

time. The remaining 153 eels, 71% of all tagged eels, that initiated downstream migration during

the study were considered in the remaining analyses (Appendix C).

Demographics of migrating eels

We compared the demographics of 123 tagged eels that initiated migration the same year

as being tagged to the 30 tagged eels that initiated migration the year after they were tagged. Eels

that migrated the year they were tagged were significantly longer, heavier, and had a greater *I*

compared to eels that migrated the year after tagging (Table 5). Of the 74 silver eels that initiated

migration, 92% began migration the year they were tagged. Of the 79 pre-silver eels that initiated migration, 70% began migration the year they were tagged. Within the combined group of silver and pre-silver eels that migrated the year they were tagged, the mean length and weight of silver eels significantly exceeded that of migrant pre-silver eels, though *I* was not significantly different between the groups (Table 6).

Seasonal timing and duration of migration

All but one of the 153 tagged eels that initiated downstream migration did so during the five-month period ranging from 1 August – 31 December, with 9 eels in 2021, 47 in 2022, 87 in 2023, and 10 in 2024 (Appendix C, Appendix D). Eels began migration past arrays between 3 days and 71 weeks from date of tagging. Most eels (86%) initiated migration at least four weeks after tagging, and about half of the eels (52%) initiated migration within 3 months of tagging. Of the 153 tagged eels that initiated downstream migration, 30 began out-migration a year after USFWS tagged them (Table 7).

We recorded a total of 895 array passage events during the 2021 to 2024 migration seasons. The number of days in the migration season where eels passed arrays was not consistent between years. In 2021, eel passage occurred on 10 days, on 47 days in 2022, 100 days in 2023 and 25 days in 2024, though differing sample sizes and array deployments between years may have influenced the number of days migration was detected each year. Despite the variable number of days where migration occurred from 2021 to 2024, nearly all (99%) migration events occurred between 1 August and 31 December (Table 8). Eel migration was most common in November across all years (Figure 8). In 2022, we recorded nearly all eel passage events during the week of 14 November. However, in 2023, several peaks occurred from late September to late

November (Figure 8). Less fish passed and fewer arrays were available for detection in 2021 and 2024, though 2021 saw similar patterns to 2023 where fish were generally detected in the up-river arrays earlier in the season. In 2024, the migration period was more bimodal with the most migratory activity in August and December (Figure 8). From 2021 to 2024, the highest number of passage events at individual arrays occurred in November, ranging from 40% of passage events at Harrisburg to 75% or passage events at Conowingo Downstream (Table 8, Figure 9). Passage timing by array was generally progressively later in the fall at the more downstream arrays in the system. Upstream arrays had more activity in August than the downstream arrays and conversely, the downstream arrays had more activity in December than upstream arrays (Figure 9). We did not detect any upstream migration after an eel reached a downstream array, therefore, supporting our assumption that all detections at an array represented downstream migration.

The duration of migration seasons was variable between years. The migration season lasted 183 days in 2021, 275 days in 2022, 142 days in 2023, and 129 days in 2024. Initiation of migration at the Harrisburg array occurred between 19 August to 29 October 2021, 25 July to 13 November 2022, 1 August to 18 December 2023 and 9 August to 12 December 2024. Completion of migration at the Havre de Grace array occurred between 24 September to 18 February 2022, 14 November to 26 April 2023, 22 August 2023 to 21 December 2023, and 10 September to 16 December 2024.

Eel movements outside the migration season

Only 9 of 895 passage events (1%) from seven unique eels occurred outside the 1 August to 31 December time period (Figure 10). One eel initiated migration prior to 1 August. This eel

passed the Harrisburg array on 25 July 2022 but didn't pass the York Haven Upstream array until after 1 August. Two (3%) of the 63 eels that completed migration from the Susquehanna River initiated migration in the fall and completed migration in the late winter or spring of the following year. One eel passed the Harrisburg array on 29 October 2021, the York Haven Upstream array on 31 October 2021, and then detected 18 February 2022 at the Havre de Grace array. Receiver arrays were not deployed between York Haven and Havre de Grace during that period, so the migration progression of that eel from November to February could not be determined. Another eel initiated migration on 1 September 2022 and continued to pass arrays through the Holtwood Upstream array, which was passed on 15 November 2022. The eel was next detected at the Conowingo Upstream array on 6 March 2023, and finally the Havre de Grace array on 6 April 2023. While the final detection of four other eels occurred after 31 December in winter or spring, these eels did not complete migration from the river and may have suffered injury or mortality that influenced the timing of their detection at downstream arrays.

Daily timing of migration

Eels arrived at receiver arrays at every hour of the day, but most (89%) arrivals occurred in the evening and overnight from 17:00 to 7:00. Between 3% and 9% of array arrivals occurred during each hour between 17:00 and 7:00 (Figure 11). The highest eel passage proportions occurred between 21:00 and 1:00 (34%). The hourly migration pattern was similar between years (Figure 11). At individual arrays, hourly passage patterns were similar, with mean passage times occurring at individual arrays from 22:00 to 01:00 (Figure 12).

Speed of migration

We calculated total migration time from Harrisburg to Havre de Grace (112.8 rkm) for 59 of the 60 eels that had detections at both arrays (Table 9). One eel that remained at the Havre de Grace array for nearly two years after its arrival was likely dead or had shed its tag and was subsequently removed from the analysis. Eels took an average of 34 days (median 22 days) to complete migration from Harrisburg past the hydroelectric facilities to Havre de Grace near the mouth of the Susquehanna River, with times ranging from 1.8 to 218 days. Migration speed averaged 15.0 rkm/day (median, 5.1 rkm/day, range = 0.52 – 61.1 rkm/day) and varied annually. The fastest overall migration speed occurred in 2022 taking eels a median of 4 days to travel from Harrisburg to Havre de Grace (Figure 13, Figure 14). Some eels moved quickly, with the minimum travel times ranging from 1.8 to 8 days each year, yet each year, there were also some eels that had travel times ranging from 3 or 4 months. In fall 2022, one eel initiated migration that took 7 months to exit the Susquehanna River. The date of initiating migration did not appear to influence the total migration time. Eels that began migration first did not necessarily complete migration first (Figure 15). Conversely, migrants starting late generally completed migration last.

We calculated migration speed for 709 events where eels passed at least two successive arrays during the study to determine the impact of dams on the duration of downstream migration. Time to pass and speed of migration between two arrays varied between river sections but were relatively similar between river sections (Table 10, Figure 16, Figure 17). Most eels passed each section of river between arrays in less than 24 hours. The proportion of eels passing between arrays in less than 24 hours decreased as distance between arrays increased. Migration speed for river sections containing dams versus sections without dams did not significantly differ (p = 0.0952, Figure 18), suggesting that dams did not delay downstream migration. From 2021 to

2024, the average speed of eels moving through river sections containing dams was 1.8 rkm/h (95% CI 1.6-2.0 rkm/hr) compared to 2.0 rkm/h (95% CI 1.78-2.21 rkm/hr) for sections without dams (Table 10).

We estimated the time that eels spent in the detection range of a single array according to an individual's arrival and departure times for 903 passage events (Table 11, Figure 19). Sixty-five percent of eels were within the detection range of an array for less than 1 hour, 84% for less than 3 hours, and 5% for more than 2 days. Generally, eels that spent more than 2 days in the vicinity of a receiver were later detected at downstream arrays and had relatively short residence times at any subsequent arrays passed, therefore, long residence times at an array did not necessarily suggest mortality or tag loss.

Total survival/escapement

We used the CJS model to determine detection probabilities at all receiver arrays in 2022, 2023, and for the receivers from Safe Harbor Upstream to Havre de Grace in 2024. Detection probabilities at each receiver varied between years, but most arrays had detection rates higher than 95% each year. The Conowingo Upstream and Safe Harbor Upstream receivers had 100% detection probability across all years (Table 12). The Muddy Run Upstream array generally had the lowest detection probability (annual estimates ranging from 66% to 92%), possibly due to complexities of the river (highly braided channel, depth up to 35m, boulders) exacerbated by the high rate of speed that eels moved past the array.

Of the 153 tagged eels that initiated migration out of the Susquehanna River from 2021 to 2024, 63 successfully out-migrated from the Susquehanna River. In the CJS modeling, the best model to estimate survival was Model 3 with φ and p varying across years and river section

(Table 13). Although Model 3 suggested the years were different, a similar pattern to survival occurred in both 2022 and 2023. Note that all the survival estimates presented here are apparent survival. No fish were recaptured after passing an array to determine if they were alive and/or uninjured during the study. Bootstrapped estimates of cumulative survival suggest that 44% (95% CI: 33 – 54%) and 35% (95% CI: 26 – 44%) of eels originating from upstream of York Haven Dam ultimately survived to Havre de Grace in 2022 and 2023, respectively. Cumulative survival of tagged downstream migrating eels obviously decreased moving downstream through the reaches of the river in both 2022 and 2023 (Table 14; Figure 20).

Apparent survival was generally highest in the undammed river sections with annual point estimates of survival ranging from 97% to 100% (Table 15; Figure 21). Bootstrap simulations of survival from undammed river sections across 2022 and 2023 yielded an average estimate of survival of 98% (95% CI: 91 – 100%) (Figure 22). This suggests that approximately 2% of silver eels may be expected to potentially experience natural mortality in a river section without hydropower facilities, though this estimate could be inflated by any latent mortality that occurred from passing a dam upstream.

Apparent annual survival in river sections that contained dams ranged from 60% to 100% from 2022 to 2024 (Table 15; Figure 21). Survival tended to be lowest in 2022 and 2023 in the river section between Muddy Run Upstream and Conowingo Upstream (2022: 72% (95% CI: 58 – 82%); 2023: 66% (95% CI: 54 – 76%)) and the river section between Safe Harbor Upstream and Holtwood Upstream (2022: 79% (95% CI: 69 – 87%); 2023: 74% (95% CI: 65 – 82%)). The remaining river sections that contained dams had apparent annual survival rates ranging from 90% to 95%. Data from 2024 could not be formally compared to those from 2022 and 2023 because of differences in receiver array coverage and lower sample size.

Environmental covariates

Eel passage occurred at a wide range of environmental conditions from 2021 to 2024, which substantially overlapped available conditions that occurred during most eel passage events from August through December (Table 16). Eels migrated past receiver arrays during river discharges ranging from 4,282 – 208,750 cfs (Figure 23), water temperatures ranging from 1.7ºC – 29ºC (Figure 24), lunar illumination ranging from 0% – 100% (Figure 25) and turbidity ranging from 1.0 – 276 formazin nephelometric units (FNU) (Figure 26).

The logistic regression model with temperature and the natural log of discharge provided the best fit to the environmental data (Table 17). All predictors in the model were significant ($p < 0.01$). The best fitting model: Eel passage = -20.9 - 0.213(Temp) + 2.12(log(CFS)), indicated that predicted probabilities of movement were generally greatest under lower temperatures and higher discharges (Table 18).

Project operations during fish passage

A total of 128 eels spanning 399 passage events were detected passing both an upstream and downstream array of a river section that contained a dam when operational data were also available. Time periods from upstream array departure to downstream array arrival ranged from under 1 hour to 109 days. A total of 105 eels (300 passage events) passed a river section containing a dam in less than 24 hours. In 2022, 111 dam passage events occurred with operational data and 96 occurred in under 24 hours. Nearly all (n=93) of the dam passage events that occurred in less than 24 hours were from November 13-16, 2022. The remaining three

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events occurred from October 14-25, 2022. In 2023, 266 dam passage events occurred with operational data and 185 occurred in under 24 hours. The events that occurred in under 24 hours spanned a 4-month period from August to December 2023, except for one passage event that occurred in March 2023. In 2024, there were 21 dam passage events with operational data and 19 of those events occurred in under 24 hours. The 2024 events in less than 24 hours occurred in August, September, and December. Passage events within 24 hours of arrival at an array upstream of a dam are described below for each hydroelectric project. The range of project operation data during each passage event that occurred within 24 hours are presented in Appendix E.

York Haven Dam

York Haven Dam has a hydraulic capacity of 17,000 cfs and spill generally occurred during eel passage events. Available operational data suggests that, on average, half the river discharge was diverted to generation and half to spill when 118 eels passed the project in 2022 and 2023.

For eels that passed the project in less than 24 hours, more specific operational information could be summarized. Twenty-eight events occurred at the project in 2022 and all during 13 to 14 November. Project flows ranged from 21,500 to 89,900. The plant operated five of the six propeller units and was generating 4,900 cfs during this period. Spill ranged from 16,100 to 85,000 cfs and comprised 77% to 95% of project flows during this passage period (Table 19).

Forty events occurred at the project in 2023 from 17 August to 18 December. Project flows ranged from 13,900 to 110,000 cfs. The plant operated between 3 and 18 units during the

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passage events. The project was generating 2,355 to 15,005 cfs and spilling between 14% and 97% of available water during the passage events (Table 19).

For all passage events combined that occurred in less than 24 hours, project flows averaged 43,752 cfs, with an average of 11 units generating during the passage events. The project generation flows averaged 9,508 cfs and spill averaged 68% during the passage events (Table 19).

Safe Harbor Dam

Safe Harbor Dam has a hydraulic capacity of 110,000 cfs and only had spill potentially occur for 7 of the 98 eels that passed the project where operational data were available. Spill only occurred during eel passage at the project in late winter of 2023 (3 events) and August of 2024 (4 events).

For eels that passed the project in less than 24 hours, more specific operational information could be summarized. Twenty-five passage events occurred in 2022 from 14 to 15 October and from 13 to 15 November. Project flows ranged from 2,714 to 85,759 cfs. The plant operated between 1 and 11 units while generating all the available flow. No spill occurred during any of the passage events at the Safe Harbor Dam. During most passage events, generally all units were in operation except for units 1, 4, and 6. All eels that passed the river section containing the dam within 24 hours during fall 2022 were passed through turbines (Table 19).

Thirty-one passage events in 2023 occurred from 18 August to 6 December. Project flows ranged from 7,900 to 64,083 cfs. The plant operated between 1 and 10 units during the passage events generating between 7,099 and 64,083 cfs. All eels that passed the river section containing the dam within 24 hours during fall 2023 were passed through turbines (Table 19).

Five passage events occurred in 2024 from 12 August to 13 December. Project flows ranged from 10,090 to 232,759 cfs. The plant operated between 3 and 12 units during the passage events generating between 10,090 to 107,392 cfs. Safe Harbor Dam only spilled water in August 2024, so at least 6 of the 10 tagged eel passage events that occurred at the project in 2024 occurred through the project turbines (Table 19).

For all passage events combined that occurred in less than 24 hours, project flows averaged 46,881 cfs, with an average of 7 units generating during the passage events. The project generation flows averaged 43,003 cfs and spill only occurred during the passage events of August 2024 (Table 19).

Holtwood Dam

Holtwood Dam has a hydraulic capacity of 62,100 cfs and had spill occurring on more than half of eel passage events. Of the 76 total events that occurred with operational data, 20 occurred during conditions with no spill which would have required eels to pass through turbines. For the remaining events, spill comprised, on average, 17% of project flows.

For eels that passed the project in less than 24 hours, more specific operational information could be summarized. Thirteen passage events occurred on 15 October 2022 and between 14 and 16 November 2022. Project flows ranged from 1,562-83,548 cfs with generation accounting for 1,562-55,081 cfs of those flows. The project ran all units except for Unit 3 during the November events. Spill ranged from 0-35% of project flows during the events (Table 19).

Forty-eight passage events occurred from 19 August to 16 December 2023. Project flows ranged from 7,083 to 69,498 cfs. The plant operated between 1 and 12 units during the passage events. The project was generating 6,178 to 48,023 cfs during the passage events and spilling between 0% and 61% of available water (Table 19).

Five passage events in 2024 occurred on 12 August and 1 to 14 December. Project flows ranged from 19,675 to 112,670 cfs. The plant operated between 4 and 13 units during the passage events. The project was generating between 19,671 and 57,238 cfs during the passage events and spilling between 0-54% of available water (Table 19).

For all passage events combined that occurred in less than 24 hours, project flows averaged 35,496 cfs, averaging 7 units generating during the passage events. The project generation flows averaged 29,231 cfs and spill averaged 11% of the project flows during the events (Table 19).

Muddy Run Pumped Storage Facility

Since the Muddy Run Pumped Storage Facility does not have a dam that spans the Susquehanna River, downstream migrating eels may pass the facility without interacting with the project. However, for the 78 eels that were detected at the Muddy Run Upstream array, 86% of those eels detected in that array were detected by the eastern receiver only or the eastern and middle receivers combined. The remaining 14% were detected only in the middle or west receivers. This suggests that although eels are not required to interact with the Muddy Run Pumped Storage Facility while moving downstream, most eels in this study traveled along the eastern side of the river when approaching the Muddy Run Pumped Storage Facility, which would increase the probability of interacting with the project, particularly while it is in pumping mode.

A total of 48 passage events occurred from 2022 to 2024 at the Muddy Run Pumped Storage Facility where operational data were available. Pumping and generating conditions both occurred for the passage of 40 eels, and a single operating mode occurred during the passage of 8

eels. One eel traveled past the project while operations were idle, 5 passed while the project was generating, and 2 passed while the project was withdrawing water from the river.

Conowingo Dam

Conowingo Dam has a hydraulic capacity of 86,000 cfs and did not have spill conditions during passage events, therefore all 50 eels that passed the project passed the project through the turbines.

For eels that passed the project in less than 24 hours, more specific operational information could be summarized. Seventeen passage events occurred in 2022, all between 14 and 16 November. Project flows ranged from 46,314-79,441 cfs. The plant operated between 9 and 11 units during the passage events, running all units, with some units being shut off periodically, generating between 46,314 and 79,441 cfs. All eels that passed the river section containing the dam within 24 hours during fall 2022 were passed through turbines (Table 19).

Eighteen passage events occurred in 2023 on 8 March 2023, and between 22 August and 28 November. Project flows ranged from 5,100 to 57,757 cfs. The plant operated between 1 and 9 units during the passage events. The project was generating between 5,100 and 57,757 cfs during the passage events. All eels that passed the river section containing the dam within 24 hours during fall 2023 were passed through turbines (Table 19).

Four passage events occurred in 2024 on 5 September 2024 and between 6 and 15 December. Project flows ranged from 11,192 to 79,275 cfs. The plant operated between 2 and 11 units during the passage events. The project was generating between 11,192 to 79,275 cfs during the passage events. All eels that passed the river section containing the dam within 24 hours during fall 2024 were passed through turbines (Table 19).

For all passage events combined that occurred in less than 24 hours, project flows averaged 43,094 cfs, with an average of 6 units generating during the passage events. The project generation flows averaged 43,094 cfs and spill did not occur during the passage events (Table 19).

Mobile Tracking

YHPC and USFWS mobile hydrophone surveys detected a total of eight tags associated with this study in the York Haven tailrace with three detected in 2022, four detected in 2023, and one tag detected both years (Table 20). Seven of the eight eels identified in the mobile tracking were presumed dead because they were never detected at a downstream array. One eel was presumed alive because it was later detected at the York Haven Downstream and Safe Harbor Upstream arrays.

Detections Beyond the Susquehanna River

Chesapeake Bay, Delaware River, and Atlantic Ocean receivers (Figure 3) detected a total of 55 tagged eels after they migrated out of the Susquehanna River. Telemetry receivers in the MATOS network were inconsistently deployed during the study period, so lack of detection at a MATOS array did not confirm lack of eel passage at that location (Appendix B). Additional data from tagged eels may become available at a future date after MATOS detection data are updated. MATOS receivers detected seven eels that initiated migration in 2021, 19 in 2022, 27 in 2023, and 2 in 2024 (Table 21). These receivers commonly detected eel movements through late fall and winter. MATOS receivers detected tagged eels between 26 November 2021 to 24 February 2022, 1 December 2022 to 9 March 2023, 14 November 2023 to 25 May 2024, and 30

December 2024 to 31 December 2024 (Table 21). Chesapeake Bay receivers detected 52 eels previously recorded at the Havre de Grace array in addition to three eels that likely passed the Havre de Grace location before the array was installed in 2021. Four eels that traveled through the Chesapeake Bay were later detected in the Atlantic Ocean off the coast of Virginia in February and May. Three eels were detected going through the Chesapeake and Delaware (C&D) Canal and to the Delaware River and Bay. Like the Chesapeake Bay detections, those eels were detected between November and February. One eel that traveled into the Delaware River was later detected in January off the Atlantic Coast of New Jersey.

DISCUSSION

This study aimed to describe the seasonal timing and duration of silver eel migration, evaluate the relationship between environmental variables and eel migration events, and describe the impact of the hydroelectric dams on eel movement and escapement from the Susquehanna River. In the study, out of the 217 tagged, 70% of them initiated downstream migration over the four study years. Nine receiver arrays in the lower Susquehanna River effectively tracked eel downstream migration with high detection rates at each array despite some periodic receiver losses during the study.

Timing and Duration of Migration

Nearly all eels initiated and completed their migration in the Susquehanna River during the period of 1 August to 31 December. Eels did not move consistently during this time, with array detections occurring on only a portion of available days each year. Eels that successfully migrated out of the Susquehanna River, as indicated by detection at the Havre de Grace array,

were able to complete migration in an average of 34 days, though the fastest eel completed migration in 1.8 days and the slowest eel took over seven months. While relatively rare, two eels initiated fall out-migration from the Susquehanna River and completed movement in the late winter and early spring of the following year. Eel detections recorded by Chesapeake Bay and Delaware River basin receivers from November to March and Atlantic Ocean receiver detections from February to May indicate that American Eels exit the Susquehanna River into the Chesapeake Bay or the Delaware Bay in winter and early spring and continue to move towards the Sargasso Sea into late spring.

Based on the results of this study, the primary downstream migration period for American Eel in the Susquehanna River is late summer through early winter, although the exact timing varies each year. The timing of downstream migration is thought to vary by latitude according to the distance of a watershed from the Sargasso Sea spawning grounds. Eels in the northern portion of their range must travel further to spawn and initiate their migration in late summer and fall (Beguer-Pon et al., 2014; Brown et al., 2009; Haro et al., 2003; Ingraham, 1999; McGrath et al., 2003). Eels in the southern portion of their range are generally closer to the spawning grounds and downstream riverine migration occurs primarily in late fall and winter (Facey and Helfman, 1985; Harrrell and Loyacano, 1982). Variability in the timing of downstream migration allows for synchronous arrival of eels at the Sargasso Sea for their suspected spawning season from February through April (Kleckner and McCleave, 1985; McCleave, 1987). Our study demonstrates a similar migration season with the Shenandoah River, another Chesapeake Bay tributary (Eyler, 2016). However, the Shenandoah River has a higher incidence of spring migration events than we observed in the Susquehanna River. Eels can make partial downstream movements and await more favorable migratory conditions the

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following year (Aarestrup et al, 2008; Reckordt et al., 2013); however, this behavior was rarely observed in the Susquehanna River.

Previous research has demonstrated that low light conditions facilitate downstream migration of American Eel (Beguer-Pon et al., 2014; Brown et al., 2009; Eyler, 2014). This study corroborates these findings, as most eels in the Susquehanna River were detected passing telemetry arrays during nighttime hours.

Environmental Variables

We evaluated the effects of water temperature, lunar phase, turbidity, and river discharge on silver eel migration. Like a number of previous studies on American Eel (Beguer-Pon et al., 2014; Eyler, 2014) and European eel (Behrmann-Godel and Eckmann, 2003; Cullen and McCarthy, 2003; Durif et al., 2003), this study found a strong association of increased river discharge with the occurrence of out-migration. In 2022, a high discharge event in November preceded by relatively low discharge conditions coincided with the largest event of tagged eel migration during the study. In the remaining study years, greater variability in fall flows coincided with several smaller migration events. The number of eels available for migration is likely linked to the magnitude of out-migration during high discharge events. For example, a high discharge event that occurred in December 2023 had relatively low eel movements associated with it, suggesting that most eels available for downstream migration that season had left the system prior to this high discharge event.

Water temperature was associated with downstream movement of American Eels in this study, although migration occurred across a wide thermal range that nearly overlapped the full range of temperature available during the migration season. Passage events were observed

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between 1.7 ºC to 29.2 ºC, like the range reported by Eyler (2014) in the Shenandoah River (3.5 ºC to 29.7 ºC). Together, water temperature and river discharge appeared to best describe eel movement in the Susquehanna River.

Results from this study suggest that downstream American Eel migration was not strongly correlated with lunar illumination or turbidity. This lack of connection with lunar illumination is consistent with research that previously documented downstream migration of silver eels in the Shenandoah River during all levels of lunar illumination (Eyler, 2014). Eyler (2014) observed eel migration during full moon conditions, though only during high discharge events. Other studies have demonstrated a higher prevalence of downstream migration occurring during the new moon phase, before the first quarter, or after the third quarter (Haraldstad et al., 1985; Okamura et al., 2002; Sudo et al., 2014, Sudo et al., 2017). A higher incidence of migration events was observed under greater lunar illumination, with nearly two-thirds occurring between half and full moon in this study. Turbidity was also not closely correlated with downstream migration events, even though higher river discharge events tended to coincide with higher levels of turbidity.

Project Impacts on Eel Migration

This study evaluated the impact of hydroelectric dams on downstream eel migration in the lower Susquehanna River. We compared the speed of passage in sections of the river that contain hydroelectric dams to undammed river sections to determine if hydroelectric dams cause delay in downstream migration. Dams did not appear to cause substantial delays in downstream migration in the Susquehanna River, as migration speed was similar between dammed and undammed river sections. Migration speed in the Susquehanna River was somewhat slower than

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rates reported in another Chesapeake Bay tributary. Eyler (2014) found that eels migrated at a rate of 22 rkm/day in the Shenandoah River, which has five dams, and 26 rkm/day in a Potomac River section with one low-head dam. In the Susquehanna River, migration occurred at an average rate of 15 rkm/day, with a median rate of 5.1 rkm/day.

The Susquehanna River Anadromous Fish Restoration Cooperative's 2010 Migratory Fish Management and Restoration Plan established a target survival for downstream migrating American Eel of 85% for each of the four hydroelectric dams and the Muddy Run Pumped Storage Facility on the lower Susquehanna River (SRAFRC 2010). Achievement of the 85% survival target at each project would result in a minimum cumulative survival of 44% for eels escaping the lower Susquehanna River. Sweka et al. (2014) developed an egg-per-recruit model to determine what level of cumulative survival would be necessary to achieve equivalent egg production for eels originating from the Susquehanna River after upstream passage was implemented compared leaving all basin eels downstream of Conowingo Dam (i.e. not implementing upstream passage). Sweka et al. found that 33% cumulative survival was the break-even point, where American Eel egg production from the Susquehanna River was equivalent between allowing upstream passage with the subsequent mortality for downstream passage compared to not allowing any upstream passage to occur in the river. For the American Eel restoration program in the Susquehanna River to have a high probability of producing more eggs to benefit the coast-wide population of eels compared to the do-nothing approach, cumulative survival from the Susquehanna River would need to be substantially more than 33%.

In this study, the cumulative project survival for silver eels leaving the Susquehanna River was 44% in 2022 and 35% in 2023. In 2022, the cumulative survival met the SRAFRC target of 44%, but the cumulative survival in 2023 was lower than the SRAFRC target. Further,

cumulative survival in 2023 was only slightly higher than the break-even point for realizing any benefits to coast-wide American Eel restoration to the Susquehanna River by implementing the upstream trap and transport program. The Susquehanna River is over 400 miles long and the watershed comprises more than 27,000 square miles. Historically, American Eels occupied most of the basin, and populations were abundant enough to support commercial fisheries into the most upstream reaches in New York (Dittman et al. 2010). The loss of this important production habitat with the construction of the main stem dams on the Susquehanna River in the early 1900s likely contributed to the coast-wide population decline observed in the American Eel population (ASMFC, 2023). Current cumulative survival estimates for the Susquehanna River result in estimated egg production from the entire river that is equivalent or only slightly higher than when compared to egg production that would occur by not allowing access to all but the lowermost 10 miles of river downstream of Conowingo Dam. Although there are ecosystem benefits by continuing the introduction of American Eels into the Susquehanna River upstream of the main stem dams, the current level of cumulative survival is precluding the Susquehanna River from contributing any substantial benefits to the restoration of the coast-wide American Eel population.

The natural mortality for downstream migrating silver eels in the Susquehanna River is assumed to be low. Survival estimates for river sections that did not contain dams was 98% in this study, but this estimate reflects a combination of natural mortality and delayed mortality that may have occurred from injury while passing an upstream hydroelectric dam. In a study conducted on the undammed main stem of the Delaware River from 2021 to 2024, survival of silver eels migrating from the upper freshwater river to the estuary was 100% (D. Fox, pers. comm., 16 September 2025). Based on the high survival in the Susquehanna in undammed river

sections cand no natural mortality observed in the nearby Delaware River study, it is assumed that natural mortality on silver eels migrating through the lower Susquehanna River is negligible.

Apparent survival at each dam, assumed from a positive detection of an eel moving past an array downstream of a river section that contained a dam during the study, ranged from 60% to 94% over the study years. Although individual project survival estimates provide insight on location and prevailing conditions associated with eel mortality in the lower Susquehanna River, this study was not designed specifically to assess survival at individual projects. Individual project survival may be overestimated if eels are injured or killed and continue to drift downstream to the next project or receiver array (see Havn et al., 2017). Conversely, survival may be underestimated at a project if an eel is mortally injured at an upstream facility and dies within the river section containing a downstream dam. Survival may also be underestimated if tag shedding occurred during downstream passage.

Results of previous site-specific studies at Conowingo (USFWS, 2012) and York Haven (YHPC, 2023, 2024) to assess project survival reported similar apparent survival results to this study. However, this study suggests that survival in the river section that contained the Muddy Run Pumped Storage Facility was lower than documented in previous studies (Normandeau Associates and Gomez and Sullivan Engineers, 2012). The estimated apparent survival for this study is similar to the survival documented in the earlier Muddy Run study, but only for eels exposed to pumping operations in the earlier study. The Muddy Run Pumped Storage Facility can entrain eels from the Susquehanna River while the project is in pumping mode, but the project does not necessarily operate in the pumping mode during the entire time period and seasonal period of eel passage in the Susquehanna River. While most eel passage events at Muddy Run could not be definitively assigned to pumping, idle, or generating phases, nighttime

activity at arrays indicates that eels likely passed the Muddy Run Pumped Storage facility at night. Generally, the Muddy Run Pumped Storage Facility operates in pumping mode from 22:00 – 07:00 (Normandeau Associates and Gomez and Sullivan Engineers, 2012), so it is possible that eels in this study were entrained at a higher rate than previously documented as they may have been following a more natural downstream migration timing that occurred in the previous study using out-of-basin eels. Conversely, the Muddy Run Pumped Storage Facility operates a relatively short distance downstream of the Holtwood Dam on the same side of the river as the Holtwood tailrace. It is possible that eel mortality at the Holtwood Dam is higher than this study suggests, with injured or dead eels originating at Holtwood being conflated with mortality attributed to Muddy Run operations. A site-specific study of eel survival at Holtwood Dam is needed to evaluate injury and mortality caused by that project. If site-specific studies at Holtwood support the apparent survival estimates in this study, additional assessment of eel passage at Muddy Run may be necessary. Because results indicate that eel survival at Safe Harbor may be the lowest of any dam on the river, the Safe Harbor project should also be assessed for downstream eel injury and mortality.

This study effectively describes demographics and the downstream migration season for mature American Eel in the Susquehanna River. While dams may not delay migration, cumulative survival of eels escaping the Susquehanna River is reduced with dam passage. The loss of these large, fecund females removes the reproductive potential for these fish to contribute to the panmictic population of this species. Studies that identify route of passage under different operating conditions and project survival at the hydroelectric dams are needed to determine if the apparent project survival rates are representative of the specific projects. Results from this study combined with site-specific studies may determine if and when eel protection measures are

needed at hydroelectric dams on the Susquehanna River to better protect downstream migrating American Eels.

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TABLES

Table 1. Summary of USFWS (2007-2016) and Constellation (2017-present) American Eel elver trap and transport activities in the Susquehanna River. Eel collection ramps were operated at both Conowingo Dam and Octoraro Creek, a tributary of the lower Susquehanna River.

Year	Conowingo Collection	Octoraro Collection	# Stocked
2007	3,881		0
2008	44,006		17,504
2009	17,437		15,316
2010	23,896		35,525
2011	84,961		126,156
2012	127,013		120,315
2013	293,141		275,479
2014	185,628		168,267
2015	58,444	7,197	58,692
2016	2,684	21,094	22,598
2017	122,300	11,347	129,902
2018	67,949	4,203	69,803
2019	126,181	14,170	139,875
2020	254,405	3,597	255,410
2021	623,095	45,230	656,671
2022	139,798	7,159	142,200
2023	217,035	62,122	278,545
2024	371,655	84,895	455,136
Totals	**2,763,509**	**261,014**	**2,967,394**

Table 2. Arrays used to determine arrival and departure times at each dam.

Dam Assessed	Upstream Array	Downstream Array	Distance Between Arrays (km)
-	Harrisburg	York Haven Upstream	13.5
York Haven	York Haven Upstream	York Haven Downstream	20.3
-	York Haven Downstream	Safe Harbor Upstream	19.0
Safe Harbor	Safe Harbor Upstream	Holtwood Upstream	16.9
Holtwood	Holtwood Upstream	Muddy Run	7.3
Muddy Run	Muddy Run	Conowingo Upstream	15.0
Conowingo	Conowingo Upstream	Conowingo Downstream	13.0
-	Conowingo Downstream	Havre de Grace	7.9
Total Distance	**Harrisburg to Havre de Grace**		**112.8**

Table 3. American Eel sampling locations and collections from 2021-2023.

Waterbody	Site	E-fishing Gear	Sample Date	Effort (sec.)	Latitude	Longitude	Tagged Eel Count	Untagged Eel Count	Total Eels Collected
Armstrong Creek	-	Backpack	6/8/2022	2075	40.47036	-76.92363	0	0	0
Armstrong Creek	**TOTAL**			*0.58 hrs*			**0**	**0**	**0**
Buffalo Creek	-	Backpack	7/13/2022	1137	40.971665	-76.892491	0	0	0
Buffalo Creek	Creek Rd.	Backpack	8/22/2023	4684	40.93191	-77.03561	6	4	10
Buffalo Creek	PIT Array Site	Backpack	6/14/2023	610	40.970905	-76.886999	0	2	2
Buffalo Creek	Prison	Backpack	7/13/2022	1615	40.976486	-76.919925	1	7	8
Buffalo Creek	Prison	Backpack	7/13/2022	4997	40.985801	-76.927873	0	42	42
Buffalo Creek	Prison	Backpack	8/30/2021	-	40.98466	-76.92646	1	0	1
Buffalo Creek	Recycling Center	Backpack	7/13/2022	2355	40.97091	-76.887414	0	1	1
Buffalo Creek	Shuck Rd.	Backpack	8/22/2023	986	40.91949	-77.10115	0	1	1
Buffalo Creek	Site 2	Backpack	8/2/2022	1157	40.92308	-77.12692	2	0	2
Buffalo Creek	Site 3	Backpack	8/2/2022	1200	40.91966	-77.10118	3	0	3
Buffalo Creek	Site 3	Backpack	6/15/2023	1728	40.919746	-77.101001	2	4	6
Buffalo Creek	Site 5	Backpack	8/31/2021	-	-	-	1	0	1
Buffalo Creek	Site 5	Backpack	8/2/2022	2400	40.93468	-77.03318	2	0	2
Buffalo Creek	Site 5	Backpack	8/8/2023	2716	40.932567	-77.035157	1	1	2
Buffalo Creek	Site 5	Backpack	6/15/2023	2123	40.932567	-77.035157	0	6	6
Buffalo Creek	Strawberry Bridge	Backpack	7/13/2022	4464	40.9857	-76.932095	0	45	45
Buffalo Creek	Strawberry Bridge	Backpack	7/19/2023	3960	-	-	0	33	33
Buffalo Creek	Swinging Bridge	Backpack	8/1/2022	6958	40.979051	-76.951766	6	0	6
Buffalo Creek	Swinging Bridge	Backpack	6/14/2023	2368	40.9795095	-76.9518974	3	22	25
Buffalo Creek	Swinging Bridge	Backpack	8/9/2023	4768	40.93191	-77.03561	1	4	5
Buffalo Creek	Swinging Bridge	Backpack	9/19/2023	6046	40.9795095	-76.9518974	4	8	12
Buffalo Creek	Swinging Bridge	Backpack	8/9/2023	3454	-	-	0	2	2
Buffalo Creek	**TOTAL**			*16.59 hrs*			*33*	*182*	*215*
Clark Creek	-	Backpack	6/8/2022	1632	40.38873	-76.94159	0	0	0

Waterbody	Site	E-fishing Gear	Sample Date	Effort (sec.)	Latitude	Longitude	Tagged Eel Count	Untagged Eel Count	Total Eels Collected
Clark Creek	**TOTAL**			**0.45 hrs**			*0*	*0*	*0*
Conodoguinet	Acri Park	Backpack	8/1/2023	4216	40.219323	-76.861595	0	22	22
Conodoguinet	Acri Park	Backpack	6/6/2023	5367	40.271025	-76.951885	1	29	30
Conodoguinet	Acri Park	Backpack	8/17/2023	5080	40.26512	-76.94938	0	33	33
Conodoguinet	Appalach. Trail	Backpack	6/9/2023	4293	40.2596321	-77.1031319	1	33	34
Conodoguinet	Appalach. Trail	Backpack	8/3/2023	3866	40.2596321	-77.1031319	1	24	25
Conodoguinet	Creek Rd.	Backpack	6/9/2022	5720	40.25542	-76.92743	1	0	1
Conodoguinet	Creek Rd.	Backpack	6/10/2022	1681	40.25542	-76.92743	0	7	7
Conodoguinet	Creek Rd.	Backpack	8/1/2023	2817	40.255182	-76.922195	2	63	65
Conodoguinet	Creekview Park	Backpack	8/18/2023	2051	40.2368801	-77.1938046	2	23	25
Conodoguinet	Creekview Park	Backpack	9/12/2023	4005	40.2368801	-77.1938046	2	31	33
Conodoguinet	Creekview Park	Backpack	8/18/2022	9903	40.235813	-77.192971	6	37	43
Conodoguinet	DeFillippo Preserve	Backpack	9/8/2023	2278	40.2556481	-77.0187575	0	12	12
Conodoguinet	DiFilippo Preserve	Backpack	7/19/2022	1414	40.256204	-77.018974	3	7	10
Conodoguinet	DiFilippo Preserve	Backpack	7/14/2022	4206	40.256204	-77.018974	6	14	20
Conodoguinet	DiFilippo Preserve	Backpack	8/15/2023	4439	40.2556481	-77.0187575	1	27	28
Conodoguinet	DiFilippo Preserve	Backpack	6/7/2023	4195	40.2556481	-77.0187575	2	41	43
Conodoguinet	Durkin Park	Backpack	9/14/2023	5749	40.2633683	-76.9853227	5	28	33
Conodoguinet	Durkin Park	Backpack	8/2/2023	4678	40.2633683	-76.9853227	2	43	45
Conodoguinet	East Pennsboro	Backpack	6/10/2022	5470	40.27103	-76.95187	3	15	18
Conodoguinet	East Pennsboro	Backpack	8/16/2022	6893	40.27103	-76.95187	8	32	40
Conodoguinet	Good Hope	Backpack	6/21/2022	3918	40.258725	-76.976364	2	16	18
Conodoguinet	Good Hope	Backpack	6/29/2023	3057	40.259459	-76.9764827	0	30	30
Conodoguinet	Hidden Creek Park	Backpack	8/2/2023	1437	40.2599171	-77.0123608	0	8	8
Conodoguinet	Hidden Creek Park	Backpack	7/14/2022	2620	40.254348	-77.009202	2	7	9
Conodoguinet	Hospital	Backpack	8/16/2023	2918	40.2579539	-76.9250753	0	9	9

Waterbody	Site	E-fishing Gear	Sample Date	Effort (sec.)	Latitude	Longitude	Tagged Eel Count	Untagged Eel Count	Total Eels Collected
Conodoguinet	Indian Cr. Rec. Club	Backpack	8/17/2023	4286	40.252005	-76.967245	0	27	27
Conodoguinet	Letort Falls	Backpack	7/28/2022	1359	40.23589	-77.141137	1	10	11
Conodoguinet	Letort Falls	Backpack	8/16/2022	4409	40.23589	-77.141137	1	11	12
Conodoguinet	Letort Falls	Backpack	8/18/2023	6238	40.2374291	-77.1412437	0	41	41
Conodoguinet	Longs Gap Rd.	Backpack	8/18/2022	3317	40.224808	-77.189679	0	4	4
Conodoguinet	Mowery Const.	Backpack	6/7/2023	2477	40.258763	-77.026374	0	17	17
Conodoguinet	N. Middleton Park	Backpack	8/16/2022	880	40.231291	-77.217763	0	0	0
Conodoguinet	N. Middleton Park	Backpack	8/16/2022	880	40.231291	-77.217763	0	0	0
Conodoguinet	Oyster Mill Rd.	Backpack	8/16/2023	1297	40.2698891	-76.9420822	0	2	2
Conodoguinet	Pine Hill Arb.	Backpack	6/6/2023	2366	40.2715843	-76.9312282	1	21	22
Conodoguinet	Ridley Park	Backpack	6/9/2022	4110	40.27706	-76.92563	1	7	8
Conodoguinet	Ridley Park	Backpack	9/8/2023	1949	40.2772531	-76.9252625	0	28	28
Conodoguinet	Ridley Park	Backpack	8/15/2023	4435	40.2772531	-76.9252625	3	61	64
Conodoguinet	Srouji Park	Backpack	9/22/2022	1519	40.243376	-76.970562	2	4	6
Conodoguinet	Srouji Park	Backpack	6/15/2022	2366	40.243376	-76.970562	1	13	14
Conodoguinet	Srouji Park	Backpack	6/21/2022	3554	40.243376	-76.970562	5	17	22
Conodoguinet	Srouji Park	Backpack	8/31/2023	4628	40.2433113	-76.9709045	3	19	22
Conodoguinet	Srouji Park	Backpack	6/29/2023	4805	40.2433113	-76.9709045	1	35	36
Conodoguinet	Srouji Park	Backpack	7/27/2023	4216	40.219323	-76.861595	3	35	38
Conodoguinet	Valley View Dr.	Backpack	8/3/2023	1354	40.256047	-77.082358	0	7	7
Conodoguinet	Valley View Dr.	Backpack	6/7/2023	1192	40.256047	-77.082358	0	12	12
Conodoguinet	Willow Mill Park	Backpack	7/13/2022	3913	40.261074	-77.041454	1	14	15
Conodoguinet	Willow Mill Park	Backpack	9/22/2022	949	40.261074	-77.041454	0	4	4
Conodoguinet	Willow Mill Park	Backpack	8/2/2023	2999	40.259327	-77.0413451	0	23	23
Conodoguinet	Youth Park	Backpack	6/10/2022	2765	40.25385	-76.95926	2	9	11
Conodoguinet	Youth Park	Backpack	8/1/2023	2817	40.25347	-76.9593	2	27	29
Conodoguinet	Youth Park	Backpack	9/13/2023	6098	40.25347	-76.9593	12	45	57

Waterbody	Site	E-fishing Gear	Sample Date	Effort (sec.)	Latitude	Longitude	Tagged Eel Count	Untagged Eel Count	Total Eels Collected
Conodoguinet Cr.	*TOTAL*			*50.96 hrs*			*89*	*1084*	*1173*
Fishing Creek	East	Backpack	6/8/2022	555	40.34362	-76.91002	0	0	0
Fishing Creek	West	Backpack	6/8/2022	1053	40.32999	-76.96015	0	0	0
Fishing Creek	West	Backpack	6/8/2022	1327	40.33742	-76.92916	0	0	0
Fishing Creek	*West*			*0.82 hrs*			*0*	*0*	*0*
Juniata River	Amity Hall	Boat	9/6/2023	9148	40.4309045	-77.0132787	2	5	7
Juniata River	Amity Hall	Boat	7/18/2023	9192	40.4309045	-77.0132787	3	7	10
Juniata River	Amity Hall	Boat	8/23/2023	11085	40.4309045	-77.0132787	6	4	10
Juniata River	Amity Hall	Boat	8/3/2021	715	40.43085	-77.01033	7	4	11
Juniata River	Amity Hall	Boat	7/11/2022	-	40.430838	-77.013312	8	13	21
Juniata River	Amity Hall	Boat	6/8/2023	-	40.4309045	-77.0132787	12	10	22
Juniata River	Amity Hall	Boat	8/25/2022	-	40.430838	-77.013312	15	21	36
Juniata River	Central Juniata Pk.	Backpack	6/22/2022	1029	40.565967	-77.400887	0	0	0
Juniata River	Central Juniata Pk.	Backpack	6/22/2022	1029	40.565967	-77.400887	0	0	0
Juniata River	Greenwood	Boat	8/10/2021	6952	40.53	-77.14252	5	5	10
Juniata River	Greenwood	Boat	7/12/2022	-	40.530229	-77.142092	6	6	12
Juniata River	Howe Twp Access	Boat	7/12/2022	-	40.491791	-77.097022	0	0	0
Juniata River	Howe Twp Access	Boat	7/12/2022	-	40.491791	-77.097022	0	0	0
Juniata River	Howe Twp Access	Boat	6/28/2023	6290	40.491704	-77.097208	1	5	6
Juniata River	Lewistown Narrow	Boat	8/3/2022	-	40.604216	-77.470981	3	8	11
Juniata River	Lewistown Narrow	Backpack	6/22/2022	1497	40.604216	-77.470981	0	0	0
Juniata River	Millerstown	Backpack	6/22/2022	1144	40.540348	-77.150332	0	0	0
Juniata River	Millerstown	Backpack	6/22/2022	1144	40.540348	-77.150332	0	0	0
Juniata River	Greenwood Access	Boat	8/30/2023	7819	40.5302092	-77.1421994	3	4	7
Juniata River	Greenwood Access	Boat	6/28/2023	10044	40.5302092	-77.1421994	6	11	17
Juniata River	Thompsontown	Boat	7/12/2022	-	40.554281	-77.235888	3	1	4
Juniata River	Victory Park	Backpack	6/22/2022	495	40.594518	-77.578151	0	0	0

Waterbody	Site	E-fishing Gear	Sample Date	Effort (sec.)	Latitude	Longitude	Tagged Eel Count	Untagged Eel Count	Total Eels Collected
Juniata River	*TOTAL*			*19.59 hrs*			*80*	*104*	*184*
Middle Creek		Backpack	7/11/2022	1494	40.773718	-77.153133	0	1	1
Middle Creek	*TOTAL*			*0.42 hrs*			*0*	*1*	*1*
Penns Creek	-	-	7/11/2022	-	40.827586	-76.868472	0	0	0
Penns Creek	Millmont	Backpack	7/11/2022	1007	40.878505	-77.155537	0	0	0
Penns Creek	New Berlin	Backpack	7/11/2022	985	40.876138	-76.983597	0	0	0
Penns Creek	Weikert	-	7/11/2022	-	40.856939	-77.294473	0	0	0
Penns Creek	*TOTAL*			*0.55 hrs*			0	0	0
Sherman Creek	Dellville Cover Br.	Backpack	6/21/2022	1055	40.364515	-77.115257	0	0	0
Sherman Creek	Mountainview Rd	Backpack	6/21/2022	568	40.344288	-77.152628	0	0	0
Sherman Creek	Zeigler 1	Backpack	7/28/2022	1369	40.351782	-77.395334	0	0	0
Sherman Creek	Zeigler Dam	Backpack	7/28/2022	1104	40.347282	-77.396149	0	0	0
Sherman Creek	*TOTAL*			*1.14 hrs*			*0*	*0*	*0*
Susquehanna R.	Clemson Island	Boat	7/27/2022	-	40.469033	-76.949471	5	9	14
Susquehanna R.	Clemson Island	Boat	8/2/2021	-	40.4692	-76.94923	0	0	0
Susquehanna R.	Liverpool	Backpack	7/28/2022	850	40.580184	-76.979541	0	0	0
Susquehanna R.	McKee's Falls	Backpack	7/28/2022	345	40.659288	-76.918228	0	0	0
Susquehanna R.	S Main St.	Boat	9/7/2023	-	40.33242	-76.91738	5	20	25
Susquehanna R.	Shady Nook	Boat	7/27/2022	-	40.822847	-76.839177	0	0	0
Susquehanna R.	Shikellamy St. Park	Boat	7/26/2022	-	40.88346	-76.792651	0	1	1
Susquehanna R.	Shikellamy St. Park	Boat	10/13/2021	-	40.88372	-76.796007	2	0	2
Susquehanna R.	Warrior Trail Ramp	Boat	8/17/2022	-	41.178671	-76.106796	1	3	4
Susquehanna R.	*TOTAL*			*0.33 hrs*			*13*	*33*	*46*
Tuscarora Cr.	Market St.	Backpack	6/22/2022	4162	40.527447	-77.391389	1	0	1
Tuscarora Cr.		Backpack	7/12/2023	6652	40.527447	-77.391389	0	2	2
Tuscarora Cr.	*TOTAL*			*3.00 hrs*			*1*	*2*	*3*

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Waterbody	Site	E-fishing Gear	Sample Date	Effort (sec.)	Latitude	Longitude	Tagged Eel Count	Untagged Eel Count	Total Eels Collected
Wiconisco Creek	-	Backpack	6/8/2022	1807	40.53523	-76.94961	0	0	0
Wiconisco Creek				*0.50 hrs*			*0*	*0*	*0*
Yellow Breeches	Mouth	Backpack	7/27/2023	813	40.22571	-76.86085	1	0	1
Yellow Breeches	*TOTAL*			*0.23 hrs*			*1*	*0*	*1*
ALL	*TOTAL*			*95.16 hrs*			*217*	*1406*	*1623*

Table 4. Biological data and tag information for 217 eels tagged by USFWS staff from 2021-2023. Eels that initiated downstream migration are identified in bold text.

Tag ID	Tagging Date	Migration Year	Color Phase	Collection & Release Waterbody	Total Length (mm)	Weight (g)	Eye Width (mm)	Eye Height (mm)	Pankhurst Eye Index (I)
A69-1602-60044	**8/10/2021**	**2021**	**Pre-silver**	**Juniata River**	**757**	**1180**	**9.8**	**9.6**	**9.8**
A69-1602-60045	**10/13/2021**	**2022**	**Pre-silver**	**Susquehanna River**	**668**	**710**	**6.3**	**6.3**	**4.7**
A69-1602-60046	8/3/2021		Pre-silver	Juniata River	705	940	8.1	7.2	6.5
A69-1602-60047	8/31/2021		Pre-silver	Buffalo Creek	673	750	8.8	8.8	9
A69-1602-60048	**8/10/2021**	**2021**	**Pre-silver**	**Juniata River**	**807**	**1130**	**8.3**	**7.9**	**6.4**
A69-1602-60049	**8/1/2022**	**2022**	**Pre-silver**	**Buffalo Creek**	**707**	**870**	**7.9**	**7.3**	**6.4**
A69-1602-60050	**8/10/2021**	**2021**	**Silver**	**Juniata River**	**766**	**1000**	**8.2**	**7.8**	**6.6**
A69-1602-60051	**8/1/2022**	**2022**	**Pre-silver**	**Buffalo Creek**	**700**	**820**	**8**	**7.7**	**6.9**
A69-1602-60052	8/10/2021		Pre-silver	Juniata River	752	1040	8.2	6.9	6
A69-1602-60053	8/30/2021		Silver	Buffalo Creek	719	925	9	7.8	7.7
A69-1602-60054	**8/3/2021**	**2021**	**Silver**	**Juniata River**	**783**	**1140**	**8.2**	**8.3**	**6.8**
A69-1602-60055	8/1/2022		Silver	Buffalo Creek	800	1250	9.2	8.6	7.8
A69-1602-60056	**8/3/2021**	**2021**	**Pre-silver**	**Juniata River**	**825**	**1540**	**9.7**	**9.2**	**8.5**
A69-1602-60057	8/1/2022		Pre-silver	Buffalo Creek	705	890	7.8	7.4	6.4
A69-1602-60058	8/3/2021		Pre-silver	Juniata River	721	1050	7.7	7.7	6.5
A69-1602-60059	8/2/2022		Silver	Buffalo Creek	833	1325	9.3	8.8	7.7
A69-1602-60060	**8/3/2021**	**2021**	**Silver**	**Juniata River**	**772**	**1230**	**9.6**	**9.6**	**9.4**
A69-1602-60061	8/1/2022		Pre-silver	Buffalo Creek	707	890	8.4	7.8	7.3
A69-1602-60062	**8/3/2021**	**2021**	**Silver**	**Juniata River**	**850**	**1700**	**8.9**	**9.1**	**7.5**
A69-1602-60063	**10/13/2021**	**2021**	**Silver**	**Susquehanna River**	**705**	**810**	**8.1**	**8.4**	**7.6**
A69-1602-60064	**8/3/2021**	**2021**	**Silver**	**Juniata River**	**815**	**1320**	**8.9**	**8.9**	**7.6**
A69-1602-60065	8/10/2021		Silver	Juniata River	875	1590	9.8	9.7	8.5
A69-1604-14641	**6/8/2023**	**2023**	**Pre-Silver**	**Juniata River**	**728**	**1040**	**8.3**	**7.6**	**6.82**
A69-1604-14642	6/8/2023		Pre-Silver	Juniata River	766	1040	8.2	7.4	6.24
A69-1604-14643	**6/8/2023**	**2023**	**Pre-Silver**	**Juniata River**	**796**	**1430**	**8.6**	**7.9**	**6.72**

Tag ID	Tagging Date	Migration Year	Color Phase	Collection & Release Waterbody	Total Length (mm)	Weight (g)	Eye Width (mm)	Eye Height (mm)	Pankhurst Eye Index (*I*)
A69-1604-14644	6/8/2023		Pre-Silver	Juniata River	738	1080	8	7.4	6.31
A69-1604-14645	6/9/2023		Pre-Silver	Conodoguinet Creek	675	-	8.3	7.7	7.45
A69-1604-14646	**6/14/2023**	**2023**	**Pre-Silver**	**Buffalo Creek**	**705**	**780**	**8.1**	**7.5**	**6.78**
A69-1604-14647	**6/14/2023**	**2023**	**Pre-Silver**	**Buffalo Creek**	**707**	**930**	**8.3**	**7.9**	**7.29**
A69-1604-14648	**6/14/2023**	**2023**	**Pre-Silver**	**Buffalo Creek**	**697**	**870**	**8.7**	**7.8**	**7.67**
A69-1604-14649	6/15/2023		Pre-Silver	Buffalo Creek	715	780	7.9	7.2	6.26
A69-1604-14650	6/15/2023		Pre-Silver	Buffalo Creek	731	830	9	8.2	7.95
A69-1604-14651	6/28/2023		Silver	Juniata River	813	1450	8.57	7.63	6.34
A69-1604-14652	**6/28/2023**	**2023**	**Silver**	**Juniata River**	**747**	**1200**	**7.74**	**7**	**5.71**
A69-1604-14653	6/28/2023		Silver	Juniata River	777	1225	7.15	7.52	5.44
A69-1604-14654	**6/28/2023**	**2023**	**Silver**	**Juniata River**	**748**	**1300**	**7.13**	**6.63**	**4.97**
A69-1604-14655	**6/28/2023**	**2023**	**Silver**	**Juniata River**	**831**	**1520**	**7.15**	**6.79**	**4.59**
A69-1604-14656	6/28/2023		Pre-Silver	Juniata River	720	1000	7.02	7.23	5.54
A69-1604-14657	**6/28/2023**	**2023**	**Silver**	**Juniata River**	**829**	**1490**	**8.06**	**8.04**	**6.14**
A69-1604-14658	**6/29/2023**	**2023**	**Pre-Silver**	**Conodoguinet Creek**	**737**	**990**	**8.3**	**7.74**	**6.85**
A69-1604-14659	**7/18/2023**	**2023**	**Silver**	**Juniata River**	**831**	**1550**	**7.08**	**6.49**	**4.35**
A69-1604-14660	**7/18/2023**	**2023**	**Silver**	**Juniata River**	**815**	**1458**	**7.8**	**7.55**	**5.68**
A69-1604-14661	**7/18/2023**	**2023**	**Silver**	**Juniata River**	**784**	**1540**	**6.88**	**7.18**	**4.95**
A69-1604-14662	**7/26/2023**	**2023**	**Pre-Silver**	**Yellow Breeches Creek**	**780**	**1450**	**8.16**	**8.19**	**6.73**
A69-1604-14663	7/27/2023		Silver	Conodoguinet Creek	827	1710	8.15	7.75	6
A69-1604-14664	**7/27/2023**	**2023**	**Pre-Silver**	**Conodoguinet Creek**	**734**	**1024**	**7.47**	**7.97**	**6.38**
A69-1604-14665	**7/27/2023**	**2023**	**Pre-Silver**	**Conodoguinet Creek**	**726**	**1080**	**8.06**	**7.58**	**6.62**
A69-1604-14666	**8/1/2023**	**2023**	**Pre-Silver**	**Conodoguinet Creek**	**744**	**1100**	**7.85**	**7.74**	**6.41**
A69-1604-14667	8/1/2023		Silver	Conodoguinet Creek	730	900	8.19	7.96	7.02
A69-1604-14668	**8/1/2023**	**2023**	**Silver**	**Conodoguinet Creek**	**735**	**950**	**8.03**	**7.53**	**6.47**
A69-1604-14669	**8/1/2023**	**2023**	**Silver**	**Conodoguinet Creek**	**759**	**1050**	**9.35**	**7.75**	**7.56**
A69-1604-14670	**8/2/2023**	**2023**	**Pre-Silver**	**Conodoguinet Creek**	**736**	**920**	**7.78**	**7.48**	**6.21**

Tag ID	Tagging Date	Migration Year	Color Phase	Collection & Release Waterbody	Total Length (mm)	Weight (g)	Eye Width (mm)	Eye Height (mm)	Pankhurst Eye Index (*I*)
A69-1604-14671	**8/2/2023**	**2024**	**Pre-Silver**	**Conodoguinet Creek**	**671**	**780**	**8.5**	**7.58**	**7.57**
A69-1604-14672	**8/3/2023**	**2023**	**Silver**	**Conodoguinet Creek**	**743**	**930**	**7.83**	**6.97**	**5.79**
A69-1604-14673	**8/8/2023**	**2024**	**Silver**	**Buffalo Creek**	**743**	**820**	**-**	**-**	**-**
A69-1604-14674	**8/9/2023**	**2023**	**Silver**	**Buffalo Creek**	**677**	**790**	**8**	**8.5**	**7.9**
A69-1604-14675	8/15/2023		Silver	Conodoguinet Creek	745	1250	8.18	7.57	6.54
A69-1604-14676	8/15/2023		Pre-Silver	Conodoguinet Creek	724	940	7.35	7.31	5.83
A69-1604-14677	8/15/2023		Pre-Silver	Conodoguinet Creek	720	960	8.12	7.58	6.72
A69-1604-14678	**8/15/2023**	**2023**	**Pre-Silver**	**Conodoguinet Creek**	**748**	**1000**	**7.64**	**7.19**	**5.77**
A69-1604-14679	**8/18/2023**	**2023**	**Silver**	**Conodoguinet Creek**	**733**	**1100**	**8.97**	**7.84**	**7.57**
A69-1604-14680	8/18/2023		Silver	Conodoguinet Creek	680	800	8.46	7.47	7.33
A69-1604-14681	**8/22/2023**	**2023**	**Pre-Silver**	**Buffalo Creek**	**733**	**1050**	**7.05**	**7.05**	**5.33**
A69-1604-14682	**8/22/2023**	**2023**	**Silver**	**Buffalo Creek**	**732**	**985**	**7.71**	**7.67**	**6.34**
A69-1604-14683	6/8/2023		Silver	Juniata River	741	1530	8.3	7.7	6.78
A69-1604-14684	**6/8/2023**	**2023**	**Silver**	**Juniata River**	**844**	**1720**	**9.4**	**8.6**	**7.54**
A69-1604-14685	**6/8/2023**	**2023**	**Pre-Silver**	**Juniata River**	**872**	**1640**	**8.6**	**7.9**	**6.13**
A69-1604-14686	**6/8/2023**	**2024**	**Pre-Silver**	**Juniata River**	**764**	**890**	**8.1**	**7.8**	**6.5**
A69-1604-14687	**6/8/2023**	**2023**	**Silver**	**Juniata River**	**754**	**1150**	**8.2**	**7.6**	**6.5**
A69-1604-14688	**6/8/2023**	**2023**	**Pre-Silver**	**Juniata River**	**745**	**1080**	**7.7**	**7.2**	**5.85**
A69-1604-14689	**6/8/2023**	**2023**	**Pre-Silver**	**Juniata River**	**706**	**880**	**8.2**	**7.6**	**6.94**
A69-1604-14690	8/22/2023	2024	Silver	Buffalo Creek	738	880	7.31	6.98	5.43
A69-1604-14691	**9/19/2023**	**2023**	**Silver**	**Buffalo Creek**	**805**	**1140**	**9.25**	**8.68**	**7.84**
A69-1604-14692	**9/19/2023**	**2023**	**Silver**	**Buffalo Creek**	**760**	**980**	**8.79**	**8.44**	**7.67**
A69-1604-14693	**9/19/2023**	**2024**	**Silver**	**Buffalo Creek**	**741**	**900**	**8.9**	**7.79**	**7.38**
A69-1604-14694	**9/19/2023**	**2023**	**Silver**	**Buffalo Creek**	**813**	**1350**	**10.31**	**9.12**	**9.12**
A69-1604-14695	**9/14/2023**	**2023**	**Pre-Silver**	**Conodoguinet Creek**	**769**	**1040**	**8.29**	**7.46**	**6.33**
A69-1604-14696	**9/14/2023**	**2023**	**Pre-Silver**	**Conodoguinet Creek**	**725**	**980**	**8.59**	**7.49**	**7**
A69-1604-14697	**9/14/2023**	**2023**	**Silver**	**Conodoguinet Creek**	**718**	**975**	**8.76**	**7.75**	**7.45**

Tag ID	Tagging Date	Migration Year	Color Phase	Collection & Release Waterbody	Total Length (mm)	Weight (g)	Eye Width (mm)	Eye Height (mm)	Pankhurst Eye Index (*I*)
A69-1604-14698	9/14/2023	2023	Silver	Conodoguinet Creek	763	1000	8.57	8.13	7.18
A69-1604-14699	9/14/2023	2023	Silver	Conodoguinet Creek	749	975	8.09	8.1	6.87
A69-1604-14700	9/13/2023	2023	Pre-Silver	Conodoguinet Creek	755	1050	8.94	7.88	7.36
A69-1604-14701	9/13/2023	2023	Pre-Silver	Conodoguinet Creek	710	880	9.22	7.93	8.13
A69-1604-14702	9/13/2023	2023	Silver	Conodoguinet Creek	771	1080	8.72	7.36	6.58
A69-1604-14703	9/13/2023	2023	Pre-Silver	Conodoguinet Creek	743	900	8.86	7.71	7.26
A69-1604-14704	9/13/2023	2023	Pre-Silver	Conodoguinet Creek	797	1000	9.23	8.11	7.41
A69-1604-14705	9/13/2023	2023	Pre-Silver	Conodoguinet Creek	751	1050	8.92	7.88	7.38
A69-1604-14706	9/13/2023	2023	Silver	Conodoguinet Creek	752	1000	8.58	7.65	6.88
A69-1604-14707	9/13/2023	2023	Silver	Conodoguinet Creek	727	810	8.48	7.32	6.74
A69-1604-14708	9/13/2023	2023	Silver	Conodoguinet Creek	726	980	8.39	7.89	7.17
A69-1604-14709	9/13/2023	2023	Silver	Conodoguinet Creek	741	1020	9.14	8.23	7.99
A69-1604-14710	9/13/2023	2023	Silver	Conodoguinet Creek	813	1360	9.07	8.44	7.4
A69-1604-14711	9/13/2023	2023	Silver	Conodoguinet Creek	771	1000	8.33	7.91	6.72
A69-1604-14712	9/13/2023	2023	Silver	Conodoguinet Creek	755	900	9.35	8.23	8.04
A69-1604-14713	9/12/2023	2023	Silver	Conodoguinet Creek	727	950	8.25	7.59	6.78
A69-1604-14714	9/7/2023	2023	Silver	Susquehanna	864	1400	10.65	9.17	8.93
A69-1604-14715	9/7/2023	2023	Silver	Susquehanna	891	1550	10.81	9.11	8.74
A69-1604-14716	9/7/2023		Pre-Silver	Susquehanna	725	900	7.74	6.94	5.84
A69-1604-14717	9/7/2023	2023	Silver	Susquehanna	721	900	8.82	8.04	7.74
A69-1604-14718	9/7/2023	2024	Silver	Susquehanna	756	1000	8.11	7.61	6.42
A69-1604-14719	9/6/2023	2023	Silver	Juniata River	896	1400	8.48	7.87	5.86
A69-1604-14720	9/6/2023		Pre-Silver	Juniata River	806	1200	7.87	7.22	5.55
A69-1604-14721	8/31/2023	2023	Pre-Silver	Conodoguinet Creek	740	1025	8.55	7.42	6.77
A69-1604-14722	8/31/2023	2023	Silver	Conodoguinet Creek	816	1450	8.26	7.05	5.64
A69-1604-14723	8/31/2023	2023	Silver	Conodoguinet Creek	792	1175	9.38	7.96	7.45
A69-1604-14724	8/30/2023	2023	Silver	Juniata River	771	1250	8.71	7.39	6.6

Tag ID	Tagging Date	Migration Year	Color Phase	Collection & Release Waterbody	Total Length (mm)	Weight (g)	Eye Width (mm)	Eye Height (mm)	Pankhurst Eye Index (I)
A69-1604-14725	**8/30/2023**	**2023**	**Silver**	**Juniata River**	**833**	**1350**	**9.14**	**8.27**	**7.14**
A69-1604-14726	**8/30/2023**	**2024**	**Pre-Silver**	**Juniata River**	**740**	**950**	**7.85**	**7.12**	**5.95**
A69-1604-14727	**8/23/2023**	**2024**	**Pre-Silver**	**Juniata River**	**765**	**1075**	**7.37**	**6.81**	**5.16**
A69-1604-14728	8/23/2023		Pre-Silver	Juniata River	728	825	8.12	6.82	6.02
A69-1604-14729	**8/23/2023**	**2023**	**Silver**	**Juniata River**	**834**	**1500**	**9.04**	**7.56**	**6.49**
A69-1604-14730	**8/23/2023**	**2024**	**Pre-Silver**	**Juniata River**	**679**	**780**	**8.47**	**7.06**	**6.97**
A69-1604-14731	**8/23/2023**	**2023**	**Silver**	**Juniata River**	**774**	**1150**	**8.45**	**7.8**	**6.7**
A69-1604-14732	8/23/2023		Pre-Silver	Juniata River	785	1020	8.27	7.37	6.12
A69-1604-14733	8/22/2023		Silver	Buffalo Creek	748	1075	7.63	7.74	6.2
A69-1604-14734	8/22/2023		Pre-Silver	Buffalo Creek	729	850	8.21	7.92	7.01
A69-1604-14735	**8/22/2023**	**2024**	**Silver**	**Buffalo Creek**	**776**	**1000**	**8.03**	**7.82**	**6.36**
A69-1604-6840	**7/14/2022**	**2022**	**Silver**	**Conodoguinet Creek**	**723**	**1000**	**8.4**	**7.9**	**7.2**
A69-1604-6841	7/14/2022		Pre-silver	Conodoguinet Creek	664	680	7.6	7.3	6.6
A69-1604-6842	7/19/2022		Pre-silver	Conodoguinet Creek	723	790	8.3	7.8	7
A69-1604-6843	7/19/2022		Pre-silver	Conodoguinet Creek	678	1000	7.9	7.6	7
A69-1604-6844	**7/19/2022**	**2022**	**Silver**	**Conodoguinet Creek**	**787**	**1450**	**8.5**	**8.3**	**7**
A69-1604-6845	**8/16/2022**	**2022**	**Silver**	**Conodoguinet Creek**	**860**	**1525**	**10.3**	**9.7**	**9.1**
A69-1604-6846	8/16/2022		Pre-silver	Conodoguinet Creek	720	1000	7.9	7.2	6.2
A69-1604-6847	**8/16/2022**	**2022**	**Pre-silver**	**Conodoguinet Creek**	**770**	**1100**	**8.3**	**7.8**	**6.6**
A69-1604-6848	**8/16/2022**	**2022**	**Silver**	**Conodoguinet Creek**	**751**	**1050**	**8.2**	**7.8**	**6.7**
A69-1604-6849	**8/16/2022**	**2022**	**Pre-silver**	**Conodoguinet Creek**	**733**	**1100**	**8.1**	**7.6**	**6.6**
A69-1604-6850	**8/16/2022**	**2022**	**Pre-silver**	**Conodoguinet Creek**	**692**	**900**	**8.4**	**7.9**	**7.5**
A69-1604-6851	**8/16/2022**	**2022**	**Silver**	**Conodoguinet Creek**	**786**	**1175**	**8.5**	**8.2**	**7**
A69-1604-6852	**8/16/2022**	**2022**	**Pre-silver**	**Conodoguinet Creek**	**708**	**1090**	**8.4**	**8**	**7.5**
A69-1604-6853	**8/17/2022**	**2023**	**Pre-silver**	**Susquehanna River**	**791**	**1180**	**8.5**	**8**	**6.8**
A69-1604-6854	**8/18/2022**	**2022**	**Silver**	**Conodoguinet Creek**	**790**	**1200**	**8.4**	**8**	**6.7**
A69-1604-6855	**8/18/2022**	**2022**	**Silver**	**Conodoguinet Creek**	**760**	**1195**	**8.7**	**7.8**	**7**

Tag ID	Tagging Date	Migration Year	Color Phase	Collection & Release Waterbody	Total Length (mm)	Weight (g)	Eye Width (mm)	Eye Height (mm)	Pankhurst Eye Index (*I*)
A69-1604-6856	8/18/2022		Pre-silver	Conodoguinet Creek	694	870	8.3	7.8	7.3
A69-1604-6857	8/18/2022		Silver	Conodoguinet Creek	720	1000	7	8.3	6.4
A69-1604-6858	**8/18/2022**	**2022**	**Pre-silver**	**Conodoguinet Creek**	**712**	**780**	**8.7**	**8.1**	**7.8**
A69-1604-6859	8/18/2022		Pre-silver	Conodoguinet Creek	711	750	8.5	8.1	7.6
A69-1604-6860	**8/25/2022**	**2023**	**Pre-silver**	**Juniata River**	**718**	**965**	**7.5**	**7.2**	**5.9**
A69-1604-6861	**8/25/2022**	**2023**	**Pre-silver**	**Juniata River**	**744**	**915**	**7.8**	**7.8**	**6.4**
A69-1604-6862	**8/25/2022**	**2022**	**Silver**	**Juniata River**	**900**	**1566**	**9.3**	**9.3**	**7.5**
A69-1604-6863	8/25/2022		Silver	Juniata River	745	1058	8.1	7.7	6.6
A69-1604-6864	8/25/2022		Silver	Juniata River	769	1120	8.5	7.6	6.6
A69-1604-6865	8/25/2022		Pre-silver	Juniata River	703	750	8.2	7.7	7.1
A69-1604-6866	**8/25/2022**	**2022**	**Silver**	**Juniata River**	**902**	**1850**	**10.4**	**10.1**	**9.1**
A69-1604-6867	8/25/2022		Pre-silver	Juniata River	750	1000	8.3	7.7	6.7
A69-1604-6868	**8/25/2022**	**2022**	**Silver**	**Juniata River**	**806**	**1520**	**7.9**	**7.8**	**6**
A69-1604-6869	**8/25/2022**	**2023**	**Silver**	**Juniata River**	**732**	**920**	**8.3**	**7.8**	**7**
A69-1604-6870	**8/25/2022**	**2022**	**Silver**	**Juniata River**	**816**	**1260**	**8.2**	**7.9**	**6.2**
A69-1604-6871	**8/25/2022**	**2023**	**Pre-silver**	**Juniata River**	**766**	**960**	**7.9**	**7.2**	**5.8**
A69-1604-6872	**8/25/2022**	**2023**	**Pre-silver**	**Juniata River**	**740**	**1090**	**7.9**	**7.2**	**6**
A69-1604-6873	**8/25/2022**	**2023**	**Pre-silver**	**Juniata River**	**708**	**1000**	**7.8**	**7**	**6.1**
A69-1604-6874	**8/25/2022**	**2022**	**Silver**	**Juniata River**	**761**	**1100**	**8**	**7.8**	**6.4**
A69-1604-6875	**6/6/2023**	**2023**	**Pre-Silver**	**Conodoguinet Creek**	**707**	**910**	**8**	**7.1**	**6.33**
A69-1604-6876	**9/22/2022**	**2023**	**Pre-silver**	**Conodoguinet Creek**	**695**	**710**	**8.1**	**8.1**	**7.4**
A69-1604-6877	**6/6/2023**	**2023**	**Pre-Silver**	**Conodoguinet Creek**	**705**	**890**	**8.5**	**7.6**	**7.22**
A69-1604-6878	6/7/2023		Pre-Silver	Conodoguinet Creek	707	870	8	7.5	6.67
A69-1604-6879	**6/7/2023**	**2023**	**Pre-Silver**	**Conodoguinet Creek**	**789**	**1150**	**8.3**	**7.8**	**6.45**
A69-1604-6880	**6/8/2023**	**2023**	**Pre-Silver**	**Juniata River**	**838**	**1020**	**10.2**	**9.4**	**9**
A69-1604-6881	**9/22/2022**	**2022**	**Silver**	**Conodoguinet Creek**	**742**	**900**	**9.1**	**9.1**	**8.8**
A69-1604-6882	**6/9/2022**	**2022**	**Pre-silver**	**Conodoguinet Creek**	**708**	**910**	**7.1**	**6.9**	**5.4**

Tag ID	Tagging Date	Migration Year	Color Phase	Collection & Release Waterbody	Total Length (mm)	Weight (g)	Eye Width (mm)	Eye Height (mm)	Pankhurst Eye Index (*I*)
A69-1604-6883	6/9/2022		Pre-silver	Conodoguinet Creek	735	990	7.2	7.2	5.5
A69-1604-6884	6/10/2022		Pre-silver	Conodoguinet Creek	762	1110	6.9	7	5
A69-1604-6885	**6/10/2022**	**2022**	**Pre-silver**	**Conodoguinet Creek**	**695**	**830**	**6.4**	**6.4**	**4.6**
A69-1604-6886	**8/16/2022**	**2022**	**Pre-silver**	**Conodoguinet Creek**	**703**	**970**	**8.3**	**7.8**	**7.2**
A69-1604-6887	**6/10/2022**	**2022**	**Silver**	**Conodoguinet Creek**	**725**	**970**	**7.9**	**7.9**	**6.8**
A69-1604-6888	**6/10/2022**	**2022**	**Pre-silver**	**Conodoguinet Creek**	**729**	**1000**	**7.7**	**7.7**	**6.4**
A69-1604-6889	**6/10/2022**	**2022**	**Pre-silver**	**Conodoguinet Creek**	**687**	**850**	**7.8**	**7.7**	**6.9**
A69-1604-6890	6/15/2022		Silver	Conodoguinet Creek	740	1150	8	8	6.8
A69-1604-6891	**6/21/2022**	**2022**	**Silver**	**Conodoguinet Creek**	**749**	**1150**	**7.9**	**8**	**6.6**
A69-1604-6892	6/21/2022		Silver	Conodoguinet Creek	776	1250	7.7	7.8	6.1
A69-1604-6893	6/21/2022		Pre-silver	Conodoguinet Creek	695	995	7.4	7.5	6.3
A69-1604-6894	**6/21/2022**	**2023**	**Pre-silver**	**Conodoguinet Creek**	**706**	**850**	**7.4**	**7.4**	**6.1**
A69-1604-6895	6/21/2022		Silver	Conodoguinet Creek	745	975	7.5	7.5	5.9
A69-1604-6896	6/21/2022		Pre-silver	Conodoguinet Creek	725	712	7.4	7.3	5.9
A69-1604-6897	**6/21/2022**	**2022**	**Pre-silver**	**Conodoguinet Creek**	**699**	**730**	**7.6**	**7.3**	**6.2**
A69-1604-6898	**6/22/2022**	**2022**	**Silver**	**Tuscarora Creek**	**812**	**1290**	**8.6**	**8.8**	**7.3**
A69-1604-6899	7/11/2022		Pre-silver	Juniata River	714	875	7.8	7.7	6.6
A69-1604-6900	**7/11/2022**	**2023**	**Pre-silver**	**Juniata River**	**704**	**930**	**7.8**	**7.8**	**6.8**
A69-1604-6901	**7/11/2022**	**2022**	**Silver**	**Juniata River**	**768**	**1080**	**8.2**	**8.1**	**6.8**
A69-1604-6902	**7/11/2022**	**2022**	**Pre-silver**	**Juniata River**	**722**	**1060**	**7.9**	**7.7**	**6.6**
A69-1604-6903	7/11/2022		Pre-silver	Juniata River	742	890	7.1	7.2	5.4
A69-1604-6904	**7/12/2022**	**2022**	**Silver**	**Juniata River**	**777**	**1400**	**8.6**	**8**	**7**
A69-1604-6905	**7/11/2022**	**2022**	**Pre-silver**	**Juniata River**	**749**	**1090**	**7.3**	**7.2**	**5.5**
A69-1604-6906	7/11/2022		Silver	Juniata River	792	1500	8.6	8.2	7
A69-1604-6907	**7/11/2022**	**2022**	**Silver**	**Juniata River**	**858**	**1100**	**8.5**	**8.3**	**6.5**
A69-1604-6908	**7/12/2022**	**2023**	**Pre-silver**	**Juniata River**	**749**	**980**	**7.5**	**7.3**	**5.7**
A69-1604-6909	7/12/2022		Pre-silver	Juniata River	726	960	7.4	7.4	5.9

Tag ID	Tagging Date	Migration Year	Color Phase	Collection & Release Waterbody	Total Length (mm)	Weight (g)	Eye Width (mm)	Eye Height (mm)	Pankhurst Eye Index (*I*)
A69-1604-6910	7/12/2022		Pre-silver	Juniata River	738	870	7.5	7.4	5.9
A69-1604-6911	7/12/2022		Silver	Juniata River	735	1150	7.6	7.2	5.9
A69-1604-6912	7/12/2022		Pre-silver	Juniata River	712	1050	7.5	7.4	6.1
A69-1604-6913	**7/12/2022**	**2023**	**Pre-silver**	**Juniata River**	**730**	**850**	**7.9**	**7.7**	**6.5**
A69-1604-6914	**7/12/2022**	**2022**	**Pre-silver**	**Juniata River**	**788**	**1100**	**7.7**	**7.5**	**5.8**
A69-1604-6915	**7/12/2022**	**2023**	**Pre-silver**	**Juniata River**	**713**	**850**	**7.1**	**7**	**5.5**
A69-1604-6916	**7/13/2022**	**2022**	**Pre-silver**	**Buffalo Creek**	**627**	**675**	**7.4**	**7.3**	**6.8**
A69-1604-6917	7/13/2022		Pre-silver	Conodoguinet Creek	713	770	7.7	7.5	6.4
A69-1604-6918	**7/14/2022**	**2022**	**Pre-silver**	**Conodoguinet Creek**	**667**	**785**	**7.5**	**7**	**6.2**
A69-1604-6919	**7/14/2022**	**2022**	**Pre-silver**	**Conodoguinet Creek**	**707**	**850**	**7.8**	**7.6**	**6.6**
A69-1604-6920	**7/14/2022**	**2022**	**Silver**	**Conodoguinet Creek**	**819**	**1100**	**8.5**	**8.1**	**6.6**
A69-1604-6921	**7/14/2022**	**2022**	**Silver**	**Conodoguinet Creek**	**775**	**1070**	**7.9**	**7.7**	**6.2**
A69-1604-6922	7/14/2022		Pre-silver	Conodoguinet Creek	706	900	7.9	7.7	6.8
A69-1604-6923	**7/14/2022**	**2023**	**Pre-silver**	**Conodoguinet Creek**	**708**	**620**	**7.7**	**7**	**6**
A69-1604-6924	**8/1/2022**	**2023**	**Pre-silver**	**Buffalo Creek**	**711**	**900**	**7.8**	**7.6**	**6.5**
A69-1604-6925	**8/2/2022**	**2022**	**Pre-silver**	**Buffalo Creek**	**707**	**700**	**7.8**	**7.5**	**6.5**
A69-1604-6926	**8/2/2022**	**2022**	**Pre-silver**	**Buffalo Creek**	**689**	**780**	**7.9**	**7.8**	**7**
A69-1604-6927	**8/2/2022**	**2022**	**Pre-silver**	**Buffalo Creek**	**747**	**900**	**7.9**	**7.4**	**6.2**
A69-1604-6928	**8/2/2022**	**2022**	**Pre-silver**	**Buffalo Creek**	**710**	**850**	**8.8**	**8.1**	**7.9**
A69-1604-6929	**8/2/2022**	**2022**	**Pre-silver**	**Buffalo Creek**	**801**	**1200**	**8.5**	**8.3**	**6.9**
A69-1604-6930	**7/27/2022**	**2023**	**Pre-silver**	**Susquehanna River**	**728**	**850**	**7.3**	**7.5**	**5.9**
A69-1604-6931	**7/28/2022**	**2023**	**Pre-silver**	**Conodoguinet Creek**	**714**	**720**	**7.2**	**6.9**	**5.5**
A69-1604-6932	8/3/2022		Silver	Juniata River	810	1300	8.3	7.9	6.4
A69-1604-6933	8/3/2022		Silver	Juniata River	771	1350	9.1	8.4	7.8
A69-1604-6934	8/2/2022		Pre-silver	Buffalo Creek	725	830	7.6	7.5	6.2
A69-1604-6935	**8/3/2022**	**2023**	**Pre-silver**	**Juniata River**	**707**	**660**	**7.9**	**7.4**	**6.5**
A69-1604-6936	**7/27/2022**	**2022**	**Silver**	**Susquehanna River**	**749**	**1050**	**7.6**	**7.5**	**6**

Tag ID	Tagging Date	Migration Year	Color Phase	Collection & Release Waterbody	Total Length (mm)	Weight (g)	Eye Width (mm)	Eye Height (mm)	Pankhurst Eye Index (*I*)
A69-1604-6937	7/27/2022		Silver	Susquehanna River	697	850	9.4	8.6	9.1
A69-1604-6938	7/27/2022		Silver	Susquehanna River	809	1550	8	7.7	6
A69-1604-6939	**7/27/2022**	**2023**	**Pre-silver**	**Susquehanna River**	**747**	**880**	**7.4**	**7.4**	**5.8**

Table 5. Demographics of eels tagged from 2021-2023 that initiated migration the same year as tagging compared to eels that initiated migration the year after they were tagged. Length, weight, and Pankhurst's eye index values are averages with ranges in parentheses.

Migratory Status	No. of Eels	% Silver	Total Length (mm)	Weight (g)	Pankhurst Eye Index (I)
Migrated Year of Tagging	123	55%	762	1,111	6.9
			(627-902)	(675-1,850)	(4.4-9.8)
Migrated Year After Tagging	30	20%	727	877	6.2
			(668-791)	(620-1,180)	(4.7-7.6)
t-test			p<0.001 (df78)	p<0.001 (df 86)	p<0.001 (df 59)

Table 6. Demographics of silver and pre-silver eels that initiated migration the same year as tagging. Length, weight, and Pankhurst's eye index values are averages with ranges in parentheses.

Migrating Eels	No. of Eels	% of Tagged	Total Length (mm)	Weight (g)	Pankhurst Eye Index (I)
Silver	68	72%	784	1,201	7.0
			(677-902)	(790-1850)	(4.4-9.4)
Pre-Silver	55	48%	736	999	6.8
			(627-872)	(675-1640)	(4.6-9.8)
t-test			p<0.001 (df 120)	p<0.001 (df 121)	p=0.35 (df 121)

Table 7. Number of eels that migrated downstream each year compared to the year of tagging.

Tagging Year	# Eels Tagged	# Migrated Year Tagged	# Migrated Year After Tagging	Total Migrated
2021	16	9	1	10
2022	101	46	19	65
2023	100	68	10	78
Total	**217**	**123**	**30**	**153**

Table 8. Proportion of eels passed by month at each array. Empty cells indicate no receiver deployment during that time period.

Month	Harrisburg	York Haven Upstream	York Haven Downstream	Safe Harbor Upstream	Holtwood Upstream	Muddy Run Upstream	Conowingo Upstream	Conowingo Downstream	Havre de Grace	All Sites Combined
2021										
August	22.2%									10.0%
September	66.7%	85.7%	100.0%						33.3%	70.0%
October	11.1%	14.3%							33.3%	15.0%
November	0.0%	0.0%							33.3%	5.0%
December	0.0%	0.0%							0.0%	0.0%
2022										
Jan-July	2.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.8%	0.7%
August	6.4%	4.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.8%
September	17.0%	10.6%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.4%
October	10.6%	17.0%	5.0%	7.7%	3.8%	13.3%	9.1%	5.3%	0.0%	8.7%
November	63.8%	68.1%	90.0%	92.3%	96.2%	80.0%	90.9%	94.7%	85.7%	82.2%
December	0.0%	0.0%	0.0%	0.0%	0.0%	6.7%	0.0%	0.0%	9.5%	1.1%
2023										
Jan-July	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.9%	3.3%	3.0%	0.5%
August	7.0%	7.0%	6.2%	5.0%	4.8%	5.3%	5.7%	3.3%	3.0%	5.6%
September	36.0%	19.8%	12.3%	12.5%	6.5%	3.5%	2.9%	3.3%	3.0%	14.0%
October	22.1%	27.9%	21.0%	17.5%	21.0%	22.8%	11.4%	6.7%	6.1%	19.6%
November	32.6%	43.0%	56.8%	61.3%	56.5%	57.9%	62.9%	73.3%	66.7%	53.5%
December	2.3%	2.3%	3.7%	3.8%	11.3%	10.5%	14.3%	10.0%	18.2%	6.7%

Table 8. Continued.

Month	Harrisburg	York Haven Upstream	York Haven Downstream	Safe Harbor Upstream	Holtwood Upstream	Muddy Run Upstream	Conowingo Upstream	Conowingo Downstream	Havre de Grace	All Sites Combined
2024										
Jan-July	0.0%			9.1%	25.0%	0.0%	14.3%	0.0%	0.0%	8.2%
August	44.4%			36.4%	25.0%	20.0%	14.3%	20.0%	0.0%	26.5%
September	0.0%			0.0%	0.0%	0.0%	14.3%	20.0%	25.0%	6.1%
October	0.0%			0.0%	0.0%	0.0%	0.0%	0.0%	25.0%	2.0%
November	22.2%			9.1%	0.0%	0.0%	0.0%	0.0%	0.0%	6.1%
December	33.3%			45.5%	50.0%	80.0%	57.1%	60.0%	50.0%	51.0%
All Years Combined										
Jan-July	0.7%	0.0%	0.0%	0.8%	2.1%	0.0%	3.1%	1.9%	3.3%	1.0%
August	9.9%	5.7%	4.1%	6.2%	5.2%	5.2%	4.7%	3.7%	1.6%	5.7%
September	29.8%	20.0%	10.7%	7.7%	4.2%	2.6%	3.1%	3.7%	4.9%	12.2%
October	16.6%	23.6%	15.6%	13.1%	14.6%	19.5%	9.4%	5.6%	6.6%	15.2%
November	39.7%	49.3%	67.2%	66.2%	62.5%	58.4%	65.6%	74.1%	67.2%	58.7%
December	3.3%	1.4%	2.5%	6.2%	11.5%	14.3%	14.1%	11.1%	16.4%	7.3%

Table 9. Migration duration and speed for eels that traveled from Harrisburg to Havre de Grace (112.8 rkm).

	Count	Time (d)				Speed (km/d)			
		Average	Median	Min	Max	Average	Median	Min	Max
2021	4	54	49	8.0	112	5.4	3.3	1.0	14
2022	20	24	4	1.8	218	28.6	30.6	0.5	61
2023	32	35	27	3.0	101	7.9	4.2	1.1	37
2024	3	73	98	3.3	119	12.1	1.2	0.9	34
Combined	**59**	**34**	**22**	**1.8**	**218**	**15.0**	**5.1**	**0.5**	**61**

Table 10. Speed (km/day) of eels migrating between arrays in the lower Susquehanna River and time (hours) spent traveling sections of river during the 2021-2024 migration seasons. Dammed river sections are denoted by a (*).

2021-2024 Combined			Speed (km/h)				Elapsed Time (h)				
River Section	Distance Between Arrays (km)	# Eels	Avg,	Med.	Min.	Max.	Avg.	Med.	Min.	Max.	% traversed section in <24 hrs
Harrisburg to York Haven Upstream	13.5	139	1.92	1.41	0.01	6.32	101	9.6	2.4	2062	71
York Haven Upstream to York Haven Downstream*	20.3	121	1.65	0.97	0.01	5.23	168	21.0	3.9	2013	56
York Haven Downstream to Safe Harbor Upstream	19	119	1.82	0.97	0.01	4.86	90	19.7	3.9	1268	61
Safe Harbor Upstream to Holtwood Upstream*	16.9	96	1.33	0.91	0.01	3.94	110	18.5	4.3	2618	64
Holtwood Upstream to Muddy Run*	7.3	76	2.39	2.64	0.01	5.45	36	2.8	1.3	605	87
Muddy Run to Conowingo Upstream*	15	52	1.69	1.55	0.02	4.51	43	9.7	3.3	637	79
Conowingo Upstream to Conowingo Downstream*	13	54	2.03	1.52	0.01	5.15	138	8.6	2.5	1589	72
Conowingo Downstream to Havre de Grace	7.9	52	2.7	2.76	0.01	8.87	70	2.9	0.9	1338	81
River Sections with No Dams	40.4	310	2.01	1.37	0.01	8.87	92	9.6	0.89	2062	69
River Sections with Dams	72.5	399	1.77	1.07	0.01	5.45	108	14.5	1.34	2618	69

Table 10. Continued.

2022			Speed (km/h)				Elapsed Time (h)				% traversed section in <24 hrs
River Section	Distance Between Arrays (km)	# Eels	Avg.	Med.	Min.	Max.	Avg.	Med.	Min.	Max.	
Harrisburg to York Haven Upstream	13.5	47	1.91	1.46	0.01	4.83	132.8	9.30	2.8	2062	74
York Haven Upstream to York Haven Downstream*	20.3	40	2.38	2.76	0.01	5.23	186.5	7.40	3.9	1628	70
York Haven Downstream to Safe Harbor Upstream	19	38	3.38	3.94	0.02	4.86	71.1	4.80	3.9	1221	89
Safe Harbor Upstream to Holtwood Upstream*	16.9	26	2.46	2.91	0.37	3.94	10.3	5.8	4.3	46	96
Holtwood Upstream to Muddy Run*	7.3	14	2.76	3.58	0.01	4.83	48	2.1	1.5	605	93
Muddy Run to Conowingo Upstream*	15	12	2.09	2.43	0.45	3.48	11.8	6.5	4.3	33	92
Conowingo Upstream to Conowingo Downstream*	13	20	3.11	3.75	0.02	5.15	41.8	3.5	2.5	694	90
Conowingo Downstream to Havre de Grace	7.9	19	2.75	3.24	0.01	5.32	73	2.4	1.5	712	74
Open River Sections	40.4	104	2.6	3.23	0.01	5.32	99.3	5	1.5	2062	80
Dammed River Sections	72.5	112	2.54	2.98	0.01	5.23	83.7	5.7	1.5	1628	85

Table 10. Continued.

2023			Speed (km/h)				Elapsed Time (h)				% traversed section in <24 hrs
River Section	Distance Between Arrays (km)	# Eels	Avg.	Med.	Min.	Max.	Avg.	Med.	Min.	Max.	
Harrisburg to York Haven Upstream	13.5	85	1.76	0.95	0.01	5.15	90.3	14.3	2.6	905	68
York Haven Upstream to York Haven Downstream*	20.3	79	1.3	0.83	0.01	5.06	162.3	24.4	4	2013	49
York Haven Downstream to Safe Harbor Upstream	19	80	1.1	0.79	0.01	4.08	100.1	24.3	4.7	1268	49
Safe Harbor Upstream to Holtwood Upstream*	16.9	63	0.85	0.70	0.01	2.88	161.5	24.3	5.9	2618	49
Holtwood Upstream to Muddy Run*	7.3	56	2.22	2.43	0.02	5.45	35.6	3	1.3	425	84
Muddy Run to Conowingo Upstream*	15	35	1.47	0.78	0.02	4.51	58.9	19.1	3.3	637	71
Conowingo Upstream to Conowingo Downstream*	13	29	1.42	0.59	0.01	5.04	216.6	22.2	2.6	1589	59
Conowingo Downstream to Havre de Grace	7.9	29	2.84	2.76	0.02	8.87	30.5	2.9	0.9	324	86
Open River Sections	40.4	194	1.65	0.89	0.01	8.87	85.4	18.1	0.9	1268	63
Dammed River Sections	72.5	262	1.43	0.8	0.01	5.45	127.2	19.8	1.3	2618	61

Table 11. Time (hours) that eels spent within the detection range of a single array.

Array	# Eels	Avg.	Med.	Min.	Max.
Harrisburg	158	17.7	0.24	0.02	1027
York Haven Upstream	140	14.4	0.29	0.02	837
York Haven Downstream	122	0.4	0.17	0.00	12
Safe Harbor Upstream	131	85.7	0.93	0.04	9694
Holtwood Upstream	96	10.5	1.25	0.17	336
Muddy Run Upstream	77	22.9	0.34	0.00	1180
Conowingo Upstream	64	32.1	2.31	0.18	668
Conowingo Downstream	54	18.7	0.69	0.00	758
Havre de Grace	61	327.8	1.99	0.05	15244
Overall	903	46.4	0.48	0.00	15244

Table 12. Detection probabilities for receiver arrays in the Susquehanna River from 2022-2024.

Array	2022		2023		2024	
	Detection Probability	95% CI	Detection Probability	95% CI	Detection Probability	95% CI
Harrisburg	98%	(89%-100%)	100%	(98%-100%)		
York Haven Upstream	98%	(89%-100%)	100%	(98%-100%)		
York Haven Downstream	98%	(88%-100%)	100%	(97%-100%)		
Safe Harbor	100%	(100%-100%)	100%	(100%-100%)		
Holtwood	97%	(80%-100%)	99%	(96%-100)	100%	(100%-100%)
Muddy Run	66%	(48%-81%)	92%	(80%-97)	83%	(37%-98%)
Conowingo Upstream	100%	(100%-100%)	100%	(100%-100%)	100%	(100%-100%)
Conowingo Downstream	82%	(63%-93%)	96%	(88%-99%)	100%	(100%-100%)
Havre de Grace	100%	(0%-100%)	100%	(100%-100%)	83%*	(0%-100%)

 *Limited MATOS data available at the time of this report, likely reducing detection probability
for Havre de Grace in 2024.

Table 13. Cormack-Jolly-Seber (CJS) models for 2022 and 2023 silver eel migration data in the Susquehanna River. A "Constant" effect assumes survival (φ) and detection probability (p) were the same across years of study and/or space (constant detection at receiver arrays and constant survival between receiver arrays, while "Varying" effects assume φ and p varied across years and/or space. The best model, according to AIC$_c$, was Model 3 in which φ and p both varied across years and space.

	Year Effect	**Space Effect**	**AICc**
Model 1	Constant	Constant	814.03
Model 2	Varying	Constant	805.75
Model 3	*Varying*	*Varying*	*659.10*
Model 4	Constant	Varying	668.23

Table 14. Bootstrapped estimates of cumulative survival of tagged downstream migrating eels originating upstream of York Haven Dam to some downstream point in the Susquehanna River. Cumulative survival to a certain point is the product of survival estimates through river sections upstream of that point.

Cumulative survival to:	**2022**	**2023**
York Haven Upstream	1.00 (1.00 – 1.00)	1.00 (1.00 – 1.00)
York Haven Downstream	0.92 (0.86 – 0.96)	0.90 (0.84 – 0.94)
Safe Harbor Upstream	0.90 (0.84 – 0.95)	0.88 (0.81 – 0.93)
Holtwood Upstream	0.71 (0.61 – 0.80)	0.65 (0.56 – 0.74)
Muddy Run Upstream	0.67 (0.57 – 0.76)	0.61 (0.50 – 0.70)
Conowingo Upstream	0.48 (0.37 – 0.58)	0.40 (0.30 – 0.49)
Conowingo Downstream	0.45 (0.34 – 0.55)	0.36 (0.27 – 0.45)
Havre de Grace	0.44 (0.33 – 0.54)	0.35 (0.26 – 0.44)

Table 15.Apparent survival of tagged downstream migrating eels through river sections in the lower Susquehanna River in 2022 to 2024.

River Section	2022		2023		2024	
	Apparent Survival	95% CI	Apparent Survival	95% CI	Apparent Survival	95% CI
Harrisburg to York Haven Upstream	100%	100%-100%	100%	100%-100%		
York Haven Upstream to Downstream (York Haven Dam)	92%	86%-96%	90%	83%-94%		
York Haven Downstream to Safe Harbor Upstream	99%	94%-100%	98%	93%-100%		
Safe Harbor Upstream to Holtwood Upstream (Safe Harbor Dam)	79%	69%-87%	74%	65%-82%	60%	30%-84%
Holtwood Upstream to Muddy Run Upstream (Holtwood Dam)	95%	85%-99%	94%	82%-98%	100%	100%-100%
Muddy Run Upstream to Conowingo Upstream (Muddy Run Pumped Storage Facility)	72%	58%-82%	66%	54%-76%	100%	100%-100%
Conowingo Upstream to Downstream (Conowingo Dam)	94%	85%-98%	93%	81%-97%	83%	37%-98%
Conowingo Downstream to Havre de Grace	98%	89%-100%	98%	86%-100%	97%	0%-100%

Table 16. Range of environmental conditions that occurred during eel passage events and conditions that occurred from August through December of each study year.

	Year	Temperature (C)			River Discharge (cfs)			Lunar Illumination			Turbidity (fnu)		
		Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Eel Passage Events	2021	18.7	8.3	25.3	119,177	29,483	176,770	0.48	0.01	0.95	57.6	6	114.1
	2022	12.9	2.8	29.2	55,896	4,282	87,437	0.67	0	0.99	30.8	1	71.4
	2023	11.9	2.6	27.1	29,515	11,470	179,229	0.58	0	1	13.9	1.77	205.6
	2024	12.2	1.7	24.8	77,113	8,545	208,750	0.48	0	1	63.8	2.4	275.7
All Dates August to December	2021	15.2	3.5	27.8	41,674	9,235	176,770	0.51	0	1	18.2	1.6	133
	2022	15.4	0	29.8	20,266	3,426	101,452	0.5	0	1	8	0.8	71
	2023	15.4	2.6	28.3	30,905	11,093	179,229	0.5	0	1	17.8	1.7	206
	2024	15.8	0.4	29.8	21,066	4,958	208,750	0.46	0	1	15.3	0.9	276

Table 17. Logistic regression models used to evaluate the probability of eel movement with environmental covariates. Models that did not converge are designated with an "NC."

Model #	Model Predictor Covariates	AIC
8	Temp+log(CFS)	3423.2
13	Temp+CFSTrend5	3689.2
12	Temp+CFSTrend3	3760.0
9	Temp+Turbidity	3786.7
14	log(CFS)+Lunar	3790.2
11	Temp+CFSTrend2	3830.7
10	Temp+Lunar	3872.9
1	Temp	3926.9
17	Lunar+CFSTrend5	4215.5
7	CFSTrend5	4242.5
16	Lunar+CFSTrend3	4271.7
3	Turbidity	4300.4
6	CFSTrend3	4307.5
15	Lunar+CFSTrend2	4334.9
5	CFSTrend2	4368.4
4	Lunar	4448.4
0	Null model	4486.6
2	log(CFS)	NC
18	yDay	NC
19	yDay + log(CFS)	NC

Covariate	Description
CFS	River Discharge (cubic feet per second)
CFSTrend2	Change in Discharge over Past Two Days
CFSTrend3	Change in Discharge over Past Three Days
CFSTrend5	Change in Discharge over Past Five Days
Lunar	Proportion of Lunar Illumination
Month	Month of Year
Temp	Water Temperature (^{o}C)
Turbidity	Turbidity (FNU-formazin nephelometric unit)
yDay	Day of Year

Table 18. Predictions of the probability of American Eel downstream migration under temperature (C°) and river discharge (cfs) based on the best-fitting random effects logistic regression model.

Temperature	Discharge (CFS)												
	5,000	20,000	35,000	50,000	65,000	80,000	95,000	110,000	125,000	140,000	155,000	170,000	185,000
1	0.05	0.48	0.75	0.87	0.92	0.95	0.96	0.97	0.98	0.98	0.99	0.99	0.99
2	0.04	0.43	0.71	0.84	0.90	0.93	0.95	0.97	0.97	0.98	0.98	0.99	0.99
3	0.03	0.38	0.66	0.81	0.88	0.92	0.94	0.96	0.97	0.97	0.98	0.98	0.99
4	0.02	0.33	0.61	0.77	0.86	0.90	0.93	0.95	0.96	0.97	0.97	0.98	0.98
5	0.02	0.28	0.56	0.73	0.83	0.88	0.91	0.94	0.95	0.96	0.97	0.97	0.98
6	0.02	0.24	0.51	0.69	0.79	0.86	0.90	0.92	0.94	0.95	0.96	0.97	0.97
7	0.01	0.20	0.46	0.64	0.76	0.83	0.87	0.91	0.93	0.94	0.95	0.96	0.97
8	0.01	0.17	0.40	0.59	0.72	0.80	0.85	0.89	0.91	0.93	0.94	0.95	0.96
9	0.01	0.14	0.35	0.54	0.67	0.76	0.82	0.86	0.89	0.91	0.93	0.94	0.95
10	0.01	0.12	0.31	0.49	0.62	0.72	0.79	0.83	0.87	0.89	0.91	0.93	0.94
11	0.01	0.10	0.26	0.43	0.57	0.67	0.75	0.80	0.84	0.87	0.89	0.91	0.92
12	0.00	0.08	0.22	0.38	0.52	0.63	0.71	0.77	0.81	0.85	0.87	0.89	0.91
13	0.00	0.07	0.19	0.33	0.46	0.57	0.66	0.73	0.78	0.82	0.85	0.87	0.89
14	0.00	0.05	0.16	0.29	0.41	0.52	0.61	0.68	0.74	0.78	0.82	0.84	0.87
15	0.00	0.04	0.13	0.25	0.36	0.47	0.56	0.63	0.69	0.74	0.78	0.81	0.84
16	0.00	0.04	0.11	0.21	0.31	0.42	0.51	0.58	0.65	0.70	0.74	0.78	0.81
17	0.00	0.03	0.09	0.17	0.27	0.36	0.45	0.53	0.60	0.65	0.70	0.74	0.77
18	0.00	0.02	0.07	0.15	0.23	0.32	0.40	0.48	0.54	0.60	0.65	0.70	0.73
19	0.00	0.02	0.06	0.12	0.19	0.27	0.35	0.42	0.49	0.55	0.60	0.65	0.69
20	0.00	0.02	0.05	0.10	0.16	0.23	0.30	0.37	0.44	0.50	0.55	0.60	0.64
21	0.00	0.01	0.04	0.08	0.14	0.20	0.26	0.32	0.39	0.45	0.50	0.55	0.59
22	0.00	0.01	0.03	0.07	0.11	0.17	0.22	0.28	0.34	0.39	0.45	0.49	0.54
23	0.00	0.01	0.03	0.06	0.09	0.14	0.19	0.24	0.29	0.34	0.39	0.44	0.49
24	0.00	0.01	0.02	0.05	0.08	0.11	0.16	0.20	0.25	0.30	0.34	0.39	0.43
25	0.00	0.01	0.02	0.04	0.06	0.09	0.13	0.17	0.21	0.25	0.30	0.34	0.38
26	0.00	0.00	0.01	0.03	0.05	0.08	0.11	0.14	0.18	0.22	0.26	0.29	0.33
27	0.00	0.00	0.01	0.02	0.04	0.06	0.09	0.12	0.15	0.18	0.22	0.25	0.29
28	0.00	0.00	0.01	0.02	0.03	0.05	0.07	0.10	0.12	0.15	0.18	0.21	0.25
29	0.00	0.00	0.01	0.02	0.03	0.04	0.06	0.08	0.10	0.13	0.15	0.18	0.21

Table 19. Range of project operations for eels that passed a dam within 24 hours.

Project	Year	Project Flow (cfs)			Spill (cfs)			Spill			Generation (cfs)			Total Units Generating		
		Min	Max	Avg	Min	Max	Avg	Min %	Max %	Avg %	Min	Max	Avg	Min	Max	Avg
York Haven	2022	21,500	89,900	63,364	16,100	85,000	57,805	77	95	91	4,900	4,900	4,900	5	5	5
York Haven	2023	13,800	111,500	30,560	2,035	95,780	17,910	14	97	53	2,355	15,005	12,607	3	18	15
York Haven	**Years Combined**	**13,800**	**111,500**	**43,752**	**2,035**	**95,780**	**33,953**	**14**	**97**	**68**	**2,355**	**15,005**	**9,508**	**3**	**18**	**11**
Safe Harbor	2022	2,714	85,759	69,318	0	0	0	0	0	0	2,714	85,759	69,318	1	11	9
Safe Harbor	2023	7,099	64,083	30,411	0	0	0	0	0	0	7,099	64,083	30,411	1	10	6
Safe Harbor	2024	10,090	232,759	85,419	0	126,010	24,558	0	55	12	10,090	107,392	60,858	3	12	8
Safe Harbor	**Years Combined**	**2,714**	**232,759**	**46,881**	**0**	**126,010**	**1,878**	**0**	**55**	**1**	**2,714**	**107,392**	**45,003**	**1**	**12**	**7**
Holtwood	2022	1,562	83,548	60,470	0	29,347	15,226	0	35	20	1,562	55,081	45,244	3	13	11
Holtwood	2023	7,083	69,498	28,043	0	32,654	3,913	0	61	9	6,178	48,023	24,229	1	12	5
Holtwood	2024	19,675	112,670	38,794	5	61,291	5,839	0	54	6	19,670	57,238	32,955	4	13	9
Holtwood	**Years Combined**	**1,562**	**112,670**	**35,496**	**0**	**61,291**	**6,265**	**0**	**61**	**11**	**1,562**	**57,238**	**29,231**	**1**	**13**	**7**
Conowingo	2022	46,314	79,441	64,162	0	0	0	0	0	0	46,314	79,441	64,162	6	11	9
Conowingo	2023	5,100	57,757	26,377	0	0	0	0	0	0	5,100	57,757	26,377	1	9	4
Conowingo	2024	11,192	79,275	45,723	0	0	0	0	0	0	11,192	79,275	45,723	2	11	7
Conowingo	**Years Combined**	**5,100**	**79,441**	**43,094**	**0**	**0**	**0**	**0**	**0**	**0**	**5,100**	**79,441**	**43,094**	**1**	**11**	**6**

Table 20. Eels detected by YHPC and USFWS mobile hydrophone surveys in the York Haven Dam tailrace in 2022-2023.

Tag ID	Date Detected	Detected By	Status
A69-1604-6891	9/27/2022	YHPC	
A69-1604-6891	10/5/2022	USFWS	Presumed Dead
A69-1604-6891	11/1/2022	USFWS	
A69-1604-6898	10/25/2022	YHPC	Presumed Dead
A69-1604-6907	11/29/2022	YHPC	Presumed Dead
A69-1604-6907	12/21/2022	YHPC	
A69-1604-6092	12/21/2022	YHPC	
A69-1604-6092	9/29/2023	YHPC	
A69-1604-6092	10/12/2023	YHPC	
A69-1604-6092	10/19/2023	YHPC	
A69-1604-6092	11/3/2023	YHPC	Presumed Dead
A69-1604-6092	11/16/2023	YHPC	
A69-1604-6092	11/22/2023	YHPC	
A69-1604-6092	11/30/2023	YHPC	
A69-1604-14722	10/12/2023	YHPC	Presumed Dead
A69-1604-6871	10/19/2023	YHPC	Presumed Dead
A69-1604-14719	11/3/2023	YHPC	
A69-1604-14719	11/16/2023	YHPC	
A69-1604-14719	11/22/2023	YHPC	Presumed Alive
A69-1604-14719	11/30/2023	YHPC	
A69-1604-14710	11/16/2023	YHPC	Presumed Dead

Table 21. Eels detected beyond the Susquehanna River. Data courtesy of the Atlantic Coast Telemetry Network and MATOS program cooperators.

Transmitter	Tag Year	Migration Year	Havre de Grace	Chesapeake Bay off Patapsco River, MD	Chesapeake Bay Bridge	Chesapeake Bay off Dares Beach, MD	Chesapeake Bay Cedar Point, MD	Chesapeake Bay off Hoopers Island, MD	Chesapeake Bay off Rappahannock River, VA
A69-1602-60044	2021	2021			1/3/2022		1/6/2022		
A69-1602-60045	2021	2022	12/16/2022						
A69-1602-60050	2021	2021	11/15/2021		1/4/2022		2/14/2022		
A69-1602-60054	2021	2021			12/8/2021		12/26/2021		
A69-1602-60056	2021	2021					12/16/2021		
A69-1602-60060	2021	2021	9/24/2021			12/5/2021			
A69-1602-60062	2021	2021	10/1/2021		11/26/2021		12/23/2021		
A69-1602-60063	2021	2021	2/18/2022		2/24/2022				
A69-1604-14647	2023	2023	12/11/2023						
A69-1604-14654	2023	2023	11/10/2023		12/13/2023				
A69-1604-14658	2023	2023	12/9/2023		12/20/2023				
A69-1604-14659	2023	2023	11/6/2023		1/7/2024				
A69-1604-14661	2023	2023	10/3/2023		12/3/2023				
A69-1604-14674	2023	2023	12/18/2023		1/14/2024				
A69-1604-14685	2023	2023	11/8/2023		12/30/2023				
A69-1604-14687	2023	2023	11/23/2023		1/10/2024				
A69-1604-14689	2023	2023	11/25/2023		1/10/2024				
A69-1604-14693	2023	2024	12/6/2024						12/30/2024
A69-1604-14696	2023	2023	10/15/2023						
A69-1604-14697	2023	2023	11/28/2023		12/20/2023	1/13/2024			
A69-1604-14699	2023	2023	11/5/2023		12/9/2023			12/12/2023	
A69-1604-14700	2023	2023	11/29/2023		1/5/2024				
A69-1604-14707	2023	2023	11/27/2023						
A69-1604-14708	2023	2023	11/28/2023	12/4/2023	12/22/2023	12/26/2023			
A69-1604-14709	2023	2023	11/7/2023		1/3/2024				
A69-1604-14711	2023	2023	11/25/2023		12/31/2023				

Transmitter	Tag Year	Migration Year	Havre de Grace	Chesapeake Bay off Patapsco River, MD	Chesapeake Bay Bridge	Chesapeake Bay off Dares Beach, MD	Chesapeake Bay Cedar Point, MD	Chesapeake Bay off Hoopers Island, MD	Chesapeake Bay off Rappahannock River, VA
A69-1604-14717	2023	2023	12/12/2023		1/13/2024				
A69-1604-14723	2023	2023	11/5/2023		1/9/2024				
A69-1604-14724	2023	2023	11/25/2023		12/15/2023				
A69-1604-14725	2023	2023	11/18/2023		12/10/2023				
A69-1604-14727	2023	2024	9/10/2024						12/31/2024
A69-1604-6840	2022	2022	12/17/2022		12/23/2022		1/11/2023		
A69-1604-6844	2022	2022	11/15/2022		12/25/2022		12/30/2022		
A69-1604-6848	2022	2022	11/15/2022				1/8/2023		
A69-1604-6849	2022	2022	11/16/2022		12/20/2022		12/23/2022		
A69-1604-6851	2022	2022	11/16/2022		1/27/2023		2/16/2023		
A69-1604-6852	2022	2022	11/15/2022				1/12/2023		
A69-1604-6858	2022	2022	11/17/2022		12/23/2022		1/15/2023		
A69-1604-6868	2022	2022	11/16/2022		12/25/2022				
A69-1604-6872	2022	2023	8/22/2023		12/6/2023			12/15/2023	
A69-1604-6874	2022	2022	11/15/2022		12/1/2022		12/13/2022		
A69-1604-6877	2023	2023	11/21/2023		12/26/2023				
A69-1604-6881	2022	2022	11/15/2022		12/15/2022		12/23/2022		
A69-1604-6885	2022	2022	11/14/2022		12/24/2022		12/29/2022		
A69-1604-6886	2022	2022	11/14/2022		1/19/2023		1/27/2023		
A69-1604-6889	2022	2022	11/16/2022				12/26/2022		
A69-1604-6894	2022	2023	9/30/2023		12/5/2023			12/15/2023	
A69-1604-6904	2022	2022	11/14/2022		12/23/2022		1/18/2023		1/24/2023
A69-1604-6905	2022	2022	11/16/2022		1/14/2023		1/19/2023		
A69-1604-6921	2022	2022	11/14/2022				12/10/2022		
A69-1604-6923	2022	2023	11/7/2023		12/26/2023				
A69-1604-6929	2022	2022	11/16/2022		12/23/2022		12/26/2022		
A69-1604-6930	2022	2023	11/27/2023		12/11/2023				
A69-1604-6935	2022	2023	11/28/2023		12/8/2023			12/15/2023	
A69-1604-6936	2022	2022	11/14/2022		1/17/2023				

Table 21. Continued.

