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ARTICLE OPEN ACCESS

Recompression Improves Release Success in Pollack (*Pollachius pollachius*): A Step Towards Assessing Post Release Mortality in a Recreational Fishery

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Received: 27 March 2025 | **Revised:** 27 September 2025 | **Accepted:** 16 December 2025

Keywords: acoustic telemetry | barotrauma | fisheries management

ABSTRACT

The recreational fishery for pollack (*Pollachius pollachius*) in the northeast Atlantic is impacted by the species' high sensitivity to barotrauma. When captured at depth and brought to the surface, gas expansion within the peritoneal cavity can cause a variety of injuries and hinder release. Via an experimental weighted cage, this study evaluated the efficacy of releasing Pollack at depth as a barotrauma mitigation strategy. We found that depth-release significantly increased the probability of released Pollack displaying an active escape response to 83%, compared to 56% for surface-released fish; however, increased capture depth and fish size negatively affected success. Camera observations of depth-released Pollack confirmed the recovery of vital reflexes (vestibulo-ocular reflex, equilibrium maintenance) within 1.5–4 min. Further acoustic telemetry demonstrated that individuals subsequently displayed active dispersion from the release site (0.1–23.8 km) and showed active vertical movements for up to 6 months post-release. These findings indicate that depth-release improves survival outcomes, though further research is required to optimise release methods in open-water environments.

1 | Introduction

Marine Recreational Fisheries (MRF) are wide-spread and diverse, encompassing any fishing activity for marine fishes for pleasure and/or personal consumption (Cooke and Schramm 2007; Hyder et al. 2018). The sector is largely unlicensed in most countries, and as a result of fishing activity occurring in remote locations, MRF is intrinsically hard to study relative to commercial fisheries (Hyder et al. 2018). Despite this, MRF participation per capita is predicted to