Transmitter	Chesapeake Bay off York River, VA	Chesapeake Bay Bridge Tunnel	Atlantic Ocean, VA	C&D Canal	Delaware River	Delaware Bay	Atlantic Ocean, NJ
A69-1602-60044							
A69-1602-60045		3/9/2023					
A69-1602-60050							
A69-1602-60054	1/5/2022						
A69-1602-60056							
A69-1602-60060							
A69-1602-60062							
A69-1602-60063							
A69-1604-14647				1/13/2024	1/18/2024	2/3/2024	
A69-1604-14654		1/10/2024					
A69-1604-14658							
A69-1604-14659			2/7/2024				
A69-1604-14661							
A69-1604-14674							
A69-1604-14685		1/15/2024					
A69-1604-14687			2/17/2024				
A69-1604-14689							
A69-1604-14693							
A69-1604-14696				11/14/2023	11/14/2023	11/14/2023	
A69-1604-14697							
A69-1604-14699							
A69-1604-14700							
A69-1604-14707				12/20/2023	12/25/2023		1/12/2024
A69-1604-14708							
A69-1604-14709							

Transmitter	Chesapeake Bay off York River, VA	Chesapeake Bay Bridge Tunnel	Atlantic Ocean, VA	C&D Canal	Delaware River	Delaware Bay	Atlantic Ocean, NJ
A69-1604-14711							
A69-1604-14717							
A69-1604-14723			2/12/2024				
A69-1604-14724							
A69-1604-14725	1/6/2024	1/7/2024					
A69-1604-14727							
A69-1604-6840		1/26/2023					
A69-1604-6844							
A69-1604-6848		1/14/2023					
A69-1604-6849		1/11/2023					
A69-1604-6851		2/26/2023					
A69-1604-6852							
A69-1604-6858							
A69-1604-6868		2/6/2023					
A69-1604-6872			5/25/2024				
A69-1604-6874							
A69-1604-6877							
A69-1604-6881							
A69-1604-6885		1/21/2023					
A69-1604-6886		3/7/2023					
A69-1604-6889		1/16/2023					
A69-1604-6894							
A69-1604-6904							
A69-1604-6905							
A69-1604-6921							
A69-1604-6923							
A69-1604-6929							
A69-1604-6930							
A69-1604-6935							
A69-1604-6936							
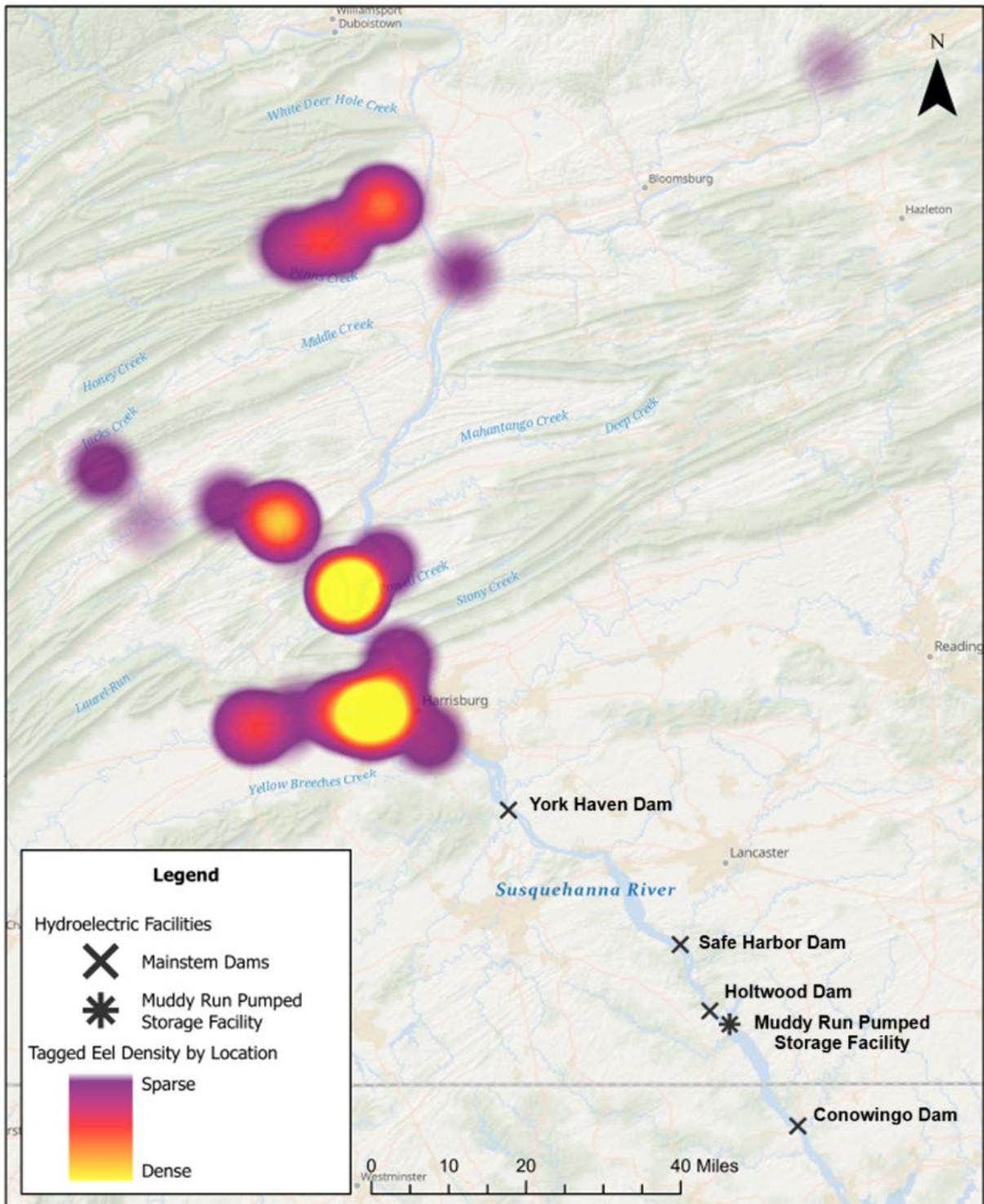
Figure 1. Eel tagging locations and locations of main stem dams on the Susquehanna River. Number of eels tagged per location ranged from 1 to 89.
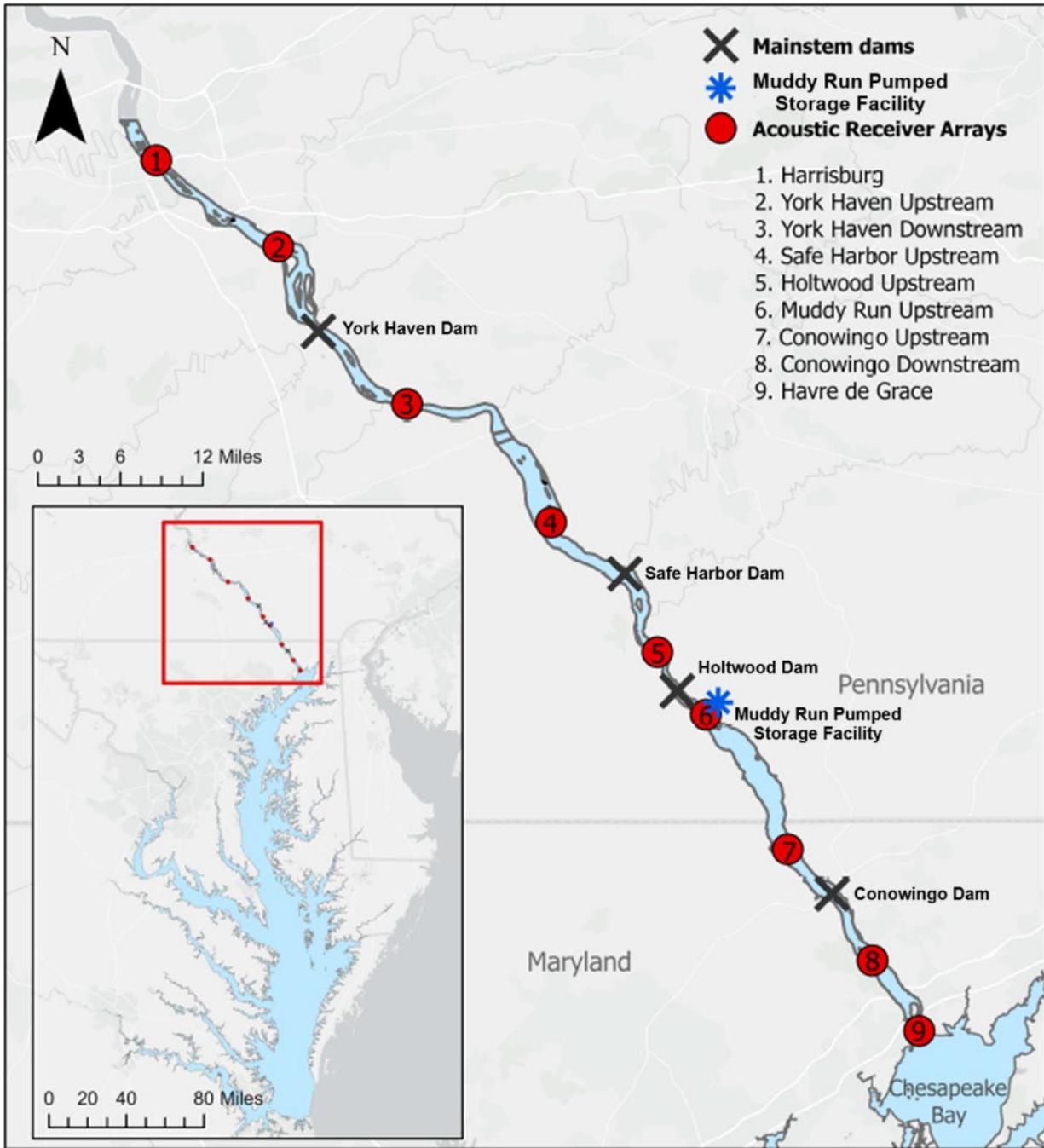
Figure 2. Map of the lower Susquehanna River study area and location of the acoustic receiver arrays in relation to the hydroelectric projects.
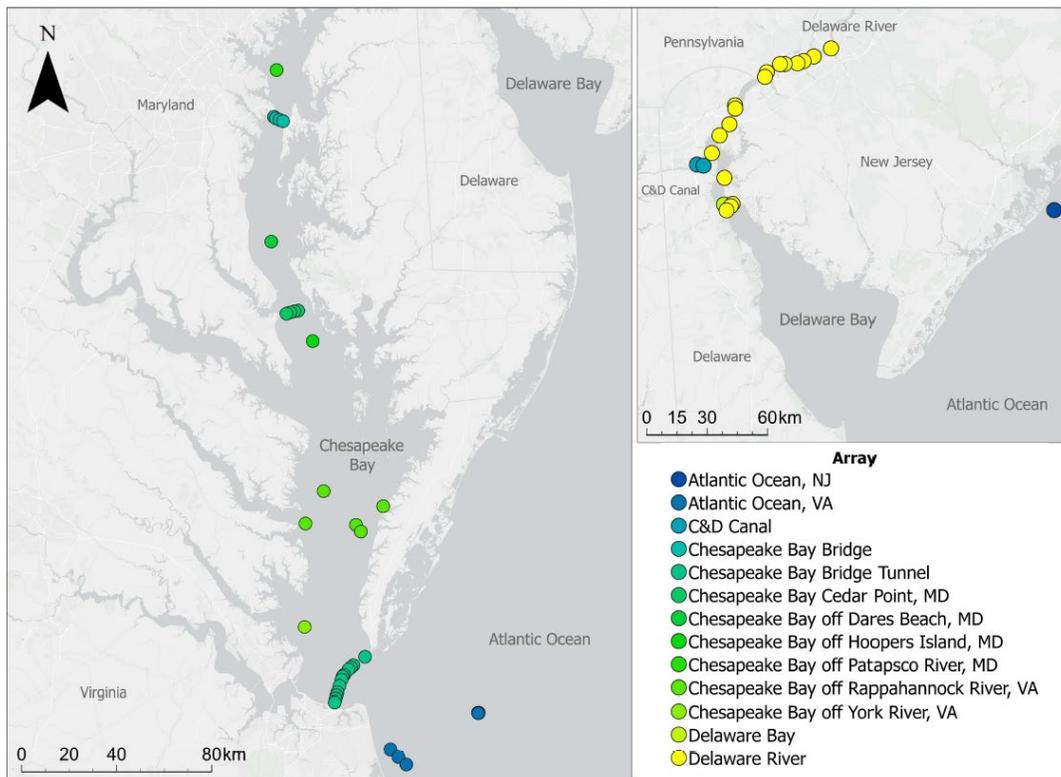
Figure 3. Map of Chesapeake Bay, Delaware River, and Atlantic Coast receivers managed by partners through Atlantic Cooperative Telemetry Network that detected eels tagged in the Susquehanna River.

Figure 4. Length (mm) frequency of 217 eels selected for acoustic tagging from 2021-2023 by maturity stage for individual years (top panel) and all years combined (bottom panel).

Figure 5. Weight (g) frequency of 217 eels selected for acoustic tagging from 2021-2023 by maturity stage for individual years (top panel) and all years combined (bottom panel).
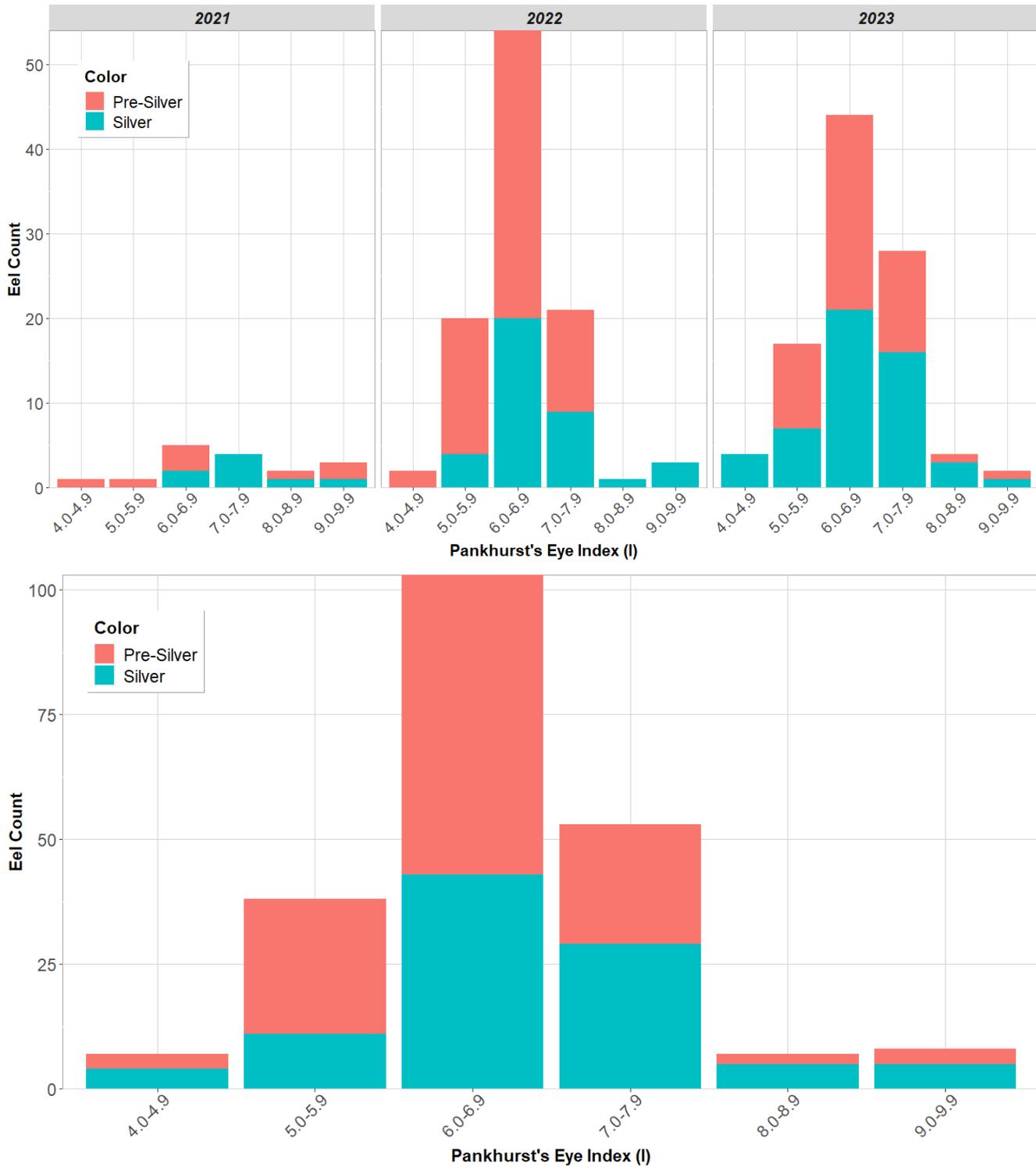
Figure 6. Pankhurst's Eye Index (I) (mm) frequency of 217 eels selected for acoustic tagging from 2021-2023 by maturity stage for individual years (top panel) and all years combined (bottom panel).
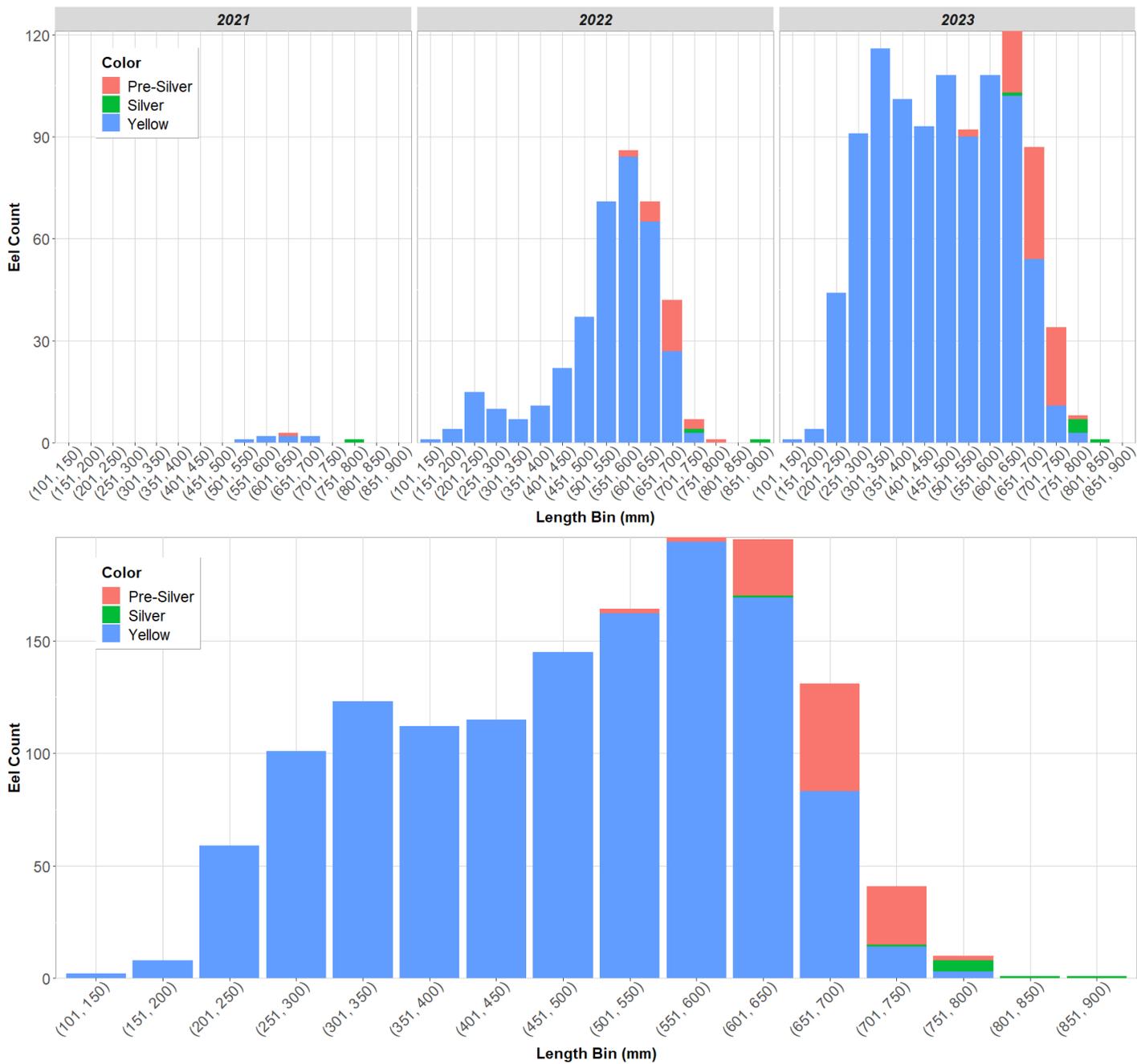
Figure 7. Length frequency of eels that were not selected for tagging in the 2021-2023 seasons by maturity stage for individual years (top panel) and all years combined (bottom panel).
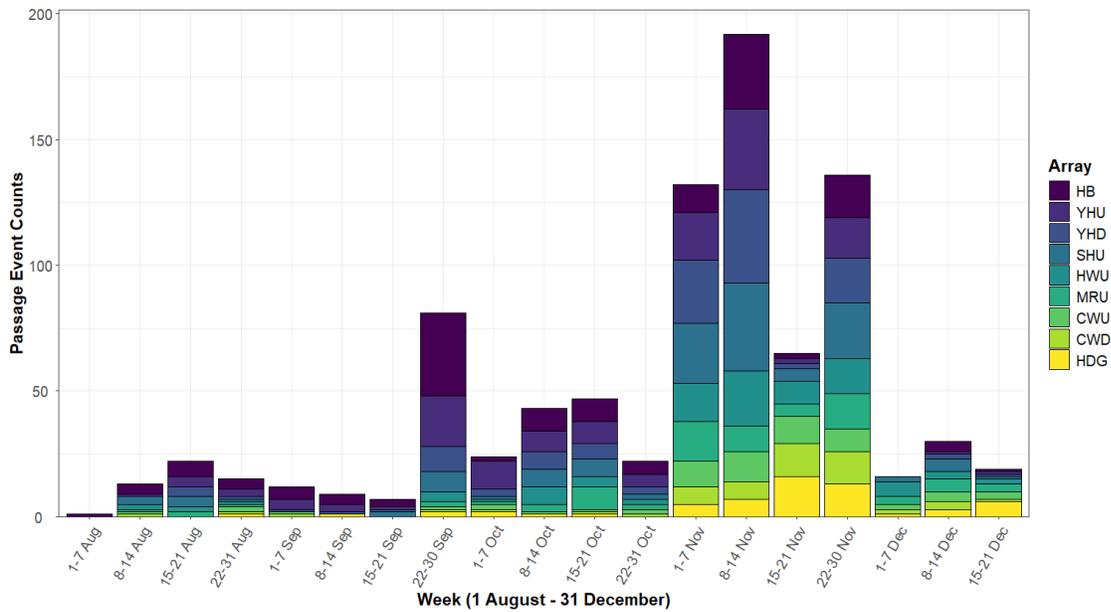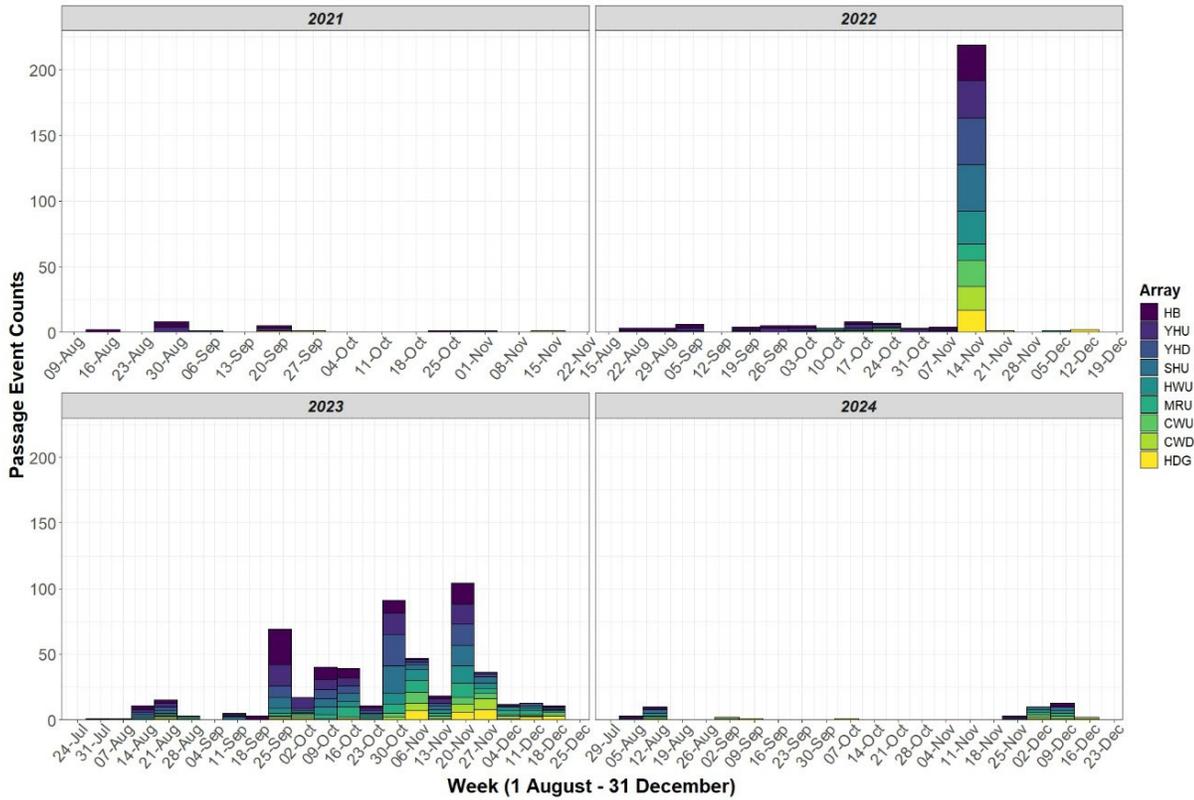
Figure 8. Number of eel detections by week with all arrays combined from 1 August to 31 December during each study year (top panel) and number of eel detections by week with all arrays combined from 1 August to 31 December for all years combined (bottom panel). Harrisburg = HB, York Haven Upstream = YHU, York Haven Downstream = YHD, Safe Harbor Downstream = SHU, Holtwood Upstream = HWU, Muddy Run Upstream = MRU, Conowingo Upstream = CWU, Conowingo Downstream = CWD, and Havre de Grace = HDG.
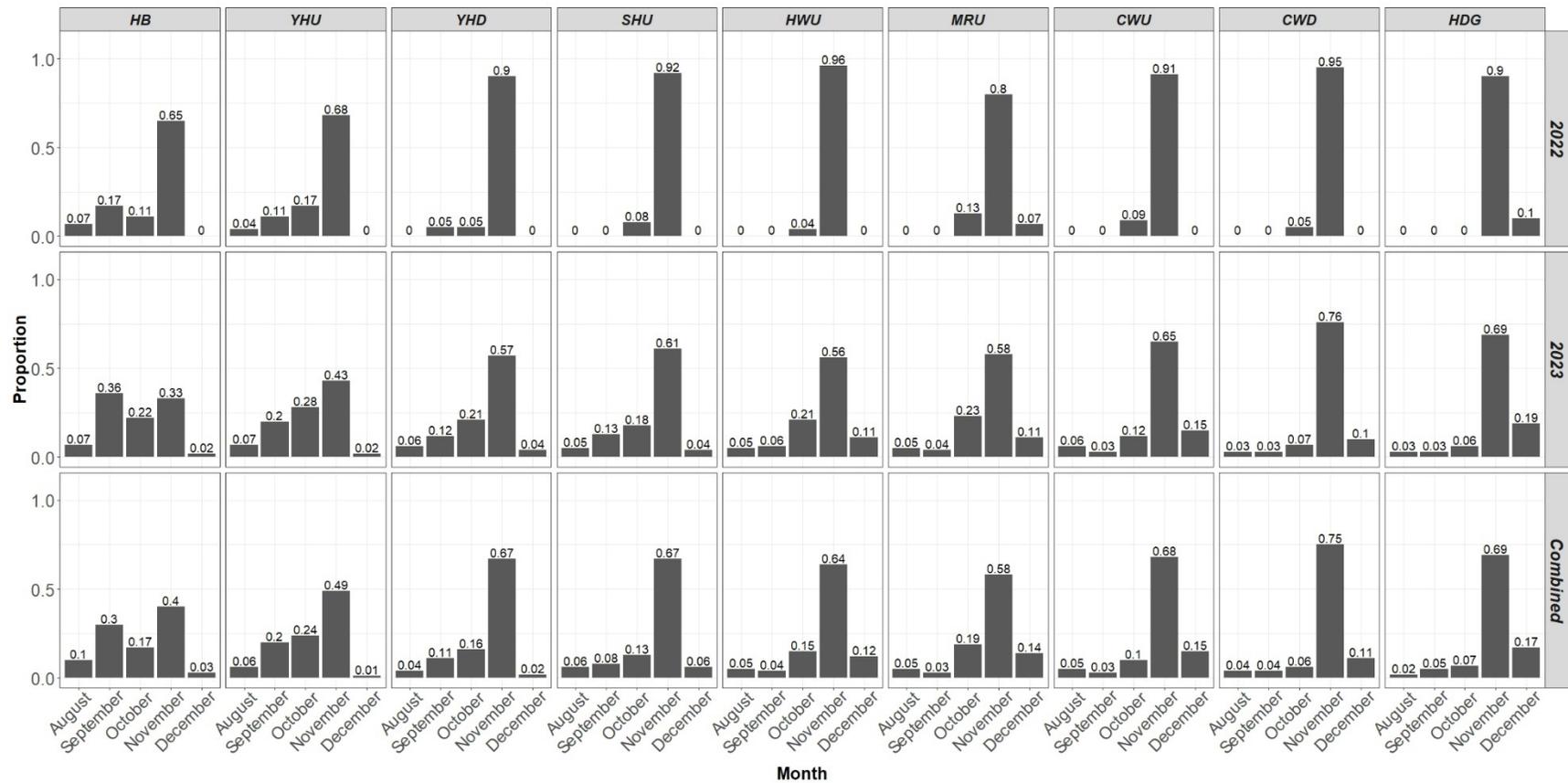
Figure 9. Proportion of tagged eels passing each array by month during August through December 2022, 2023, and all years combined (2021-2024). Harrisburg = HB, York Haven Upstream = YHU, York Haven Downstream = YHD, Safe Harbor Downstream = SHU, Holtwood Upstream = HWU, Muddy Run Upstream = MRU, Conowingo Upstream = CWU, Conowingo Downstream = CWD, and Havre de Grace = HDG.
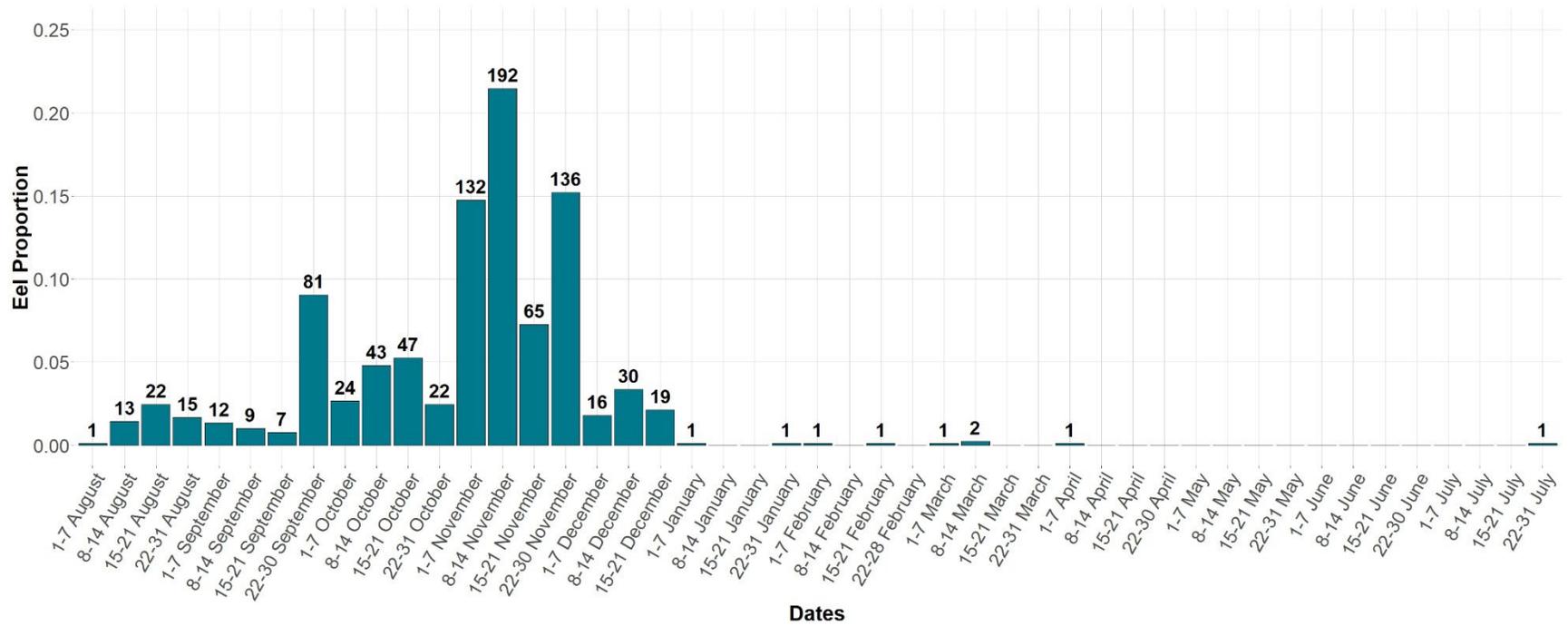
Figure 10. Proportion and counts of migration eels by week from 2021-2024.
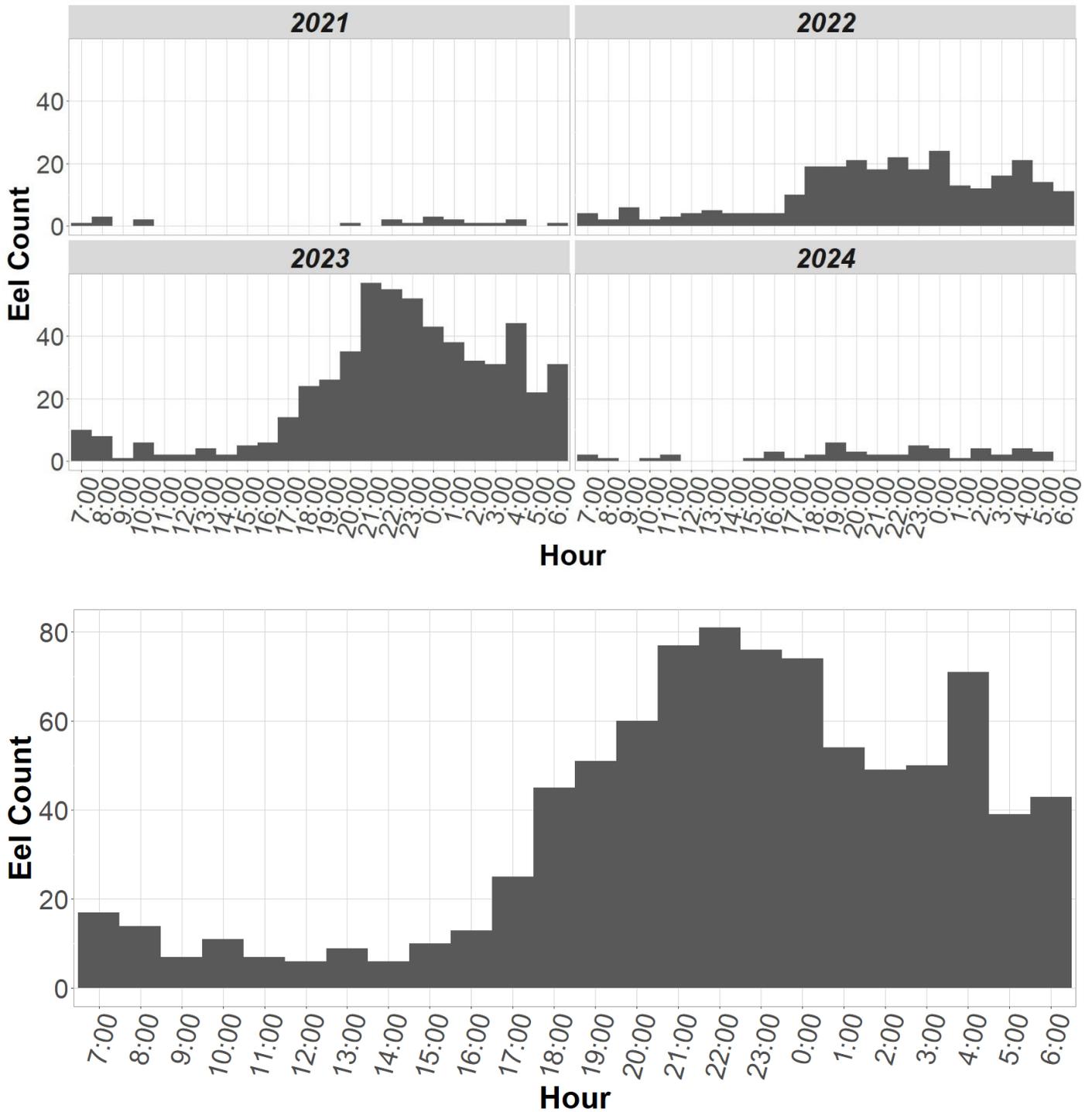
Figure 11. Number of eel passage events at an array by hour per year (top panel) and across combined years (bottom panel) of the 2021-2024 Susquehanna River migration seasons.
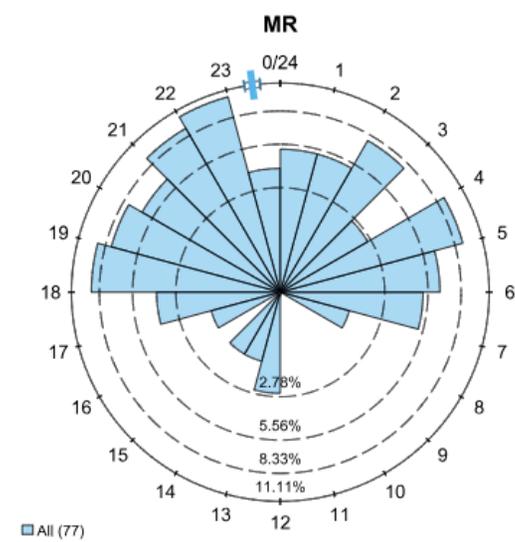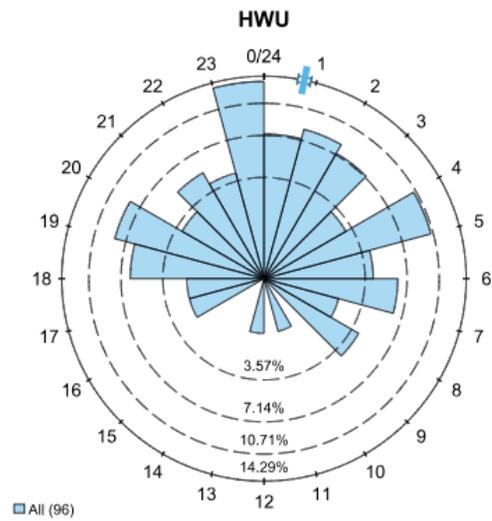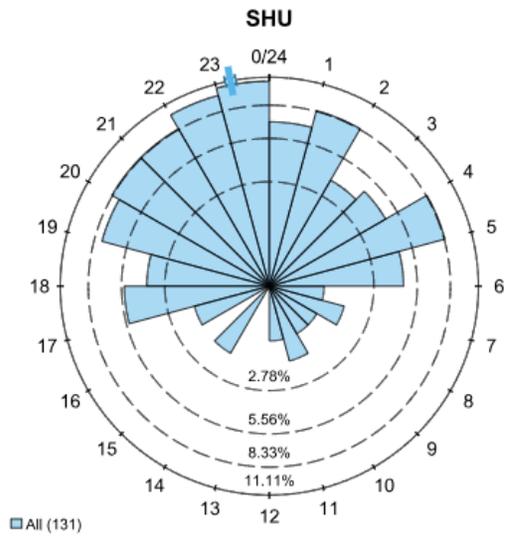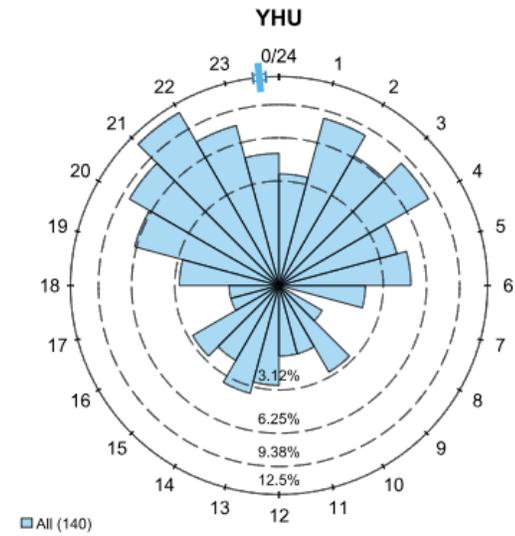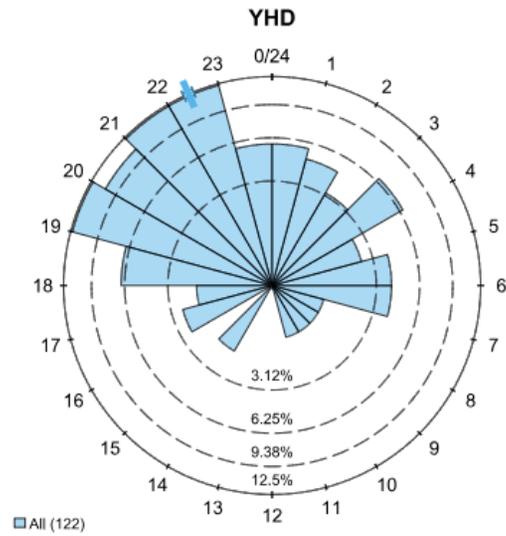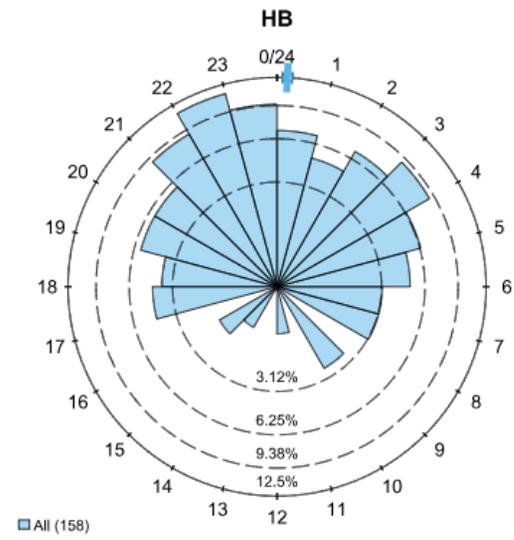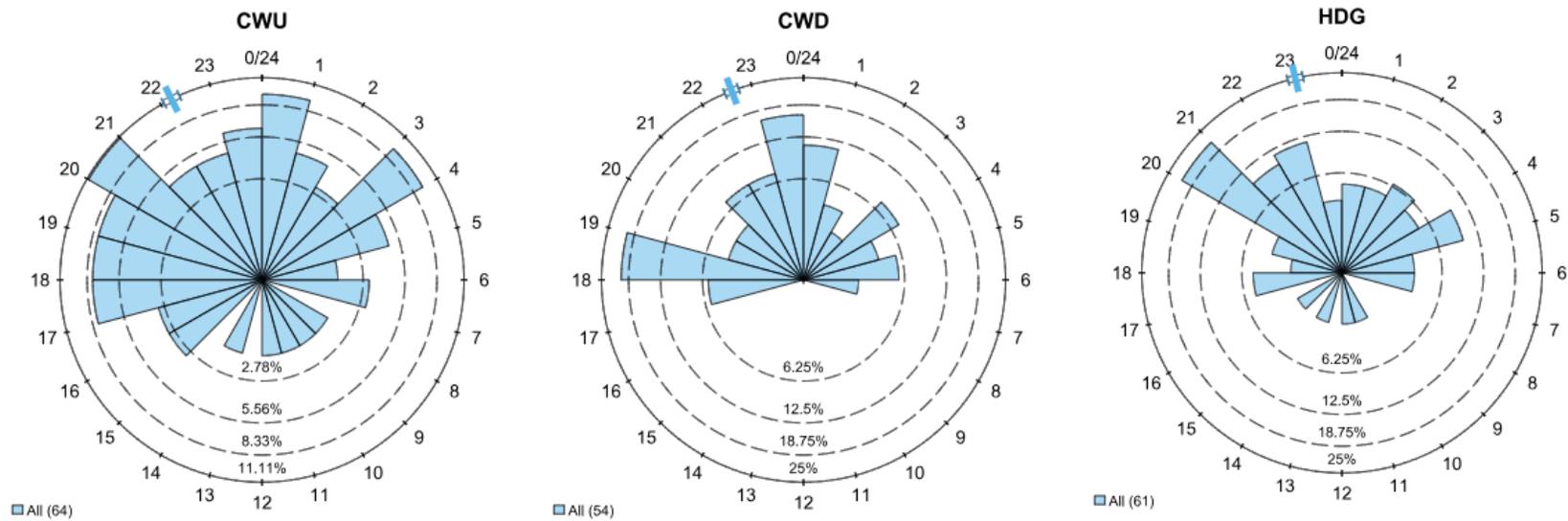
Figure 12. Percentage of migrants by hour of arrival at the nine lower Susquehanna River acoustic monitoring arrays (HB = Harrisburg, YHU = York Haven Upstream, YHD = York Haven Downstream, SHU = Safe Harbor Upstream, HWU = Holtwood Upstream, MR = Muddy Run Upstream, CWU = Conowingo Upstream, CWD = Conowingo Downstream, HDG = Havre de Grace). Colored lines on the outer ring represent the mean.
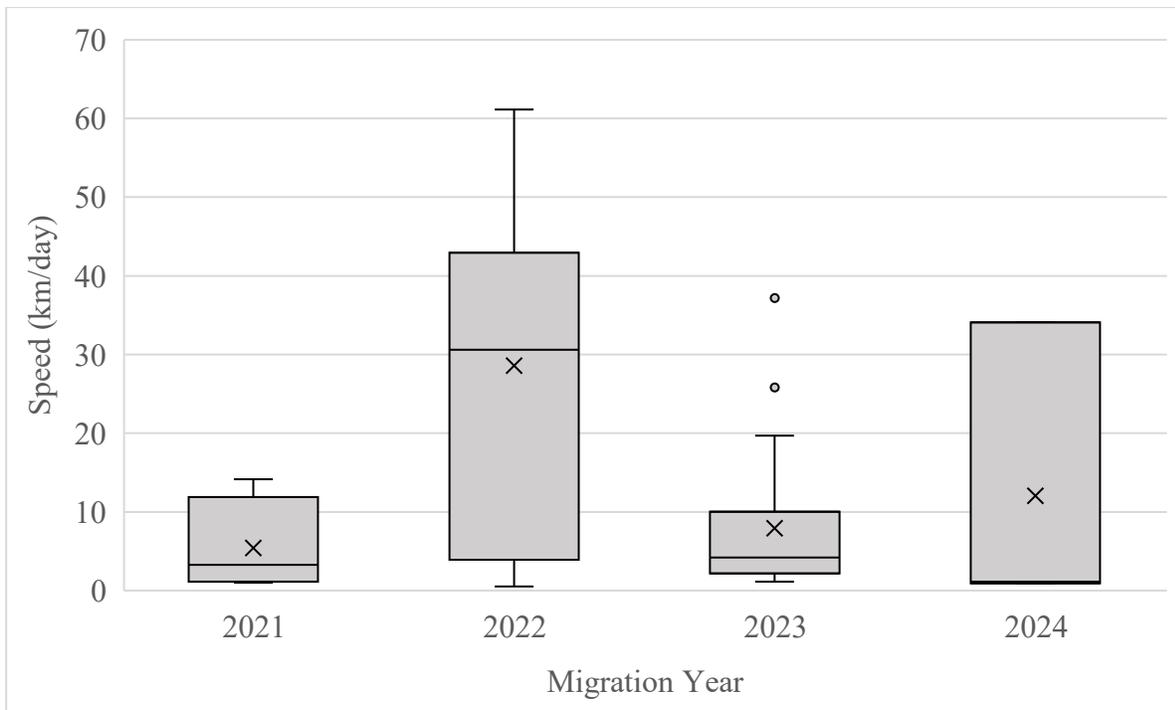
Figure 13. Migration speed of American Eels traveling from Harrisburg to Havre de Grace (112.8 rkm).
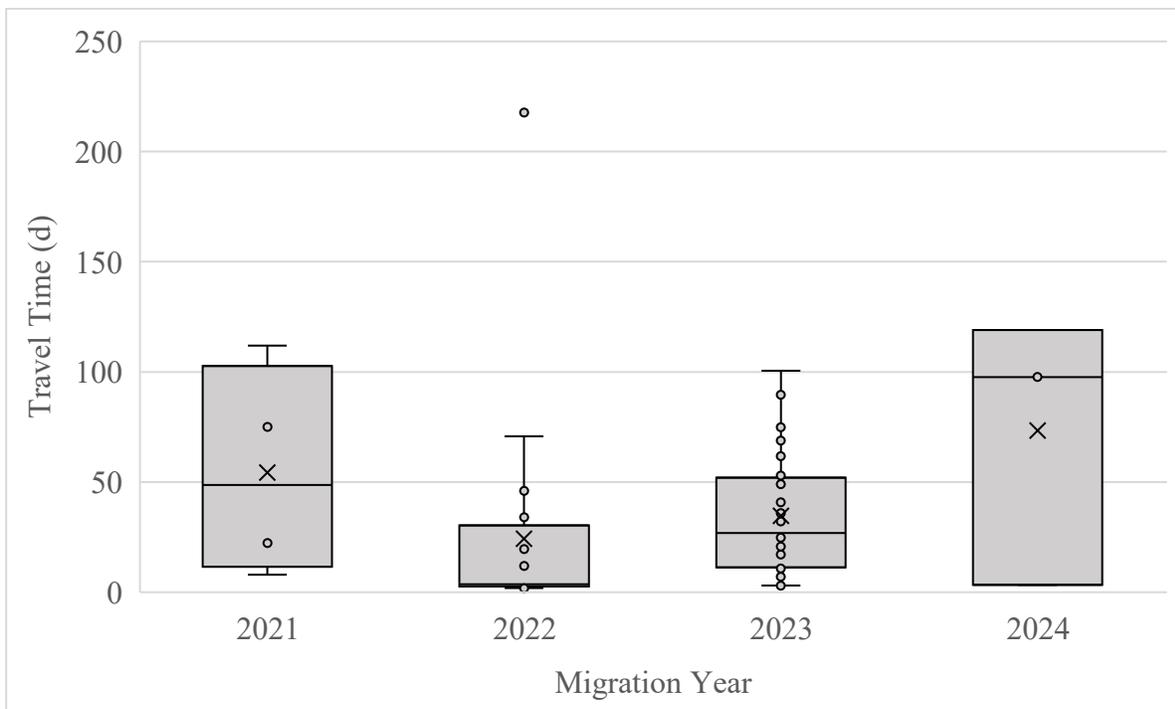
Figure 14. Duration of migration for American Eels traveling from Harrisburg to Havre de Grace (112.8 rkm).
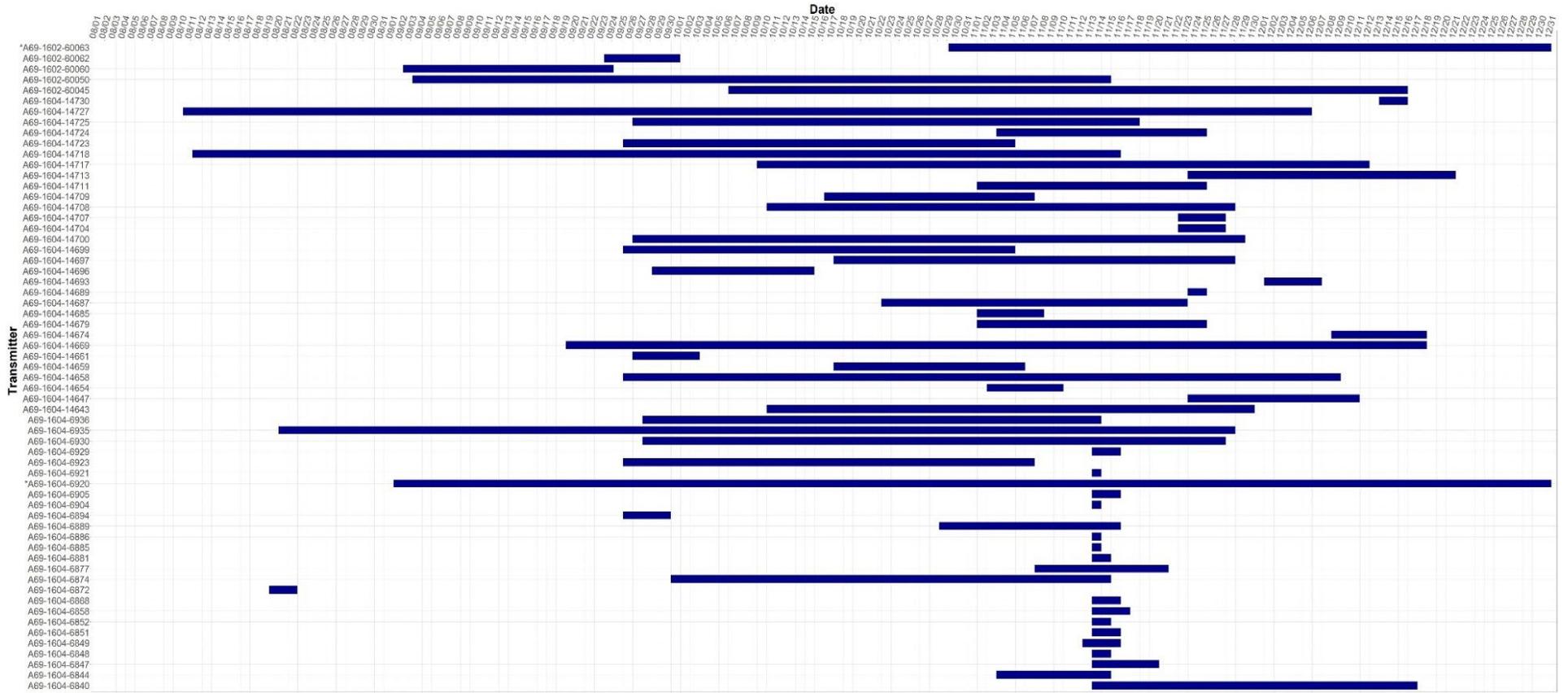
Figure 15. Travel dates between Harrisburg and Havre de Grace array detections for 59 eels that successfully exited the Susquehanna River during the 2021-2024 migration seasons.
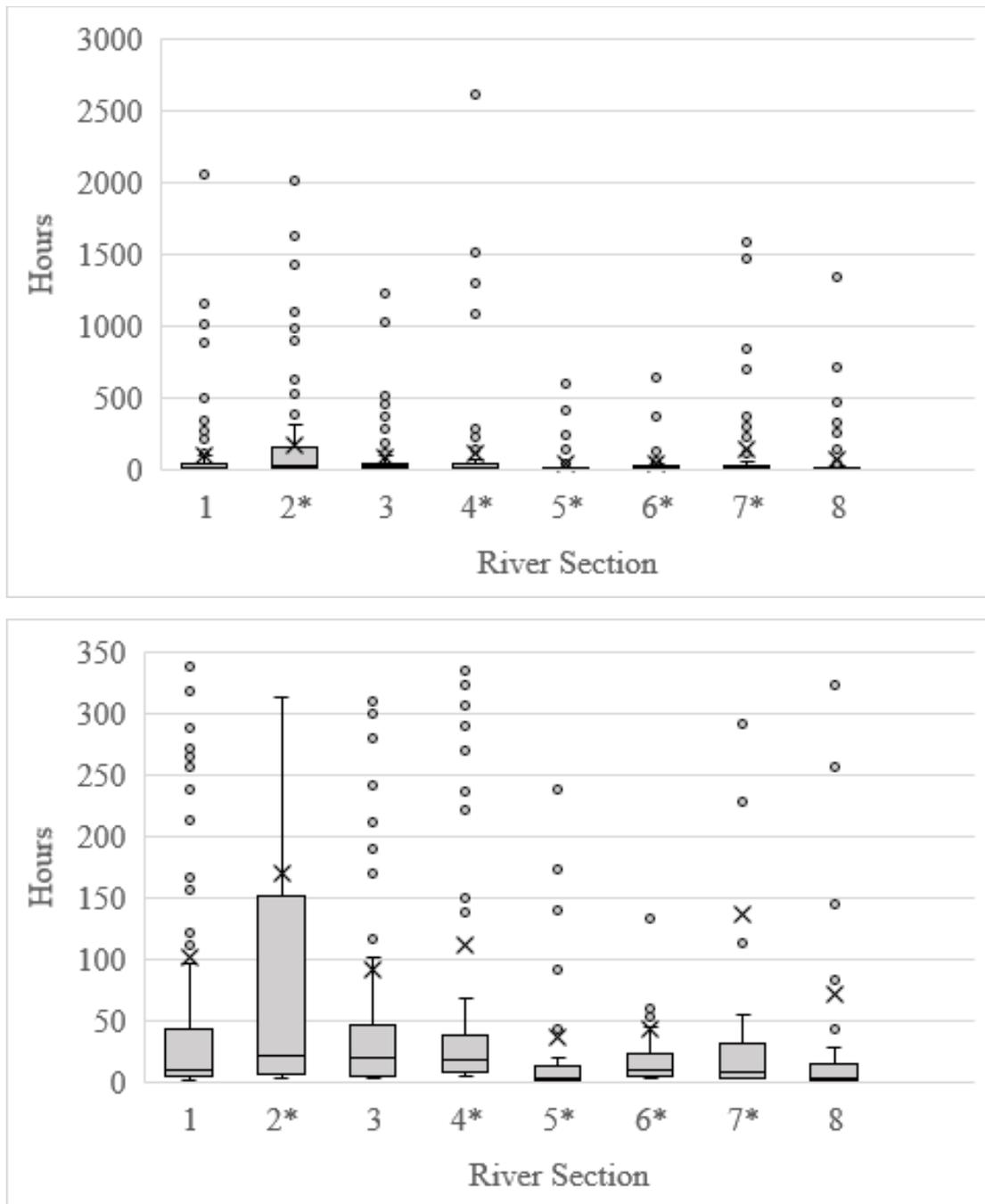
Figure 16. Elapsed time for American Eel to pass river sections between arrays in the lower Susquehanna River. 1 = Harrisburg to York Haven Upstream, 2 = York Haven Upstream to York Haven Downstream, 3 = York Haven Downstream to Safe Harbor Upstream, 4 = Safe Harbor Upstream to Holtwood Upstream, 5 = Holtwood Upstream to Muddy Run Upstream, 6 = Muddy Run Upstream to Conowingo Upstream, 7 = Conowingo Upstream to Conowingo Downstream, 8 = Conowingo Downstream to Havre de Grace. Sections with Dams are deonted with an asterisk. Top figure represents all data and bottom figure has y-axis truncated to eliminate outliers of elapsed passage time greater than 350 hours.
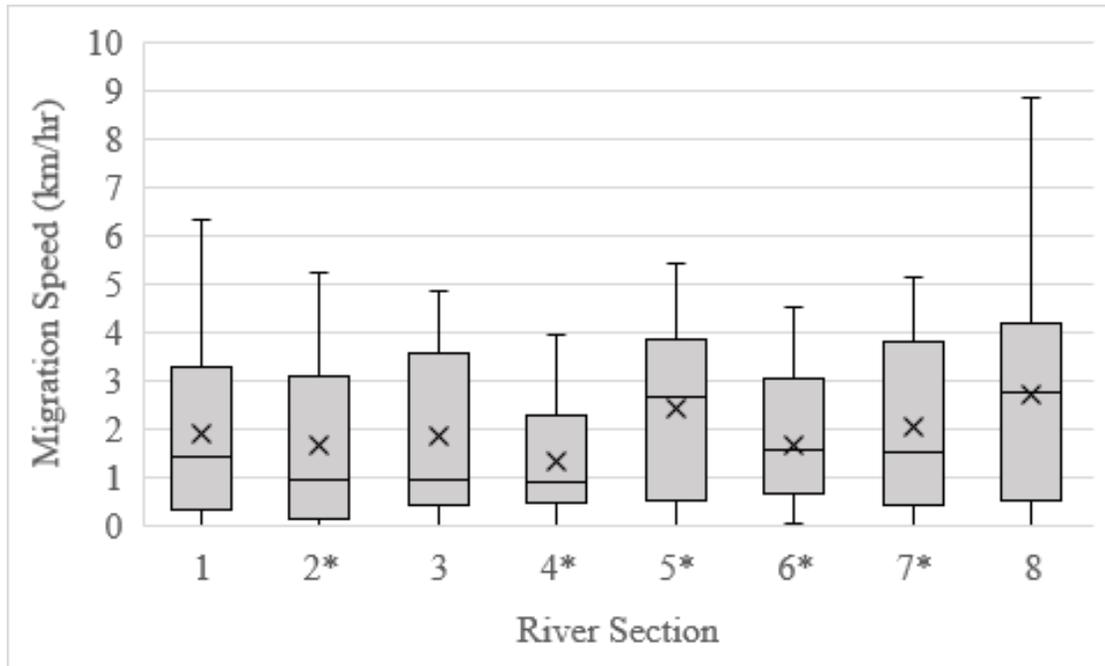
Figure 17. Speed of American Eel that passed river sections between arrays in the lower Susquehanna River. 1 = Harrisburg to York Haven Upstream, 2 = York Haven Upstream to York Haven Downstream, 3 = York Haven Downstream to Safe Harbor Upstream, 4 = Safe Harbor Upstream to Holtwood Upstream, 5 = Holtwood Upstream to Muddy Run Upstream, 6 = Muddy Run Upstream to Conowingo Upstream, 7 = Conowingo Upstream to Conowingo Downstream, 8 = Conowingo Downstream to Havre de Grace. Sections with Dams are deonted with an asterisk.
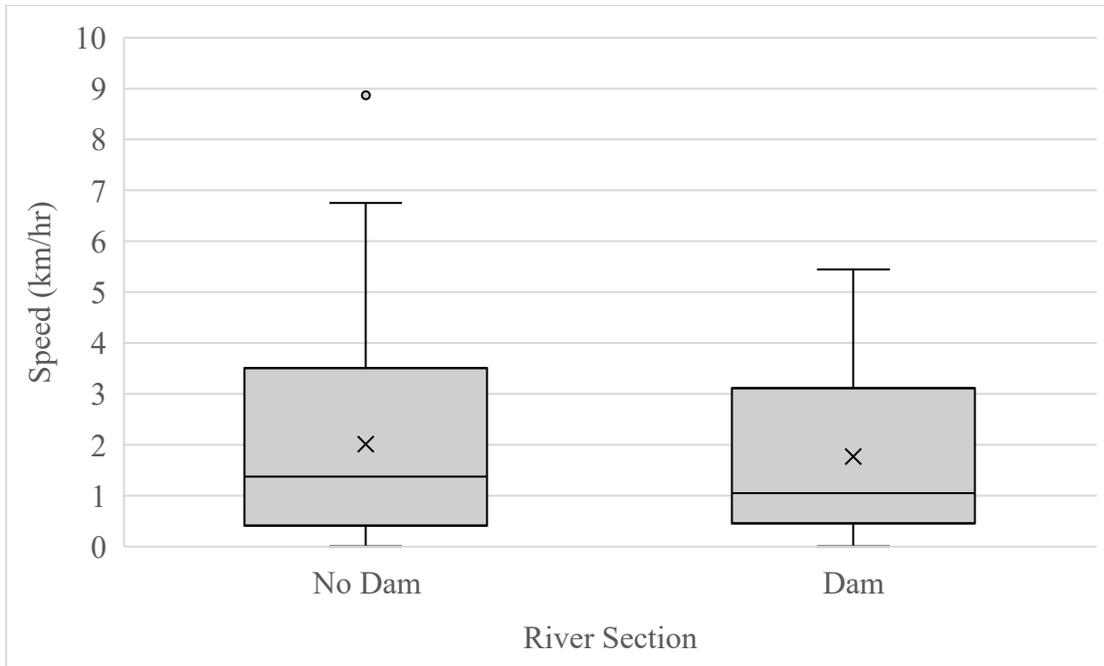
Figure 18. Speed of migration for American Eels passing through river sections that contained a dam or did not contain a dam.
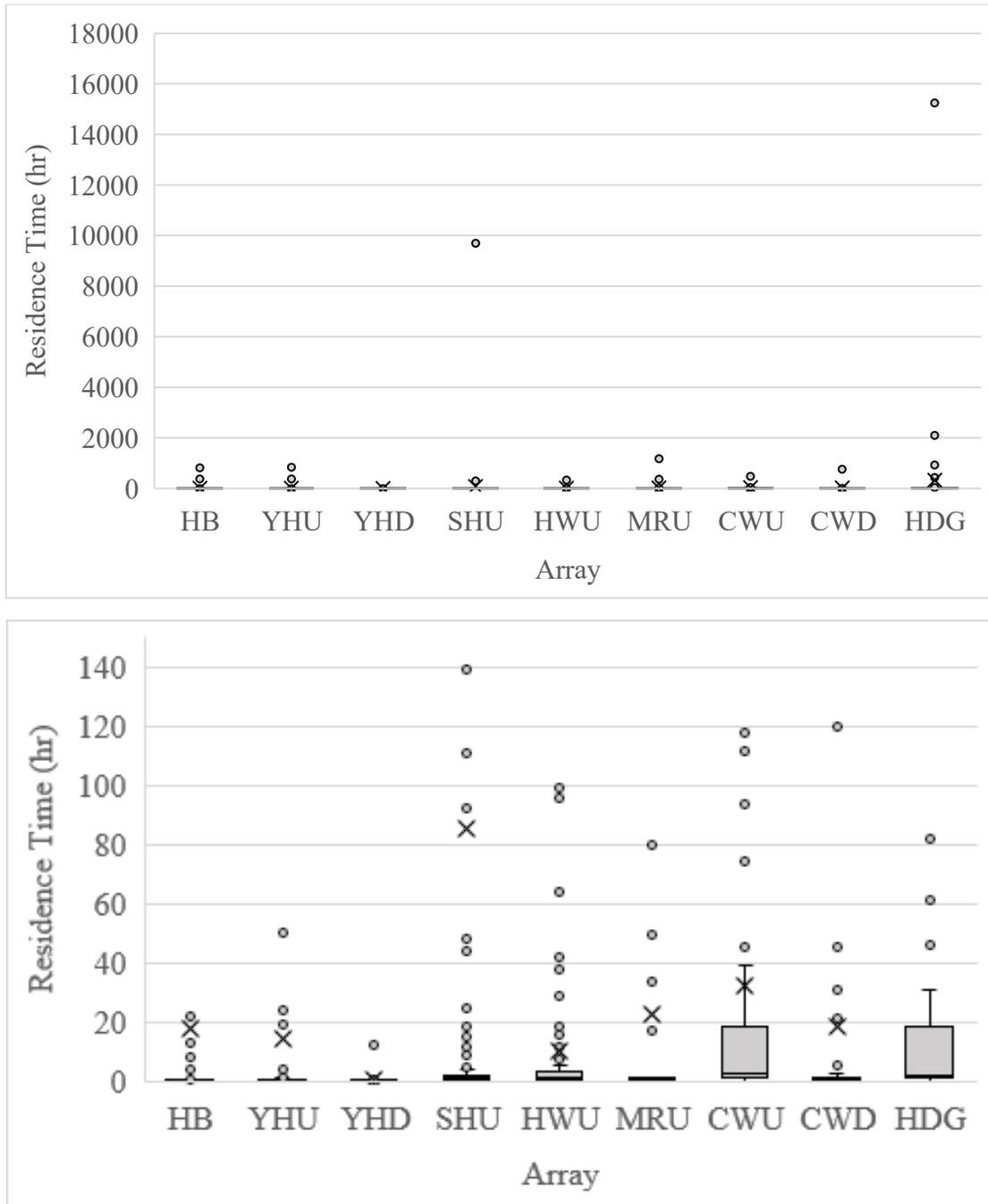
Figure 19. Elapsed time that American Eels were detected in the vicinity of a single array. Harrisburg = HB, York Haven Upstream = YHU, York Haven Downstream = YHD, Safe Harbor Downstream = SHU, Holtwood Upstream = HWU, Muddy Run Upstream = MRU, Conowingo Upstream = CWU, Conowingo Downstream = CWD, and Havre de Grace = HDG. Top figure represents all data and bottom figure has y-axis truncated to eliminate outliers of elapsed passage time greater than 140 hours.
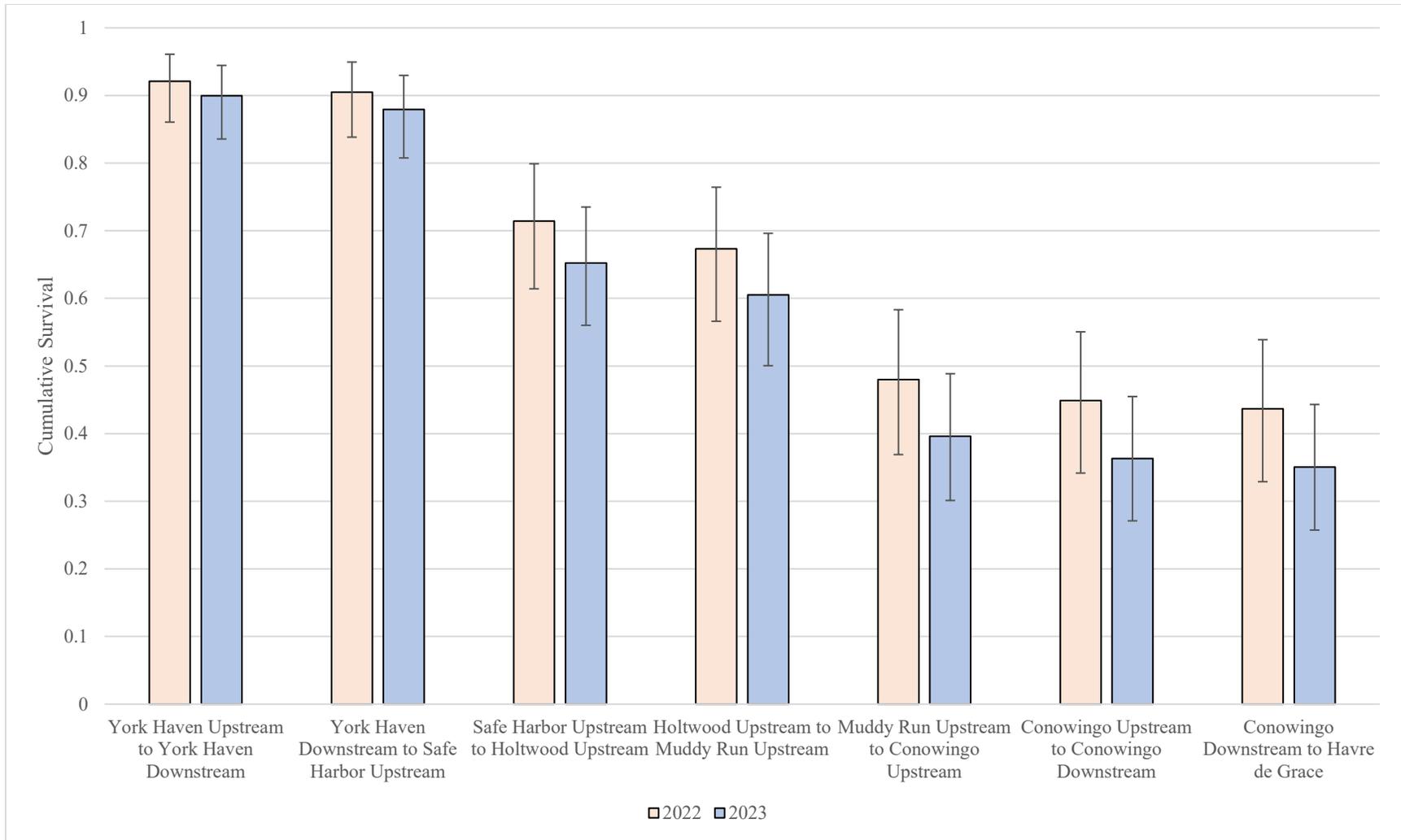
Figure 20. Cumulative survival of tagged eels traveling downstream through the sections of the Susquehanna River in 2022 and 2023.
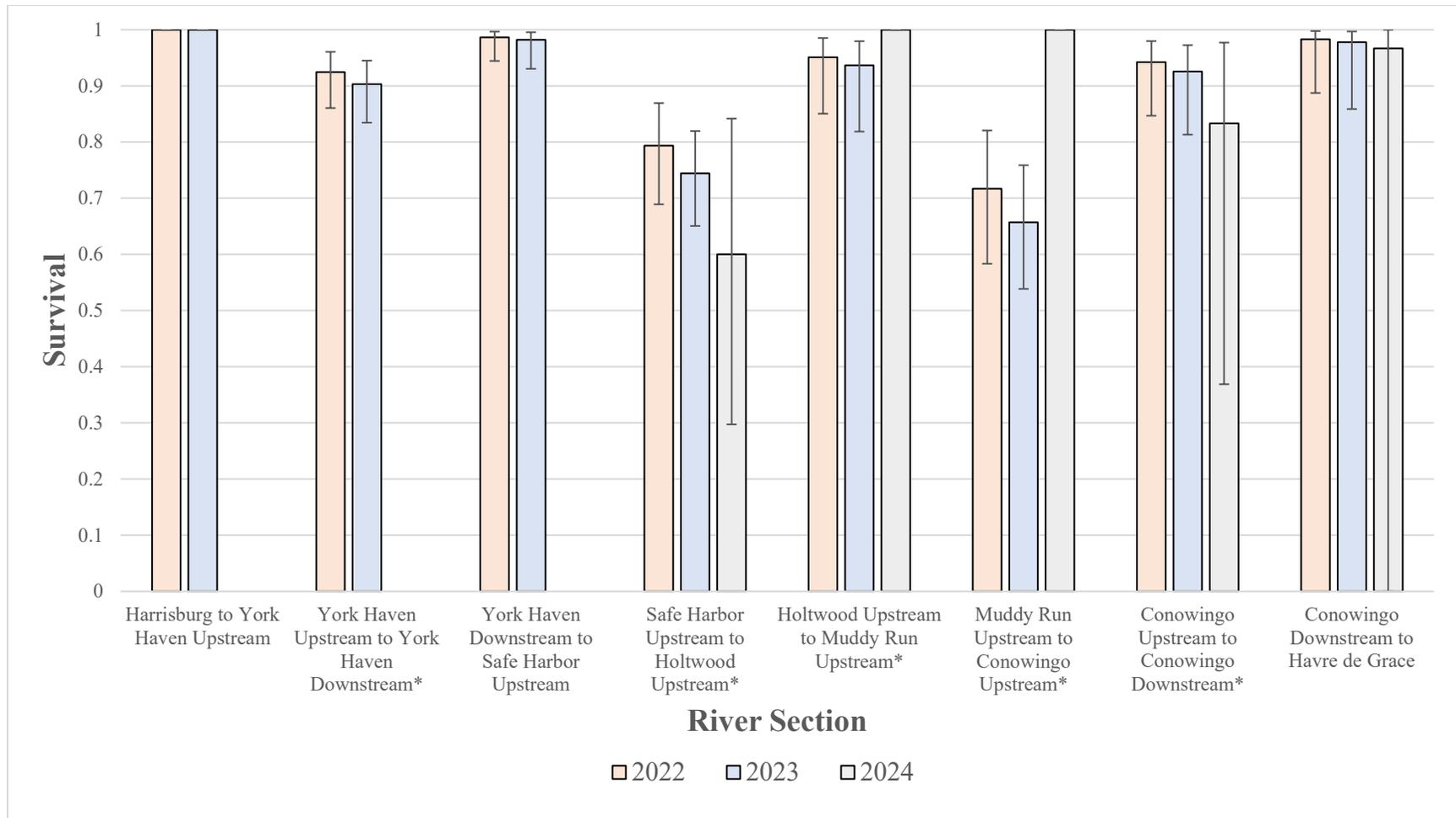
Figure 21. Apparent survival of downstream migrating tagged eels in Susquehanna River sections. Error bars represent 95% confidence limits. Data from 2024 are added for qualitative comparisons only since receiver coverage was incomplete and sample size was very low (n = 10 eels). River sections denotated with an (*) contain a dam.
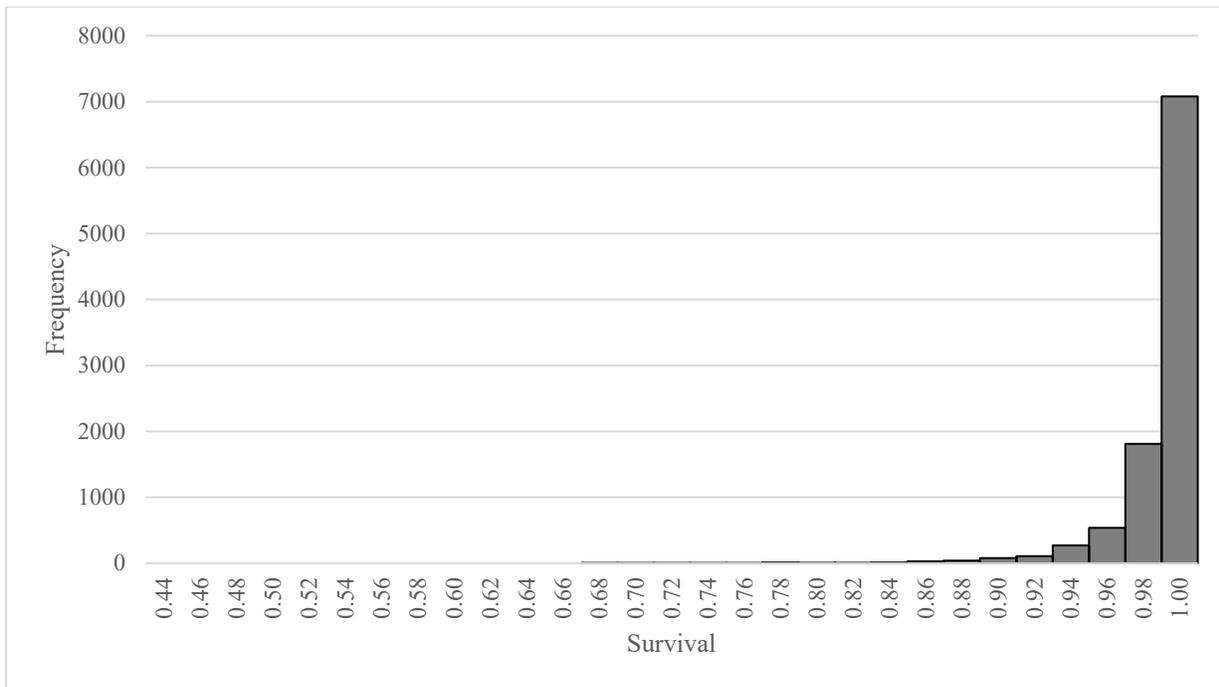
Figure 22. Bootstrap estimate frequencies of tagged eel survival in Susquehanna River sections that did not contain a dam in 2022 and 2023.
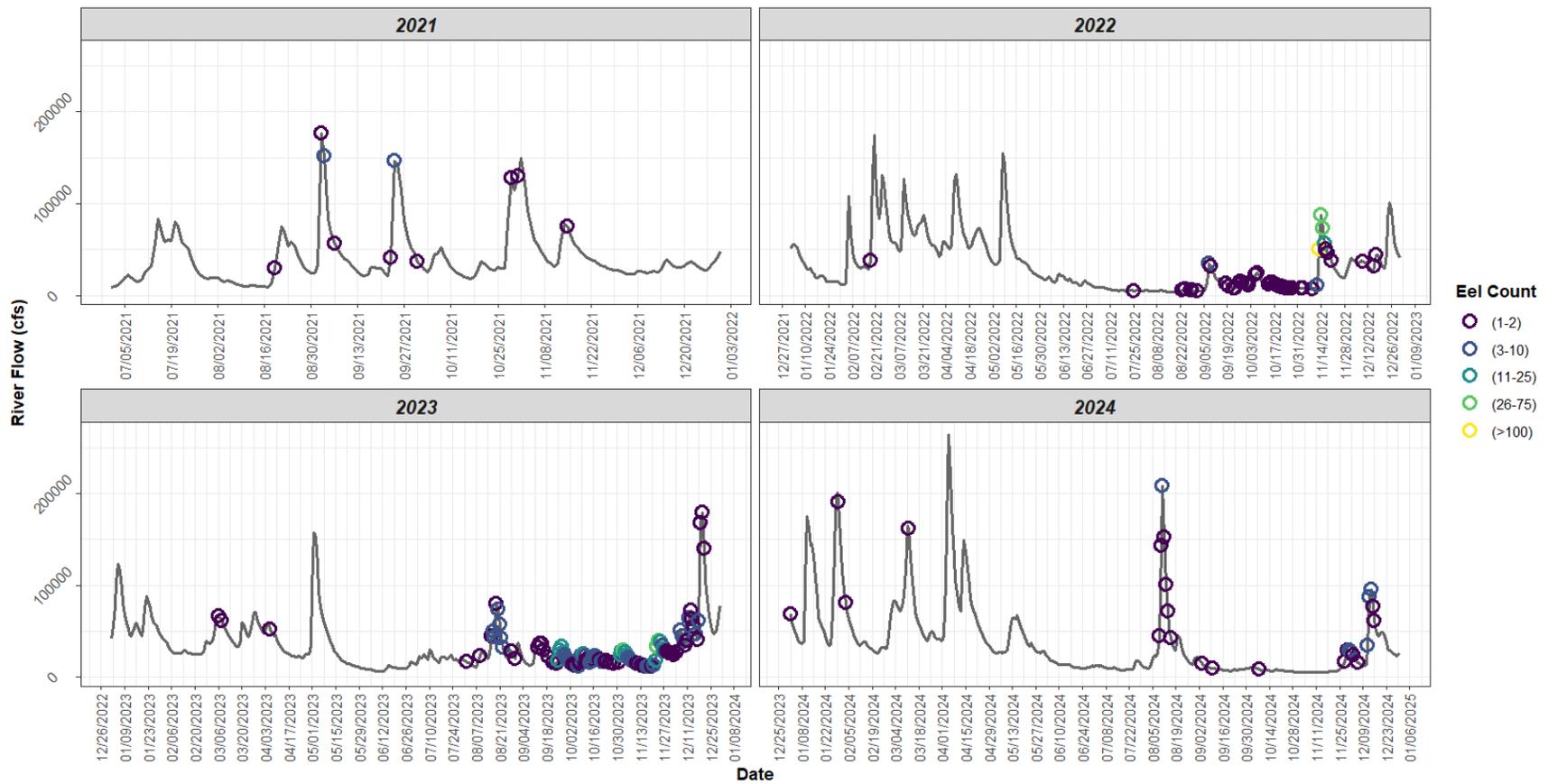
Figure 23. Mean daily river discharge (cfs) (Harrisburg, PA; USGS 01570500) in the lower Susquehanna River alongside recorded eel migratory events from 2021-2024.
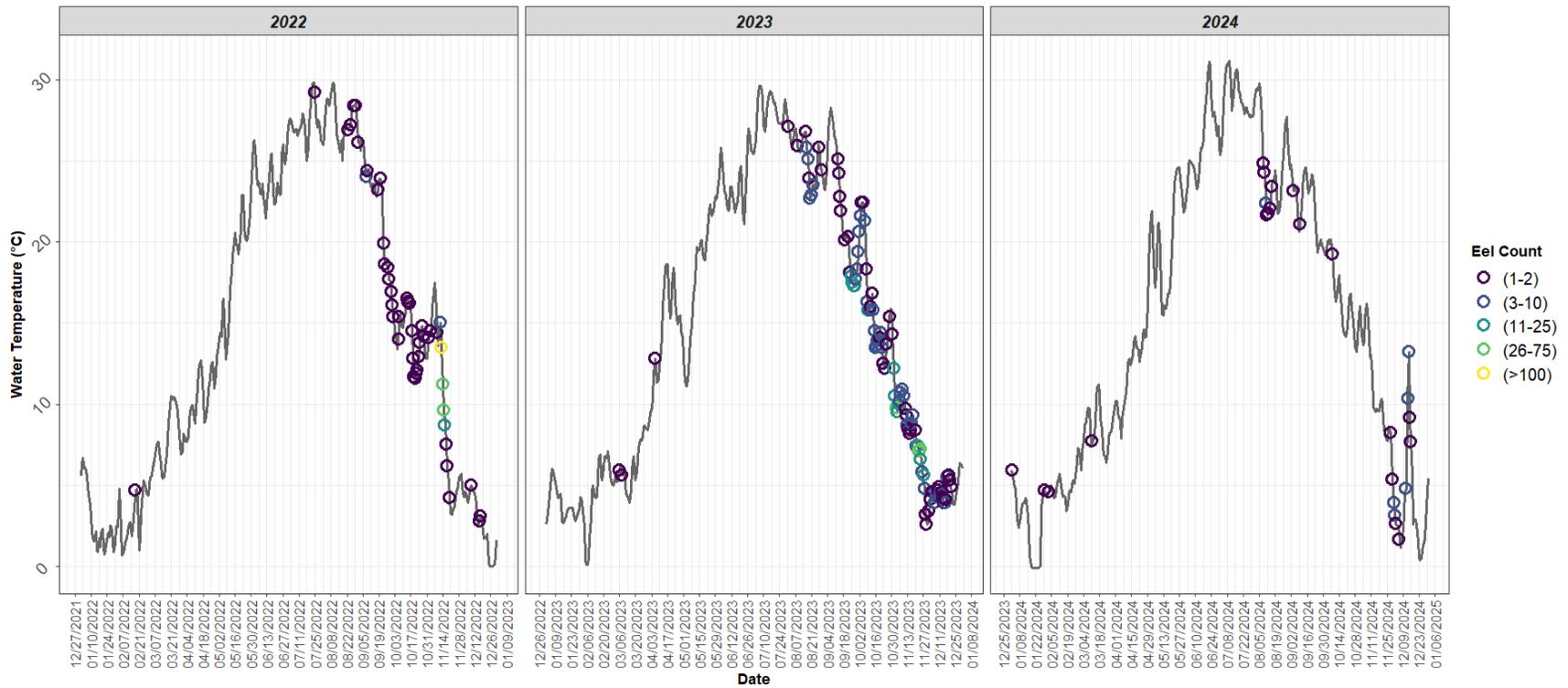
Figure 24. Mean water temperature (Columbia, PA; USGS 01576003) in the lower Susquehanna River alongside recorded eel migratory events.
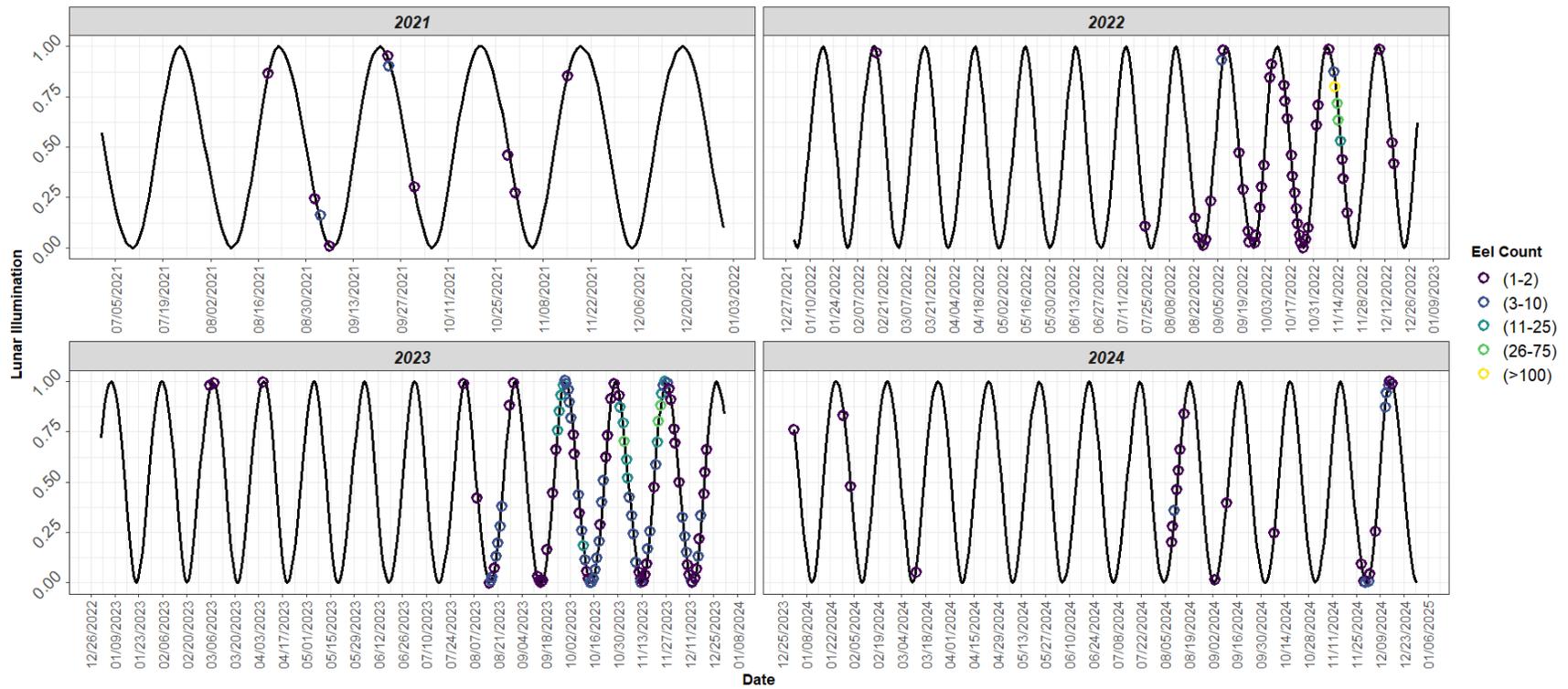
Figure 25. Lunar phase, represented as proportion of the moon illuminated (US Navy Astronomical Application Department). Points represent dates that eel migratory events were recorded at any acoustic receiver array.
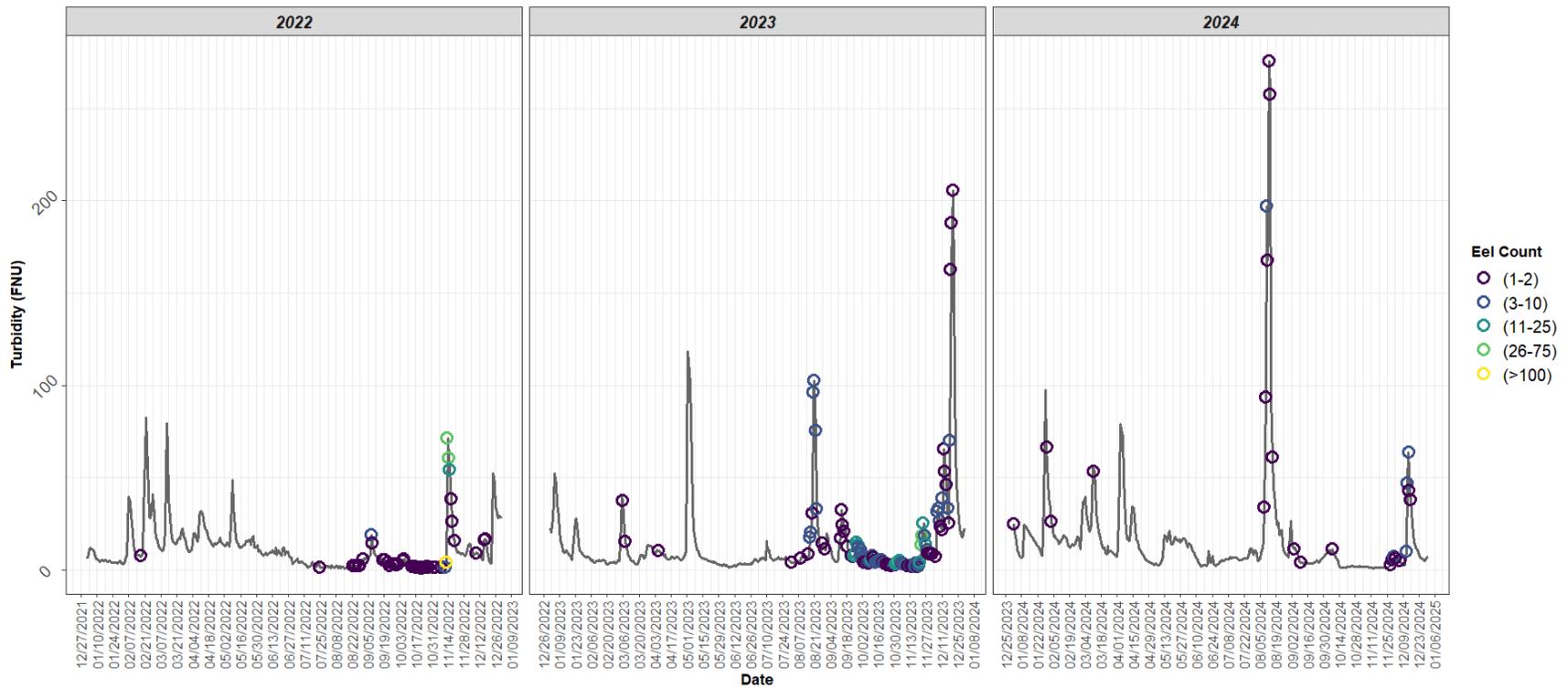
Figure 26. Mean daily turbidity (Columbia, PA; USGS 01576003) in the lower Susquehanna River. Points represent dates that eel migratory events were recorded at any acoustic receiver array.

APPENDICES

Appendix A. Deployment, removal, and data download dates for individual receivers in the lower Susquehanna River arrays. YHPC removed all receivers prior to winter each year.

Array	Array #	Station	Receiver	Deployed	Removed / Last Download Date	Latitude	Longitude
Harrisburg	1	East Island	VR2W-128099	8/2/2021	10/13/2021	40.2531	-76.8819
Harrisburg	1	East Island	VR2Tx-487413	10/13/2021	11/14/2024[1]	40.2531	-76.8819
Harrisburg	1	East Shore	VR2W-127872	8/2/2021	10/13/2021	40.2546	-76.8807
Harrisburg	1	East Shore	VR2Tx-487417	10/13/2021	11/27/2024[1]	40.2504	-76.8852
Harrisburg	1	West Island	VR2W-124293	8/2/2021	10/13/2021	40.2505	-76.8853
Harrisburg	1	West Island	VR2Tx-487418	10/13/2021	7/9/2025	40.2504	-76.8852
Harrisburg	1	West Shore	VR2W-126681	8/2/2021	10/13/2021	40.2494	-76.8861
Harrisburg	1	West Shore	VR2Tx-487412	10/13/2021	11/29/2024[1]	40.2494	-76.8862
York Haven Upstream	2	East Island	VR2Tx-487374	8/31/2021	12/21/2021	40.1842	-76.7518
York Haven Upstream	2	East Island	VR2Tx-487374	5/24/2022	11/29/2022	40.1842	-76.7518
York Haven Upstream	2	East Island	VR2Tx-487373	11/29/2022	12/21/2022	40.1842	-76.7518
York Haven Upstream	2	East Island	VR2Tx-487373	5/24/2023	1/10/2024	40.1842	-76.7518
York Haven Upstream	2	East Shore	VR2Tx-487372	8/31/2021	12/21/2021	40.1854	-76.7514
York Haven Upstream	2	East Shore	VR2Tx-487372	5/24/2022	11/29/2022	40.1854	-76.7514
York Haven Upstream	2	East Shore	VR2Tx-487368	11/29/2022	12/21/2022	40.1854	-76.7514
York Haven Upstream	2	East Shore	VR2Tx-487372	5/24/2023	1/10/2024	40.1854	-76.7514
York Haven Upstream	2	West Island	VR2Tx-487371	8/31/2021	12/21/2021	40.1813	-76.7588
York Haven Upstream	2	West Island	VR2Tx-487371	5/24/2022	11/29/2022	40.1813	-76.7588
York Haven Upstream	2	West Island	VR2Tx-487369	11/29/2022	12/21/2022	40.1813	-76.7588
York Haven Upstream	2	West Island	VR2Tx-487371	5/24/2023	1/10/2024	40.1813	-76.7588
York Haven Upstream	2	West Shore	VR2Tx-487370	8/31/2021	12/21/2021	40.1799	-76.7598
York Haven Upstream	2	West Shore	VR2Tx-487370	5/24/2022	11/29/2022	40.1799	-76.7598
York Haven Upstream	2	West Shore	VR2Tx-487371	11/29/2022	12/21/2022	40.1799	-76.7598
York Haven Upstream	2	West Shore	VR2Tx-487370	5/24/2023	1/10/2024	40.1799	-76.7598
York Haven Downstream[2]	3	East	VR2Tx-487368	8/30/2021	8/25/2022	40.0573	-76.6197
York Haven Downstream	3	East	VR2Tx-488390	5/24/2022	12/21/2022	40.0573	-76.6197
York Haven Downstream	3	East	VR2Tx-488390	5/24/2023	1/10/2024	40.0573	-76.6197
York Haven Downstream[3]	3	West	VR2Tx-487369	8/30/2021	10/5/2021	40.0564	-76.6202

Array	Array #	Station	Receiver	Deployed	Removed / Last Download Date	Latitude	Longitude
York Haven Downstream	3	West	VR2Tx-488389	5/24/2022	12/21/2022	40.0564	-76.6202
York Haven Downstream	3	West	VR2Tx-488389	5/24/2023	1/25/2024	40.0564	-76.6202
Safe Harbor Upstream	4	East	VR2Tx-487416	6/30/2022	7/10/2025	39.9663	-76.4707
Safe Harbor Upstream	4	Middle	VR2Tx-487419	6/30/2022	3/28/2025	39.9663	-76.4707
Safe Harbor Upstream	4	West	VR2Tx-488588	6/30/2022	3/28/2025	39.9605	-76.4826
Holtwood Upstream	5	East	VR2Tx-488585	6/1/2022	6/29/2022	39.9035	-76.3682
Holtwood Upstream	5	East	VR2Tx-488585	6/29/2022	3/13/2025	39.8586	-76.3566
Holtwood Upstream	5	Far West	VR2Tx-488588	6/1/2022	6/29/2022	39.8937	-76.3830
Holtwood Upstream	5	West	VR2Tx-488586	6/1/2022	3/13/2025	39.9017	-76.3760
Muddy Run Upstream[3]	6	East	VR2W-108981	6/16/2022	1/3/2024	39.8116	-76.3062
Muddy Run Upstream	6	East	VR2W-139325	2/26/2024	10/16/2024	39.8116	-76.3062
Muddy Run Upstream	6	East	VR2Tx-491699	10/16/2024	1/30/2025	39.8116	-76.3062
Muddy Run Upstream[3]	6	Middle	VR2W-111043	6/16/2022	4/20/2023	39.8094	-76.3071
Muddy Run Upstream	6	Middle	VR2W-138206	7/5/2023	2/10/2025	39.8094	-76.3071
Muddy Run Upstream[3]	6	West	VR2W-111046	6/16/2022	4/20/2023	39.8064	-76.3113
Muddy Run Upstream	6	West	VR2W-138207	7/5/2023	2/9/2024	39.6933	-76.2257
Muddy Run Upstream	6	West	VR2Tx-491697	5/29/2024	2/10/2025	39.6933	-76.2257
Conowingo Upstream	7	East	VR2W-107266	6/27/2022	2/10/2025	39.7017	-76.2174
Conowingo Upstream[3]	7	Middle	VR2W-107267	6/27/2022	11/23/2022	39.6987	-76.2203
Conowingo Upstream[3]	7	Middle	VR2W-138208	1/30/2023	4/15/2024	39.6987	-76.2203
Conowingo Upstream	7	Middle	VR2Tx-491695	7/19/2024	2/10/2025	39.6987	-76.2203
Conowingo Upstream[3]	7	West	VR2W-114403	6/27/2022	2/9/2024	39.6933	-76.2257
Conowingo Upstream	7	West	VR2Tx-491696	5/29/2024	2/10/2025	39.6933	-76.2257
Conowingo Downstream[3]	8	East	VR2W-111048	6/17/2022	12/5/2023	39.6115	-76.1267
Conowingo Downstream	8	East	VR2Tx-491700	7/19/2024	1/30/2025	39.6115	-76.1267
Conowingo Downstream[3]	8	Far West	VR2W-114404	6/30/2022	1/3/2024	39.6050	-76.1354
Conowingo Downstream	8	Far West	VR2Tx-491698	5/24/2024	1/30/2025	39.6050	-76.1354
Conowingo Downstream[3]	8	Middle	VR2W-108982	6/17/2022	4/20/2023	39.6094	-76.1311
Conowingo Downstream	8	Middle	VR2W-139326	7/14/2023	1/30/2025	39.6094	-76.1311
Conowingo Downstream[3]	8	West	VR2W-107269	6/17/2022	12/5/2023	39.6064	-76.1339
Conowingo Downstream	8	West	VR2Tx-491699	5/29/2024	11/20/2024	39.6064	-76.1339
Havre de Grace	9	Channel	VR2Tx-487414	9/20/2021	3/10/2025	39.5502	-76.0819

Array	Array #	Station	Receiver	Deployed	Removed / Last Download Date	Latitude	Longitude
Havre de Grace	9	Shore	VR2Tx-487415	9/20/2021	3/10/2025	39.5477	-76.0849

[1] Last date of detection due to battery failure

[2] Receiver temporarily lost

[3] Receiver permanently lost

Appendix B. Deployment, removal, and data download dates for individual receivers in the external Atlantic Coast Telemetry Network partners Chesapeake Bay, Delaware River, and Atlantic Ocean arrays.

Location	Receiver	Deployed	Last Download Date	Active at Study End? (Y/N)	Latitude	Longitude
Atlantic Ocean, NJ	VR2AR-553939	12/6/2023	6/18/2024	Y	39.42246	-74.29608
Atlantic Ocean, VA	VR2AR-551217	11/24/2023	5/22/2024	N	36.96250	-74.76630
Atlantic Ocean, VA	VR2AR-554073	2/4/2024	6/4/2024	Y	36.89868	-75.48996
Atlantic Ocean, VA	VR2AR-554074	2/4/2024	6/4/2024	Y	36.89868	-75.49332
Atlantic Ocean, VA	VR2AR-554075	2/4/2024	6/4/2024	Y	36.89810	-75.49164
Atlantic Ocean, VA	VR2AR-554076	2/4/2024	6/4/2024	Y	36.89693	-75.49085
Atlantic Ocean, VA	VR2AR-554077	2/4/2024	6/4/2024	Y	36.89693	-75.49243
Atlantic Ocean, VA	VR2AR-554082	2/4/2024	6/4/2024	Y	36.89449	-75.49164
Atlantic Ocean, VA	VR2AR-554084	2/4/2024	6/4/2024	Y	36.89250	-75.48990
Atlantic Ocean, VA	VR2AR-551289	4/22/2022	10/4/2024	Y	36.74094	-75.84794
Atlantic Ocean, VA	VR2AR-551296	4/22/2022	10/4/2024	Y	36.74094	-75.84794
Atlantic Ocean, VA	VR2AR-551303	4/21/2122	10/4/2024	Y	36.71410	-75.81260
Chesapeake Bay Bridge	VR2AR-551061	11/22/2021	7/11/2024	Y	38.99027	-76.40287
Chesapeake Bay Bridge	VR2AR-551062	11/22/2021	7/11/2024	Y	38.98522	-76.39458
Chesapeake Bay Bridge	VR2AR-551069	3/3/2022	7/11/2024	Y	38.97983	-76.37792
Chesapeake Bay Bridge	VR2AR-551064	11/22/2021	8/22/2024	Y	38.97515	-76.36226
Chesapeake Bay Bridge Tunnel	VR2AR-549775	6/24/2022	4/4/2023	N	36.93481	-76.13196
Chesapeake Bay Bridge Tunnel	VR2AR-551065	6/24/2022	4/4/2023	N	36.94607	-76.12811
Chesapeake Bay Bridge Tunnel	VR2AR-551070	6/24/2022	4/4/2023	N	36.94607	-76.12811
Chesapeake Bay Bridge Tunnel	VR2AR-551066	6/24/2022	4/4/2023	N	36.96833	-76.11979
Chesapeake Bay Bridge Tunnel	VR2AR-549781	4/4/2023	4/10/2024	N	36.99075	-76.11076
Chesapeake Bay Bridge Tunnel	VR2AR-549777	10/26/2022	9/12/2023	N	37.01288	-76.10163
Chesapeake Bay Bridge Tunnel	VR2AR-552345	9/12/2023	8/22/2024	N	37.02405	-76.09702
Chesapeake Bay Bridge Tunnel	VR2AR-549774	10/26/2022	9/12/2023	Lost	37.02975	-76.09047
Chesapeake Bay Bridge Tunnel	VR2AR-549785	10/26/2022	9/12/2023	Lost	37.04920	-76.07030
Chesapeake Bay Bridge Tunnel	VR2AR-549786	5/18/2022	10/26/2022	N	37.05666	-76.05957
Chesapeake Bay Bridge Tunnel	VR2AR-549784	5/18/2022	9/12/2023	N	37.06427	-76.04861
Chesapeake Bay Bridge Tunnel	VR2AR-551065	9/12/2023	5/2/2024	N	37.09446	-75.99670
Chesapeake Bay Cedar Point, MD	VR2AR-547715	12/13/2022	9/12/2023	N	38.30508	-76.34701
Chesapeake Bay Cedar Point, MD	VR2AR-546211	5/19/2021	9/12/2023	N	38.30897	-76.32943

Location	Receiver	Deployed	Last Download Date	Active at Study End? (Y/N)	Latitude	Longitude
Chesapeake Bay Cedar Point, MD	VR2AR-546476	12/13/2023	9/12/2023	N	38.30906	-76.32953
Chesapeake Bay Cedar Point, MD	VR2AR-546470	5/19/2021	9/12/2023	N	38.31305	-76.31206
Chesapeake Bay Cedar Point, MD	VR2AR-547714	12/13/2022	9/12/2023	N	38.31305	-76.31206
Chesapeake Bay Cedar Point, MD	VR2AR-546304	12/13/2022	9/12/2023	N	38.31705	-76.29423
Chesapeake Bay Cedar Point, MD	VR2AR-546323	5/19/2021	10/5/2023	N	38.31565	-76.29455
Chesapeake Bay off Dares Beach, MD	VR2AR-139121	9/6/2023	5/2/2024	N	38.55620	-76.41470
Chesapeake Bay off Dares Beach, MD	VR2AR-450135	9/7/2022	6/6/2023	N	38.55620	-76.41470
Chesapeake Bay off York River, VA	VR2AR-101374	5/22/2023	8/29/2023	N	37.20070	-76.26609
Chesapeake Bay off Patapsco River, MD	VR2AR-139120	9/5/2023	12/20/2023	N	39.15205	-76.39119
Chesapeake Bay off Rappahannock River, VA	VR2AR-450067	9/16/2022	5/5/2023	N	37.56743	-76.26208
Chesapeake Bay off Hoopers Island, MD	VR2AR-139114	7/11/2023	9/5/2023	N	38.20900	-76.23000
Chesapeake Bay off Rappahannock River, VA	VR2AR-555066	8/27/2024	5/10/2025	Y	37.53896	-76.01525
Chesapeake Bay off Rappahannock River, VA	VR2AR-800768	8/27/2024	5/10/2025	Y	37.56270	-76.03722
Chesapeake Bay off Rappahannock River, VA	VR2AR-555063	8/27/2024	5/10/2025	Y	37.68144	-76.18106
Chesapeake Bay off Rappahannock River, VA	VR2AR-800777	8/27/2024	5/10/2025	Y	37.62854	-75.91558
C&D Canal	VR2W-132544	3/7/2022	3/21/2023	N	39.55535	-75.64542
C&D Canal	VR2W-126828	3/21/2023	5/2/2024	N	39.51678	-75.54159
Delaware Bay	VR2W-111412	3/3/2023	6/7/2024	N	39.82424	-75.38090
Delaware River	VR2AR-549338	8/29/2022	4/10/2024	N	39.43398	-75.51767
Delaware River	VR2AR-548120	8/29/2022	4/10/2024	N	39.42175	-75.53357
Delaware River	VR2W-137198	3/21/2023	4/10/2024	N	39.43888	-75.54330
Delaware River	VR2W-130000	3/3/2023	5/9/2024	N	39.55222	-75.62100
Delaware River	VR2W-129999	3/7/2022	3/21/2023	N	39.58875	-75.58916
Delaware River	VR2W-130003	3/21/2023	5/2/2024	N	39.64047	-75.55992
Delaware River	VR2W-130007	3/21/2023	5/2/2024	N	39.67289	-75.52269
Delaware River	VR2W-133129	4/4/2023	5/2/2024	N	39.72789	-75.50123
Delaware River	VR2W-133128	4/4/2023	6/7/2024	N	39.71847	-75.50042
Delaware River	VR2W-129292	11/8/2023	6/7/2024	N	39.81054	-75.38813
Delaware River	VR2W-134622	3/9/2022	6/7/2024	N	39.84736	-75.33102
Delaware River	VR2W-133126	4/11/2023	6/7/2024	N	39.84774	-75.31325
Delaware River	VR2W-133130	3/7/2022	6/7/2024	N	39.13462	39.84981
Delaware River	VR2W-106800	4/11/2023	6/7/2024	N	39.85636	-75.24168

Location	Receiver	Deployed	Last Download Date	Active at Study End? (Y/N)	Latitude	Longitude
Delaware River	VR2W-134620	4/11/2023	6/7/2024	N	39.86969	-75.20335
Delaware River	VR2W-111414	4/11/2023	6/7/2024	N	39.89325	-75.13798

Appendix C. Study-wide eel arrival and departure times by array from 2021-2024. All times noted are in Eastern Daylight Savings Time. H = Harrisburg; YHU = York Haven Upstream; YHD = York Haven Downstream; SH = Safe Harbor Upstream; HW = Holtwood Upstream; MR = Muddy Run Upstream; CWU = Conowingo Upstream; CWD = Conowingo Downstream; HDG = Havre de Grace. A = Arrival at the Array; D = Departure from the Array; # = number of detections at the array.

Transmitter	H A	H D	H #	YHU A	YHU D	YHU #	YHD A	YHD D	YHD #	SH A	SH D	SH #
A69-1602-60044	9/3/2021 0:40	9/3/2021 0:41	3	9/3/2021 2:50	9/3/2021 2:58	13						
A69-1602-60045	10/6/2022 22:58	10/6/2022 23:12	25	10/7/2022 3:24	10/7/2022 3:44	36	11/13/2022 14:18	11/13/2022 14:22	15	11/13/2022 19:41	11/13/2022 20:06	30
A69-1602-60048	9/24/2021 8:27	9/24/2021 8:31	7	9/24/2021 10:52	9/24/2021 10:59	13						
A69-1602-60049	11/13/2022 9:08	11/13/2022 9:20	20	11/13/2022 13:15	11/13/2022 13:18	9	11/13/2022 18:02	11/13/2022 18:09	15	11/13/2022 22:38	11/13/2022 23:25	90
A69-1602-60050	9/3/2021 1:59	9/3/2021 2:01	5	9/3/2021 4:31	9/3/2021 4:37	10						
A69-1602-60051	10/2/2022 4:28	10/2/2022 4:50	35	10/2/2022 21:04	10/2/2022 21:28	59						
A69-1602-60054	8/19/2021 6:38	8/19/2021 10:24	16									
A69-1602-60056	8/19/2021 7:38	8/19/2021 21:18	1398									
A69-1602-60060	9/3/2021 0:15	9/3/2021 0:19	7	9/3/2021 4:16	9/3/2021 4:30	23						
A69-1602-60062	9/24/2021 0:29	9/24/2021 0:42	18	9/24/2021 20:04	9/24/2021 20:21	22						
A69-1602-60063	10/29/2021 8:09	10/29/2021 8:12	3	10/31/2021 22:38	10/31/2021 22:54	25						
A69-1602-60064	9/3/2021 8:05	9/3/2021 8:10	12	9/3/2021 10:50	9/3/2021 11:08	25	9/6/2021 1:09	9/6/2021 1:12	3			
A69-1604-14641	9/22/2023 6:36	9/23/2023 4:36	29	9/27/2023 20:50	9/27/2023 21:05	27	9/28/2023 7:35	9/28/2023 8:00	36	9/29/2023 21:03	9/30/2023 22:19	146
A69-1604-14643	10/10/2023 23:43	10/11/2023 0:03	8	10/11/2023 5:21	10/11/2023 6:34	75	10/18/2023 5:37	10/18/2023 5:47	18	11/2/2023 20:07	11/2/2023 20:55	61
A69-1604-14646	11/2/2023 0:09	11/2/2023 0:19	16	11/2/2023 4:43	11/2/2023 5:14	40	11/3/2023 4:01	11/3/2023 4:25	30	11/4/2023 6:05	11/4/2023 20:51	79
A69-1604-14647	11/23/2023 22:45	11/23/2023 22:57	13	11/24/2023 1:34	11/24/2023 1:50	23	11/24/2023 21:24	11/24/2023 21:39	15	11/26/2023 19:36	12/6/2023 17:42	1169
A69-1604-14648	11/25/2023 2:14	11/25/2023 2:39	30	11/26/2023 18:43	11/26/2023 19:06	21	11/27/2023 1:55	11/27/2023 2:14	22	11/27/2023 23:02	11/28/2023 17:46	14
A69-1604-14652	11/2/2023 1:27	11/2/2023 1:49	24	11/2/2023 20:00	11/2/2023 20:17	30	11/3/2023 0:33	11/3/2023 0:44	24	11/3/2023 19:50	11/3/2023 20:25	41
A69-1604-14654	11/2/2023 23:44	11/2/2023 23:58	13	11/3/2023 3:08	11/3/2023 3:42	27	11/3/2023 22:33	11/3/2023 22:39	15	11/4/2023 4:08	11/4/2023 4:46	42

123

Transmitter	H A	H D	H #	YHU A	YHU D	YHU #	YHD A	YHD D	YHD #	SH A	SH D	SH #
A69-1604-14655	10/10/2023 3:47	10/10/2023 4:03	21	10/10/2023 21:12	10/10/2023 21:42	34	10/15/2023 0:39	10/15/2023 0:44	9	10/19/2023 5:57	10/21/2023 1:46	175
A69-1604-14657	10/15/2023 22:59	10/16/2023 0:26	41	10/17/2023 2:59	10/17/2023 3:38	34	11/2/2023 20:20	11/2/2023 20:28	16	11/4/2023 19:38	11/4/2023 20:29	50
A69-1604-14658	9/25/2023 22:41	9/25/2023 23:01	22	9/26/2023 4:22	9/26/2023 5:02	46	9/27/2023 3:05	9/27/2023 3:17	18	9/28/2023 1:53	9/30/2023 1:56	330
A69-1604-14659	10/17/2023 4:13	10/17/2023 5:10	25	10/17/2023 22:33	10/17/2023 23:08	45	11/3/2023 20:05	11/3/2023 20:25	27	11/4/2023 5:07	11/4/2023 20:19	67
A69-1604-14660	9/19/2023 2:31	9/19/2023 2:42	18	10/10/2023 4:17	10/10/2023 5:36	35	10/22/2023 0:00	10/22/2023 0:06	14	10/22/2023 6:02	10/22/2023 7:15	73
A69-1604-14661	9/26/2023 23:18	9/26/2023 23:30	11	9/27/2023 2:29	9/27/2023 2:43	21	9/27/2023 21:12	9/27/2023 21:21	17	9/28/2023 21:24	9/28/2023 22:56	55
A69-1604-14662				10/14/2023 23:49	10/14/2023 23:51	3	10/15/2023 21:59	10/15/2023 22:12	22	10/16/2023 22:43	10/16/2023 23:41	44
A69-1604-14664	9/25/2023 4:50	9/25/2023 5:11	4	9/26/2023 3:57	9/26/2023 5:02	51	11/24/2023 19:27	11/24/2023 19:40	20	11/27/2023 20:17	11/27/2023 23:11	93
A69-1604-14665	11/22/2023 18:03	11/22/2023 18:21	23	11/22/2023 21:59	11/22/2023 22:28	37						
A69-1604-14666	9/24/2023 22:14	9/24/2023 22:29	15	9/25/2023 3:08	9/25/2023 3:15	12	9/25/2023 22:20	9/25/2023 22:38	31	9/26/2023 23:48	9/27/2023 1:33	133
A69-1604-14668	11/23/2023 7:22	11/23/2023 7:42	27	11/23/2023 11:58	11/23/2023 12:25	32	11/23/2023 21:22	11/23/2023 21:28	14	11/24/2023 16:54	11/24/2023 17:25	38
A69-1604-14669	9/20/2023 0:52	11/1/2023 19:32	5464	11/15/2023 1:11	11/15/2023 1:41	55	11/23/2023 18:11	11/23/2023 18:32	22	12/12/2023 17:04	12/12/2023 18:53	97
A69-1604-14670	8/23/2023 1:47	8/23/2023 1:58	17	8/23/2023 6:17	8/23/2023 6:59	35	8/23/2023 23:43	8/24/2023 0:08	38	9/15/2023 1:23	9/15/2023 2:47	69
A69-1604-14671	11/30/2024 2:22	11/30/2024 2:32	20							12/1/2024 5:13	12/1/2024 19:09	85
A69-1604-14672	10/9/2023 21:26	10/9/2023 21:45	14	10/10/2023 1:40	10/10/2023 1:56	24	10/10/2023 7:46	10/10/2023 20:03	34	10/11/2023 2:15	10/11/2023 3:17	57
A69-1604-14673	8/13/2024 16:36	8/13/2024 16:48	22							8/14/2024 5:15	8/14/2024 6:19	33
A69-1604-14674	12/8/2023 2:50	12/8/2023 3:01	11	12/8/2023 22:16	12/8/2023 23:13	58	12/12/2023 19:35	12/12/2023 19:46	17	12/13/2023 17:20	12/14/2023 17:54	71
A69-1604-14678	9/26/2023 5:00	9/26/2023 5:24	26	9/26/2023 23:29	9/26/2023 23:52	35						
A69-1604-14679	11/1/2023 5:55	11/1/2023 6:13	31	11/1/2023 21:45	11/1/2023 21:54	17	11/2/2023 7:34	11/2/2023 19:44	46	11/23/2023 2:54	11/23/2023 3:05	8
A69-1604-14681	10/17/2023 3:44	11/1/2023 19:31	12888	11/1/2023 23:48	11/2/2023 0:01	25	11/3/2023 4:37	11/3/2023 4:58	18	11/4/2023 0:26	11/4/2023 1:50	95
A69-1604-14682	10/23/2023 6:50	10/30/2023 19:59	22	11/1/2023 22:19	11/1/2023 22:34	26	11/2/2023 3:25	11/2/2023 3:37	24	11/2/2023 22:45	11/2/2023 23:35	80

Transmitter	H A	H D	H #	YHU A	YHU D	YHU #	YHD A	YHD D	YHD #	SH A	SH D	SH #
A69-1604-14684	11/2/2023 21:12	11/2/2023 21:50	40	11/3/2023 2:49	11/3/2023 3:23	41	11/4/2023 22:30	11/4/2023 22:39	15	11/5/2023 19:23	11/5/2023 19:59	57
A69-1604-14685	11/1/2023 22:35	11/1/2023 22:49	18	11/2/2023 20:18	11/2/2023 20:40	27	11/3/2023 21:03	11/3/2023 21:15	19	11/4/2023 22:10	11/4/2023 23:01	64
A69-1604-14686	8/10/2024 7:39	8/10/2024 7:50	18							8/16/2024 21:00	8/17/2024 0:07	97
A69-1604-14687	10/22/2023 1:21	11/1/2023 16:56	354	11/1/2023 21:20	11/1/2023 21:45	26	11/2/2023 23:22	11/2/2023 23:37	19	11/3/2023 4:57	11/3/2023 5:51	72
A69-1604-14688	9/27/2023 20:39	9/27/2023 20:56	24	9/28/2023 0:49	9/28/2023 1:04	20	10/26/2023 2:58	10/26/2023 3:27	46	11/6/2023 18:15	11/6/2023 19:37	73
A69-1604-14689	11/23/2023 3:17	11/23/2023 3:42	32	11/23/2023 13:16	11/23/2023 13:44	36	11/23/2023 22:49	11/23/2023 23:00	12	11/24/2023 4:38	11/24/2023 5:32	48
A69-1604-14690	12/12/2024 20:47	12/12/2024 20:54	16							12/13/2024 11:34	12/13/2024 12:39	37
A69-1604-14691	9/27/2023 23:43	9/27/2023 23:53	18	9/28/2023 3:36	9/28/2023 3:52	27	9/28/2023 21:38	9/28/2023 21:56	21	9/29/2023 4:13	9/29/2023 5:30	70
A69-1604-14692	11/17/2023 23:44	11/18/2023 0:00	21	11/18/2023 3:24	11/18/2023 4:29	56						
A69-1604-14693										12/1/2024 2:00	12/1/2024 3:23	81
A69-1604-14694	11/23/2023 18:07	11/23/2023 18:23	22	11/23/2023 21:29	11/23/2023 22:15	33	11/25/2023 14:05	11/25/2023 14:21	21	11/30/2023 11:26	11/30/2023 14:38	214
A69-1604-14695	11/22/2023 4:35	11/22/2023 5:02	29	11/22/2023 18:45	11/22/2023 18:55	20	11/23/2023 0:29	11/23/2023 0:31	3	11/23/2023 17:12	11/23/2023 18:37	96
A69-1604-14696	9/28/2023 20:48	9/28/2023 20:57	7	10/3/2023 22:35	10/3/2023 22:51	35	10/4/2023 5:24	10/4/2023 5:33	8	10/9/2023 3:47	10/9/2023 4:35	20
A69-1604-14697	10/17/2023 20:33	10/17/2023 21:30	40	10/22/2023 23:18	10/22/2023 23:25	6	11/2/2023 21:31	11/2/2023 21:43	18	11/15/2023 18:56	11/15/2023 21:52	129
A69-1604-14698	11/23/2023 8:49	11/23/2023 9:17	39	11/23/2023 15:09	11/23/2023 15:58	50	11/24/2023 5:04	11/24/2023 5:17	24	11/25/2023 14:33	11/26/2023 12:01	874
A69-1604-14699	9/25/2023 23:33	9/25/2023 23:51	16	11/1/2023 19:55	11/1/2023 20:01	11	11/2/2023 2:33	11/2/2023 2:49	23	11/2/2023 22:48	11/2/2023 23:44	61
A69-1604-14700	9/26/2023 2:20	9/26/2023 2:31	14	10/18/2023 7:04	11/22/2023 3:18	136	11/22/2023 10:42	11/22/2023 10:59	34	11/22/2023 19:12	11/24/2023 15:41	40
A69-1604-14701	12/18/2023 15:09	12/18/2023 15:21	17	12/18/2023 18:07	12/18/2023 18:21	24	12/18/2023 23:21	12/18/2023 23:22	2	12/19/2023 4:01	12/19/2023 4:19	23
A69-1604-14702	9/25/2023 1:54	9/25/2023 2:06	15	9/25/2023 6:14	9/25/2023 6:30	29	9/26/2023 1:46	9/26/2023 2:03	23	9/26/2023 23:19	9/27/2023 1:05	110
A69-1604-14703	10/10/2023 22:33	10/10/2023 23:35	13	11/2/2023 0:25	11/2/2023 0:54	31	11/3/2023 5:31	11/3/2023 5:49	32	11/5/2023 2:00	11/5/2023 2:58	100
A69-1604-14704	11/22/2023 4:41	11/22/2023 4:59	36	11/22/2023 19:15	11/22/2023 19:35	21	11/23/2023 22:19	11/23/2023 22:32	23	11/24/2023 4:25	11/24/2023 5:38	62

Transmitter	H A	H D	H #	YHU A	YHU D	YHU #	YHD A	YHD D	YHD #	SH A	SH D	SH #
A69-1604-14705	10/17/2023 7:27	10/17/2023 20:29	27	10/18/2023 1:31	10/18/2023 1:56	45	10/18/2023 23:01	10/18/2023 23:20	32	11/3/2023 21:31	11/3/2023 22:40	39
A69-1604-14706	9/25/2023 4:53	9/25/2023 5:08	16	9/29/2023 5:47	9/29/2023 6:27	42	10/2/2023 6:27	10/2/2023 6:48	20	10/4/2023 22:02	10/4/2023 23:01	75
A69-1604-14707	11/22/2023 19:12	11/22/2023 19:56	34	11/22/2023 23:27	11/22/2023 23:55	18	11/23/2023 22:16	11/23/2023 22:27	18	11/24/2023 17:41	11/24/2023 18:36	70
A69-1604-14708	10/10/2023 22:00	10/10/2023 22:28	37	10/22/2023 6:34	10/22/2023 8:37	96	11/4/2023 4:25	11/4/2023 4:48	23	11/25/2023 17:38	11/25/2023 18:50	90
A69-1604-14709	10/16/2023 3:23	10/16/2023 3:54	34	10/16/2023 21:41	10/17/2023 3:42	762	10/24/2023 4:40	10/24/2023 4:53	15	11/2/2023 0:23	11/2/2023 1:07	18
A69-1604-14710	11/13/2023 19:23	11/13/2023 19:44	28	11/13/2023 23:15	11/13/2023 23:27	23						
A69-1604-14711	11/1/2023 20:11	11/1/2023 20:36	33	11/3/2023 20:28	11/3/2023 21:46	54	11/13/2023 21:39	11/13/2023 21:57	22	11/22/2023 22:25	11/22/2023 22:59	29
A69-1604-14712	11/23/2023 21:50	11/23/2023 22:10	32	11/24/2023 2:34	11/24/2023 3:20	47	11/24/2023 22:00	11/24/2023 22:15	20	11/25/2023 17:42	11/25/2023 20:00	111
A69-1604-14713	11/23/2023 18:43	11/23/2023 19:05	25	11/24/2023 0:56	11/25/2023 0:46	52	11/26/2023 8:07	11/26/2023 8:17	21	11/26/2023 20:16	11/26/2023 21:19	75
A69-1604-14714	10/10/2023 0:44	10/10/2023 2:08	26	10/11/2023 21:11	10/12/2023 3:23	32	10/18/2023 23:08	10/18/2023 23:21	18	10/20/2023 20:10	10/20/2023 20:49	36
A69-1604-14715	9/27/2023 5:21	9/27/2023 5:39	19	10/7/2023 21:26	10/7/2023 21:33	8	10/9/2023 23:11	10/9/2023 23:21	20	10/10/2023 21:35	10/10/2023 22:39	66
A69-1604-14717	10/9/2023 23:37	10/9/2023 23:46	12	10/10/2023 4:19	10/10/2023 4:29	19	11/1/2023 21:45	11/1/2023 22:00	17	11/3/2023 22:40	11/3/2023 23:54	75
A69-1604-14718	8/11/2024 2:41	8/11/2024 2:51	7							8/11/2024 11:36	8/11/2024 11:39	2
A69-1604-14719	10/31/2023 21:02	11/1/2023 19:09	19	11/1/2023 22:58	11/1/2023 23:12	24	12/12/2023 20:05	12/12/2023 20:29	22	2/3/2024 16:41	3/13/2025 14:21	2223
A69-1604-14721	11/22/2023 6:36	11/22/2023 6:53	22	11/22/2023 21:19	11/22/2023 21:52	38	11/23/2023 5:40	11/23/2023 5:47	12	11/24/2023 4:57	11/24/2023 16:49	55
A69-1604-14722	9/26/2023 20:58	9/26/2023 21:11	20	10/7/2023 21:47	10/7/2023 21:55	14						
A69-1604-14723	9/26/2023 0:16	9/26/2023 0:33	25	10/5/2023 21:59	10/5/2023 23:10	45	10/8/2023 1:12	10/8/2023 1:50	34	10/9/2023 4:57	10/13/2023 1:11	228
A69-1604-14724	11/3/2023 22:50	11/3/2023 23:05	30	11/7/2023 23:08	11/7/2023 23:24	23	11/8/2023 21:05	11/8/2023 21:19	27	11/18/2023 23:23	11/19/2023 3:59	295
A69-1604-14725	9/27/2023 0:25	9/27/2023 3:41	48				11/1/2023 22:59	11/1/2023 23:12	15	11/3/2023 0:23	11/3/2023 1:19	57
A69-1604-14726	11/28/2024 18:49	11/28/2024 19:07	40							11/30/2024 19:34	11/30/2024 21:46	89
A69-1604-14727	8/9/2024 19:19	8/9/2024 19:32	17							8/10/2024 15:01	8/10/2024 15:53	19

Transmitter	H A	H D	H #	YHU A	YHU D	YHU #	YHD A	YHD D	YHD #	SH A	SH D	SH #
A69-1604-14729	10/16/2023 23:17	10/16/2023 23:39	24	10/17/2023 3:56	10/17/2023 4:19	40	10/19/2023 22:04	10/19/2023 22:12	9	10/20/2023 5:29	10/20/2023 5:50	30
A69-1604-14730	12/12/2024 19:31	12/12/2024 19:43	18							12/13/2024 10:52	12/13/2024 12:14	62
A69-1604-14731	10/10/2023 1:20	10/10/2023 1:55	18	11/1/2023 22:34	11/1/2023 22:43	19	11/2/2023 22:34	11/2/2023 22:42	12	11/4/2023 6:12	11/4/2023 7:34	121
A69-1604-14735	12/12/2024 19:37	12/12/2024 19:43	14							12/13/2024 8:23	12/13/2024 17:11	44
A69-1604-6840	11/13/2022 22:38	11/13/2022 22:45	8	11/14/2022 1:58	11/14/2022 2:08	19	11/14/2022 6:05	11/14/2022 6:09	8	11/15/2022 1:00	11/15/2022 1:30	44
A69-1604-6844	11/3/2022 5:55	11/3/2022 6:19	22	11/9/2022 17:56	11/9/2022 18:03	12	11/13/2022 19:45	11/13/2022 19:47	4	11/13/2022 23:44	11/14/2022 0:00	25
A69-1604-6845	9/8/2022 22:34	9/8/2022 22:44	13	10/20/2022 22:59	10/21/2022 3:08	34	11/13/2022 23:28	11/13/2022 23:48	17			
A69-1604-6847	11/13/2022 3:04	11/13/2022 3:19	25	11/13/2022 9:27	11/13/2022 9:32	9	11/13/2022 18:33	11/13/2022 18:39	3	11/13/2022 22:53	11/13/2022 23:37	25
A69-1604-6848	11/13/2022 5:01	11/13/2022 5:10	14	11/13/2022 14:53	11/13/2022 14:54	2	11/13/2022 20:01	11/13/2022 20:04	6	11/14/2022 1:08	11/14/2022 1:36	34
A69-1604-6849	11/12/2022 23:05	11/12/2022 23:17	19	11/13/2022 3:07	11/13/2022 3:11	4	11/13/2022 18:14	11/13/2022 18:18	11	11/13/2022 22:43	11/13/2022 23:23	46
A69-1604-6850	11/13/2022 5:42	11/13/2022 5:58	29	11/13/2022 15:22	11/13/2022 15:27	7	11/13/2022 19:50	11/13/2022 19:55	12	11/15/2022 17:25	11/15/2022 17:31	5
A69-1604-6851	11/13/2022 2:14	11/13/2022 2:29	16	11/13/2022 12:22	11/13/2022 12:25	6	11/13/2022 19:43	11/13/2022 19:49	9	11/14/2022 0:46	11/14/2022 1:24	33
A69-1604-6852	11/13/2022 0:07	11/13/2022 0:18	20	11/13/2022 4:52	11/13/2022 5:03	24	11/13/2022 19:27	11/13/2022 19:31	7	11/13/2022 23:34	11/13/2022 23:58	45
A69-1604-6853	9/14/2023 0:51	9/14/2023 1:08	19	9/14/2023 23:18	9/15/2023 0:12	50	9/16/2023 3:09	9/16/2023 3:29	32	9/16/2023 23:22	9/17/2023 0:41	77
A69-1604-6854	9/18/2022 3:51	9/18/2022 4:04	15	9/20/2022 21:11	9/20/2022 21:31	29	9/23/2022 23:41	9/23/2022 23:49	16	11/13/2022 20:24	11/13/2022 20:48	42
A69-1604-6855	8/25/2022 5:10	9/28/2022 6:36	3221	10/19/2022 3:41	10/19/2022 4:16	35						
A69-1604-6858	11/13/2022 4:06	11/13/2022 4:18	20	11/13/2022 14:08	11/13/2022 14:09	2	11/13/2022 18:57	11/13/2022 19:01	10	11/13/2022 23:32	11/14/2022 0:00	28
A69-1604-6860	9/24/2023 23:09	9/24/2023 23:24	19	9/28/2023 20:54	9/28/2023 21:11	29	10/11/2023 23:03	10/11/2023 23:26	27	10/15/2023 4:33	10/15/2023 5:16	24
A69-1604-6861	8/1/2023 2:01	8/1/2023 2:09	16	8/9/2023 23:30	8/12/2023 1:29	60	11/3/2023 22:00	11/3/2023 22:14	25	11/4/2023 20:11	11/4/2023 21:07	75
A69-1604-6862	11/12/2022 17:45	11/12/2022 17:57	19	11/13/2022 3:47	11/13/2022 3:54	10	11/13/2022 18:01	11/13/2022 18:07	7	11/13/2022 22:02	11/13/2022 22:21	20
A69-1604-6866	8/28/2022 3:31	8/28/2022 3:44	5	8/29/2022 22:53	8/29/2022 22:57	10	9/9/2022 0:18	9/9/2022 0:27	13	10/22/2022 0:36	10/22/2022 3:07	171

Transmitter	H A	H D	H #	YHU A	YHU D	YHU #	YHD A	YHD D	YHD #	SH A	SH D	SH #
A69-1604-6868	11/13/2022 1:17	11/13/2022 1:22	12	11/13/2022 5:25	11/13/2022 5:35	10	11/13/2022 19:28	11/13/2022 19:36	11	11/14/2022 0:39	11/14/2022 1:22	33
A69-1604-6869	9/25/2023 22:52	9/25/2023 23:31	22	10/7/2023 23:02	10/7/2023 23:19	25	10/9/2023 1:01	10/9/2023 1:13	18	10/16/2023 2:59	10/16/2023 3:56	29
A69-1604-6870	10/18/2022 20:34	10/19/2022 4:58	139	11/2/2022 6:41	11/2/2022 7:38	29	11/18/2022 22:21	11/18/2022 23:15	67			
A69-1604-6871	9/27/2023 6:06	9/27/2023 6:21	16	9/27/2023 22:48	9/27/2023 23:22	49						
A69-1604-6872	8/19/2023 23:12	8/19/2023 23:16	6	8/20/2023 2:16	8/20/2023 2:24	18	8/20/2023 6:25	8/20/2023 6:25	1	8/20/2023 23:32	8/21/2023 0:42	84
A69-1604-6873	8/17/2023 6:09	8/17/2023 6:18	17	8/17/2023 15:50	8/17/2023 16:09	28	8/17/2023 22:32	8/17/2023 22:40	16	8/18/2023 3:24	8/18/2023 3:58	37
A69-1604-6874	9/30/2022 23:36	10/1/2022 0:10	14	10/1/2022 5:21	10/1/2022 5:39	22	10/22/2022 21:52	10/22/2022 22:03	19	10/23/2022 4:25	10/23/2022 6:03	99
A69-1604-6875	9/25/2023 4:14	9/25/2023 4:28	16	11/1/2023 21:06	11/1/2023 21:11	9	11/4/2023 22:57	11/4/2023 23:13	18	11/8/2023 1:04	11/8/2023 1:12	9
A69-1604-6876	9/26/2023 1:44	9/26/2023 1:56	16	9/26/2023 6:06	9/26/2023 6:15	16	9/27/2023 3:07	9/27/2023 3:20	17	9/28/2023 3:36	10/10/2023 20:37	3244
A69-1604-6877	11/7/2023 21:31	11/7/2023 21:50	23	11/8/2023 1:33	11/8/2023 1:41	15	11/12/2023 22:24	11/12/2023 22:39	23	11/14/2023 23:06	11/15/2023 1:08	108
A69-1604-6879	9/25/2023 21:16	9/25/2023 21:41	22	9/26/2023 4:26	9/26/2023 5:28	36	11/7/2023 21:11	11/7/2023 21:49	27	11/24/2023 19:21	11/24/2023 19:59	25
A69-1604-6880	10/10/2023 3:07	10/10/2023 3:22	12	10/10/2023 20:23	10/10/2023 20:57	35	11/3/2023 1:28	11/3/2023 1:39	14	11/3/2023 23:39	11/4/2023 3:49	202
A69-1604-6881	11/13/2022 3:23	11/13/2022 3:37	22	11/13/2022 15:21	11/13/2022 15:25	8	11/13/2022 20:28	11/13/2022 20:37	13	11/14/2022 1:27	11/14/2022 1:58	40
A69-1604-6882	11/13/2022 0:11	11/13/2022 0:23	21	11/13/2022 4:30	11/13/2022 4:33	6	11/13/2022 20:12	11/13/2022 20:14	8	11/14/2022 0:43	11/14/2022 1:14	42
A69-1604-6885	11/13/2022 4:18	11/13/2022 4:29	18	11/13/2022 12:15	11/13/2022 12:19	6	11/13/2022 17:18	11/13/2022 17:24	10	11/13/2022 21:59	11/13/2022 22:11	14
A69-1604-6886	11/13/2022 2:47	11/13/2022 2:58	16	11/13/2022 8:06	11/13/2022 9:04	16	11/13/2022 19:04	11/13/2022 19:09	11	11/14/2022 0:29	11/14/2022 0:38	9
A69-1604-6887	11/13/2022 4:49	11/13/2022 5:01	15	11/13/2022 10:56	11/13/2022 10:57	4	11/13/2022 16:10	11/13/2022 16:13	8	11/13/2022 21:00	11/13/2022 21:22	29
A69-1604-6888	11/13/2022 7:50	11/13/2022 8:02	17	11/13/2022 11:46	11/13/2022 11:49	5	11/13/2022 19:14	11/13/2022 19:18	8	11/13/2022 23:21	11/13/2022 23:51	40
A69-1604-6889	10/28/2022 1:24	10/28/2022 1:33	13	10/28/2022 21:36	10/28/2022 22:03	23	11/13/2022 18:33	11/13/2022 18:38	7	11/13/2022 23:15	11/13/2022 23:37	28
A69-1604-6891	8/23/2022 4:33	8/23/2022 4:46	10	8/24/2022 0:48	8/24/2022 0:56	11						
A69-1604-6894	9/25/2023 22:07	9/25/2023 22:22	16	9/26/2023 20:53	9/26/2023 21:19	27	9/27/2023 2:36	9/27/2023 3:01	26	9/28/2023 0:05	9/28/2023 0:50	75

Transmitter	H A	H D	H #	YHU A	YHU D	YHU #	YHD A	YHD D	YHD #	SH A	SH D	SH #
A69-1604-6897	9/8/2022 23:08	9/8/2022 23:39	19	9/10/2022 0:56	9/27/2022 22:06	3088	11/12/2022 20:30	11/12/2022 20:35	5	11/13/2022 20:34	11/13/2022 20:46	16
A69-1604-6898	7/26/2022 0:25	7/26/2022 1:21	16	10/19/2022 23:24	10/19/2022 23:53	36						
A69-1604-6900	8/16/2023 22:36	8/16/2023 22:47	18	8/17/2023 2:45	8/17/2023 3:16	36	8/17/2023 10:43	8/17/2023 10:53	14	8/18/2023 2:36	8/18/2023 3:22	101
A69-1604-6901	11/13/2022 3:04	11/13/2022 3:12	16	11/13/2022 6:19	11/13/2022 6:39	35				11/13/2022 21:43	11/13/2022 22:01	17
A69-1604-6902	9/8/2022 23:38	9/8/2022 23:44	9	10/27/2022 5:16	11/12/2022 0:17	60						
A69-1604-6904	11/13/2022 3:04	11/13/2022 3:11	15	11/13/2022 13:09	11/13/2022 13:12	6	11/13/2022 18:09	11/13/2022 18:12	8	11/13/2022 22:09	11/13/2022 22:23	19
A69-1604-6905	11/13/2022 4:29	11/13/2022 4:40	20	11/13/2022 12:36	11/13/2022 12:41	9	11/13/2022 19:36	11/13/2022 19:41	10	11/14/2022 0:04	11/14/2022 0:45	58
A69-1604-6907	10/16/2022 22:59	10/16/2022 23:19	26	11/2/2022 6:09	11/3/2022 1:23	21						
A69-1604-6908	9/27/2023 21:33	9/27/2023 21:42	15	9/28/2023 1:21	9/28/2023 1:38	24	9/28/2023 7:39	9/28/2023 8:33	28	10/10/2023 21:05	10/10/2023 22:14	98
A69-1604-6913	11/23/2023 0:18	11/23/2023 0:42	44	11/23/2023 16:39	11/23/2023 17:14	39	11/23/2023 22:55	11/23/2023 23:03	16	11/24/2023 4:51	11/24/2023 5:50	51
A69-1604-6914	9/24/2022 1:43	9/24/2022 2:23	34	9/27/2022 4:25	9/27/2022 5:39	33	11/13/2022 19:44	11/13/2022 19:47	6	11/14/2022 1:18	11/14/2022 1:45	38
A69-1604-6915	11/1/2023 16:47	11/1/2023 16:57	13	11/1/2023 22:37	11/1/2023 23:02	28	11/2/2023 22:43	11/2/2023 22:50	16	11/3/2023 20:55	11/3/2023 21:32	57
A69-1604-6916	11/13/2022 9:33	11/13/2022 9:40	12	11/13/2022 13:48	11/13/2022 13:50	3	11/13/2022 19:47	11/13/2022 19:51	6	11/14/2022 0:15	11/14/2022 0:47	48
A69-1604-6918	11/13/2022 22:58	11/13/2022 23:02	6	11/14/2022 2:25	11/14/2022 2:30	9	11/14/2022 7:43	11/14/2022 7:46	3	11/14/2022 19:47	11/14/2022 20:27	47
A69-1604-6919	11/13/2022 17:59	11/13/2022 18:06	7	11/13/2022 21:05	11/13/2022 21:13	12	11/14/2022 1:06	11/14/2022 1:10	10	11/14/2022 5:15	11/14/2022 5:37	18
A69-1604-6920	9/1/2022 5:27	9/1/2022 5:57	19	9/8/2022 4:51	9/8/2022 5:36	42	11/15/2022 0:38	11/15/2022 0:41	4	11/15/2022 5:42	11/15/2022 6:38	60
A69-1604-6921	11/13/2022 3:46	11/13/2022 3:54	13	11/13/2022 9:27	11/13/2022 9:31	7	11/13/2022 16:05	11/13/2022 16:12	12	11/13/2022 20:39	11/13/2022 21:16	28
A69-1604-6923	9/25/2023 23:09	9/25/2023 23:23	15	10/7/2023 22:52	10/7/2023 23:03	17	11/3/2023 2:37	11/3/2023 2:47	12	11/3/2023 8:12	11/3/2023 20:28	64
A69-1604-6924	11/21/2023 21:21	11/21/2023 21:33	12	11/22/2023 1:40	11/22/2023 2:35	57	11/23/2023 22:44	11/23/2023 22:56	13	11/24/2023 4:16	11/24/2023 5:13	69
A69-1604-6925	11/13/2022 2:46	11/13/2022 2:54	12	11/13/2022 12:10	11/13/2022 12:14	10	11/13/2022 17:02	11/13/2022 17:06	10	11/13/2022 21:31	11/13/2022 21:46	15
A69-1604-6926	11/13/2022 6:15	11/13/2022 6:27	17	11/13/2022 10:32	11/13/2022 10:39	11	11/13/2022 16:16	11/13/2022 16:24	15	11/13/2022 21:22	11/13/2022 21:42	25

Transmitter	H A	H D	H #	YHU A	YHU D	YHU #	YHD A	YHD D	YHD #	SH A	SH D	SH #
A69-1604-6927	11/13/2022 3:47	11/13/2022 4:10	29	11/13/2022 15:45	11/13/2022 15:53	15	11/13/2022 20:45	11/13/2022 20:52	13	11/14/2022 2:25	11/14/2022 2:52	42
A69-1604-6928	11/13/2022 22:04	11/13/2022 22:07	7	11/14/2022 0:55	11/14/2022 1:02	12	11/14/2022 5:06	11/14/2022 5:09	6	11/14/2022 22:28	11/23/2022 18:04	54
A69-1604-6929	11/13/2022 9:41	11/13/2022 9:48	16	11/13/2022 13:43	11/13/2022 13:46	6	11/13/2022 19:29	11/13/2022 19:32	8	11/14/2022 0:20	11/14/2022 17:35	58
A69-1604-6930	9/27/2023 3:48	9/27/2023 4:02	26	10/7/2023 22:45	10/7/2023 22:59	24	10/10/2023 4:15	10/10/2023 4:26	21	10/11/2023 23:01	10/12/2023 6:04	129
A69-1604-6931	9/29/2023 20:54	9/30/2023 1:59	27	10/1/2023 7:06	10/10/2023 0:37	6316	11/2/2023 0:21	11/2/2023 0:40	21	11/4/2023 7:28	11/8/2023 21:04	186
A69-1604-6935	8/20/2023 10:11	8/20/2023 10:20	12	8/20/2023 23:56	8/21/2023 0:06	18	8/21/2023 4:32	8/21/2023 4:33	2	8/22/2023 6:21	8/28/2023 1:43	336
A69-1604-6936	9/27/2022 21:46	9/27/2022 22:08	21	9/28/2022 2:30	9/28/2022 2:58	33	10/6/2022 4:52	10/6/2022 5:04	28	10/14/2022 2:58	10/14/2022 5:15	191
A69-1604-6939	11/22/2023 19:34	11/22/2023 19:43	10	11/22/2023 22:32	11/22/2023 22:46	24	11/23/2023 3:12	11/23/2023 3:16	10	11/23/2023 8:50	11/23/2023 8:59	10

Appendix C. Continued.

Transmitter	HW A	HW D	HW #	MR A	MR D	MR #	CWU A	CWU D	CWU #	CWD A	CWD D	CWD #
A69-1602-60044												
A69-1602-60045	11/14/2022 1:07	11/14/2022 1:58	44	11/14/2022 17:53	11/14/2022 17:53	2	11/14/2022 22:12	11/15/2022 17:23	596			
A69-1602-60048												
A69-1602-60049	11/15/2022 21:03	11/15/2022 21:18	6	11/16/2022 0:46	1/4/2023 4:45	42361						
A69-1602-60050												
A69-1602-60051												
A69-1602-60054												
A69-1602-60056												
A69-1602-60060												
A69-1602-60062												
A69-1602-60063												
A69-1602-60064												
A69-1604-14641	11/23/2023 21:49	11/23/2023 23:05	72	11/24/2023 2:26	11/24/2023 3:36	18						

Transmitter	HW A	HW D	HW #	MR A	MR D	MR #	CWU A	CWU D	CWU #	CWD A	CWD D	CWD #
A69-1604-14643	11/3/2023 5:08	11/3/2023 18:23	104	11/4/2023 6:52	11/5/2023 15:32	12	11/11/2023 4:24	11/11/2023 23:17	398	11/28/2023 18:52	11/30/2023 2:02	77
A69-1604-14646	11/6/2023 20:36	11/6/2023 21:32	16	11/6/2023 23:29	11/7/2023 0:39	17						
A69-1604-14647	12/7/2023 2:31	12/7/2023 18:09	60	12/8/2023 0:48	12/8/2023 0:55	8	12/9/2023 20:07	12/10/2023 0:20	347			
A69-1604-14648	1/30/2024 16:37	1/30/2024 16:57	7									
A69-1604-14652	11/10/2023 1:38	11/14/2023 4:49	457	11/20/2023 0:51	11/23/2023 8:44	66						
A69-1604-14654	11/4/2023 23:35	11/5/2023 0:36	45	11/5/2023 2:45	11/5/2023 18:41	27	11/5/2023 23:02	11/6/2023 1:43	216	11/10/2023 18:18	11/10/2023 18:44	21
A69-1604-14655												
A69-1604-14657	11/5/2023 19:15	11/5/2023 20:15	68	11/5/2023 22:23	11/5/2023 23:28	10						
A69-1604-14658	10/2/2023 0:32	10/2/2023 3:28	71	10/2/2023 6:08	10/2/2023 6:24	19	10/3/2023 4:51	10/3/2023 21:38	2347	12/9/2023 1:23	12/9/2023 2:22	2
A69-1604-14659	11/5/2023 3:07	11/5/2023 4:01	61	11/5/2023 18:53	11/5/2023 20:17	20	11/6/2023 1:05	11/6/2023 3:20	217	11/6/2023 18:07	11/6/2023 19:27	54
A69-1604-14660	10/28/2023 1:07	10/28/2023 4:39	60	10/28/2023 6:21	10/28/2023 6:24	7						
A69-1604-14661	9/30/2023 1:15	9/30/2023 17:49	91	9/30/2023 20:29	9/30/2023 20:40	10	10/1/2023 20:54	10/1/2023 21:18	73	10/3/2023 0:37	10/3/2023 0:46	12
A69-1604-14662	10/18/2023 0:26	10/18/2023 2:02	82	10/18/2023 5:07	10/18/2023 5:13	13						
A69-1604-14664	12/7/2023 21:59	12/8/2023 0:02	87	12/8/2023 1:39	12/8/2023 2:47	14						
A69-1604-14665												
A69-1604-14666	9/28/2023 3:59	9/28/2023 6:15	111	10/15/2023 23:39	10/15/2023 23:59	14						
A69-1604-14668	11/25/2023 1:00	11/25/2023 2:17	63	11/25/2023 4:23	11/25/2023 4:28	5						
A69-1604-14669	12/13/2023 23:35	12/16/2023 15:24	196	12/16/2023 19:13	12/16/2023 20:16	5	12/17/2023 2:20	12/17/2023 7:42	428			
A69-1604-14670												
A69-1604-14671	12/2/2024 5:21	12/2/2024 6:10	62	12/2/2024 19:11	12/2/2024 19:37	16	12/3/2024 3:58	12/3/2024 5:05	54			
A69-1604-14672	10/11/2023 23:24	10/12/2023 1:43	82	10/12/2023 3:03	10/12/2023 3:12	23						

Transmitter	HW A	HW D	HW #	MR A	MR D	MR #	CWU A	CWU D	CWU #	CWD A	CWD D	CWD #
A69-1604-14673												
A69-1604-14674	12/16/2023 4:35	12/16/2023 8:13	107	12/16/2023 16:38	12/16/2023 17:48	15	12/18/2023 15:19	12/18/2023 17:03	162			
A69-1604-14678												
A69-1604-14679	11/24/2023 0:31	11/24/2023 1:45	70	11/24/2023 4:27	11/24/2023 5:32	8	11/24/2023 10:30	11/24/2023 12:54	153	11/25/2023 19:20	11/25/2023 20:48	26
A69-1604-14681												
A69-1604-14682												
A69-1604-14684												
A69-1604-14685	11/5/2023 6:29	11/5/2023 7:29	71	11/5/2023 22:05	11/5/2023 23:10	11	11/6/2023 6:22	11/6/2023 19:26	24	11/6/2023 23:01	11/7/2023 0:05	12
A69-1604-14686												
A69-1604-14687	11/5/2023 0:59	11/5/2023 2:41	103	11/5/2023 5:14	11/5/2023 6:25	27	11/7/2023 18:48	11/7/2023 20:53	65	11/23/2023 0:00	11/23/2023 1:09	18
A69-1604-14688												
A69-1604-14689	11/24/2023 12:49	11/24/2023 14:31	99	11/24/2023 17:12	11/24/2023 18:20	17	11/24/2023 21:40	11/25/2023 0:12	142	11/25/2023 2:47	11/25/2023 3:56	25
A69-1604-14690												
A69-1604-14691	9/29/2023 23:39	9/30/2023 1:17	111	10/17/2023 0:10	10/17/2023 0:15	5						
A69-1604-14692												
A69-1604-14693	12/1/2024 22:02	12/1/2024 22:38	33	12/2/2024 19:07	12/2/2024 19:34	26	12/3/2024 1:18	12/6/2024 5:10	341	12/6/2024 20:25	12/6/2024 20:53	11
A69-1604-14694	12/2/2023 8:27	12/2/2023 18:38	280	12/3/2023 6:48	12/3/2023 8:00	40						
A69-1604-14695												
A69-1604-14696	10/10/2023 1:43	10/10/2023 3:42	102	10/10/2023 5:05	10/10/2023 5:20	10	10/11/2023 0:35	10/14/2023 22:18	1178	10/15/2023 21:23	10/15/2023 22:19	21
A69-1604-14697	11/17/2023 1:22	11/17/2023 2:33	35	11/17/2023 18:12	11/17/2023 19:25	15	11/18/2023 1:08	11/18/2023 19:08	857	11/28/2023 6:38	11/28/2023 7:42	26
A69-1604-14698	11/27/2023 23:56	11/29/2023 6:30	224	11/29/2023 21:41	11/29/2023 22:54	35						

Transmitter	HW A	HW D	HW #	MR A	MR D	MR #	CWU A	CWU D	CWU #	CWD A	CWD D	CWD #
A69-1604-14699	11/3/2023 19:58	11/3/2023 21:01	63	11/3/2023 23:41	11/3/2023 23:49	20	11/4/2023 19:03	11/4/2023 20:51	175	11/5/2023 0:46	11/5/2023 1:41	28
A69-1604-14700	11/25/2023 8:54	11/25/2023 10:41	58	11/25/2023 12:10	11/25/2023 13:11	6	11/27/2023 18:21	11/27/2023 20:30	134	11/28/2023 18:28	11/28/2023 18:33	4
A69-1604-14701												
A69-1604-14702	10/8/2023 6:44	10/8/2023 7:48	88	10/15/2023 13:00	10/15/2023 14:18	16						
A69-1604-14703												
A69-1604-14704	11/24/2023 23:11	11/25/2023 0:06	65	11/25/2023 2:53	11/25/2023 3:54	10	11/25/2023 20:02	11/27/2023 2:57	335	11/27/2023 17:39	11/27/2023 18:52	32
A69-1604-14705	11/13/2023 18:50	11/27/2023 19:10	529									
A69-1604-14706	10/17/2023 0:49	10/17/2023 2:33	104	10/17/2023 5:13	10/17/2023 5:19	11						
A69-1604-14707	11/25/2023 2:03	11/25/2023 20:46	602	11/25/2023 22:20	11/25/2023 23:22	12	11/26/2023 8:29	11/26/2023 12:43	356	11/26/2023 21:16	11/26/2023 21:55	10
A69-1604-14708	11/26/2023 16:51	11/26/2023 17:59	86	11/26/2023 21:12	11/26/2023 21:17	6	11/27/2023 5:38	11/27/2023 20:08	355	11/28/2023 18:27	11/28/2023 19:50	41
A69-1604-14709	11/3/2023 0:43	11/3/2023 2:06	93	11/4/2023 21:45	11/4/2023 21:56	34	11/5/2023 4:05	11/6/2023 19:00	823	11/6/2023 22:17	11/6/2023 23:17	2
A69-1604-14710												
A69-1604-14711	11/23/2023 10:46	11/23/2023 11:44	50	11/23/2023 21:59	11/23/2023 23:02	9	11/24/2023 18:09	11/24/2023 21:37	292	11/25/2023 0:40	11/25/2023 2:02	45
A69-1604-14712												
A69-1604-14713	11/28/2023 0:32	11/28/2023 3:03	93	11/28/2023 6:11	11/28/2023 7:13	9	11/28/2023 16:52	11/28/2023 19:14	104	12/10/2023 22:13	12/10/2023 22:14	2
A69-1604-14714												
A69-1604-14715	10/11/2023 21:14	10/11/2023 22:29	61	10/12/2023 2:39	10/12/2023 2:48	22						
A69-1604-14717	11/5/2023 2:00	11/5/2023 2:59	51	11/5/2023 18:44	11/5/2023 19:45	5	11/6/2023 0:00	11/6/2023 3:02	210	12/5/2023 21:14	12/6/2023 18:39	20
A69-1604-14718	8/12/2024 0:48	8/12/2024 1:13	11	8/12/2024 2:36	8/12/2024 2:36	1	8/12/2024 7:02	8/12/2024 7:43	40	8/14/2024 4:23	8/14/2024 5:05	42
A69-1604-14719												
A69-1604-14721	11/24/2023 23:53	11/25/2023 1:08	73	11/25/2023 3:53	11/25/2023 4:59	19	12/21/2023 17:44	1/10/2024 17:18	16728			

Transmitter	HW A	HW D	HW #	MR A	MR D	MR #	CWU A	CWU D	CWU #	CWD A	CWD D	CWD #
A69-1604-14722												
A69-1604-14723	10/22/2023 6:22	10/22/2023 20:01	475	11/1/2023 18:41	11/1/2023 19:09	27	11/2/2023 4:04	11/2/2023 22:34	414	11/5/2023 5:05	11/5/2023 6:28	21
A69-1604-14724	11/21/2023 1:17	11/22/2023 19:14	115	11/22/2023 21:43	11/22/2023 22:52	27	11/23/2023 21:44	11/24/2023 20:26	680	11/25/2023 1:40	11/25/2023 4:13	111
A69-1604-14725	11/3/2023 18:30	11/3/2023 19:54	60	11/3/2023 21:51	11/3/2023 21:59	19	11/4/2023 4:43	11/4/2023 20:00	1737	11/5/2023 0:40	11/5/2023 5:06	21
A69-1604-14726												
A69-1604-14727	8/11/2024 20:24	8/11/2024 20:49	24				9/4/2024 4:01	9/4/2024 5:23	83	9/5/2024 0:18	9/10/2024 0:14	102
A69-1604-14729	10/21/2023 6:06	10/21/2023 20:37	60									
A69-1604-14730	12/13/2024 21:03	12/13/2024 22:16	60	12/13/2024 23:44	12/13/2024 23:47	4	12/14/2024 4:35	12/14/2024 6:49	163	12/15/2024 4:30	12/15/2024 4:32	3
A69-1604-14731	11/5/2023 1:17	11/5/2023 2:08	64	11/5/2023 2:50	11/5/2023 4:05	19						
A69-1604-14735	12/13/2024 22:36	12/13/2024 23:22	23	12/14/2024 0:51	12/14/2024 0:55	6	12/14/2024 18:19	12/14/2024 20:19	97	12/14/2024 23:48	12/15/2024 0:13	5
A69-1604-6840	11/15/2022 6:43	11/15/2022 8:01	76	11/15/2022 18:12	11/15/2022 18:12	1	11/15/2022 23:13	11/16/2022 1:23	188	11/16/2022 4:50	12/17/2022 18:44	16
A69-1604-6844	11/14/2022 4:17	11/14/2022 4:33	21				11/14/2022 20:24	11/14/2022 21:02	33	11/14/2022 23:35	11/14/2022 23:51	5
A69-1604-6845												
A69-1604-6847	11/14/2022 4:39	11/14/2022 5:12	28	11/14/2022 7:05	11/14/2022 7:06	2	11/15/2022 16:04	11/16/2022 1:27	117	11/16/2022 18:49	11/16/2022 18:52	5
A69-1604-6848	11/14/2022 18:02	11/14/2022 18:29	43	11/14/2022 20:23	11/14/2022 20:23	1	11/15/2022 0:51	11/15/2022 2:06	74	11/15/2022 5:06	11/15/2022 5:07	3
A69-1604-6849	11/14/2022 4:47	11/14/2022 5:17	21				11/15/2022 18:44	11/15/2022 19:04	5	11/15/2022 22:06	11/15/2022 22:06	1
A69-1604-6850												
A69-1604-6851	11/14/2022 19:02	11/14/2022 19:48	49				11/15/2022 23:04	11/16/2022 0:30	89	11/16/2022 18:07	11/16/2022 18:09	3
A69-1604-6852	11/14/2022 18:09	11/14/2022 18:39	28				11/15/2022 11:30	11/15/2022 13:17	134	11/15/2022 17:49	11/15/2022 17:50	2
A69-1604-6853												
A69-1604-6854	11/14/2022 3:46	11/14/2022 4:29	58	11/14/2022 6:20	11/14/2022 6:20	1	11/14/2022 21:04	11/14/2022 22:08	83			

Transmitter	HW A	HW D	HW #	MR A	MR D	MR #	CWU A	CWU D	CWU #	CWD A	CWD D	CWD #
A69-1604-6855												
A69-1604-6858	11/14/2022 4:37	11/14/2022 4:53	20	11/14/2022 6:31	11/14/2022 6:31	1	11/14/2022 19:47	11/14/2022 21:00	81	11/14/2022 23:33	11/14/2022 23:35	3
A69-1604-6860												
A69-1604-6861	12/20/2023 6:02	12/20/2023 11:09	224									
A69-1604-6862												
A69-1604-6866												
A69-1604-6868	11/14/2022 19:36	11/14/2022 20:31	50	11/14/2022 22:43	11/14/2022 22:46	2	11/15/2022 19:44	11/15/2022 20:05	14	11/15/2022 23:34	11/15/2022 23:35	2
A69-1604-6869	10/19/2023 0:09	10/19/2023 1:32	61	10/19/2023 3:52	10/19/2023 3:57	6						
A69-1604-6870												
A69-1604-6871												
A69-1604-6872	8/21/2023 6:34	8/21/2023 7:30	55	8/21/2023 21:01	8/21/2023 21:08	14	8/22/2023 1:52	8/22/2023 3:27	114	8/22/2023 6:52	8/22/2023 7:06	7
A69-1604-6873	8/19/2023 0:53	8/19/2023 2:16	90	8/19/2023 3:53	8/19/2023 3:59	13						
A69-1604-6874				10/24/2022 21:13	10/24/2022 21:44	17	10/25/2022 20:47	10/25/2022 21:28	33	10/27/2022 4:49	10/27/2022 5:30	28
A69-1604-6875	11/20/2023 19:09	11/20/2023 21:22	113									
A69-1604-6876												
A69-1604-6877	11/16/2023 4:33	11/16/2023 5:38	55	11/16/2023 19:44	11/16/2023 20:56	29	11/17/2023 17:19	11/20/2023 19:37	3428	11/21/2023 0:38	11/21/2023 1:21	52
A69-1604-6879	3/12/2024 23:11	3/13/2024 1:39	78									
A69-1604-6880	11/5/2023 2:17	11/5/2023 2:49	38	11/5/2023 3:35	11/5/2023 4:41	8						
A69-1604-6881	11/14/2022 7:28	11/14/2022 12:37	70	11/14/2022 14:32	11/14/2022 14:32	1	11/14/2022 19:25	11/14/2022 21:15	85	11/15/2022 0:08	11/15/2022 0:25	16
A69-1604-6882												
A69-1604-6885	11/14/2022 3:18	11/14/2022 3:37	21				11/14/2022 17:54	11/14/2022 18:28	48	11/14/2022 21:00	11/14/2022 21:01	2

Transmitter	HW A	HW D	HW #	MR A	MR D	MR #	CWU A	CWU D	CWU #	CWD A	CWD D	CWD #
A69-1604-6886	11/14/2022 6:20	11/14/2022 6:50	42				11/14/2022 15:46	11/14/2022 16:59	77			
A69-1604-6887	11/14/2022 8:44	11/14/2022 16:27	83	12/9/2022 21:38	12/25/2022 0:22	1014						
A69-1604-6888												
A69-1604-6889	11/14/2022 4:28	11/14/2022 5:07	33				11/14/2022 20:58	11/14/2022 21:58	75	11/15/2022 0:36	11/15/2022 0:37	3
A69-1604-6891												
A69-1604-6894	9/28/2023 8:00	9/28/2023 19:45	97	9/28/2023 22:38	9/28/2023 22:50	9	9/29/2023 21:14	9/29/2023 23:23	154	9/30/2023 21:33	9/30/2023 22:28	81
A69-1604-6897												
A69-1604-6898												
A69-1604-6900												
A69-1604-6901												
A69-1604-6902												
A69-1604-6904	11/14/2022 2:58	11/14/2022 3:15	25	11/14/2022 4:46	11/14/2022 4:49	3	11/14/2022 9:32	11/14/2022 9:58	44	11/14/2022 18:21	11/14/2022 18:22	2
A69-1604-6905	11/14/2022 18:42	11/14/2022 20:22	39				11/15/2022 20:00	11/15/2022 20:11	3	11/15/2022 23:29	11/15/2022 23:31	2
A69-1604-6907												
A69-1604-6908	10/13/2023 7:25	10/14/2023 21:21	99	10/15/2023 1:33	10/15/2023 1:49	15						
A69-1604-6913	12/7/2023 17:22	12/11/2023 17:23	53	12/15/2023 13:35	12/17/2023 15:09	1168	1/1/2024 17:39	1/6/2024 9:02	1350			
A69-1604-6914												
A69-1604-6915	11/4/2023 3:39	11/4/2023 4:07	41	11/4/2023 6:20	11/4/2023 6:24	10						
A69-1604-6916	11/14/2022 6:43	11/14/2022 14:44	82	11/14/2022 18:02	11/14/2022 18:05	2	11/14/2022 22:51	11/15/2022 0:18	107	11/15/2022 3:55	11/15/2022 5:28	28
A69-1604-6918	11/15/2022 2:52	11/15/2022 4:04	74									
A69-1604-6919												

Transmitter	HW A	HW D	HW #	MR A	MR D	MR #	CWU A	CWU D	CWU #	CWD A	CWD D	CWD #
A69-1604-6920	11/15/2022 19:25	11/15/2022 19:35	12				3/6/2023 0:49	3/7/2023 22:35	70	3/8/2023 4:19	3/8/2023 4:23	6
A69-1604-6921	11/14/2022 1:40	11/14/2022 2:11	36				11/14/2022 13:36	11/14/2022 15:52	92	11/14/2022 18:47	11/14/2022 18:48	2
A69-1604-6923	11/4/2023 19:30	11/4/2023 20:44	71	11/4/2023 22:47	11/4/2023 23:00	33	11/5/2023 20:48	11/6/2023 18:34	1495	11/7/2023 0:21	11/7/2023 1:25	6
A69-1604-6924	11/24/2023 19:58	11/24/2023 20:35	48									
A69-1604-6925	11/14/2022 2:21	11/14/2022 2:47	22	11/14/2022 4:19	11/14/2022 4:19	1						
A69-1604-6926												
A69-1604-6927												
A69-1604-6928												
A69-1604-6929	11/15/2022 0:38	11/15/2022 1:44	78				11/15/2022 22:26	11/15/2022 22:53	16	11/16/2022 18:46	11/16/2022 18:55	5
A69-1604-6930	10/14/2023 5:28	10/15/2023 20:11	78	10/21/2023 20:33	10/21/2023 20:42	22	10/22/2023 1:39	10/23/2023 23:19	204	11/27/2023 17:51	11/27/2023 18:49	24
A69-1604-6931	11/22/2023 19:42	11/24/2023 0:31	310	11/27/2023 19:48	11/27/2023 20:50	39	12/14/2023 3:38	12/19/2023 1:41	607			
A69-1604-6935	8/28/2023 9:45	8/28/2023 22:07	72	8/28/2023 23:28	8/28/2023 23:30	3	8/30/2023 2:31	9/26/2023 22:01	578	11/26/2023 21:32	11/28/2023 18:56	81
A69-1604-6936	10/15/2022 0:39	10/15/2022 1:59	77	10/15/2022 20:57	10/15/2022 21:39	21	10/16/2022 5:42	10/16/2022 20:49	478	11/14/2022 18:05	11/14/2022 18:05	2
A69-1604-6939												

Appendix C. Continued.

Transmitter	HDG A	HDG D	HDG #
A69-1602-60044			
A69-1602-60045	12/16/2022 11:37	12/16/2022 16:51	64
A69-1602-60048			
A69-1602-60049			
A69-1602-60050	11/15/2021 3:53	11/17/2021 3:27	411
A69-1602-60051			
A69-1602-60054			
A69-1602-60056			
A69-1602-60060	9/24/2021 23:08	9/25/2021 6:42	75
A69-1602-60062	10/1/2021 22:04	10/1/2021 23:28	65
A69-1602-60063	2/18/2022 3:19	2/18/2022 4:50	30
A69-1602-60064			
A69-1604-14641			
A69-1604-14643	11/30/2023 17:16	12/18/2023 19:12	19720
A69-1604-14646			
A69-1604-14647	12/11/2023 5:00	12/11/2023 8:36	72
A69-1604-14648			
A69-1604-14652			
A69-1604-14654	11/10/2023 21:06	11/12/2023 19:29	114
A69-1604-14655			
A69-1604-14657			
A69-1604-14658	12/9/2023 4:45	12/9/2023 20:23	53
A69-1604-14659	11/6/2023 20:37	11/6/2023 22:24	80
A69-1604-14660			
A69-1604-14661	10/3/2023 3:43	10/3/2023 22:38	88
A69-1604-14662			
A69-1604-14664			
A69-1604-14665			
A69-1604-14666			
A69-1604-14668			
A69-1604-14669	12/18/2023 13:21	12/18/2023 13:53	26
A69-1604-14670			
A69-1604-14671			
A69-1604-14672			
A69-1604-14673			
A69-1604-14674	12/18/2023 20:48	12/18/2023 21:38	75
A69-1604-14678			
A69-1604-14679	11/25/2023 22:38	11/26/2023 1:20	75
A69-1604-14681			
A69-1604-14682			
A69-1604-14684			
A69-1604-14685	11/8/2023 19:55	11/10/2023 18:59	44
A69-1604-14686			
A69-1604-14687	11/23/2023 3:20	11/23/2023 5:02	52
A69-1604-14688			
A69-1604-14689	11/25/2023 4:49	11/26/2023 4:06	154
A69-1604-14690			
A69-1604-14691			

Transmitter	HDG A	HDG D	HDG #
A69-1604-14692			
A69-1604-14693	12/6/2024 23:35	12/7/2024 1:44	123
A69-1604-14694			
A69-1604-14695			
A69-1604-14696	10/15/2023 23:58	10/16/2023 1:13	71
A69-1604-14697	11/28/2023 10:44	11/28/2023 11:37	57
A69-1604-14698			
A69-1604-14699	11/5/2023 4:32	11/5/2023 18:03	105
A69-1604-14700	11/29/2023 1:14	11/29/2023 3:23	44
A69-1604-14701			
A69-1604-14702			
A69-1604-14703			
A69-1604-14704	11/27/2023 20:47	11/27/2023 22:09	75
A69-1604-14705			
A69-1604-14706			
A69-1604-14707	11/27/2023 0:50	11/27/2023 4:00	140
A69-1604-14708	11/28/2023 21:42	11/28/2023 22:32	81
A69-1604-14709	11/7/2023 4:17	11/7/2023 22:41	125
A69-1604-14710			
A69-1604-14711	11/25/2023 4:12	11/27/2023 17:33	211
A69-1604-14712			
A69-1604-14713	12/21/2023 15:21	12/21/2023 16:35	96
A69-1604-14714			
A69-1604-14715			
A69-1604-14717	12/12/2023 20:12	12/12/2023 22:00	66
A69-1604-14718	10/8/2024 23:29	11/16/2024 18:14	524
A69-1604-14719			
A69-1604-14721			
A69-1604-14722			
A69-1604-14723	11/5/2023 19:34	11/7/2023 2:35	62
A69-1604-14724	11/25/2023 6:47	11/28/2023 16:58	93
A69-1604-14725	11/18/2023 17:04	11/18/2023 21:55	83
A69-1604-14726			
A69-1604-14727	9/10/2024 3:39	12/6/2024 17:01	118
A69-1604-14729			
A69-1604-14730	12/16/2024 0:41	12/16/2024 2:58	12
A69-1604-14731			
A69-1604-14735			
A69-1604-6840	12/17/2022 20:14	12/17/2022 22:06	83
A69-1604-6844	11/15/2022 1:20	11/15/2022 2:21	33
A69-1604-6845			
A69-1604-6847	11/20/2022 6:44	8/16/2024 11:14	48616
A69-1604-6848	11/15/2022 17:57	11/15/2022 18:28	22
A69-1604-6849	11/16/2022 0:05	11/16/2022 1:38	48
A69-1604-6850			
A69-1604-6851	11/16/2022 20:20	11/16/2022 21:04	30
A69-1604-6852	11/15/2022 20:16	11/15/2022 20:31	28
A69-1604-6853			
A69-1604-6854			

Transmitter	HDG A	HDG D	HDG #
A69-1604-6855			
A69-1604-6858	11/17/2022 0:57	11/17/2022 2:04	70
A69-1604-6860			
A69-1604-6861			
A69-1604-6862			
A69-1604-6866			
A69-1604-6868	11/16/2022 2:43	11/16/2022 18:09	92
A69-1604-6869			
A69-1604-6870			
A69-1604-6871			
A69-1604-6872	8/22/2023 22:22	8/22/2023 23:28	68
A69-1604-6873			
A69-1604-6874	11/15/2022 21:20	11/15/2022 21:23	5
A69-1604-6875			
A69-1604-6876			
A69-1604-6877	11/21/2023 4:13	12/13/2023 19:55	215
A69-1604-6879			
A69-1604-6880			
A69-1604-6881	11/15/2022 2:10	11/15/2022 3:47	101
A69-1604-6882			
A69-1604-6885	11/14/2022 22:50	11/15/2022 0:49	100
A69-1604-6886	11/14/2022 22:28	11/14/2022 23:04	26
A69-1604-6887			
A69-1604-6888			
A69-1604-6889	11/16/2022 5:22	11/16/2022 16:16	114
A69-1604-6891			
A69-1604-6894	10/1/2023 0:21	10/8/2023 19:46	230
A69-1604-6897			
A69-1604-6898			
A69-1604-6900			
A69-1604-6901			
A69-1604-6902			
A69-1604-6904	11/14/2022 20:55	11/16/2022 19:05	83
A69-1604-6905	11/16/2022 1:40	11/16/2022 2:53	54
A69-1604-6907			
A69-1604-6908			
A69-1604-6913			
A69-1604-6914			
A69-1604-6915			
A69-1604-6916			
A69-1604-6918			
A69-1604-6919			
A69-1604-6920	4/6/2023 21:37	4/6/2023 23:09	121
A69-1604-6921	11/14/2022 21:44	11/15/2022 2:22	47
A69-1604-6923	11/7/2023 18:12	11/7/2023 19:33	73
A69-1604-6924			
A69-1604-6925			
A69-1604-6926			
A69-1604-6927			
A69-1604-6928			

Transmitter	HDG A	HDG D	HDG #
A69-1604-6929	11/16/2022 20:36	11/16/2022 22:34	68
A69-1604-6930	11/27/2023 20:19	11/27/2023 22:03	91
A69-1604-6931			
A69-1604-6935	11/28/2023 20:32	11/28/2023 21:51	89
A69-1604-6936	11/14/2022 20:00	11/14/2022 21:10	84
A69-1604-6939			

Appendix D. Eel movement plots from 2021 to 2024. Note x-axis scale differences. HB = Harrisburg, YHU = York Haven Upstream, YHD = York Haven Downstream, SHU = Safe Harbor Upstream, HWU = Holtwood Upstream, MRU = Muddy Run Upstream, CWU = Conowingo Upstream, CWD = Conowingo Downstream, and HDG = Havre de Grace.
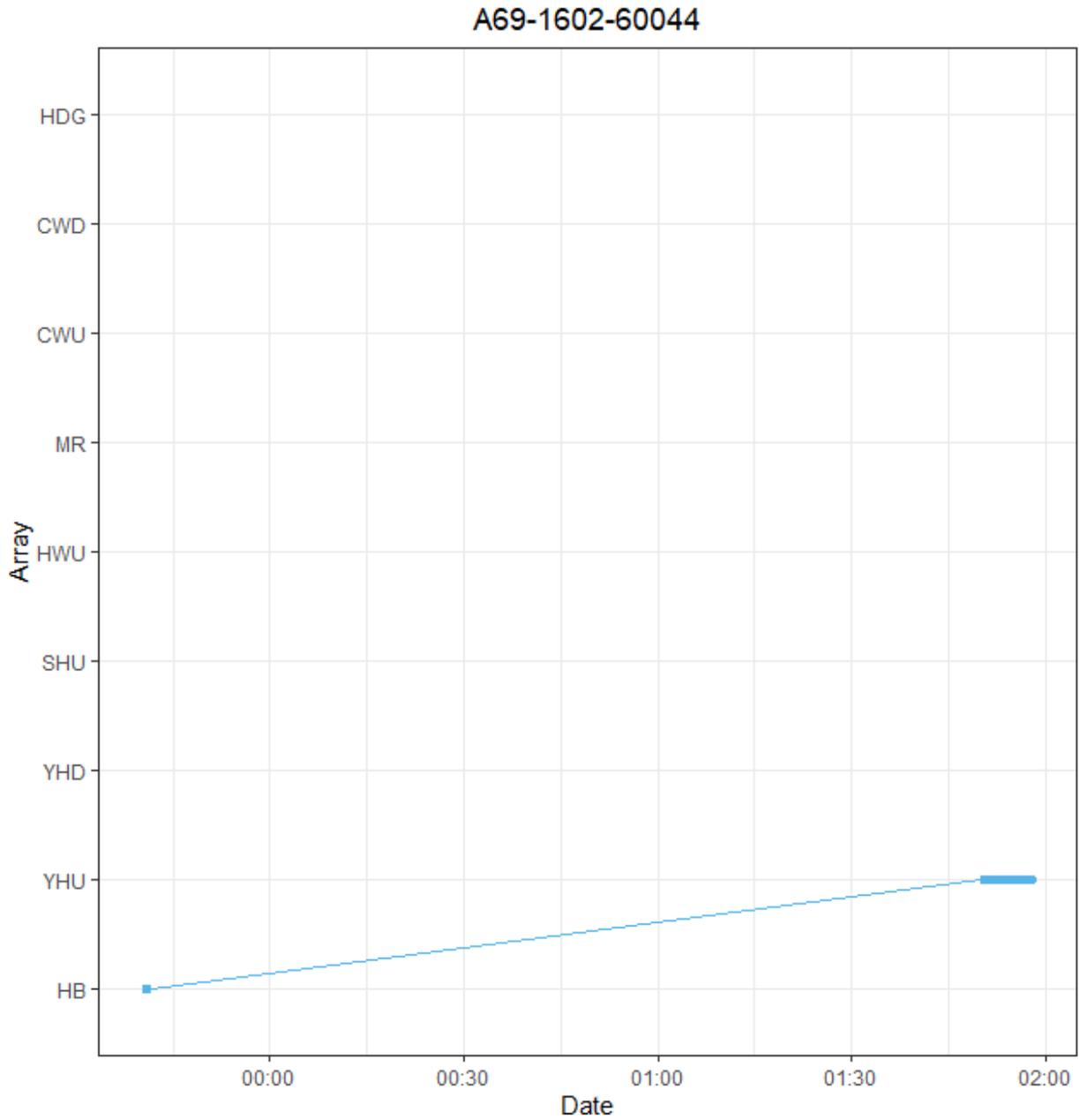
Transmitter A69-1602-60044 movement detection plot on 2-3 September 2021. This eel successfully exited the Susquehanna River.
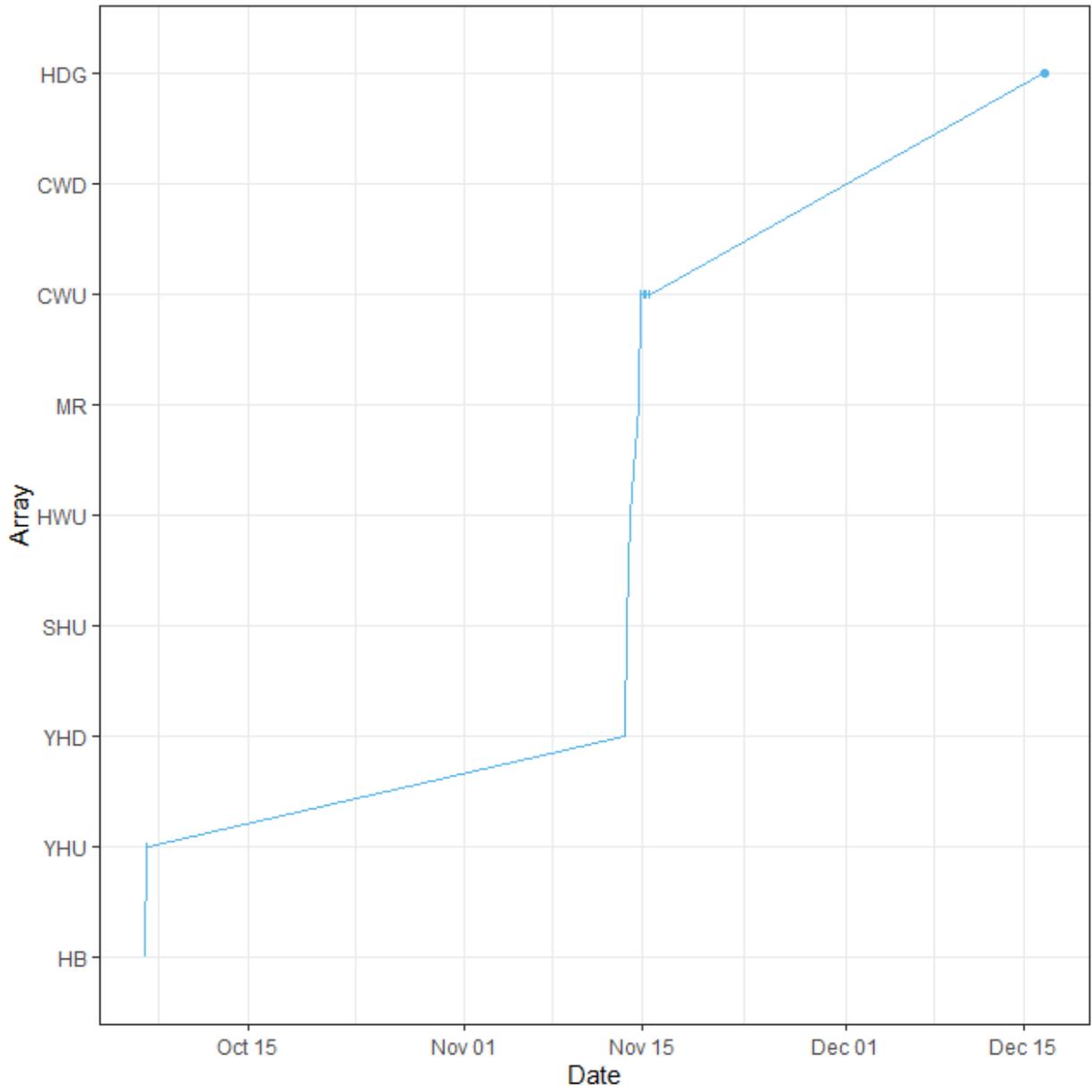
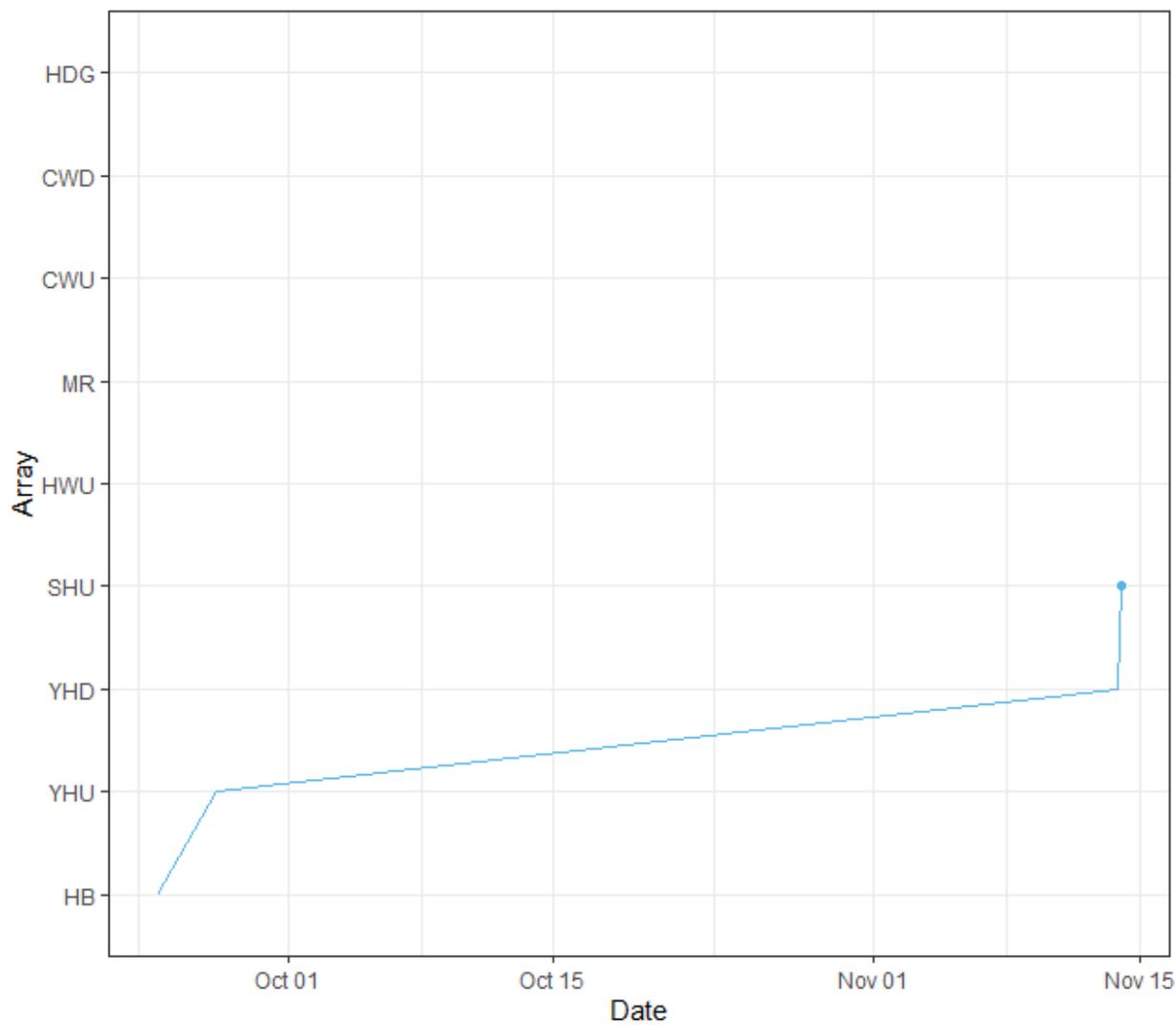Transmitter A69-1602-60045 movement detection plot on 6 October – 16 December 2022. This eel successfully exited the Susquehanna River.
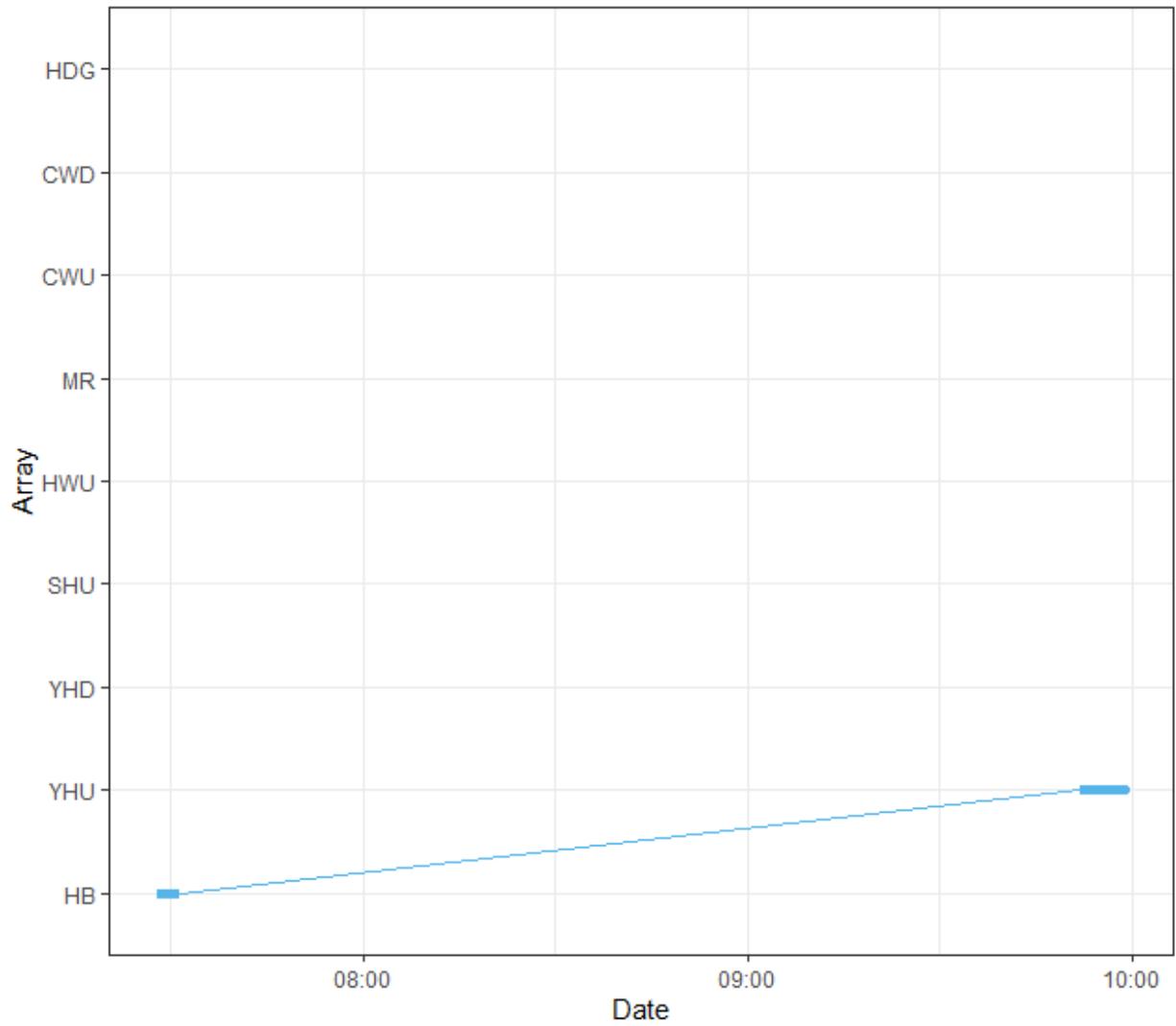
Transmitter A69-1602-60048 movement detection plot on 24 September 2021. This eel did not successfully exit the Susquehanna River.
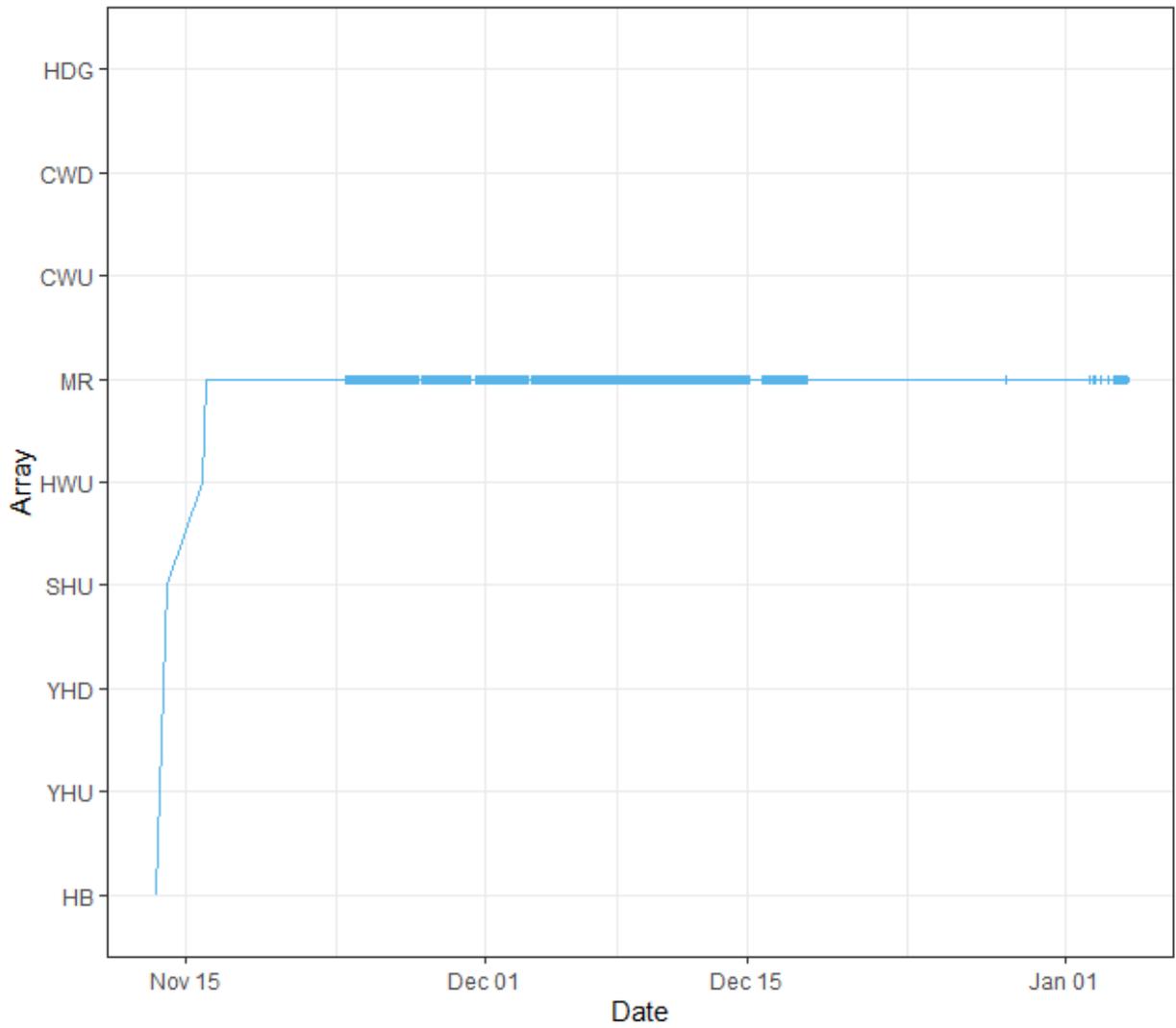
Transmitter A69-1602-60049 movement detection plot from 13 November 2022 – 4 January 2023. Eel remained at the Muddy Run Upstream array until January 2024. This eel did not successfully exit the Susquehanna River.
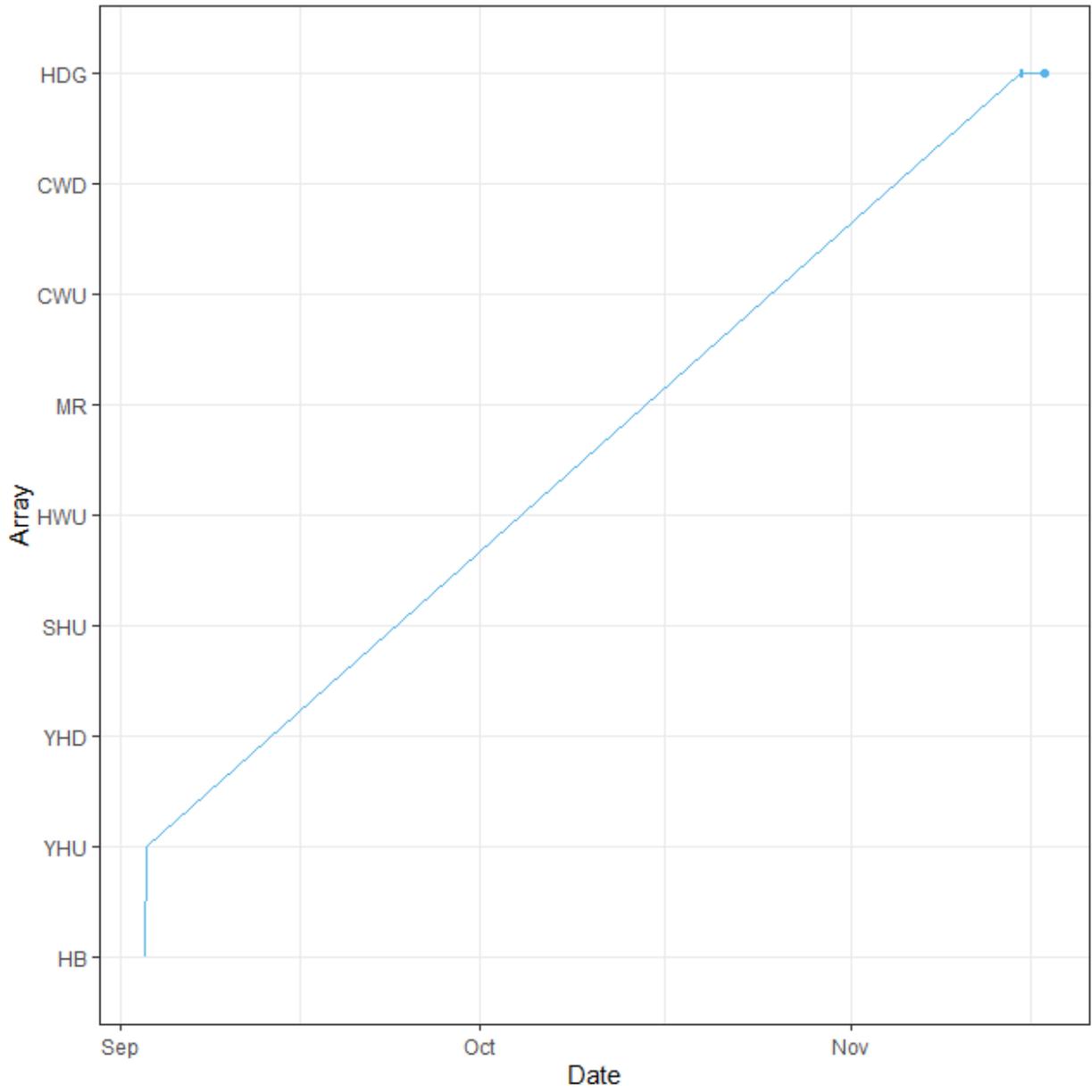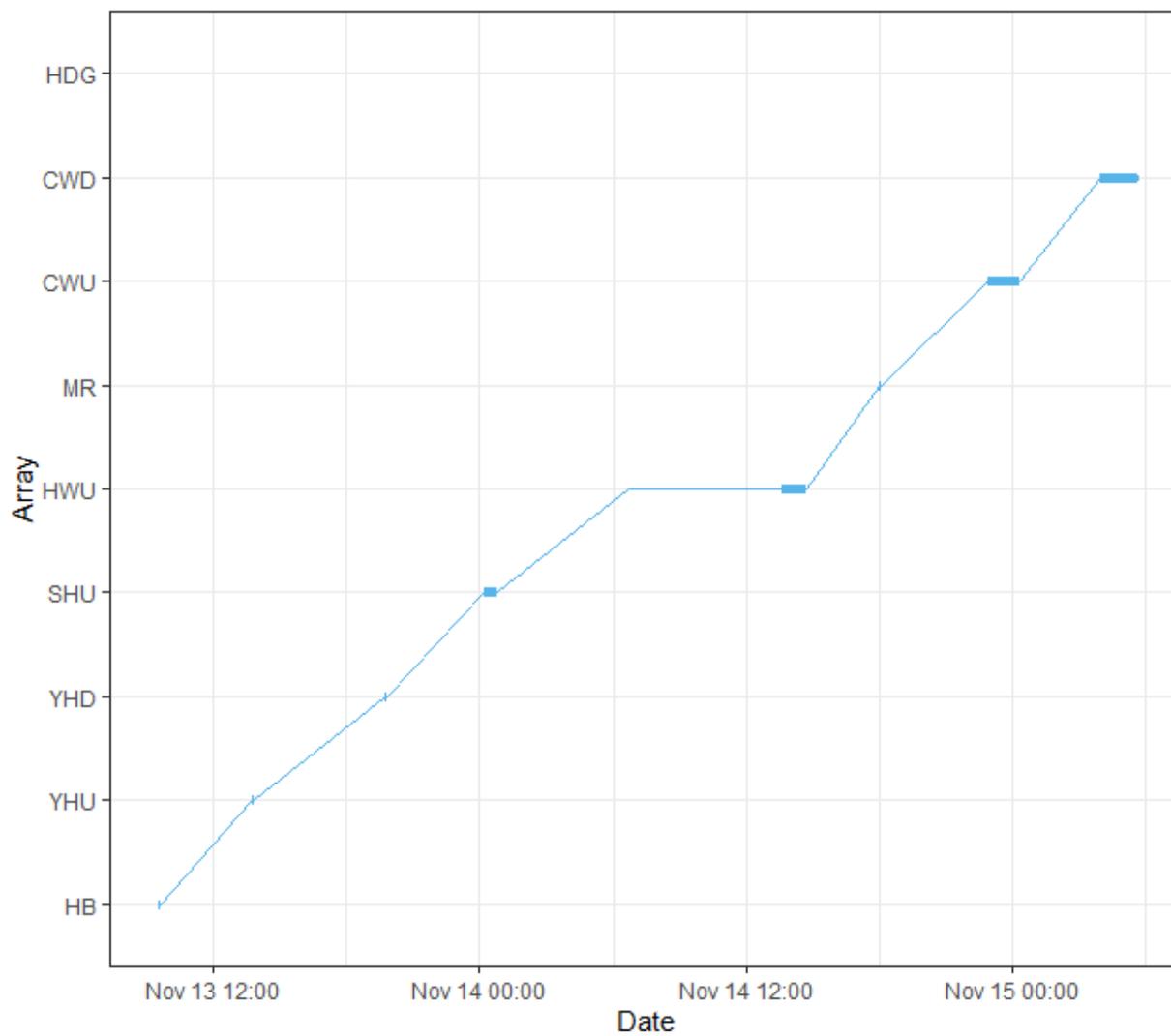
Transmitter A69-1602-60050 movement detection plot from 3 September – 17 November 2022. This eel successfully exited the Susquehanna River.
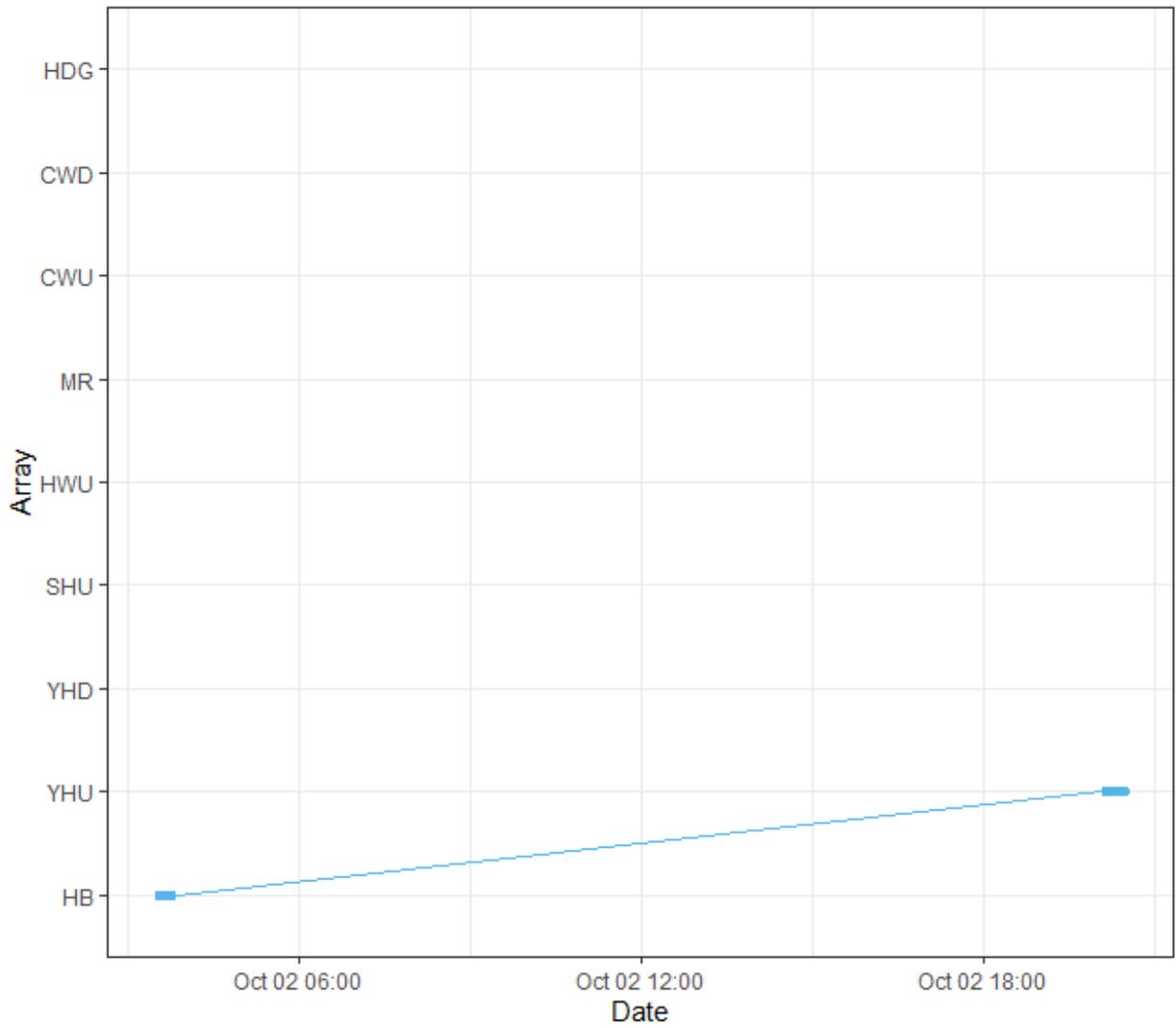
Transmitter A69-1602-60051 movement detection plot on 2 October 2022. This eel did not successfully exit the Susquehanna River.
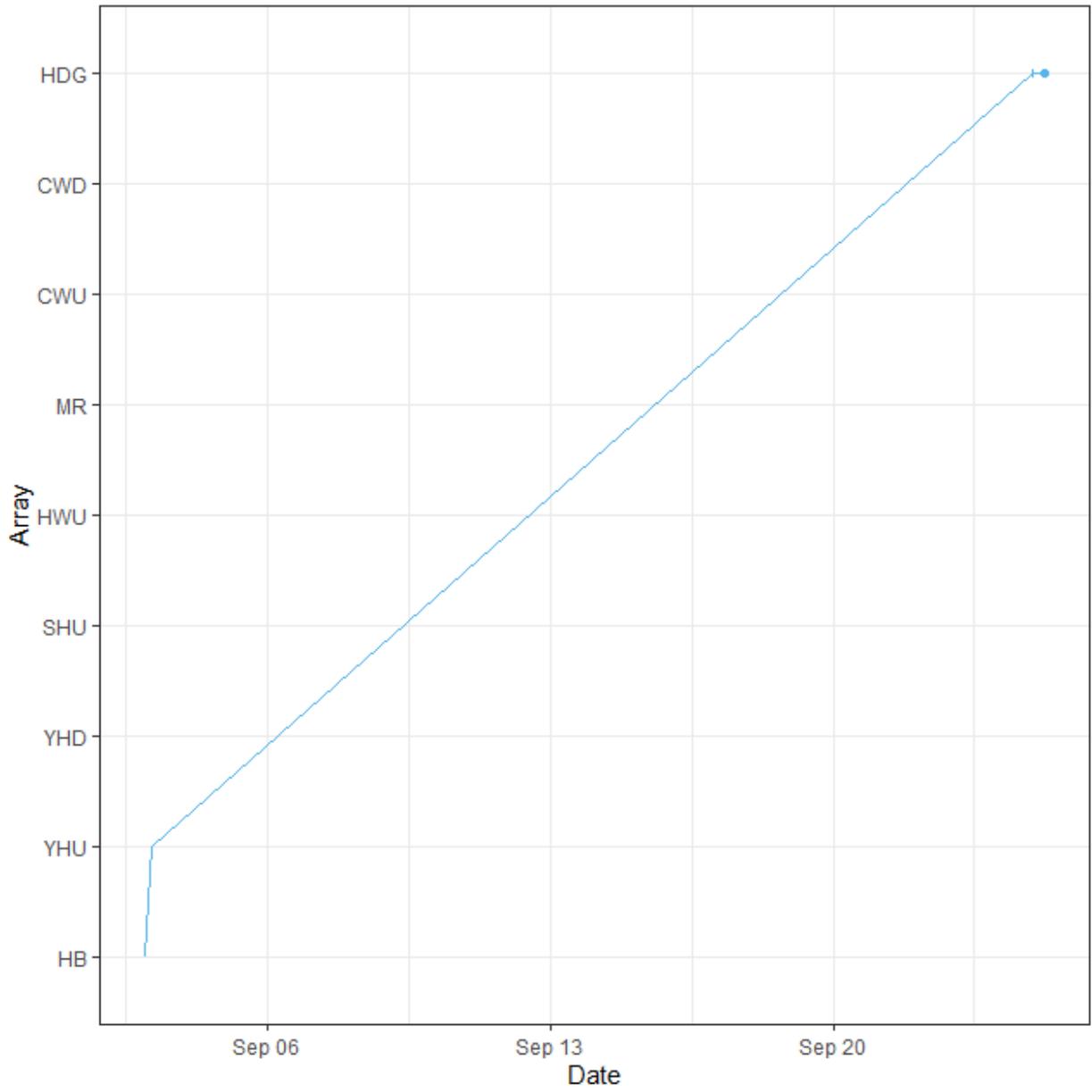
Transmitter A69-1602-60060 movement detection plot on 3-25 September 2021. This eel successfully exited the Susquehanna River.
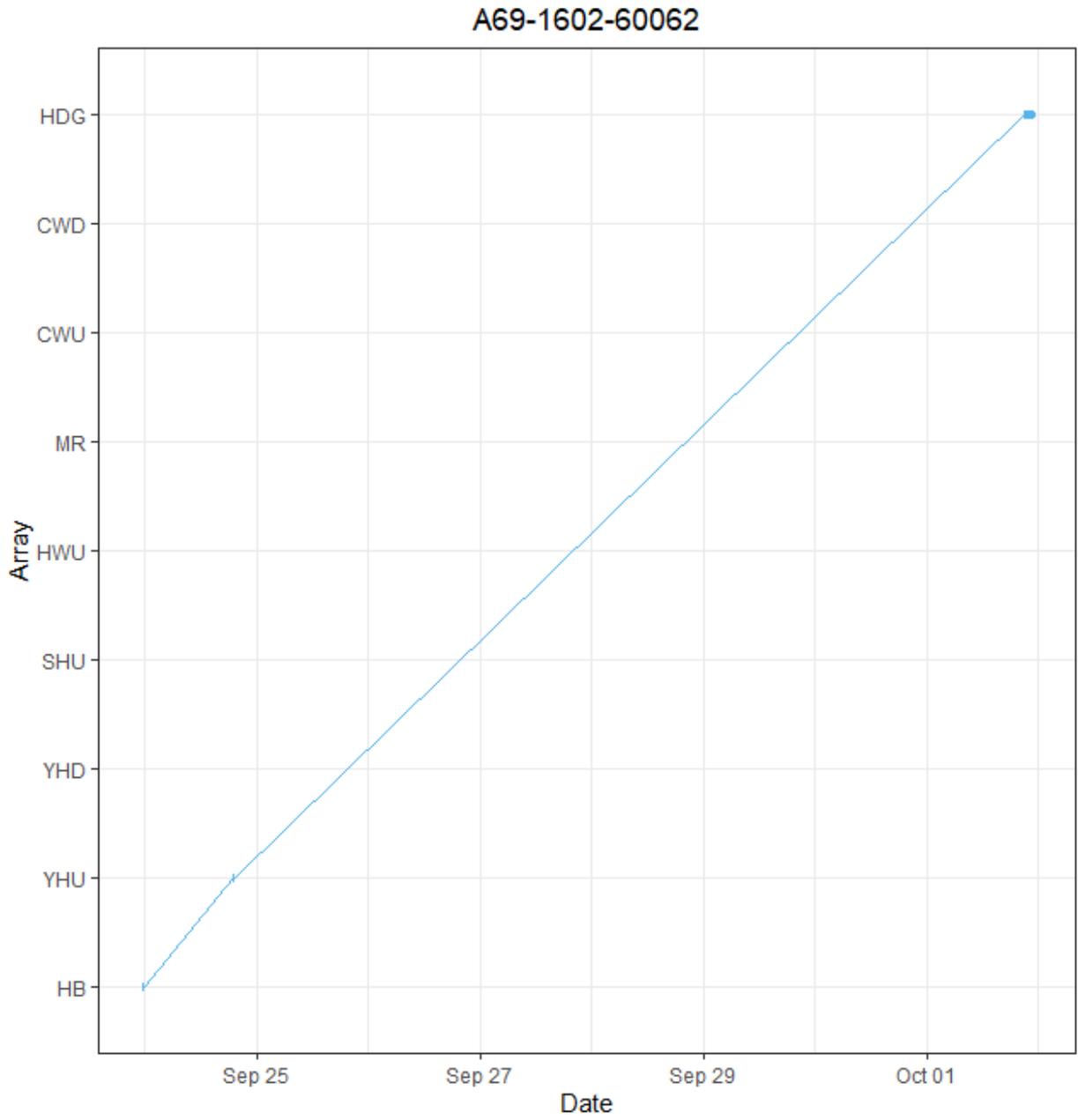
Transmitter A69-1602-60062 movement detection plot on 24 September – 1 October 2021. This eel successfully exited the Susquehanna River.

A69-1602-60063
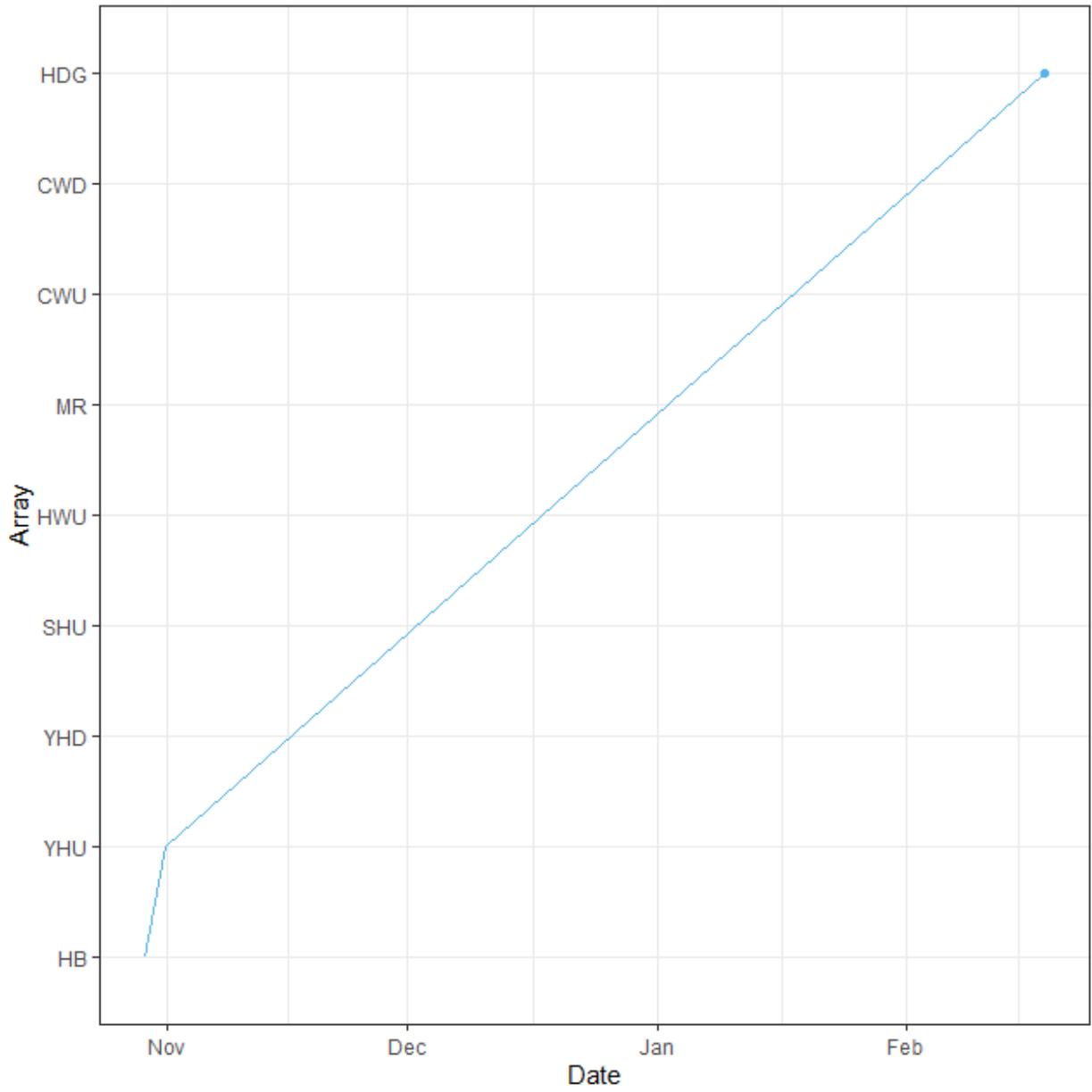
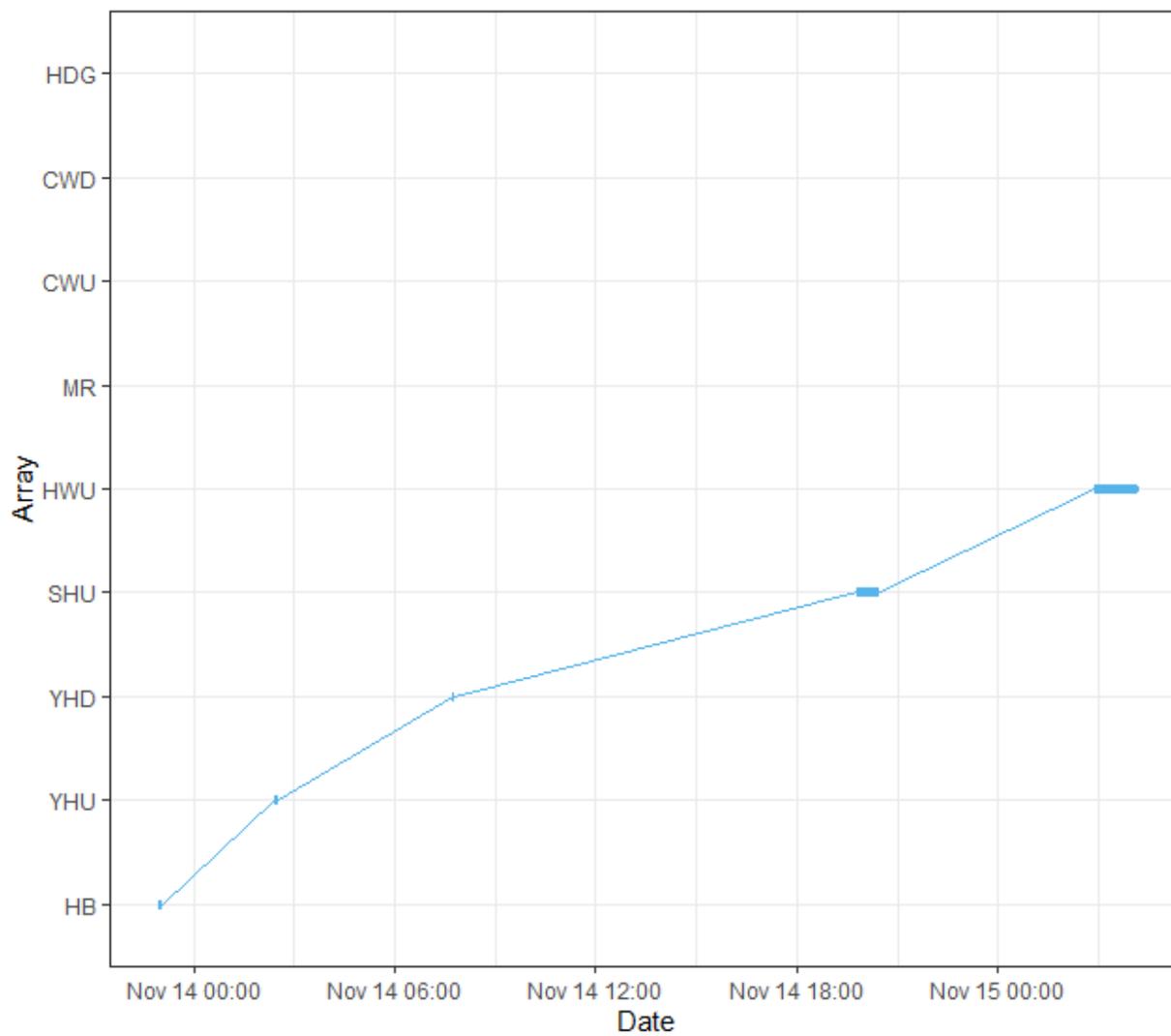Transmitter A69-1602-60063 movement detection plot on 29 October 2021 – 18 February 2022. This eel successfully exited the Susquehanna River.
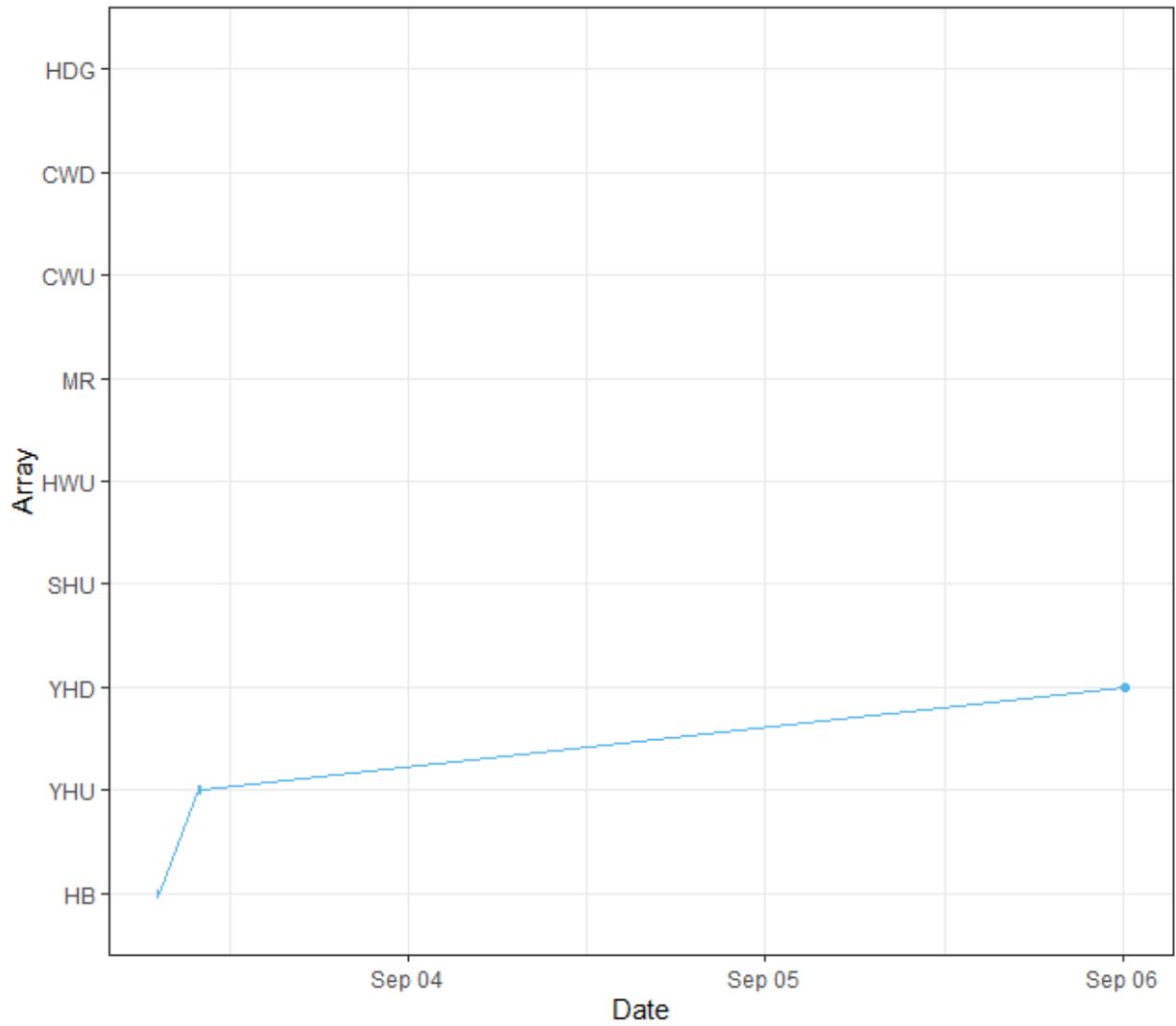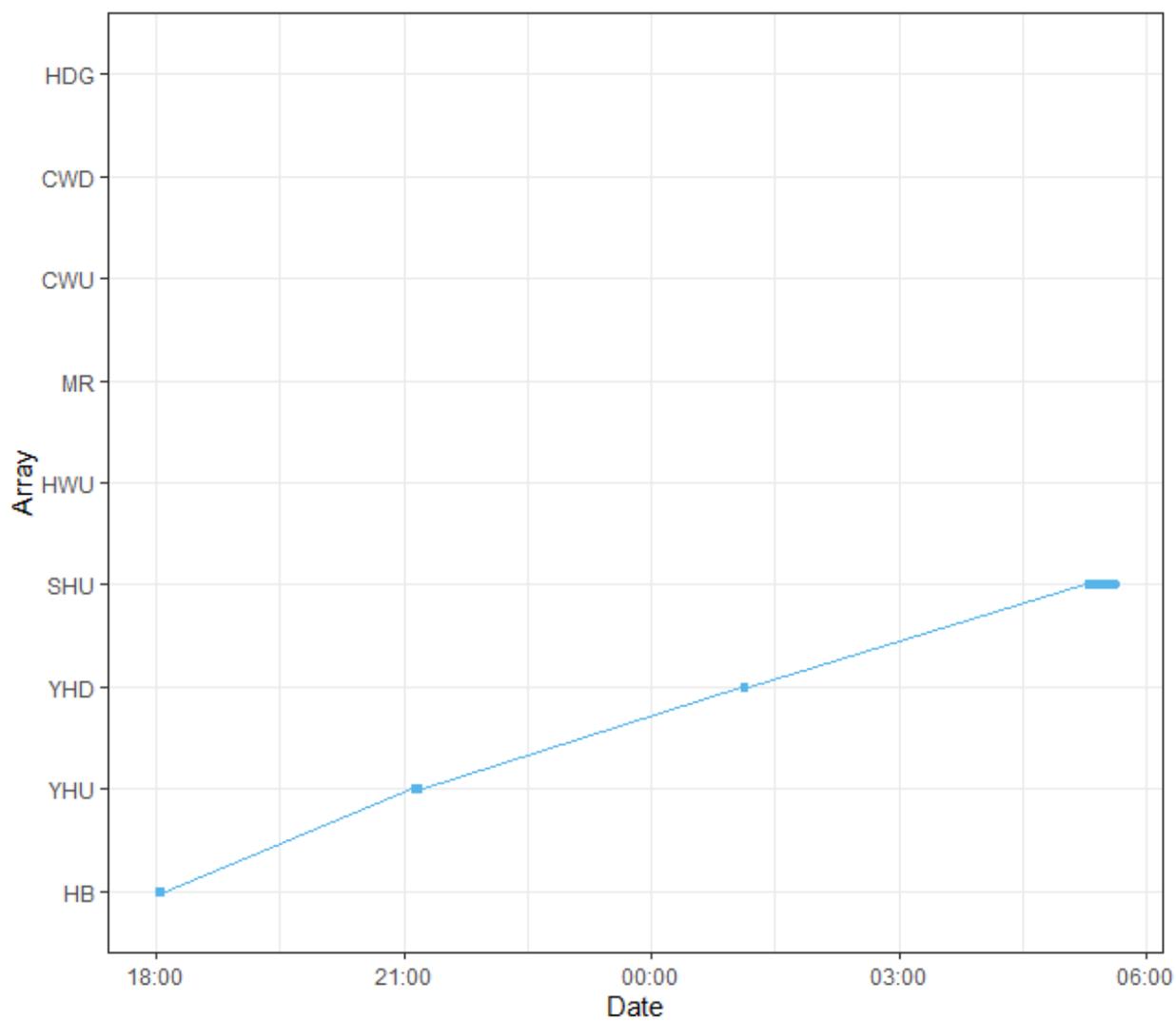
Transmitter A69-1602-60064 movement detection plot from 3-6 September 2021. This eel did not successfully exit the Susquehanna River.
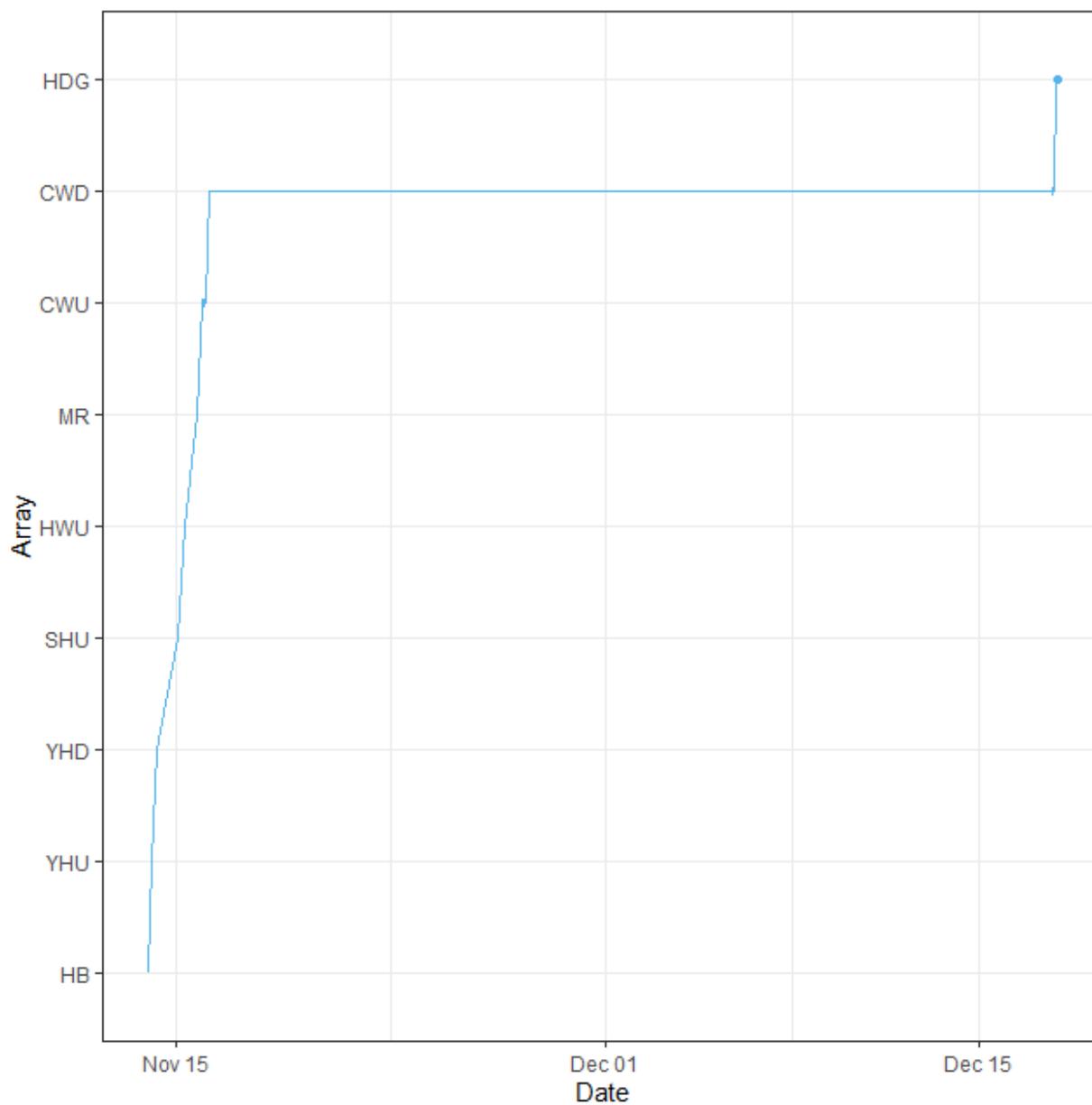
Transmitter A69-1604-6840 movement detection plot from 13 November – 17 December 2022. This eel successfully exited the Susquehanna River.
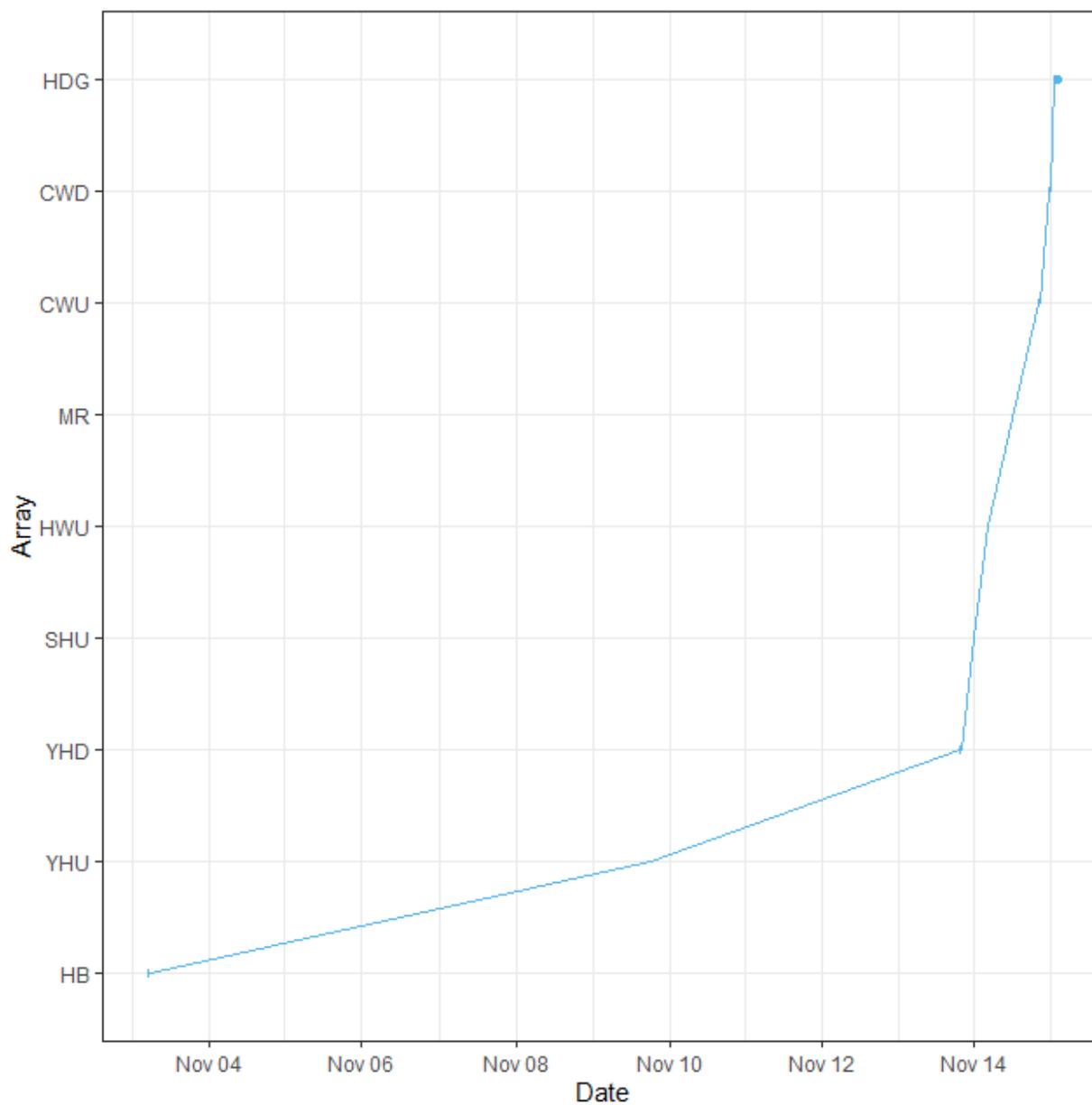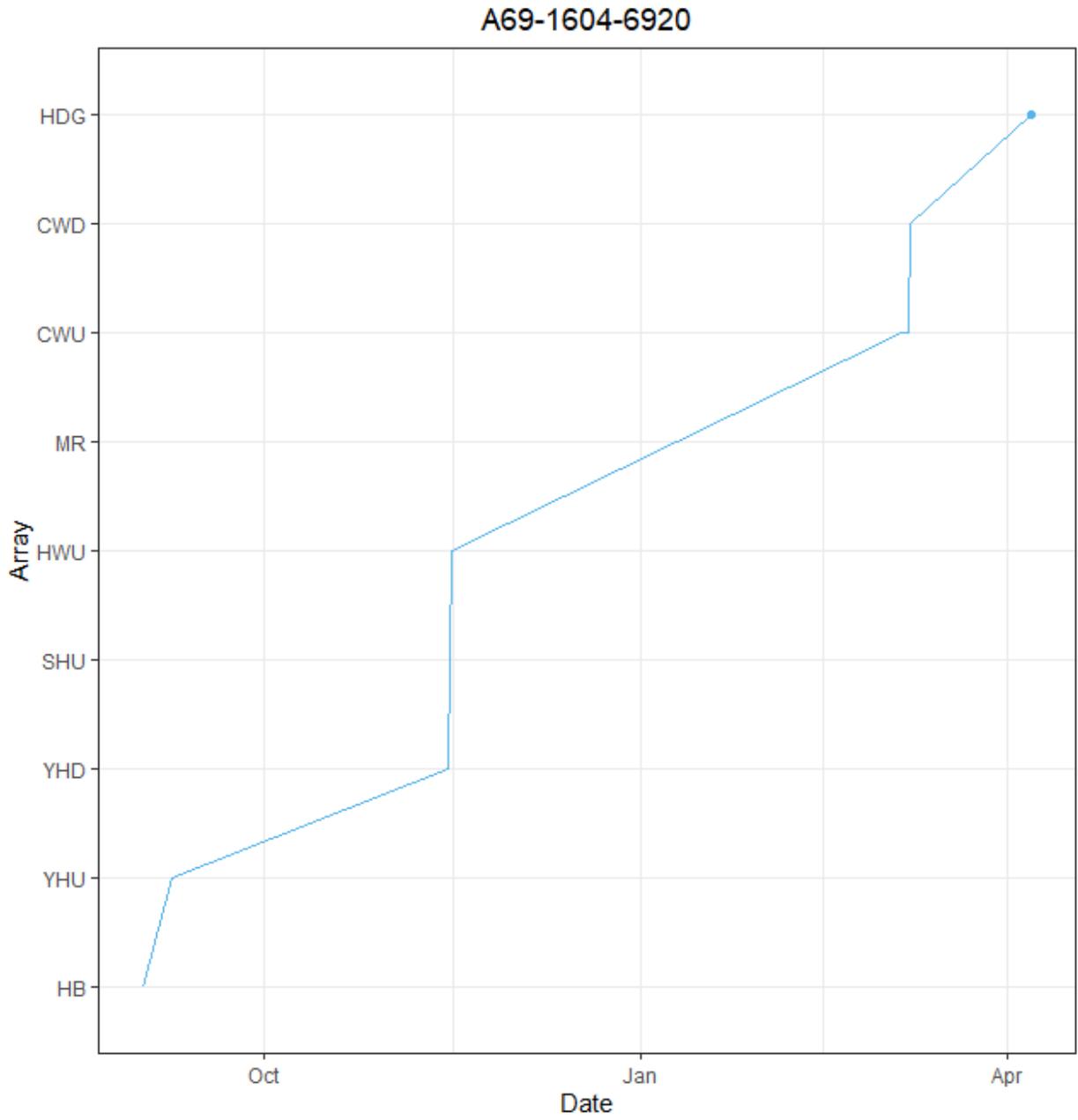
Transmitter A69-1604-6844 movement detection plot from 3-15 November 2022. This eel successfully exited the Susquehanna River.
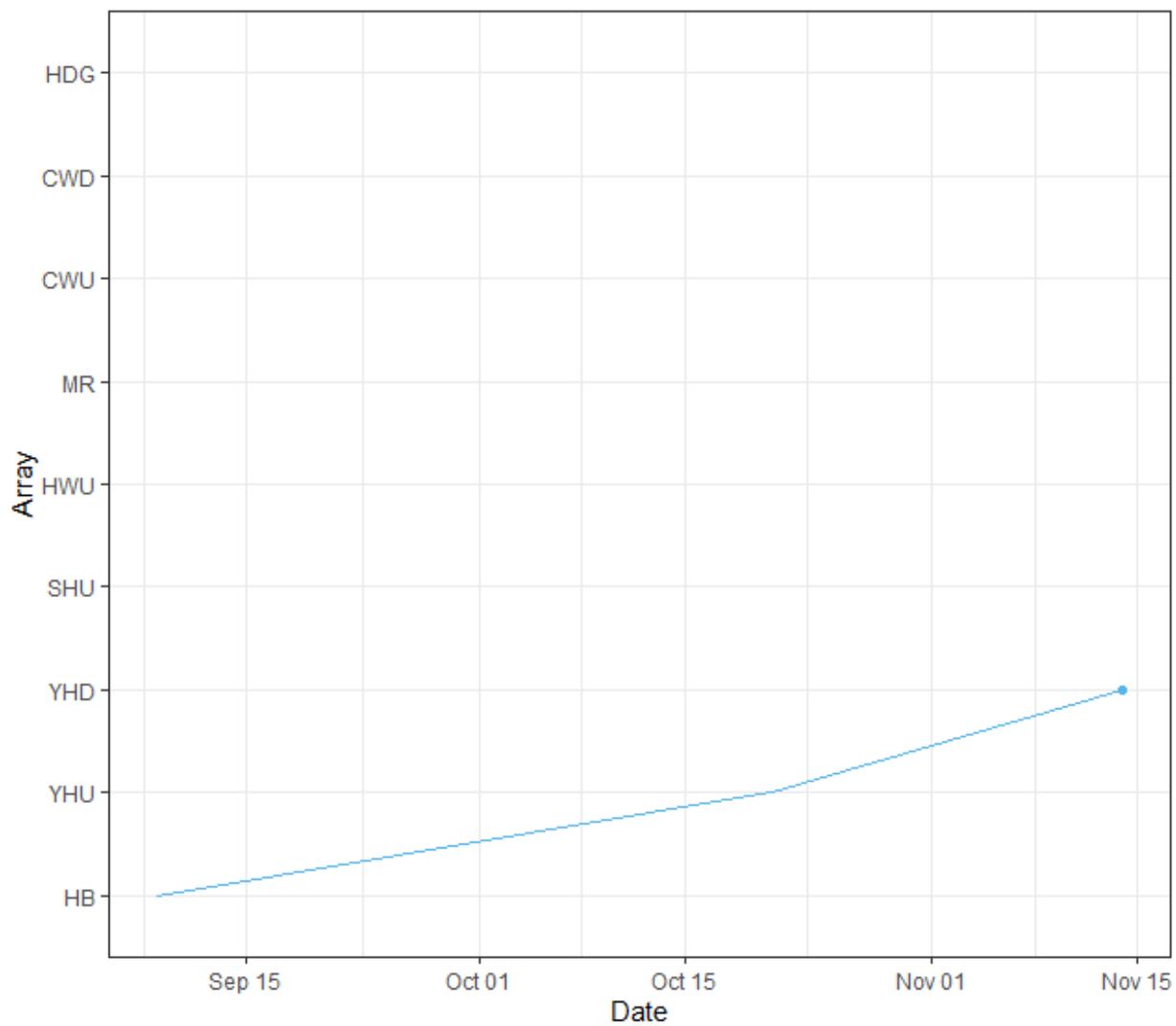
Transmitter A69-1604-6845 movement detection plot from 8 September – 13 November 2022. This eel did not successfully exit the Susquehanna River.
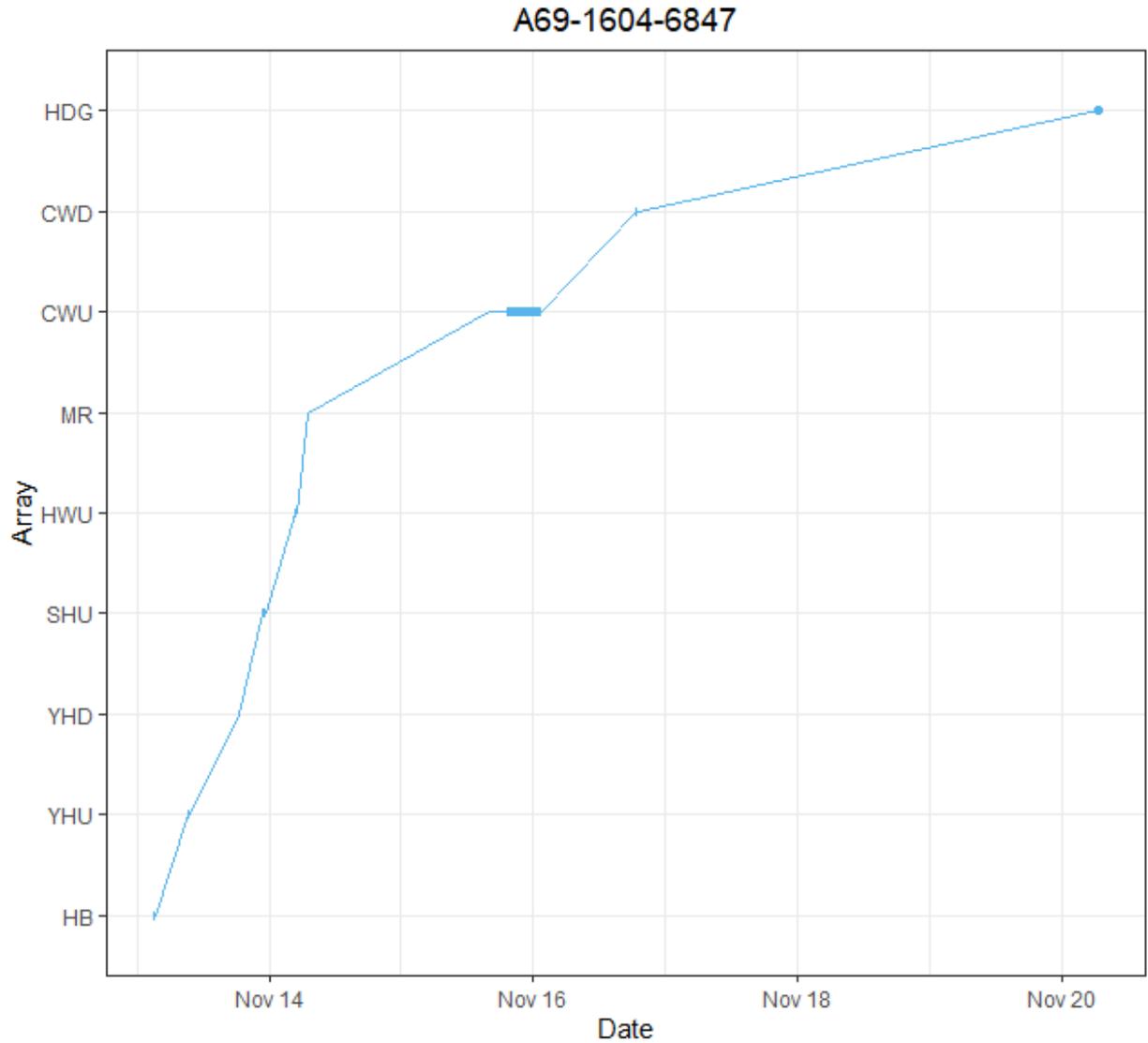
Transmitter A69-1604-6847 movement detection plot from 13-20 November 2022. This eel did not successfully exit the Susquehanna River. Note this tagged eel remained in the vicinity of the Havre de Grace Array through tag expiration in August 2024.
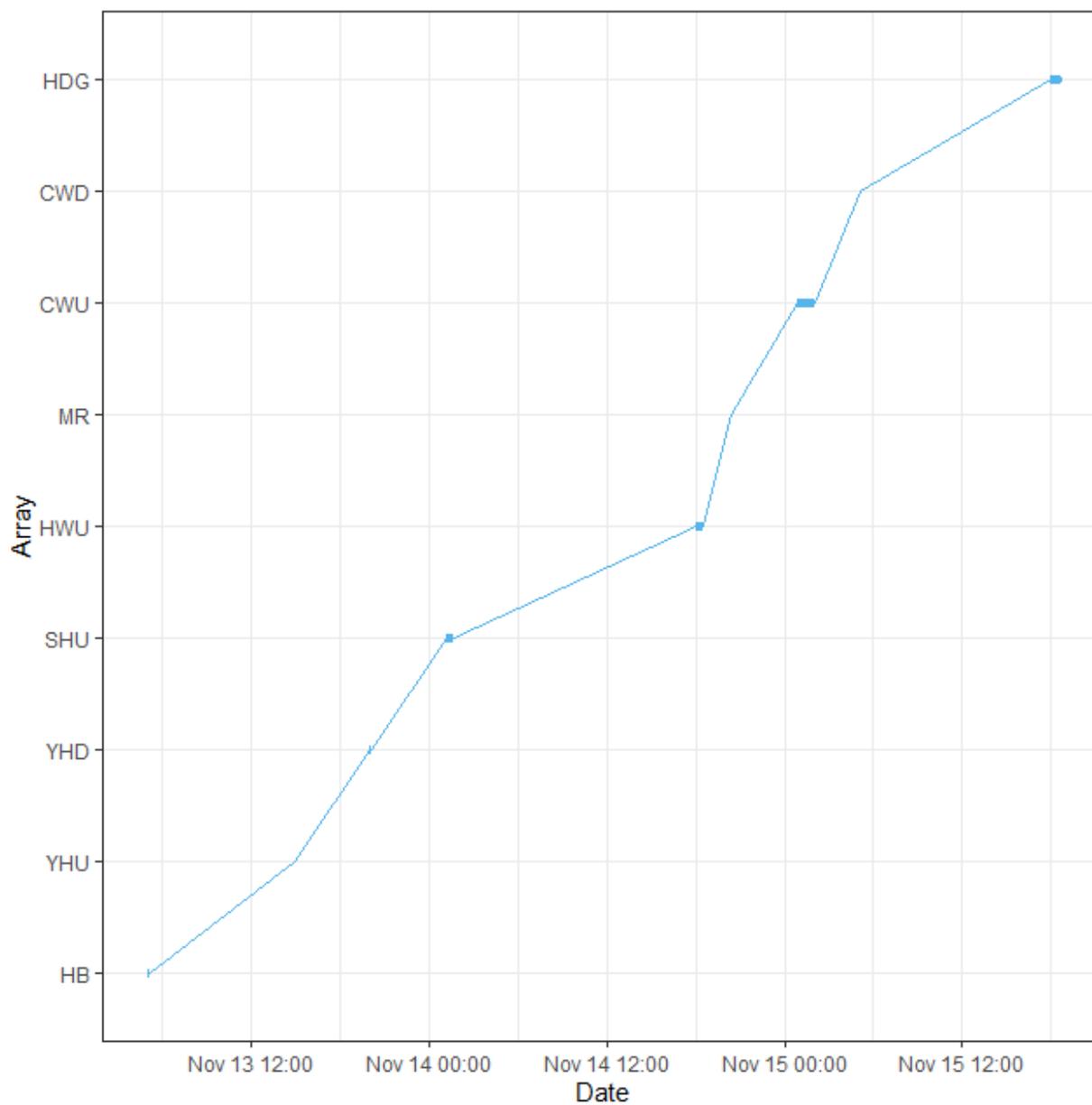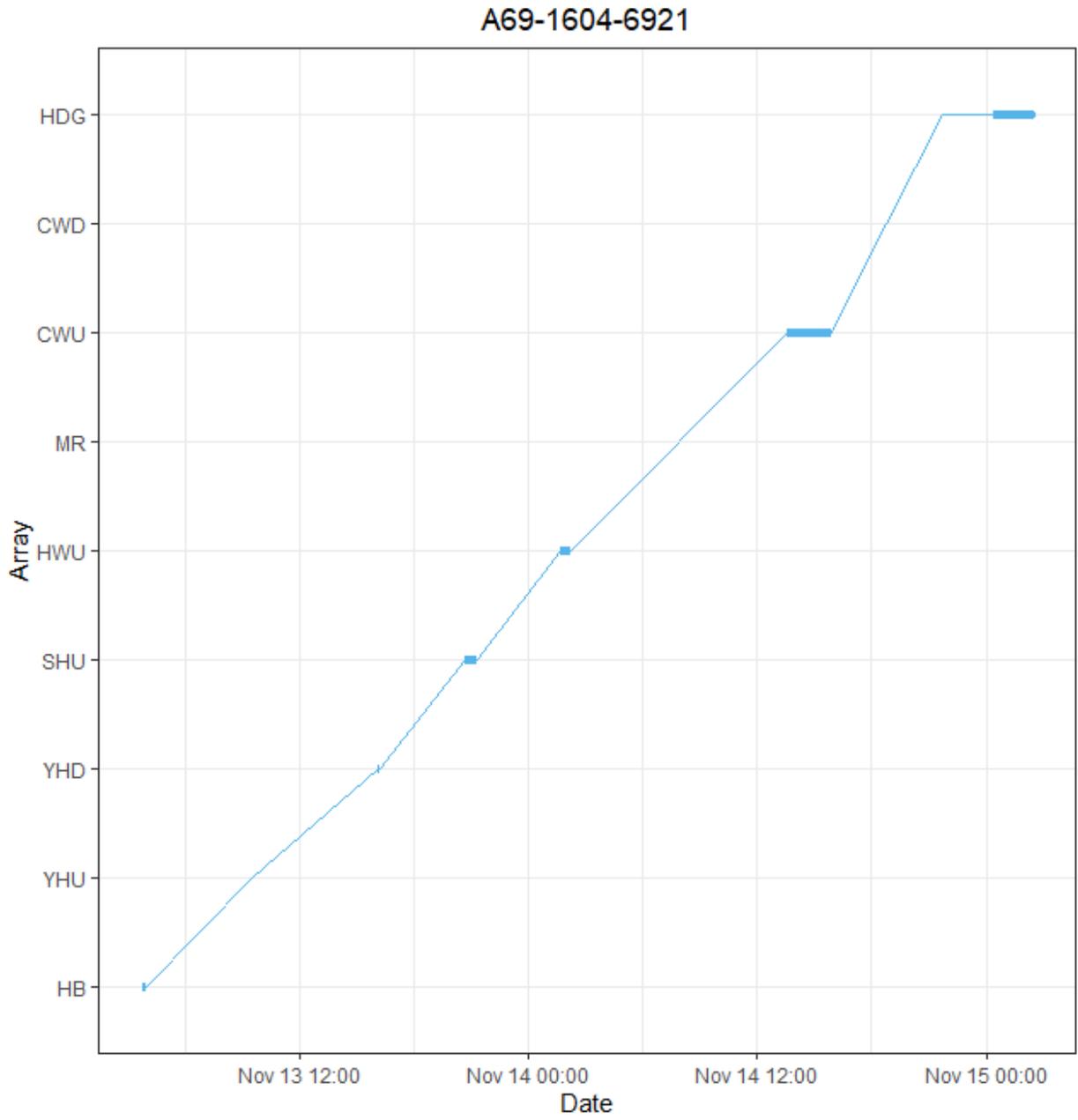
Transmitter A69-1604-6848 movement detection plot from 13-15 November 2022. This eel successfully exited the Susquehanna River.
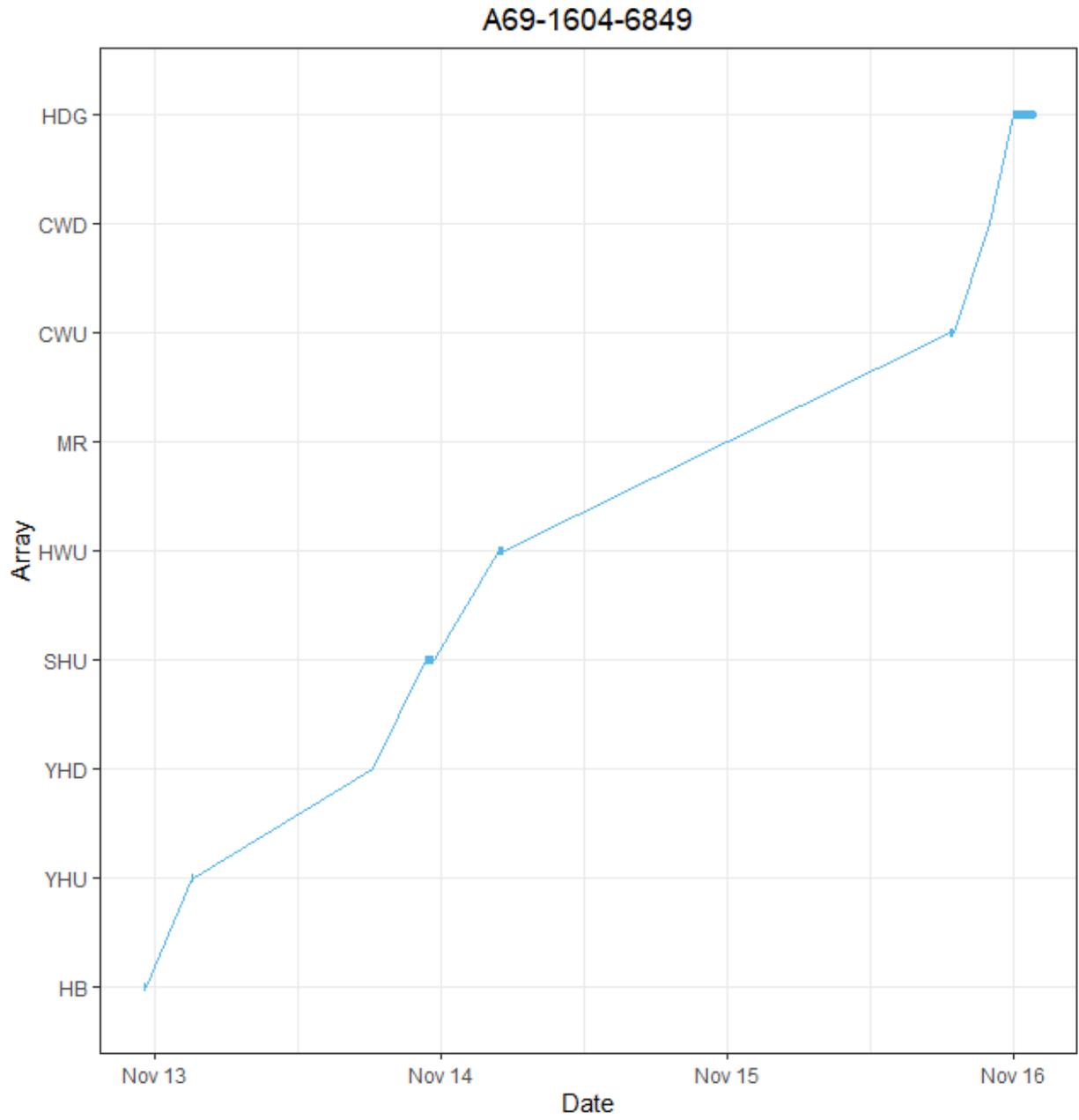
Transmitter A69-1604-6849 movement detection plot from 12-16 November 2022. This eel successfully exited the Susquehanna River.

A69-1604-6850
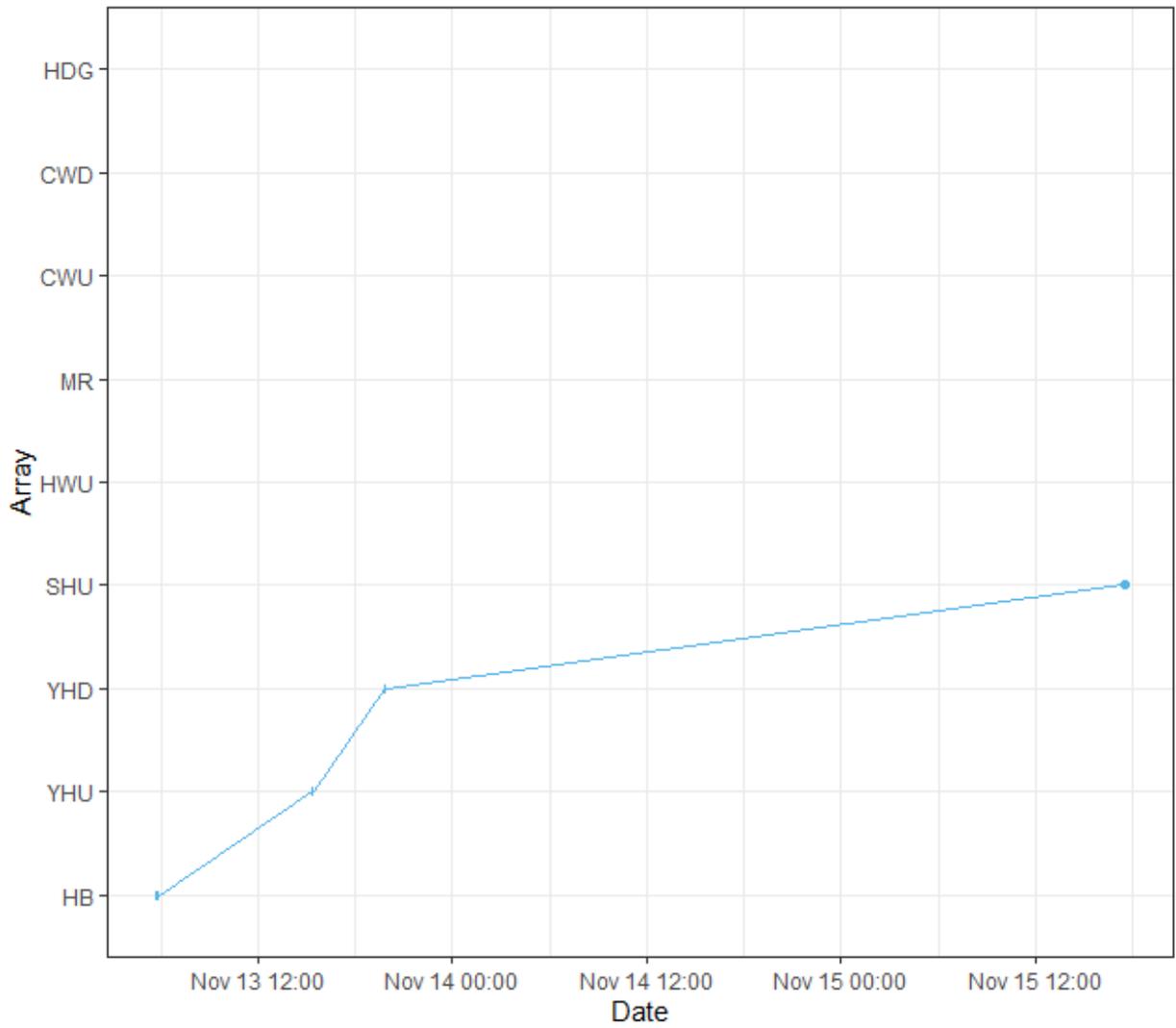
Transmitter A69-1604-6850 movement detection plot from 13-15 November 2022. This eel did not successfully exit the Susquehanna River.
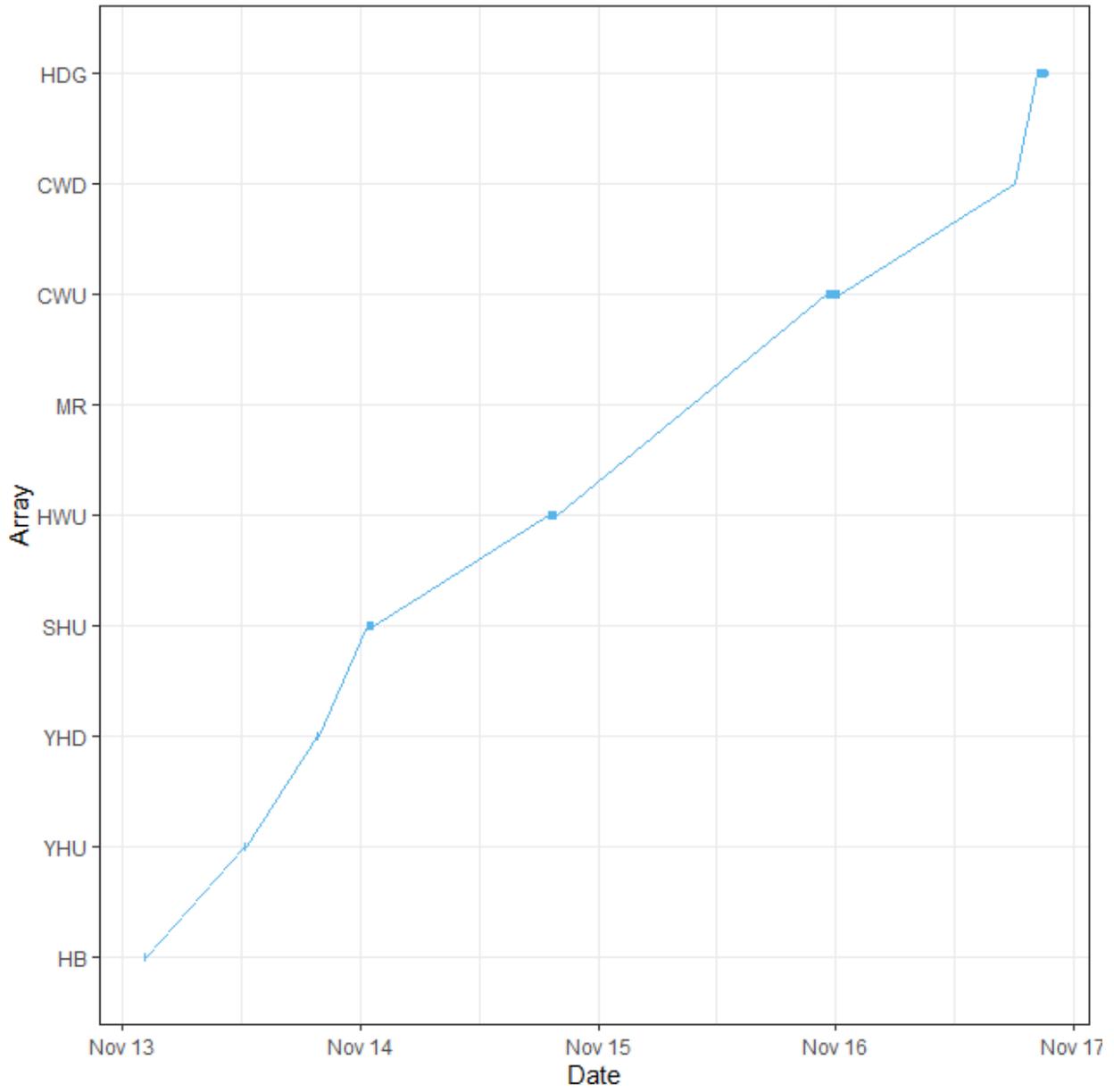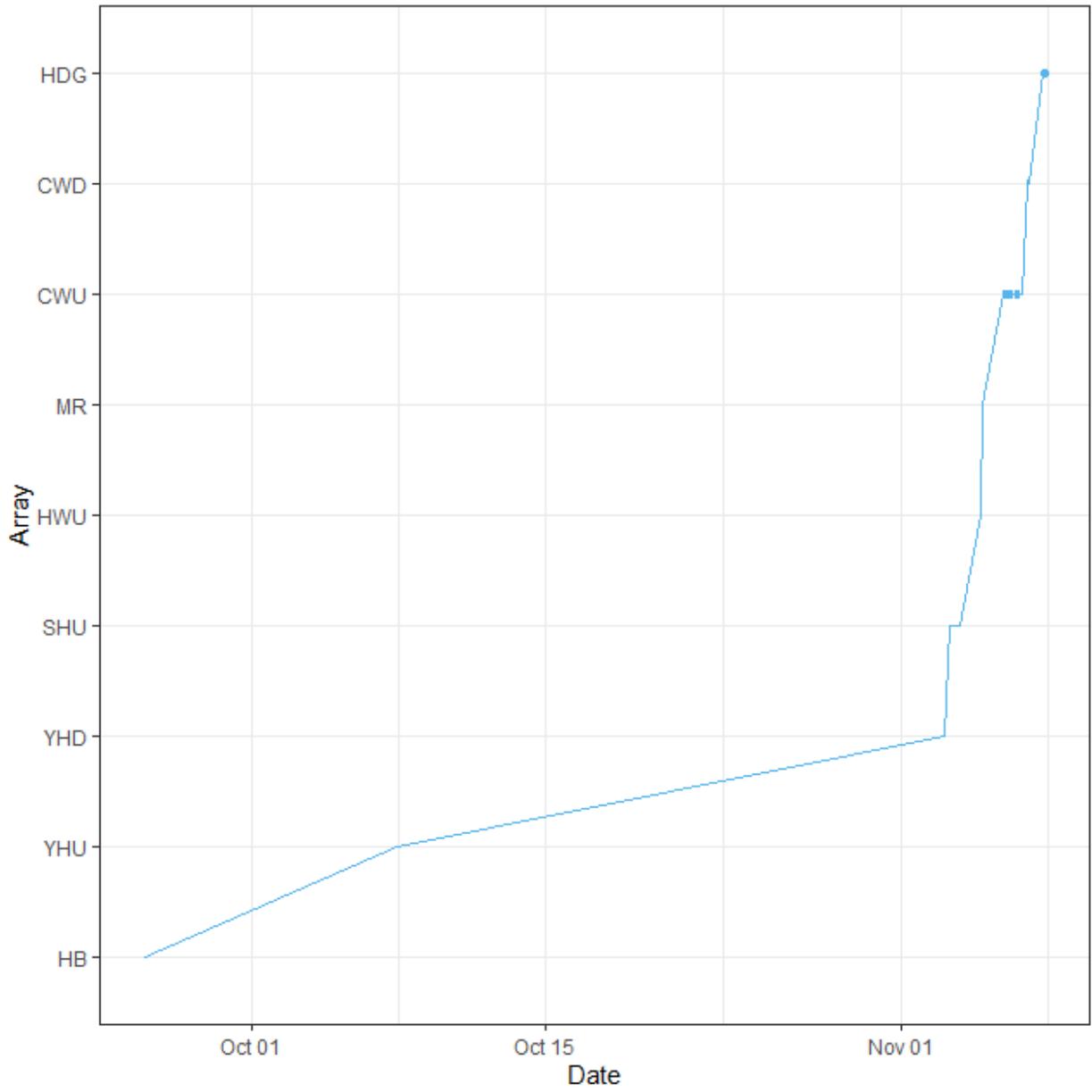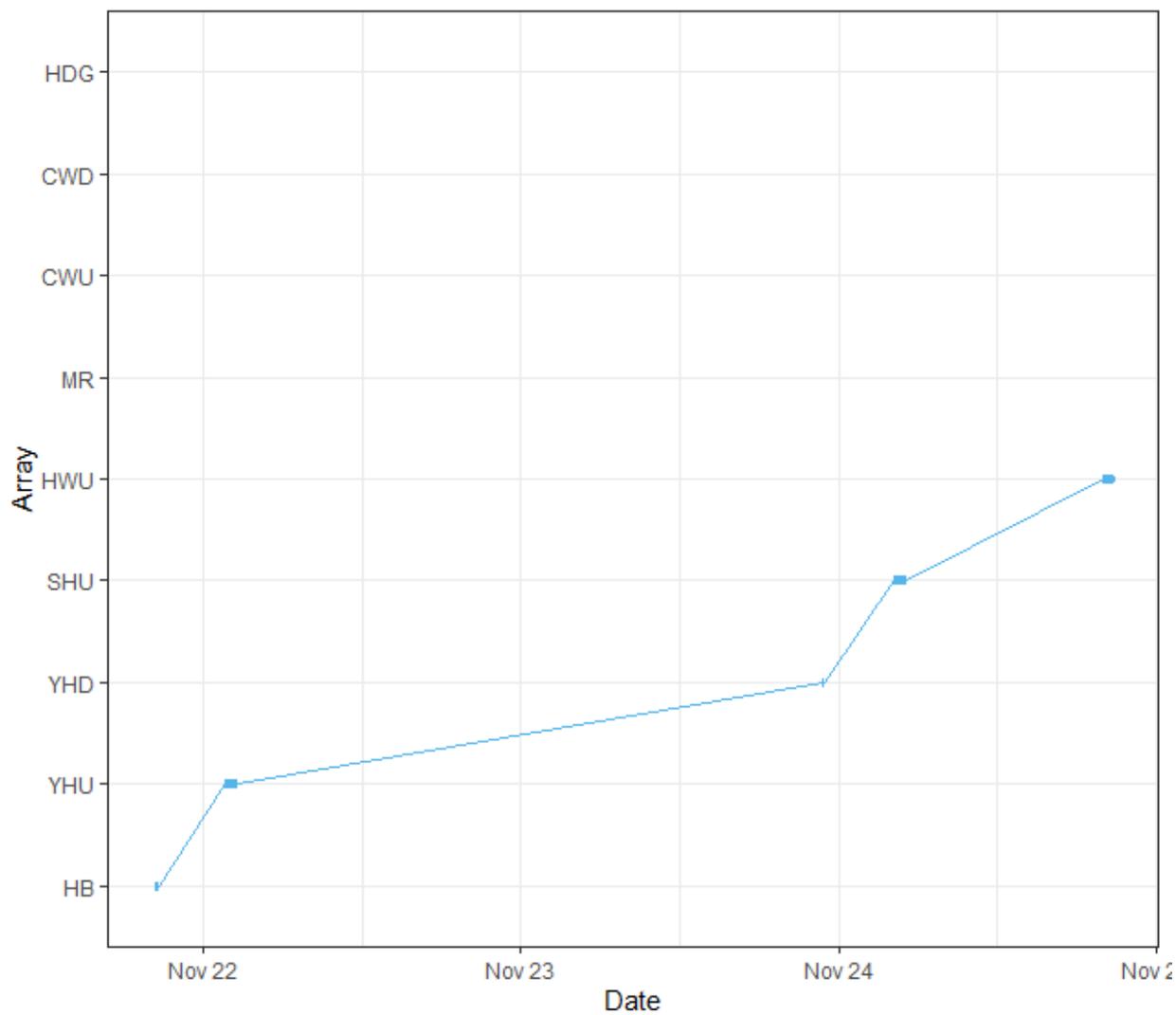
Transmitter A69-1604-6851 movement detection plot from 13-16 November 2022. This eel successfully exited the Susquehanna River.
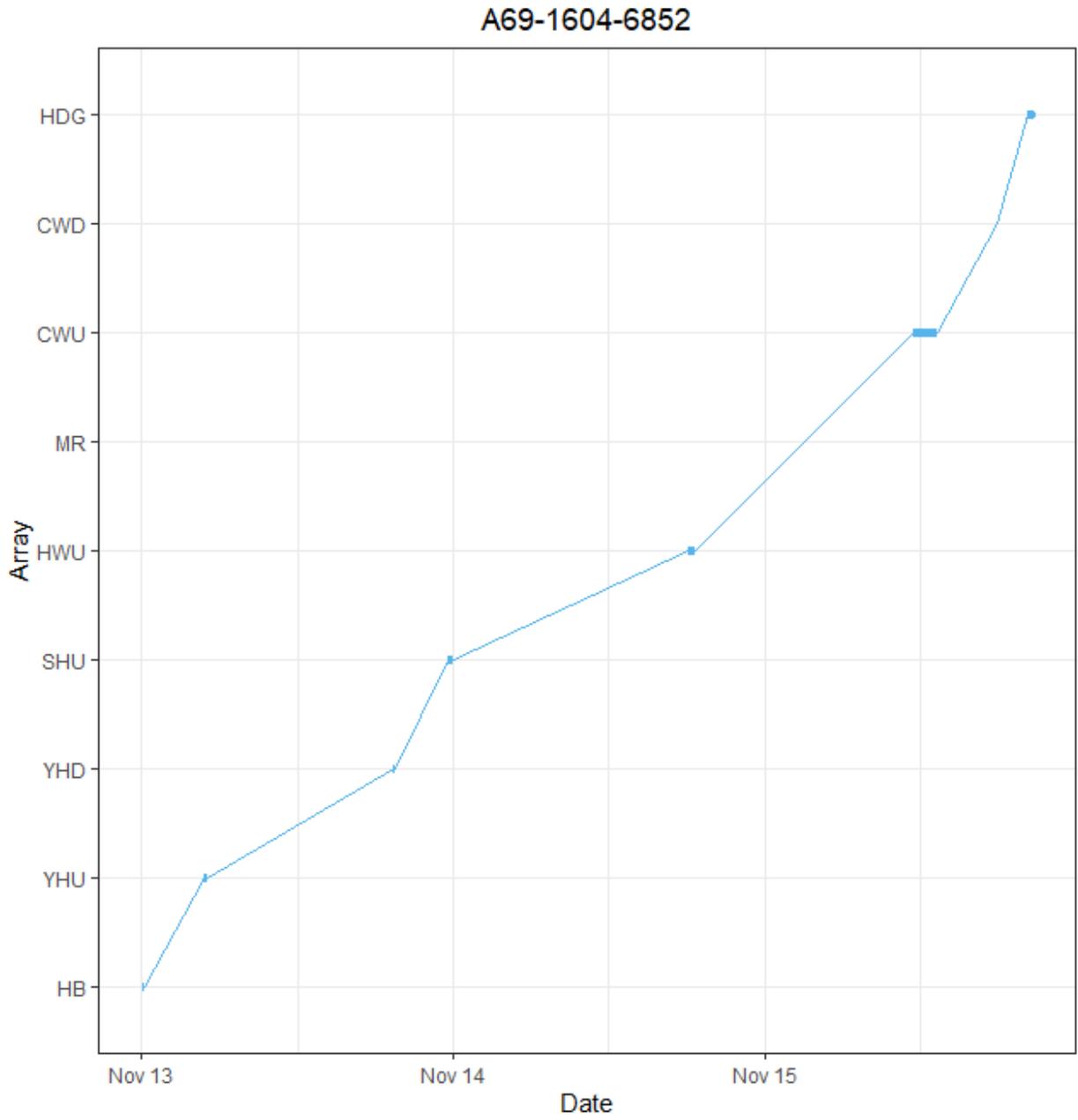
Transmitter A69-1604-6852 movement detection plot from 13-15 November 2022. This eel successfully exited the Susquehanna River.
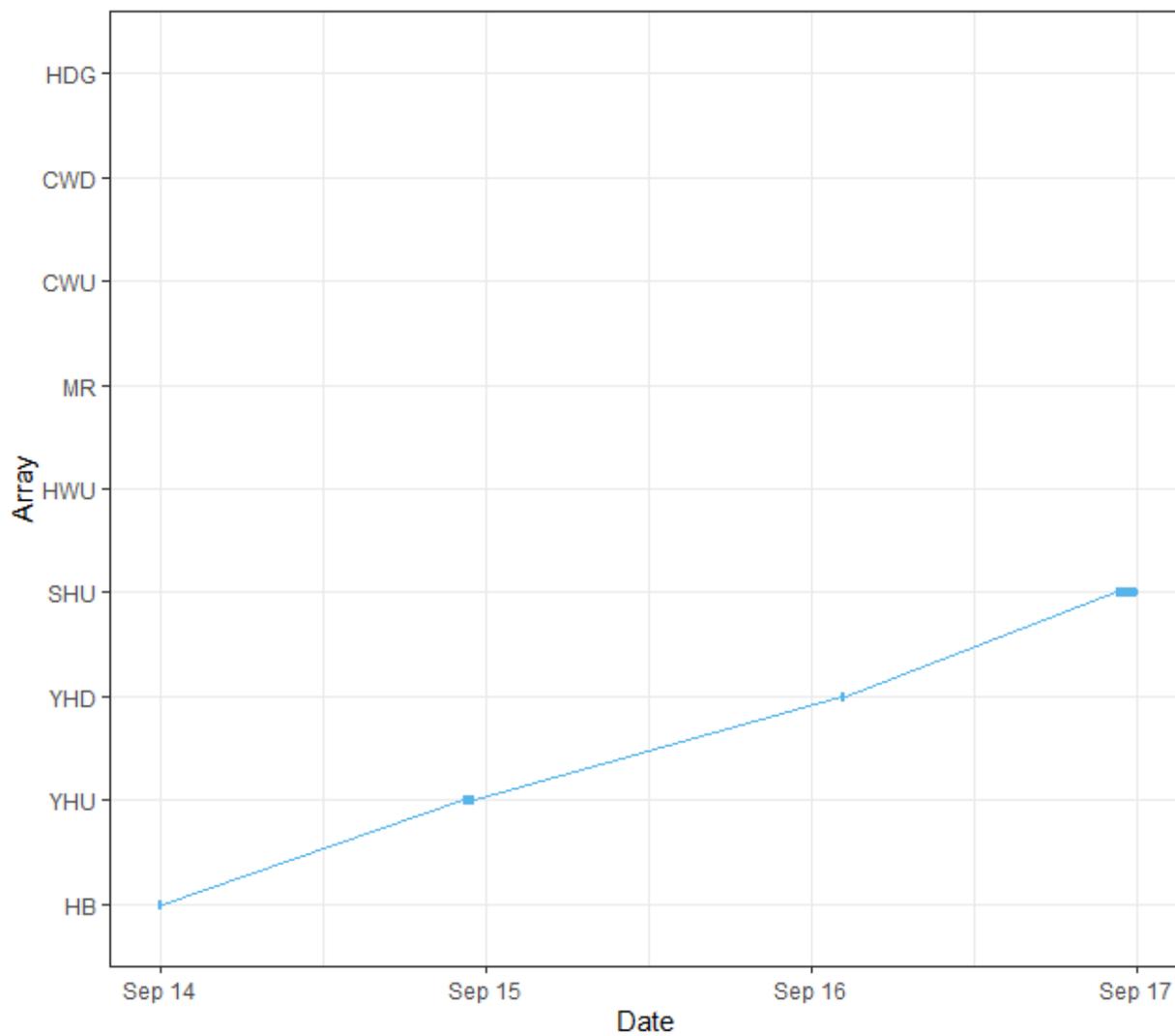
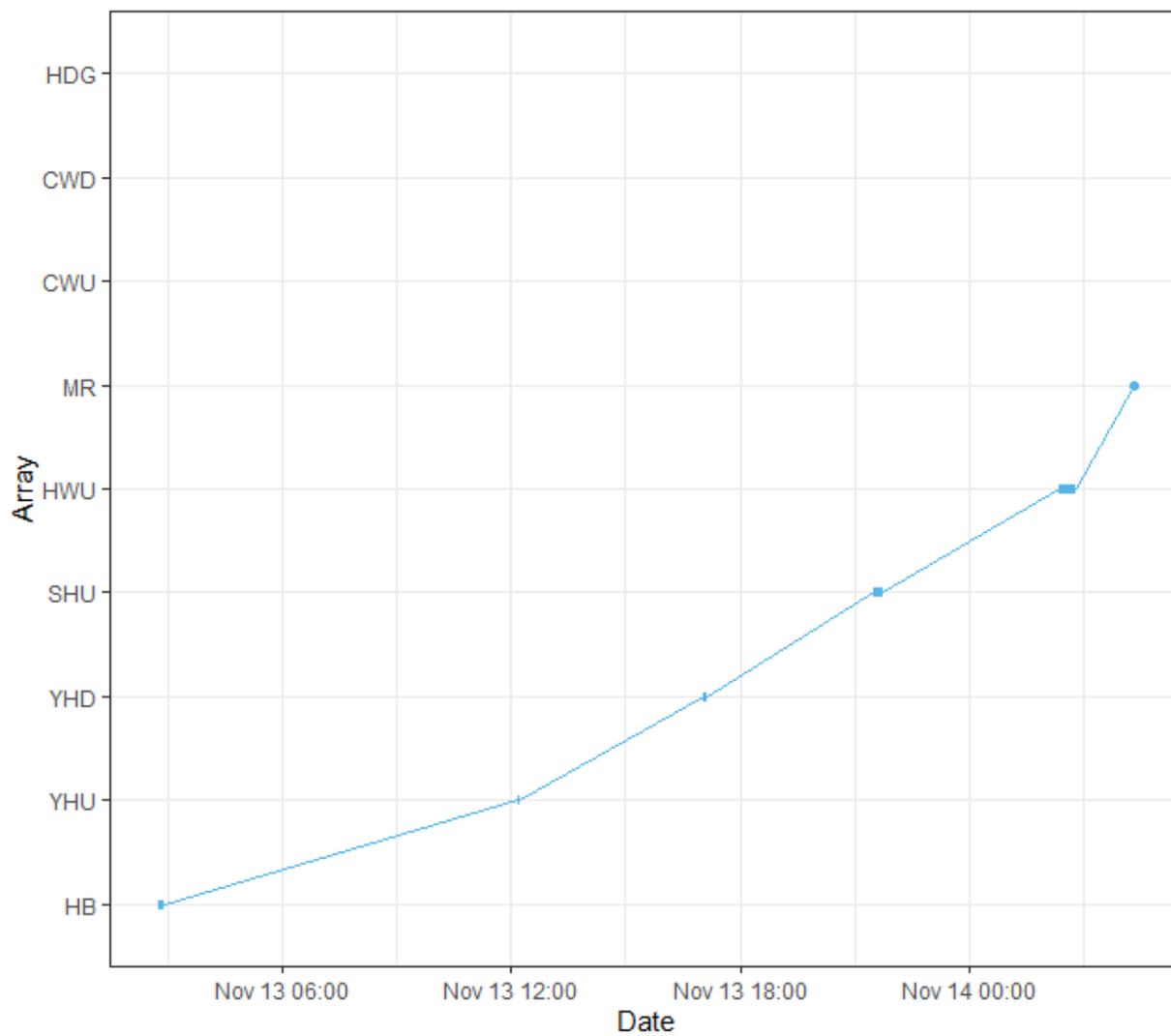Transmitter A69-1604-6853 movement detection plot from 14-17 September 2023. This eel did not successfully exit the Susquehanna River.

A69-1604-6854
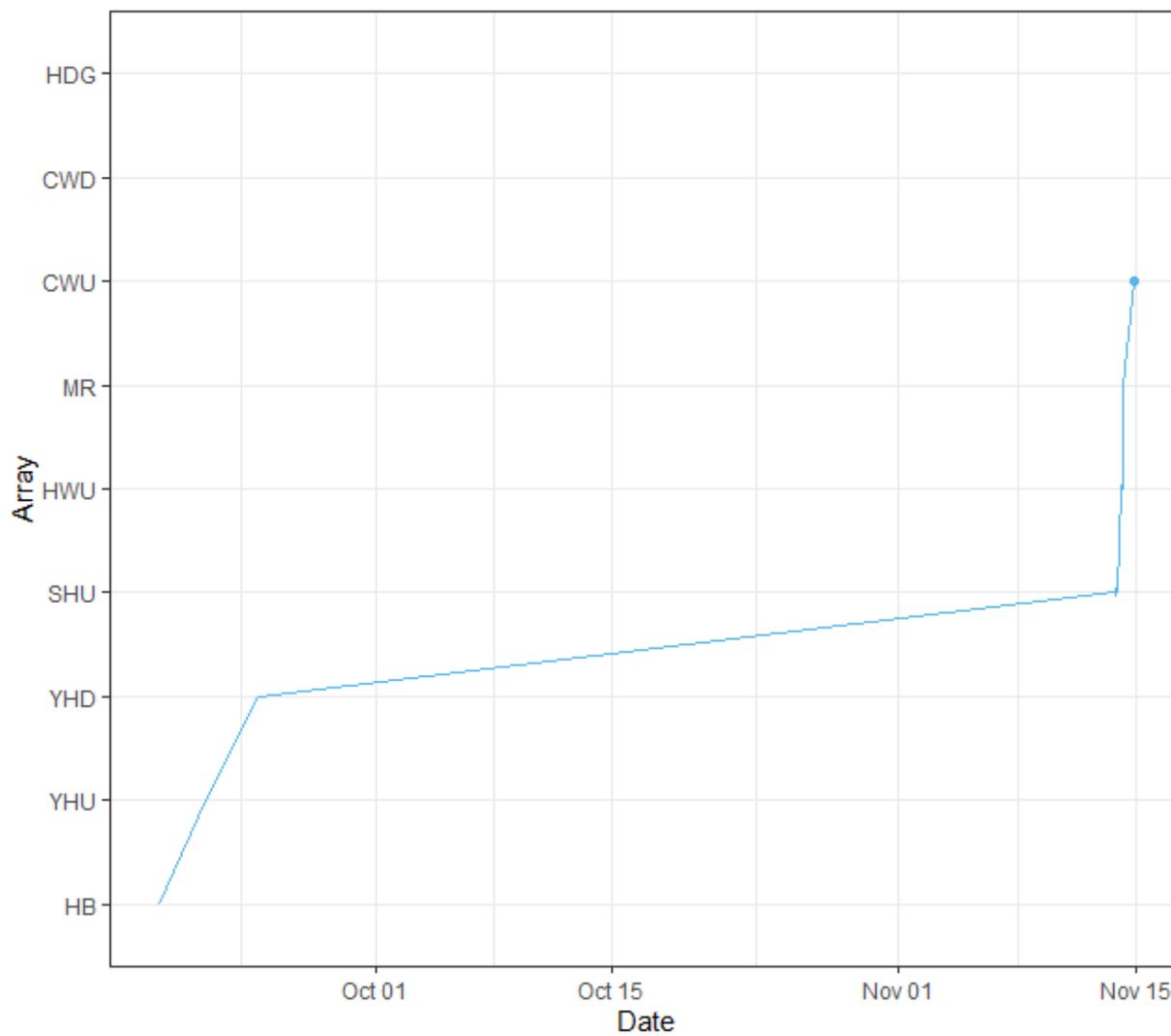
Transmitter A69-1604-6854 movement detection plot from 18 September – 14 November 2022. This eel did not successfully exit the Susquehanna River.

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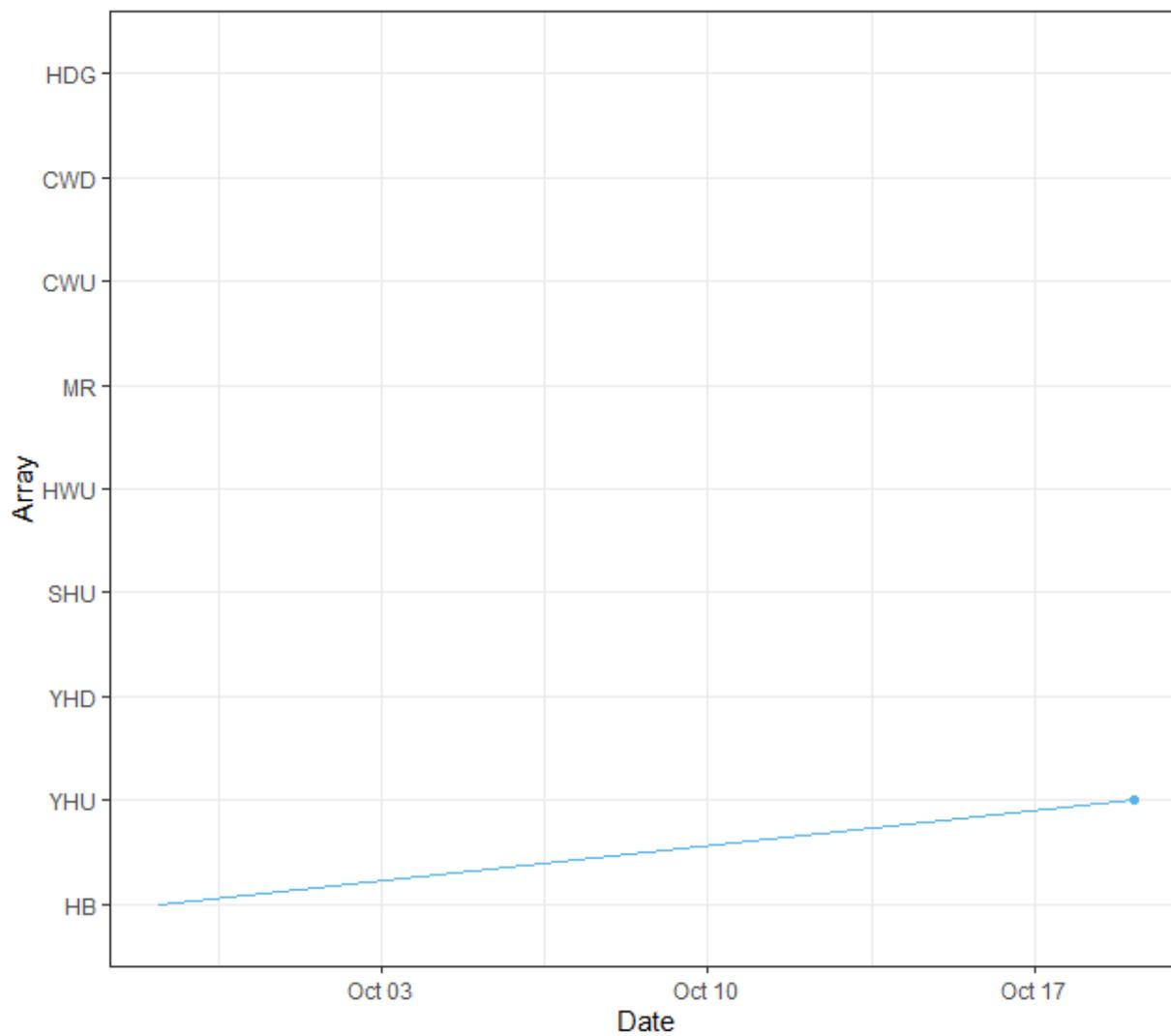
Transmitter A69-1604-6855 movement detection plot from 25 August - 19 October 2022. This eel did not successfully exit the Susquehanna River.
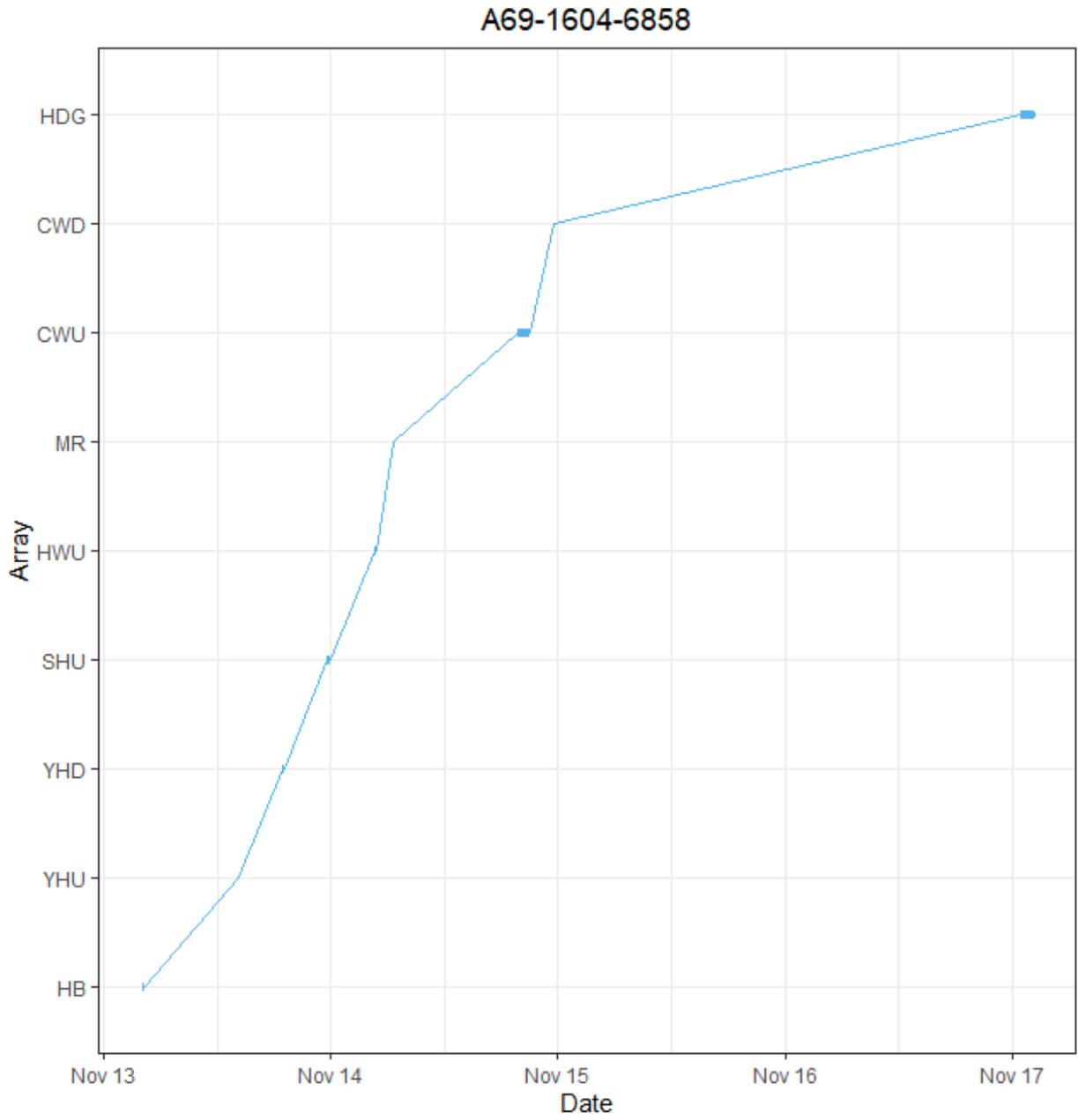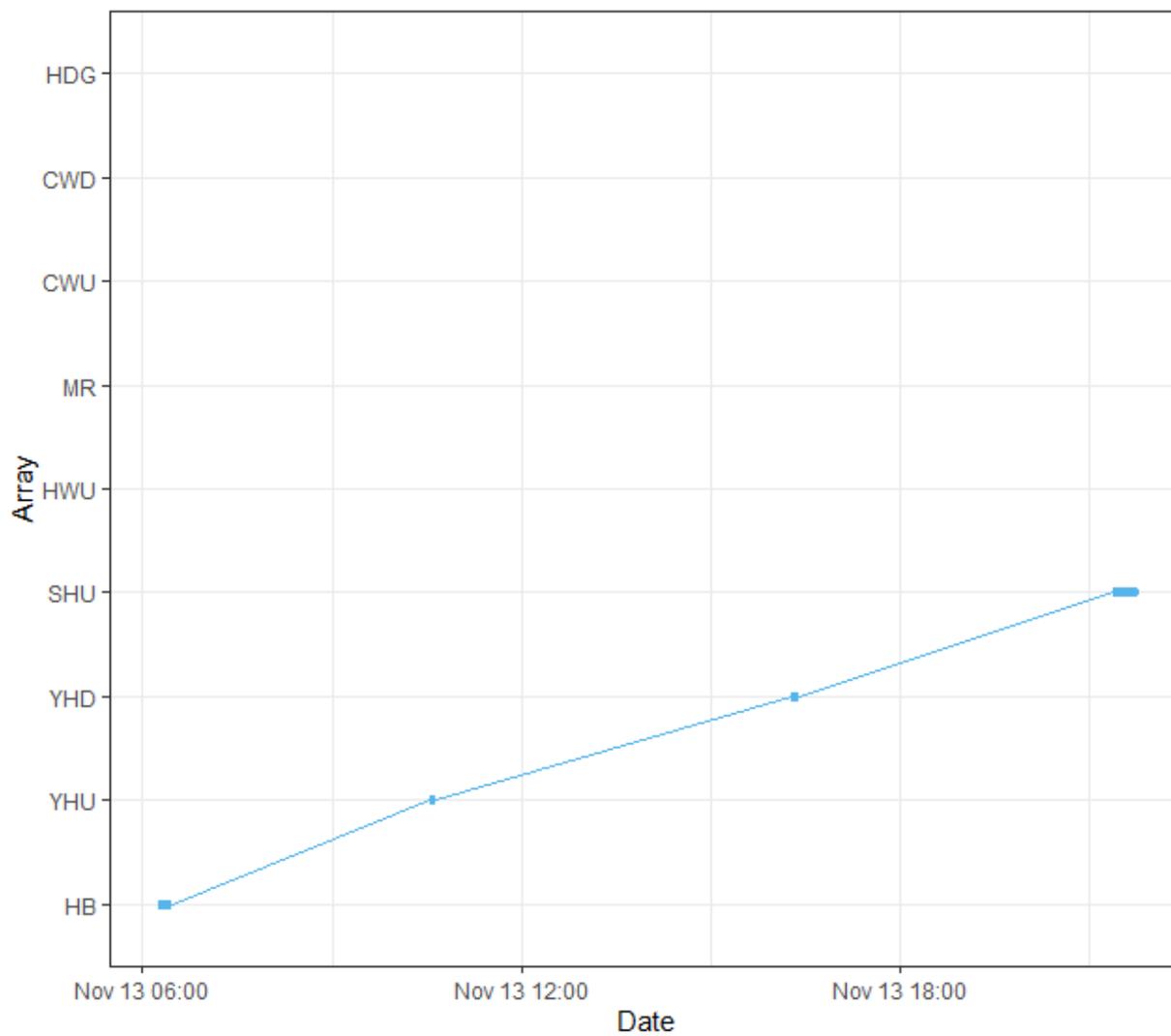
Transmitter A69-1604-6858 movement detection plot from 13-17 November 2022. This eel successfully exited the Susquehanna River.
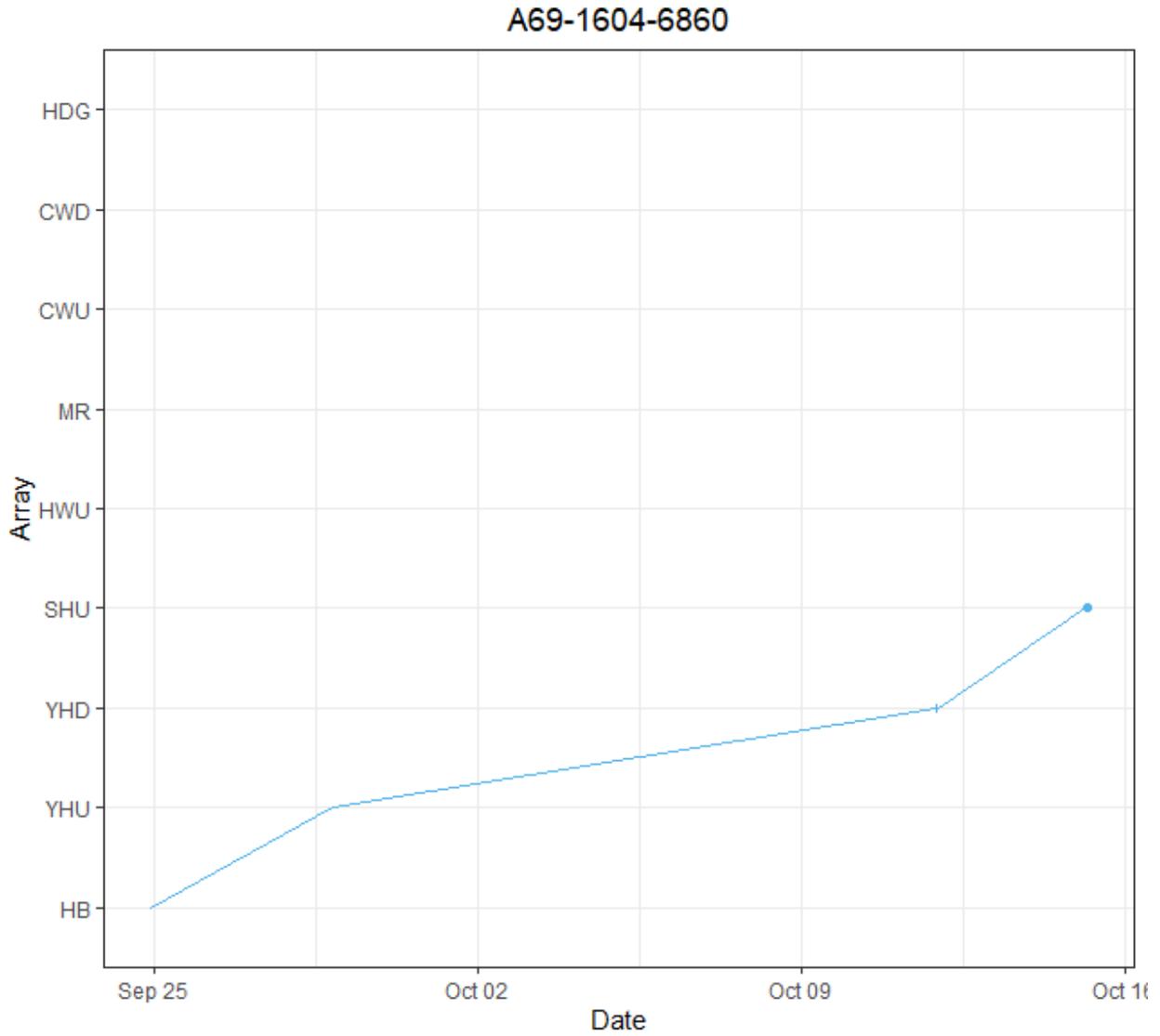
Transmitter A69-1604-6860 movement detection plot from 24 September – 15 October 2023. This eel did not successfully exit the Susquehanna River.
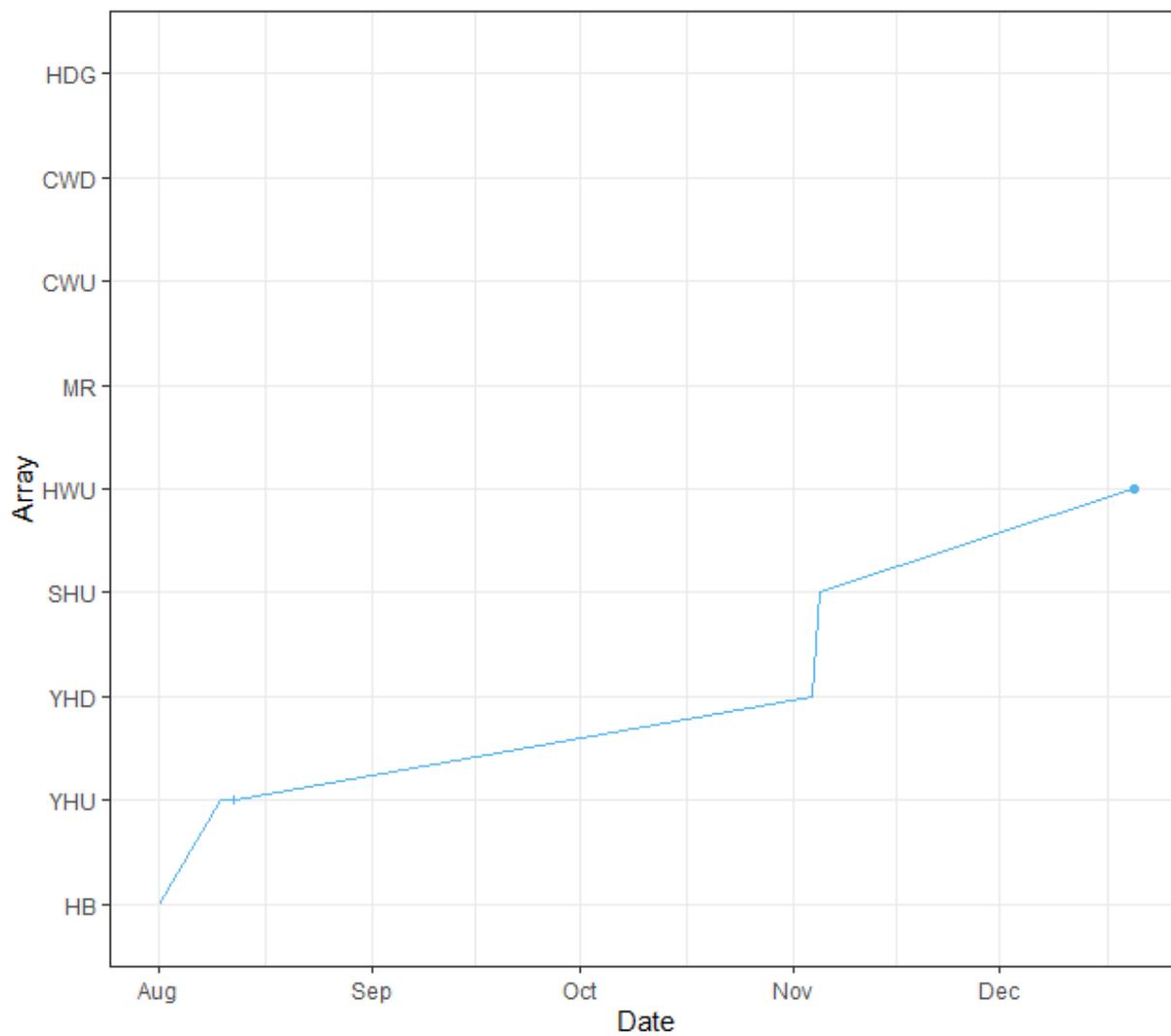
Transmitter A69-1604-6861 movement detection plot from 1 August – 20 December 2023. This eel did not successfully exit the Susquehanna River.
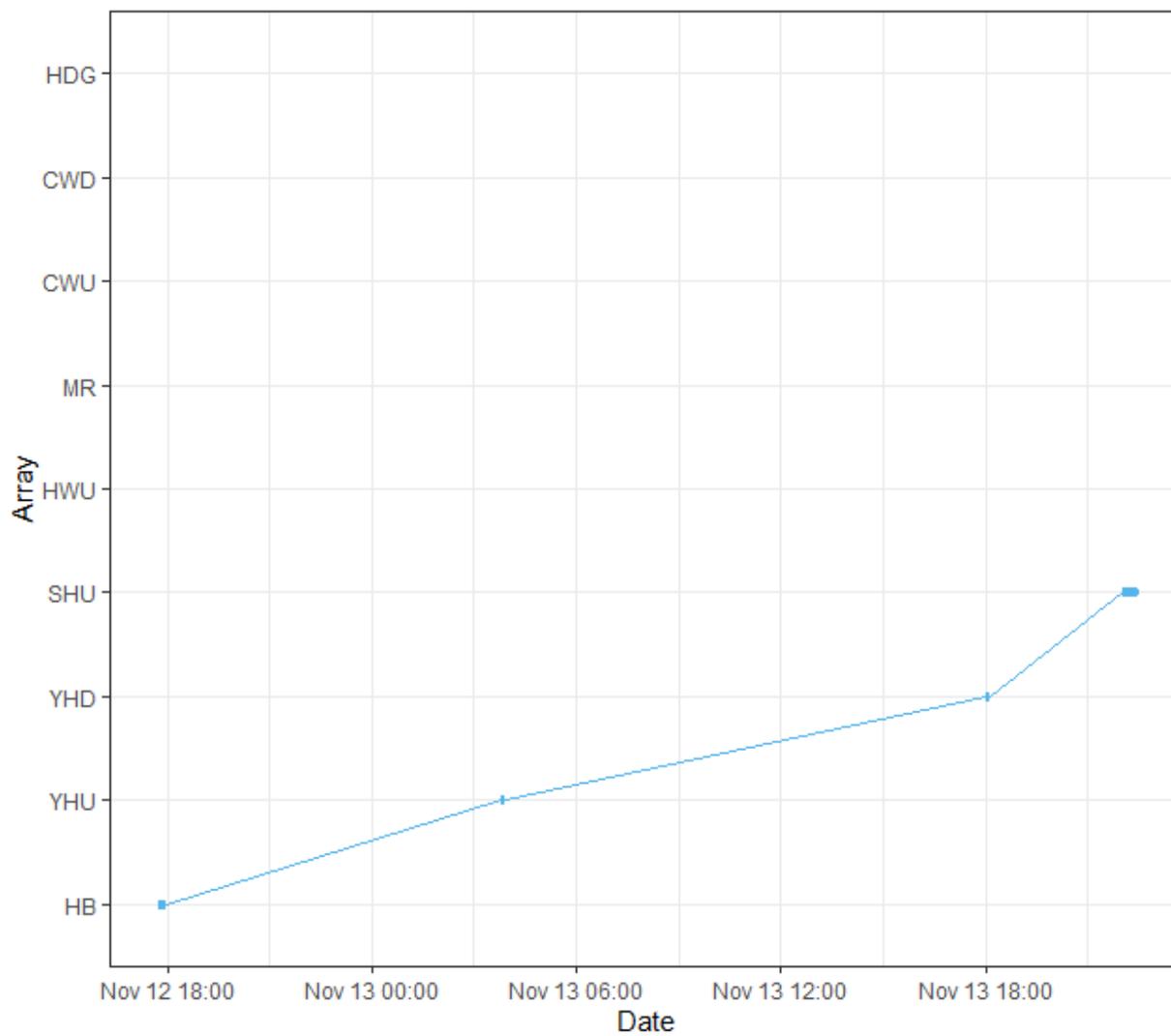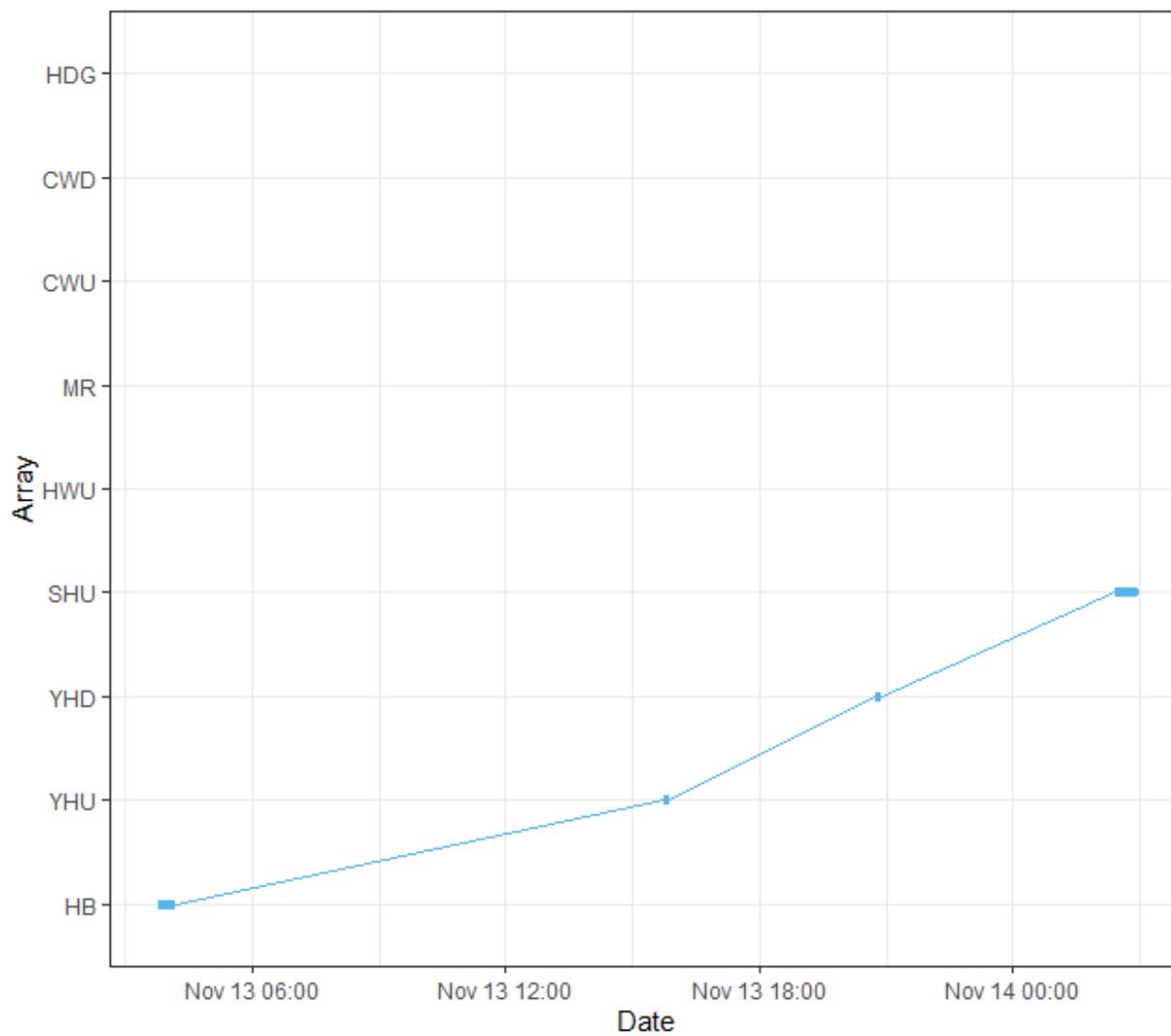
Transmitter A69-1604-6862 movement detection plot from 12-13 November 2022. This eel did not successfully exit the Susquehanna River.
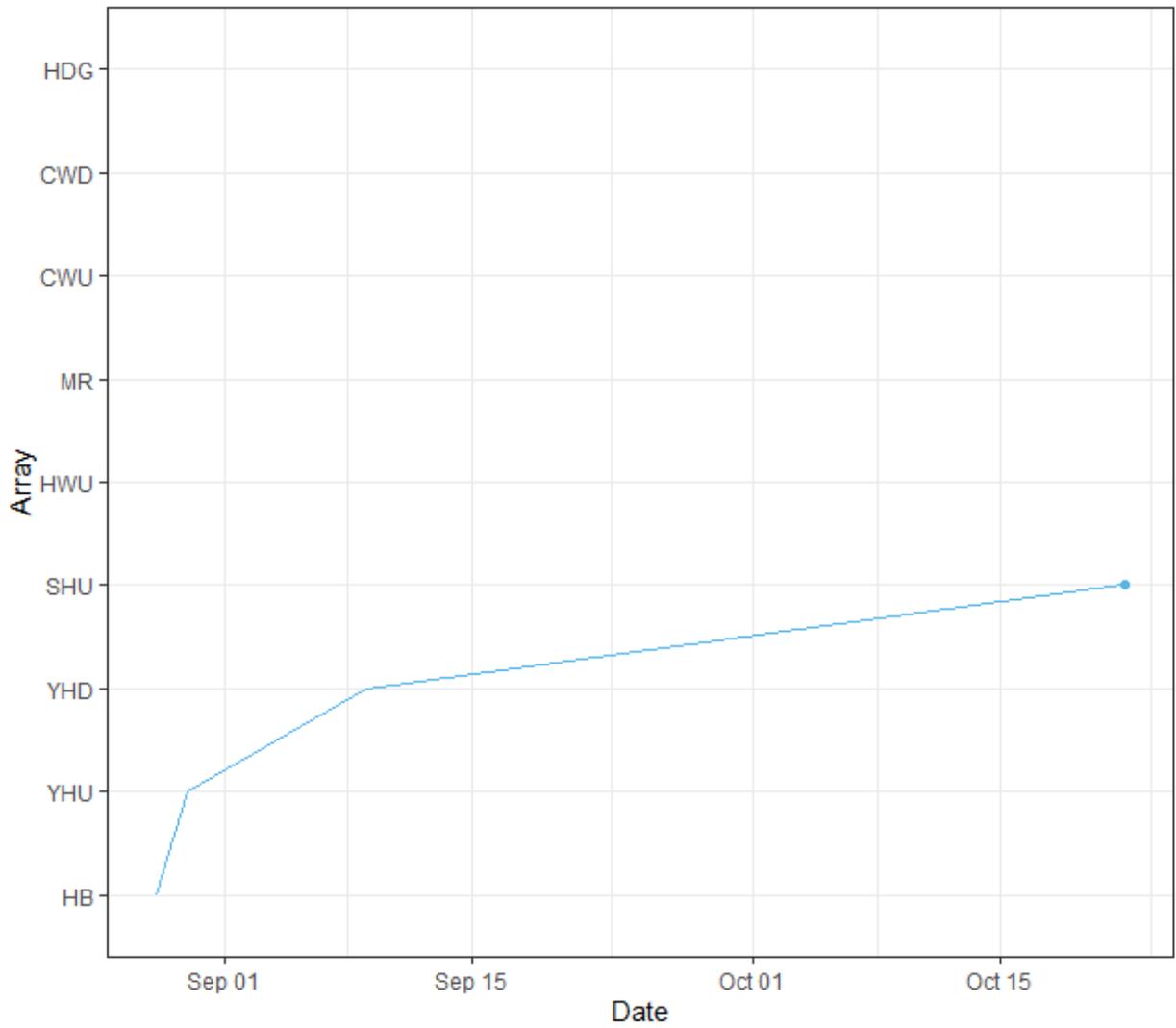
Transmitter A69-1604-6866 movement detection plot from 28 August - 22 October 2022. This eel did not successfully exit the Susquehanna River.
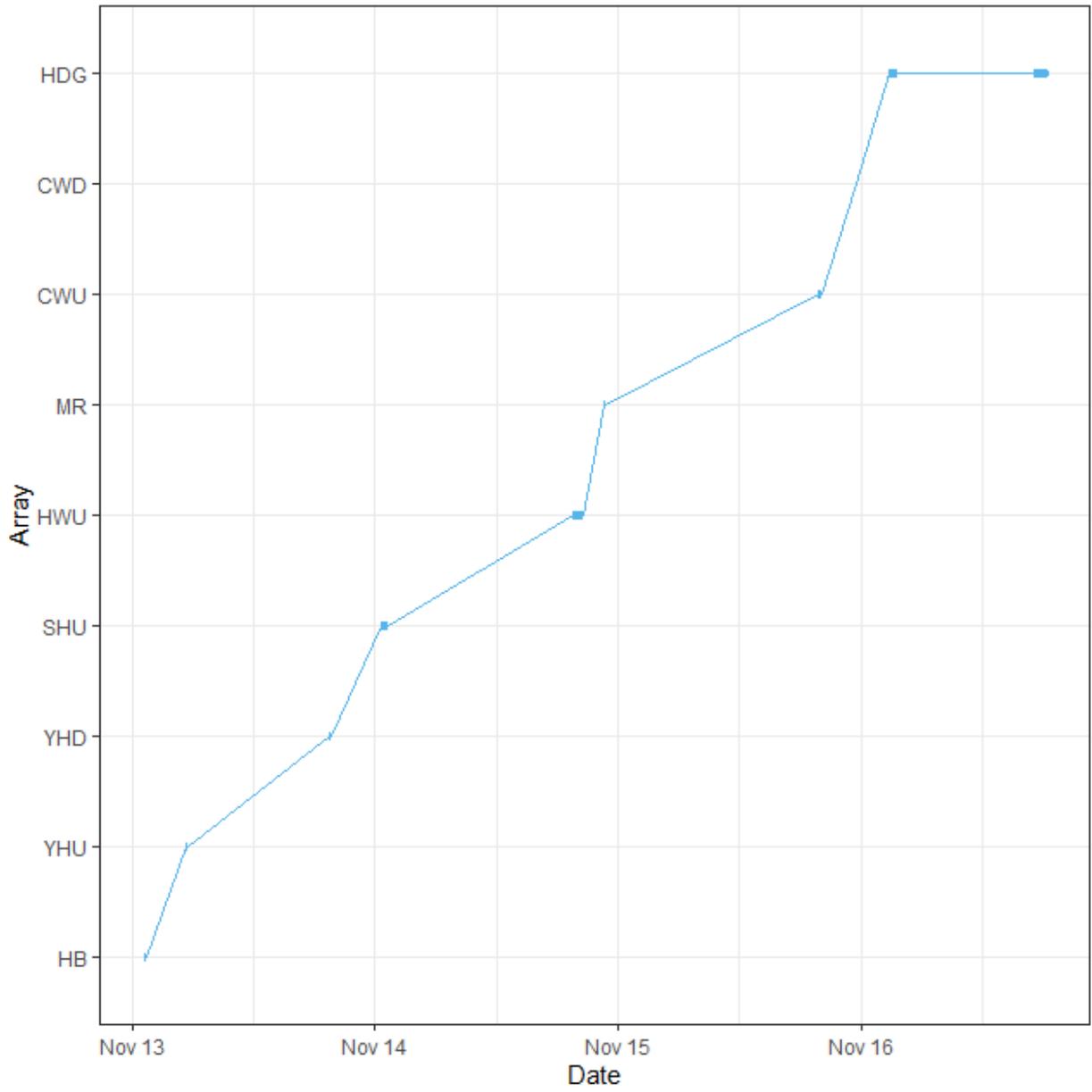
Transmitter A69-1604-6868 movement detection plot from 13-16 November 2022. This eel successfully exited the Susquehanna River.
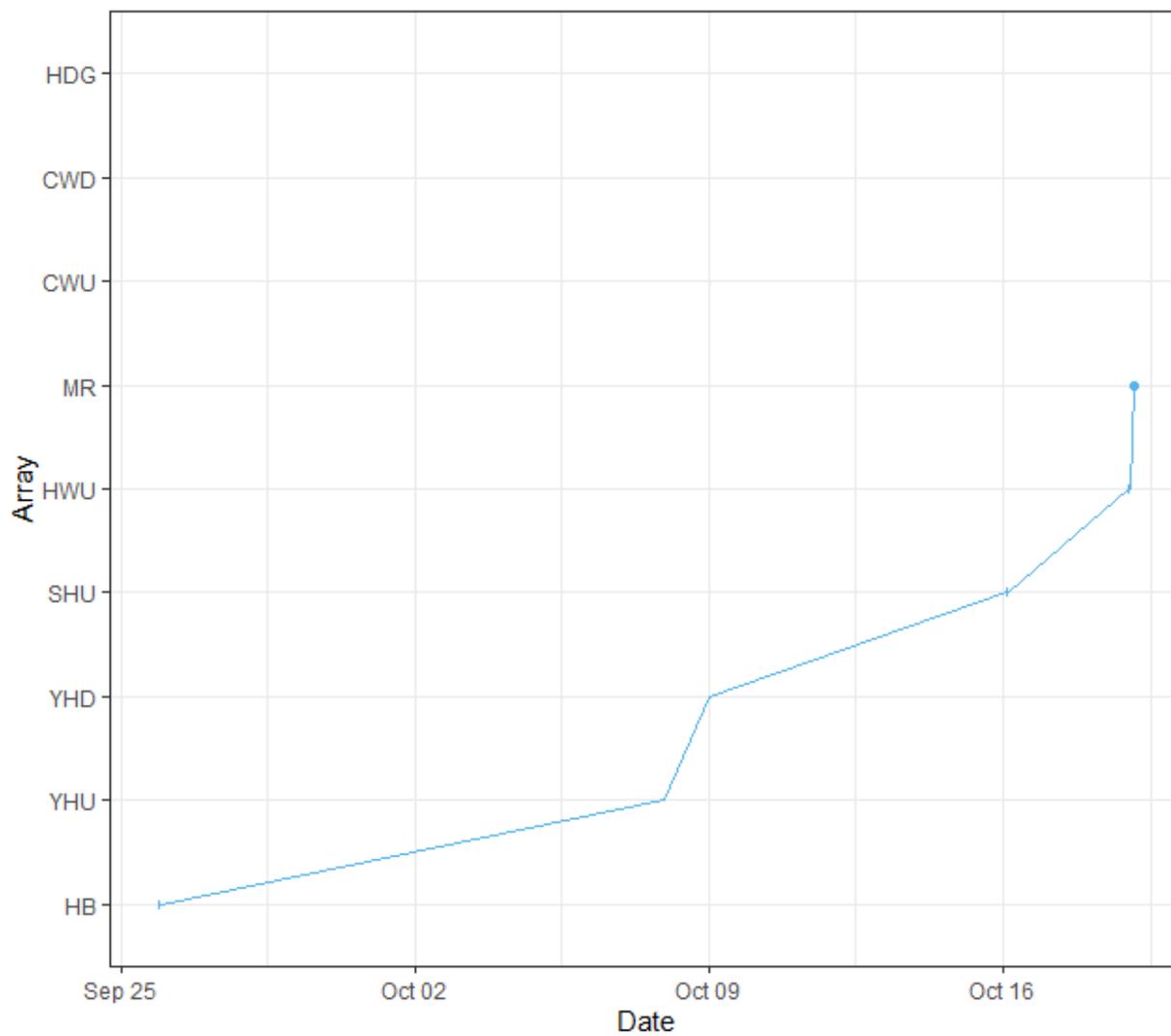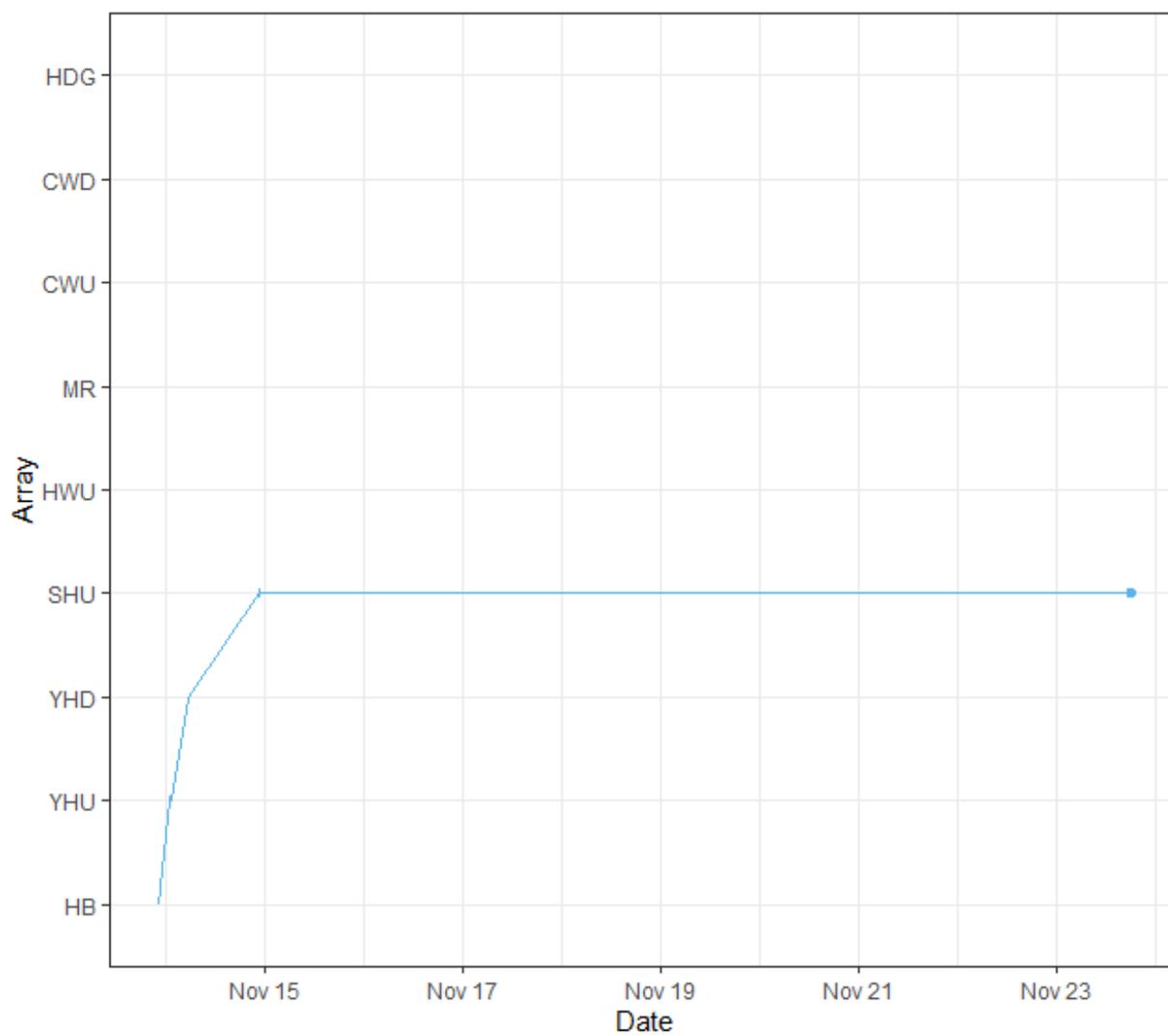
Transmitter A69-1604-6869 movement detection plot from 25 September – 19 October 2023. This eel did not successfully exit the Susquehanna River.
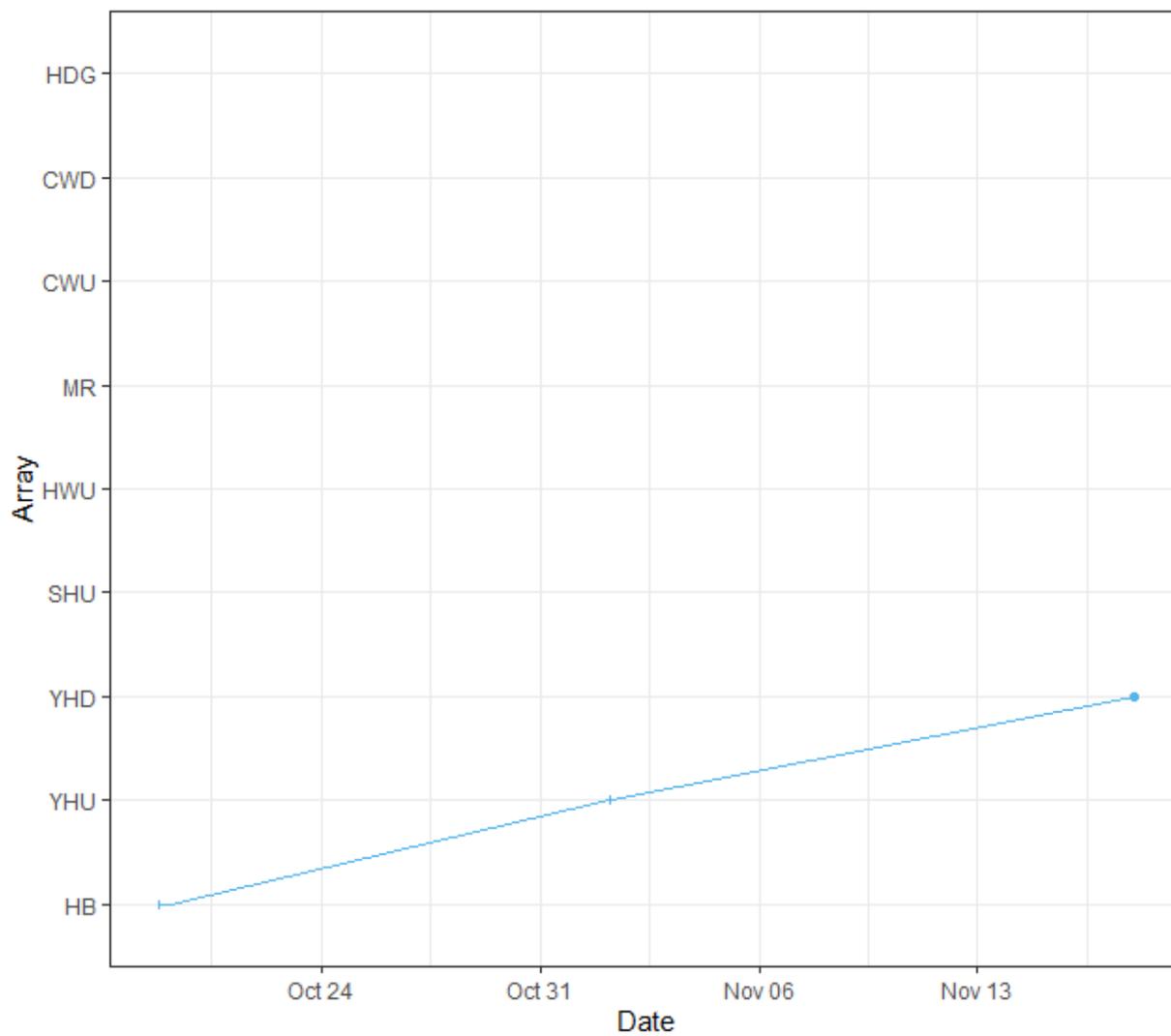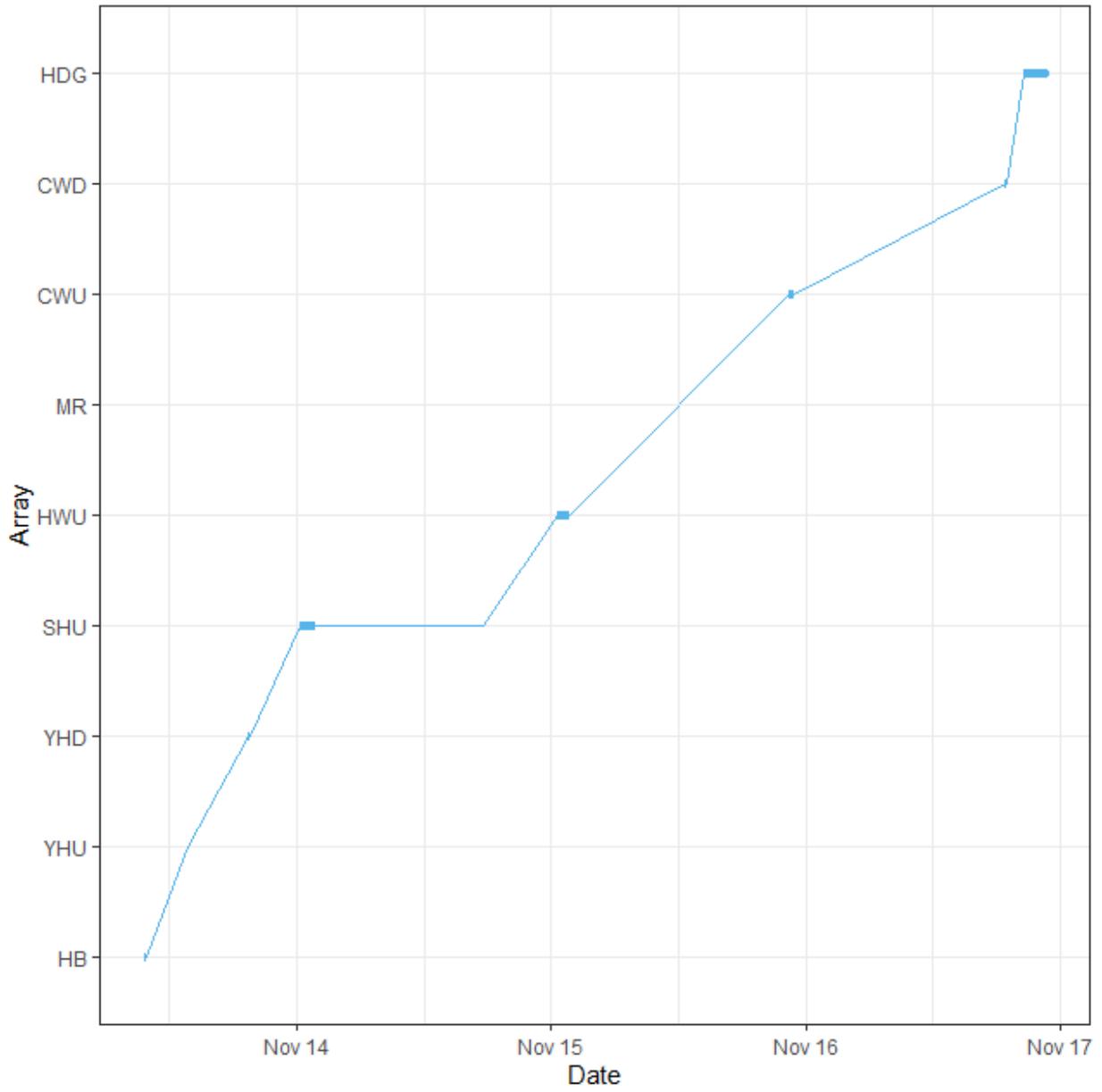
Transmitter A69-1604-6870 movement detection plot from 18 October – 18 November 2022.
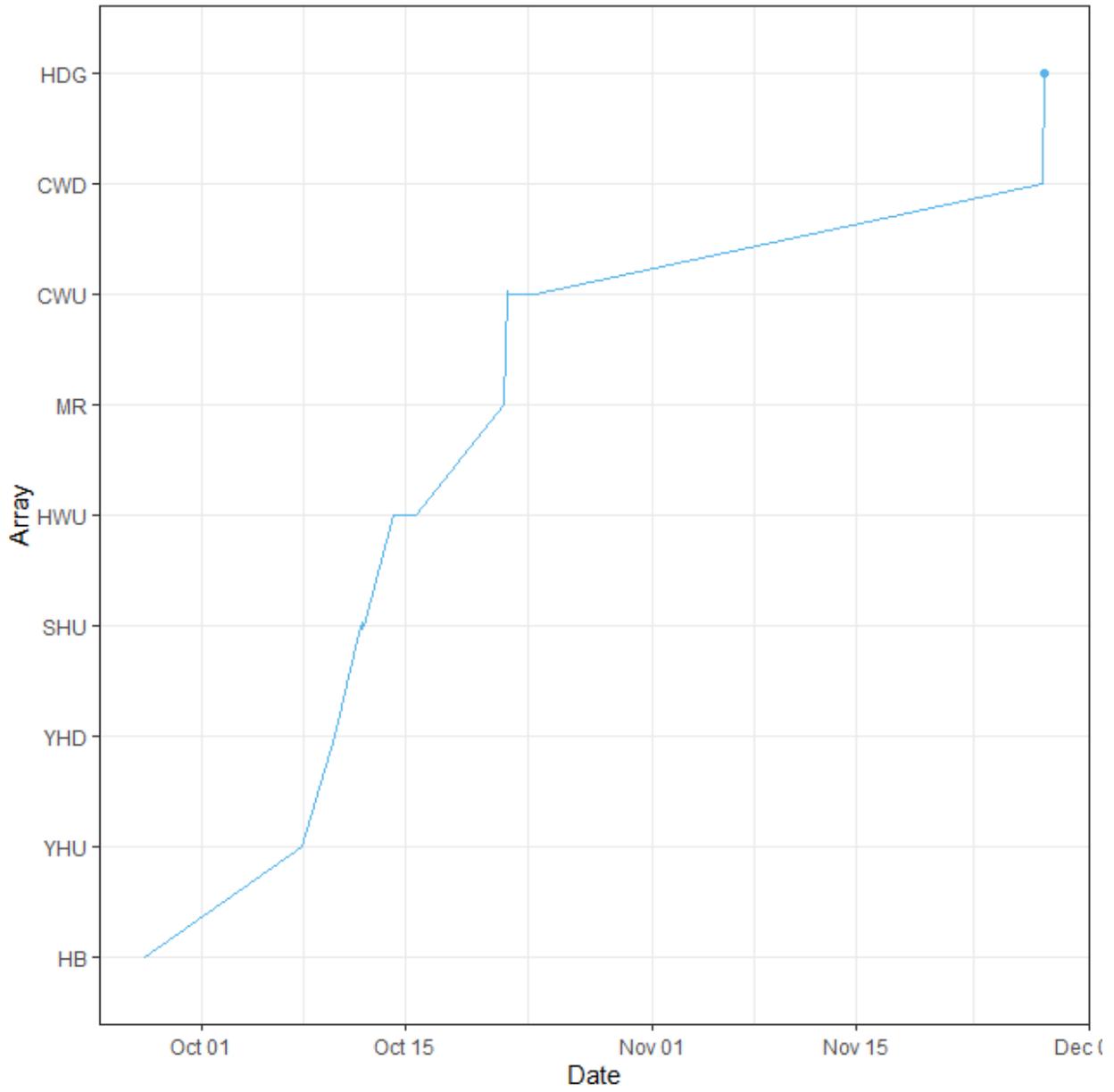This eel did not successfully exit the Susquehanna River.
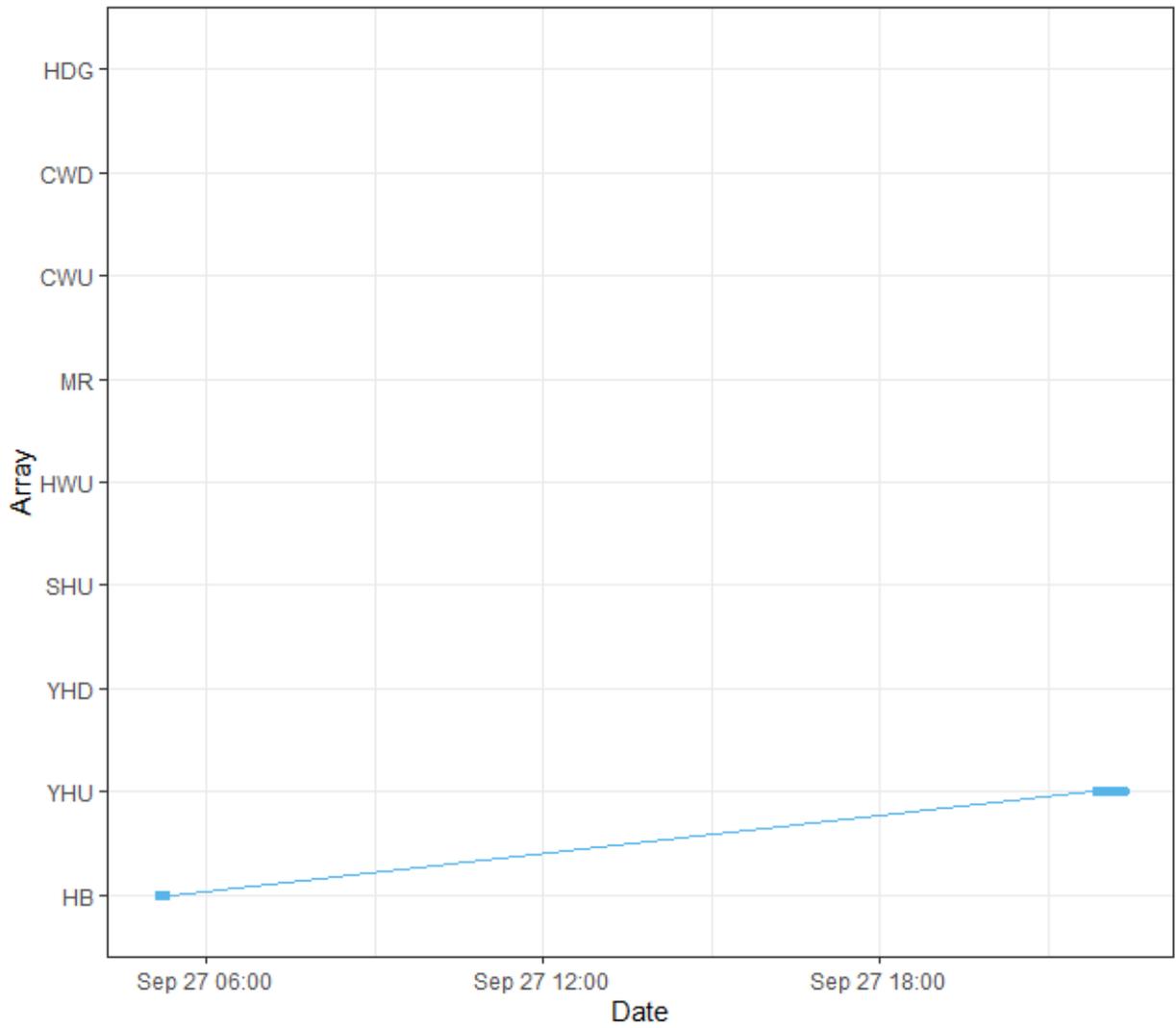
Transmitter A69-1604-6871 movement detection plot on 27 September 2023. This eel did not successfully exit the Susquehanna River.
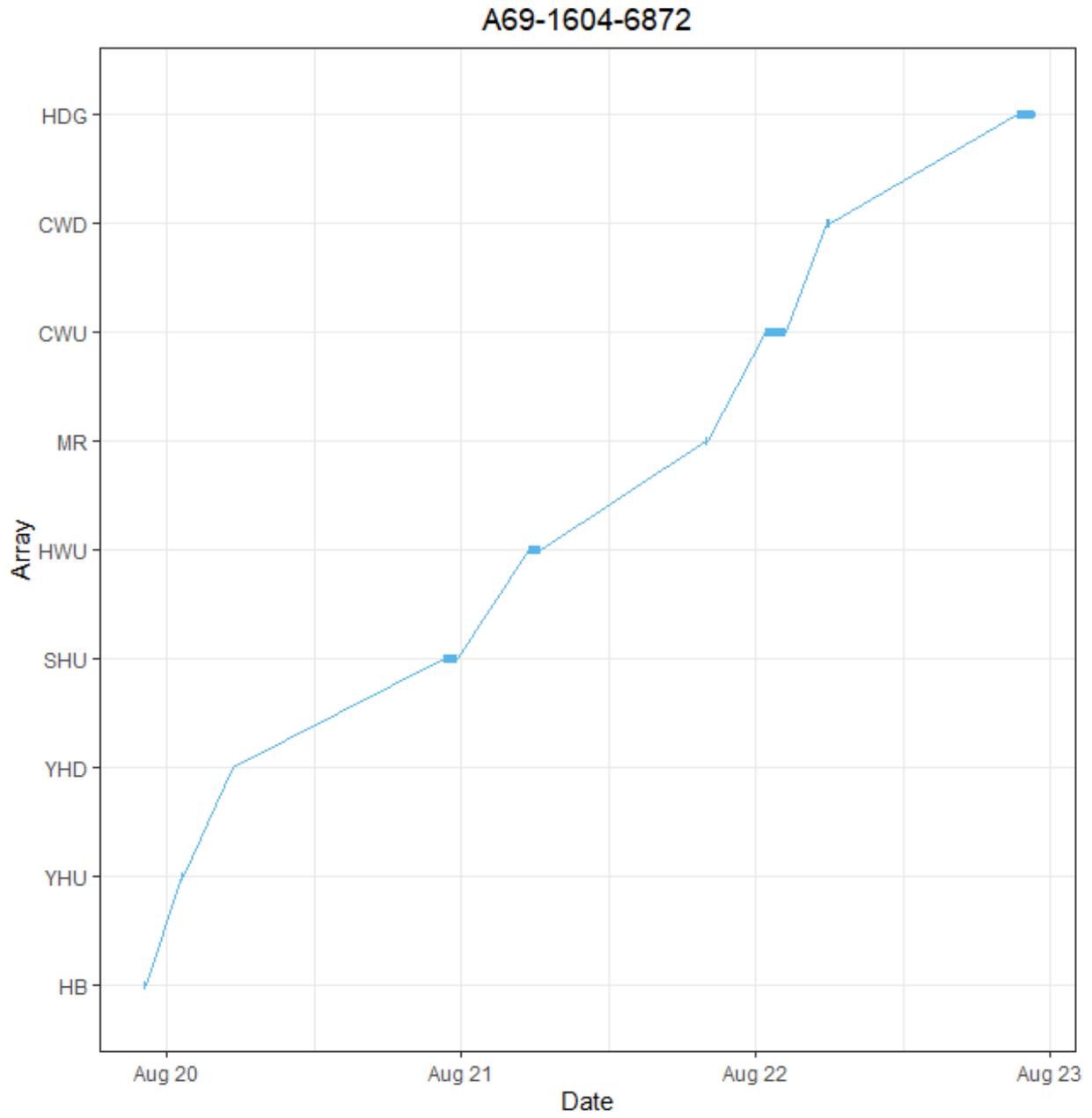
Transmitter A69-1604-6872 movement detection plot from 19-22 August 2023. This eel successfully exited the Susquehanna River.
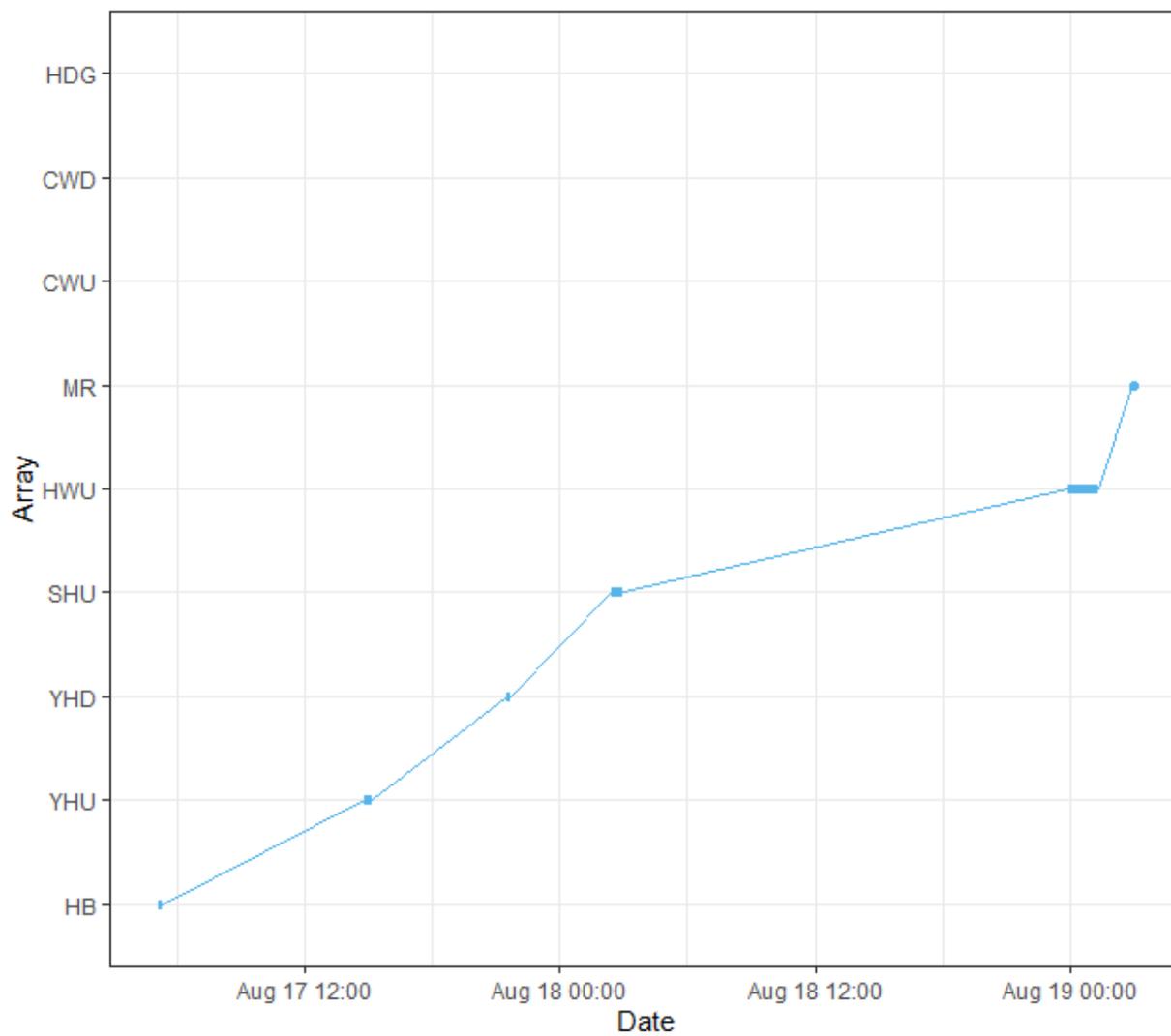
Transmitter A69-1604-6873 movement detection plot from 17-19 August 2023. This eel did not successfully exit the Susquehanna River.
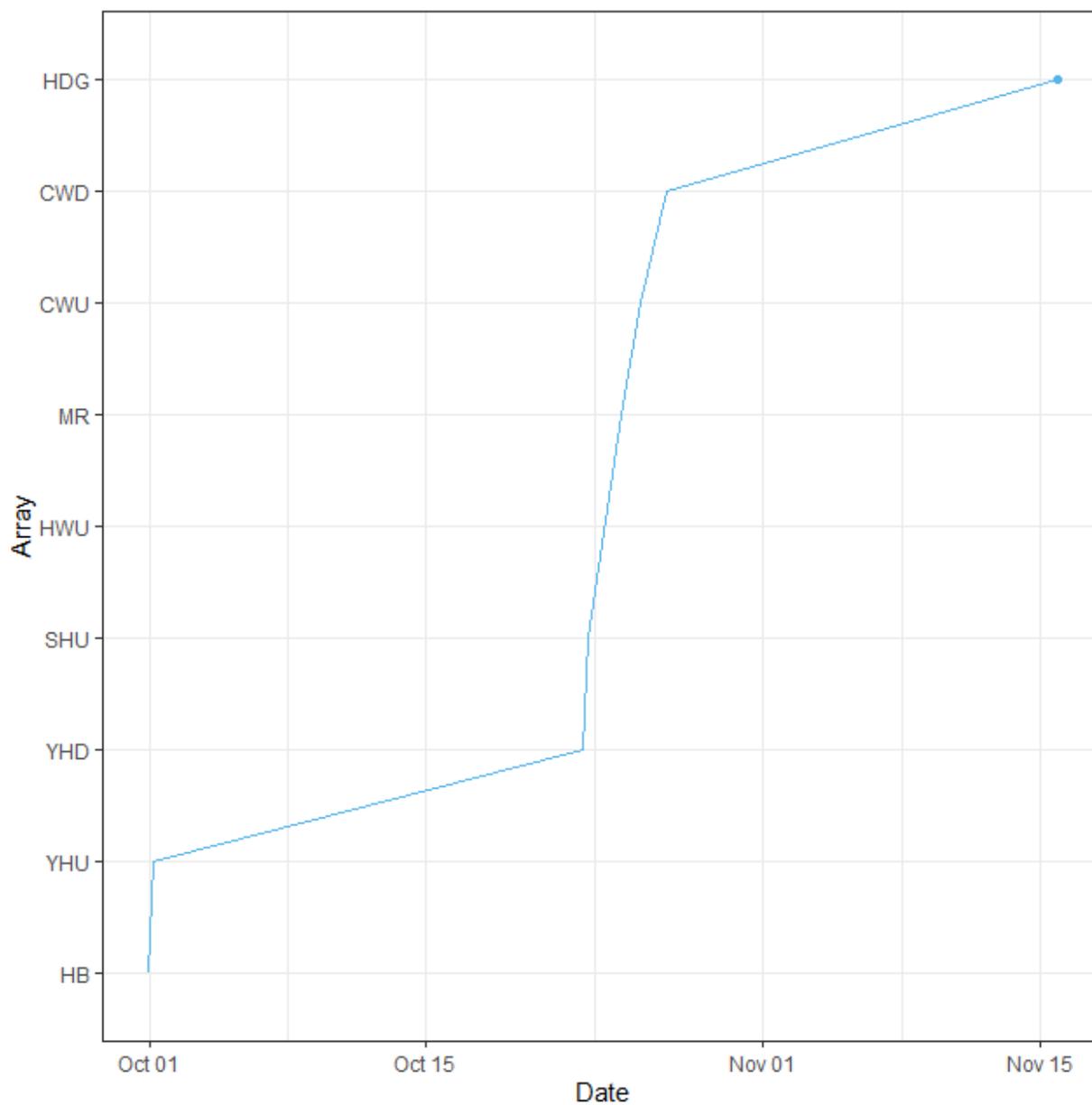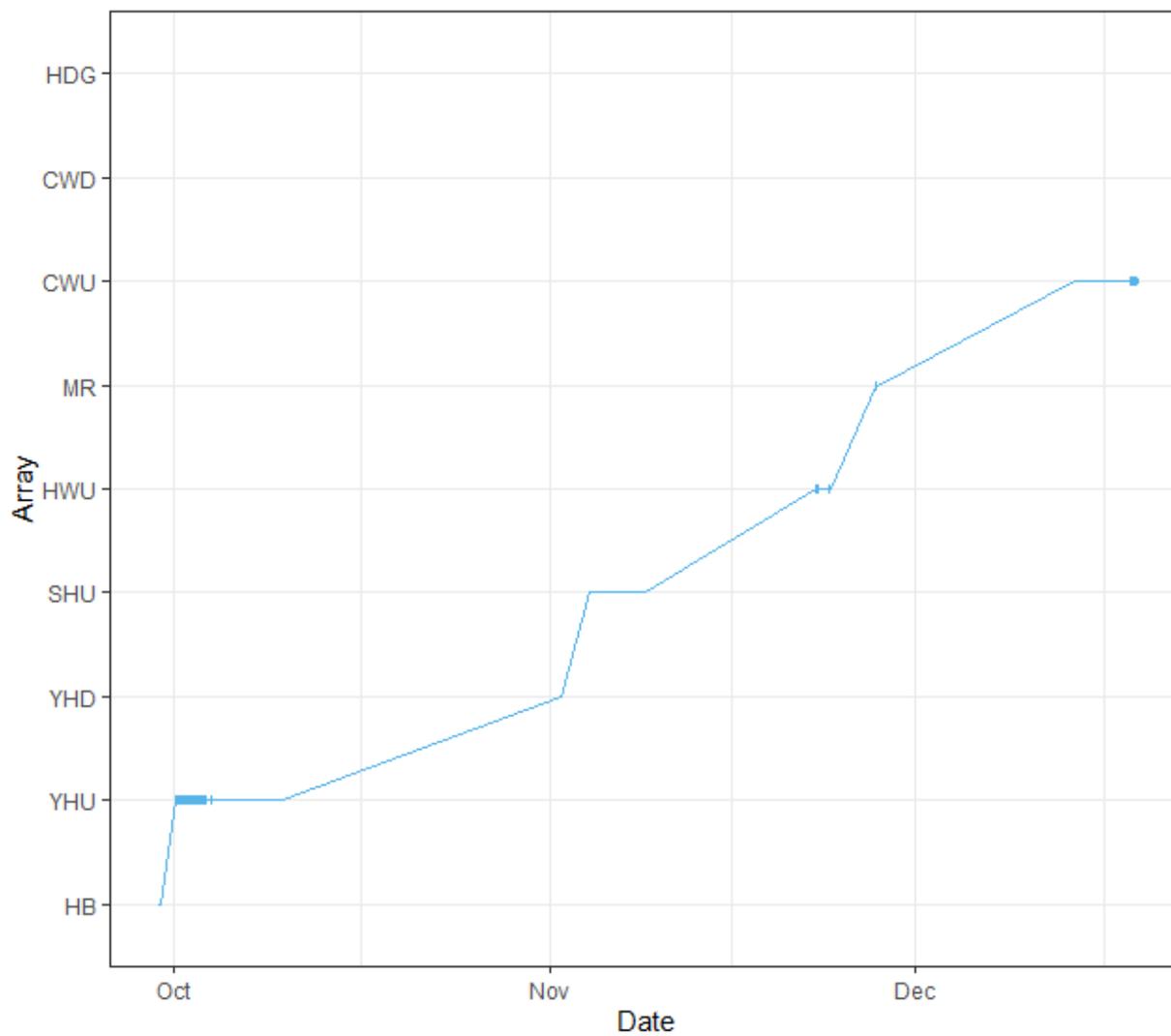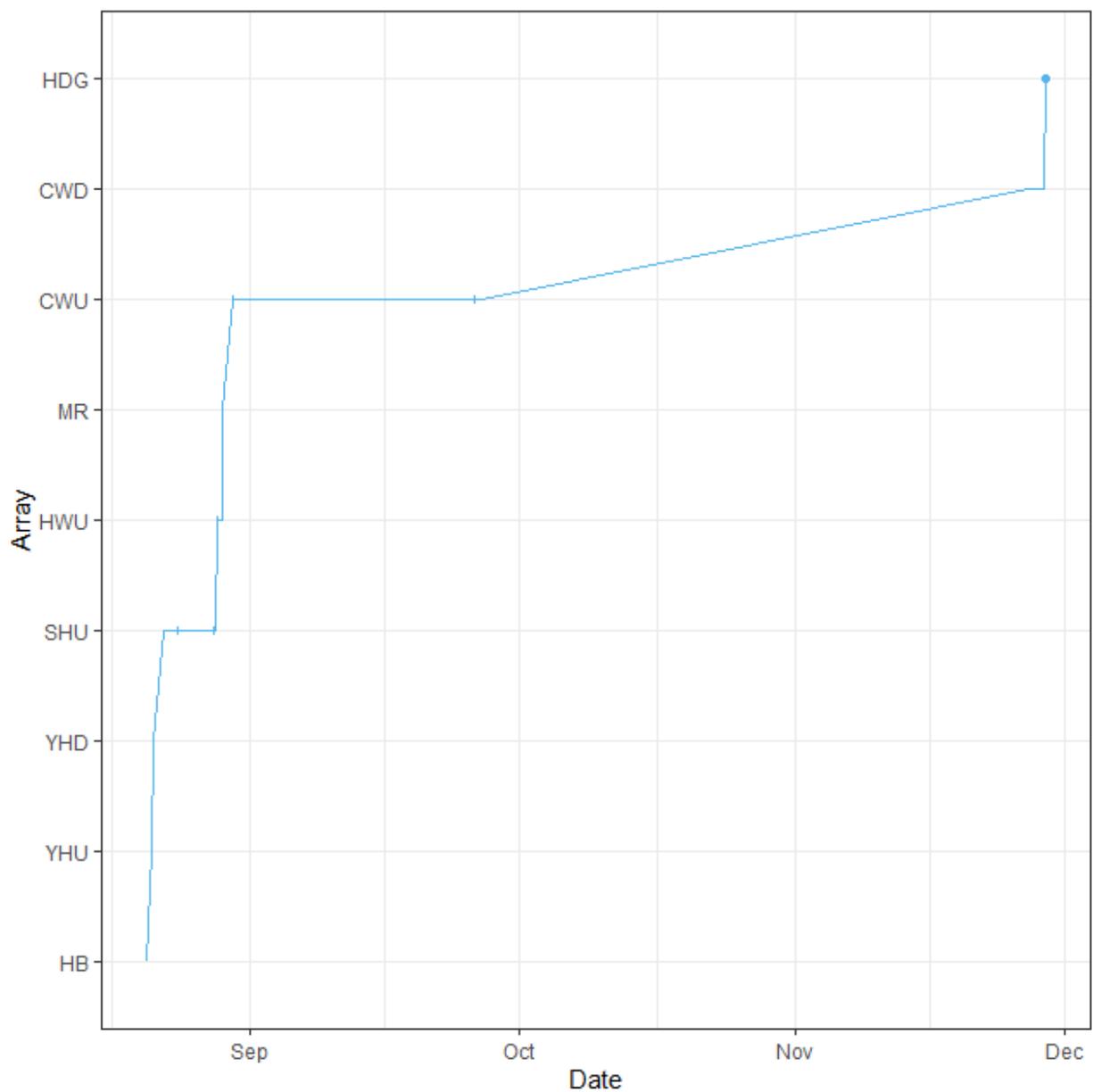
Transmitter A69-1604-6874 movement detection plot from 30 September – 15 November 2023. This eel successfully exited the Susquehanna River.

A69-1604-6875
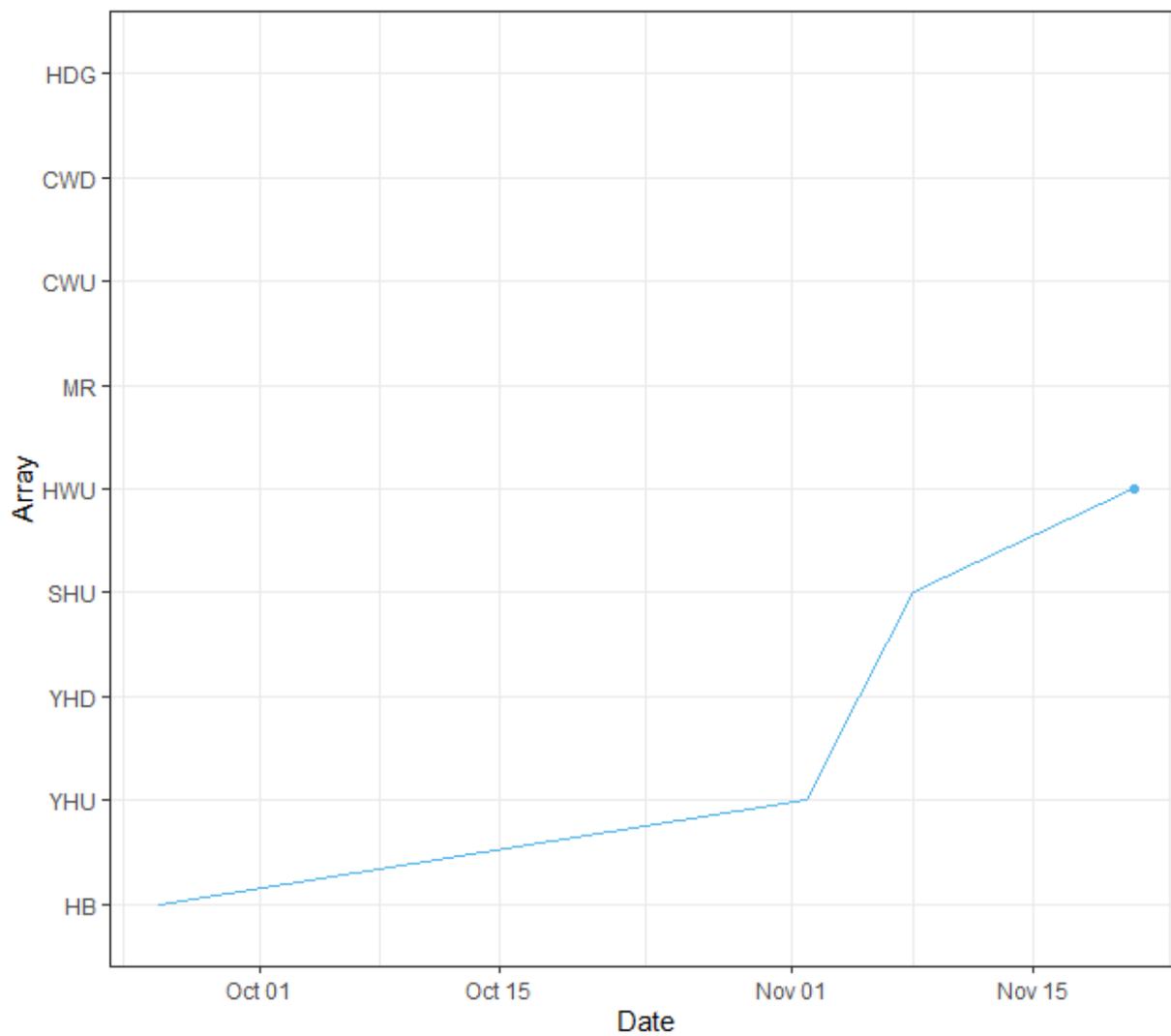
Transmitter A69-1604-6875 movement detection plot from 25 September - 20 November 2023. This eel did not successfully exit the Susquehanna River.
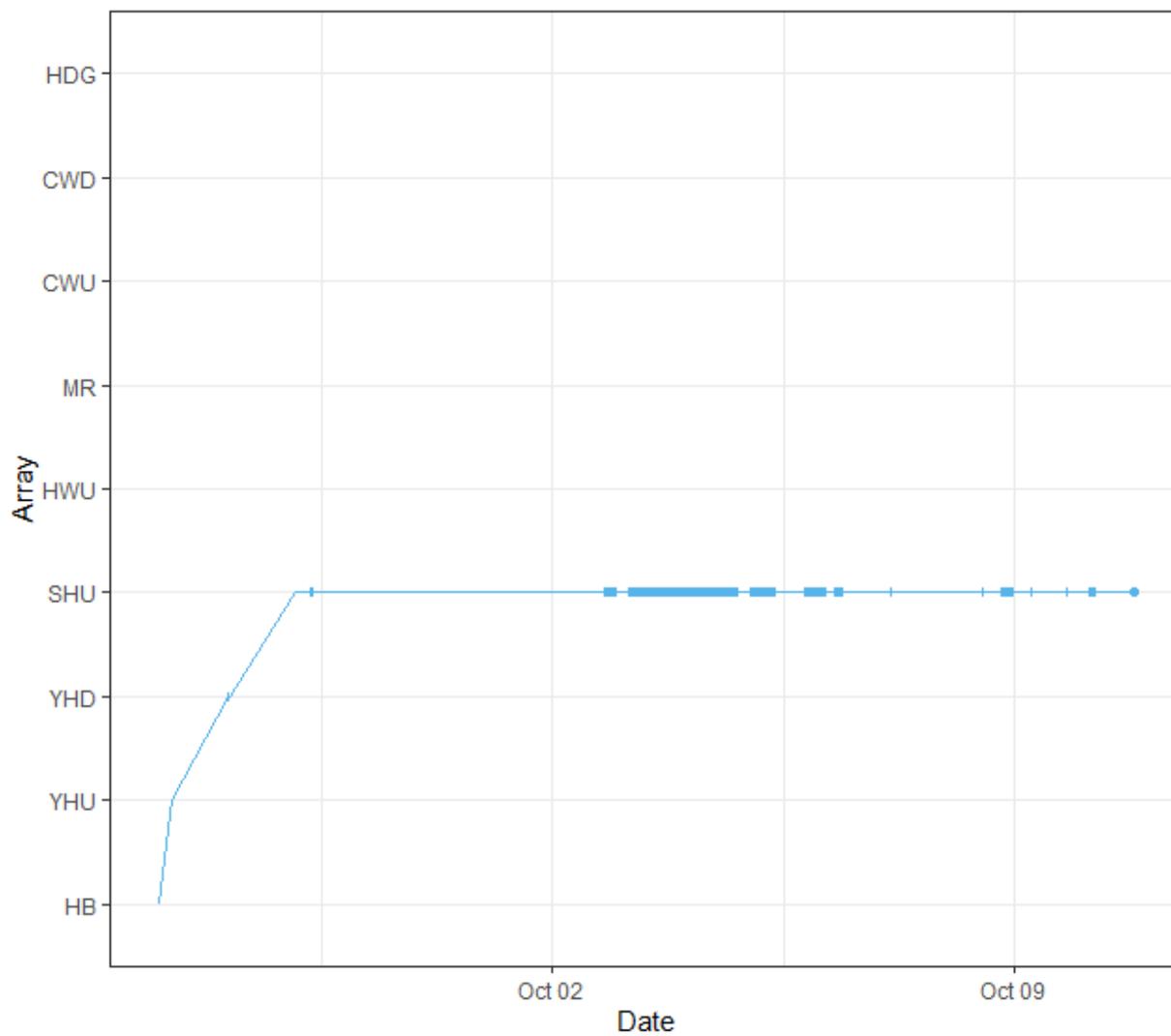
Transmitter A69-1604-6876 movement detection plot from 26 September – 10 October 2023.
This eel did not successfully exit the Susquehanna River.
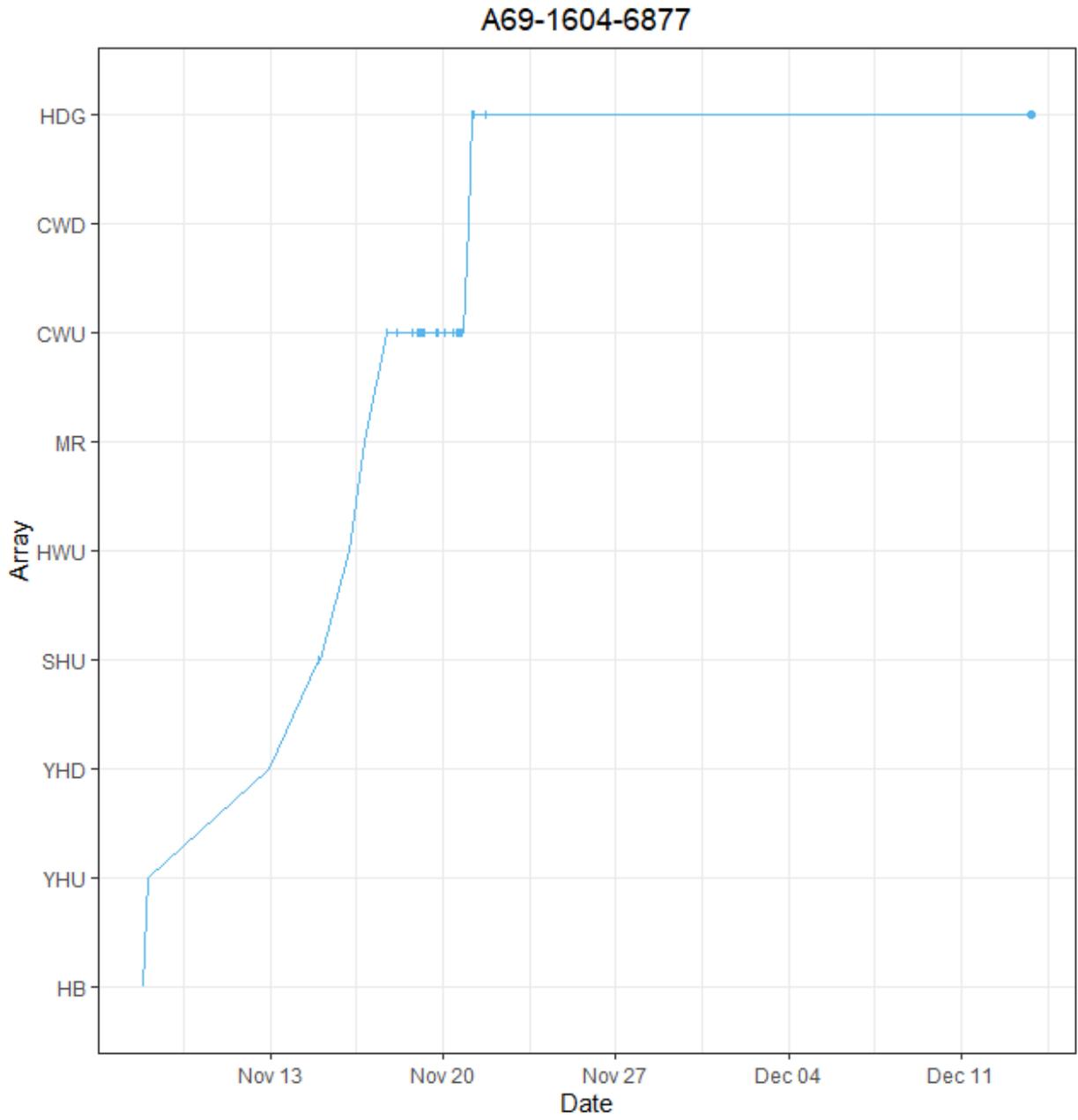
Transmitter A69-1604-6877 movement detection plot from 7 November – 13 December 2023.
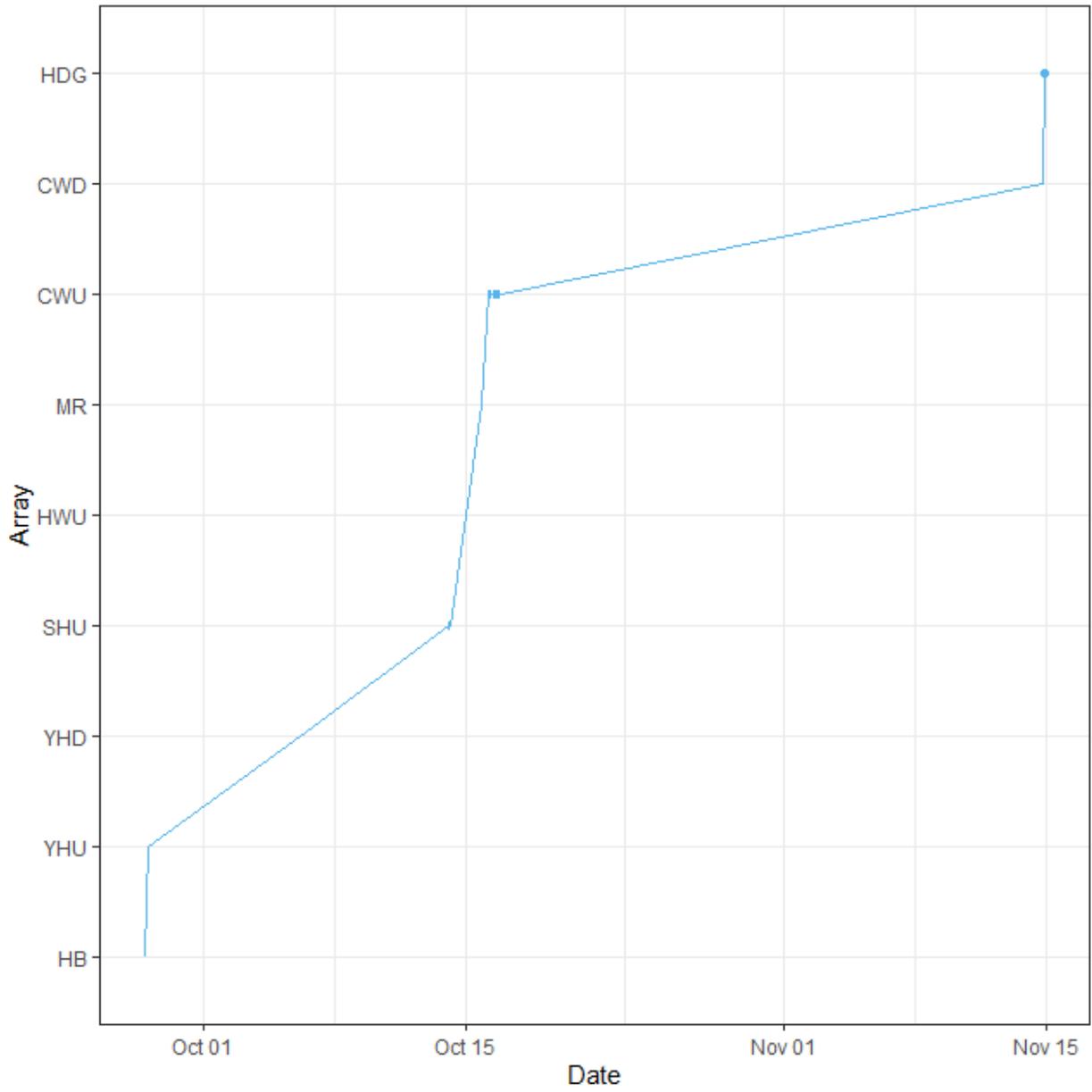This eel successfully exited the Susquehanna River.
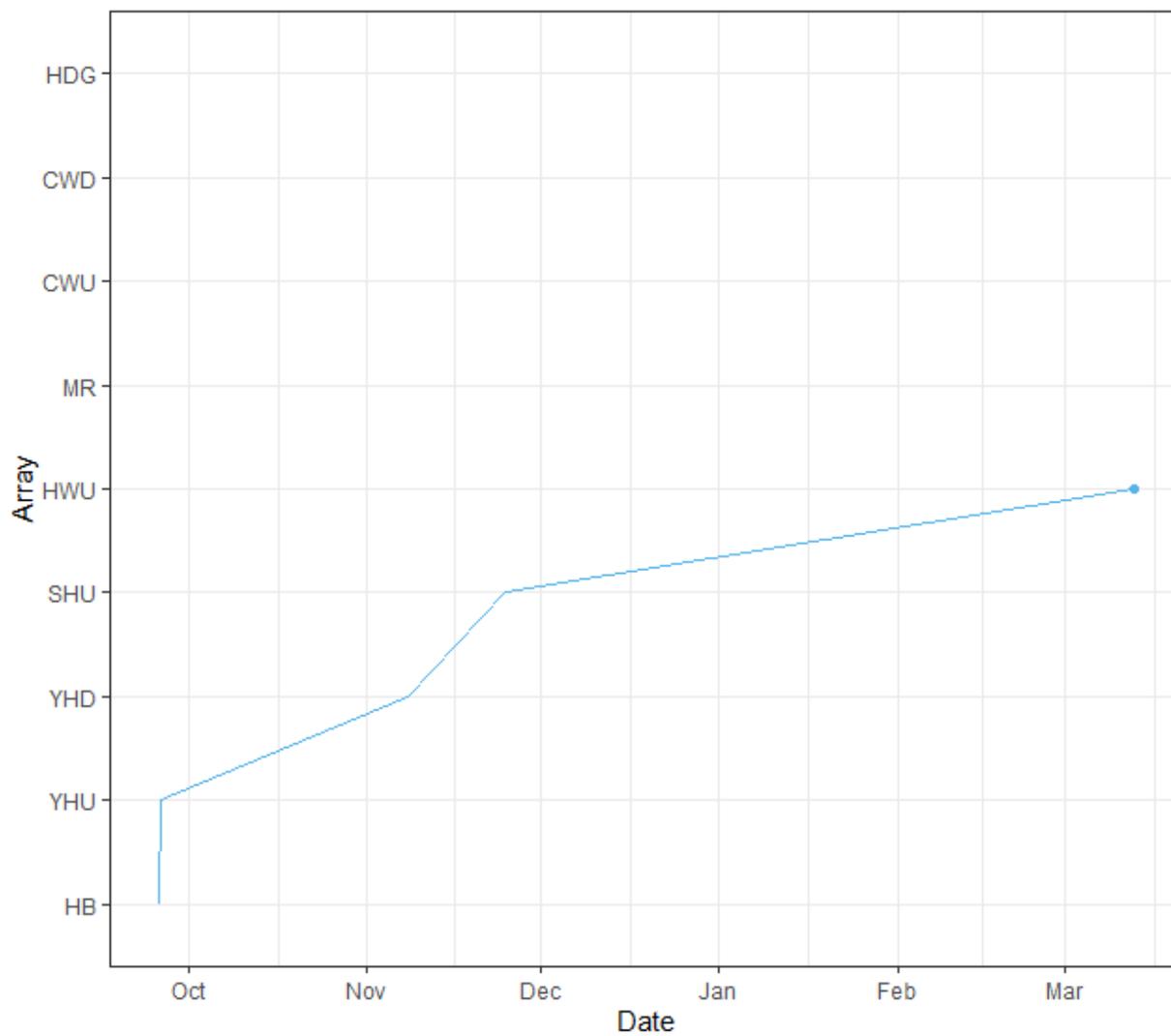
Transmitter A69-1604-6879 movement detection plot from 25 September 2023 – 13 March 2024. This eel did not successfully exit the Susquehanna River.
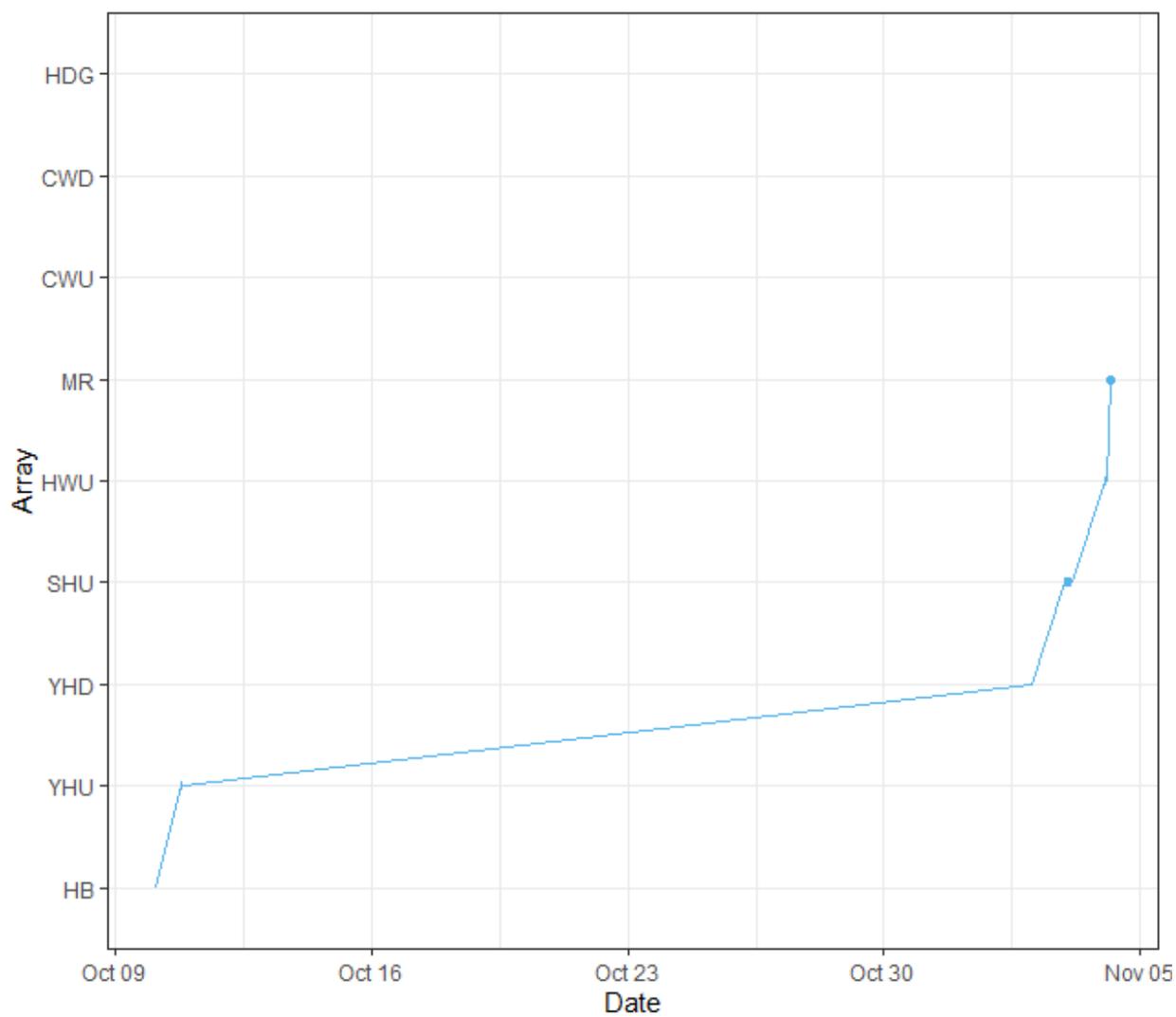
Transmitter A69-1604-6880 movement detection plot from 10 October - 5 November 2023. This eel did not successfully exit the Susquehanna River.
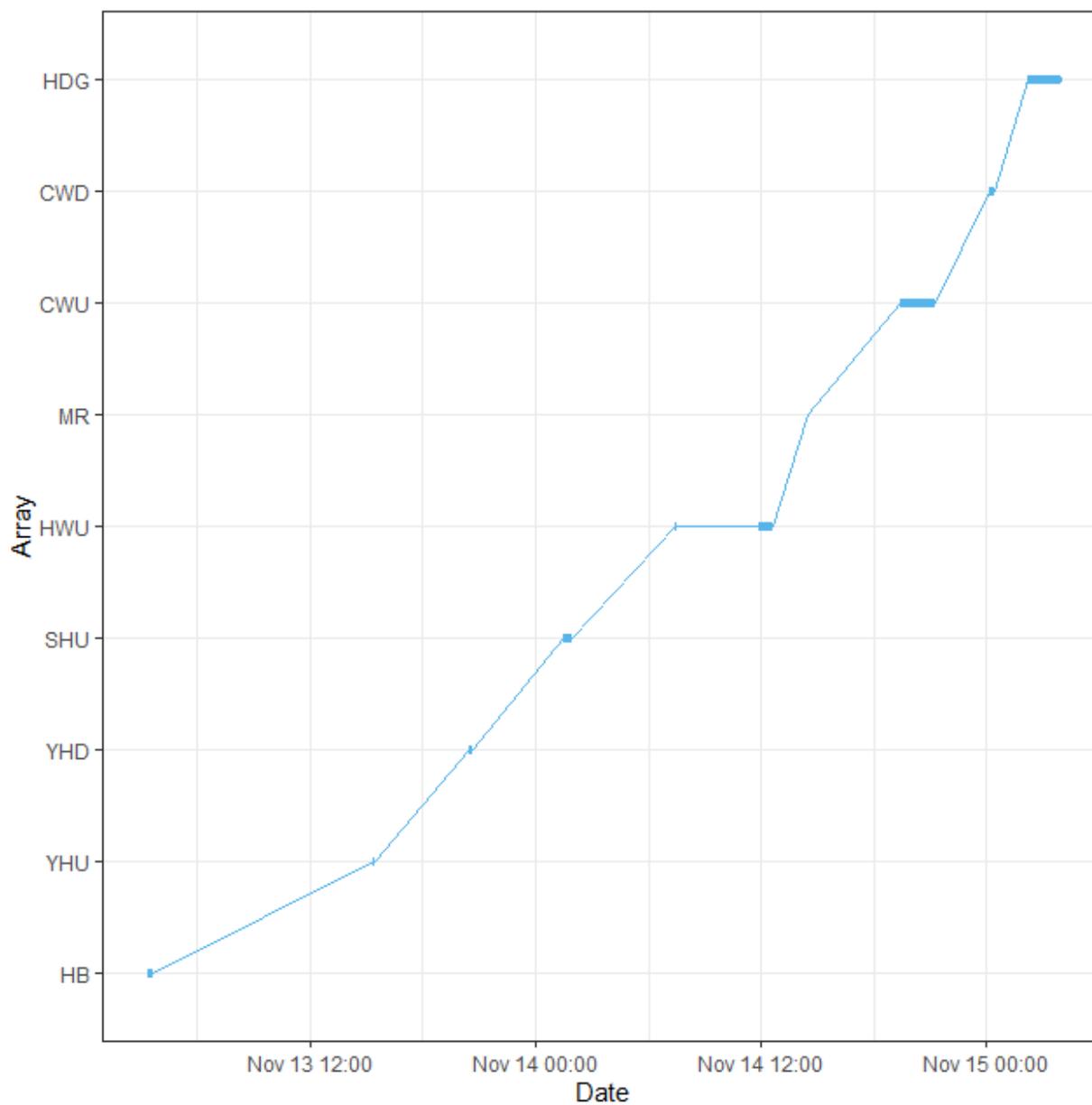
Transmitter A69-1604-6881 movement detection plot from 13-15 November 2022. This eel successfully exited the Susquehanna River.
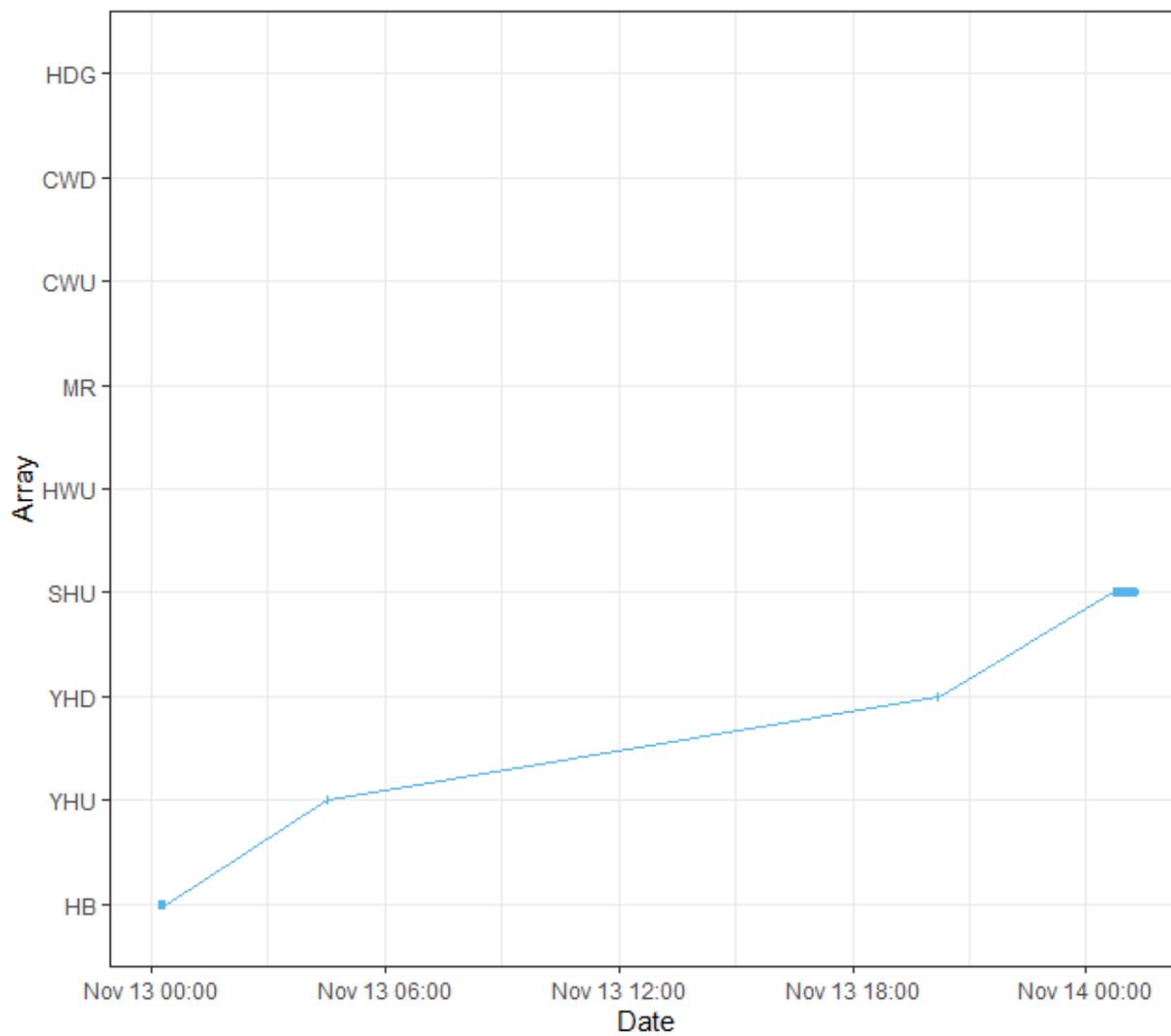
Transmitter A69-1604-6882 movement detection plot from 13-14 November 2022. This eel did not successfully exit the Susquehanna River.
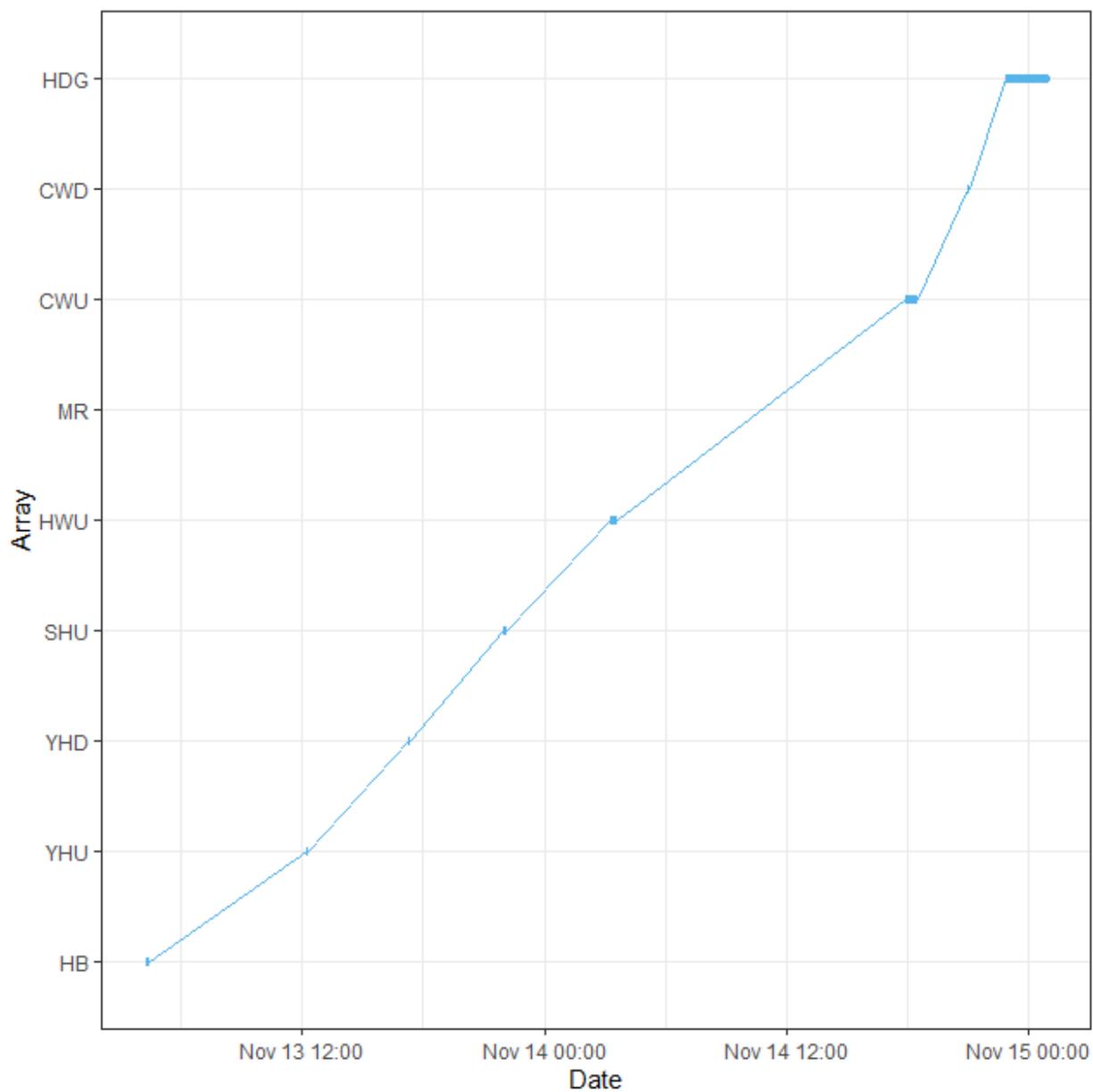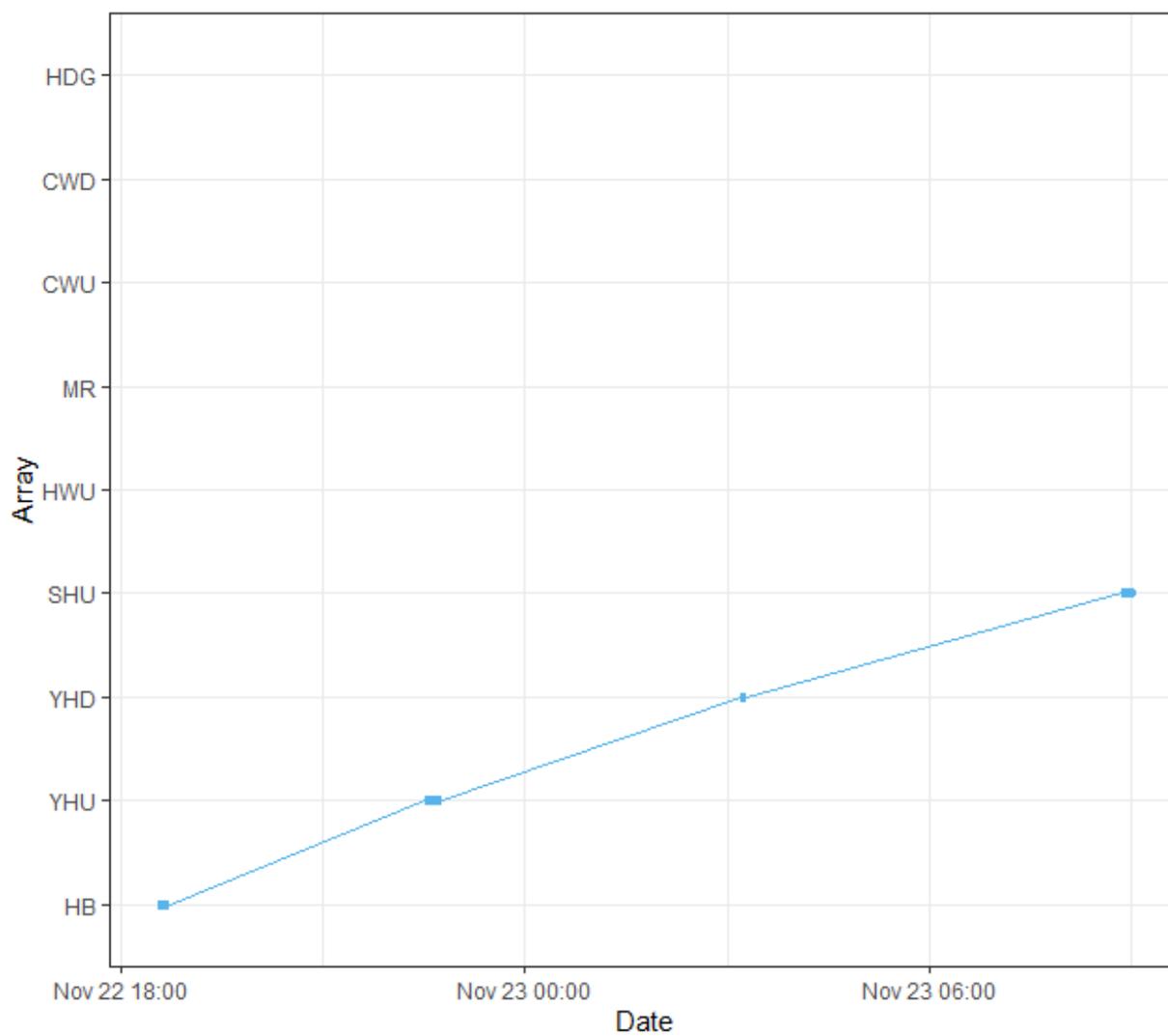
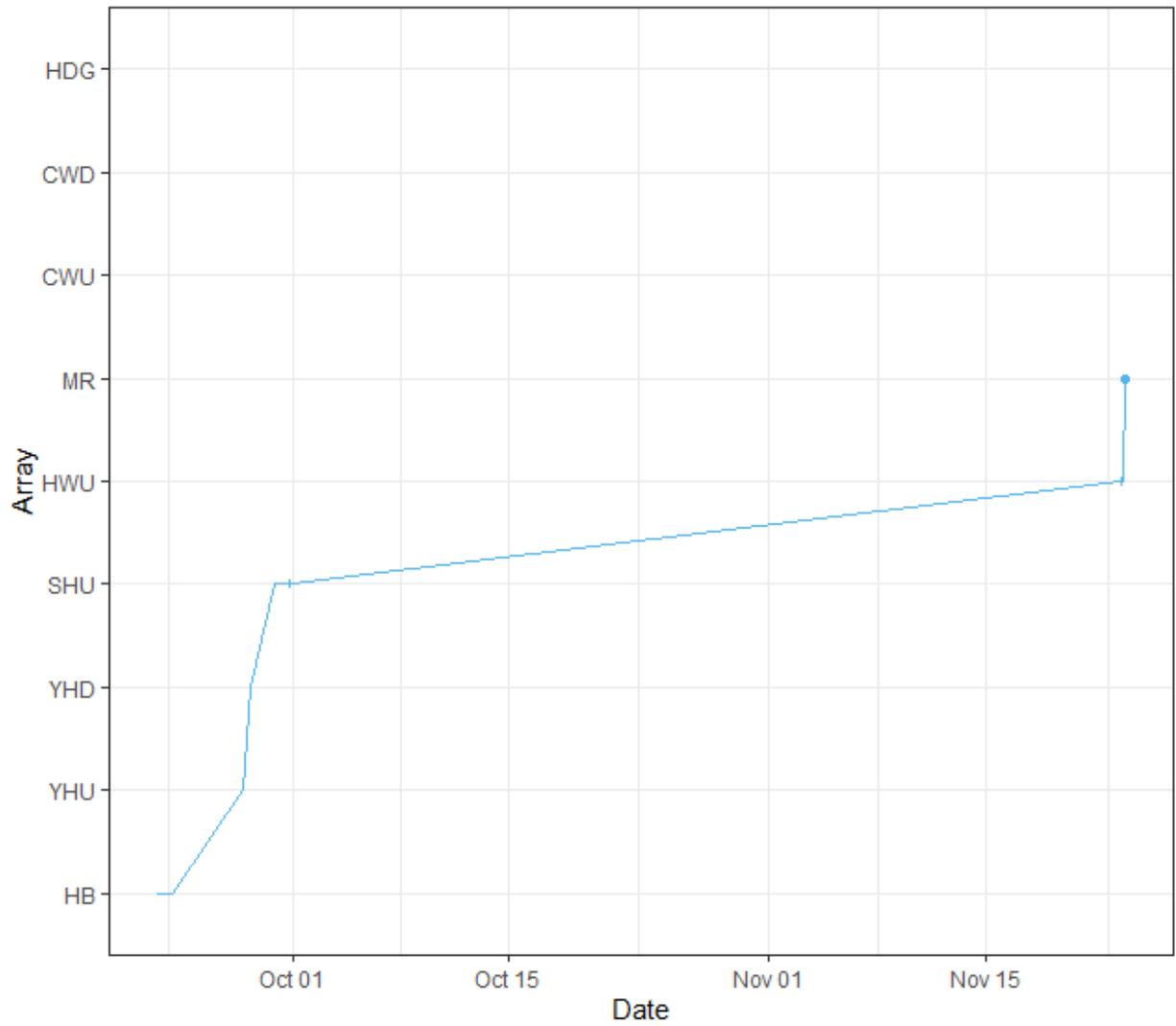Transmitter A69-1604-6885 movement detection plot from 13-15 November 2022. This eel successfully exited the Susquehanna River.
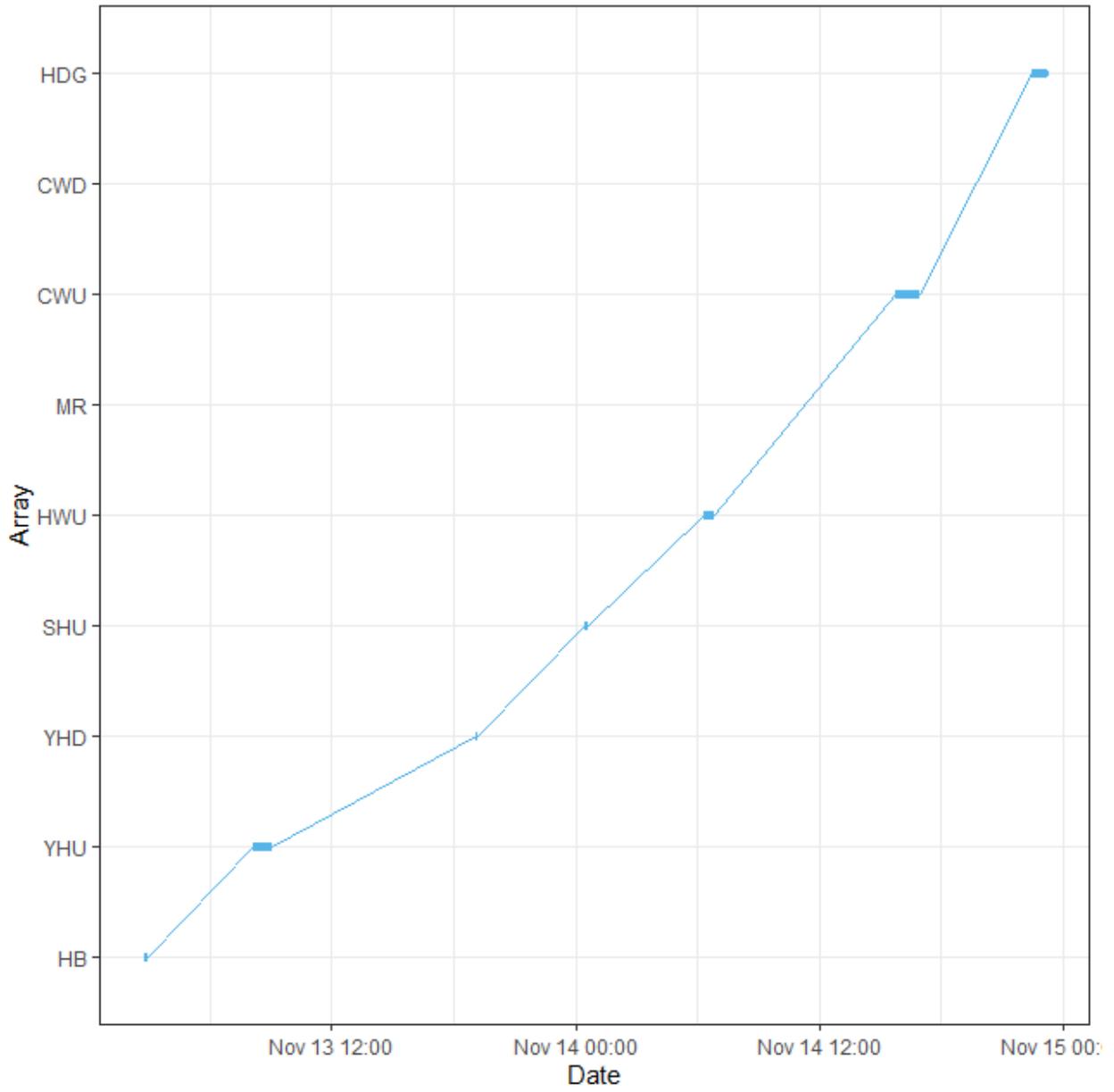
Transmitter A69-1604-6886 movement detection plot from 13-14 November 2022. This eel successfully exited the Susquehanna River.
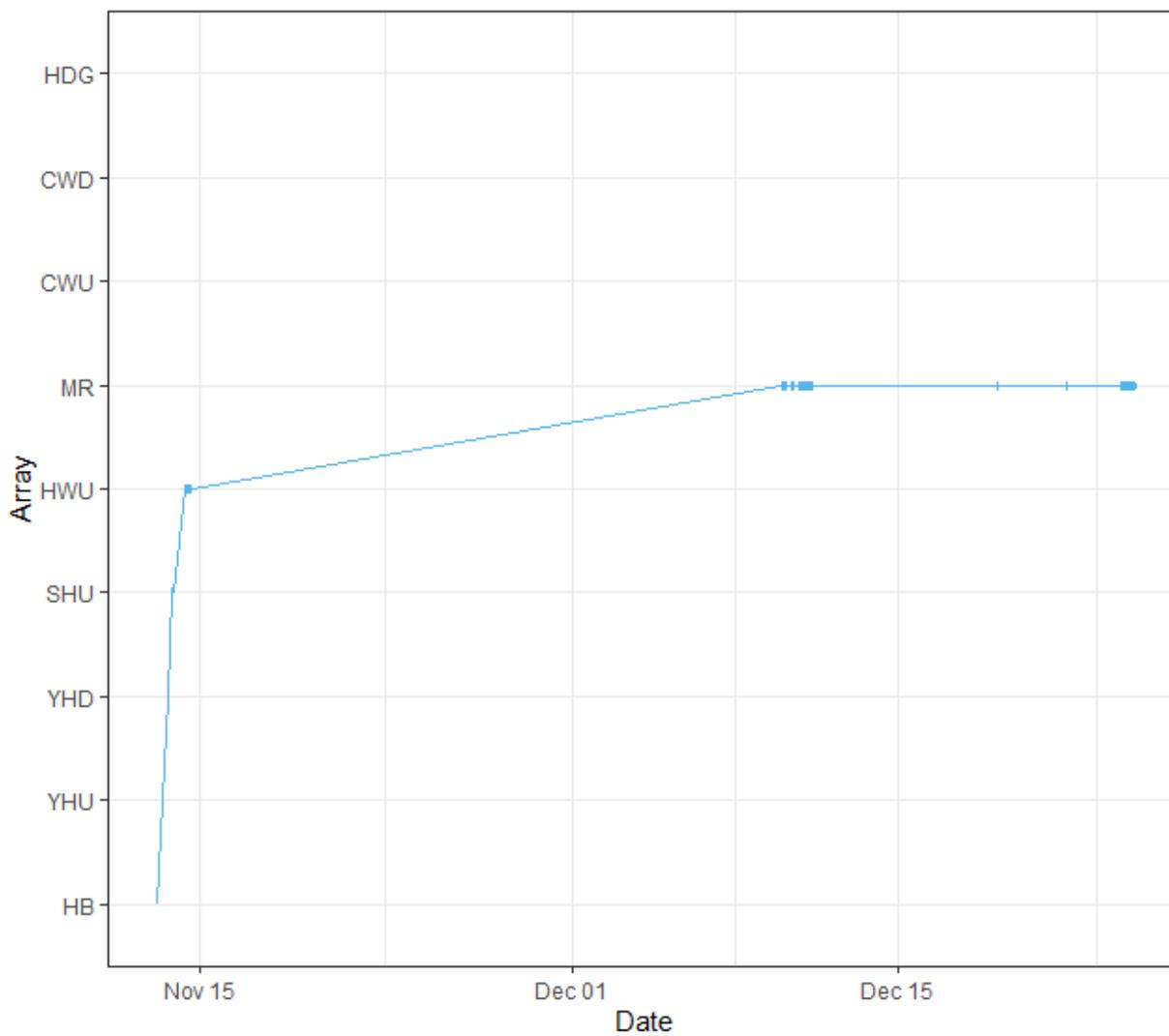
Transmitter A69-1604-6887 movement detection plot on 13 November – 25 December 2022.
This eel did not successfully exit the Susquehanna River.
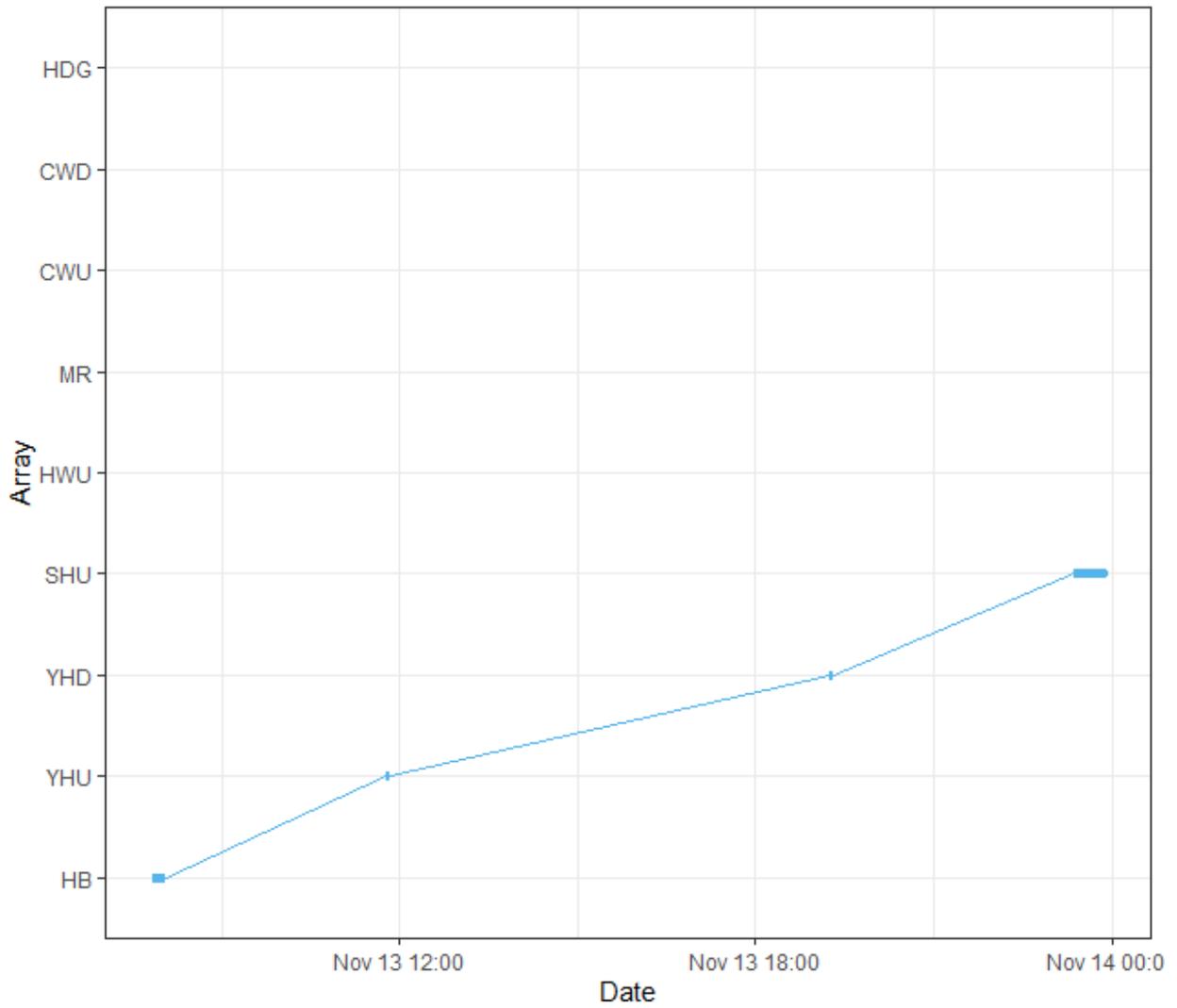
Transmitter A69-1604-6888 movement detection plot on 13 November 2022. This eel did not successfully exit the Susquehanna River.
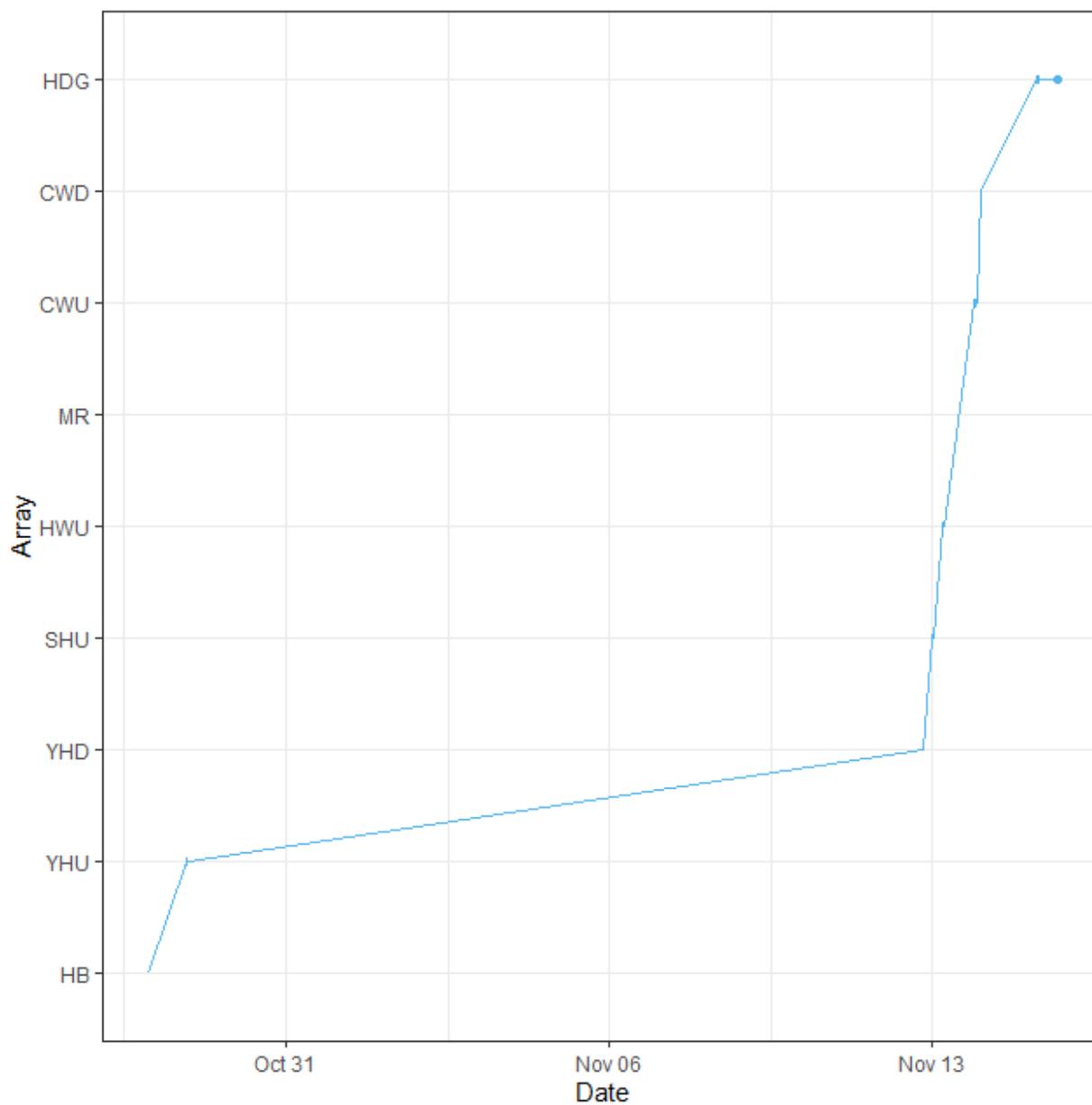
Transmitter A69-1604-6889 movement detection plot on 28 October - 16 November 2022. This eel successfully exited the Susquehanna River.

A69-1604-6891
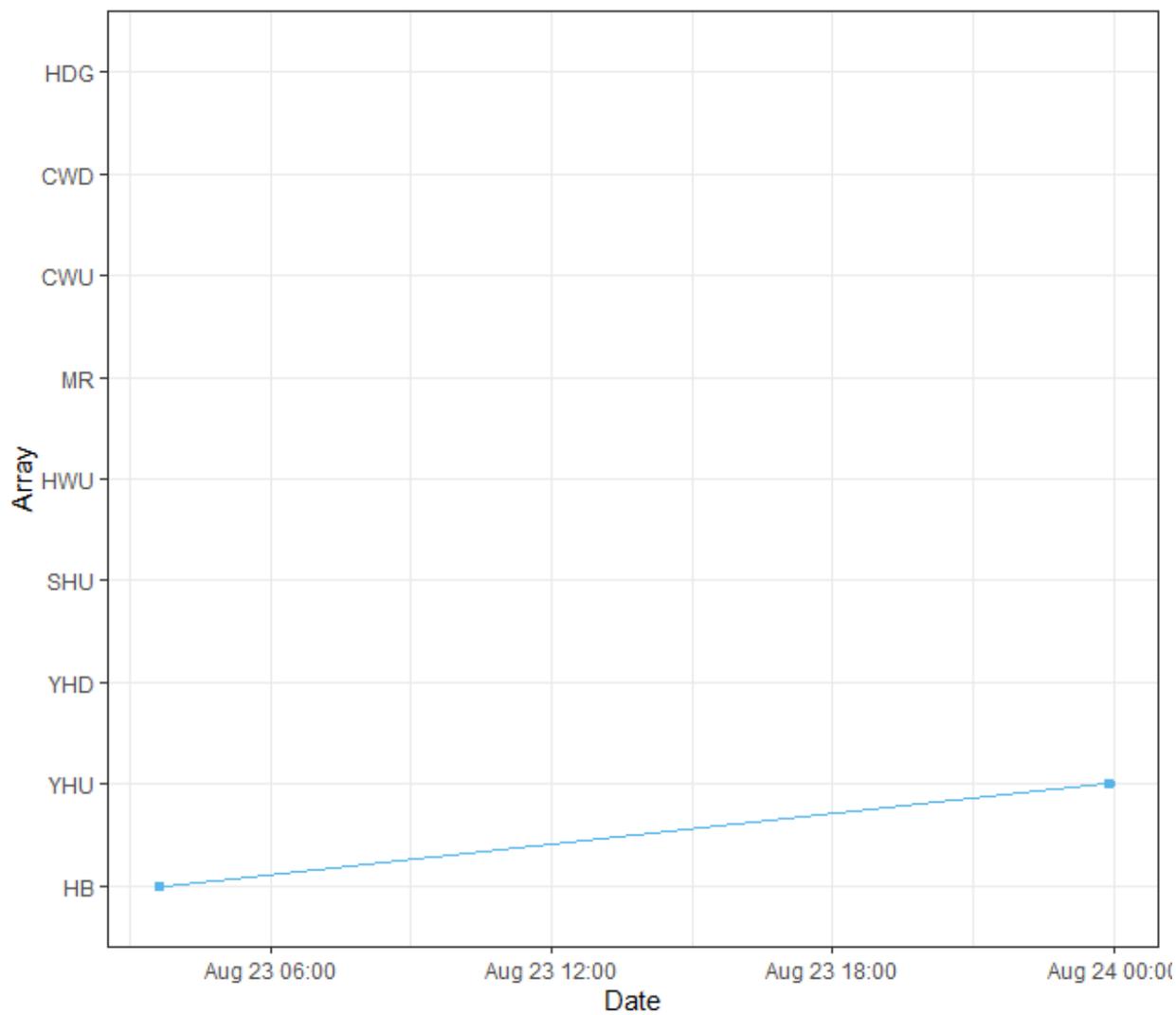
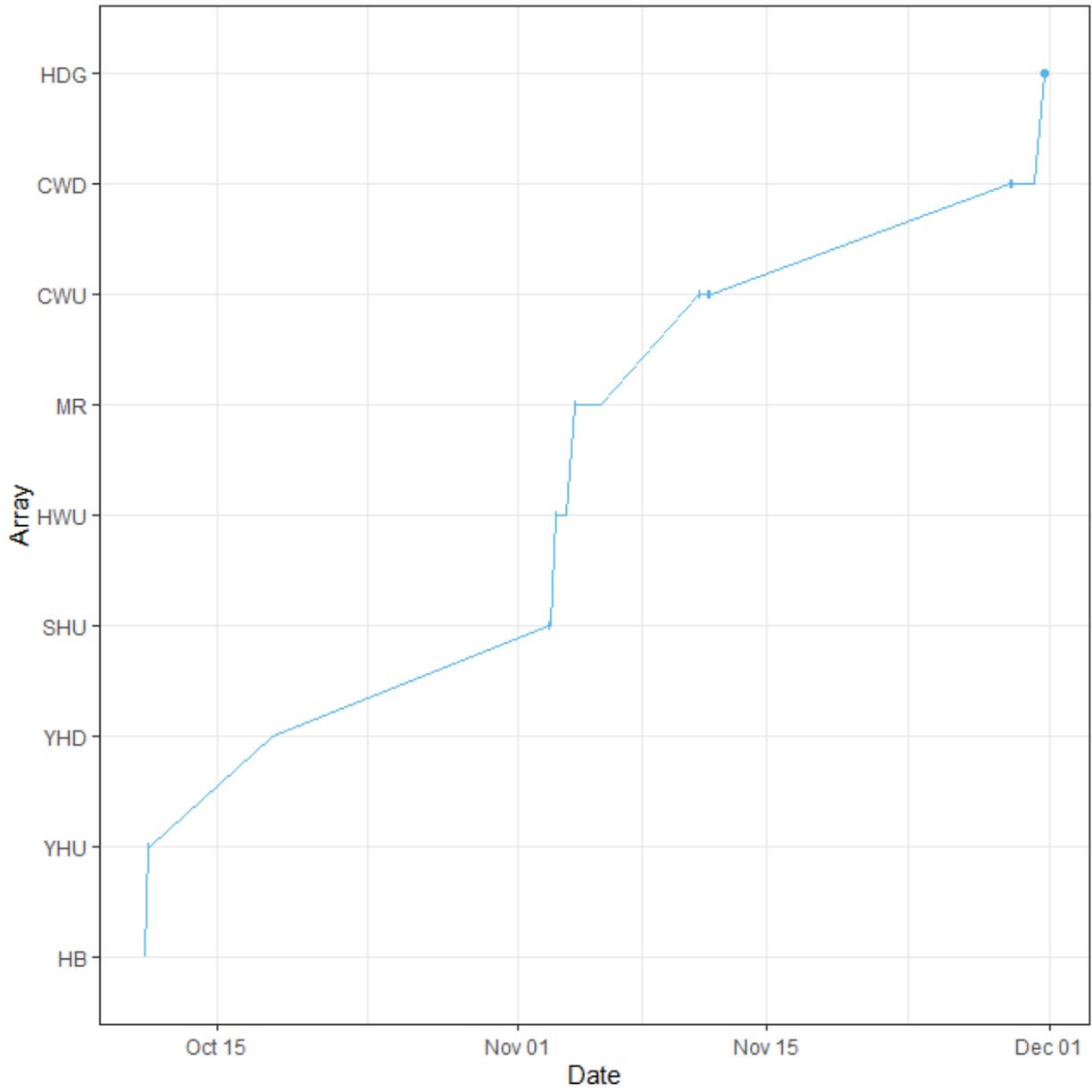Transmitter A69-1604-6891 movement detection plot on 23-24 August 2022. This eel did not successfully exit the Susquehanna River.
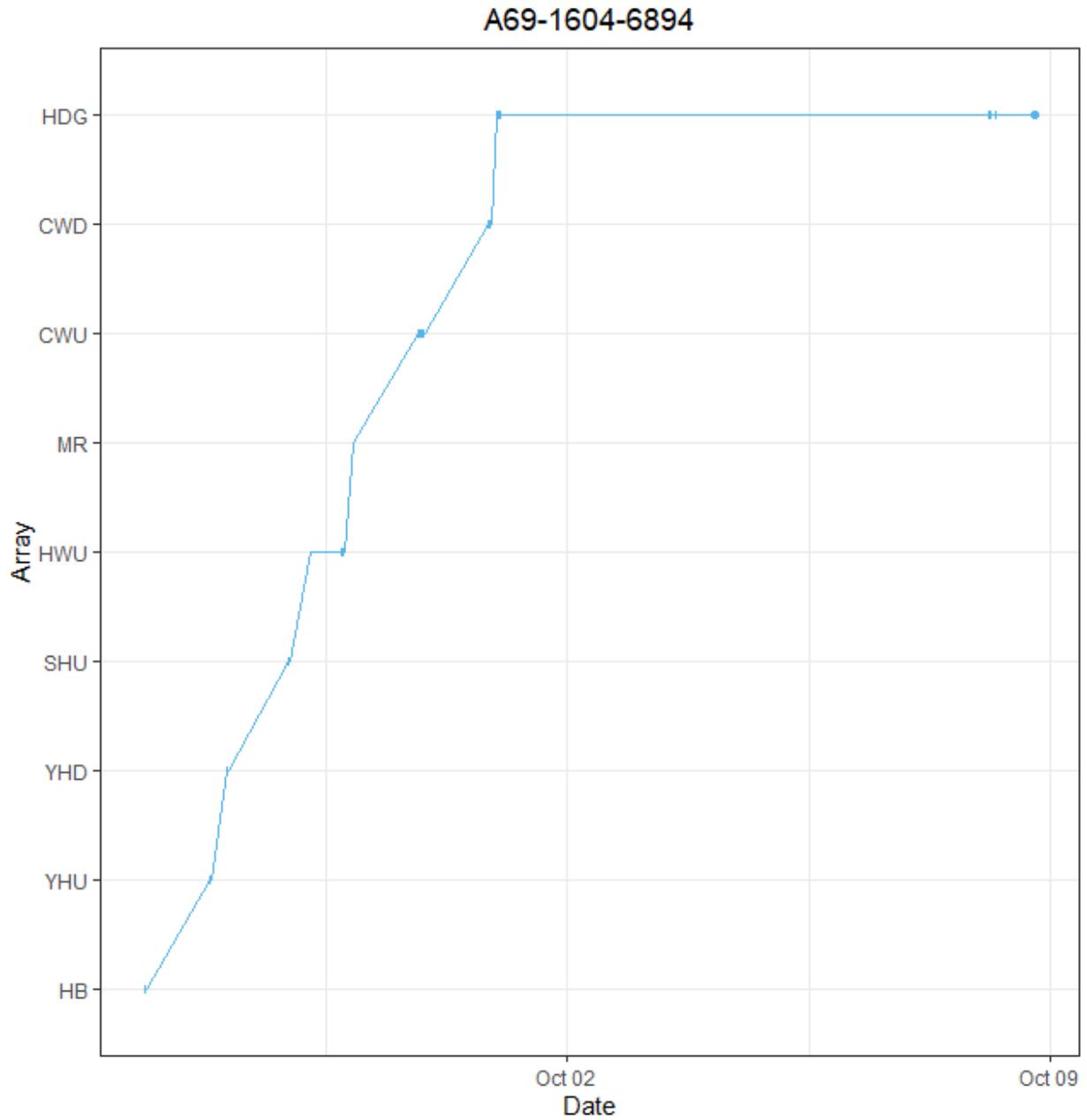
Transmitter A69-1604-6894 movement detection plot from 25 September – 8 October 2023. This eel successfully exited the Susquehanna River.
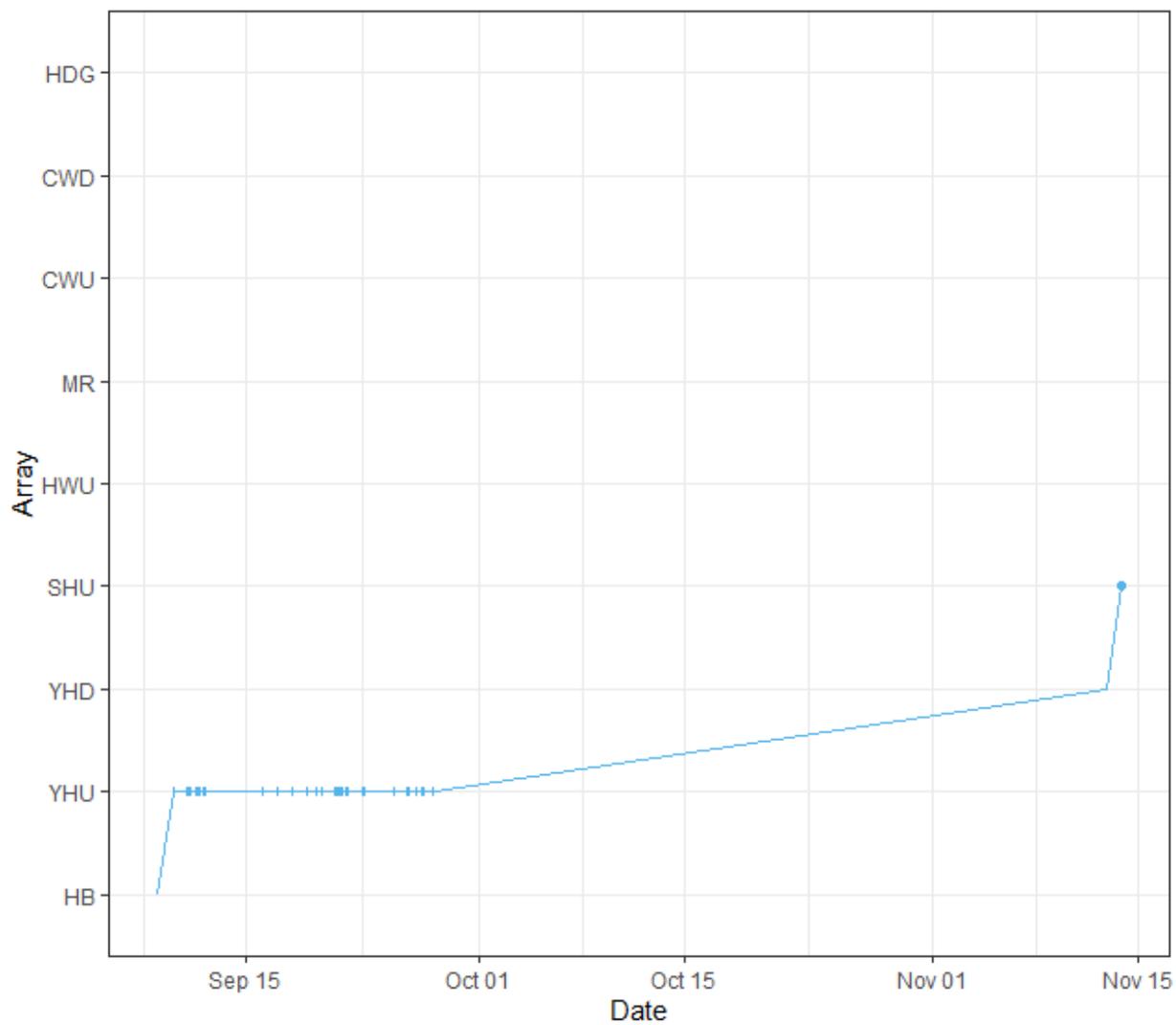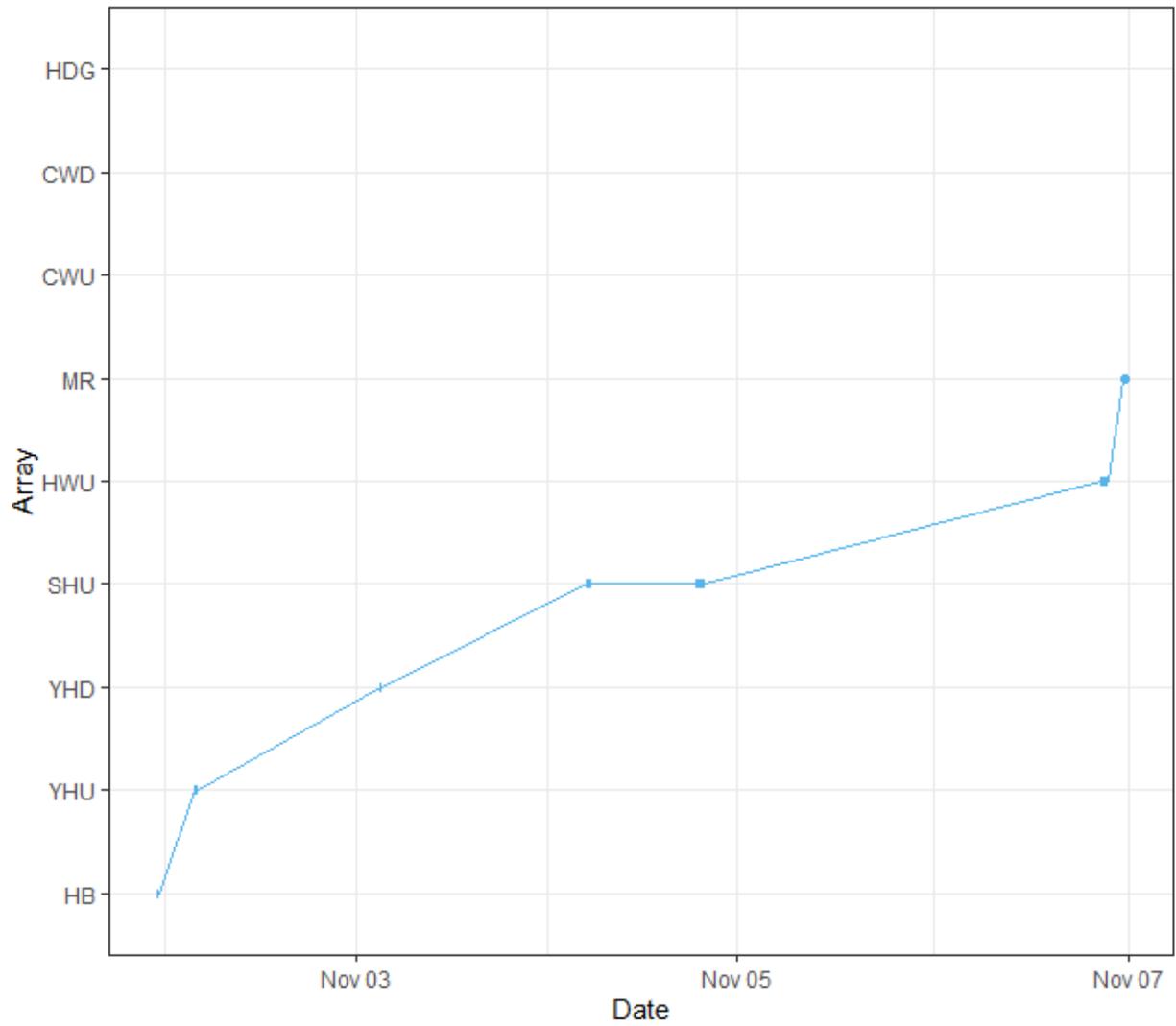
Transmitter A69-1604-6897 movement detection plot from 8 September – 13 November 2022.
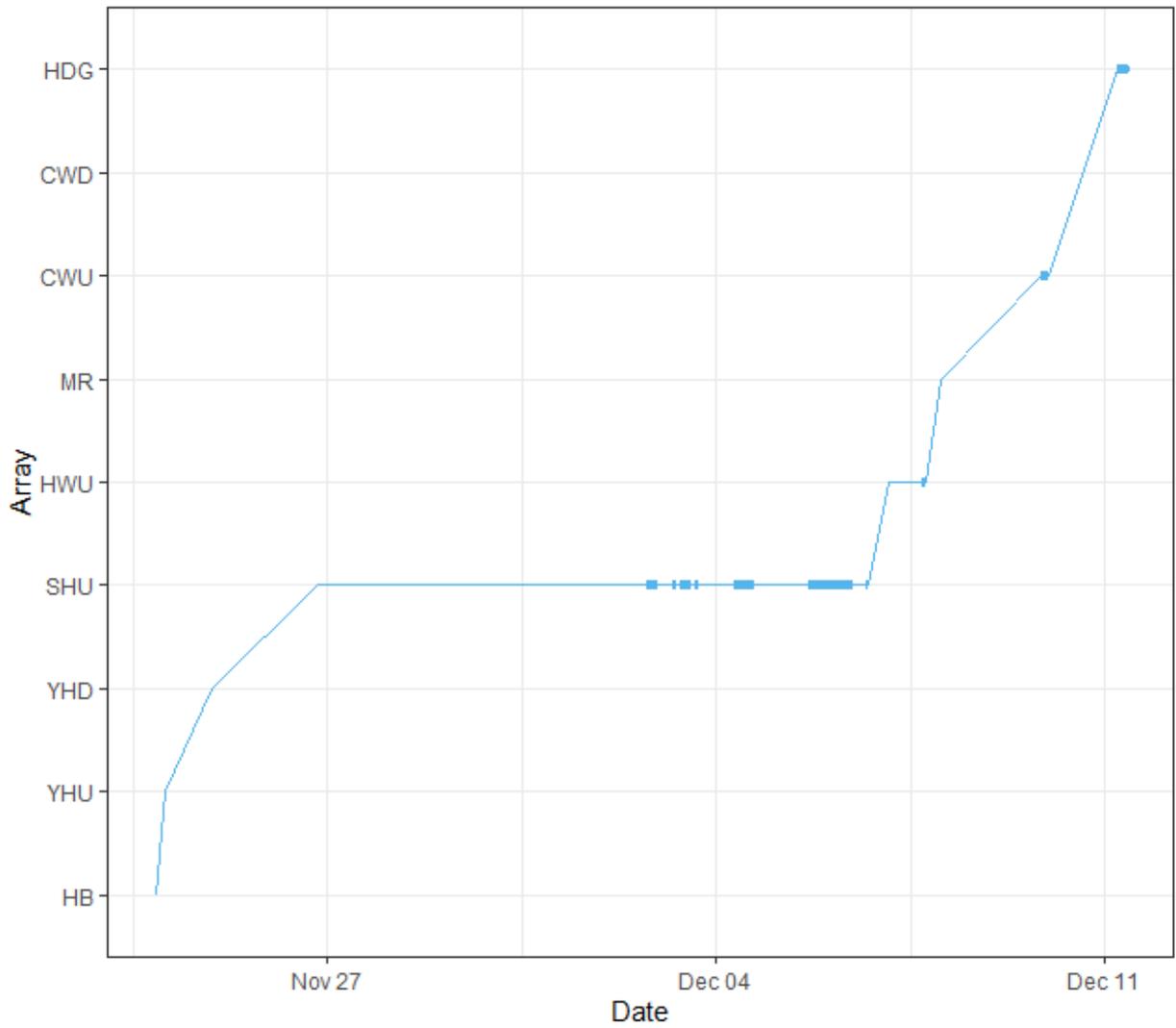This eel did not successfully exit the Susquehanna River.
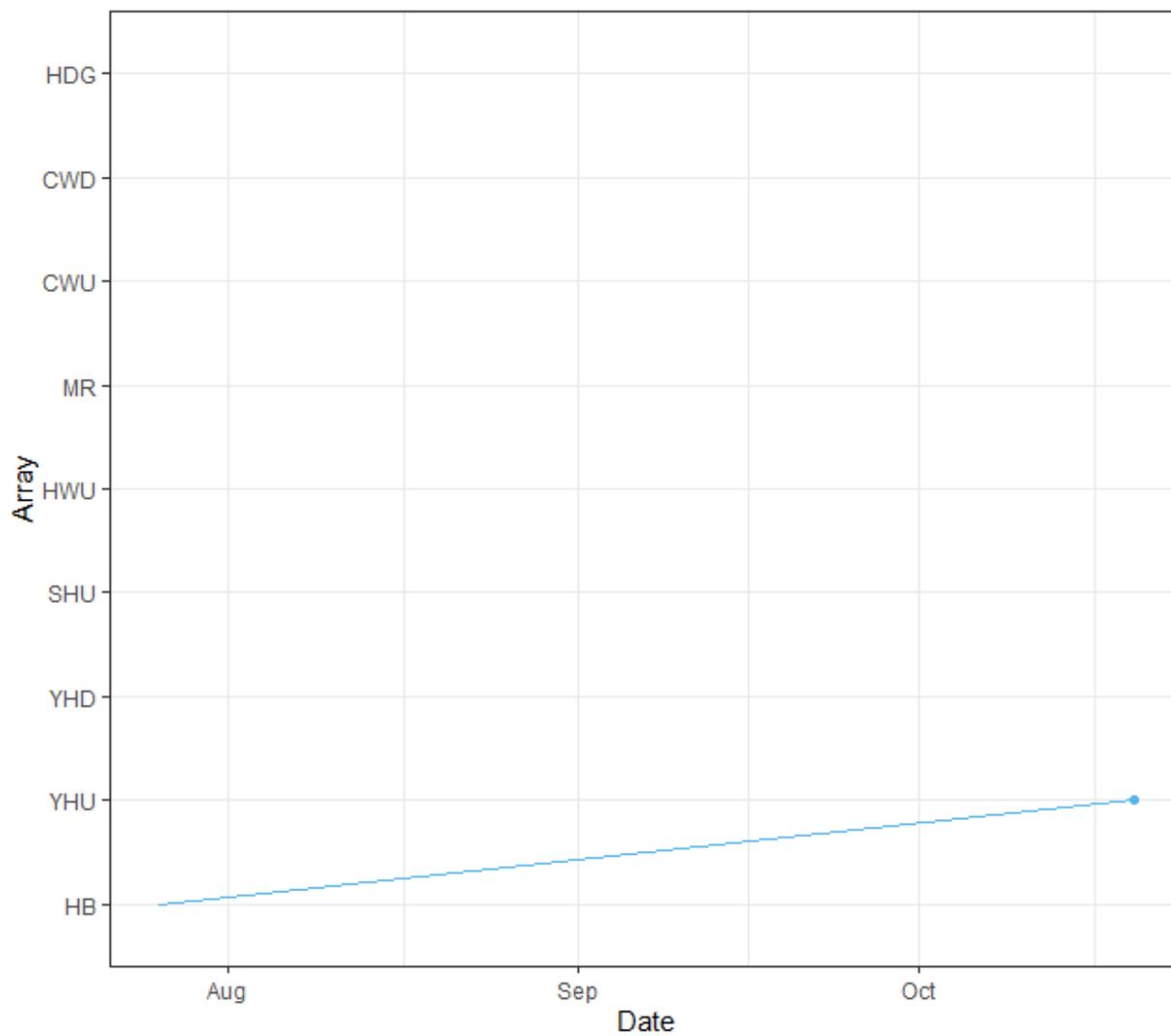
Transmitter A69-1604-6898 movement detection plot from 26 July - 19 October 2022. This eel did not successfully exit the Susquehanna River.

A69-1604-6900
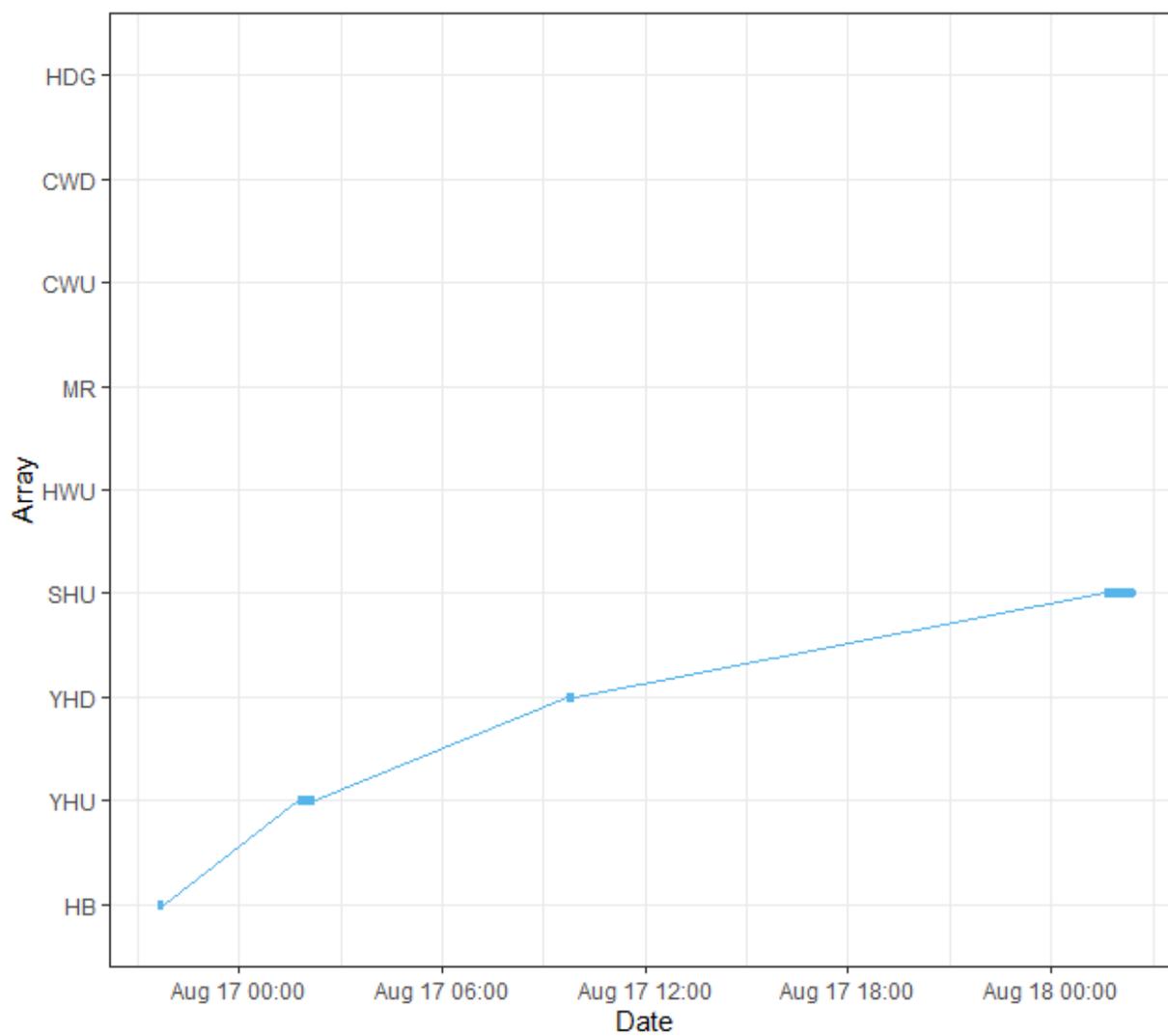
Transmitter A69-1604-6900 movement detection plot from 16-18 August 2023. This eel did not successfully exit the Susquehanna River.
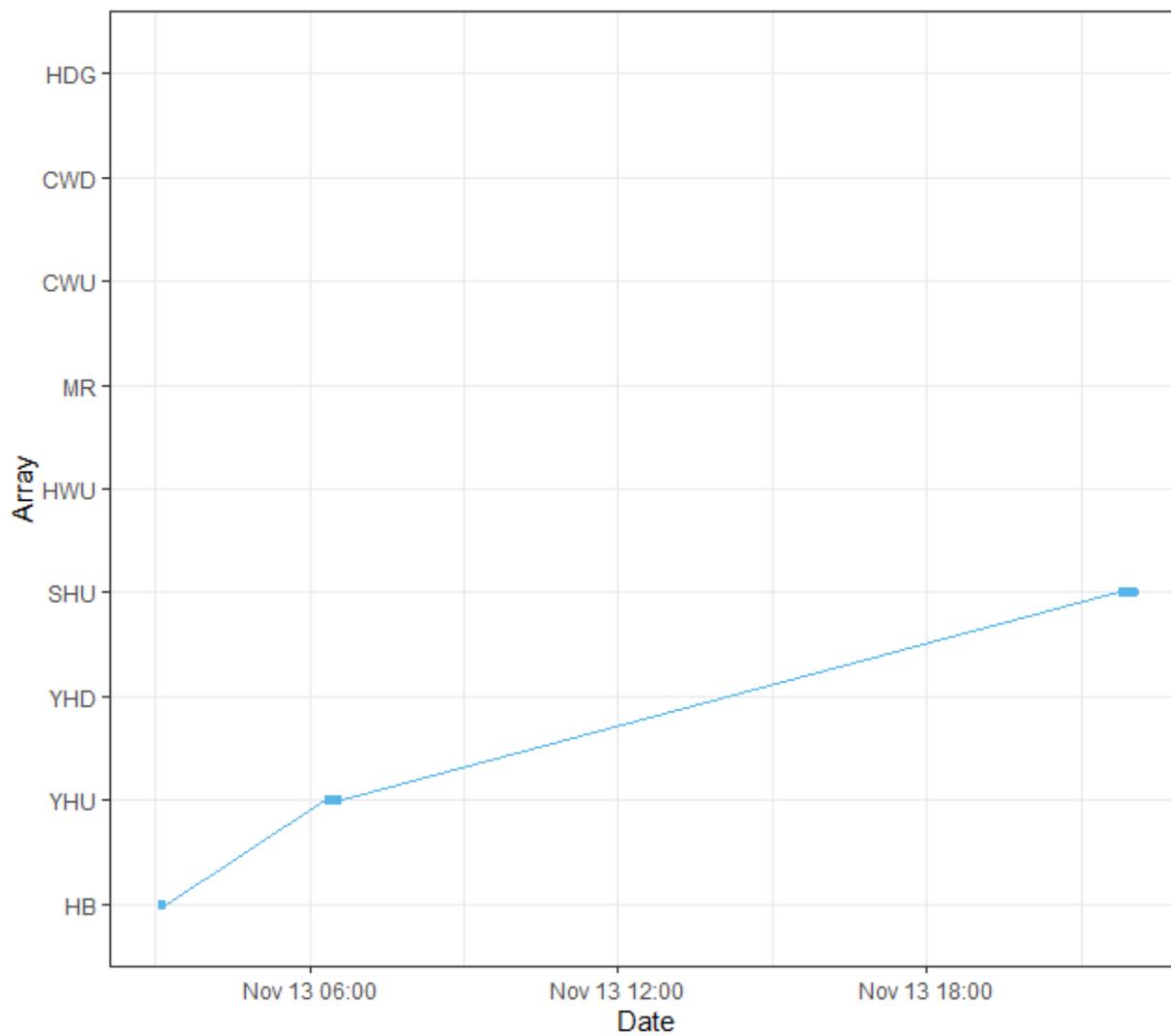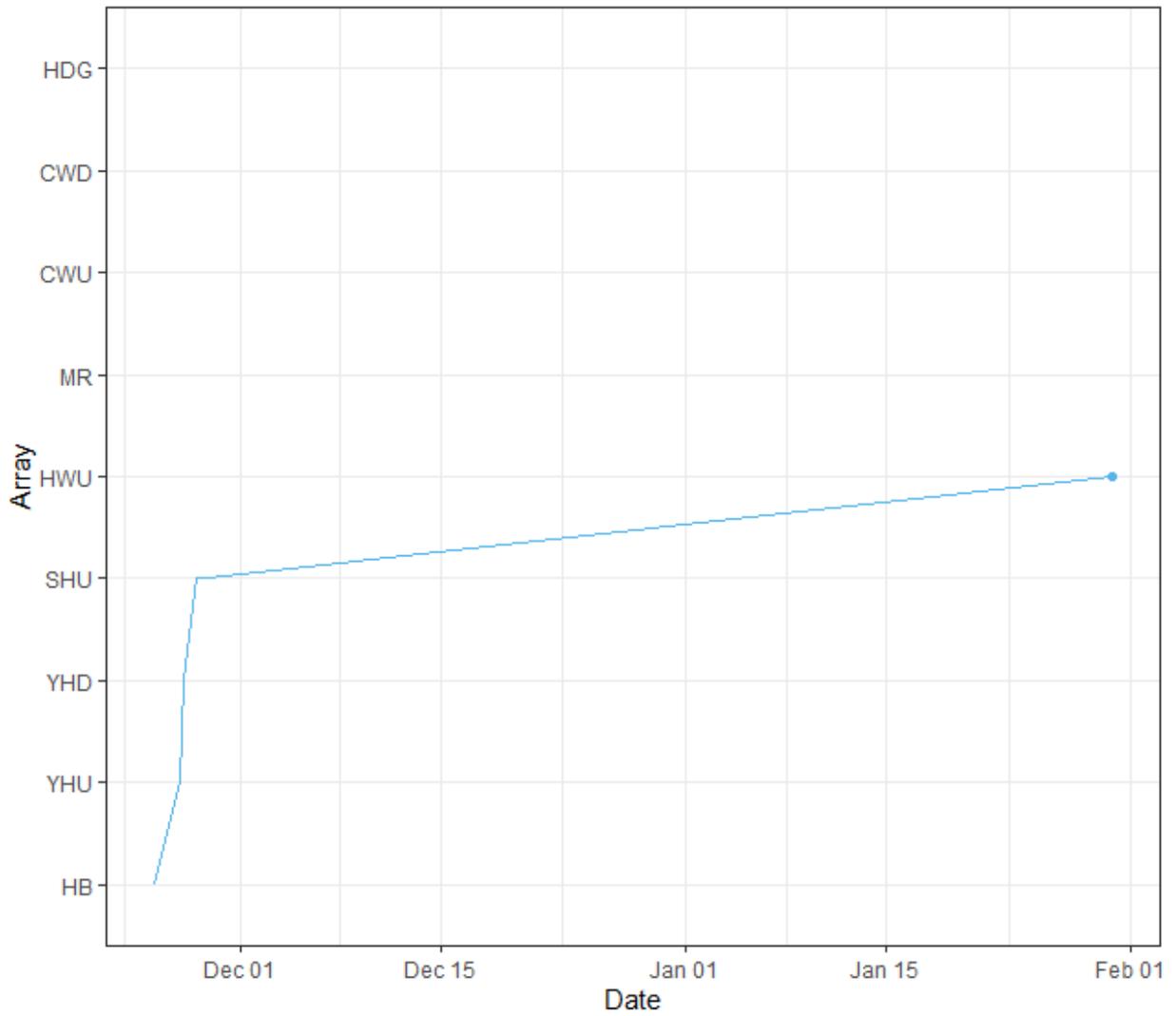
Transmitter A69-1604-6901 movement detection plot on 13 November 2022. This eel did not successfully exit the Susquehanna River.
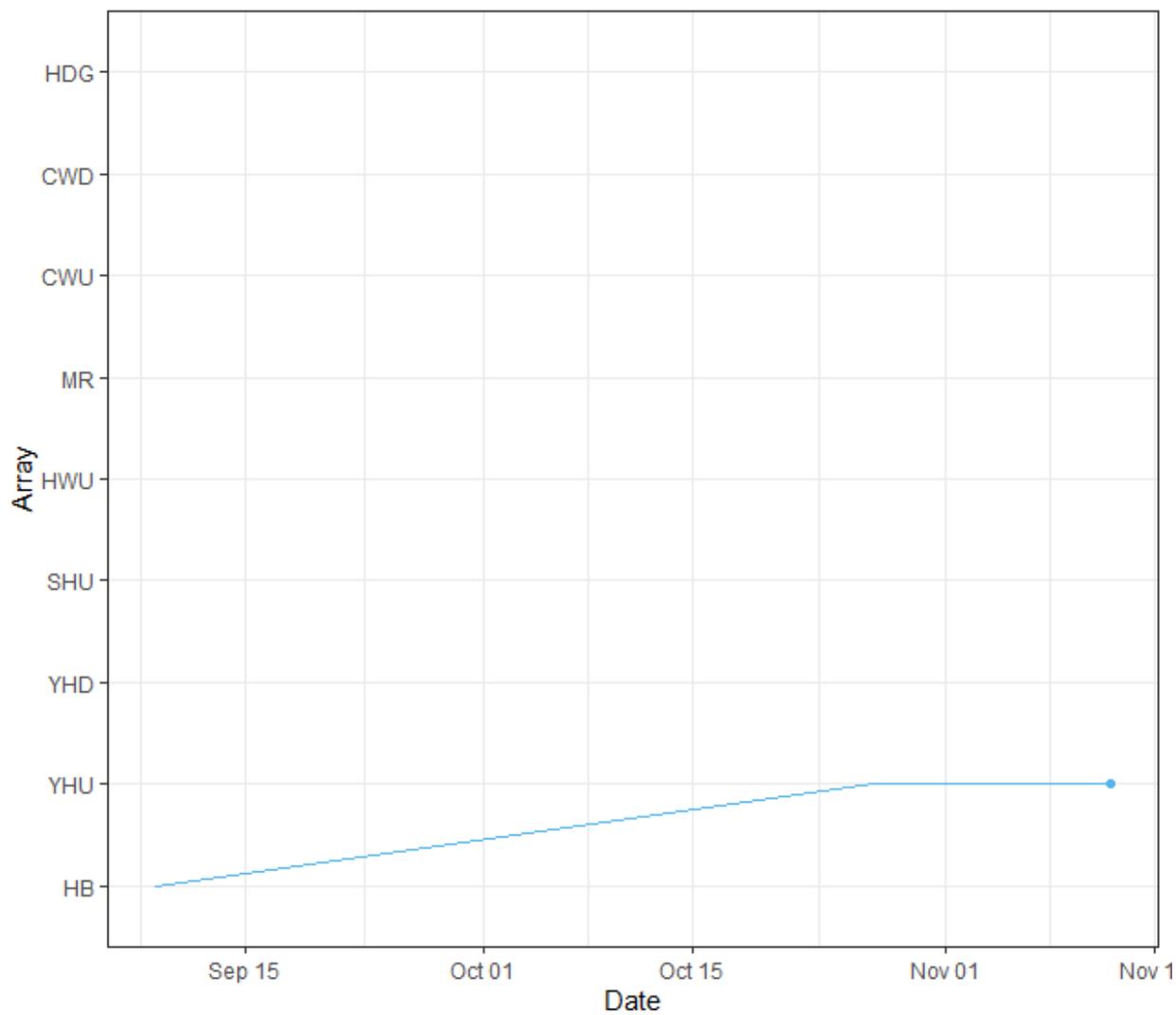
Transmitter A69-1604-6902 movement detection plot from 8 September – 12 November 2022.
This eel did not successfully exit the Susquehanna River.
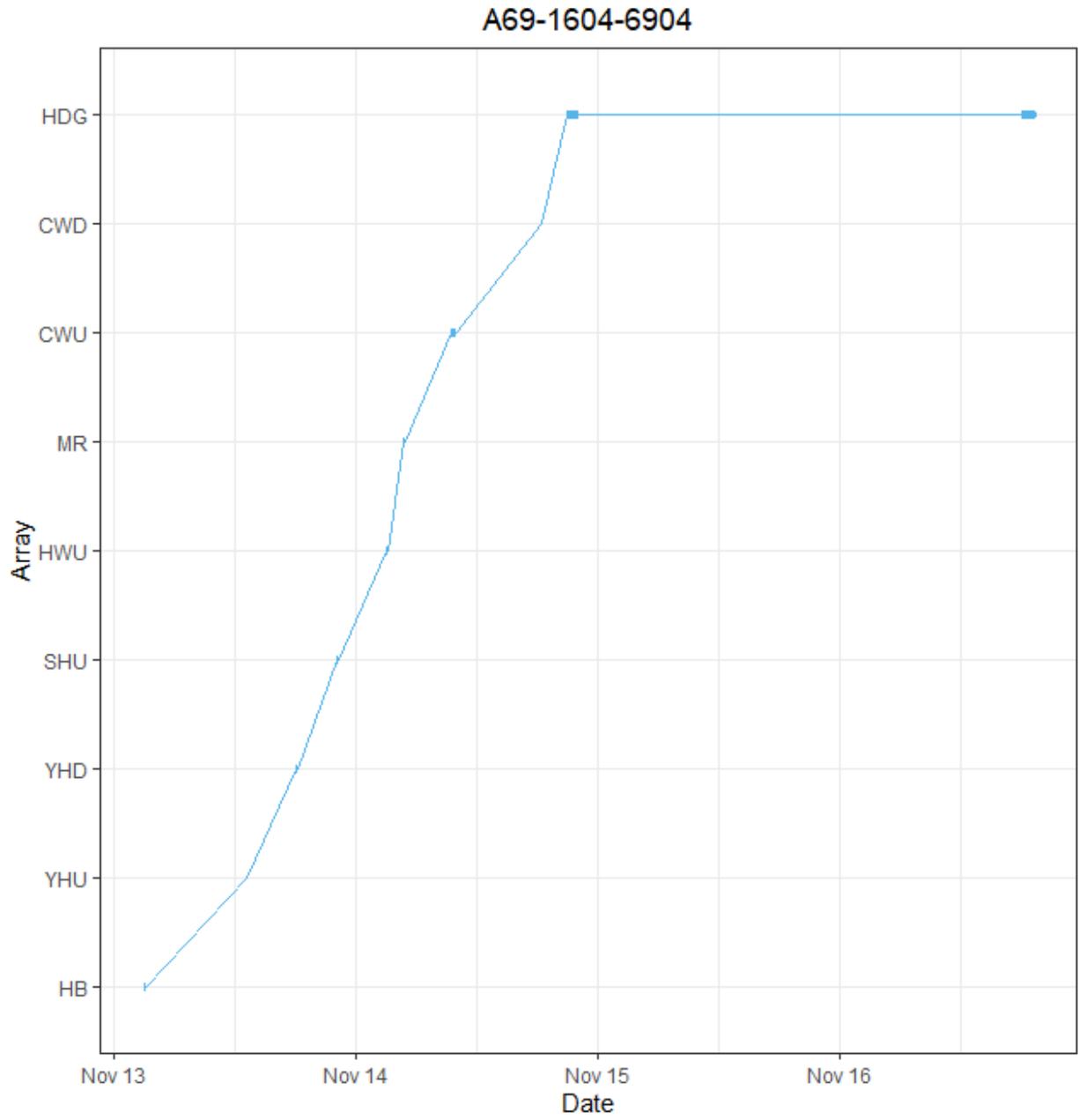
Transmitter A69-1604-6904 movement detection plot from 13-16 November 2022. This eel successfully exited the Susquehanna River.
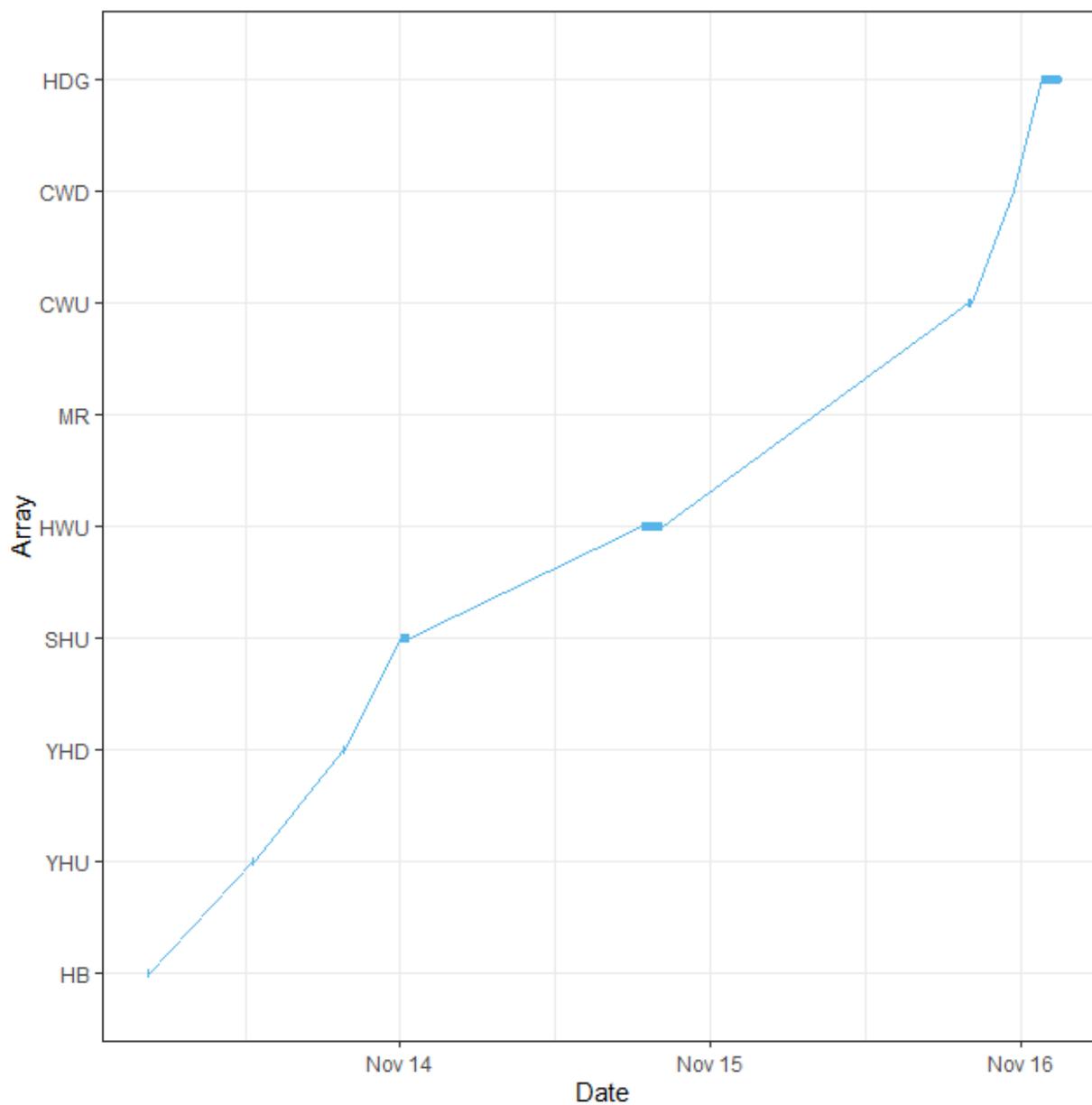
Transmitter A69-1604-6905 movement detection plot from 13-16 November 2022. This eel successfully exited the Susquehanna River.
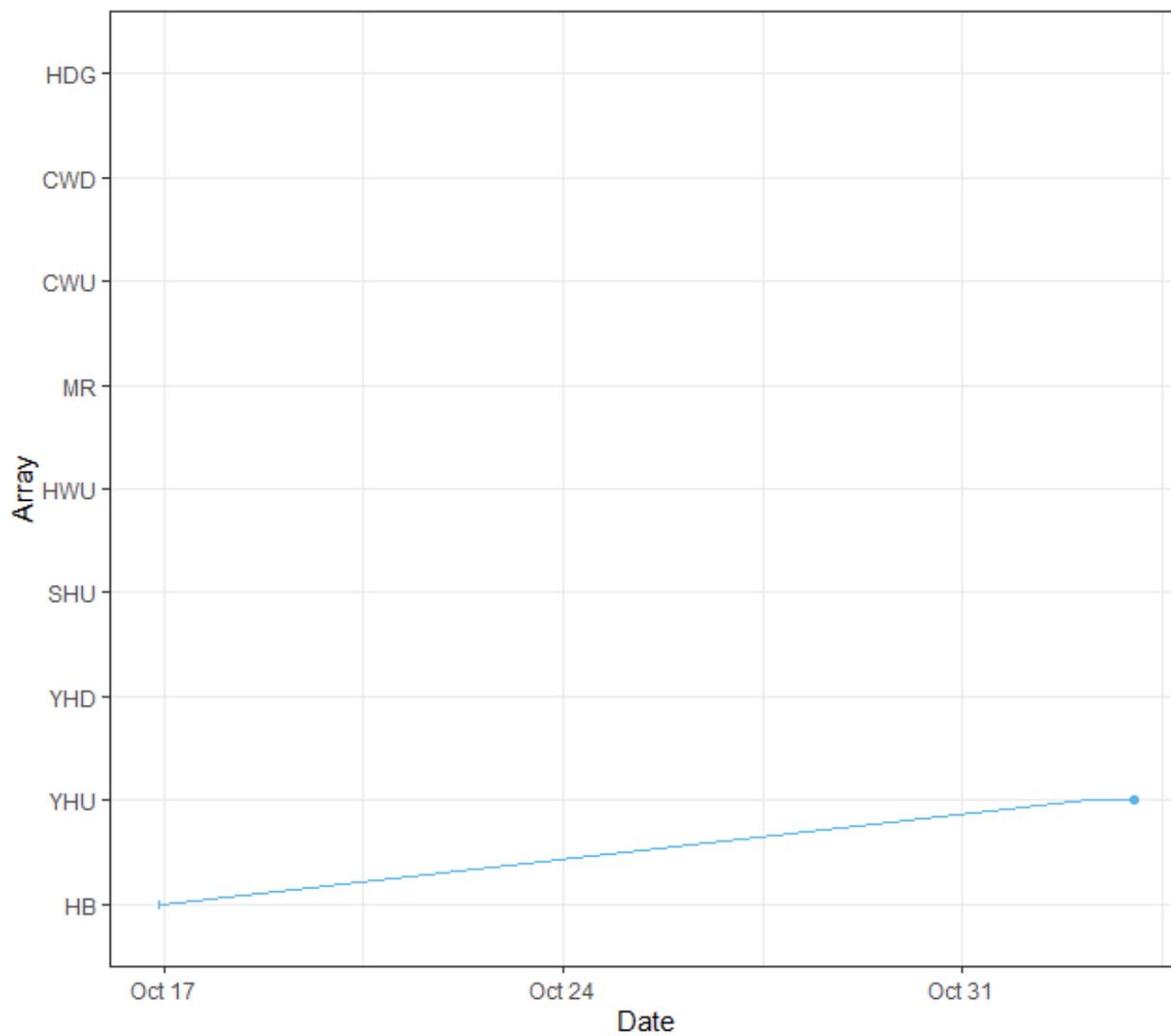
Transmitter A69-1604-6907 movement detection plot from 16 October – 3 November 2022. This eel did not successfully exit the Susquehanna River.
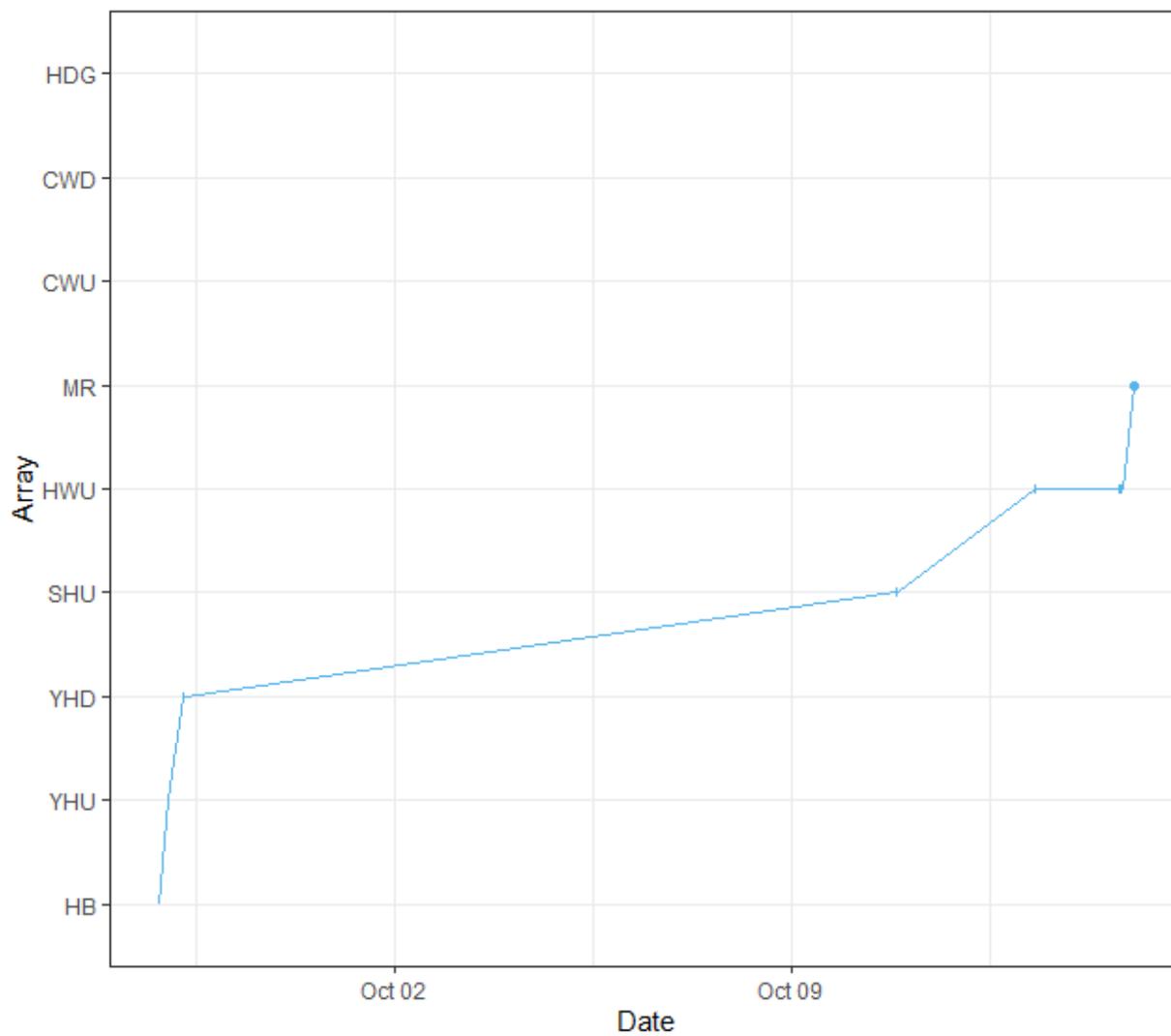
Transmitter A69-1604-6908 movement detection plot from 27 September – 15 October 2023.
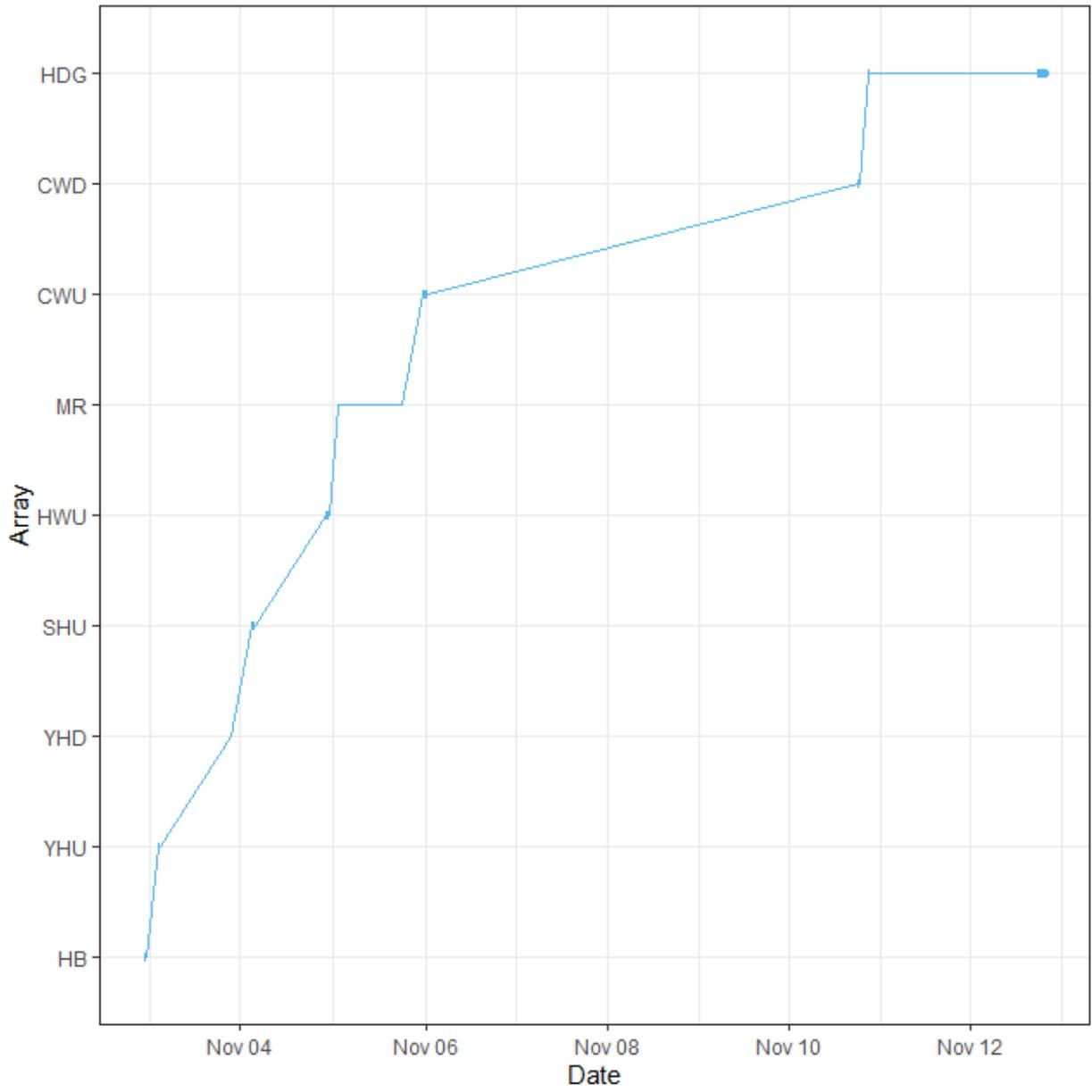This eel did not successfully exit the Susquehanna River.

A69-1604-6913
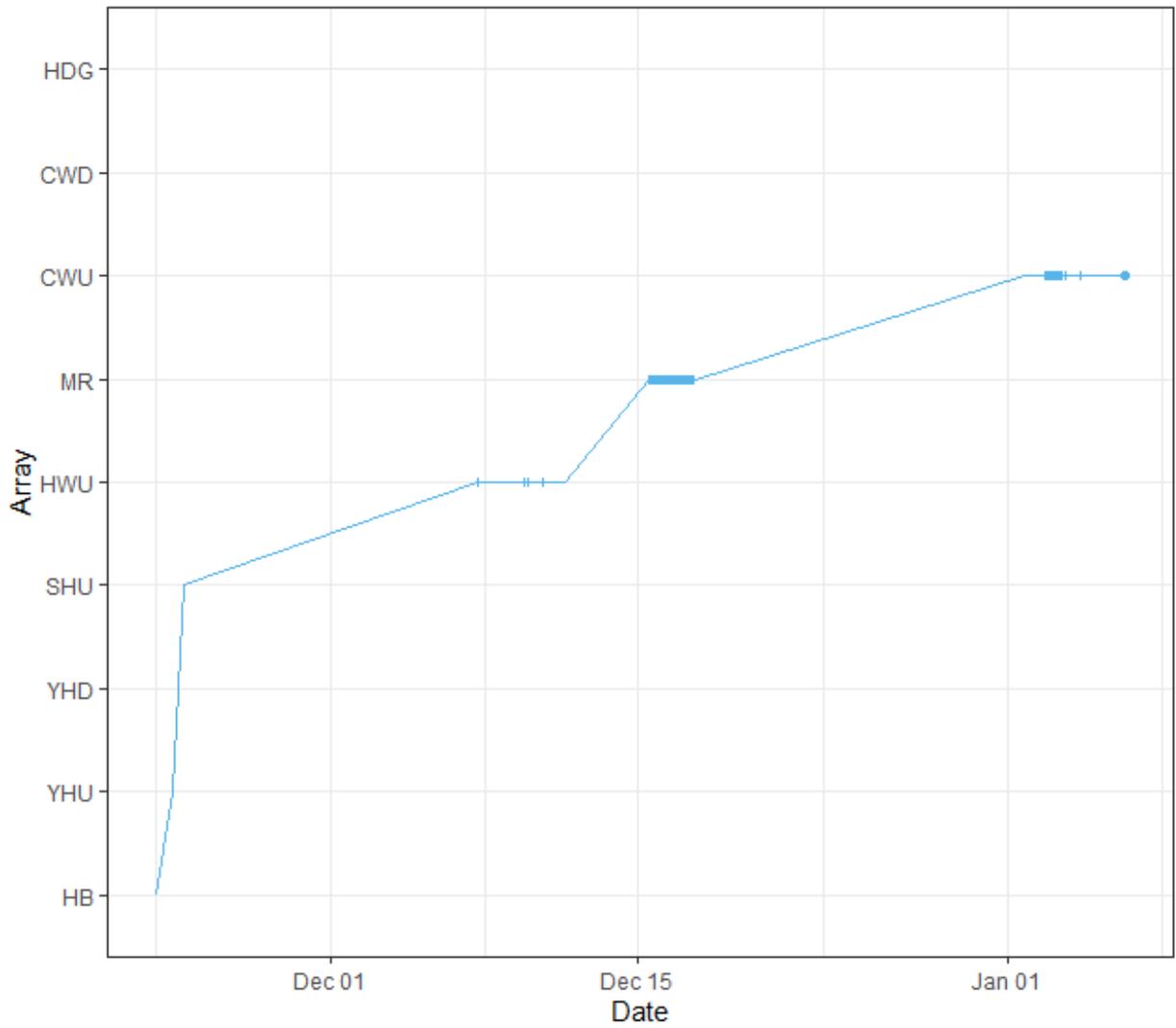
Transmitter A69-1604-6913 movement detection plot from 23 November 2023 – 6 January 2024. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-6914 movement detection plot from 24 September – 14 November 2022. This eel did not successfully exit the Susquehanna River.
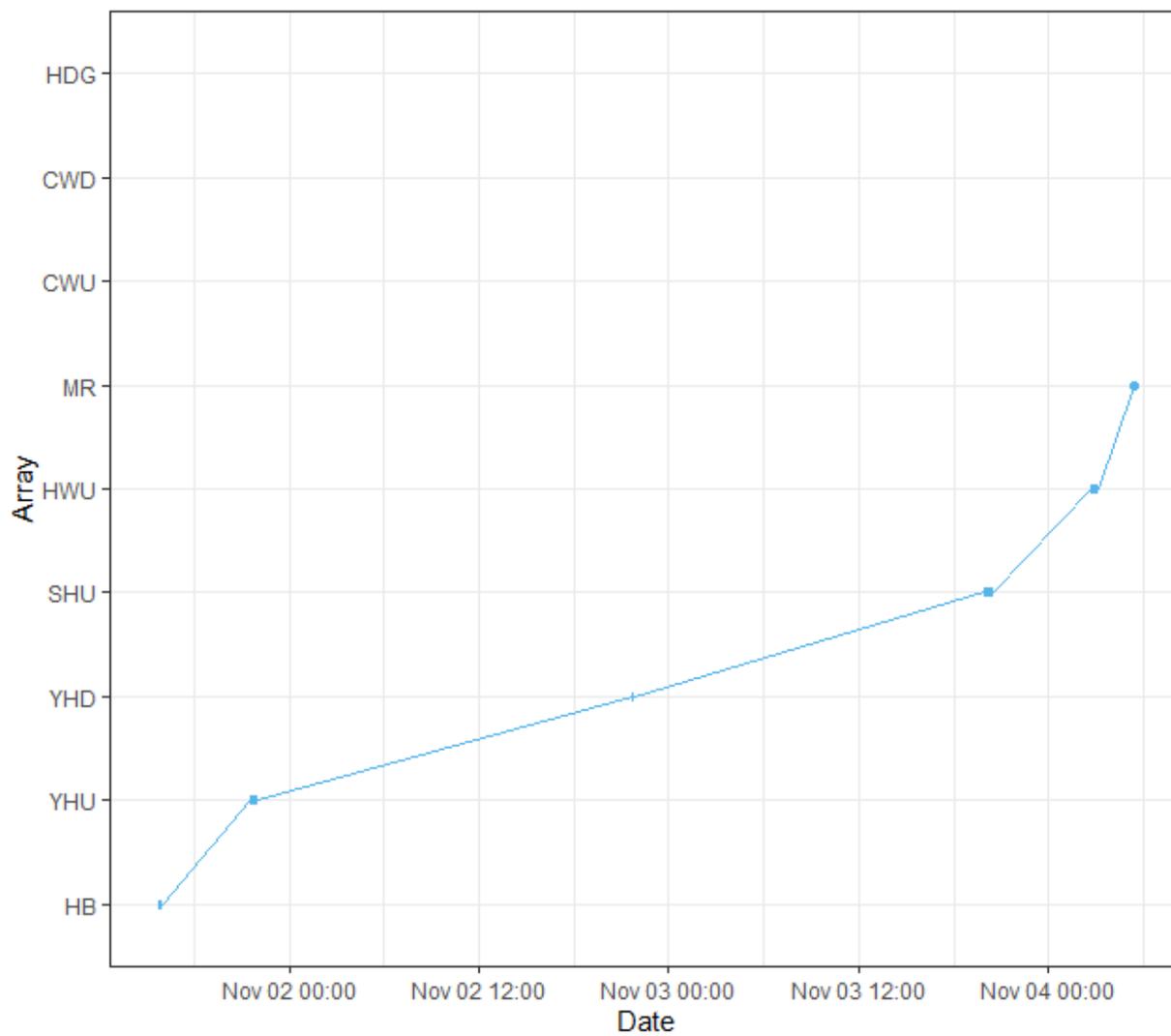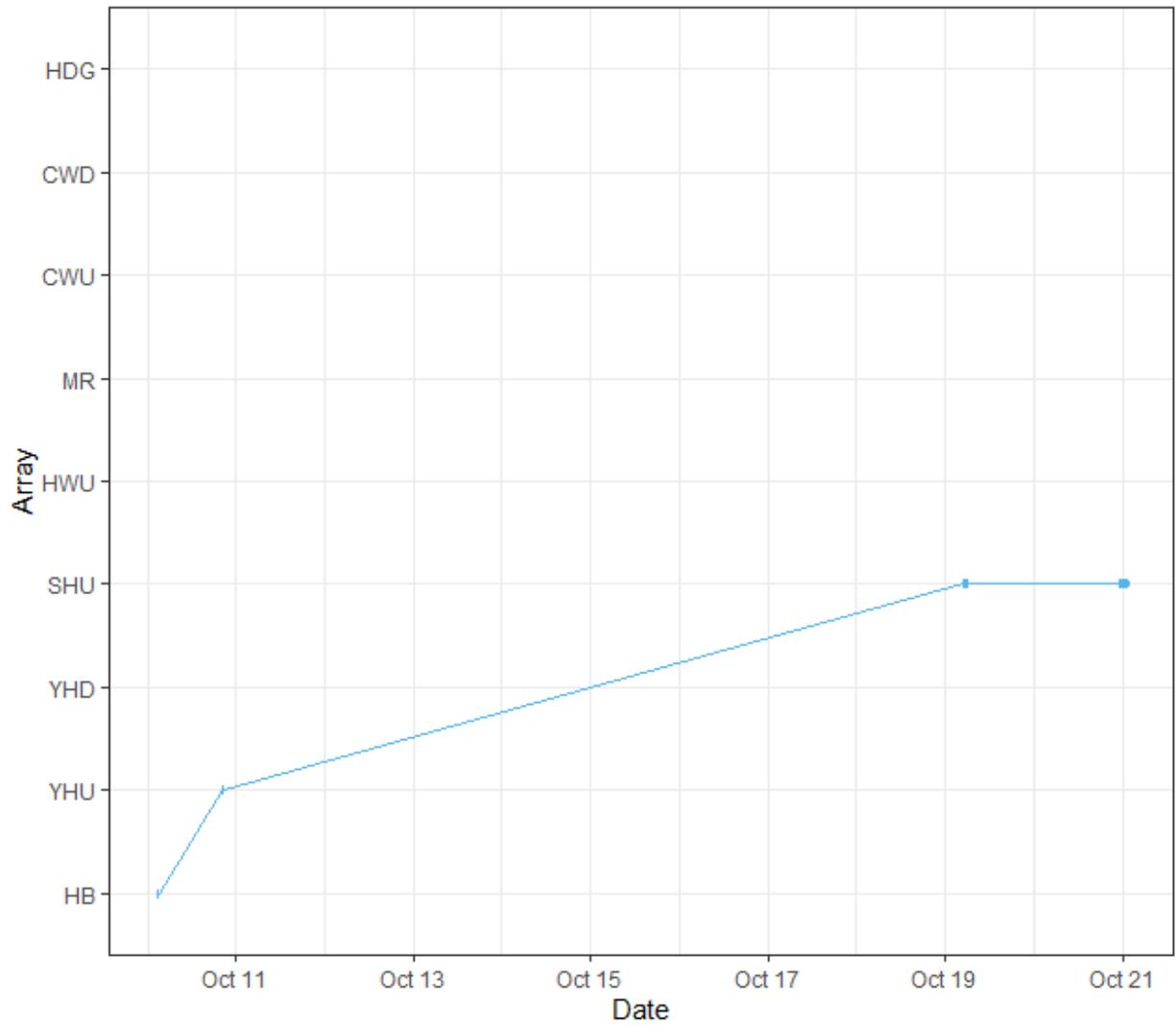
Transmitter A69-1604-6915 movement detection plot from 1-4 November 2023. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-6916 movement detection plot from 13-15 November 2022. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-6918 movement detection plot from 13-15 November 2022. This eel did not successfully exit the Susquehanna River.
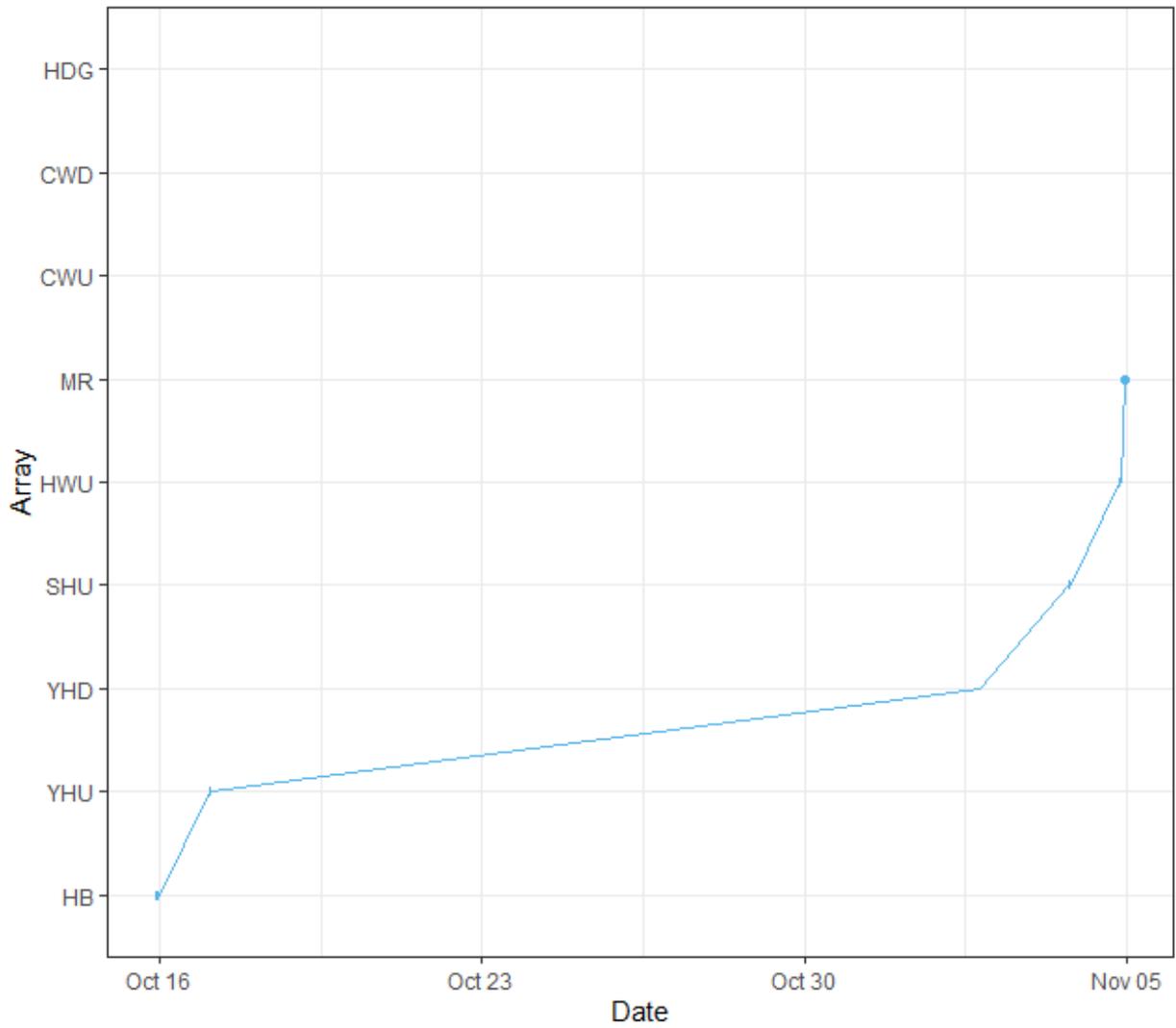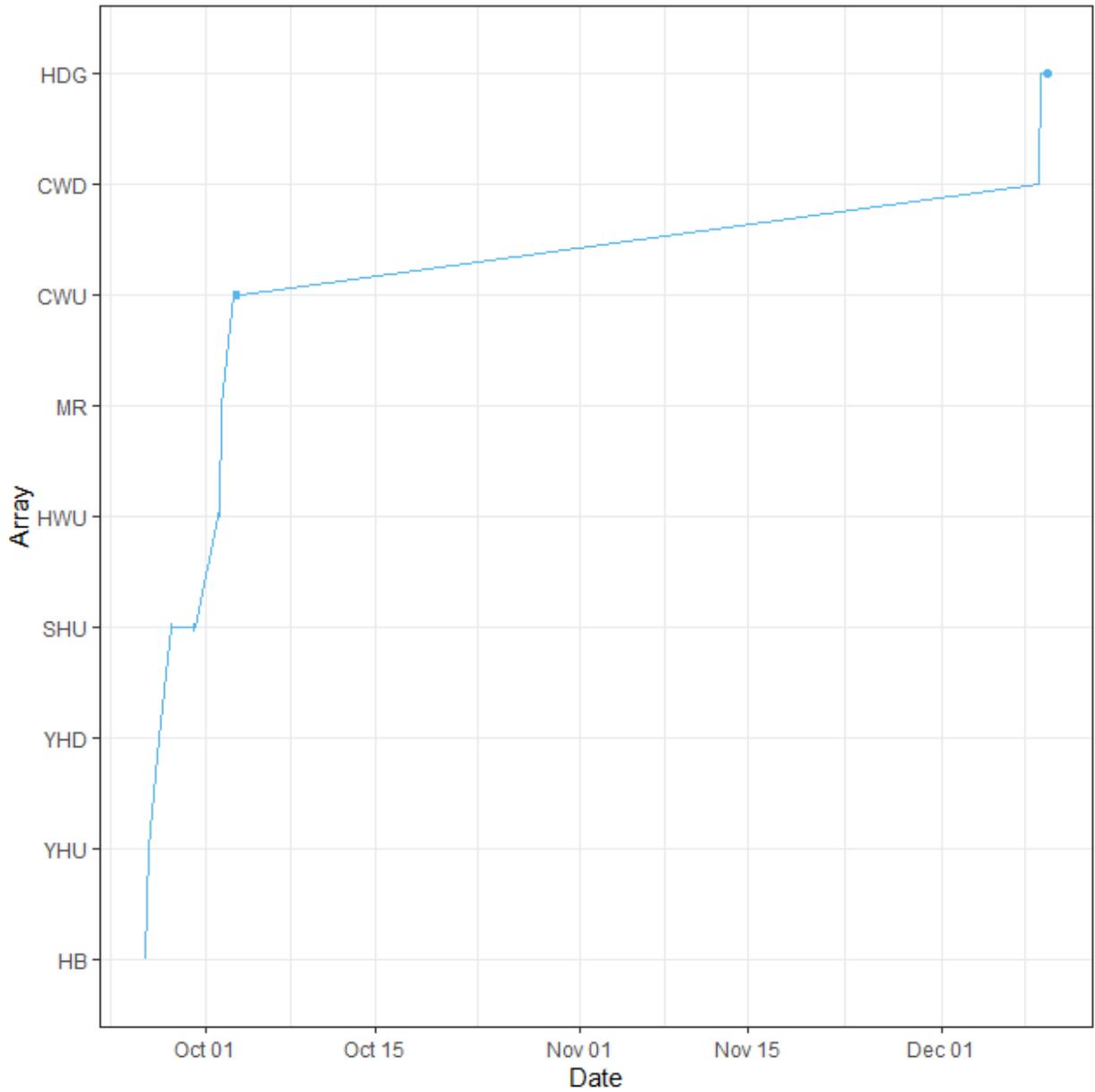
Transmitter A69-1604-6919 movement detection plot on 13-14 November 2022. This eel did not successfully exit the Susquehanna River.

A69-1604-6920

Transmitter A69-1604-6920 movement detection plot from 1 September 2022 – 6 April 2023. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-6921 movement detection plot on 13-15 November 2022. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-6923 movement detection plot on 25 September - 7 November 2023. This eel successfully exited the Susquehanna River.

A69-1604-6924

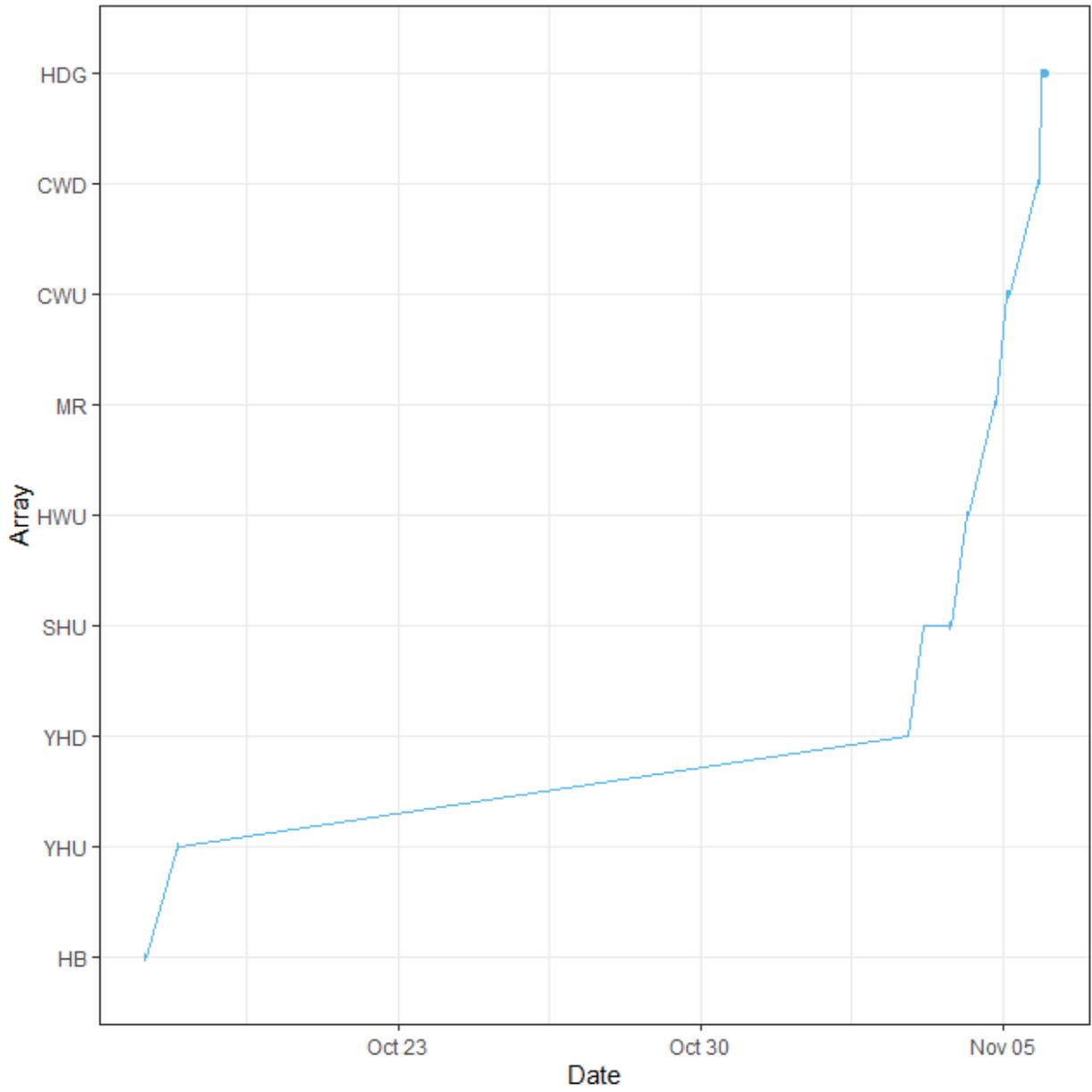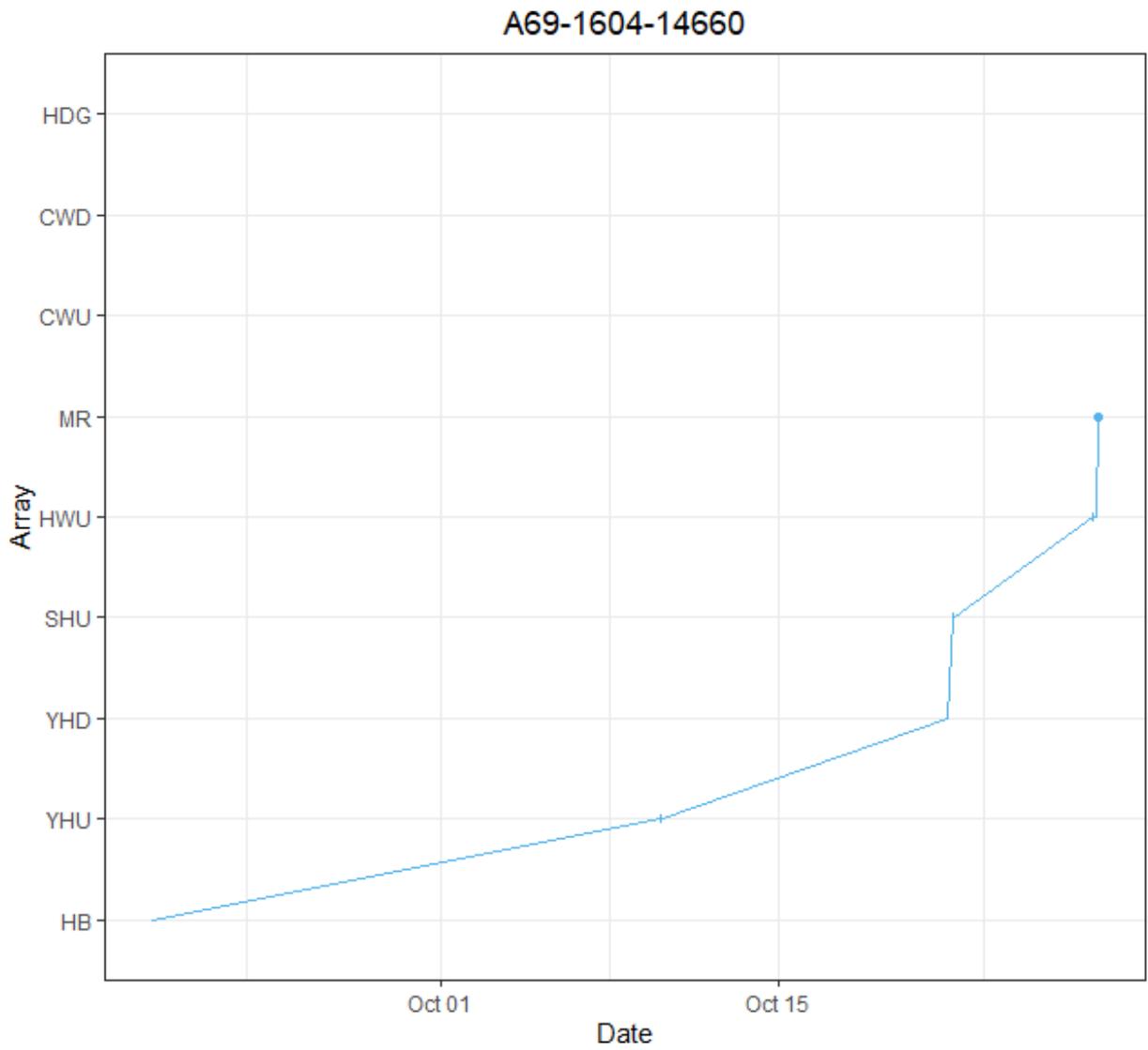Transmitter A69-1604-6924 movement detection plot from 21-24 November 2023. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-6925 movement detection plot from 13-14 November 2022. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-6926 movement detection plot on 13 November 2022. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-6927 movement detection plot from 13-14 November 2022. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-6928 movement detection plot from 13-23 November 2022. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-6929 movement detection plot from 13-16 November 2022. This eel successfully exited the Susquehanna River.
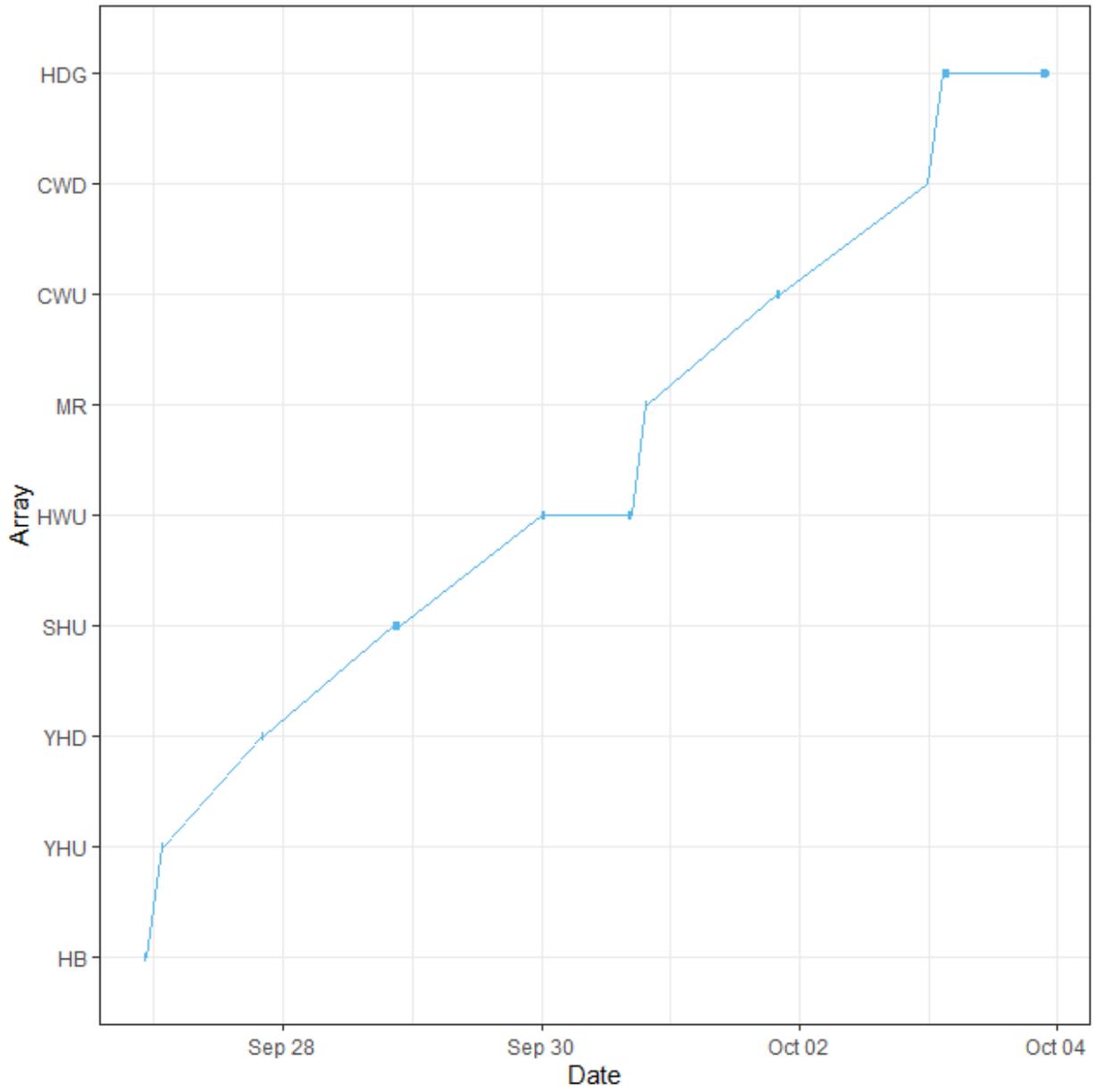
Transmitter A69-1604-6930 movement detection plot from 27 September – 27 November 2023. This eel successfully exited the Susquehanna River.
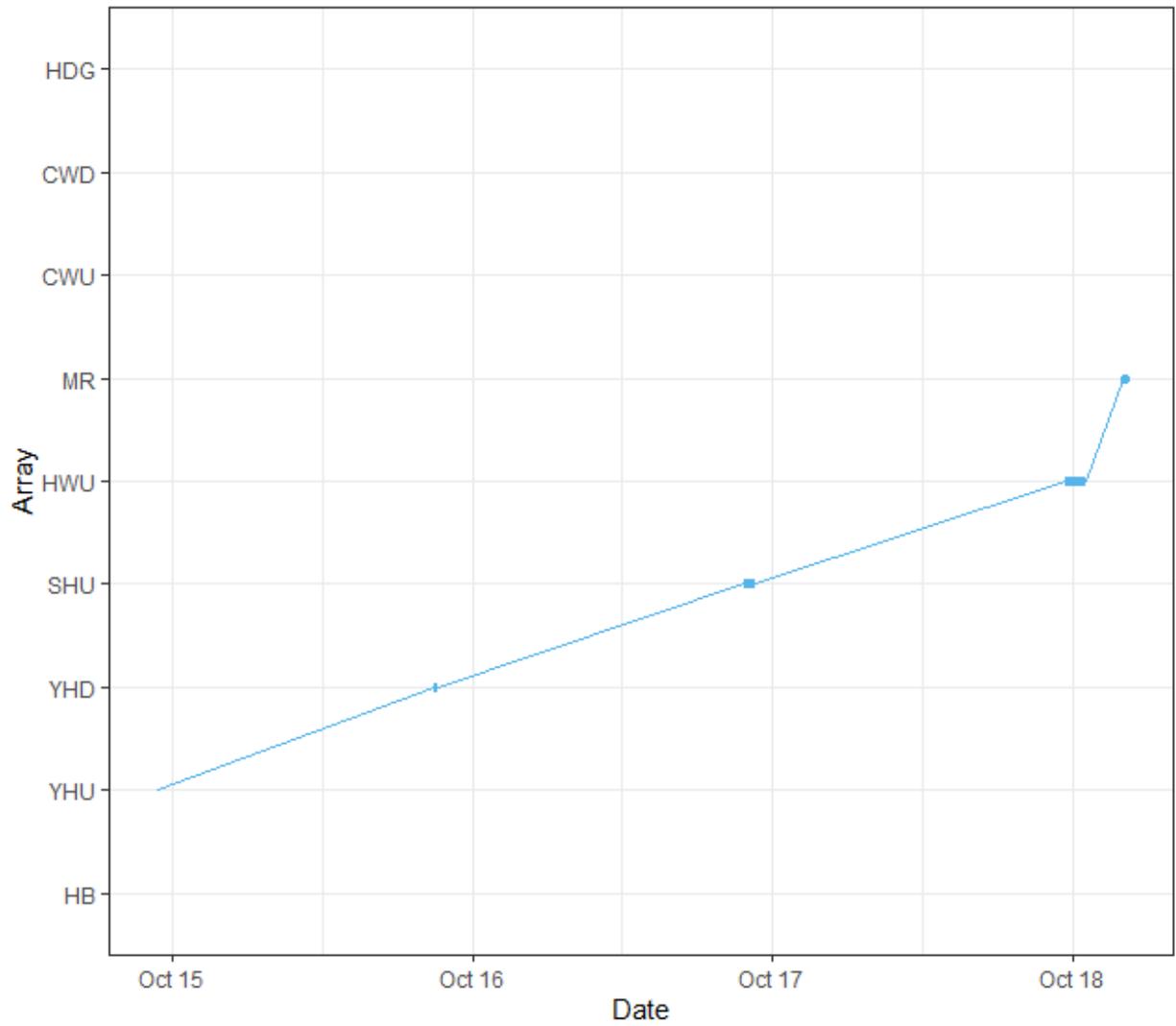
Transmitter A69-1604-6931 movement detection plot from 29 September – 19 December 2023. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-6935 movement detection plot from 20 August – 28 November 2023. This eel successfully exited the Susquehanna River.
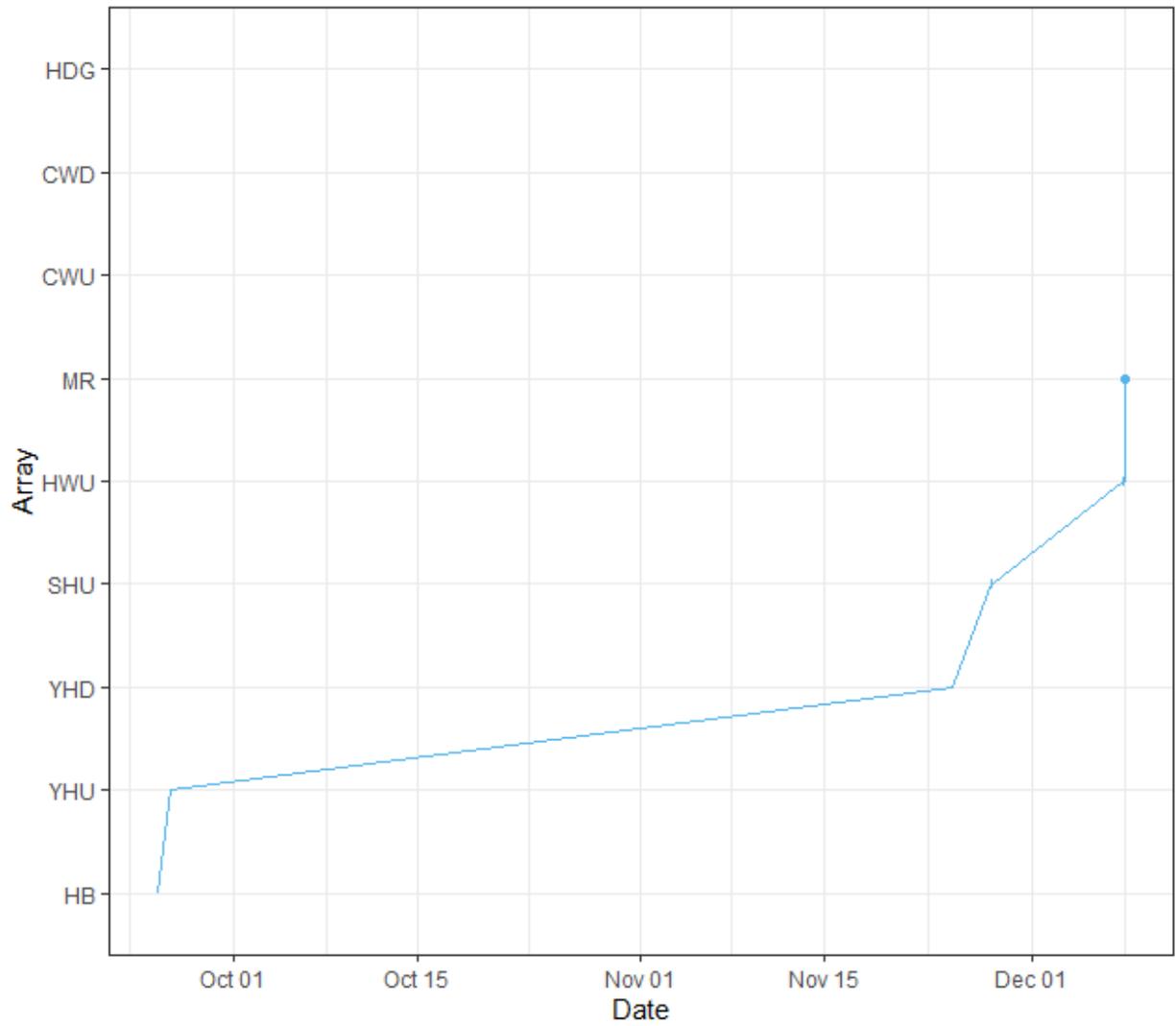
Transmitter A69-1604-6936 movement detection plot from 27 September – 14 November 2022. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-6939 movement detection plot from 22-23 November 2023. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14641 movement detection plot from 22 September – 24 November 2023.
This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14643 movement detection plot from 10 October – 30 November 2023. This eel successfully exited the Susquehanna River.
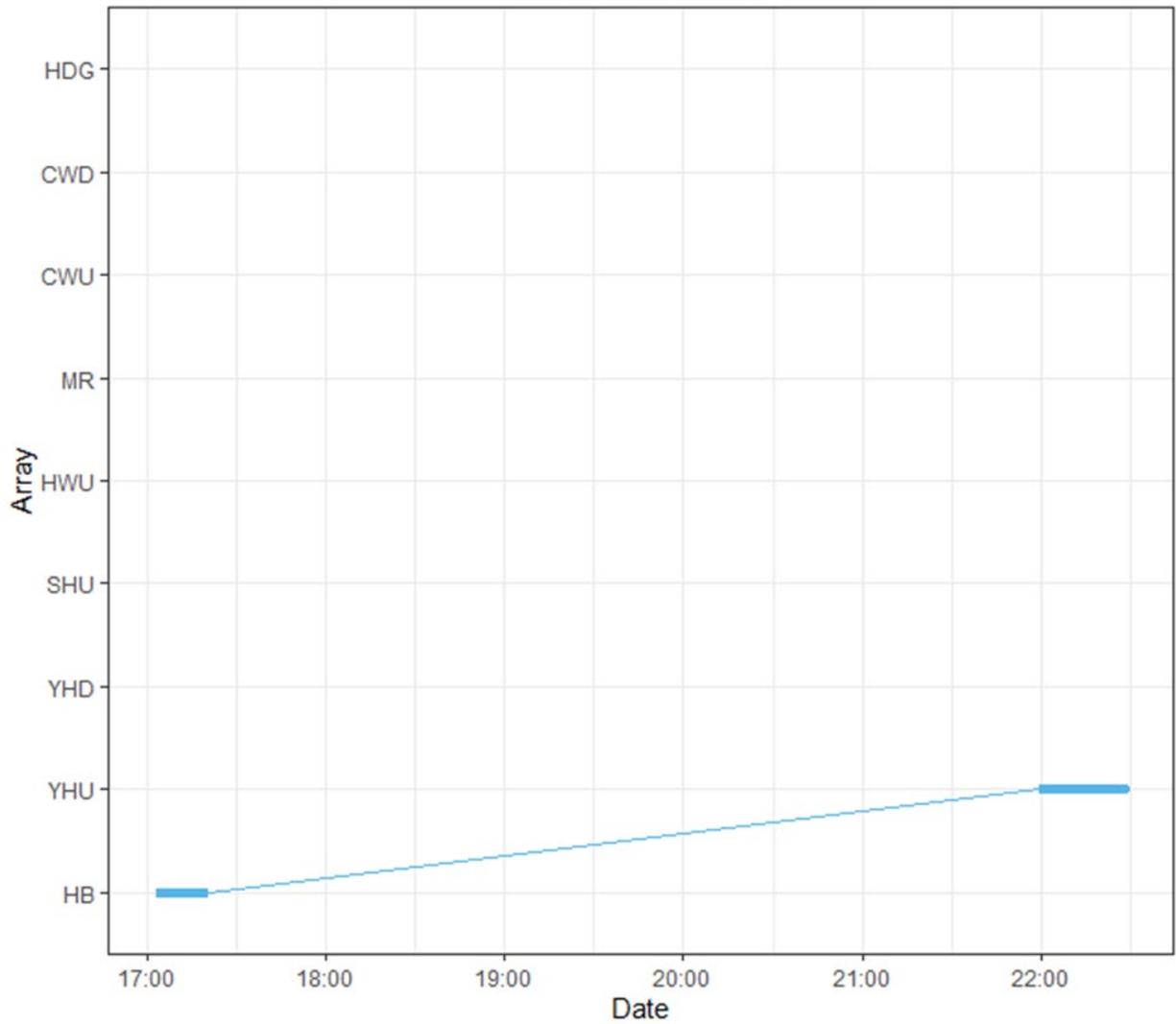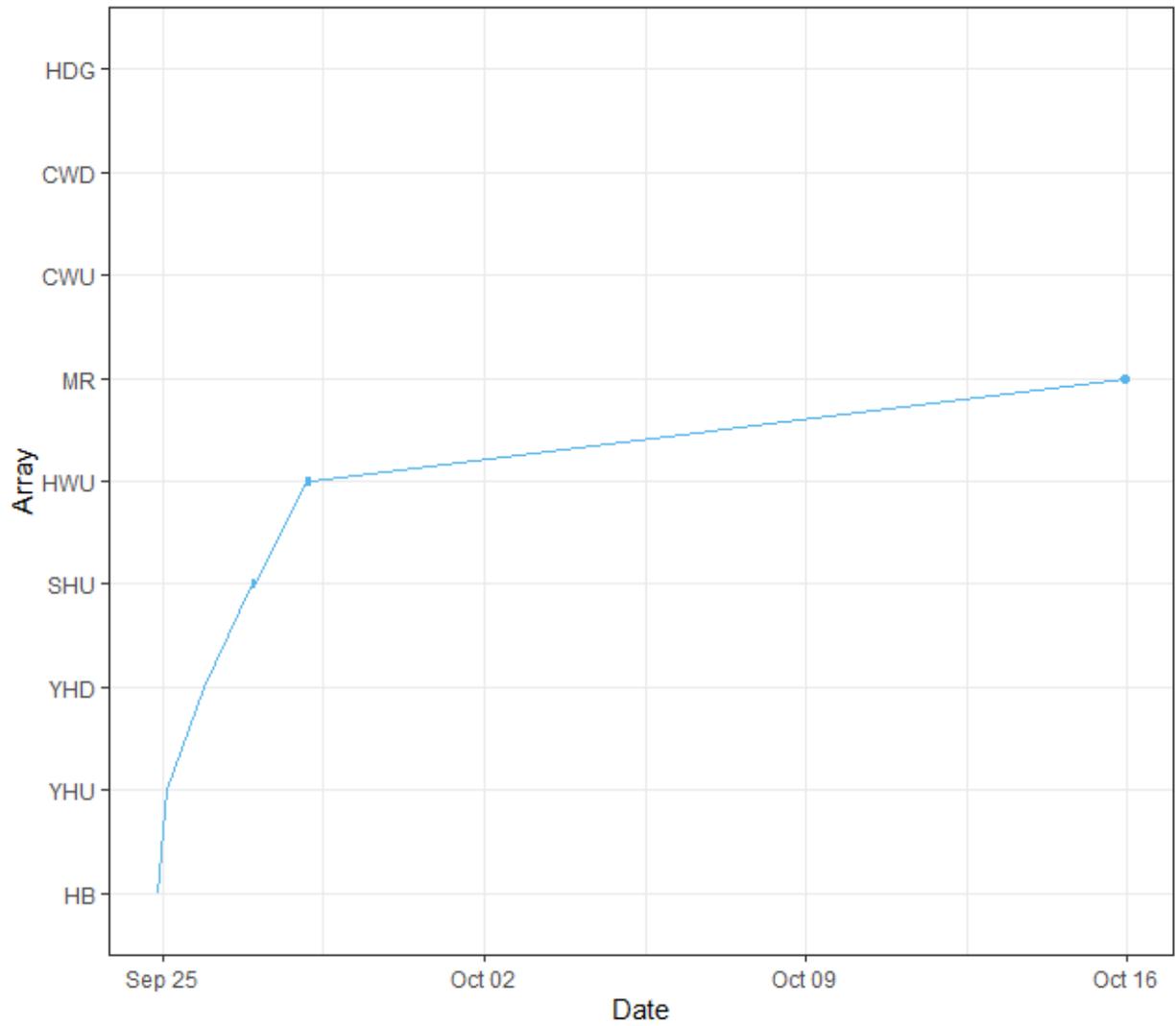
Transmitter A69-1604-14646 movement detection plot from 2-7 November 2023. This did not successfully exit the Susquehanna River.

A69-1604-14647

Transmitter A69-1604-14647 movement detection plot from 23 November – 11 December 2023. This eel successfully exited the Susquehanna River.

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Transmitter A69-1604-14648 movement detection plot from 25 November 2023 – 30 January 2024. This eel did not successfully exit the Susquehanna River.
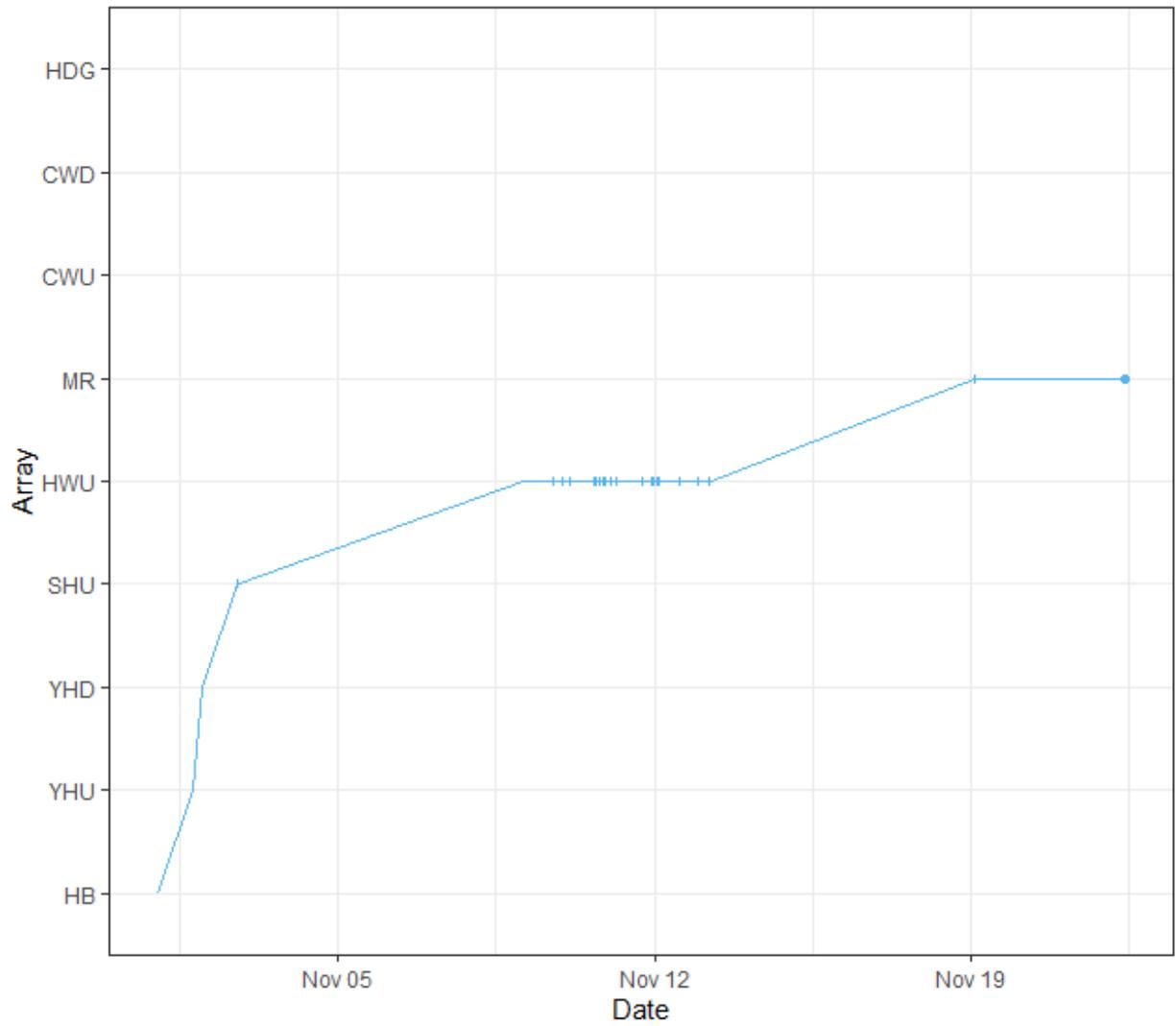
Transmitter A69-1604-14652 movement detection plot from 2-23 November 2023. This eel did not successfully exit the Susquehanna River.
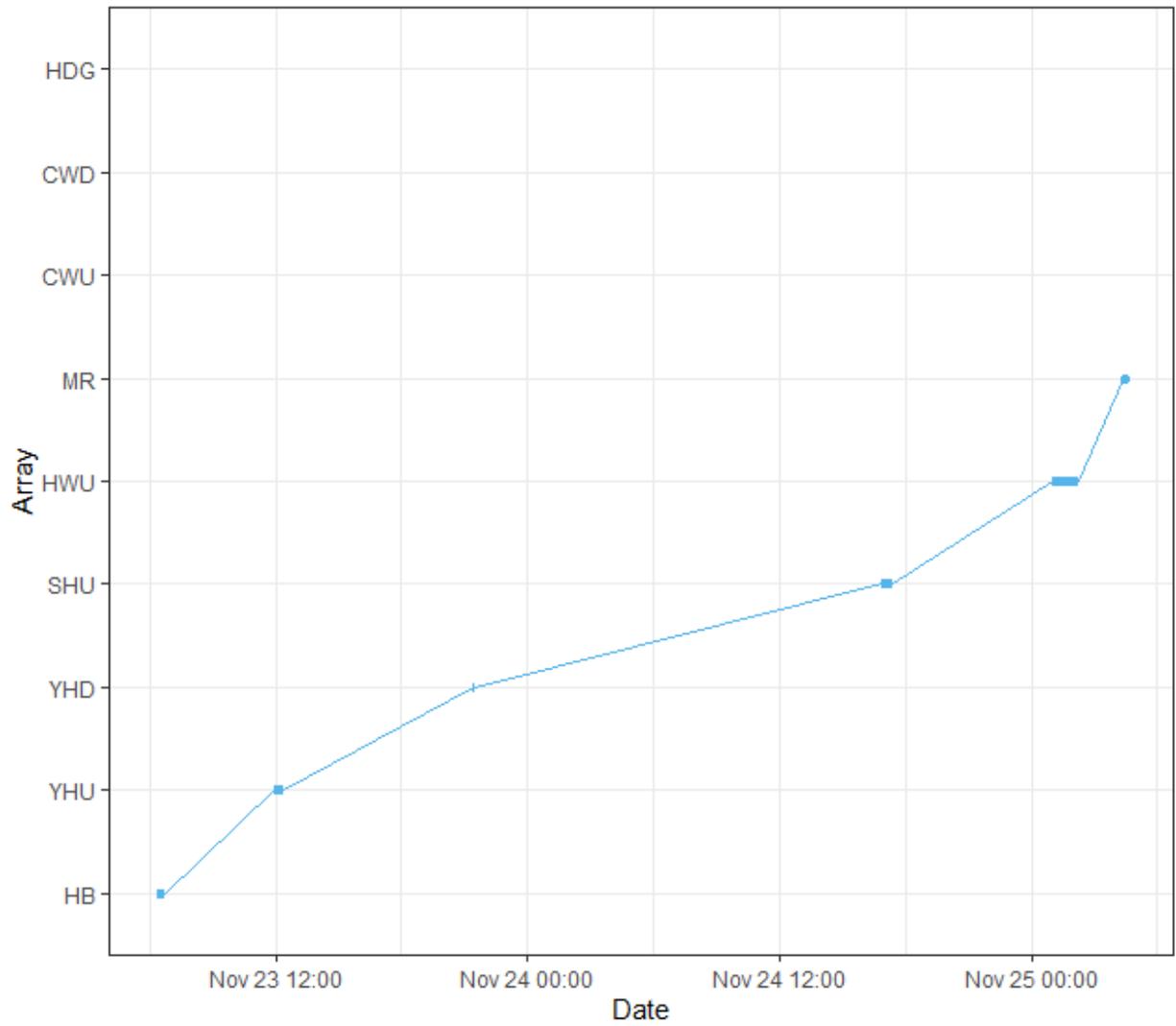
Transmitter A69-1604-14654 movement detection plot from 2-12 November 2023. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14655 movement detection plot from 10-21 October 2023. This eel did not successfully exit the Susquehanna River.
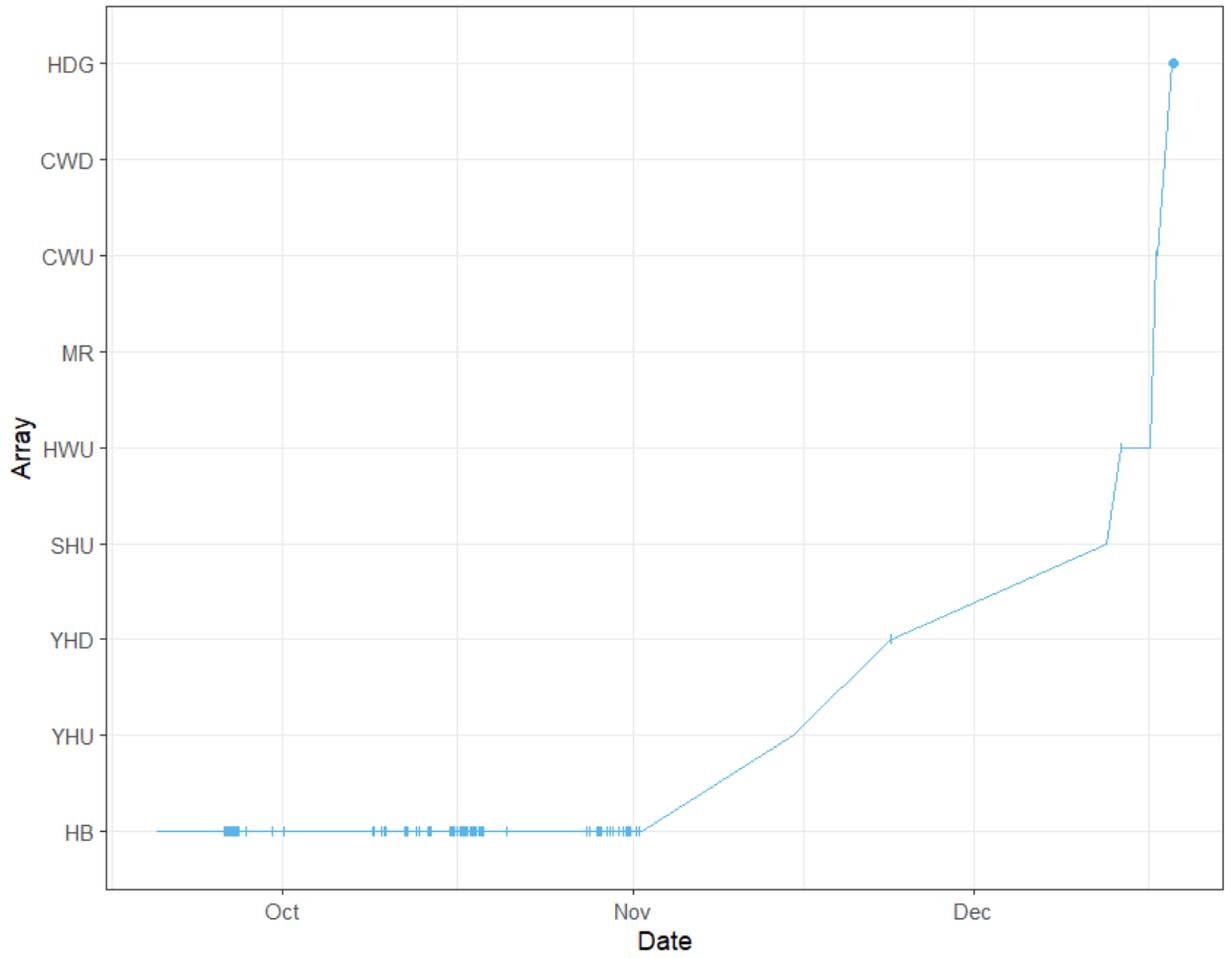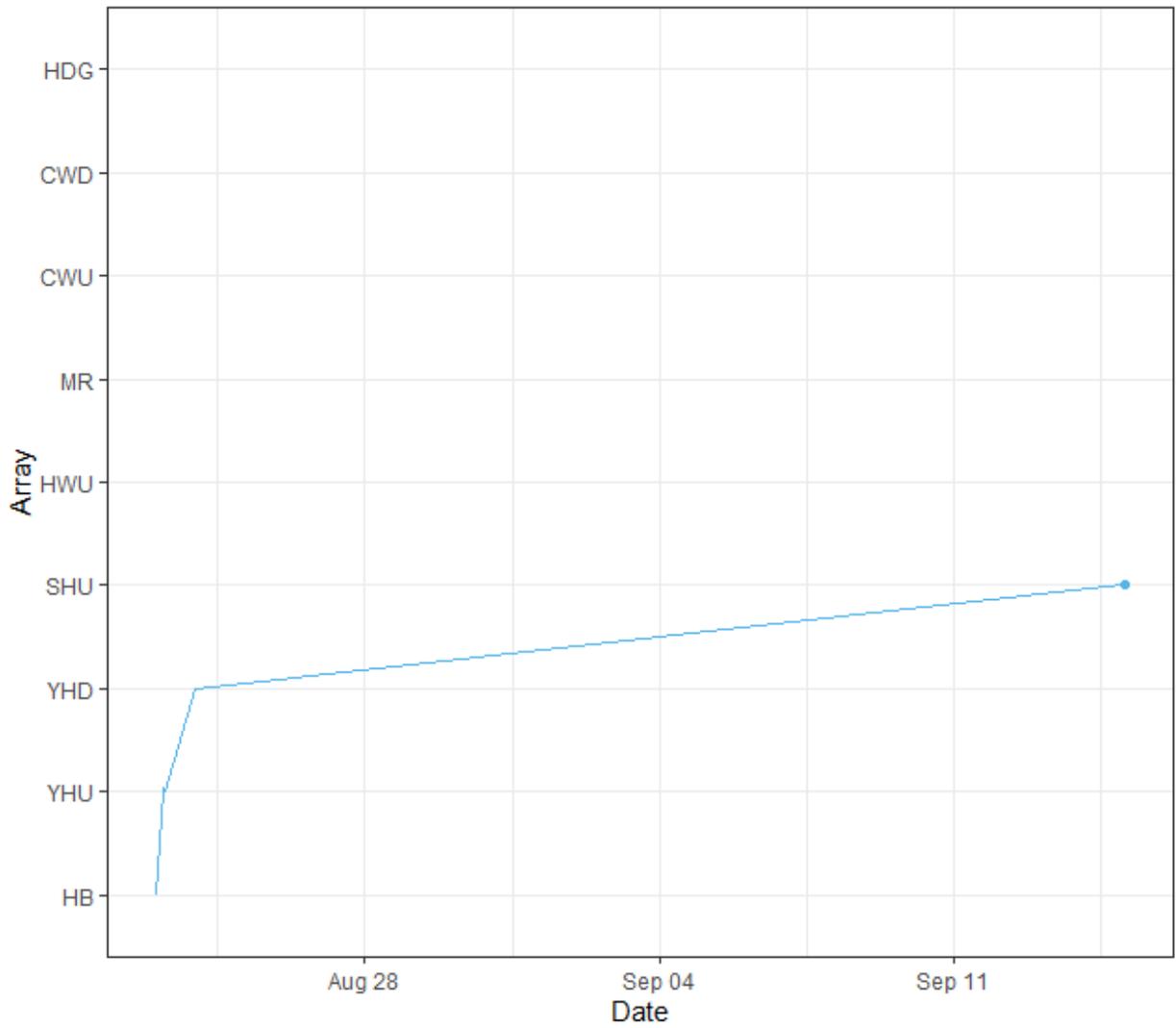
Transmitter A69-1604-14657 movement detection plot from 15 October – 5 November 2023.
This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14658 movement detection plot from 25 September – 9 December 2023. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14659 movement detection plot from 17 October – 6 November 2023.
This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14660 movement detection plot from 19 September - 28 October 2023. This eel did not successfully exit the Susquehanna River.
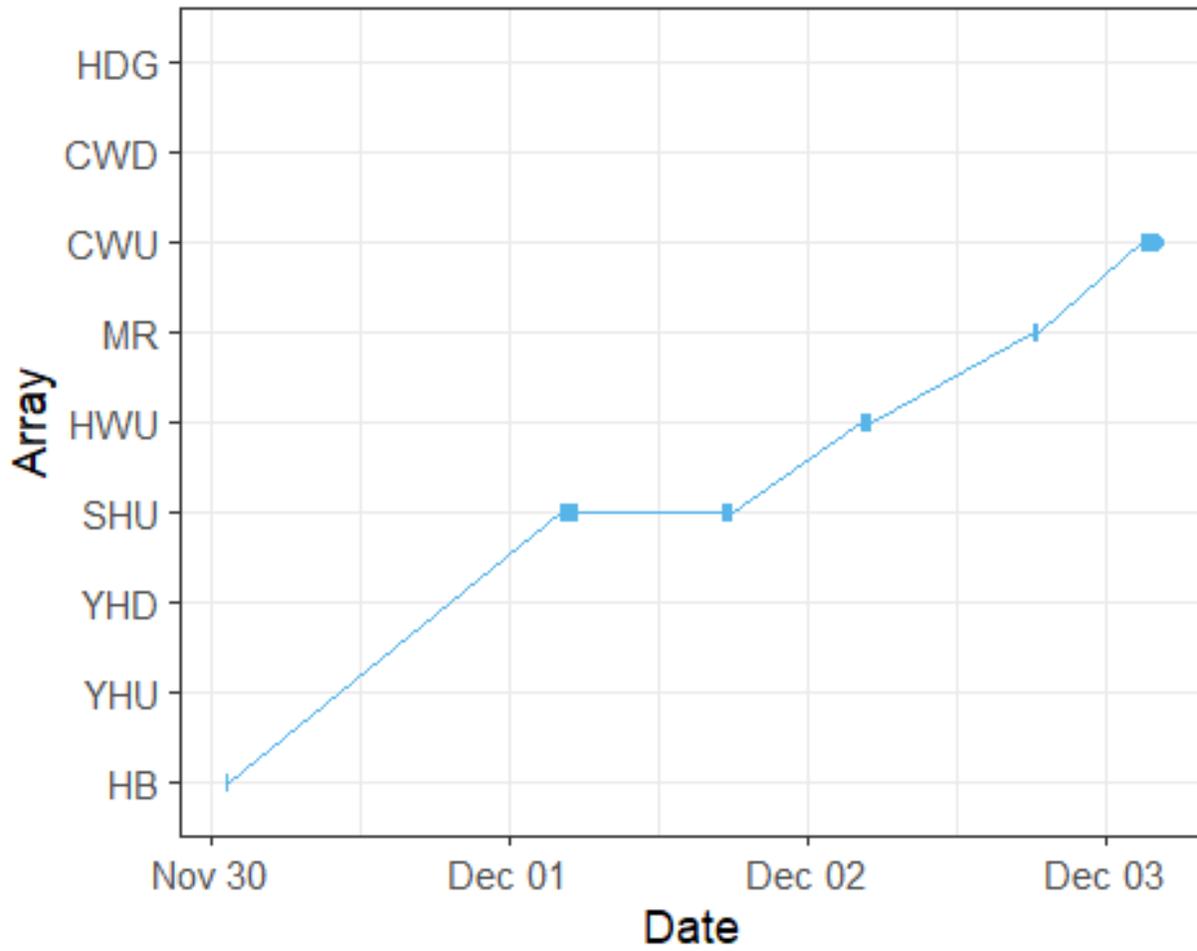
Transmitter A69-1604-14661 movement detection plot from 26 September – 3 October 2023.
This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14662 movement detection plot from 14-18 October 2023. This eel did not successfully exit the Susquehanna River.
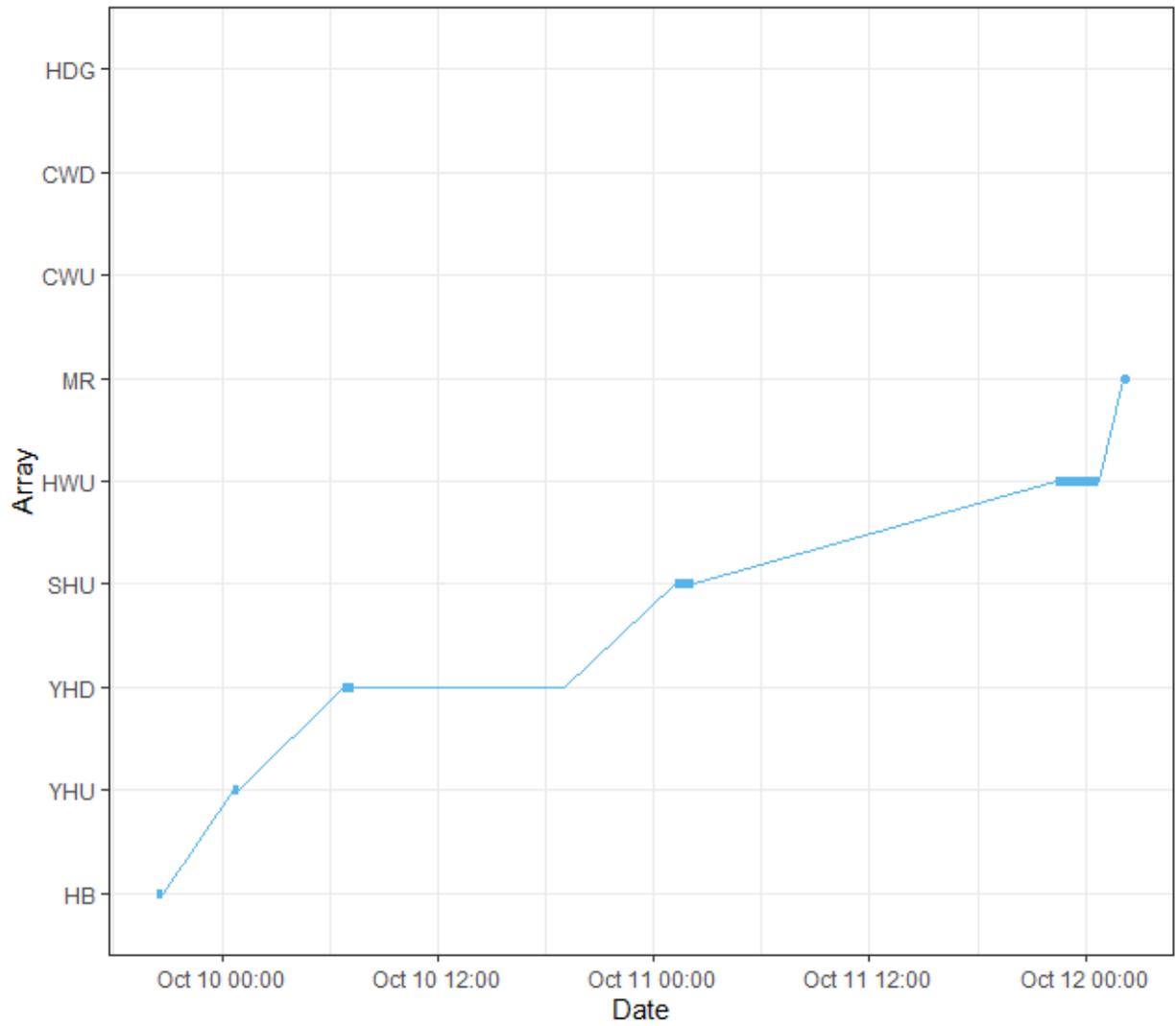
Transmitter A69-1604-14664 movement detection plot from 25 September – 8 December 2023. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14665 movement detection plot on 22 November 2023. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14666 movement detection plot from 24 September – 15 October 2023. This eel did not successfully exit the Susquehanna River.
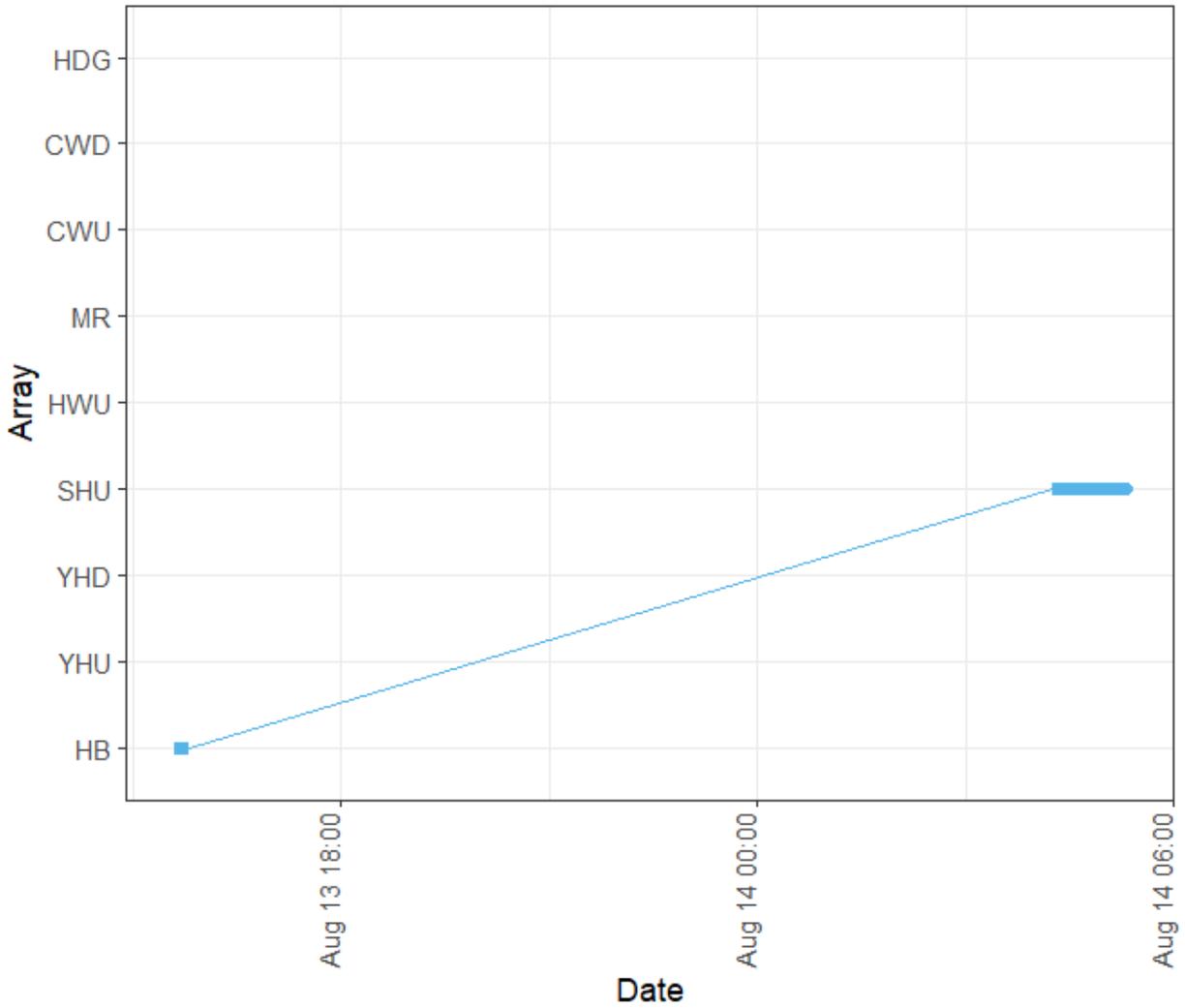
Transmitter A69-1604-14668 movement detection plot from 23-25 November 2023. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14669 movement detection plot from 20 September – 18 December 2023. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14670 movement detection plot from 23 August - 15 September 2023. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14671 movement detection plot from 30 November - 3 December 2024. This eel did not successfully exit the Susquehanna River.
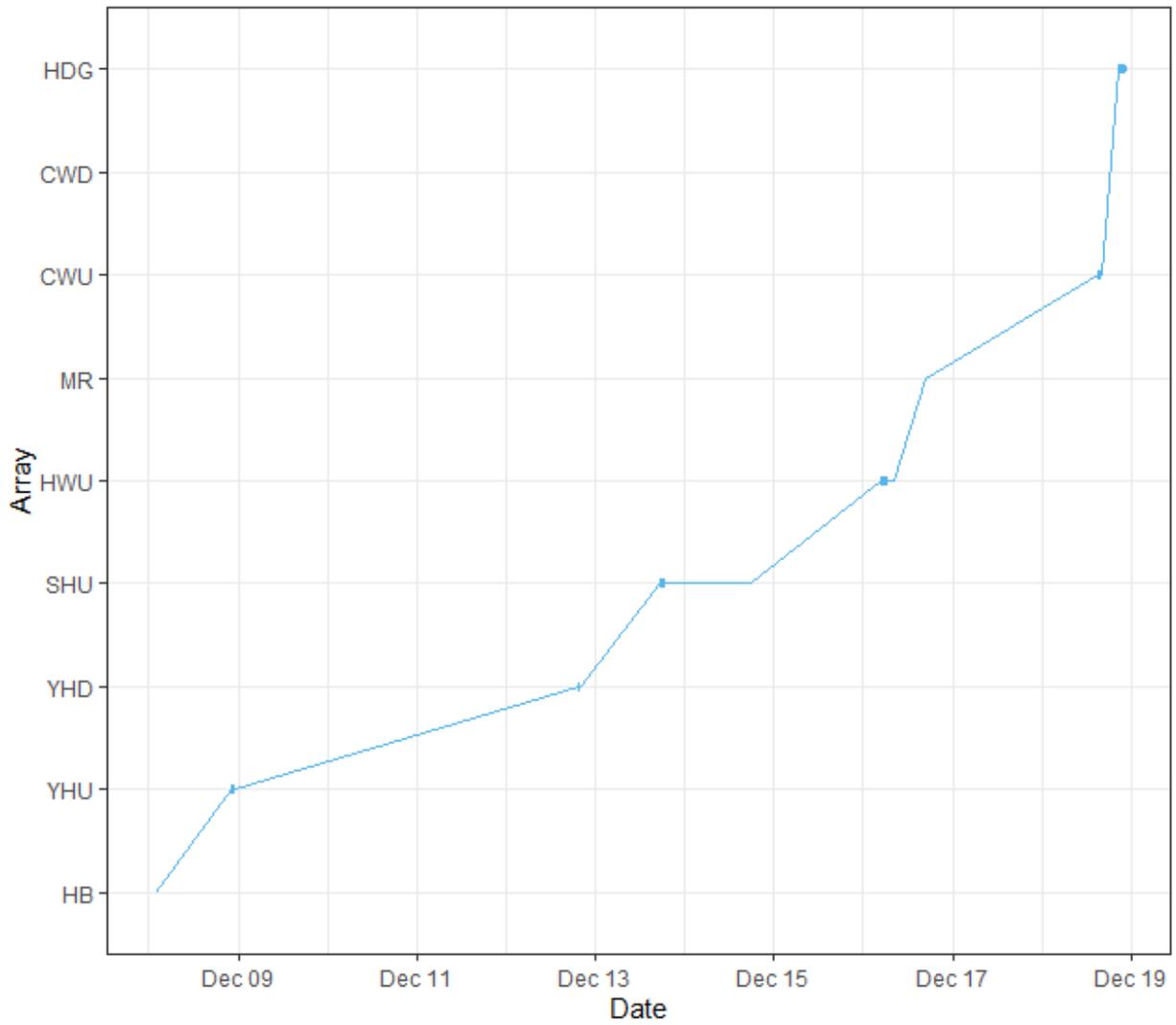
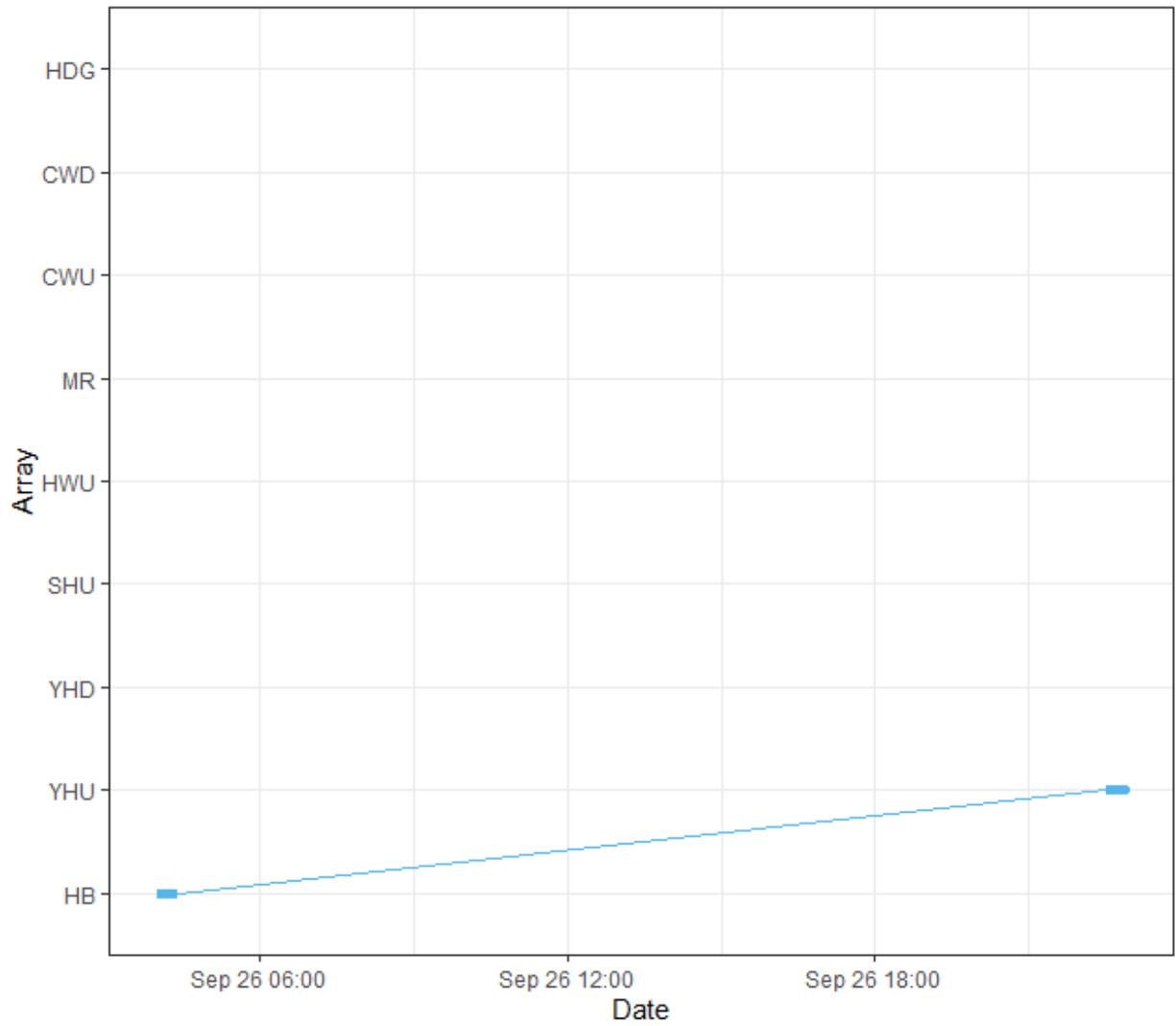Transmitter A69-1604-14672 movement detection plot from 9-12 October 2023. This eel did not successfully exit the Susquehanna River.

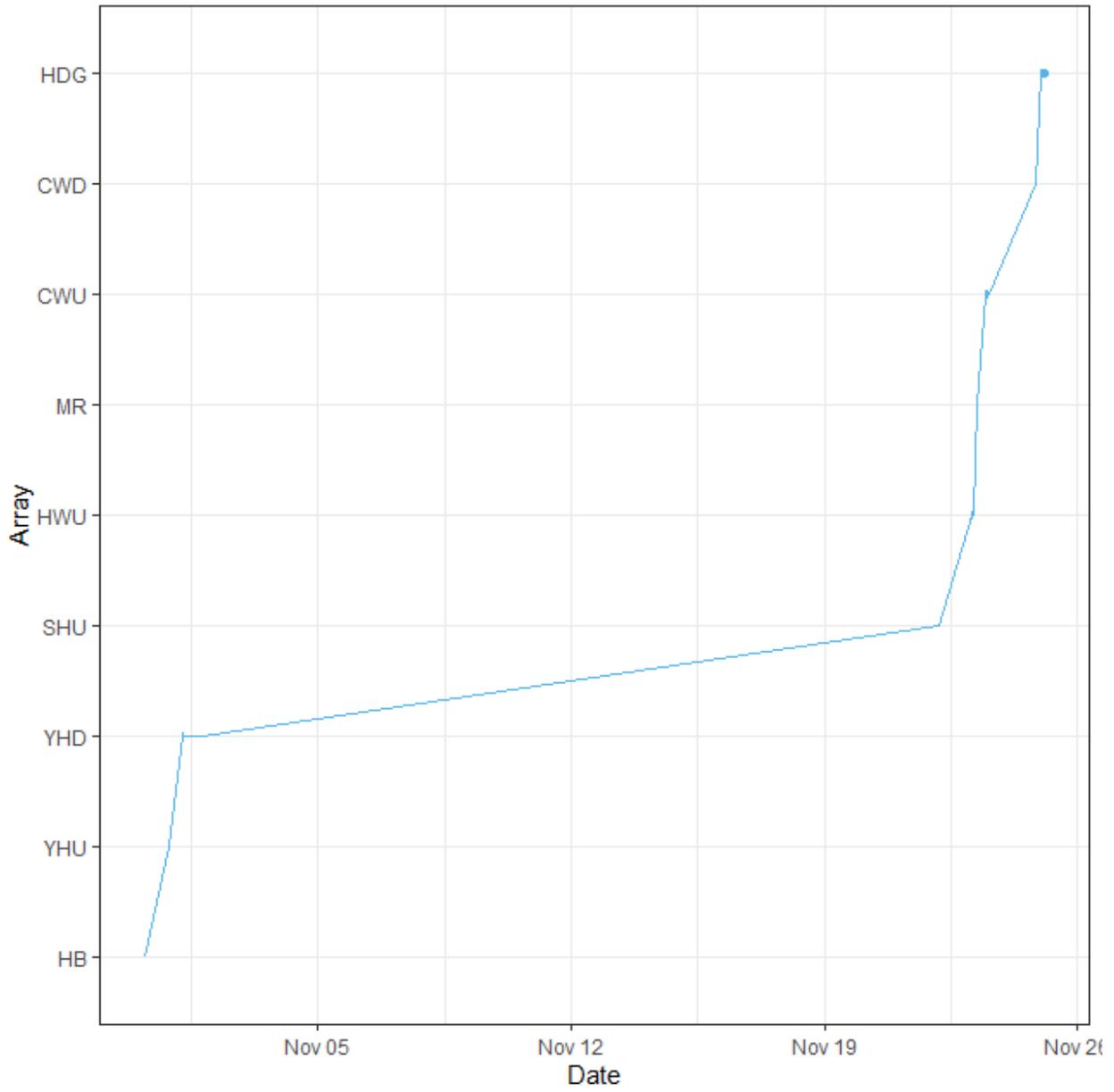Transmitter A69-1604-14673 movement detection plot from 13-14 August 2024. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14674 movement detection plot from 8-18 December 2023. This eel successfully exited the Susquehanna River.
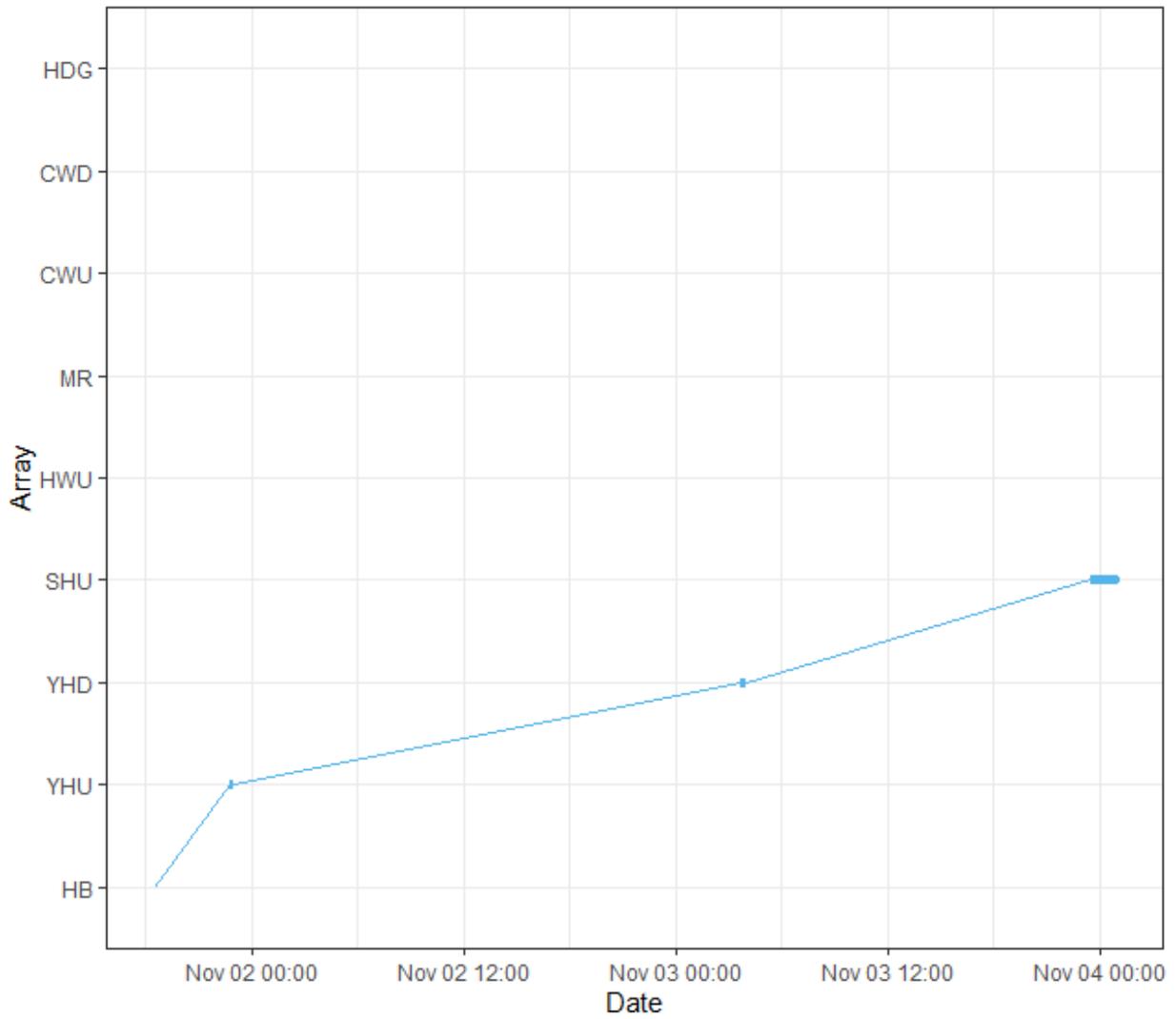
Transmitter A69-1604-14678 movement detection plot on 26 September 2023. This eel did not successfully exit the Susquehanna River.
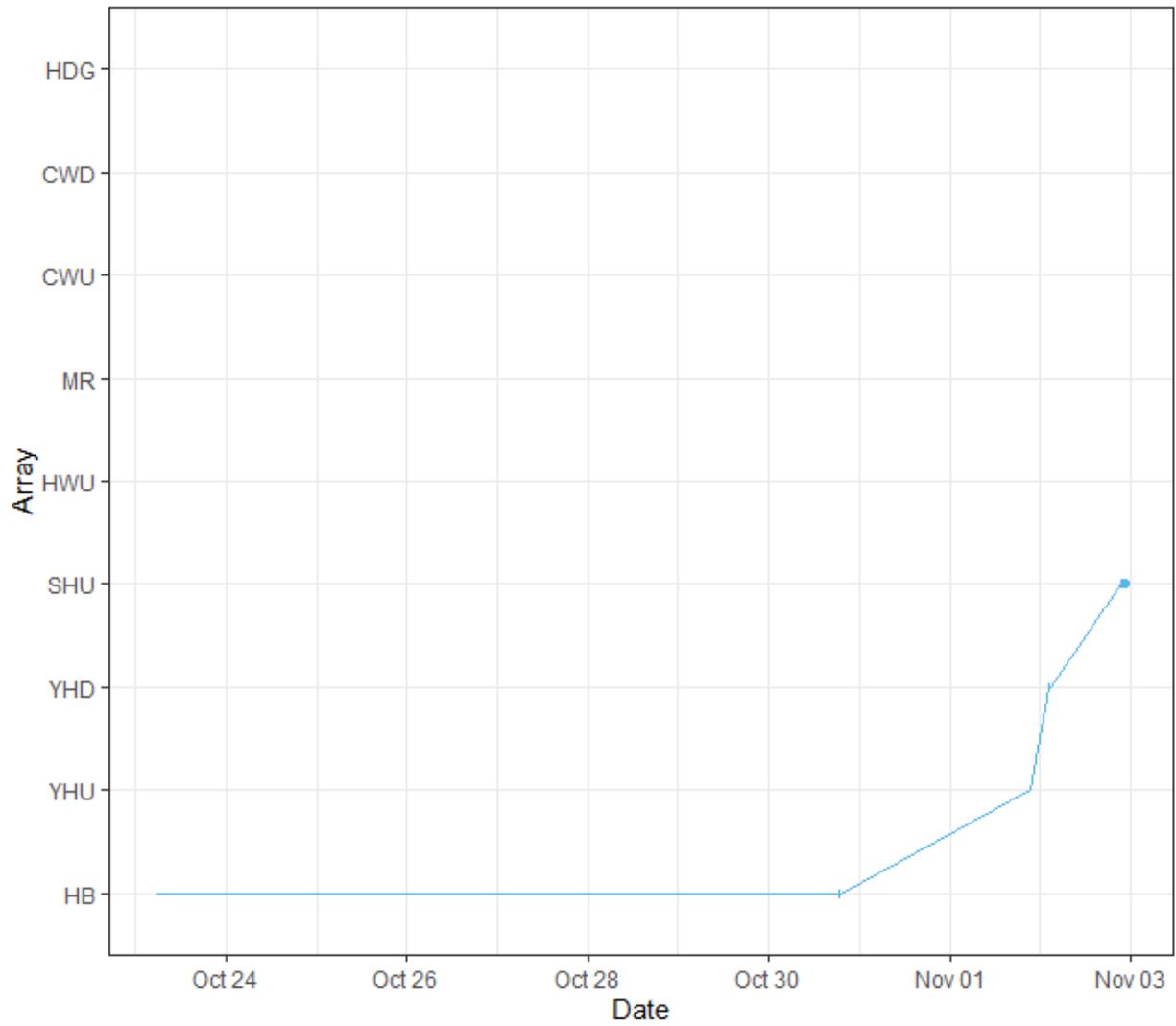
Transmitter A69-1604-14679 movement detection plot from 1-25 November 2023 September 2023. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14681 movement detection plot from 17 October - 4 November 2023.
This eel did not successfully exit the Susquehanna River.

A69-1604-14682

Transmitter A69-1604-14682 movement detection plot from 23 October - 2 November 2023.
This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14684 movement detection plot from 2-5 November 2023. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14685 movement detection plot from 1-10 November 2023. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14686 movement detection plot from 10-17 August 2024. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14687 movement detection plot from 22 October – 23 November 2023. This eel successfully exited the Susquehanna River.
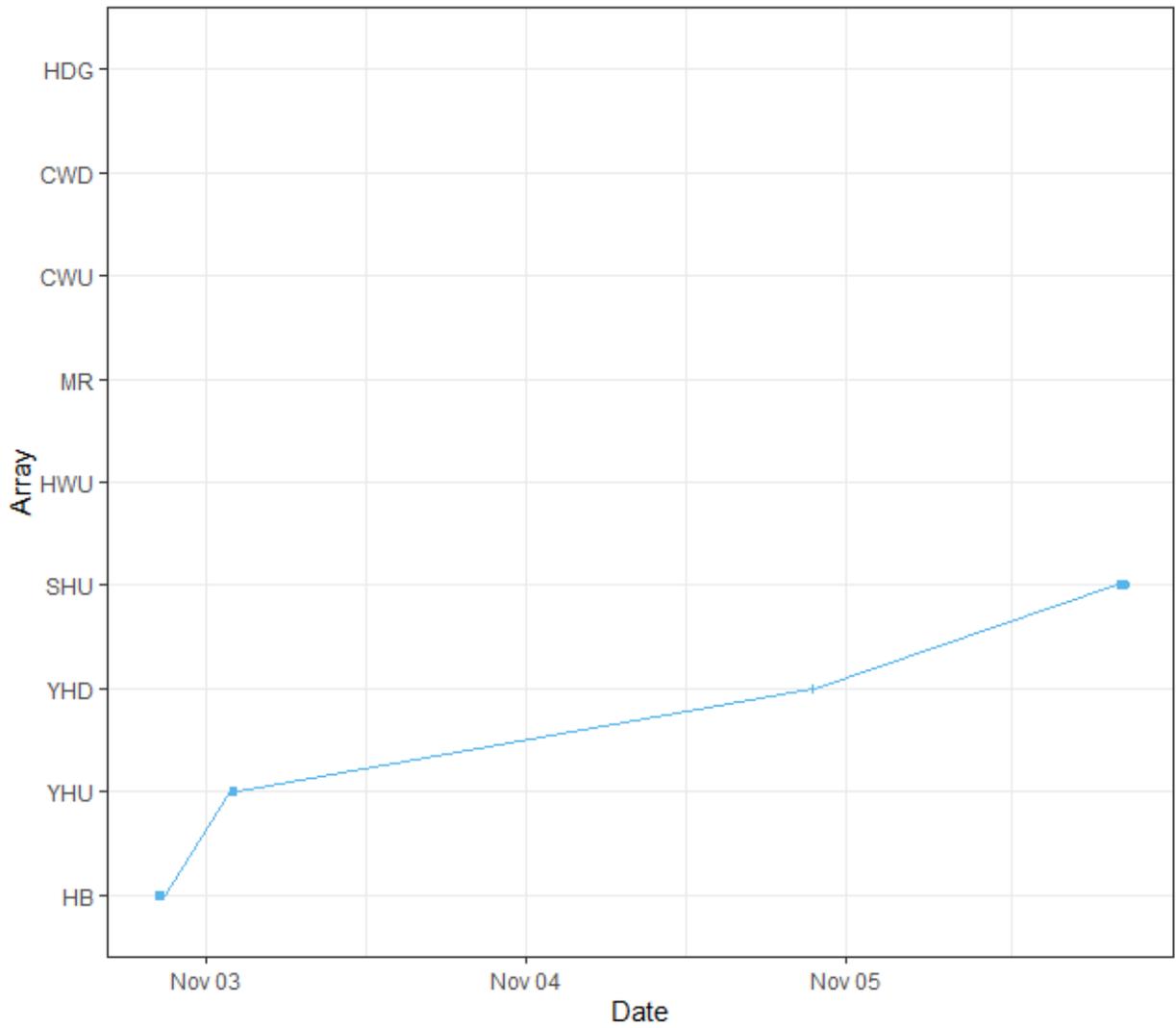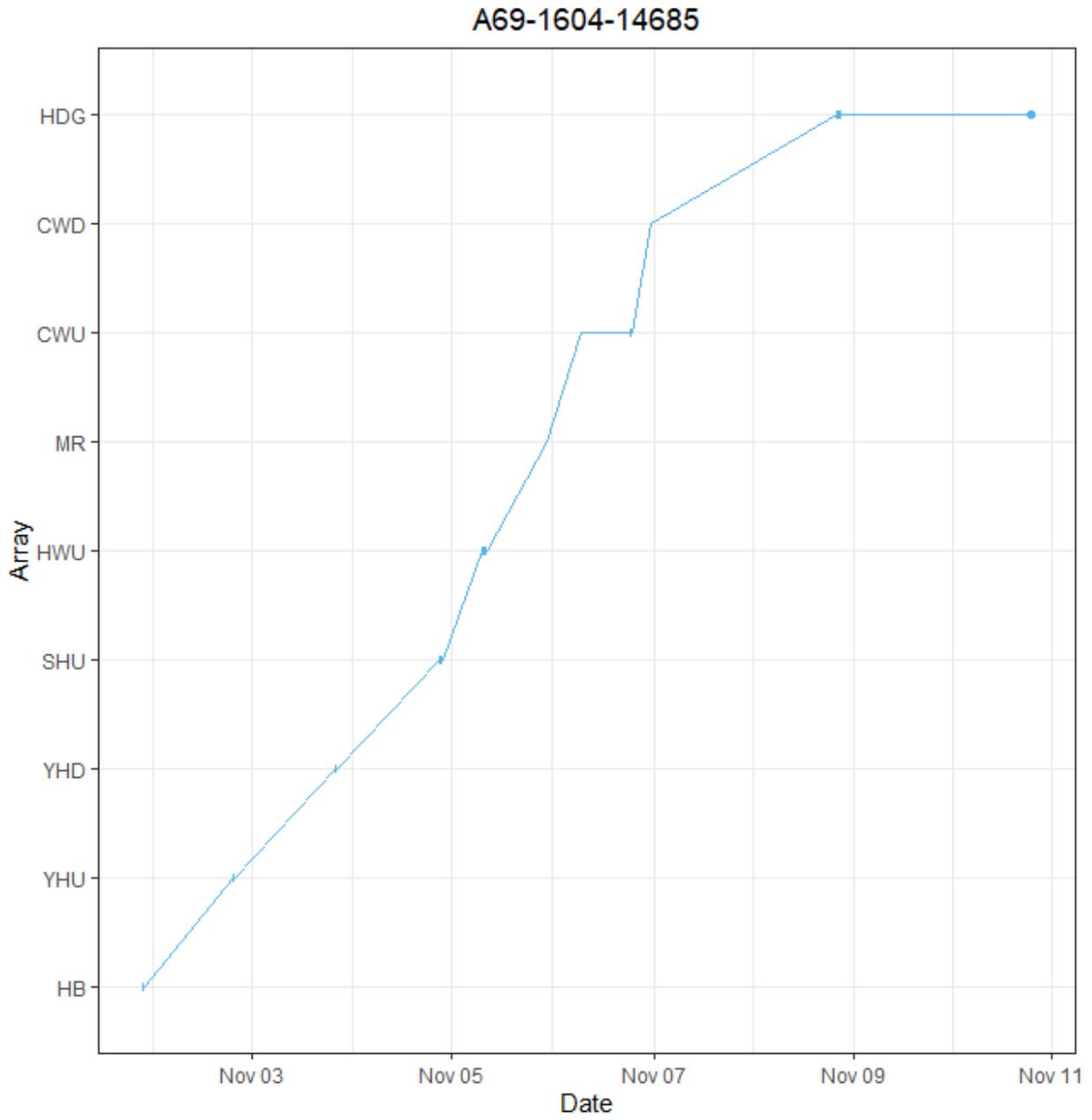
Transmitter A69-1604-14688 movement detection plot from 27 September – 6 November 2023. This eel did not successfully exit the Susquehanna River.

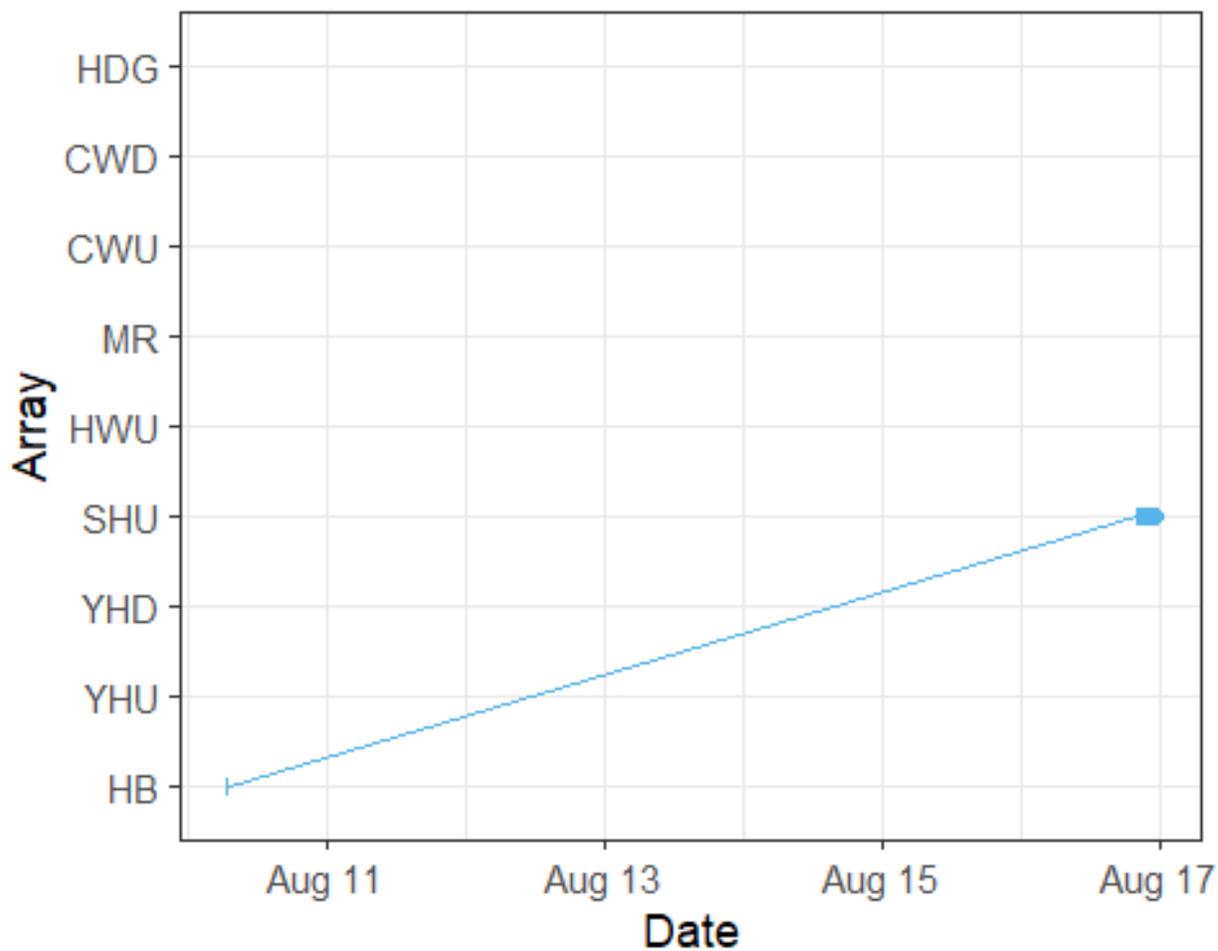Transmitter A69-1604-14689 movement detection plot from 23-26 November 2023. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14691 movement detection plot from 12-13 December 2024. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14691 movement detection plot from 27 September – 17 October 2023. This eel did not successfully exit the Susquehanna River.
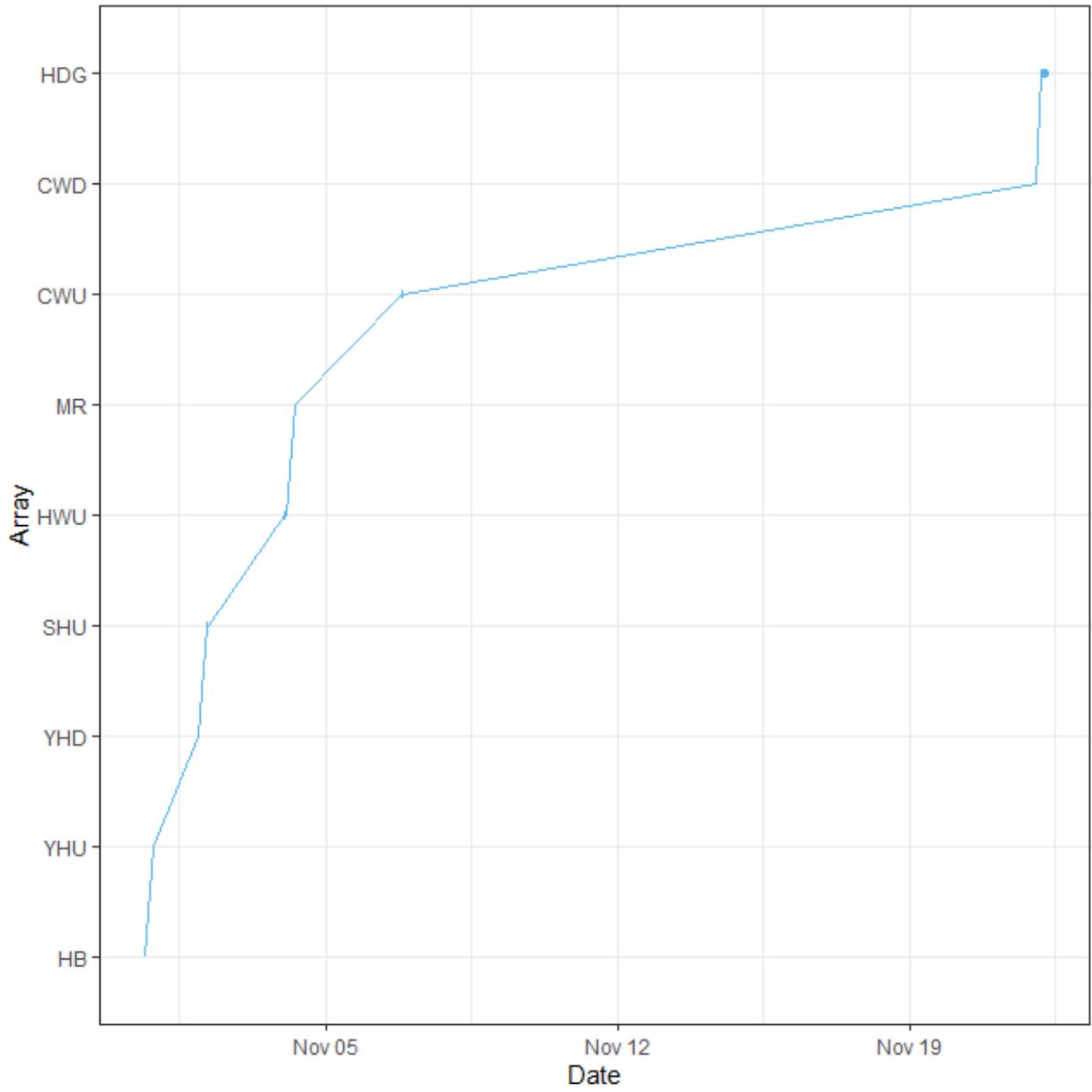
Transmitter A69-1604-14692 movement detection plot from 17-18 November 2023. This eel did not successfully exit the Susquehanna River.

A69-1604-14693

Transmitter A69-1604-14693 movement detection plot from 1-7 December 2024. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14694 movement detection plot from 23 November – 3 December 2023. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14695 movement detection plot from 22-23 November 2023. This eel did not successfully exit the Susquehanna River.
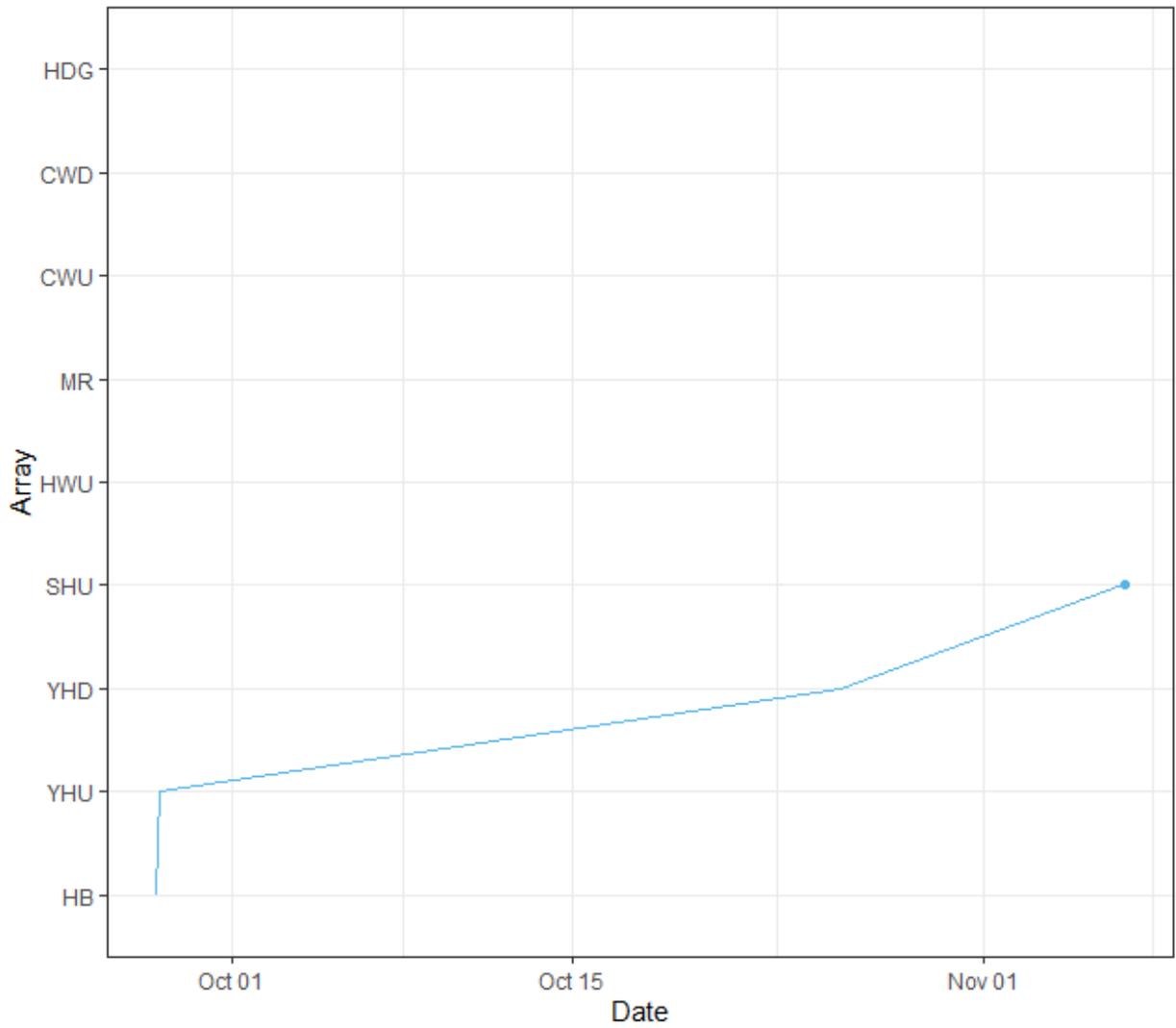
A69-1604-14696

Transmitter A69-1604-14696 movement detection plot from 28 September – 16 October 2023. This eel successfully exited the Susquehanna River.

A69-1604-14697
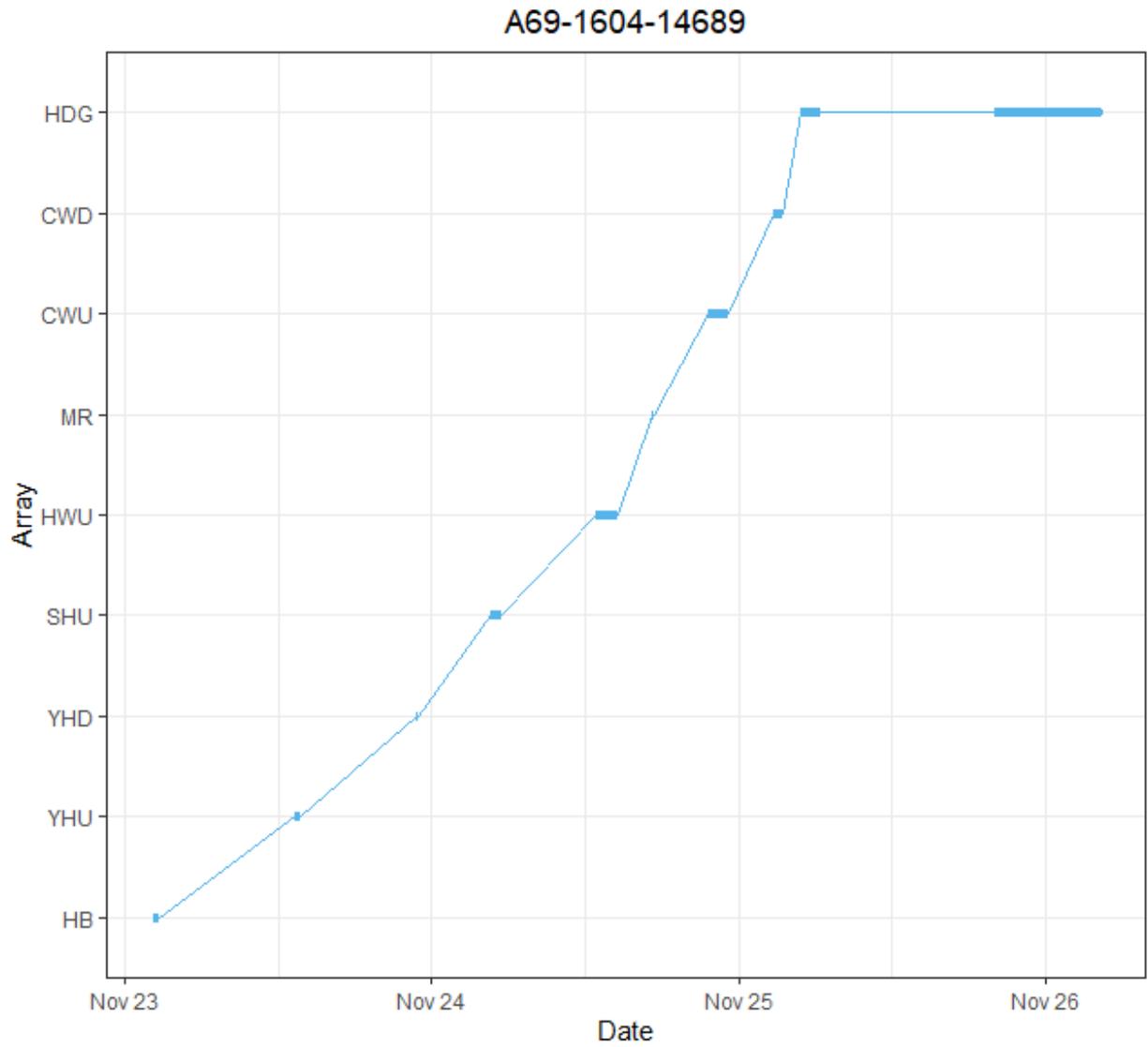
Transmitter A69-1604-14697 movement detection plot from 17 October – 28 November 2023. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14698 movement detection plot from 23-29 November 2023. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14699 movement detection plot from 25 September - 5 November 2023. This eel successfully exited the Susquehanna River.

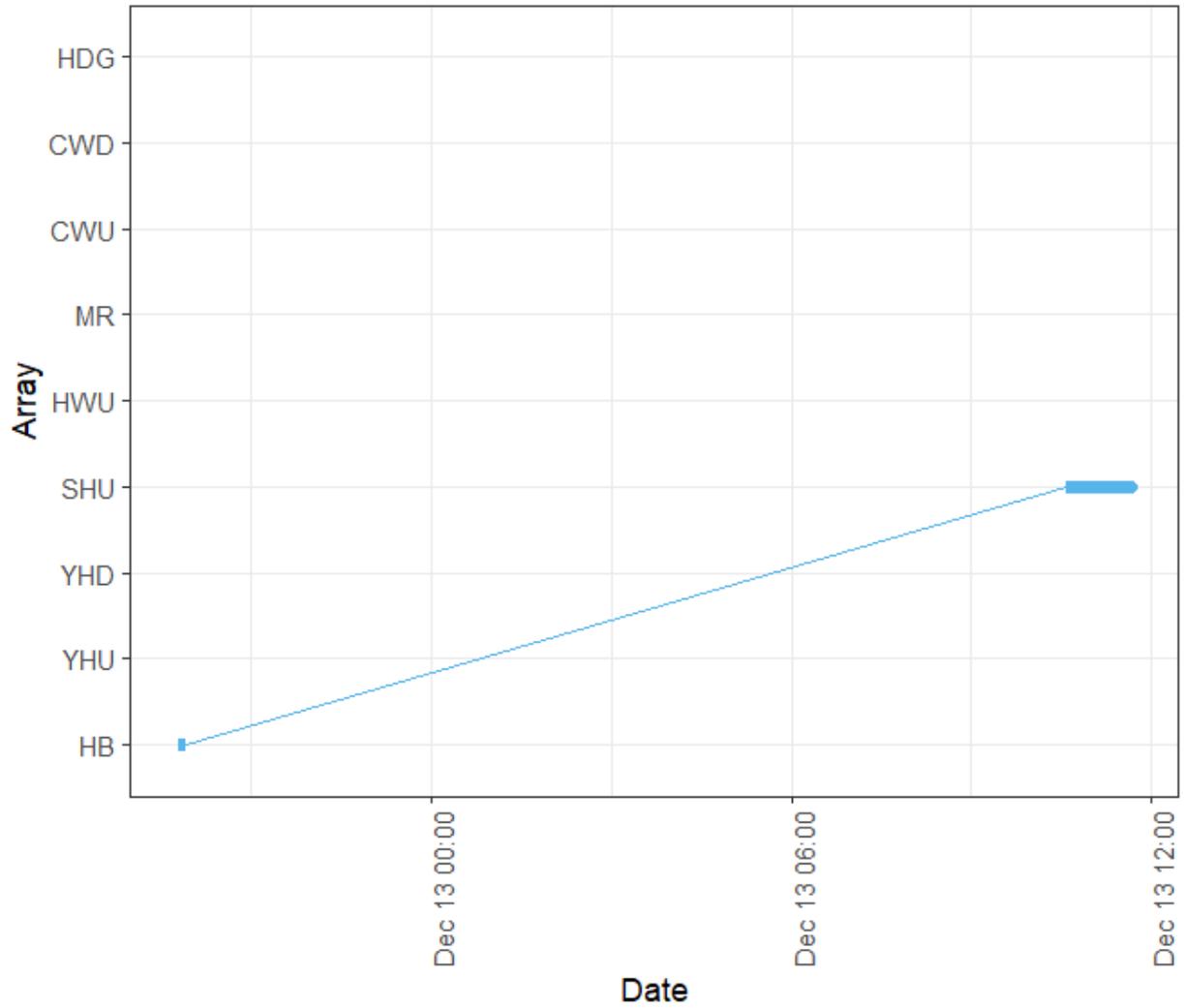Transmitter A69-1604-14700 movement detection plot from 26 September - 29 November 2023. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14701 movement detection plot from 18-19 December 2023. This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14702 movement detection plot from 25 September – 15 October 2023. This eel did not successfully exit the Susquehanna River.
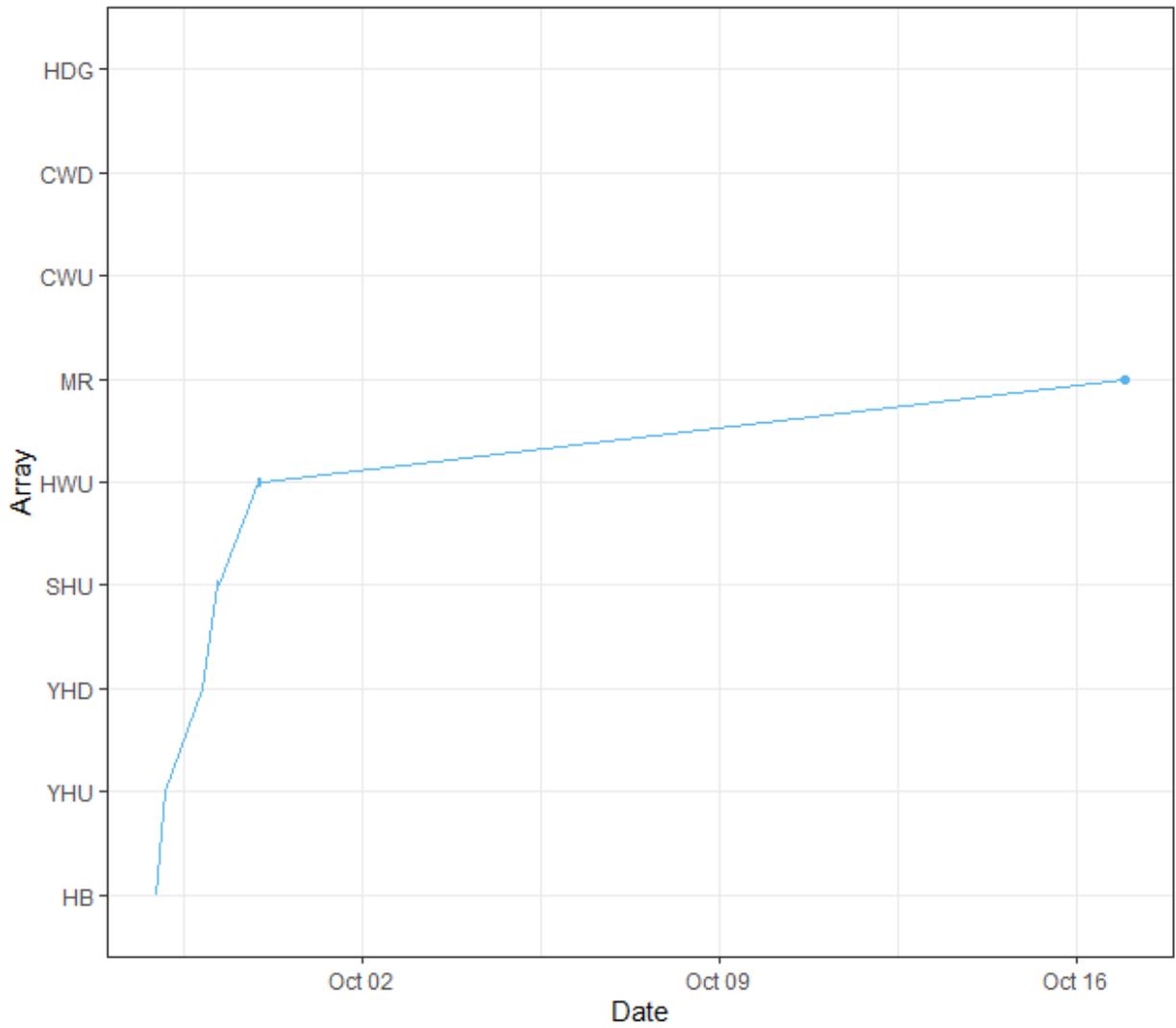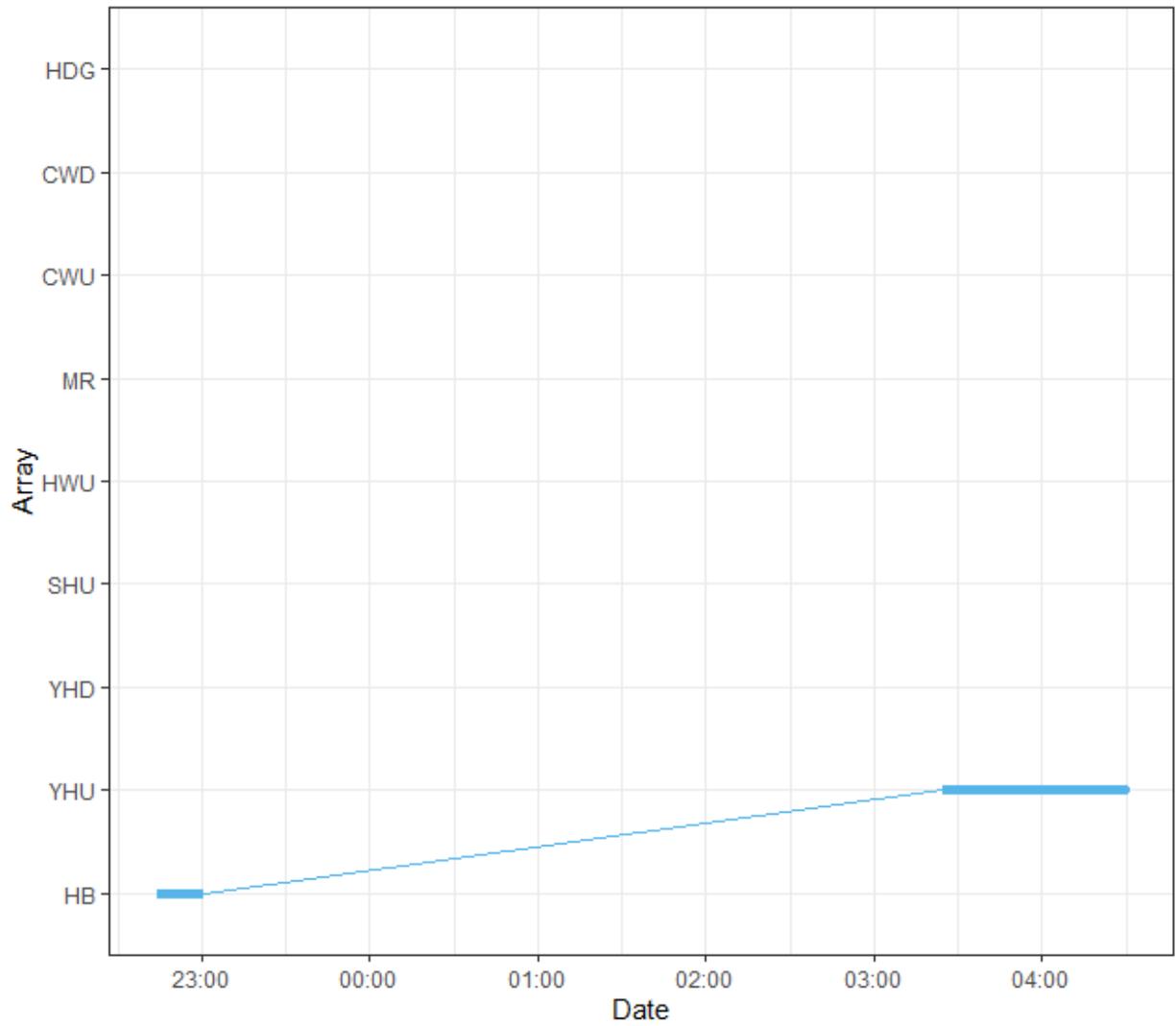
Transmitter A69-1604-14703 movement detection plot from 10 October - 5 November 2023.
This eel did not successfully exit the Susquehanna River.

A69-1604-14704

Transmitter A69-1604-14704 movement detection plot from 22-27 November 2023. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14705 movement detection plot from 17 October - 27 November 2022.
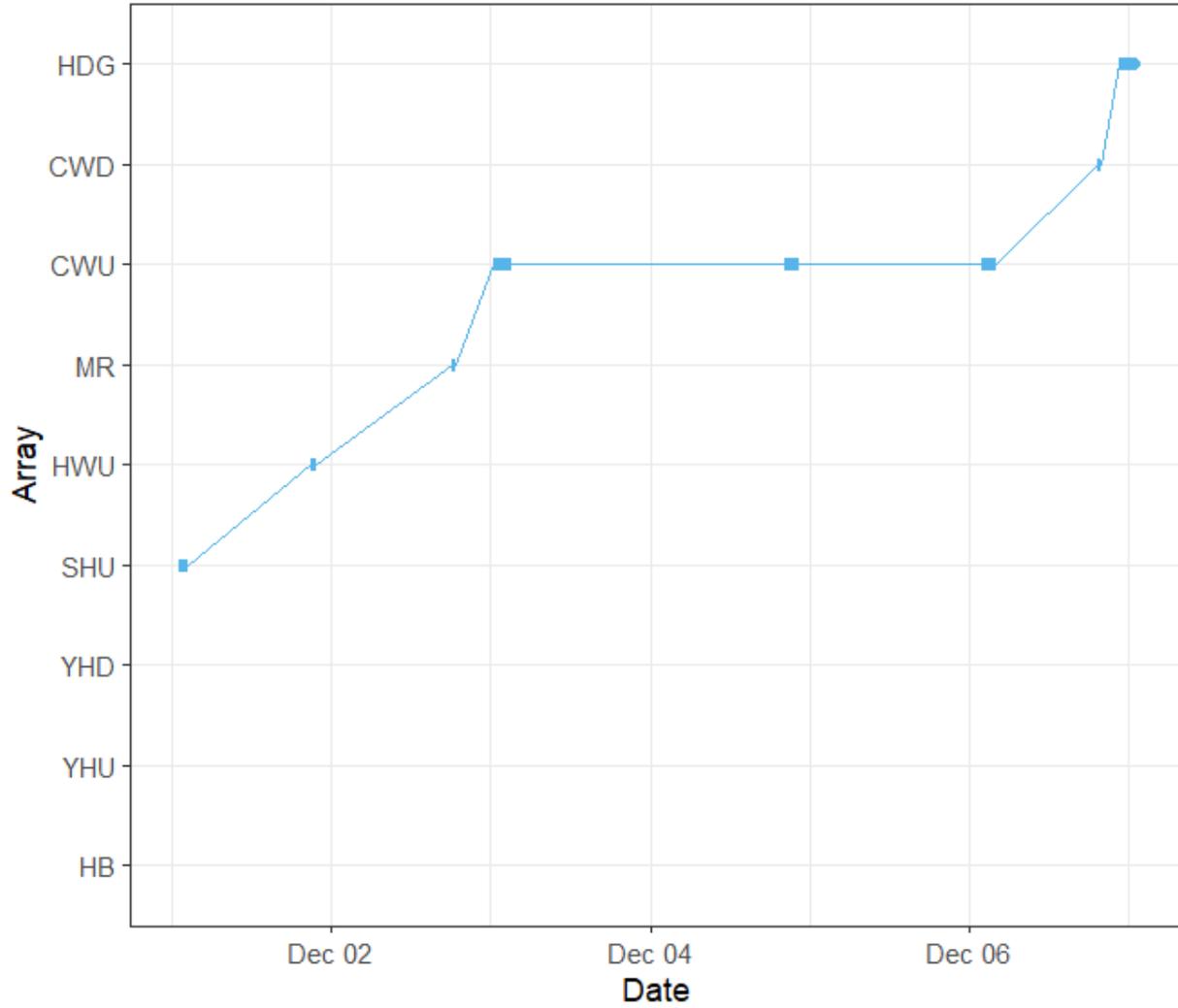This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14706 movement detection plot from 25 September – 17 October 2023.
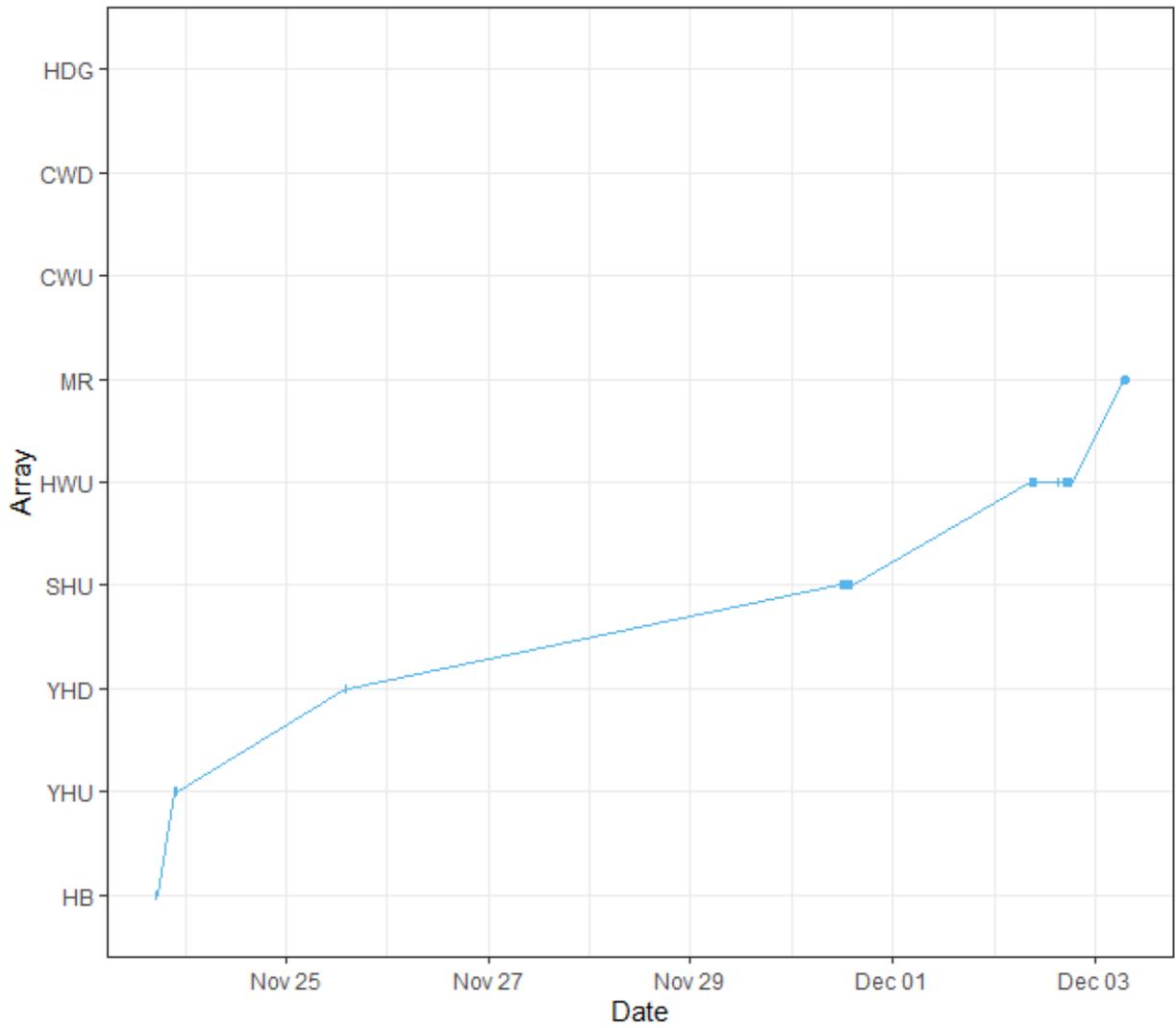This eel did not successfully exit the Susquehanna River.

Transmitter A69-1604-14707 movement detection plot from 22-27 November 2023. This eel successfully exited the Susquehanna River.

A69-1604-14708

Transmitter A69-1604-14708 movement detection plot from 10 October - 28 November 2023.
This eel successfully exited the Susquehanna River.

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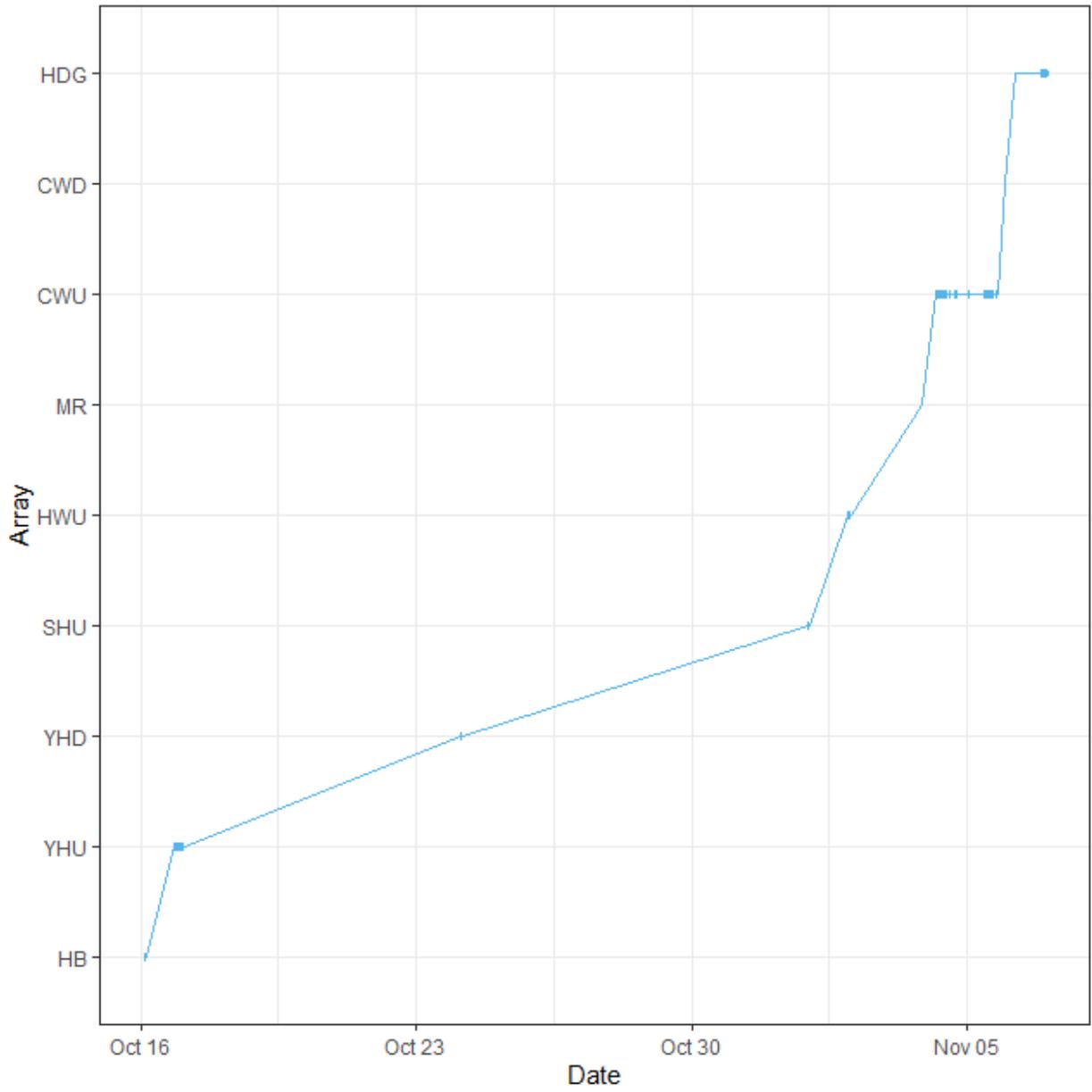
Transmitter A69-1604-14709 movement detection plot from 16 October - 7 November 2023. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14710 movement detection plot on 13 November 2023. This eel did not successfully exit the Susquehanna River.
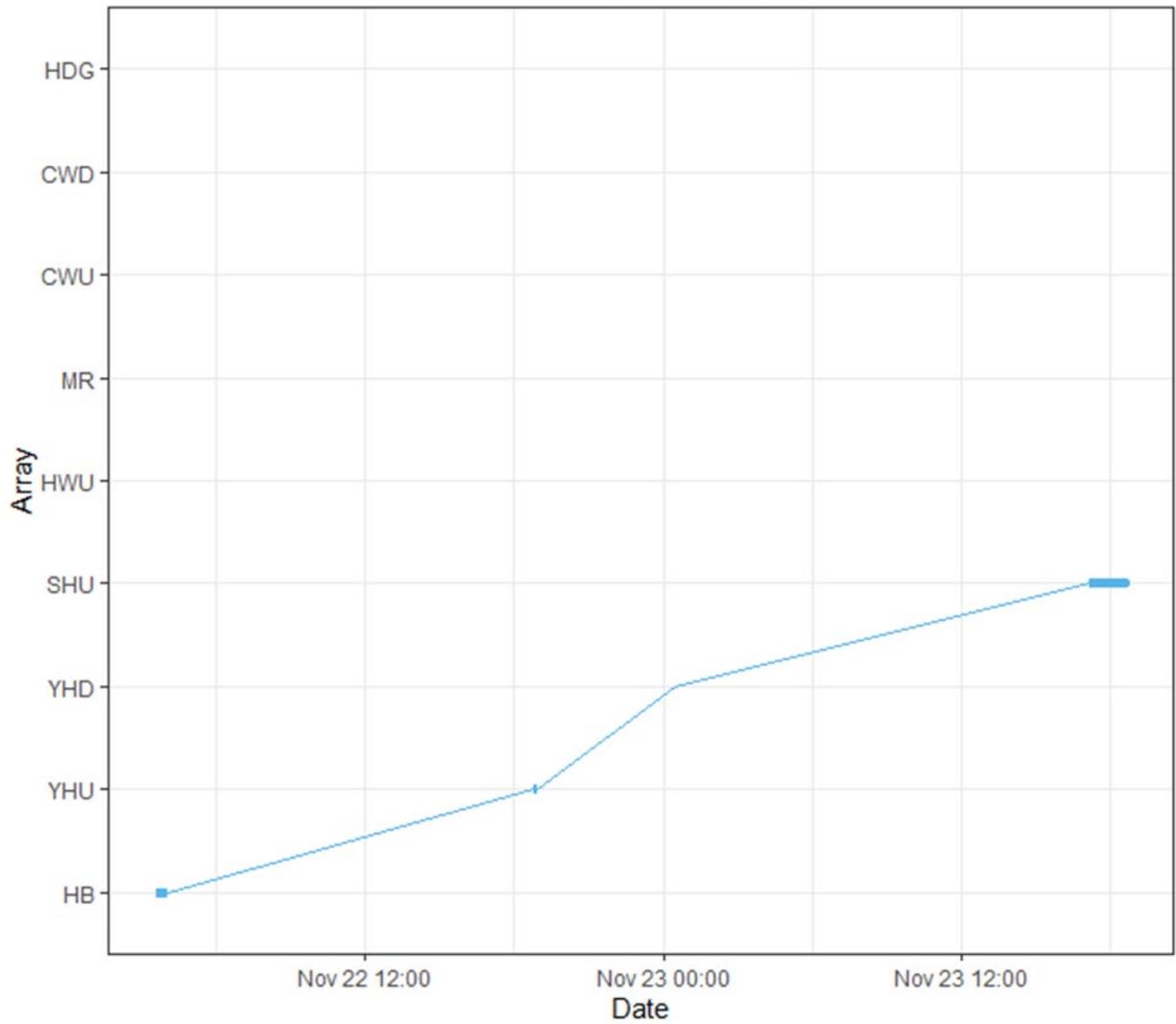
Transmitter A69-1604-14711 movement detection plot on 1-27 November 2023. This eel successfully exited the Susquehanna River.

Transmitter A69-1604-14712 movement detection plot from 23-25 November 2023. This eel did not successfully exit the Susquehanna River.
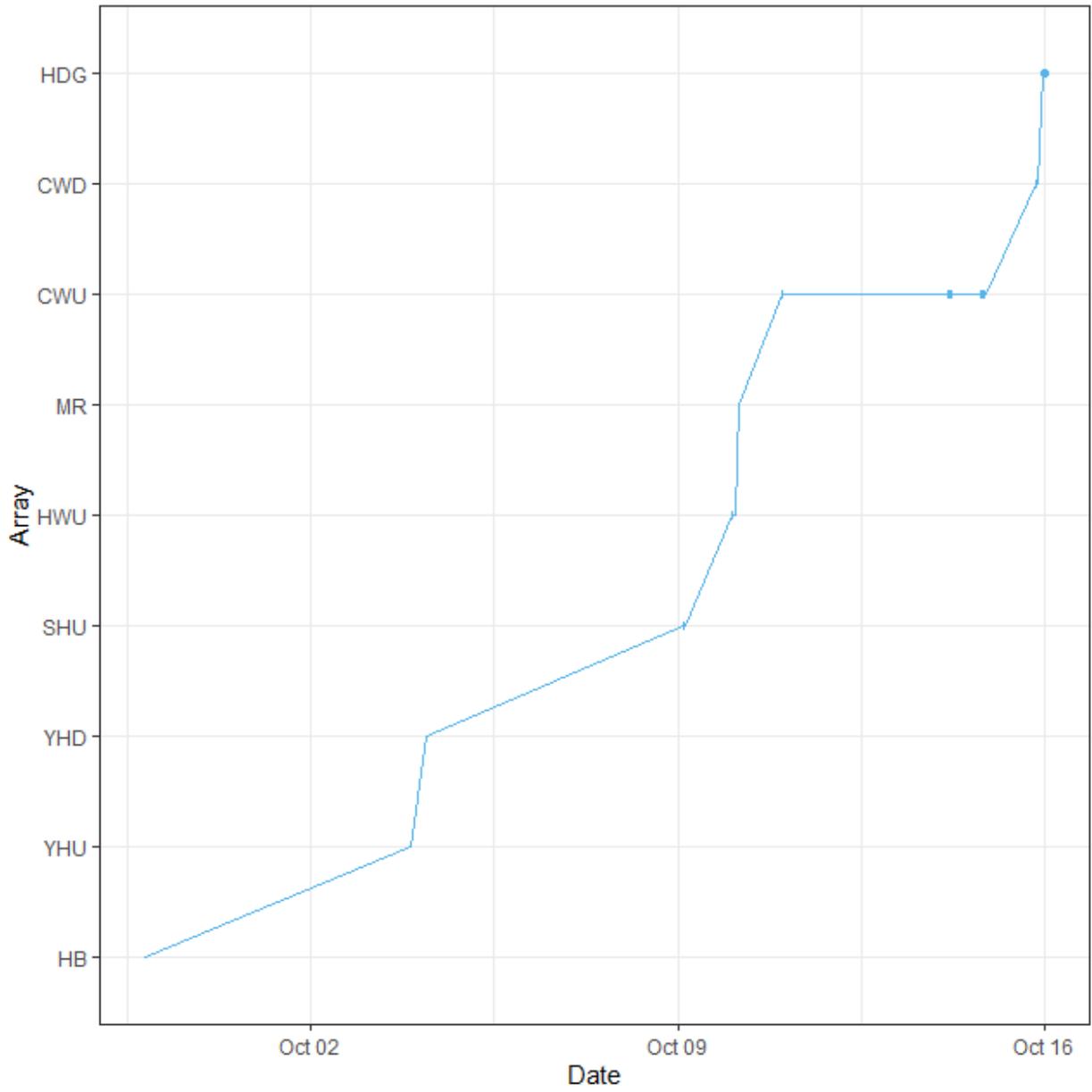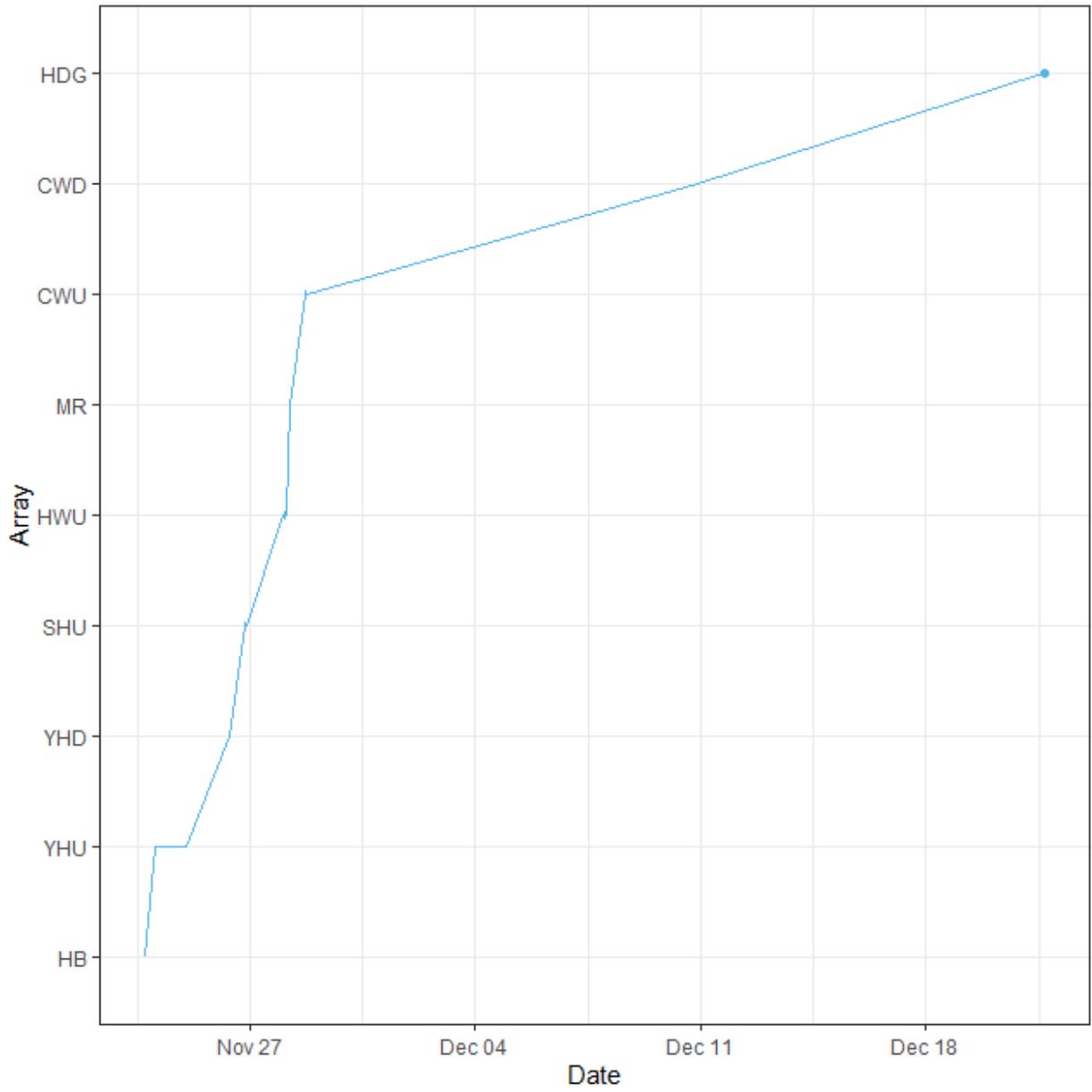
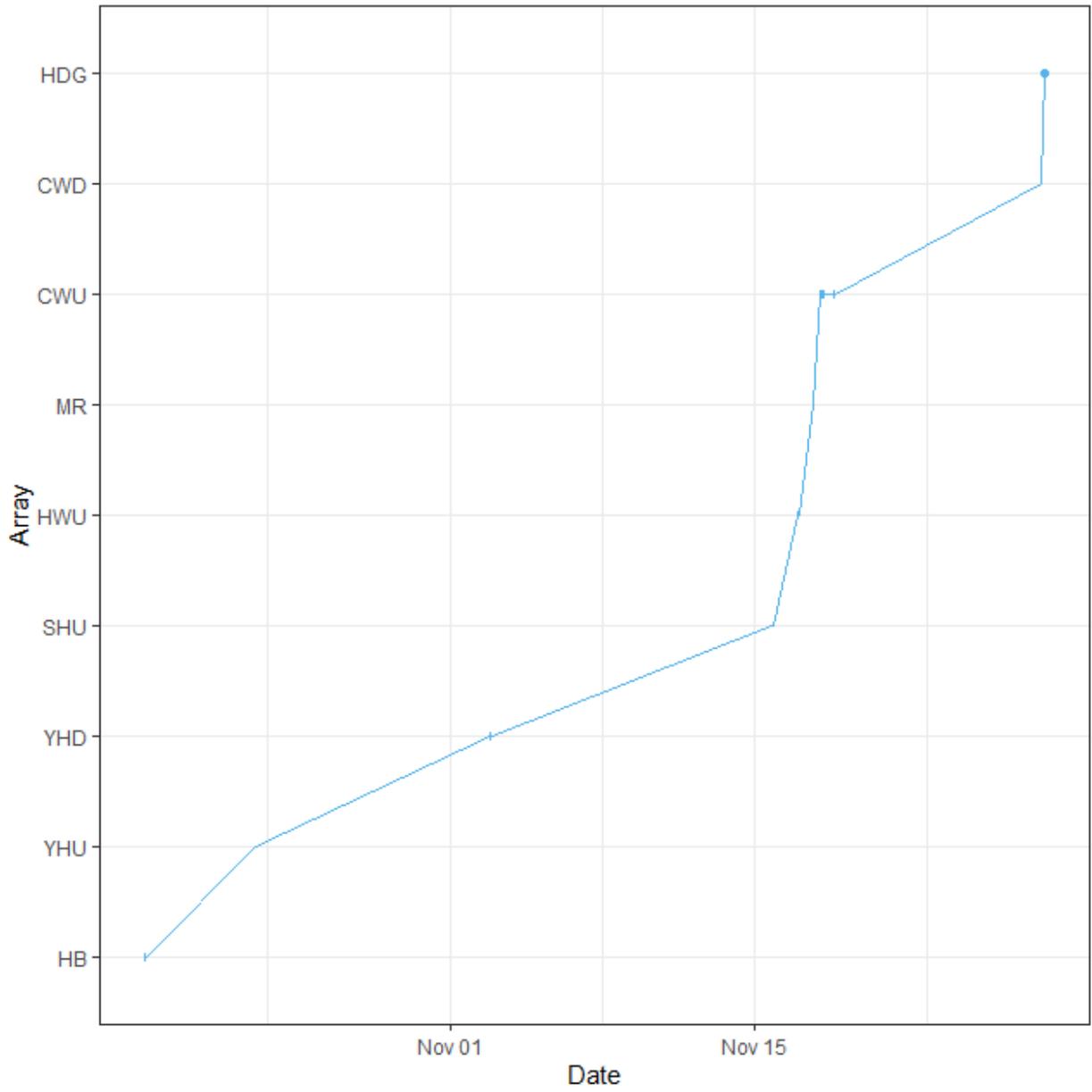Transmitter A69-1604-14713 movement detection plot on 23 November – 21 December 2023. This eel successfully exited the Susquehanna River.
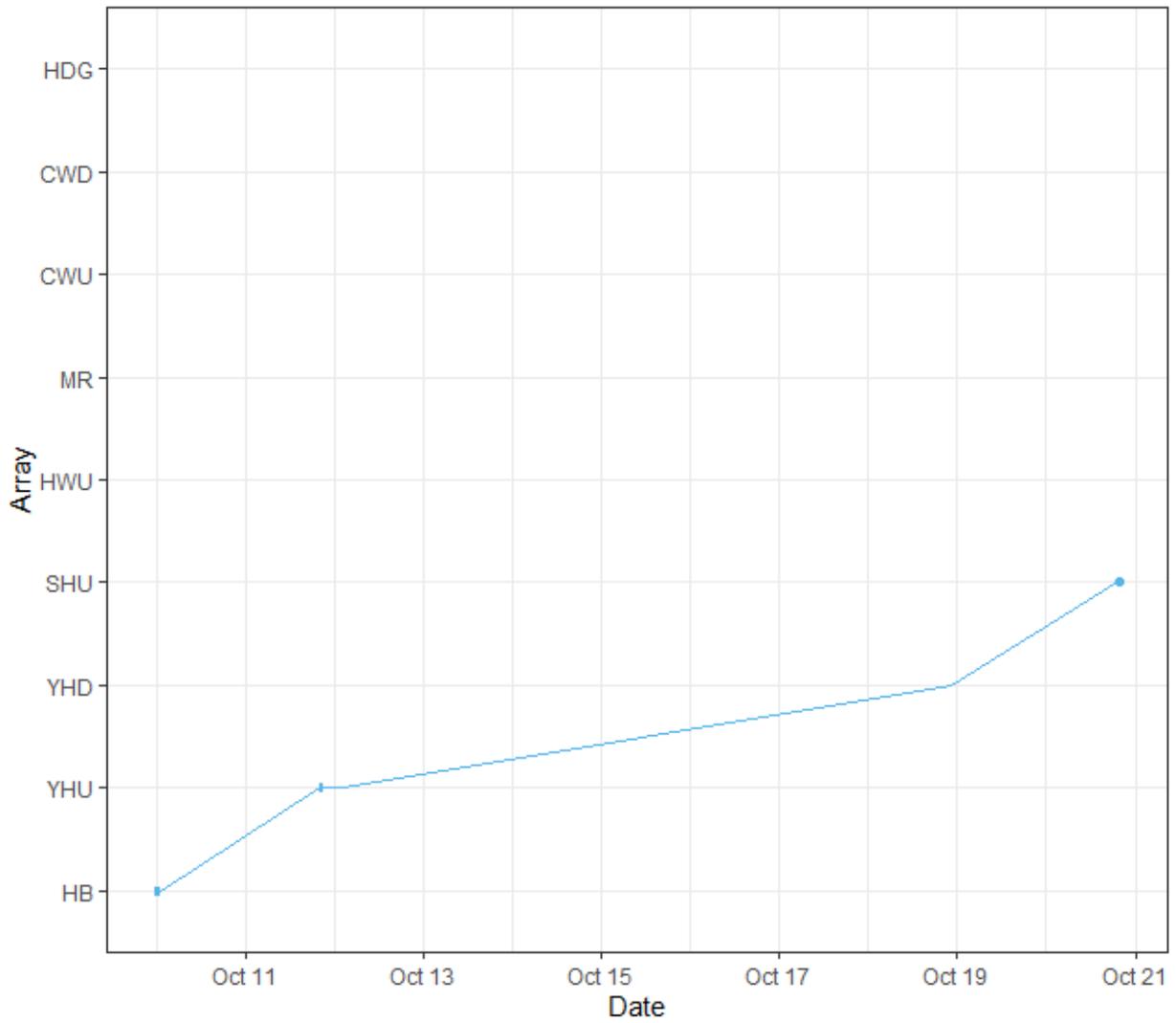
Transmitter A69-1604-14714 movement detection plot from 10-20 October 2023. This eel did not successfully exit the Susquehanna River.
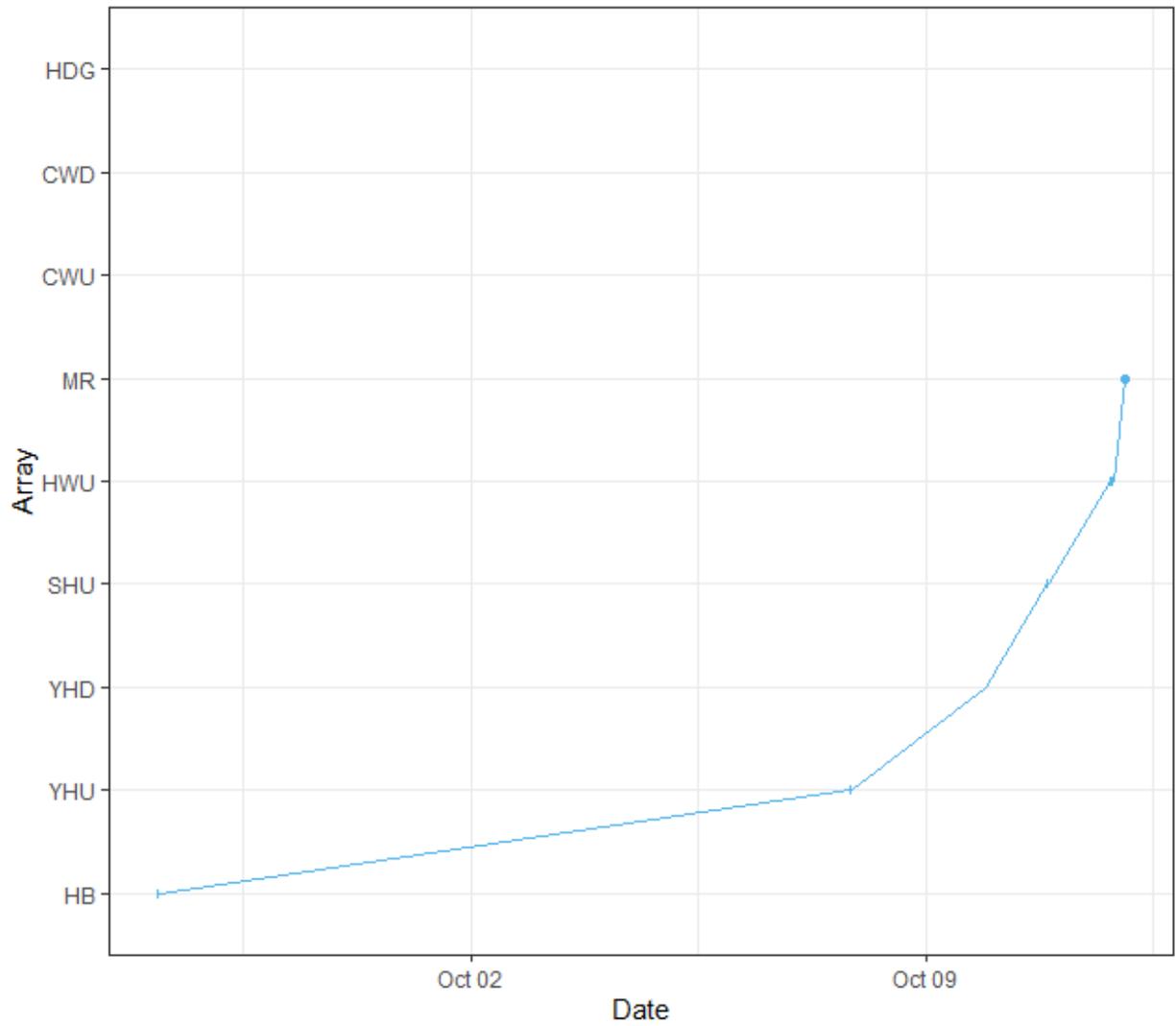
Transmitter A69-1604-14715 movement detection plot from 27 September – 12 October 2023. This eel did not successfully exit the Susquehanna River.
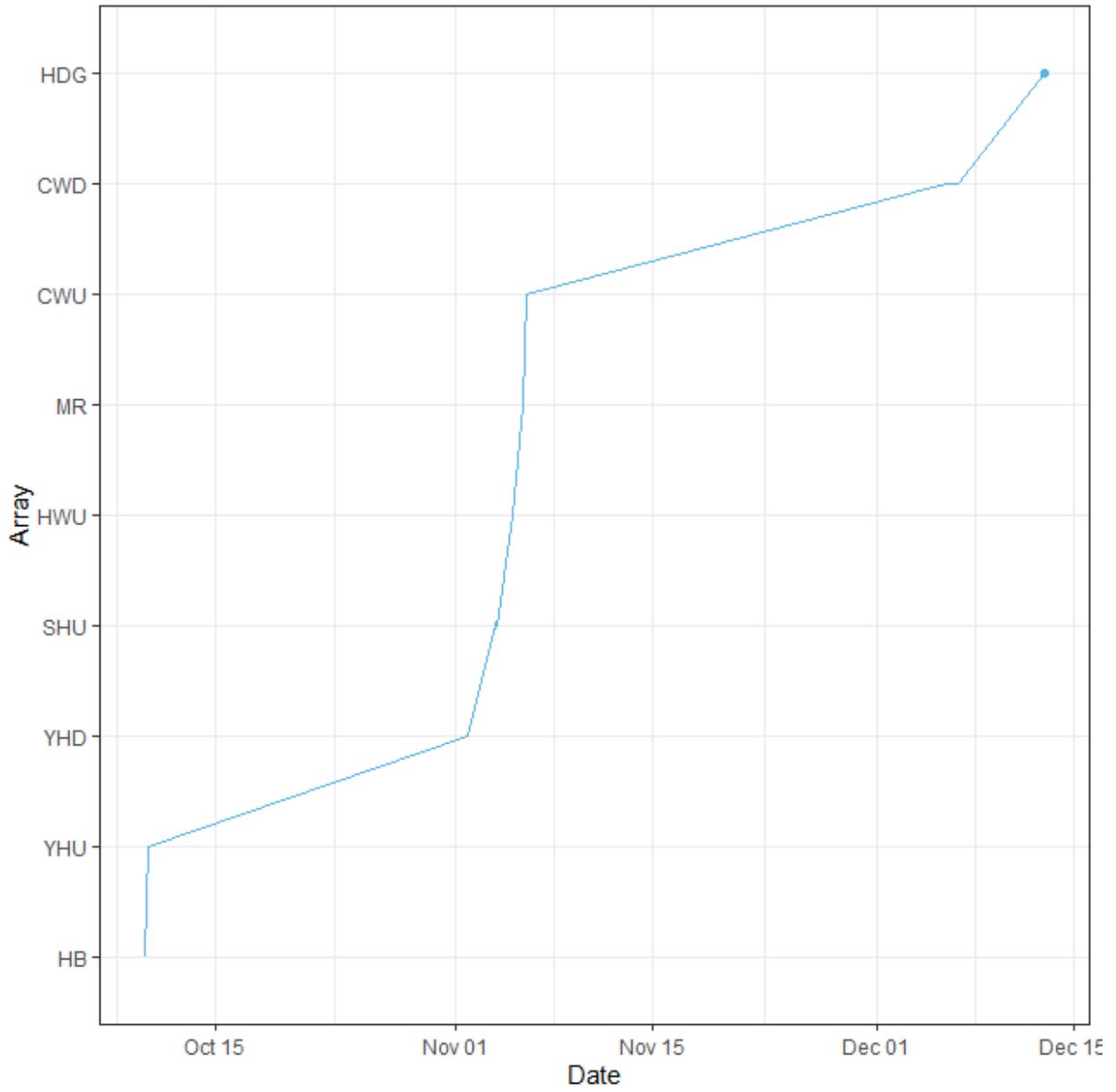
Transmitter A69-1604-14717 movement detection plot from 9 October – 12 December 2023. This eel successfully exited the Susquehanna River.
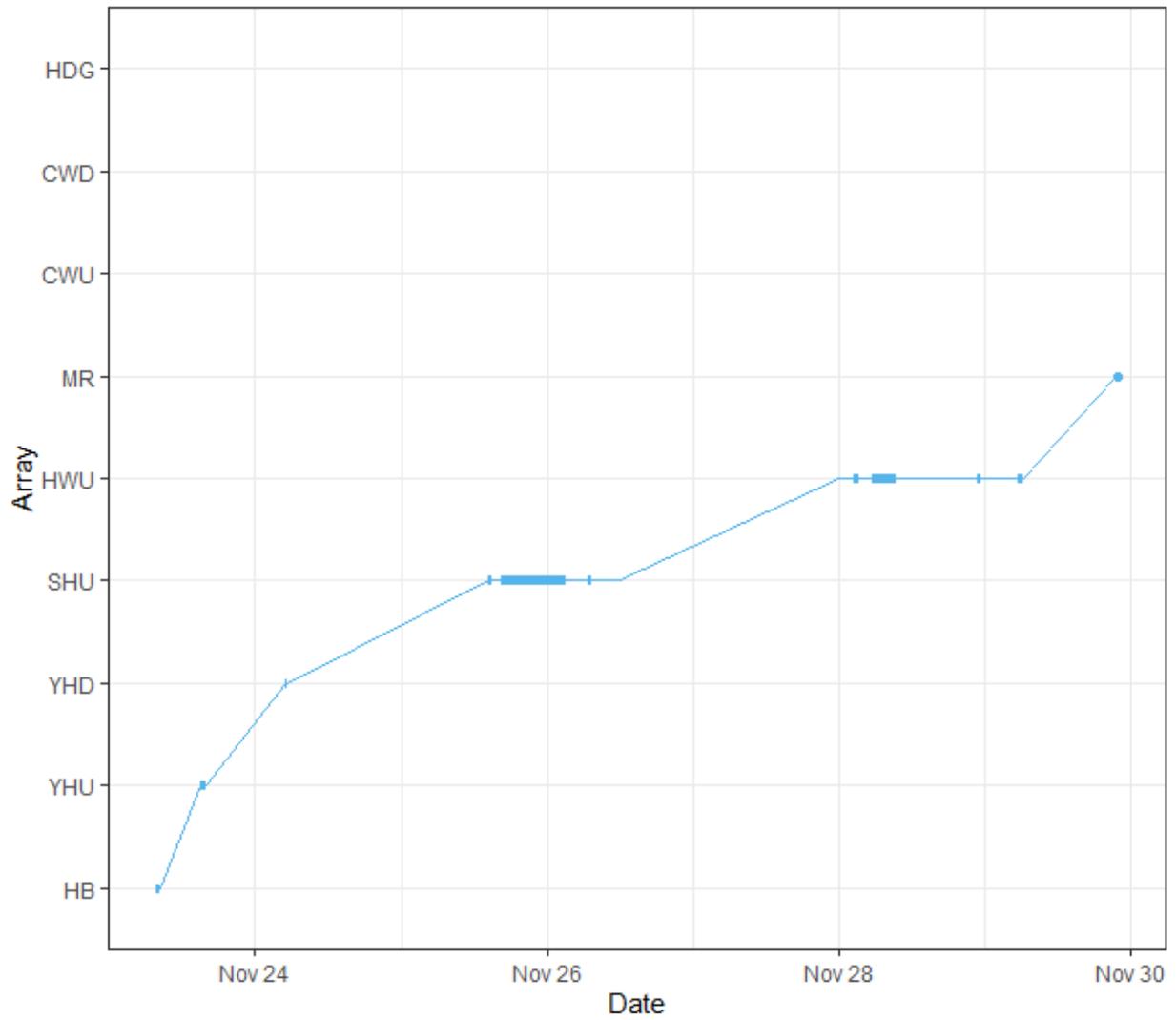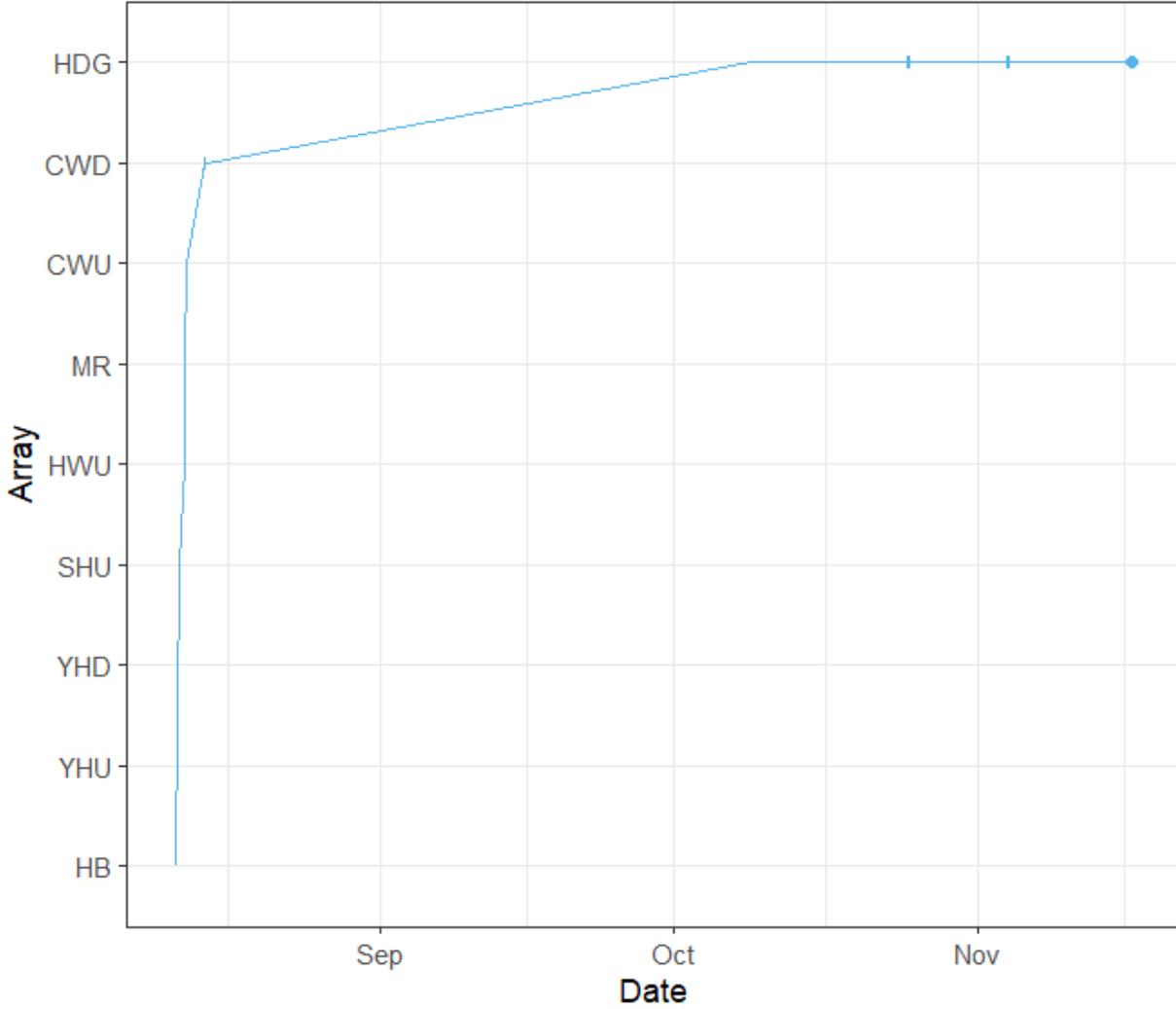
Transmitter A69-1604-14718 movement detection plot from 11 August – 16 October 2024. This eel successfully exited the Susquehanna River.
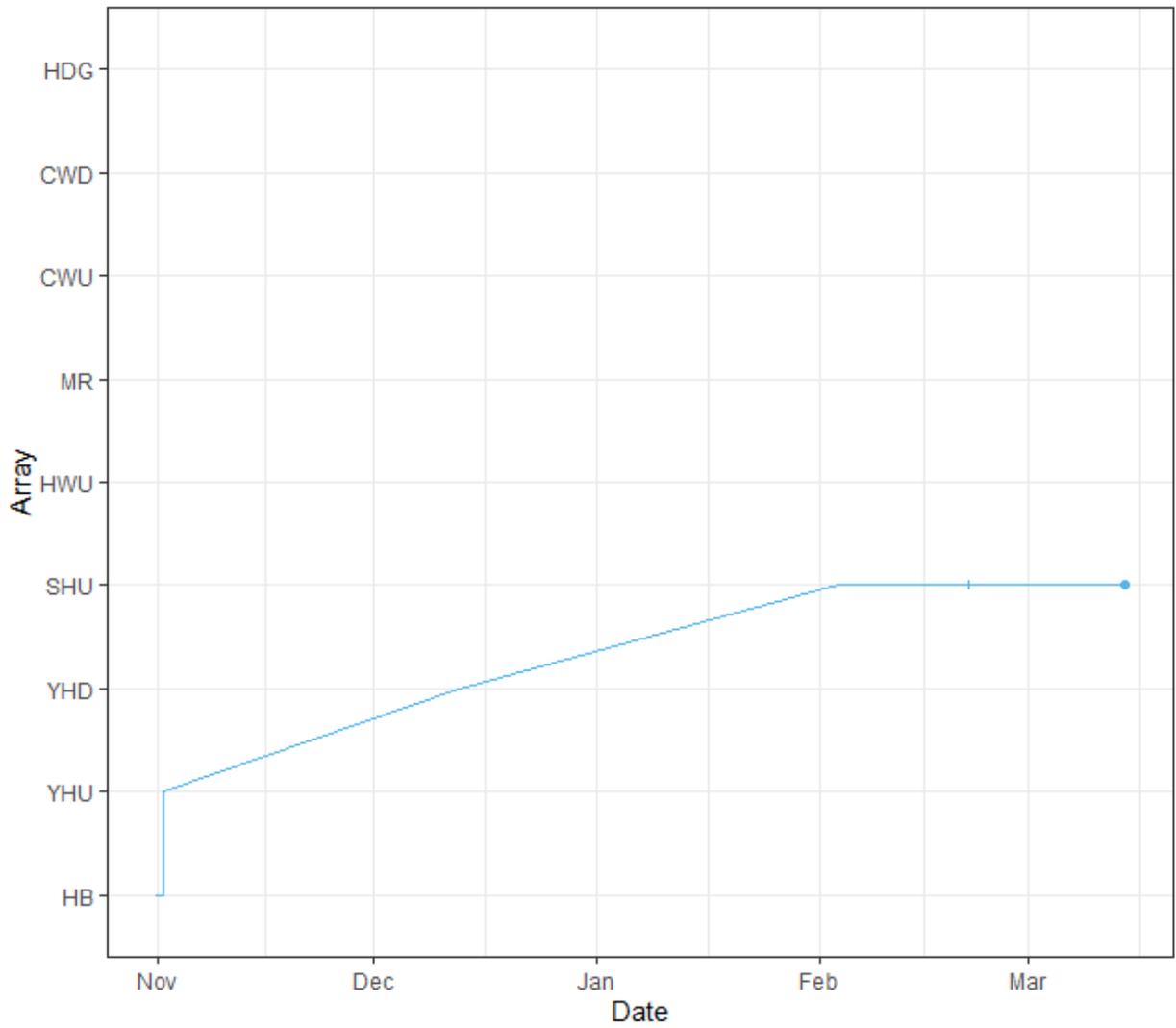
Transmitter A69-1604-14719 movement detection plot from 31 October – 13 March 2023. This eel did not successfully exit the Susquehanna River.
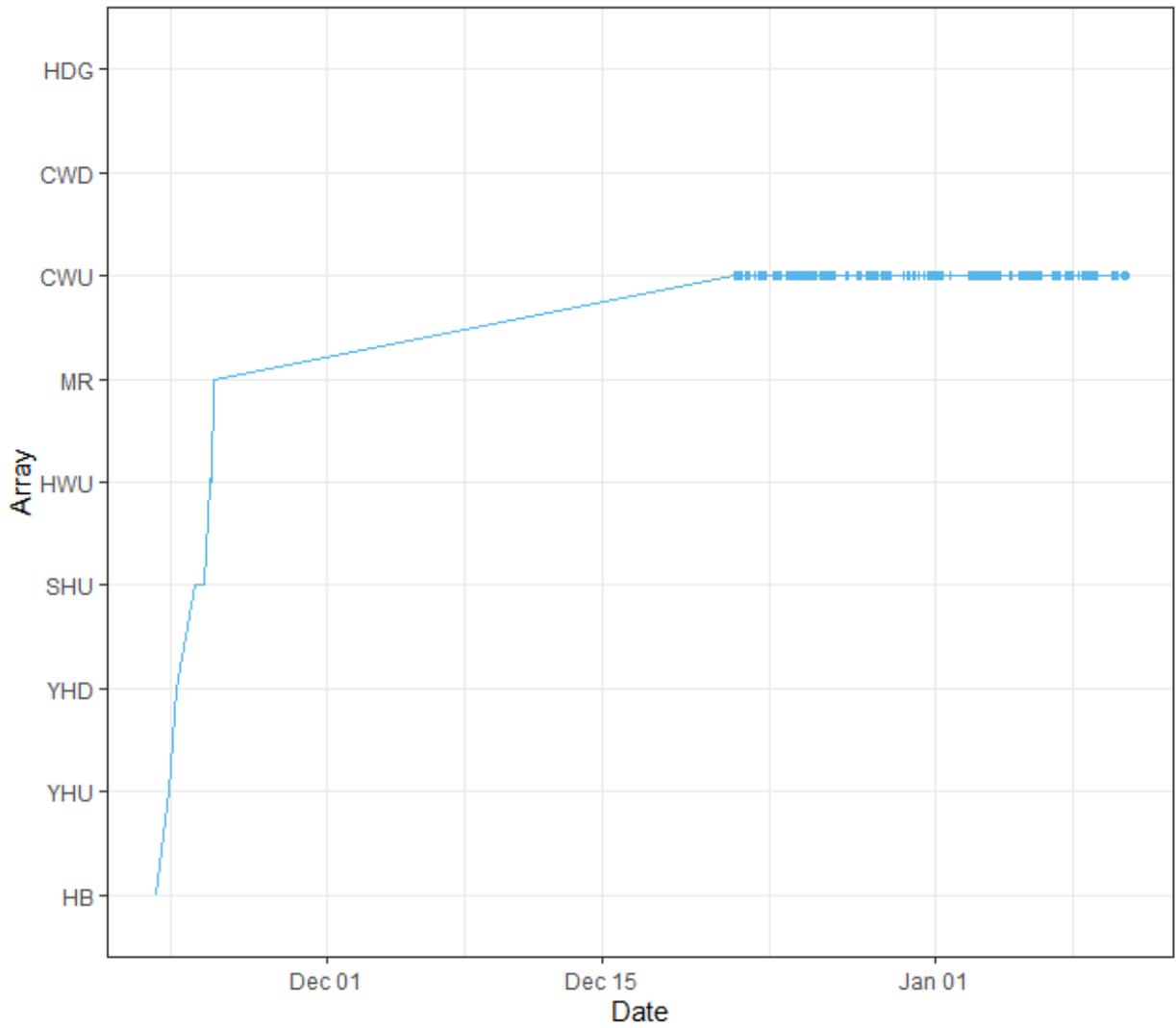
Transmitter A69-1604-14721 movement detection plot from 22 November 2023 - 10 January 2024. This eel did not successfully exit the Susquehanna River.
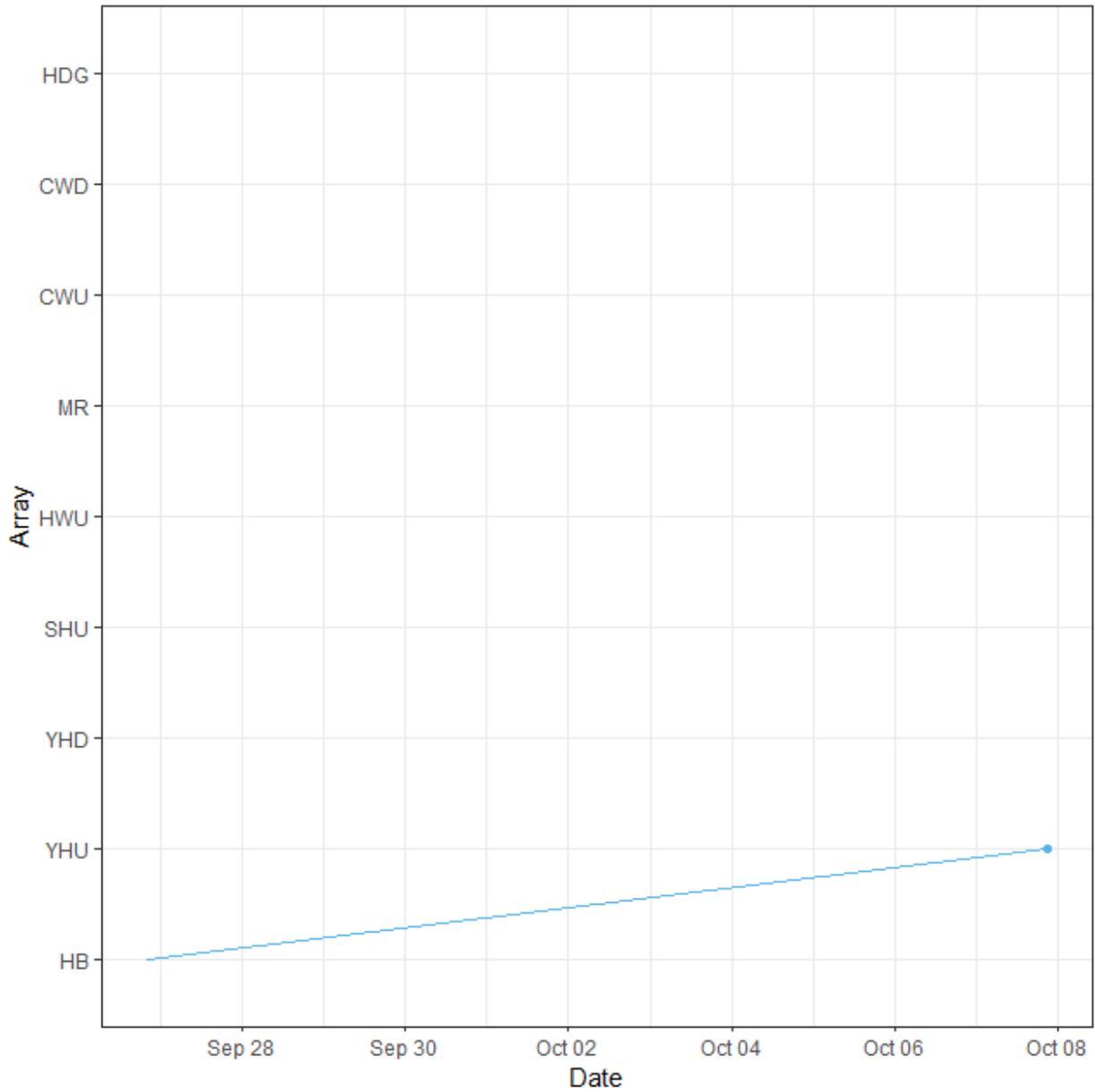
Transmitter A69-1604-14722 movement detection plot from 26 September – 7 October 2023. This eel did not successfully exit the Susquehanna River.
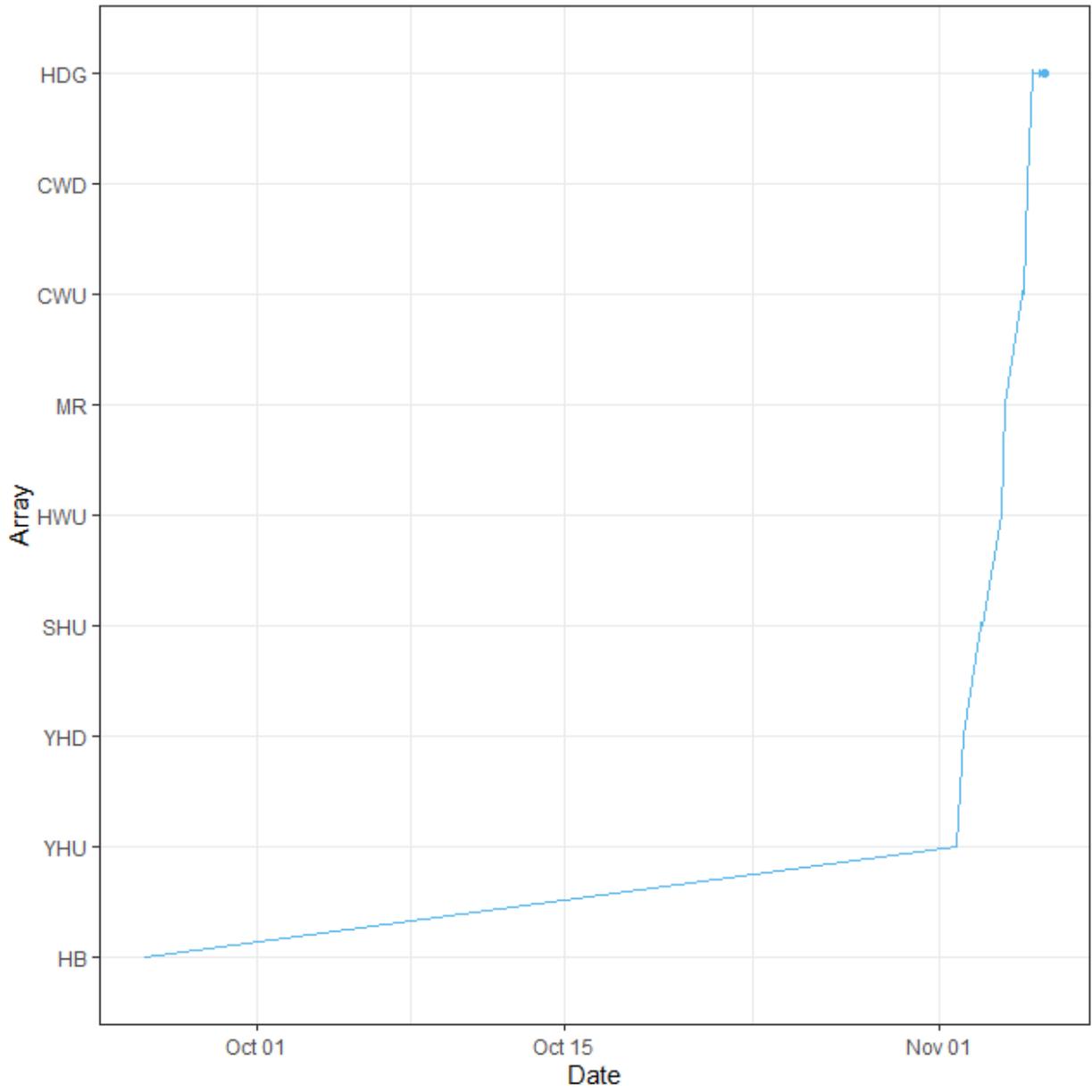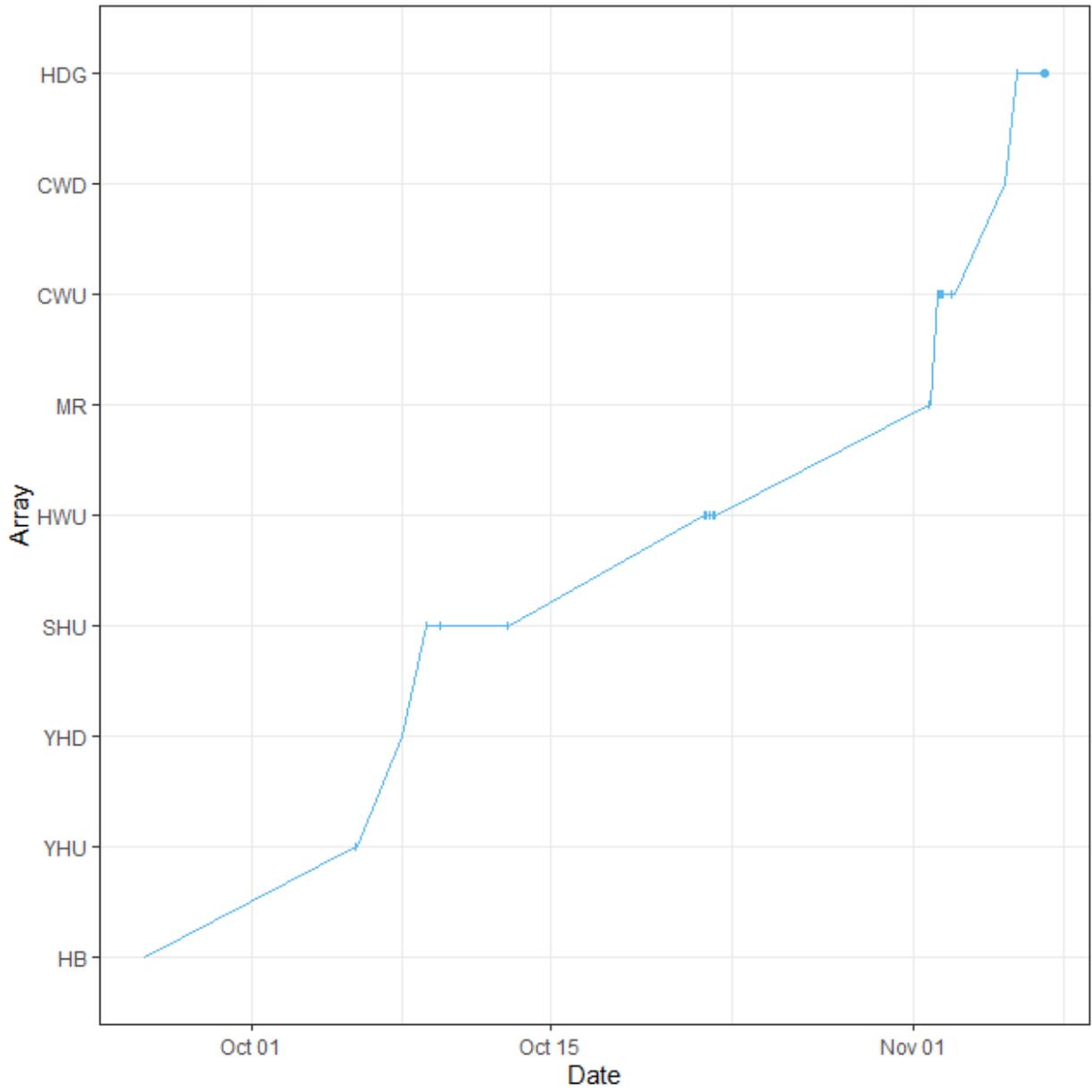
Transmitter A69-1604-14723 movement detection plot from 26 September - 7 November 2023. This eel successfully exited the Susquehanna River.
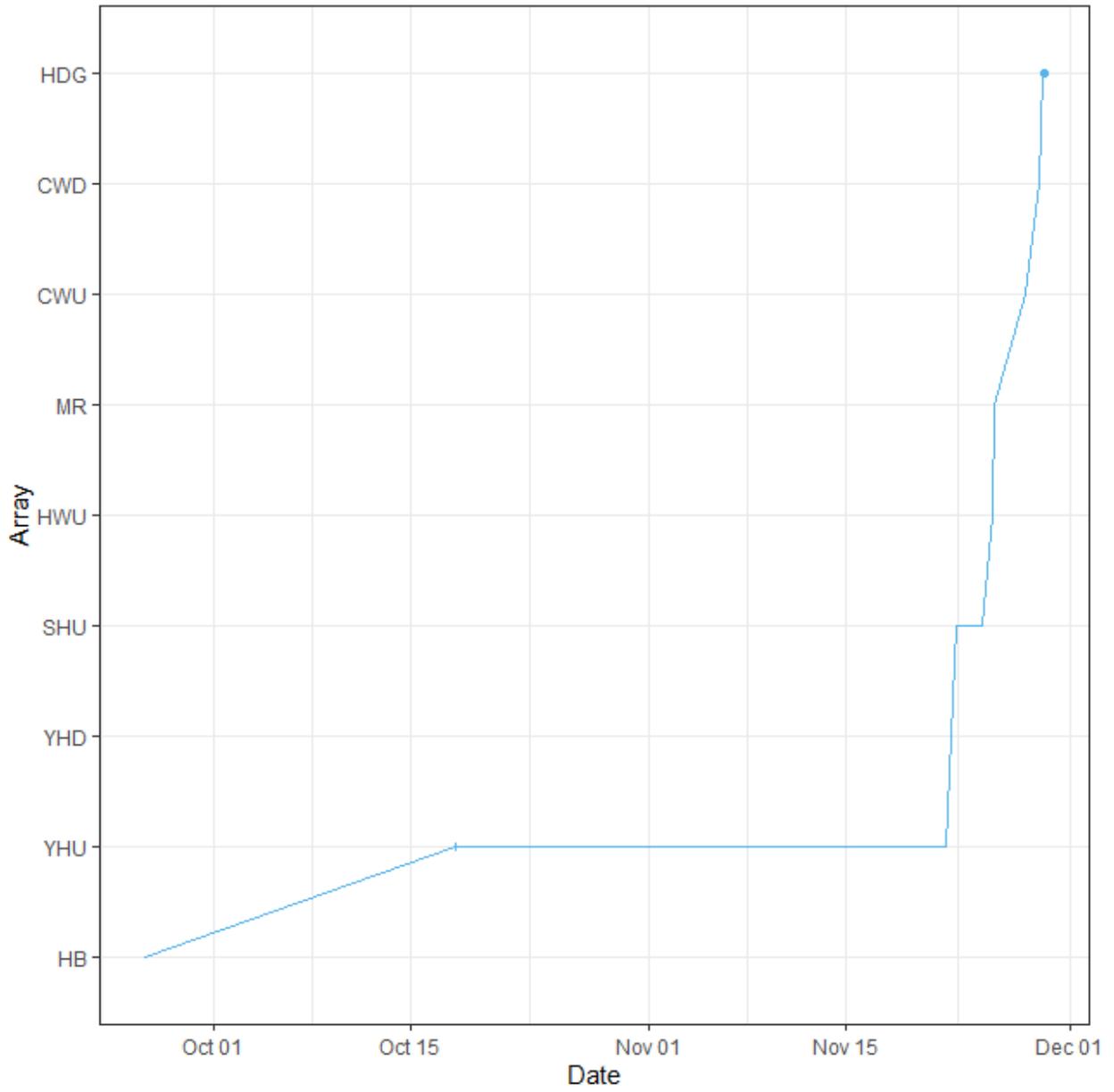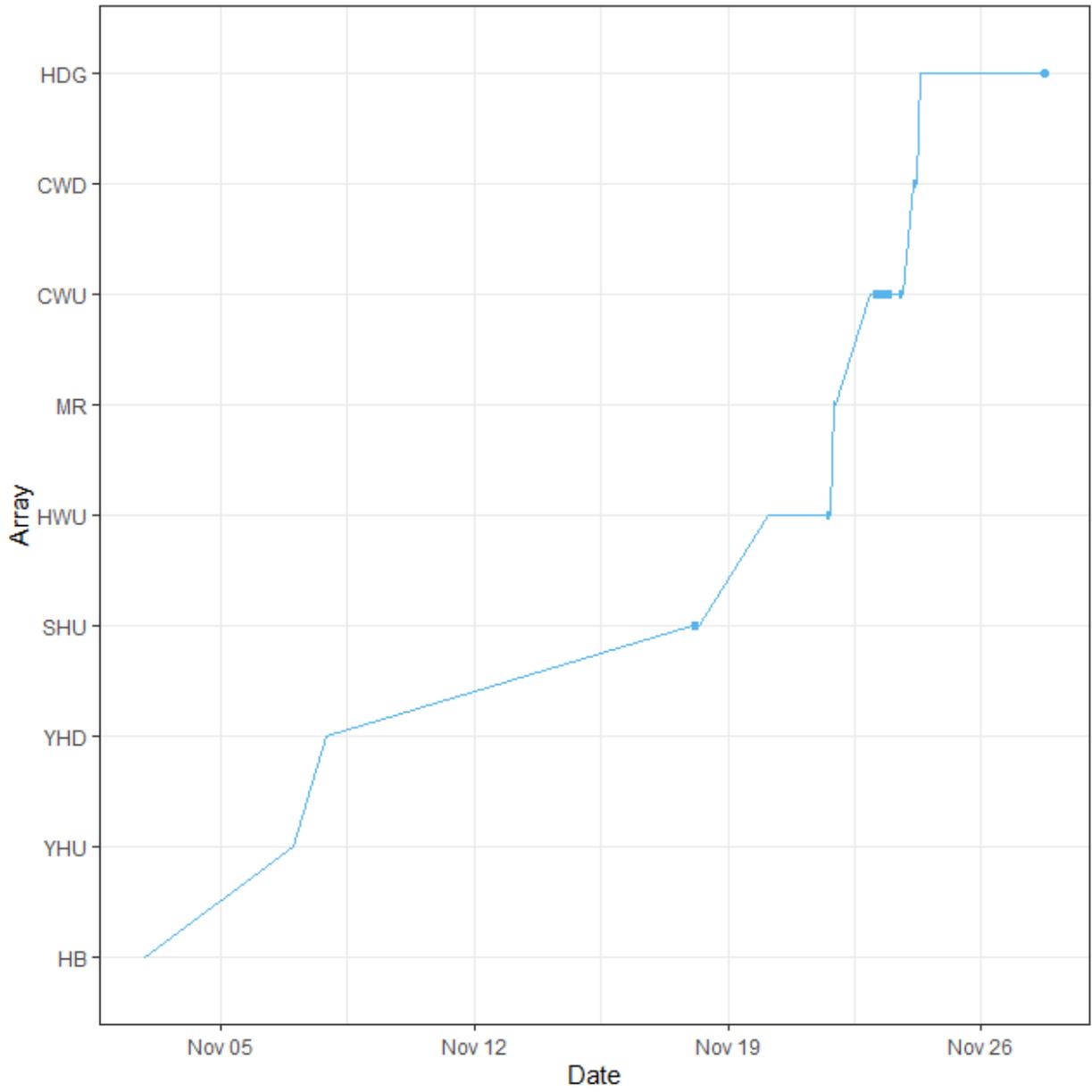
Transmitter A69-1604-14724 movement detection plot from 3-28 November 2023. This eel successfully exited the Susquehanna River.

A69-1604-14725
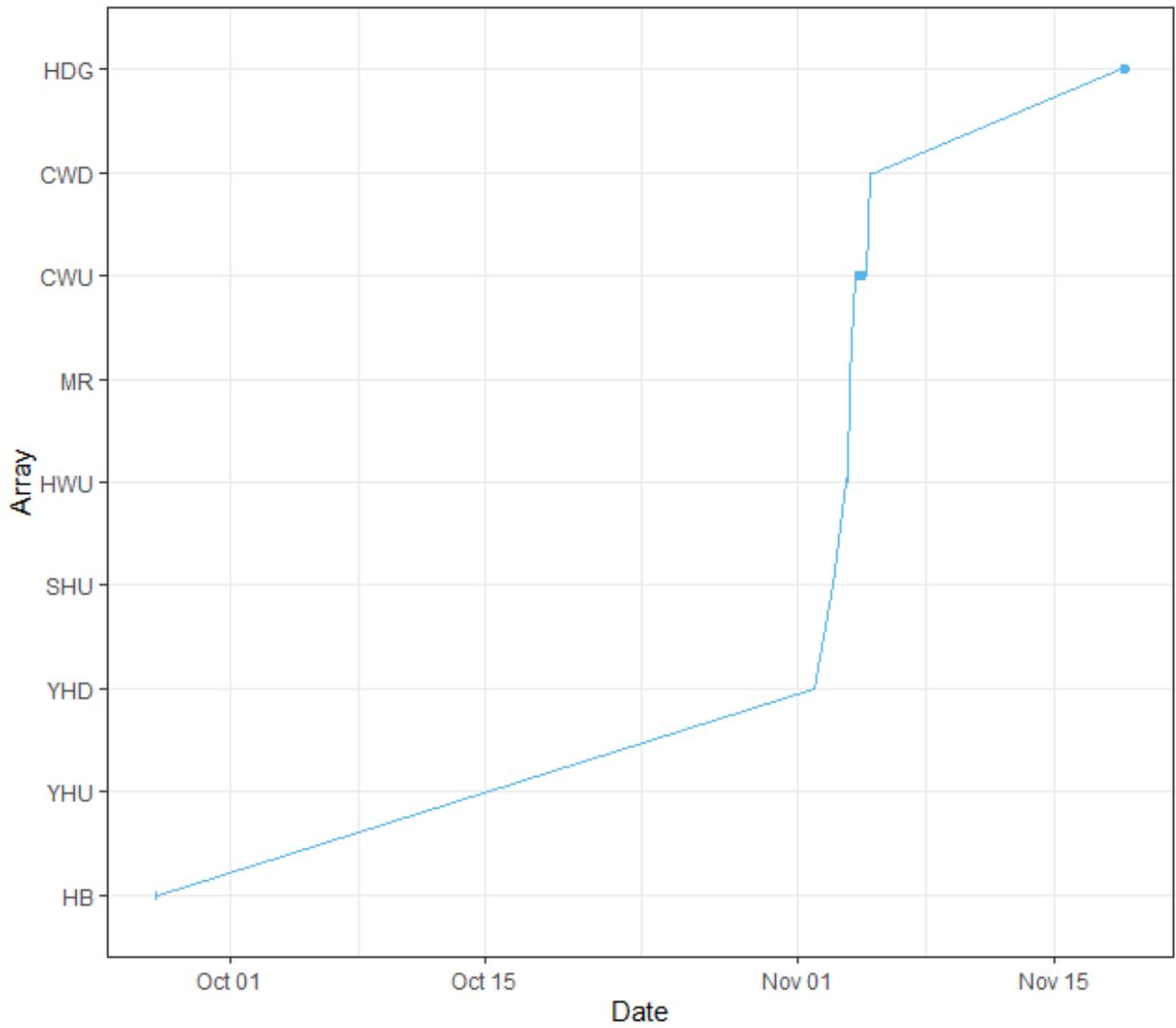
Transmitter A69-1604-14725 movement detection plot from 27 September – 18 November 2023. This eel successfully exited the Susquehanna River.
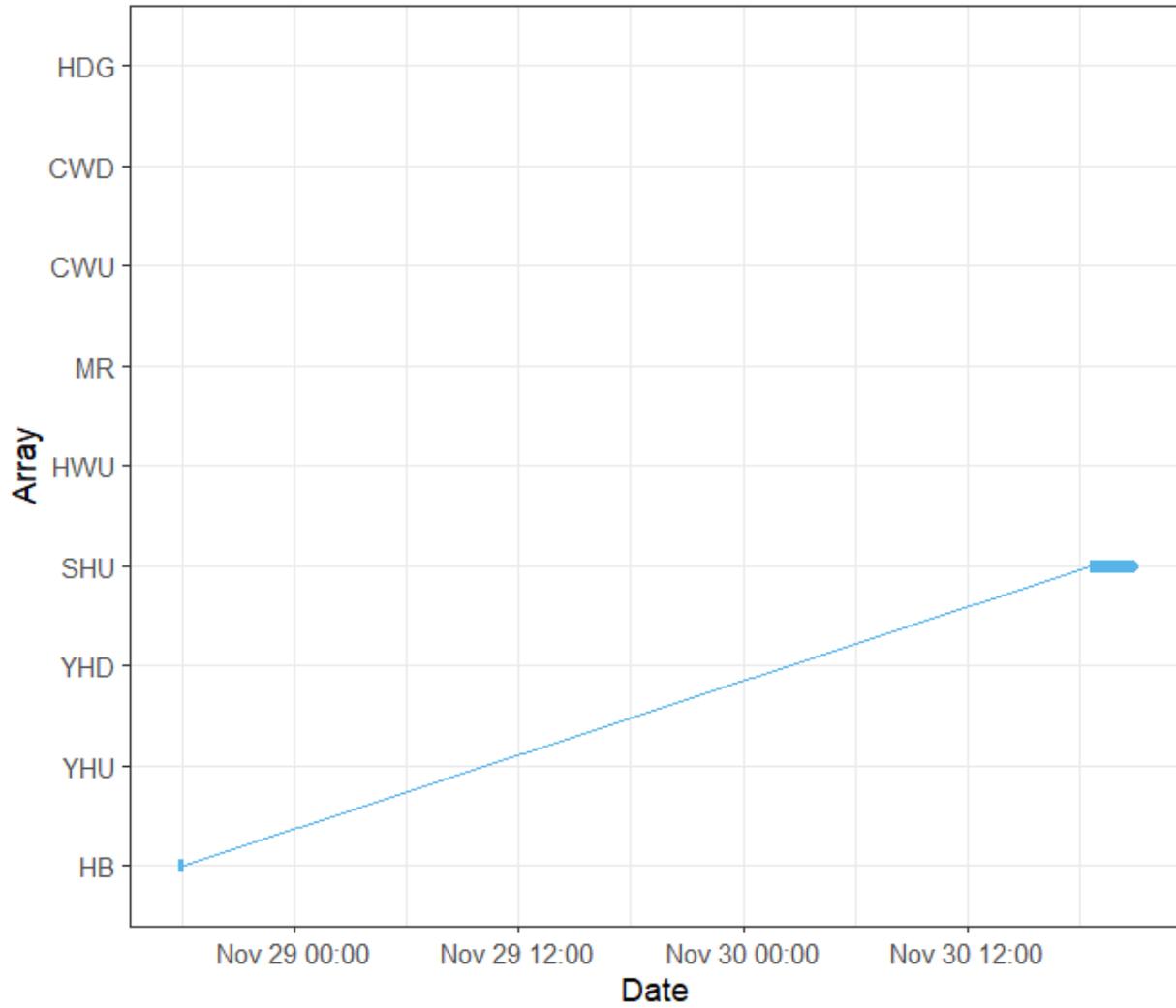
Transmitter A69-1604-14726 movement detection plot from 28-30 November 2024. This eel did not successfully exit the Susquehanna River.
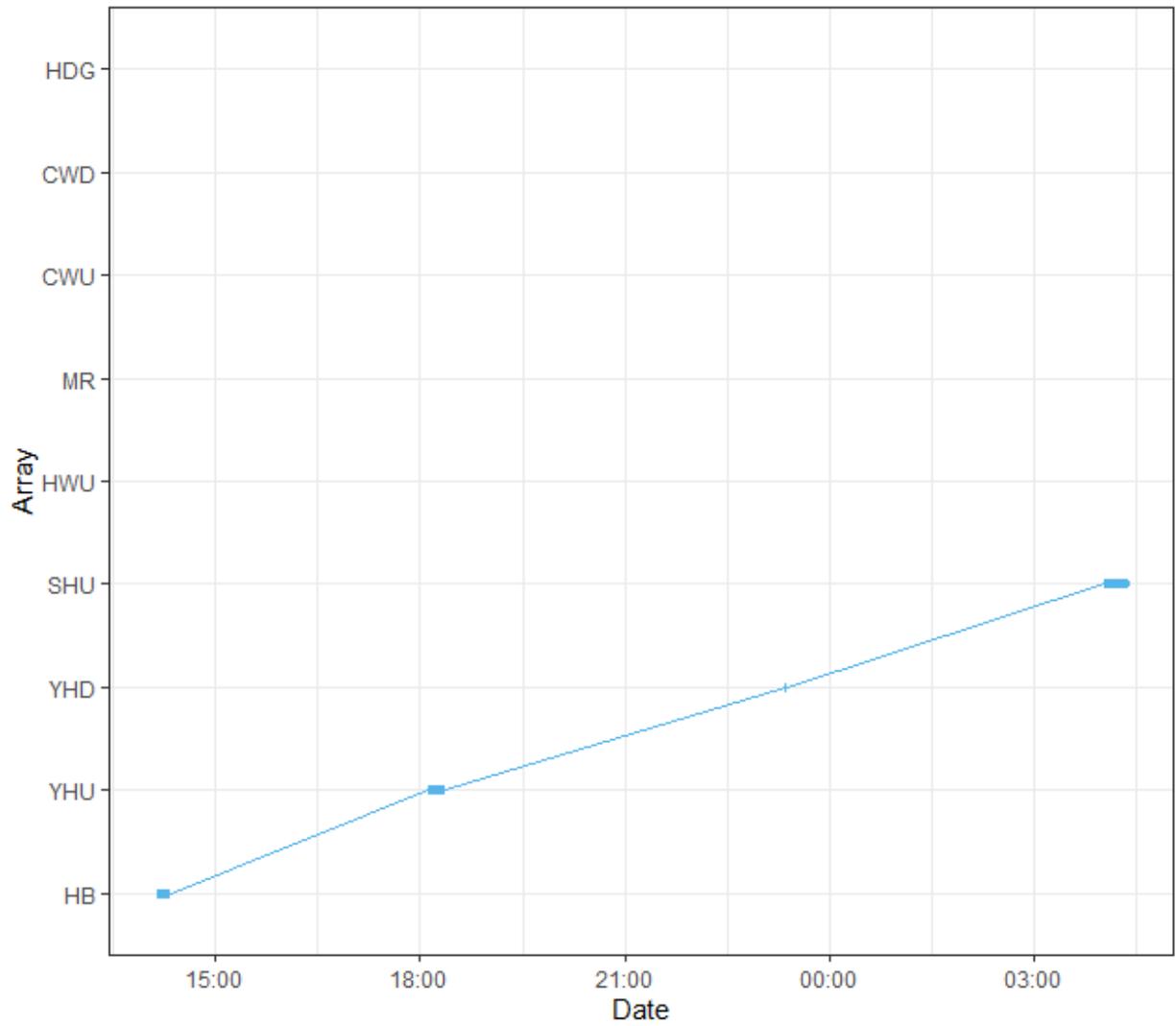
A69-1604-14727
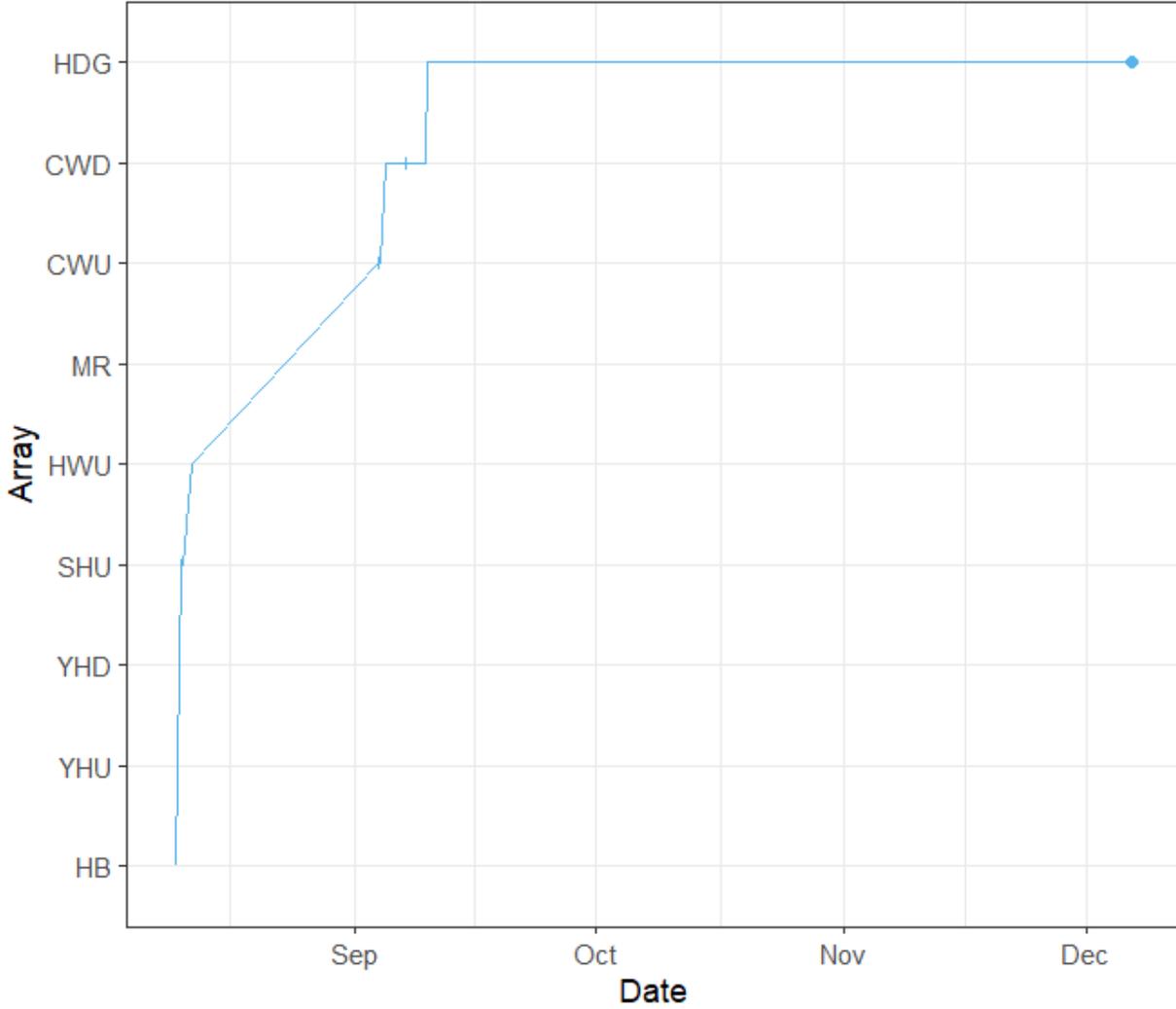
Transmitter A69-1604-14727 movement detection plot from 9 August – 6 December 2024. This eel successfully exited the Susquehanna River.
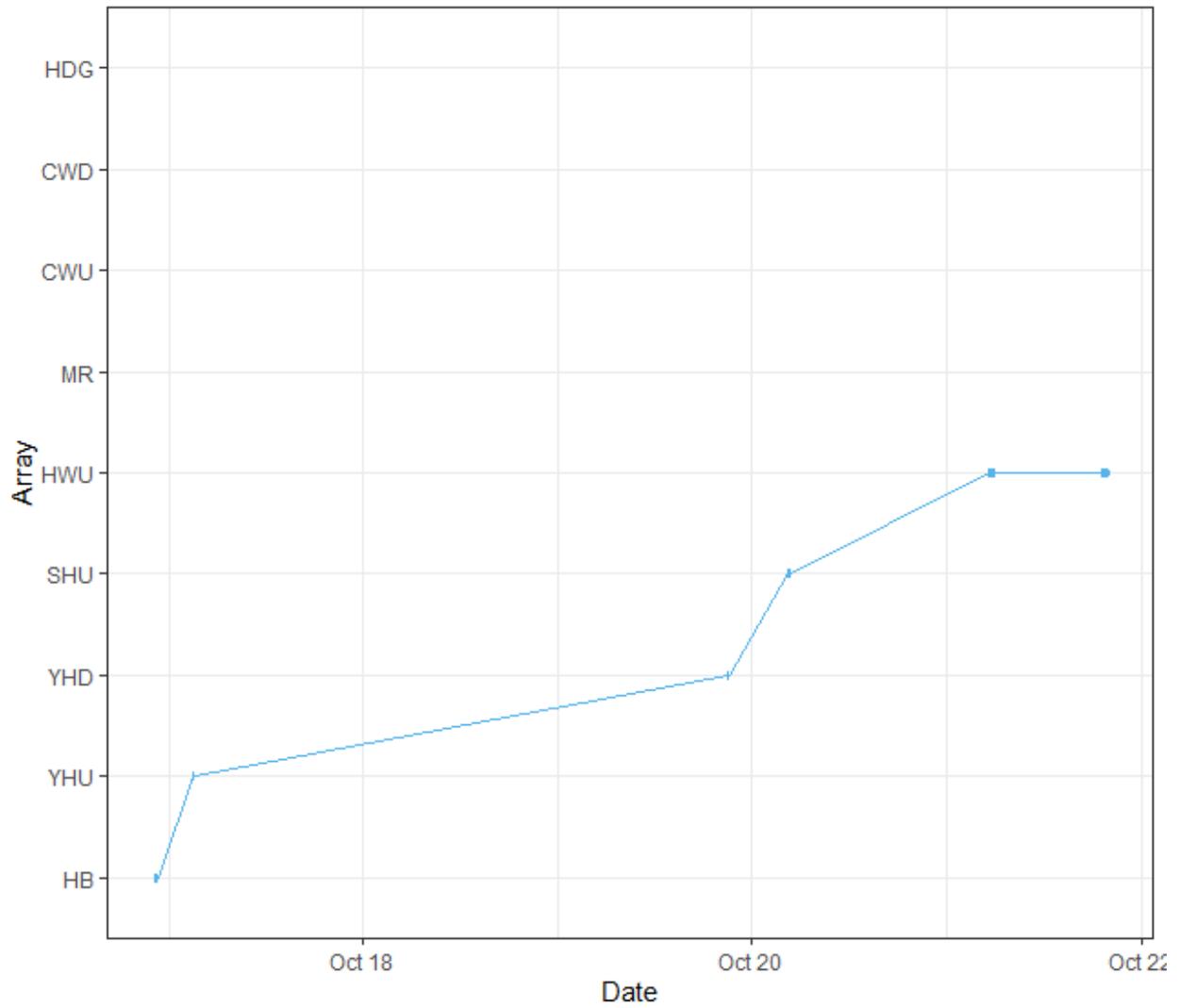
Transmitter A69-1604-14729 movement detection plot from 16-21 October 2023. This eel did not successfully exit the Susquehanna River.
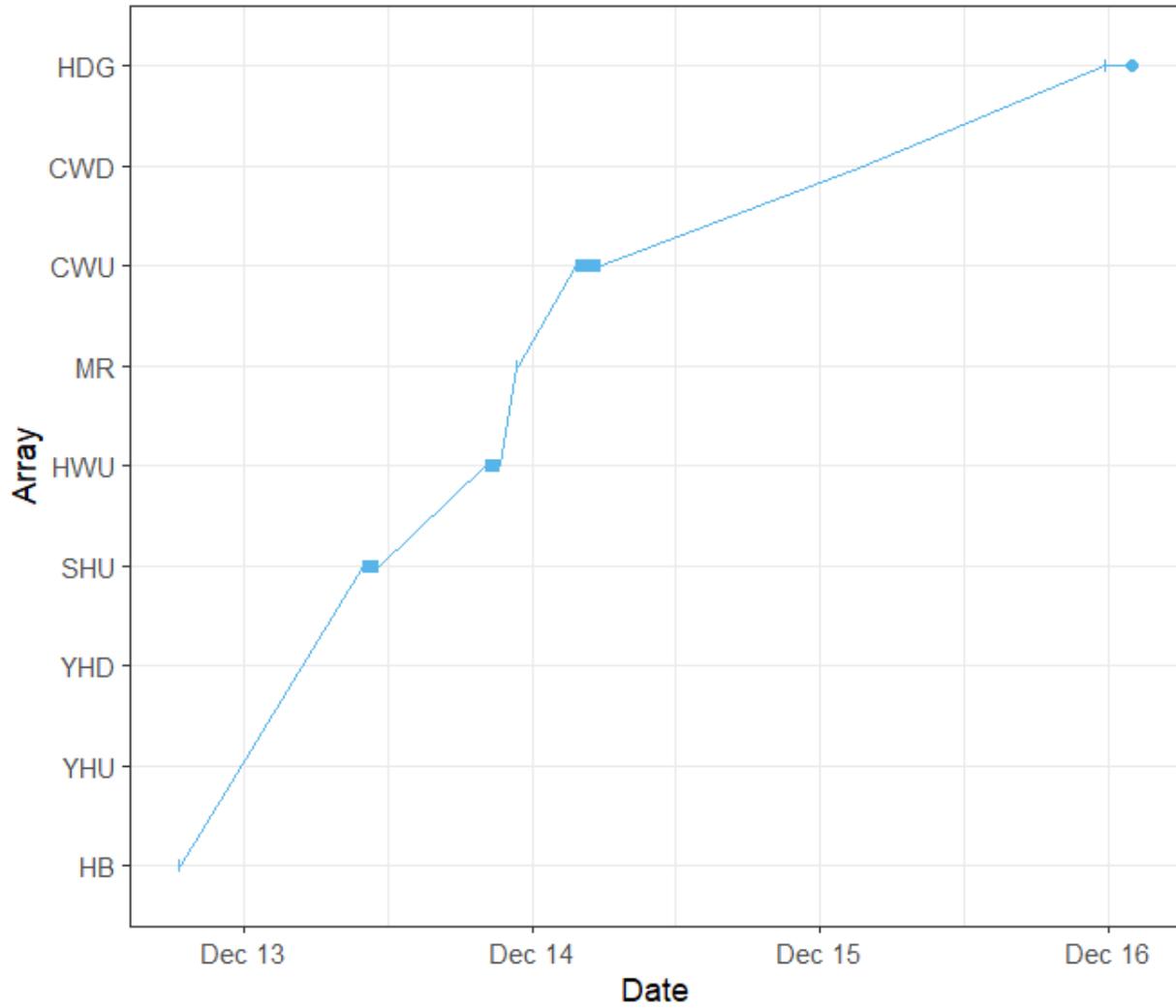
Transmitter A69-1604-14730 movement detection plot from 12-16 December 2024. This eel successfully exited the Susquehanna River.
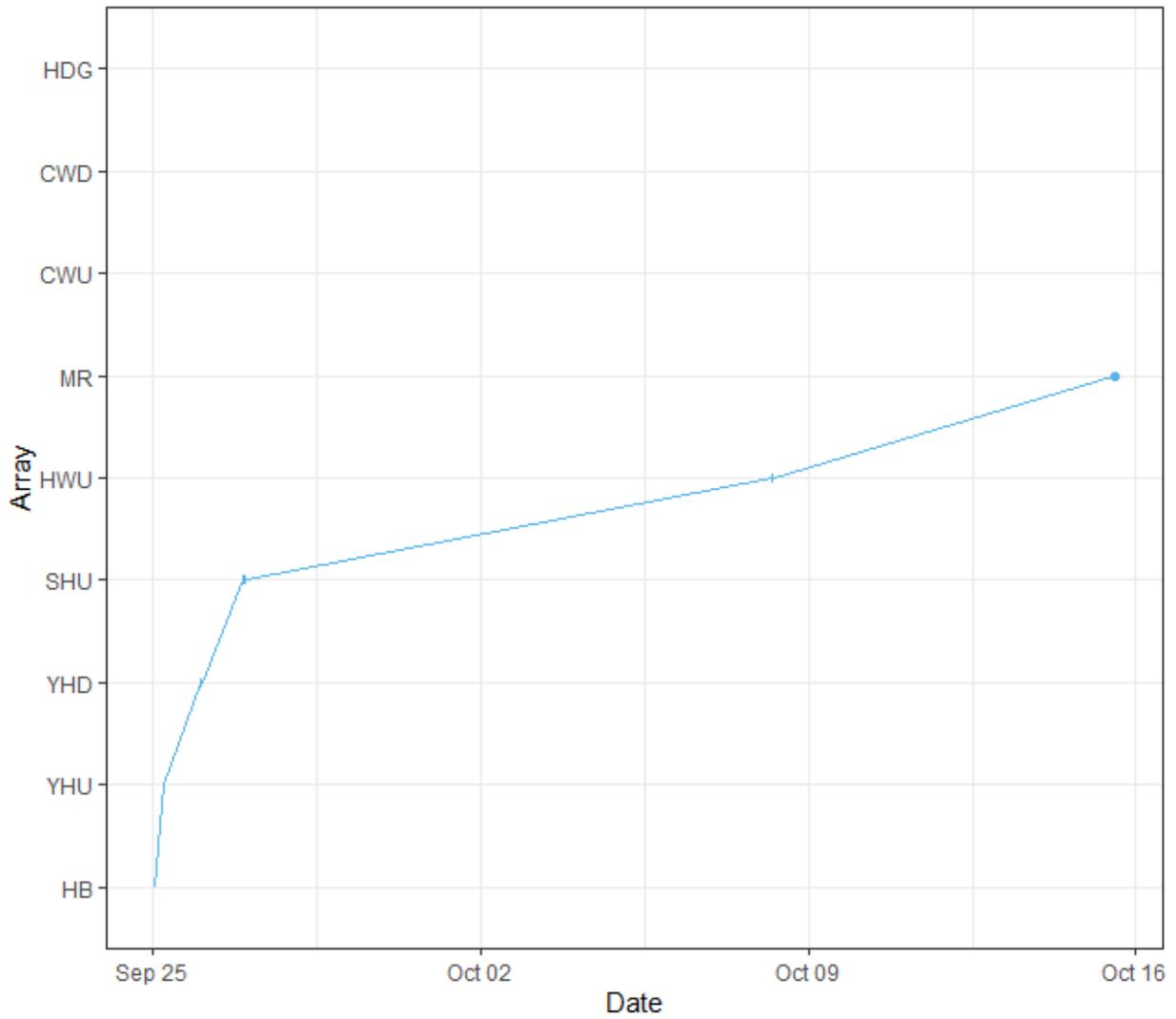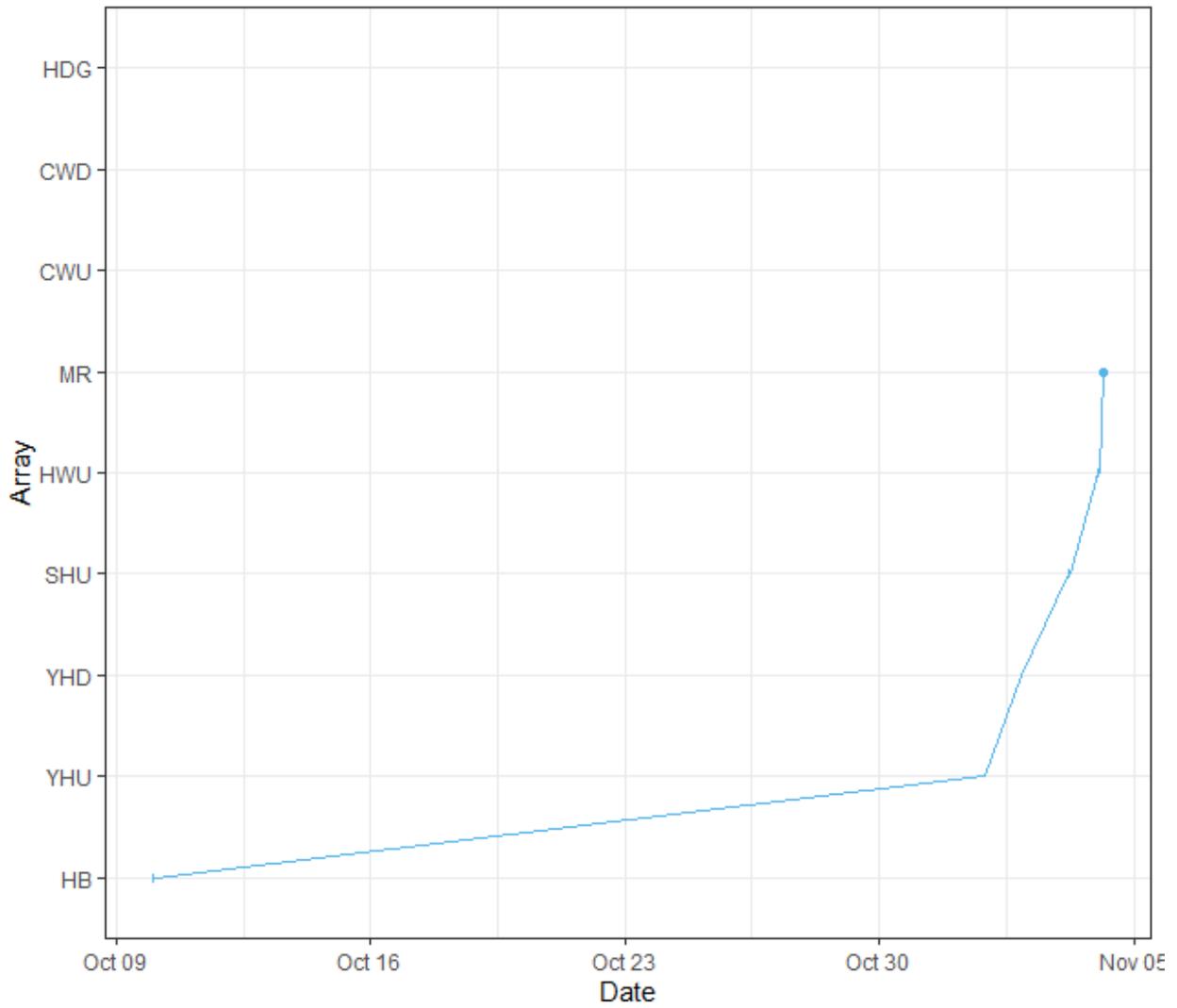
Transmitter A69-1604-14731 movement detection plot from 10 October - 5 November 2023. This eel did not successfully exit the Susquehanna River.
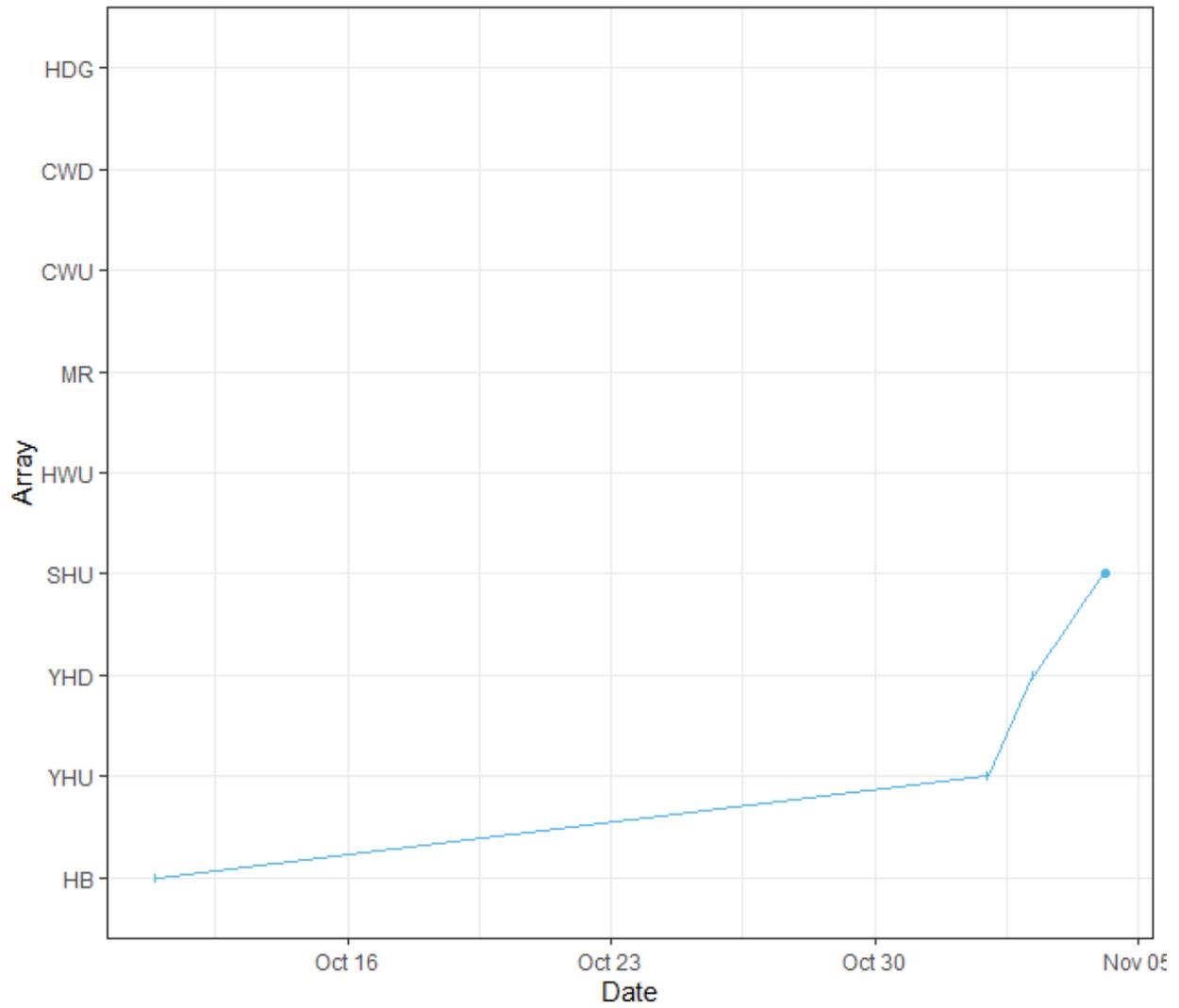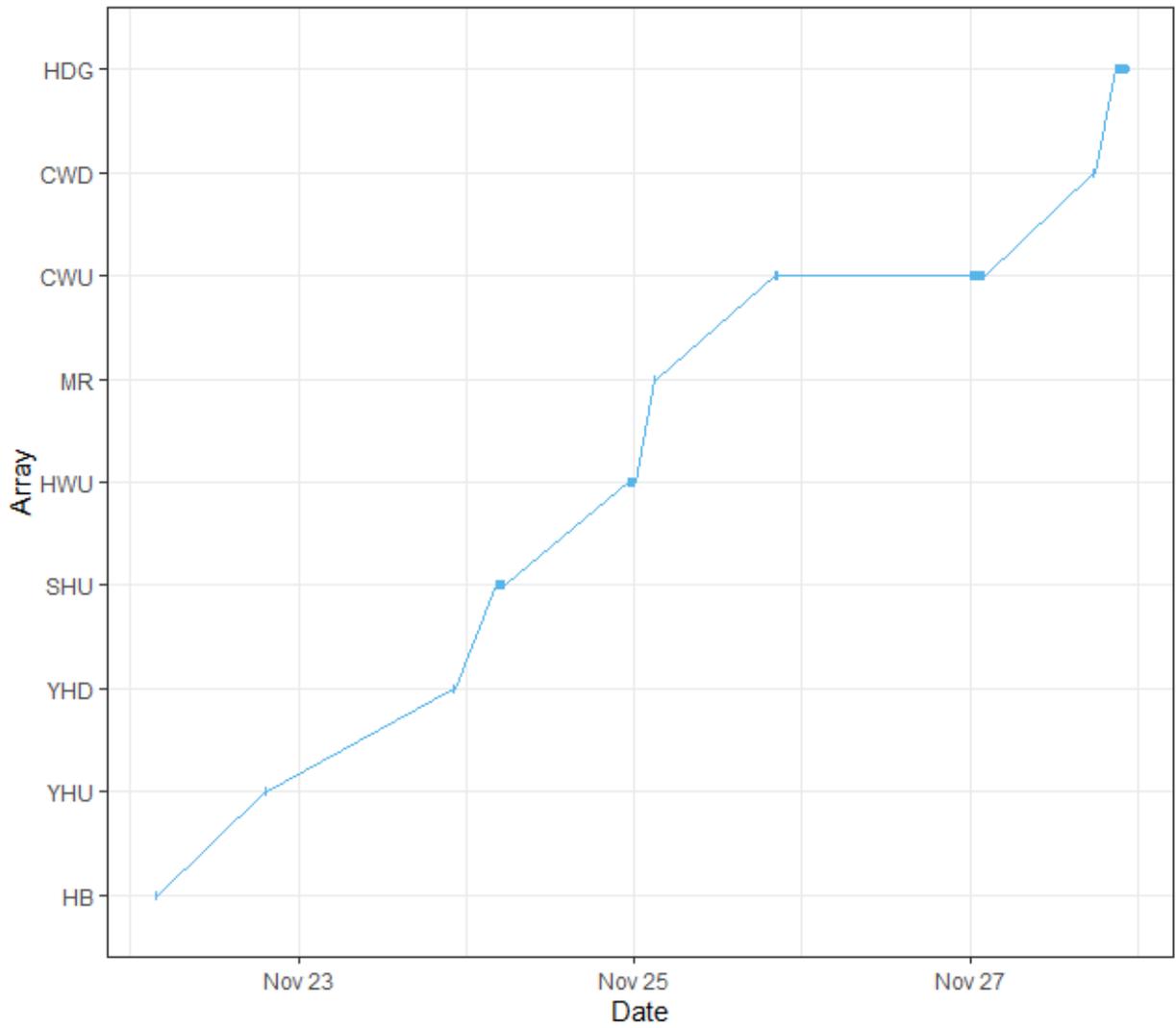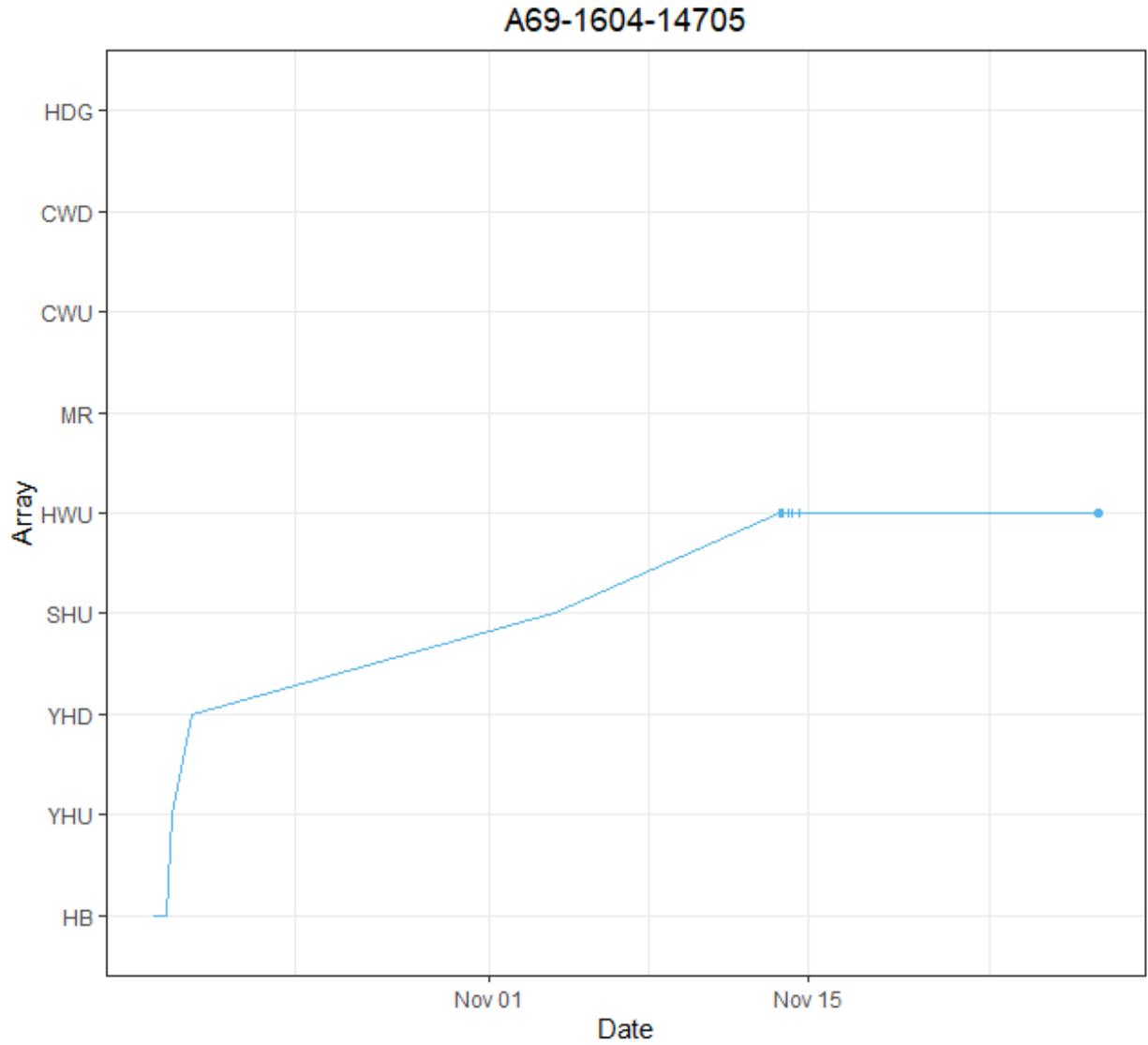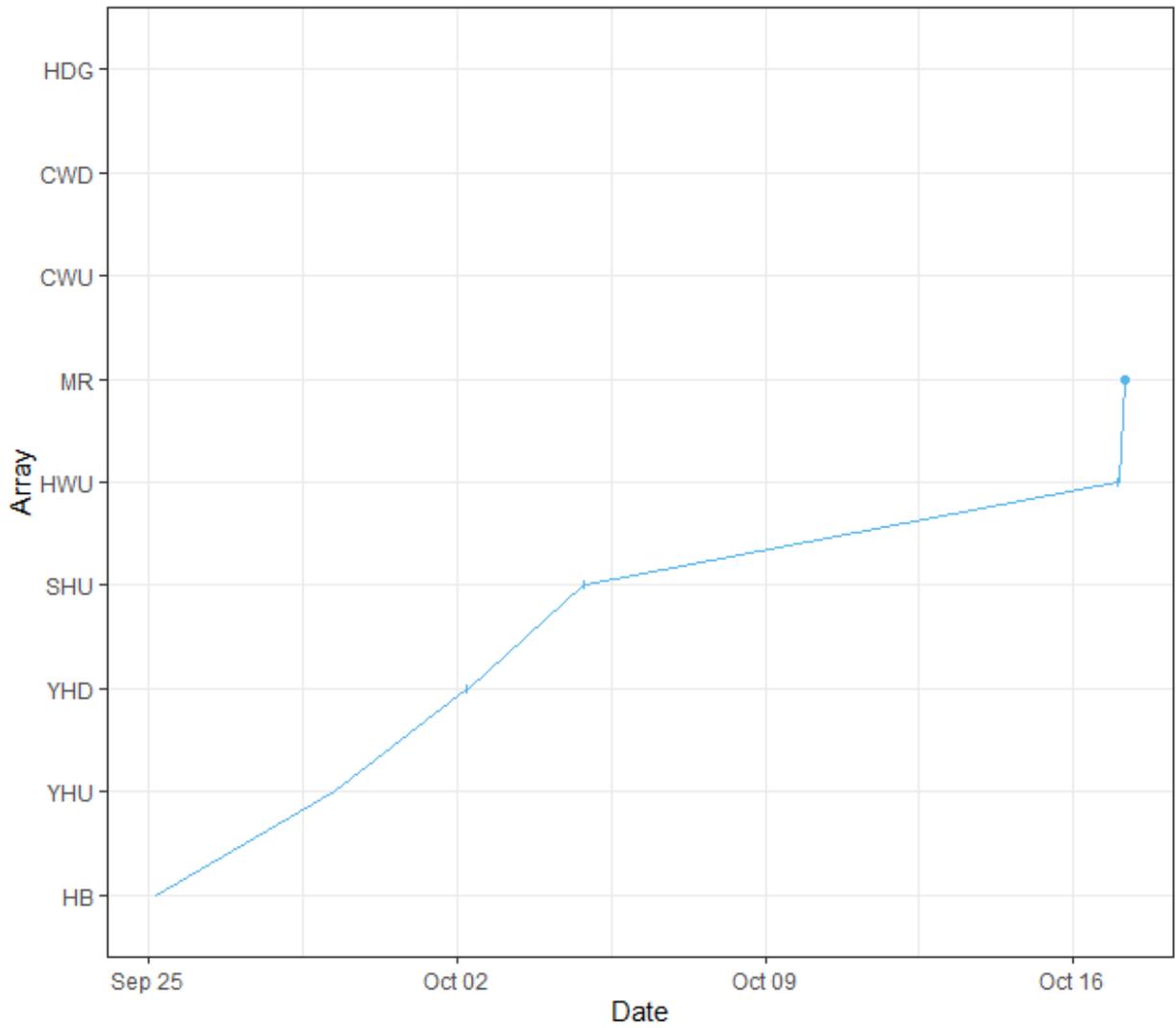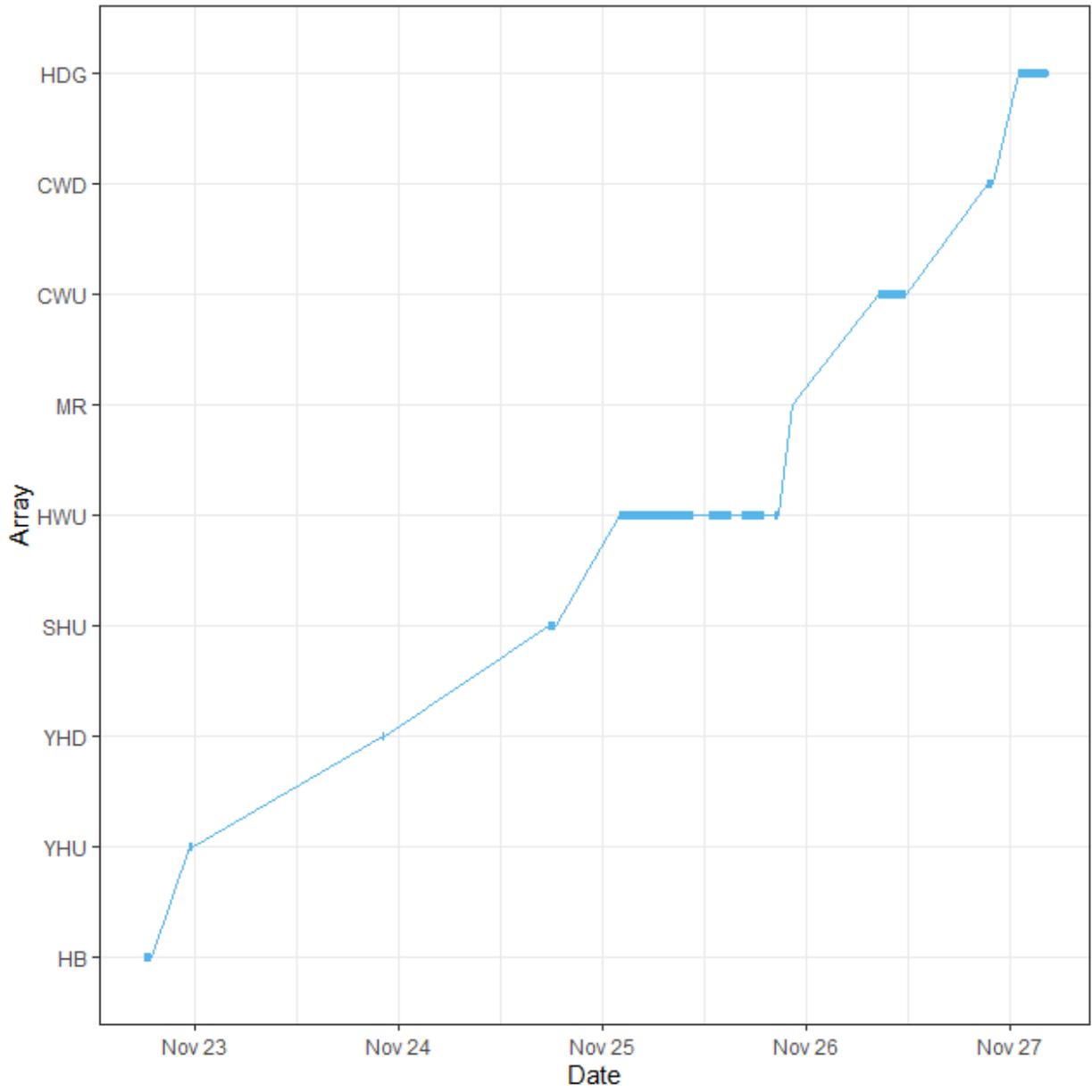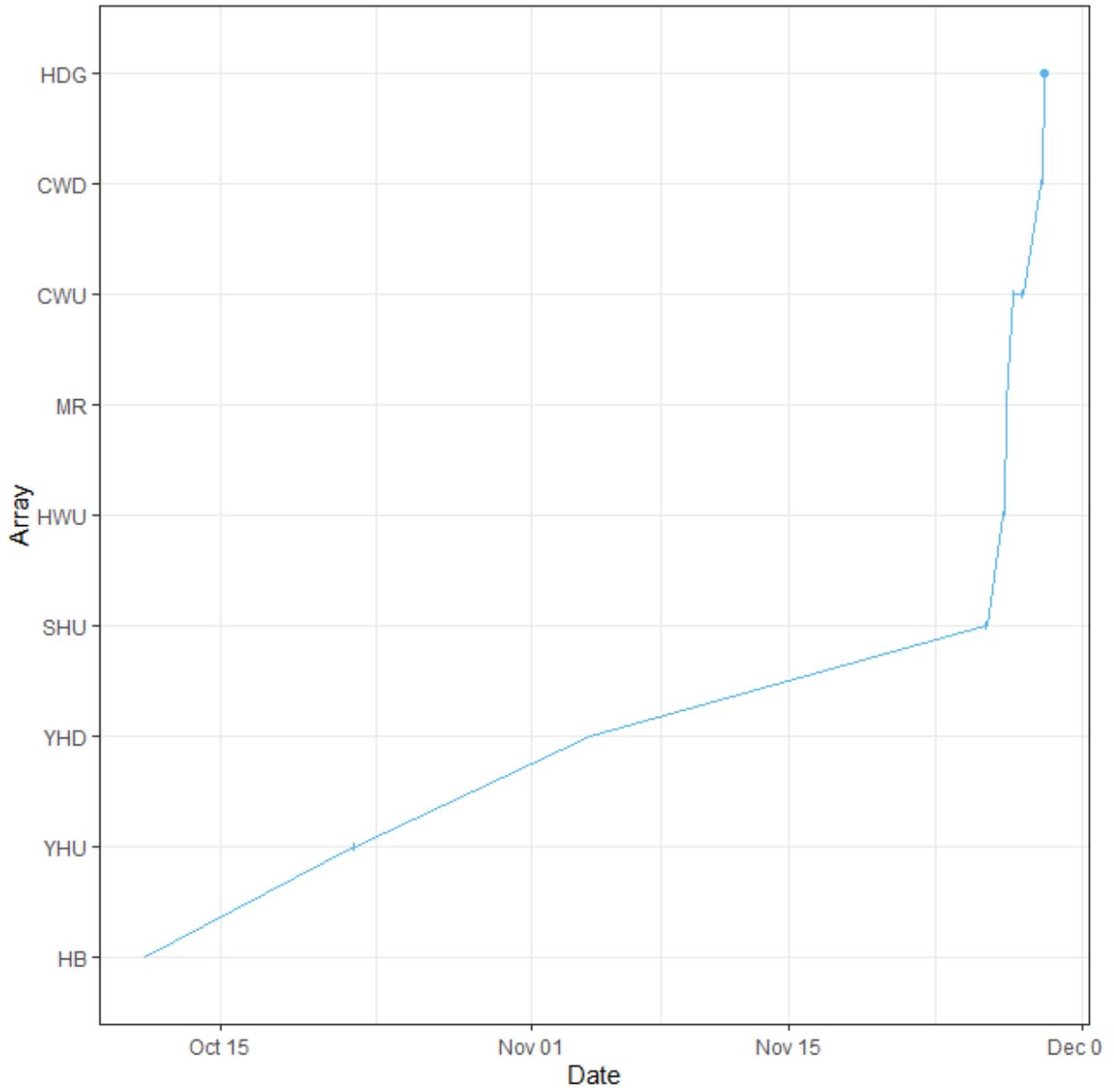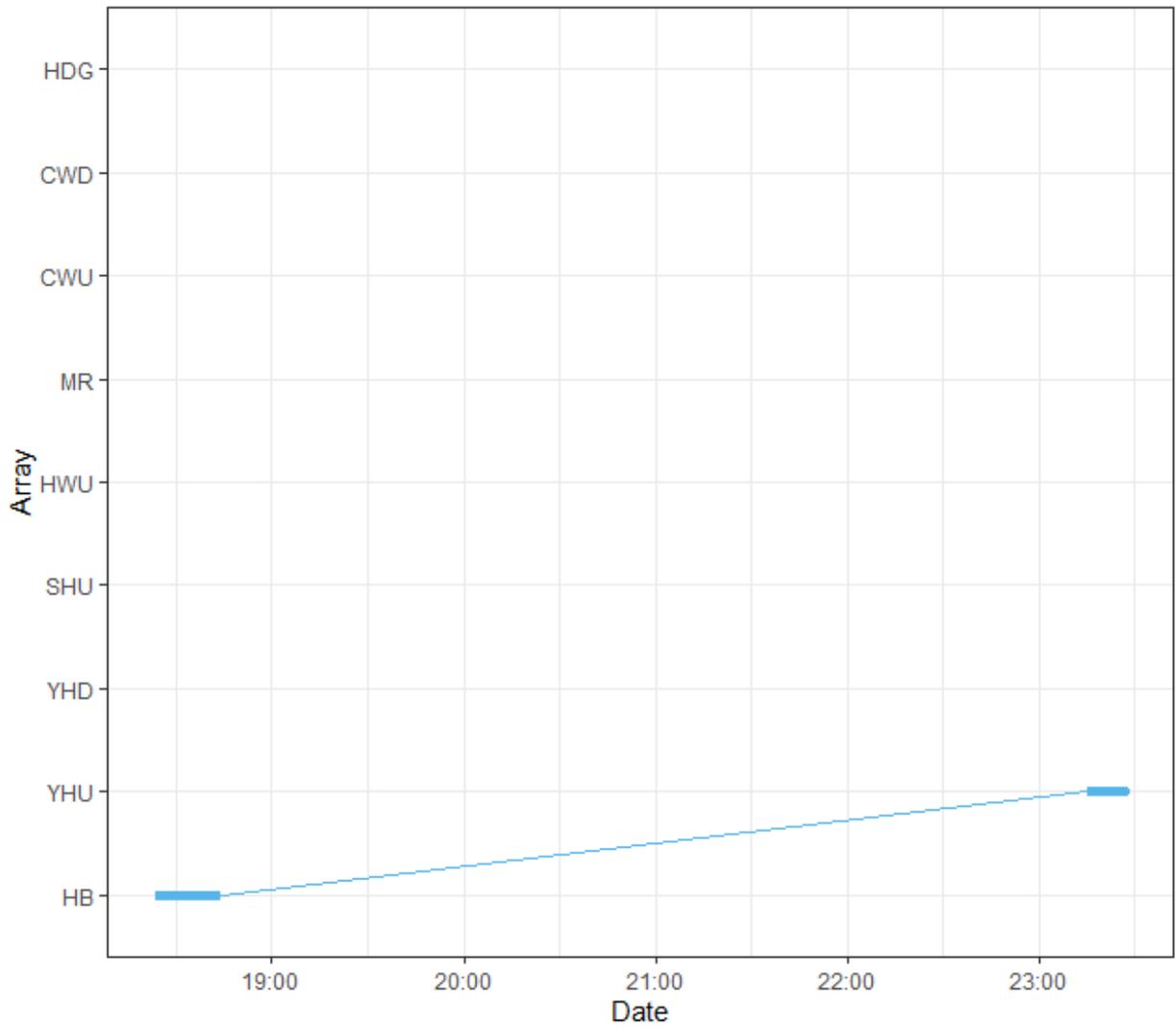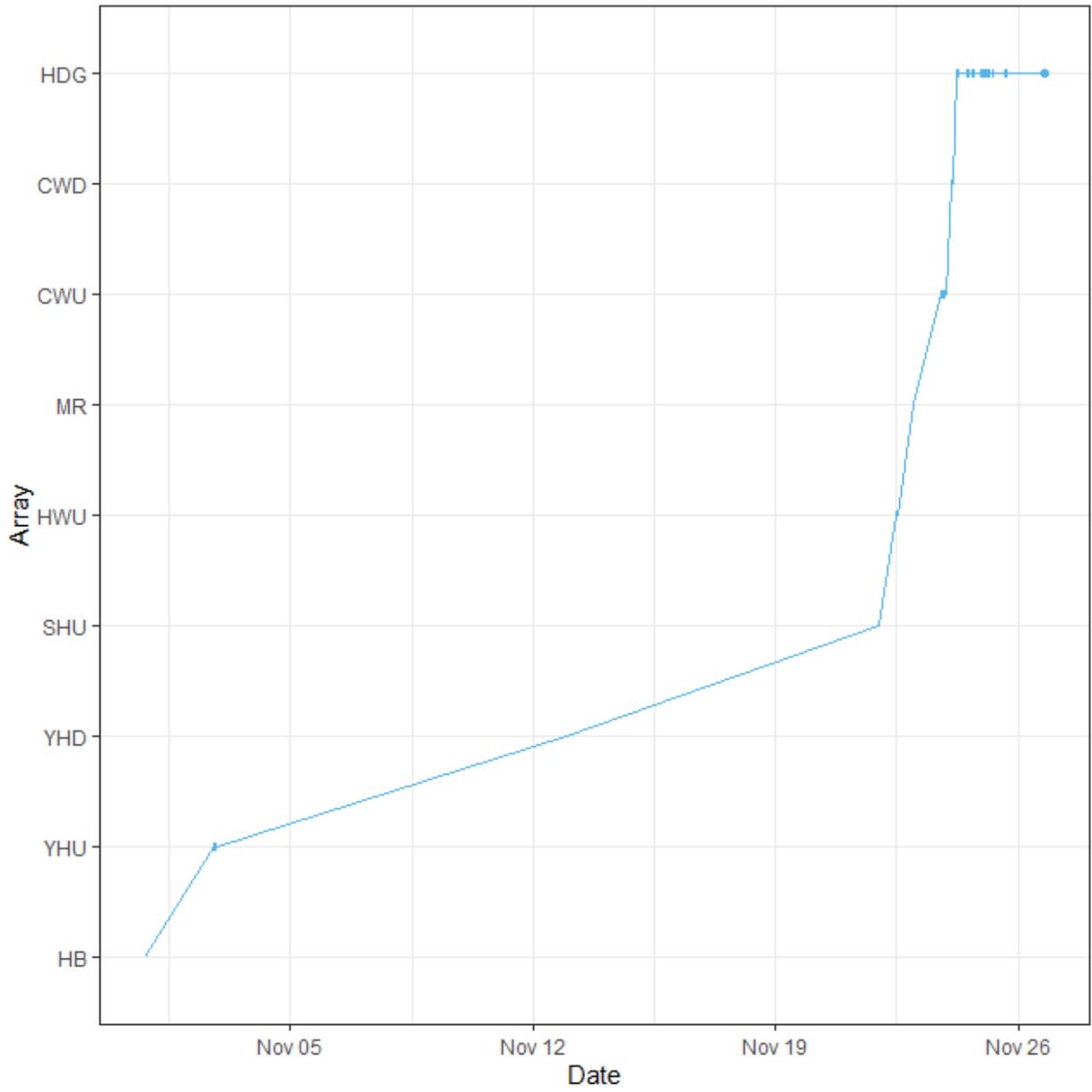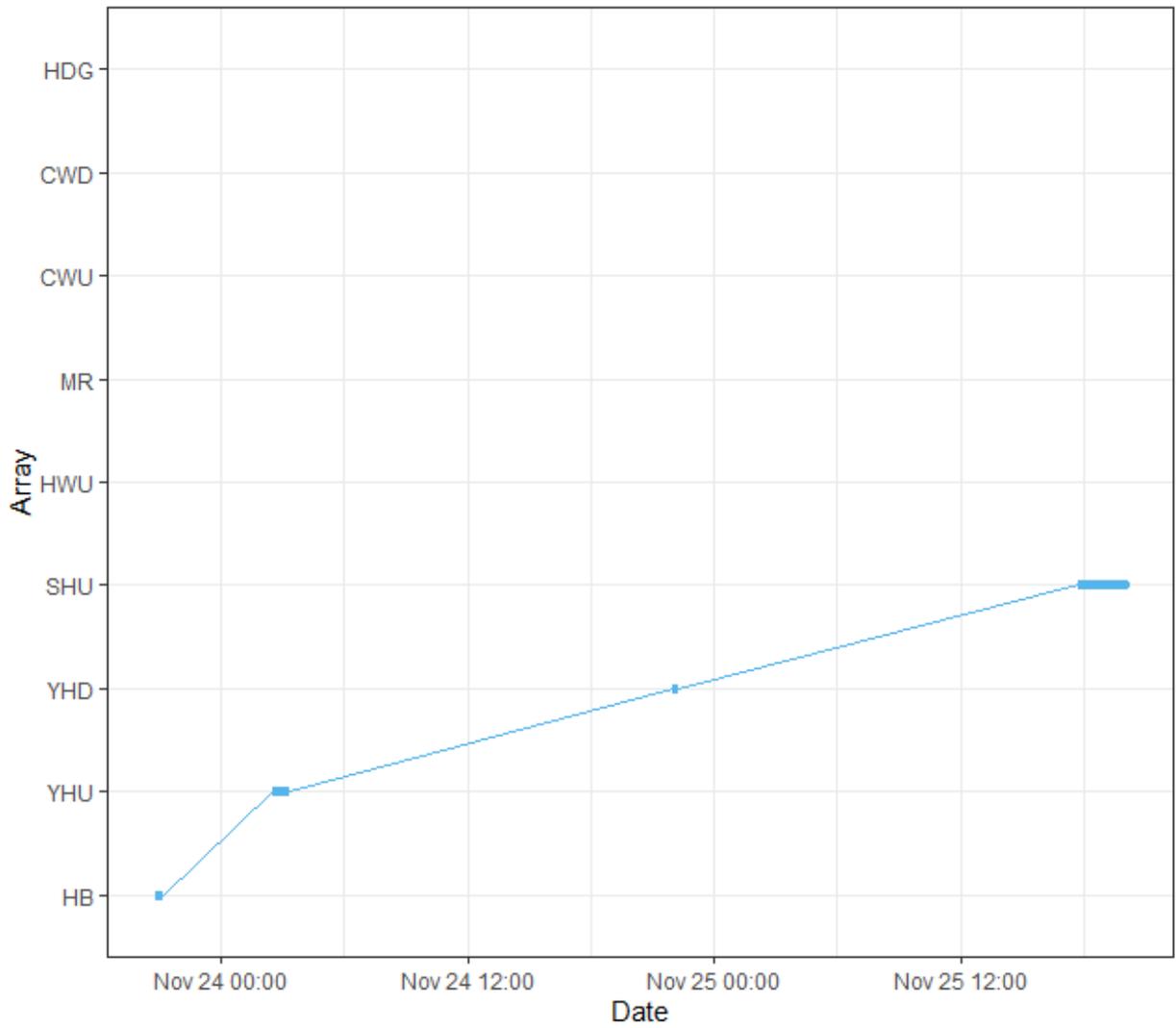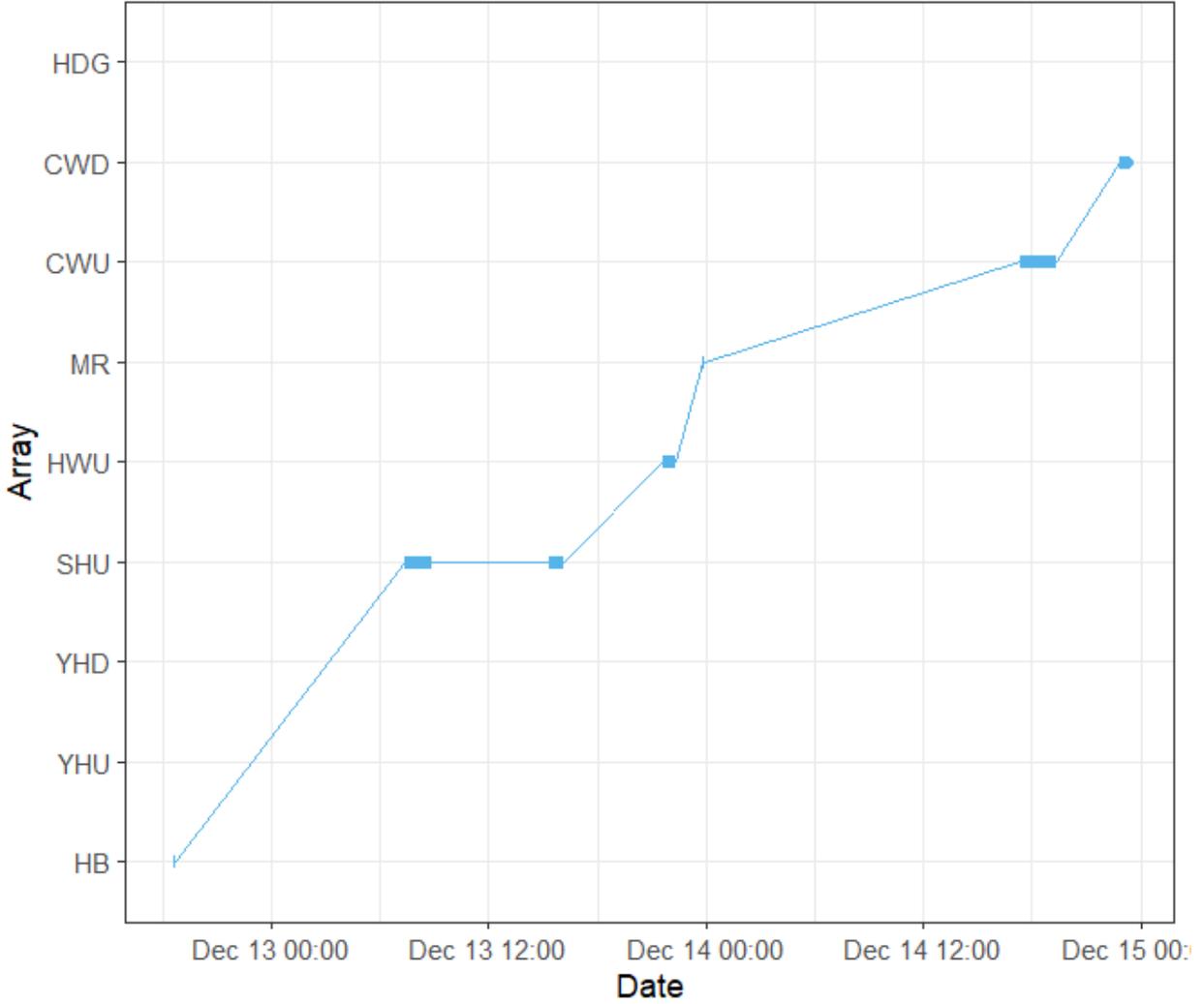
Transmitter A69-1604-14735 movement detection plot from 12-15 December 2024. This eel did not successfully exit the Susquehanna River

Appendix E. Project operations during downstream migration for eels that passed a dam within 24 hours during fall 2021-2024. Average parameters given with minimum and maximum parameters in parentheses.

Tag ID	York Haven							Safe Harbor						
	Depart Upstream Array	*Arrive Downstream Array*	*Project Flow (cfs)*	*Unit Flow (cfs)*	*Spill Flow (cfs)*	*% Spill*	*No. Units Oper.*	*Depart Upstream Array*	*Arrive Downstream Array*	*Project Flow (cfs)*	*Unit Flow (cfs)*	*Spill Flow (cfs)*	*% Spill*	*No. Units Oper.*
A69-1602-60045								11/13/2022 20:06	11/14/2022 1:07	68057 (61515-73982)	68057 (61515-73982)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1602-60049	11/13/2022 13:18	11/13/2022 18:02	67057 (59950-73400)	4900 (4900-4900)	61557 (54300-68100)	0.93 (0.92-0.93)	5 (5-5)							
A69-1604-14641	9/27/2023 21:05	9/28/2023 7:35	29338 (28000-30900)	14455 (13905-15005)	14945 (14095-15995)	0.51 (0.49-0.52)	18 (17-18)							
A69-1604-14643								11/2/2023 20:55	11/3/2023 5:08	21899 (7844-41456)	21899 (7844-41456)	0 (0-0)	0 (0-0)	6 (4-8)
A69-1604-14646	11/2/2023 5:14	11/3/2023 4:01	28994 (27700-30000)	14072 (10295-15005)	14890 (13195-17705)	0.51 (0.47-0.63)	17 (12-18)							
A69-1604-14647	11/24/2023 1:50	11/24/2023 21:24	39477 (38800-40100)	13487 (10295-15005)	25973 (24580-29405)	0.66 (0.62-0.74)	16 (12-18)	12/6/2023 17:42	12/7/2023 2:31	48622 (35927-55939)	48622 (35927-55939)	0 (0-0)	0 (0-0)	8 (7-9)
A69-1604-14648	11/26/2023 19:06	11/27/2023 1:55	32120 (31600-32700)	15005 (15005-15005)	17155 (16595-17795)	0.53 (0.53-0.54)	18 (18-18)							
A69-1604-14652	11/2/2023 20:17	11/3/2023 0:33	29875 (29700-30000)	15005 (15005-15005)	14845 (14595-14995)	0.50 (0.49-0.5)	18 (18-18)							
A69-1604-14654	11/3/2023 3:42	11/3/2023 22:33	29364 (28300-30000)	15005 (15005-15005)	14381 (13395-14995)	0.49 (0.47-0.5)	18 (18-18)	11/4/2023 4:46	11/4/2023 23:35	282074 (14048-41183)	282074 (14048-41183)	0 (0-0)	0 (0-0)	5 (4-7)
A69-1604-14657								11/4/2023 20:29	11/5/2023 20:15	24221 (13662-41183)	24221 (13662-41183)	0 (0-0)	0 (0-0)	5 (3-7)
A69-1604-14658	9/26/2023 5:02	9/27/2023 3:05	32275 (23600-36700)	14593 (13905-15005)	17545 (9495-21795)	0.54 (0.41-0.59)	18 (17-18)							
A69-1604-14659								11/4/2023 20:19	11/5/2023 4:07	24998 (18391-41183)	24998 (18391-41183)	0 (0-0)	0 (0-0)	5 (3-7)
A69-1604-14660														
A69-1604-14661	9/27/2023 2:43	9/27/2023 21:12	33642 (30500-36400)	13459 (9595-15005)	20255 (15995-25405)	0.6 (0.51-0.73)	16 (11-18)							
A69-1604-14662	10/14/2023 23:51	10/15/2023 21:59	16063 (15300-18700)	11865 (11865-11865)	4366 (3435-6735)	0.27 (0.22-0.37)	14 (14-14)							

Tag ID	York Haven							Safe Harbor						
	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.
A69-1604-14664														
A69-1604-14666	9/25/2023 3:15	9/25/2023 22:20	17764 (16400-19600)	12268 (5510-13905)	5446 (3695-11690)	0.31 (0.21-0.68)	15 (7-17)							
A69-1604-14668	11/23/2023 12:25	11/23/2023 21:22	36963 (33400-39000)	14220 (14220-14220)	22605 (18980-24780)	0.61 (0.57-0.64)	17 (17-17)	11/24/2023 17:25	11/25/2023 1:00	33862 (13626-51218)	33862 (13626-51218)	0 (0-0)	0 (0-0)	8 (3-9)
A69-1604-14669														
A69-1604-14670	8/23/2023 6:59	8/23/2023 23:43	30938 (28000-33700)	2862 (2355-3455)	28168 (26245-30345)	0.91 (0.89-0.92)	4 (3-4)							
A69-1604-14671								12/1/2024 19:09	12/2/2024 5:21	29984 (21270-41887)	29984 (21270-41887)	0 (0-0)	0 (0-0)	6 (5-7)
A69-1604-14672	10/10/2023 1:56	10/10/2023 7:46	25200 (23300-26400)	15005 (15005-15005)	10115 (8595-11395)	0.40 (0.36-0.40)	18 (18-18)	10/11/2023 3:17	10/11/2023 23:24	23631 (7265-33131)	23631 (7265-33131)	0 (0-0)	0 (0-0)	5 (3-7)
A69-1604-14674														
A69-1604-14679	11/1/2023 21:54	11/2/2023 7:34	27100 (26400-27800)	10295 (10295-10295)	16780 (16105-17505)	0.62 (0.61-0.63)	12 (12-12)	11/23/2023 3:05	11/24/2023 0:31	32325 (12918-48397)	32325 (12918-48397)	0 (0-0)	0 (0-0)	6 (4-8)
A69-1604-14682	11/1/2023 22:34	11/2/2023 3:25	26500 (26500-27400)	10295 (10295-10295)	16665 (16105-17005)	0.62 (0.61-0.62)	12 (12-12)							
A69-1604-14685								11/4/2023 23:01	11/5/2023 7:29	24076 (14800-41183)	24076 (14800-41183)	0 (0-0)	0 (0-0)	5 (3-7)
A69-1604-14687														
A69-1604-14689	11/23/2023 13:44	11/23/2023 22:49	37471 (34300-39000)	14220 (14220-14220)	23123 (19780-24780)	0.62 (0.58-0.64)	17 (17-17)	11/24/2023 5:32	11/24/2023 12:49	40777 (17440-56367)	40777 (17440-56367)	0 (0-0)	0 (0-0)	9 (7-10)
A69-1604-14691	9/28/2023 3:52	9/28/2023 21:38	271647 (27500-29000)	13748 (11705-13905)	13481 (11895-15095)	0.49 (0.46-0.56)	17 (15-17)	9/29/2023 5:30	9/29/2023 23:39	25638 (12182-45236)	25638 (12182-45236)	0 (0-0)	0 (0-0)	4 (2-7)
A69-1604-14693								12/1/2024 3:23	12/1/2024 22:02	25756 (10090-41485)	25756 (10090-41485)	0 (0-0)	0 (0-0)	5 (3-6)
A69-1604-14694														
A69-1604-14695	11/22/2023 18:55	11/23/2023 0:29	22092 (19650-25000)	14220 (14220-14220)	7697 (5280-10580)	0.35 (0.27-0.43)	17 (17-17)							

	York Haven							Safe Harbor						
Tag ID	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.
A69-1604-14696	10/3/2023 22:51	10/4/2023 5:24	14117 (13800-14250)	11865 (11865-11865)	2185 (2035-2435)	0.16 (0.15-0.17)	14 (14-14)	10/9/2023 4:35	10/10/2023 1:43	21642 (10706-41162)	21642 (10706-41162)	0 (0-0)	0 (0-0)	5 (3-8)
A69-1604-14697														
A69-1604-14698	11/23/2023 15:58	11/24/2023 5:04	38382 (36300-39000)	14220 (14220-14220)	24107 (21780-24780)	0.63 (0.61-0.64)	17 (17-17)							
A69-1604-14699	11/1/2023 20:01	11/2/2023 2:33	26400 (26400-27200)	10295 (10295-10295)	16465 (16105-16905)	0.62 (0.61-0.62)	12 (12-12)	11/2/2023 23:44	11/3/2023 19:58	26539 (7844-41430)	26539 (7844-41430)	0 (0-0)	0 (0-0)	6 (4-8)
A69-1604-14700	11/22/2023 3:18	11/22/2023 10:42	15667 (15200-16100)	10818 (10295-11080)	4832 (4120-5805)	0.31 (0.27-0.36)	13 (12-13)	11/24/2023 15:41	11/25/2023 8:54	34499 (13626-63117)	34499 (13626-63117)	0 (0-0)	0 (0-0)	8 (3-10)
A69-1604-14701	12/18/2023 18:21	12/18/2023 23:21	92600 (78000-111500)	14220 (14220-14220)	77000 (62580-95780)	0.84 (0.81-0.87)	17 (17-17)							
A69-1604-14702	9/25/2023 6:30	9/26/2023 1:46	18336 (16800-20700)	12493 (5510-13905)	5779 (3695-11690)	0.32 (0.21-0.68)	15 (7-17)							
A69-1604-14704								11/24/2023 5:38	11/24/2023 23:11	41437 (17440-63117)	41437 (17440-63117)	0 (0-0)	0 (0-0)	9 (7-10)
A69-1604-14705	10/18/2023 1:56	10/18/2023 23:01	22094 (21000-23100)	12631 (5510-15005)	9481 (6195-16890)	0.43 (0.29-0.75)	15 (7-18)							
A69-1604-14706														
A69-1604-14707	11/22/2023 23:55	11/23/2023 22:16	32638 (24000-39000)	14220 (14220-14220)	18268 (9580-24780)	0.55 (0.4-0.64)	17 (17-17)	11/24/2023 18:36	11/25/2023 2:03	31562 (13626-51218)	31562 (13626-51218)	0 (0-0)	0 (0-0)	7 (3-9)
A69-1604-14708								11/25/2023 18:50	11/26/2023 16:51	36852 (19405-51760)	36852 (19405-51760)	0 (0-0)	0 (0-0)	6 (4-9)
A69-1604-14709								11/2/2023 1:07	11/3/2023 0:43	25121 (7099-61791)	25121 (7099-61791)	0 (0-0)	0 (0-0)	6 (1-8)
A69-1604-14711								11/22/2023 22:59	11/23/2023 10:46	29421 (16029-44322)	29421 (16029-44322)	0 (0-0)	0 (0-0)	6 (5-8)
A69-1604-14712	11/24/2023 3:20	11/24/2023 22:00	39525 (38800-40100)	13435 (10295-15005)	26072 (24580-29405)	0.66 (0.62-0.74)	16 (12-18)							
A69-1604-14713														
A69-1604-14715								10/10/2023 22:39	10/11/2023 21:14	24060 (7265-33131)	24060 (7265-33131)	0 (0-0)	0 (0-0)	5 (3-7)

Tag ID	York Haven							Safe Harbor						
	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.
A69-1604-14717														
A69-1604-14718								8/11/2024 11:39	8/12/2024 0:48	212689 (191334-232759)	104621 (100095-107392)	108058 (91038-126010)	51 (48-55)	12 (12-12)
A69-1604-14721	11/22/2023 21:52	11/23/2023 5:40	25314 (21500-29500)	14220 (14220-14220)	10923 (7180-15180)	0.43 (0.34-0.52)	17 (17-17)	11/24/2023 16:49	11/24/2023 23:53	41162 (24970-63117)	41162 (24970-63117)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-14724	11/7/2023 23:24	11/8/2023 21:05	17844 (17400-18400)	13828 (10295-15005)	4023 (2395-7605)	0.23 (0.14-0.42)	17 (12-18)							
A69-1604-14725								11/3/2023 1:19	11/3/2023 18:30	27334 (7844-41430)	27334 (7844-41430)	0 (0-0)	0 (0-0)	6 (4-8)
A69-1604-14727														
A69-1604-14730								12/13/2024 12:14	12/13/2024 21:03	85528 (80639-93299)	85528 (80639-93299)	0 (0-0)	0 (0-0)	10 (9-11)
A69-1604-14731	11/1/2023 22:43	11/2/2023 22:34	28164 (26500-29800)	12742 (10295-15005)	15387 (13195-17705)	0.55 (0.47-0.63)	15 (12-18)	11/4/2023 7:34	11/5/2023 1:17	27626 (14048-41183)	27626 (14048-41183)	0 (0-0)	0 (0-0)	5 (3-7)
A69-1604-14735								12/13/2024 17:11	12/13/2024 22:36	86545 (83465-93299)	86545 (83465-93299)	0 (0-0)	0 (0-0)	11 (10-11)
A69-1604-6840	11/14/2022 2:08	11/14/2022 6:05	87083 (84150-89400)	4900 (4900-4900)	81950 (78900-84400)	0.94 (0.94-0.95)	5 (5-5)	11/15/2022 1:30	11/15/2022 6:43	73179 (71604-77189)	73179 (71604-77189)	0 (0-0)	0 (0-0)	9 (9-9)
A69-1604-6844								11/14/2022 0:00	11/14/2022 4:17	72120 (64850-73993)	72120 (64850-73993)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6847	11/13/2022 9:32	11/13/2022 18:33	61273 (44450-73400)	4900 (4900-4900)	55591 (38100-68100)	0.92 (0.89-0.93)	5 (5-5)	11/13/2022 23:37	11/14/2022 4:39	70605 (61515-73993)	70605 (61515-73993)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6848	11/13/2022 14:54	11/13/2022 20:01	70156 (62700-76700)	4900 (4900-4900)	64738 (57100-71500)	0.93 (0.92-0.94)	5 (5-5)	11/14/2022 1:36	11/14/2022 18:02	77082 (72186-80080)	77082 (72186-80080)	0 (0-0)	0 (0-0)	9 (9-9)
A69-1604-6849	11/13/2022 3:11	11/13/2022 18:14	49868 (21500-73400)	4900 (4900-4900)	44159 (16100-68100)	0.88 (0.77-0.93)	5 (5-5)	11/13/2022 23:23	11/14/2022 4:47	70605 (61515-73993)	70605 (61515-73993)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6850	11/13/2022 15:27	11/13/2022 19:50	70308 (65100-75100)	4900 (4900-4900)	64883 (59600-69800)	0.93 (0.92-0.93)	5 (5-5)							
A69-1604-6851	11/13/2022 12:25	11/13/2022 19:43	66833 (57000-75100)	4900 (4900-4900)	61333 (51300-69800)	0.93 (0.91-0.93)	5 (5-5)	11/14/2022 1:24	11/14/2022 19:02	77056 (72186-80080)	77056 (72186-80080)	0 (0-0)	0 (0-0)	9 (9-9)

	York Haven							Safe Harbor						
Tag ID	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.
A69-1604-6852	11/13/2022 5:03	11/13/2022 19:27	54847 (26500-75100)	4900 (4900-4900)	49131 (20900-69800)	0.9 (0.81-0.93)	5 (5-5)	11/13/2022 23:58	11/14/2022 18:09	75759 (61515-80080)	75759 (61515-80080)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6854								11/13/2022 20:48	11/14/2022 3:46	69367 (61515-73993)	69367 (61515-73993)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6858	11/13/2022 14:09	11/13/2022 18:57	68242 (62700-73400)	4900 (4900-4900)	62767 (57100-68100)	0.93 (0.92-0.93)	5 (5-5)	11/14/2022 0:00	11/14/2022 4:37	72120 (64850-73993)	72120 (64850-73993)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6862	11/13/2022 3:54	11/13/2022 18:01	49868 (21500-73400)	4900 (4900-4900)	44159 (16100-68100)	0.88 (0.77-0.93)	5 (5-5)							
A69-1604-6868	11/13/2022 5:35	11/13/2022 19:28	54847 (26500-75100)	4900 (4900-4900)	49131 (20900-69800)	0.9 (0.81-0.93)	5 (5-5)	11/14/2022 1:22	11/14/2022 19:36	77056 (72186-80080)	77056 (72186-80080)	0 (0-0)	0 (0-0)	9 (9-9)
A69-1604-6869														
A69-1604-6872	8/20/2023 2:24	8/20/2023 6:25	81488 (78300-84550)	2370 (2370-2370)	79505 (76330-82330)	0.97 (0.97-0.97)	3 (3-3)	8/21/2023 0:42	8/21/2023 6:34	58925 (43319-64083)	58925 (43319-64083)	0 (0-0)	0 (0-0)	9 (9-10)
A69-1604-6873	8/17/2023 16:09	8/17/2023 22:32	47900 (46400-49500)	2370 (2370-2370)	45670 (44230-47230)	0.95 (0.95-0.95)	3 (3-3)	8/18/2023 3:58	8/19/2023 0:53	41079 (28784-52330)	41079 (28784-52330)	0 (0-0)	0 (0-0)	8 (6-9)
A69-1604-6876	9/26/2023 6:15	9/27/2023 3:07	32275 (23600-36700)	14593 (13905-15005)	17545 (9495-21795)	0.54 (0.41-0.59)	18 (17-18)							
A69-1604-6877														
A69-1604-6880								11/4/2023 3:49	11/5/2023 2:17	27097 (14048-41183)	27097 (14048-41183)	0 (0-0)	0 (0-0)	5 (3-7)
A69-1604-6881	11/13/2022 15:25	11/13/2022 20:28	71221 (65100-76700)	4900 (4900-4900)	65829 (59600-71500)	0.93 (0.92-0.94)	5 (5-5)	11/14/2022 1:58	11/14/2022 7:28	75830 (72186-79708)	75830 (72186-79708)	0 (0-0)	0 (0-0)	9 (9-9)
A69-1604-6882	11/13/2022 4:33	11/13/2022 20:12	54336 (23800-76700)	4900 (4900-4900)	48661 (18300-71500)	0.89 (0.79-0.94)	5 (5-5)							
A69-1604-6885	11/13/2022 12:19	11/13/2022 17:18	64714 (57000-71550)	4900 (4900-4900)	59157 (51300-66000)	0.92 (0.91-0.93)	5 (5-5)	11/13/2022 22:11	11/14/2022 3:18	68970 (61515-73993)	68970 (61515-73993)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6886	11/13/2022 9:04	11/13/2022 19:04	62425 (44450-75100)	4900 (4900-4900)	56775 (38100-69800)	0.92 (0.89-0.93)	5 (5-5)	11/14/2022 0:38	11/14/2022 6:20	74001 (64850-79708)	74001 (64850-79708)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6887	11/13/2022 10:57	11/13/2022 16:10	60575 (49450-69400)	4900 (4900-4900)	54913 (43300-64000)	0.92 (0.9-0.93)	5 (5-5)	11/13/2022 21:22	11/14/2022 8:44	72868 (61515-79708)	72868 (61515-79708)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6888	11/13/2022 11:49	11/13/2022 19:14	65520 (53700-75100)	4900 (4900-4900)	59990 (47900-69800)	0.92 (0.91-0.93)	5 (5-5)							

	York Haven							Safe Harbor						
Tag ID	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.
A69-1604-6889								11/13/2022 23:37	11/14/2022 4:28	70605 (61515-73993)	70605 (61515-73993)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6894	9/26/2023 21:19	9/27/2023 2:36	36560 (36400-36700)	15005 (15005-15005)	21555 (21395-21795)	0.59 (0.59-0.59)	18 (18-18)	9/28/2023 0:50	9/28/2023 8:00	22171 (14833-28955)	22171 (14833-28955)	0 (0-0)	0 (0-0)	4 (2-7)
A69-1604-6900	8/17/2023 3:16	8/17/2023 10:43	50683 (50500-50900)	3940 (3940-3940)	46760 (46560-46960)	0.92 (0.92-0.92)	5 (5-5)							
A69-1604-6904	11/13/2022 13:12	11/13/2022 18:09	67057 (59950-73400)	4900 (4900-4900)	61557 (54300-68100)	0.93 (0.92-0.93)	5 (5-5)	11/13/2022 22:23	11/14/2022 2:58	68147 (61515-73993)	68147 (61515-73993)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6905	11/13/2022 12:41	11/13/2022 19:36	66833 (57000-75100)	4900 (4900-4900)	61333 (51300-69800)	0.93 (0.91-0.93)	5 (5-5)	11/14/2022 0:45	11/14/2022 18:42	76471 (64850-80080)	76471 (64850-80080)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6908	9/28/2023 1:38	9/28/2023 7:39	28680 (28000-29500)	14125 (13905-15005)	14595 (14095-15095)	0.51 (0.49-0.52)	17 (17-18)							
A69-1604-6913	11/23/2023 17:14	11/23/2023 22:55	38675 (38200-39000)	14220 (14220-14220)	24430 (23880-24780)	0.63 (0.63-0.64)	17 (17-17)							
A69-1604-6915	11/1/2023 23:02	11/2/2023 22:43	28268 (26500-29800)	12895 (10295-15005)	15342 (13195-17705)	0.55 (0.47-0.63)	15 (12-18)	11/3/2023 21:32	11/4/2023 3:39	28644 (18168-40518)	28644 (18168-40518)	0 (0-0)	0 (0-0)	5 (4-7)
A69-1604-6916	11/13/2022 13:50	11/13/2022 19:47	68063 (59950-75100)	4900 (4900-4900)	62588 (54300-69800)	0.93 (0.92-0.93)	5 (5-5)	11/14/2022 0:47	11/14/2022 6:43	74001 (64850-79708)	74001 (64850-79708)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6918	11/14/2022 2:30	11/14/2022 7:43	87486 (84150-89900)	4900 (4900-4900)	82386 (78900-85000)	0.94 (0.94-0.95)	5 (5-5)	11/14/2022 20:27	11/15/2022 2:52	73406 (71839-76567)	73406 (71839-76567)	0 (0-0)	0 (0-0)	9 (9-9)
A69-1604-6919	11/13/2022 21:13	11/14/2022 1:06	80408 (76700-84150)	4900 (4900-4900)	75133 (71500-78900)	0.94 (0.94-0.94)	5 (5-5)							
A69-1604-6920								11/15/2022 6:38	11/15/2022 19:25	76815 (70206-85759)	76815 (70206-85759)	0 (0-0)	0 (0-0)	10 (9-11)
A69-1604-6921	11/13/2022 9:31	11/13/2022 16:05	58783 (44450-69400)	4900 (4900-4900)	53044 (38100-64000)	0.91 (0.89-0.93)	5 (5-5)	11/13/2022 21:16	11/14/2022 1:40	67889 (61515-73982)	67889 (61515-73982)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6923								11/3/2023 20:28	11/4/2023 19:30	28872 (14048-40518)	28872 (14048-40518)	0 (0-0)	0 (0-0)	5 (4-8)
A69-1604-6924								11/24/2023 5:13	11/24/2023 19:58	42297 (17440-63117)	42297 (17440-63117)	0 (0-0)	0 (0-0)	9 (7-10)
A69-1604-6925	11/13/2022 12:14	11/13/2022 17:02	64714 (57000-71550)	4900 (4900-4900)	59157 (51300-66000)	0.92 (0.91-0.93)	5 (5-5)	11/13/2022 21:46	11/14/2022 2:21	68761 (61515-73993)	68761 (61515-73993)	0 (0-0)	0 (0-0)	9 (8-9)

Tag ID	York Haven							Safe Harbor						
	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.
A69-1604-6926	11/13/2022 10:39	11/13/2022 16:16	60575 (49450-69400)	4900 (4900-4900)	54913 (43300-64000)	0.92 (0.9-0.93)	5 (5-5)							
A69-1604-6927	11/13/2022 15:53	11/13/2022 20:45	71221 (65100-76700)	4900 (4900-4900)	65829 (59600-71500)	0.93 (0.92-0.94)	5 (5-5)							
A69-1604-6928	11/14/2022 1:02	11/14/2022 5:06	85958 (82650-88800)	4900 (4900-4900)	80767 (77300-83700)	0.94 (0.94-0.94)	5 (5-5)							
A69-1604-6929	11/13/2022 13:46	11/13/2022 19:29	68063 (59950-75100)	4900 (4900-4900)	62588 (54300-69800)	0.93 (0.92-0.93)	5 (5-5)	11/14/2022 17:35	11/15/2022 0:38	75890 (71970-80011)	75890 (71970-80011)	0 (0-0)	0 (0-0)	9 (9-9)
A69-1604-6935	8/21/2023 0:06	8/21/2023 4:32	62600 (61900-63300)	4240 (4240-4240)	58460 (57760-59160)	0.93 (0.93-0.93)	5 (5-5)	8/28/2023 1:43	8/28/2023 9:45	27621 (13497-44352)	27621 (13497-44352)	0 (0-0)	0 (0-0)	7 (5-8)
A69-1604-6936								10/14/2022 5:15	10/15/2022 0:39	13598 (2714-33986)	13598 (2714-33986)	0 (0-0)	0 (0-0)	4 (1-6)
A69-1604-6939	11/22/2023 22:46	11/23/2023 3:12	25240 (22200-28000)	14220 (14220-14220)	10820 (7780-13580)	0.43 (0.35-0.49)	17 (17-17)							

Tag ID	Holtwood							Conowingo						
	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.
A69-1602-60045	11/14/2022 1:58	11/14/2022 17:53	73679 (59394-83548)	54596 (54201-55081)	19083 (4546-29347)	0.25 (0.08-0.35)	13 (13-13)							
A69-1602-60049	11/15/2022 21:18	11/16/2022 0:46	72240 (71125-73247)	54562 (54501-54599)	17678 (16542-18662)	0.24 (0.23-0.25)	13 (13-13)							
A69-1604-14641	11/23/2023 23:05	11/24/2023 2:26	32045 (27788-37726)	26650 (26464-26861)	5395 (927-11262)	0.16 (0.03-0.3)	2 (2-2)							
A69-1604-14643	11/3/2023 18:23	11/4/2023 6:52	29412 (22201-32133)	29412 (22201-32133)	0 (0-0)	0 (0-0)	6 (6-6)							
A69-1604-14646	11/6/2023 21:32	11/6/2023 23:29	20593 (14697-24199)	20593 (14697-24199)	0 (0-0)	0 (0-0)	6 (5-6)							
A69-1604-14647	12/7/2023 18:09	12/8/2023 0:48	49444 (39334-54208)	46836 (39334-48023)	2608 (0-6390)	0.05 (-0.12)	12 (12-12)							
A69-1604-14648														
A69-1604-14652														
A69-1604-14654	11/5/2023 0:36	11/5/2023 2:45	23417 (18195-38983)	23413 (18195-38972)	3 (0-11)	0 (0-0)	6 (6-6)							
A69-1604-14657	11/5/2023 20:15	11/5/2023 22:23	26331 (21143-29684)	26331 (21143-29684)	0 (0-0)	0 (0-0)	6 (6-6)							
A69-1604-14658	10/2/2023 3:28	10/2/2023 6:08	13827 (13182-16309)	13021 (12377-15502)	806 (806-806)	0.06 (0.05-0.06)	2 (2-2)							
A69-1604-14659	11/5/2023 4:01	11/5/2023 18:53	24806 (21754-30696)	24426 (21754-30696)	380 (0-858)	0.02 (-0.04)	6 (6-6)	11/6/2023 3:20	11/6/2023 18:07	24668 (23045-31985)	24668 (23045-31985)	0 (0-0)	0 (0-0)	4 (4-5)
A69-1604-14660	10/28/2023 4:39	10/28/2023 6:21	10265 (9338-13026)	10265 (9338-13026)	0 (0-0)	0 (0-0)	4 (3-5)							
A69-1604-14661	9/30/2023 17:49	9/30/2023 20:29	26259 (24193-26890)	25453 (23387-26084)	806 (806-806)	0.03 (0.03-0.03)	2 (2-2)							
A69-1604-14662	10/18/2023 2:02	10/18/2023 5:07	12827 (10780-13658)	12827 (10780-13658)	0 (0-0)	0 (0-0)	3 (3-4)							
A69-1604-14664	12/8/2023 0:02	12/8/2023 1:39	39315 (30555-48056)	39278 (30555-47945)	37 (0-111)	0 (0-0)	12 (12-12)							

Tag ID	Holtwood							Conowingo						
	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.
A69-1604-14666														
A69-1604-14668	11/25/2023 2:17	11/25/2023 4:23	27921 (27760-28289)	26656 (26525-26748)	1266 (1016-1541)	0.05 (0.04-0.05)	2 (2-2)							
A69-1604-14669	12/16/2023 15:24	12/16/2023 19:13	59014 (39877-69498)	35598 (29588-39601)	23416 (10288-32654)	0.38 (0.26-0.48)	12 (12-12)							
A69-1604-14670														
A69-1604-14671	12/2/2024 6:10	12/2/2024 19:11	28782 (22788-34313)	28777 (22783-34307)	5 (5-6)	0 (0-0)	9 (8-10)							
A69-1604-14672	10/12/2023 1:43	10/12/2023 3:03	23457 (21995-24710)	23457 (21995-24710)	0 (0-0)	0 (0-0)	4 (4-4)							
A69-1604-14674	12/16/2023 8:13	12/16/2023 16:38	47370 (39652-68436)	32245 (29417-38381)	15125 (2874-32654)	0.3 (0.07-0.48)	12 (12-12)							
A69-1604-14679	11/24/2023 1:45	11/24/2023 4:27	28610 (27788-30959)	26906 (26614-27246)	1705 (906-4345)	0.06 (0.03-0.14)	2 (2-2)							
A69-1604-14682														
A69-1604-14685	11/5/2023 7:29	11/5/2023 22:05	25170 (21143-30696)	24812 (21143-30696)	357 (0-858)	0.01 (-0.04)	6 (6-6)	11/6/2023 19:26	11/6/2023 23:01	30524 (23220-31985)	30524 (23220-31985)	0 (0-0)	0 (0-0)	5 (4-5)
A69-1604-14687	11/5/2023 2:41	11/5/2023 6:14	22165 (18237-30428)	22165 (18237-30428)	0 (0-0)	0 (0-0)	6 (6-6)							
A69-1604-14689	11/24/2023 14:31	11/24/2023 17:12	44551 (41440-47705)	26969 (26692-27413)	17582 (14729-20484)	0.39 (0.36-0.43)	2 (2-2)	11/25/2023 0:12	11/25/2023 2:47	31233 (31233-31233)	31260 (31233-31369)	0 (0-0)	0 (0-0)	5 (5-5)
A69-1604-14691														
A69-1604-14693	12/1/2024 22:38	12/2/2024 19:07	27.752 (19675-34313)	27746 (19670-34307)	5 (5-6)	0 (0-0)	9 (8-10)	12/6/2024 5:10	12/6/2024 20:25	22534 (11882-32276)	22534 (11882-32276)	0 (0-0)	0 (0-0)	4 (2-5)
A69-1604-14694	12/2/2023 18:38	12/3/2023 6:48	25140 (19283-32004)	25140 (19283-32004)	0 (0-0)	0 (0-0)	9 (8-9)							
A69-1604-14695														
A69-1604-14696	10/10/2023 3:42	10/10/2023 5:05	32133 (30110-34717)	32133 (30110-34717)	0 (0-0)	0 (0-0)	6 (4-6)	10/14/2023 22:18	10/15/2023 21:23	15524 (11134-17491)	15524 (11134-17491)	0 (0-0)	0 (0-0)	3 (2-3)

Tag ID	Holtwood							Conowingo						
	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.
A69-1604-14697	11/17/2023 2:33	11/17/2023 18:12	14702 (7090-23666)	13797 (6185-22762)	905 (905-905)	0.07 (0.04-0.13)	2 (1-2)							
A69-1604-14698	11/29/2023 6:30	11/29/2023 21:41	28228 (26874-29787)	26916 (25656-27846)	1312 (905-2610)	0.05 (0.03-0.09)	2 (2-2)							
A69-1604-14699	11/3/2023 21:01	11/3/2023 23:41	29685 (24510-318483)	29685 (24510-318483)	0 (0-0)	0 (0-0)	6 (6-6)	11/4/2023 20:51	11/5/2023 0:46	29575 (24482-32122)	29575 (24482-32122)	0 (0-0)	0 (0-0)	5 (4-5)
A69-1604-14700	11/25/2023 10:41	11/25/2023 12:10	35540 (32662-37353)	26344 (26323-26388)	9197 (6332-11030)	0.26 (0.19-0.3)	2 (2-2)	11/27/2023 20:30	11/28/2023 18:28	32394 (23480-41331)	32394 (23480-41331)	0 (0-0)	0 (0-0)	5 (4-6)
A69-1604-14701														
A69-1604-14702														
A69-1604-14704	11/25/2023 0:06	11/25/2023 2:53	29825 (27760-33175)	26716 (26637-26748)	3109 (1016-6538)	0.1 (0.04-0.2)	2 (2-2)	11/27/2023 2:57	11/27/2023 17:39	32353 (32353-32353)	32353 (32353-32353)	0 (0-0)	0 (0-0)	5 (5-5)
A69-1604-14705														
A69-1604-14706	10/17/2023 2:33	10/17/2023 5:13	16159 (13351-25783)	16159 (13351-25783)	0 (0-0)	0 (0-0)	4 (3-6)							
A69-1604-14707	11/25/2023 20:46	11/25/2023 22:20	39357 (37270-40983)	26750 (26503-27058)	12607 (10766-14211)	0.32 (0.29-0.35)	2 (2-2)	11/26/2023 12:43	11/26/2023 21:16	32753 (31818-37458)	32753 (31818-37458)	0 (0-0)	0 (0-0)	5 (5-6)
A69-1604-14708	11/26/2023 17:59	11/26/2023 21:12	38049 (37257-38523)	26914 (26668-27104)	11135 (10589-11501)	0.29 (0.28-0.3)	2 (2-2)	11/27/2023 20:08	11/28/2023 18:27	32393 (23480-41331)	32393 (23480-41331)	0 (0-0)	0 (0-0)	5 (4-6)
A69-1604-14709								11/6/2023 19:00	11/6/2023 22:17	31985 (31985-31985)	31985 (31985-31985)	0 (0-0)	0 (0-0)	5 (5-5)
A69-1604-14711	11/23/2023 11:44	11/23/2023 21:59	30564 (25455-37177)	26968 (23591-28536)	3595 (906-10657)	0.11 (0.03-0.29)	2 (2-2)	11/24/2023 21:37	11/25/2023 0:40	31315 (31233-31369)	31315 (31233-31369)	0 (0-0)	0 (0-0)	5 (5-5)
A69-1604-14712														
A69-1604-14713	11/28/2023 3:03	11/28/2023 6:11	28257 (27687-28828)	27351 (26781-27923)	905 (905-906)	0.03 (0.03-0.03)	2 (2-2)							
A69-1604-14715	10/11/2023 22:29	10/12/2023 2:39	23329 (19945-25176)	23329 (19945-25176)	0 (0-0)	0 (0-0)	4 (4-4)							
A69-1604-14717	11/5/2023 2:59	11/5/2023 18:44	24077 (18237-30696)	23740 (18237-30696)	338 (0-858)	0.01 (-0.04)	6 (6-6)							

	Holtwood							Conowingo						
Tag ID	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.
A69-1604-14718	8/12/2024 1:13	8/12/2024 2:36	112538 (112406-112670)	51396 (51379-51412)	61143 (60994-61291)	0.54 (0.54-0.54)	12 (12-12)							
A69-1604-14721	11/25/2023 1:08	11/25/2023 3:53	28475 (27760-30075)	26708 (26605-26748)	1768 (1016-3342)	0.06 (0.04-0.11)	2 (2-2)							
A69-1604-14724	11/22/2023 19:14	11/22/2023 21:43	27310 (27145-27430)	26404 (26239-26524)	906 (906-906)	0.03 (0.03-0.03)	2 (2-2)	11/24/2023 20:26	11/25/2023 1:40	33843 (31233-49098)	33843 (31233-49098)	0 (0-0)	0 (0-0)	5 (5-7)
A69-1604-14725	11/3/2023 19:54	11/3/2023 21:51	31871 (31645-32133)	31871 (31645-32133)	0 (0-0)	0 (0-0)	6 (6-6)	11/4/2023 20:00	11/5/2023 0:40	30849 (24482-32122)	30849 (24482-32122)	0 (0-0)	0 (0-0)	5 (4-5)
A69-1604-14727								9/4/2024 5:23	9/5/2024 0:18	19040 (11192-23268)	19040 (11192-23268)	0 (0-0)	0 (0-0)	3 (2-4)
A69-1604-14730	12/13/2024 22:16	12/13/2024 23:44	81607 (81521-81715)	57720 (57193-57238)	24386 (24283-24523)	0.30 (0.30-0.30)	13 (13-13)	12/14/2024 6:49	12/15/2024 4:30	78245 (77902-79275)	78245 (77902-79275)	0 (0-0)	0 (0-0)	11 (11-11)
A69-1604-14731	11/5/2023 2:08	11/5/2023 2:50	18244 (18237-18251)	18244 (18237-18251)	0 (0-0)	0 (0-0)	6 (6-6)							
A69-1604-14735	12/13/2024 23:22	12/14/2024 0:51	81535 (81498-81584)	57225 (57206-57238)	24310 (24283-24354)	0.30 (0.30-0.30)	13 (13-13)	12/14/2024 20:19	12/14/2024 23:48	78245 (77902-79275)	78245 (77902-79275)	0 (0-0)	0 (0-0)	11 (11-11)
A69-1604-6840	11/15/2022 8:01	11/15/2022 18:12	73472 (71106-81687)	54786 (54489-54922)	18686 (16203-27198)	0.25 (0.23-0.33)	13 (13-13)	11/16/2022 1:23	11/16/2022 4:50	48797 (46314-58730)	48797 (46314-58730)	0 (0-0)	0 (0-0)	6 (6-8)
A69-1604-6844								11/14/2022 21:02	11/14/2022 23:35	78019 (73754-79441)	78019 (73754-79441)	0 (0-0)	0 (0-0)	11 (11-11)
A69-1604-6847	11/14/2022 5:12	11/14/2022 7:05	77435 (76550-78629)	54351 (54339-54363)	23083 (22203-24266)	0.3 (0.29-0.31)	13 (13-13)	11/16/2022 1:27	11/16/2022 18:49	57565 (46314-64666)	57565 (46314-64666)	0 (0-0)	0 (0-0)	8 (6-9)
A69-1604-6848	11/14/2022 18:29	11/14/2022 20:23	75675 (68906-81438)	54873 (54647-55081)	20802 (13825-26688)	0.27 (0.2-0.33)	13 (13-13)	11/15/2022 2:06	11/15/2022 5:06	73754 (73754-73754)	73754 (73754-73754)	0 (0-0)	0 (0-0)	11 (11-11)
A69-1604-6849								11/15/2022 19:04	11/15/2022 22:06	56186 (56186-56186)	56186 (56186-56186)	0 (0-0)	0 (0-0)	9 (9-9)
A69-1604-6850														
A69-1604-6851								11/16/2022 0:30	11/16/2022 18:07	57623 (46314-64666)	57623 (46314-64666)	0 (0-0)	0 (0-0)	8 (6-9)
A69-1604-6852								11/15/2022 13:17	11/15/2022 17:49	57688 (56186-65197)	57688 (56186-65197)	0 (0-0)	0 (0-0)	9 (9-10)

	Holtwood							Conowingo						
Tag ID	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.
A69-1604-6854	11/14/2022 4:29	11/14/2022 6:20	77233 (76550-77822)	54355 (54339-54376)	22878 (22203-23481)	0.3 (0.29-0.3)	13 (13-13)							
A69-1604-6858	11/14/2022 4:53	11/14/2022 6:31	77233 (76550-77822)	54355 (54339-54376)	22878 (22203-23481)	0.3 (0.29-0.3)	13 (13-13)	11/14/2022 21:00	11/14/2022 23:33	78019 (73754-79441)	78019 (73754-79441)	0 (0-0)	0 (0-0)	11 (11-11)
A69-1604-6862														
A69-1604-6868	11/14/2022 20:31	11/14/2022 22:43	77569 (70214-81438)	54721 (54647-54815)	22848 (15399-26688)	0.29 (0.22-0.33)	13 (13-13)	11/15/2022 20:05	11/15/2022 23:34	56695 (56186-58730)	56695 (56186-58730)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6869	10/19/2023 1:32	10/19/2023 3:52	16991 (12526-22103)	16991 (12526-22103)	0 (0-0)	0 (0-0)	7 (3-8)							
A69-1604-6872	8/21/2023 7:30	8/21/2023 21:01	48663 (44270-52811)	20408 (20313-20518)	28254 (23914-32341)	0.58 (0.54-0.61)	9 (9-9)	8/22/2023 3:27	8/22/2023 6:52	37070 (23278-57757)	37070 (23278-57757)	0 (0-0)	0 (0-0)	6 (4-9)
A69-1604-6873	8/19/2023 2:16	8/19/2023 3:53	28966 (28482-29923)	20646 (20627-20659)	8320 (7823-9272)	0.29 (0.27-0.31)	9 (9-9)							
A69-1604-6876														
A69-1604-6877	11/16/2023 5:38	11/16/2023 19:44	14228 (7083-27192)	13323 (6178-26286)	905 (905-906)	0.08 (0.03-0.13)	1 (1-2)	11/20/2023 19:37	11/21/2023 0:38	11339 (11254-11373)	11339 (11254-11373)	0 (0-0)	0 (0-0)	2 (2-2)
A69-1604-6880	11/5/2023 2:49	11/5/2023 4:35	19414 (18237-21754)	19414 (18237-21754)	0 (0-0)	0 (0-0)	6 (6-6)							
A69-1604-6881	11/14/2022 12:37	11/14/2022 14:32	70541 (68988-72468)	54761 (54670-54798)	15779 (14318-17669)	0.22 (0.21-0.24)	13 (13-13)	11/14/2022 21:15	11/15/2022 0:08	77166 (73754-79441)	77166 (73754-79441)	0 (0-0)	0 (0-0)	11 (11-11)
A69-1604-6882														
A69-1604-6885								11/14/2022 18:28	11/14/2022 21:00	79441 (79441-79441)	79441 (79441-79441)	0 (0-0)	0 (0-0)	11 (11-11)
A69-1604-6886														
A69-1604-6887														
A69-1604-6888														
A69-1604-6889								11/14/2022 21:58	11/15/2022 0:36	77166 (73754-79441)	77166 (73754-79441)	0 (0-0)	0 (0-0)	11 (11-11)
A69-1604-6894	9/28/2023 19:45	9/28/2023 22:38	30560 (29806-31295)	25943 (25768-26104)	4617 (3778-5342)	0.15 (0.13-0.17)	2 (2-2)	9/29/2023 23:23	9/30/2023 21:33	19412 (5100-40892)	19412 (5100-40892)	0 (0-0)	0 (0-0)	3 (1-6)

Tag ID	Holtwood							Conowingo						
	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.
A69-1604-6900														
A69-1604-6904	11/14/2022 3:15	11/14/2022 4:46	77384 (76740-77822)	54420 (54358-54527)	22964 (22381-23446)	0.3 (0.29-0.3)	13 (13-13)	11/14/2022 9:58	11/14/2022 18:21	77201 (73280-79441)	77201 (73280-79441)	0 (0-0)	0 (0-0)	11 (10-11)
A69-1604-6905								11/15/2022 20:11	11/15/2022 23:29	56695 (56186-58730)	56695 (56186-58730)	0 (0-0)	0 (0-0)	9 (8-9)
A69-1604-6908	10/14/2023 21:21	10/15/2023 1:33	14823 (7888-21107)	14823 (7888-21107)	0 (0-0)	0 (0-0)	4 (3-5)							
A69-1604-6913														
A69-1604-6915	11/4/2023 4:07	11/4/2023 6:20	26486 (22201-31761)	26486 (22201-31761)	0 (0-0)	0 (0-0)	6 (6-6)							
A69-1604-6916	11/14/2022 14:44	11/14/2022 18:02	71762 (68906-73832)	54883 (54780-55081)	16879 (13825-19051)	0.23 (0.2-0.26)	13 (13-13)	11/15/2022 0:18	11/15/2022 3:55	73754 (73754-73754)	73754 (73754-73754)	0 (0-0)	0 (0-0)	11 (11-11)
A69-1604-6918														
A69-1604-6919														
A69-1604-6920														
A69-1604-6921								11/14/2022 15:52	11/14/2022 18:47	79441 (79441-79441)	79441 (79441-79441)	0 (0-0)	0 (0-0)	11 (11-11)
A69-1604-6923	11/4/2023 20:44	11/4/2023 22:47	28567 (24831-31316)	28567 (24831-31316)	0 (0-0)	0 (0-0)	6 (6-6)	11/6/2023 18:34	11/7/2023 0:21	29794 (23220-31985)	29794 (23220-31985)	0 (0-0)	0 (0-0)	5 (4-5)
A69-1604-6924														
A69-1604-6925	11/14/2022 2:47	11/14/2022 4:19	73704 (62664-77822)	54544 (54358-54915)	19160 (7749-23446)	0.25 (0.12-0.3)	13 (13-13)							
A69-1604-6926														
A69-1604-6927														
A69-1604-6928														
A69-1604-6929								11/15/2022 22:53	11/16/2022 18:46	57493 (46314-64666)	57493 (46314-64666)	0 (0-0)	0 (0-0)	8 (6-9)

	Holtwood							Conowingo						
Tag ID	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.	Depart Upstream Array	Arrive Downstream Array	Project Flow (cfs)	Unit Flow (cfs)	Spill Flow (cfs)	% Spill	No. Units Oper.
A69-1604-6935	8/28/2023 22:07	8/28/2023 23:28	27170 (26591-27631)	20320 (20302-20347)	6850 (6289-7284)	0.25 (0.24-0.26)	9 (9-9)							
A69-1604-6936	10/15/2022 1:59	10/15/2022 20:57	13065 (1562-24156)	13065 (1562-24156)	0 (0-0)	0 (0-0)	4 (3-6)							
A69-1604-6939														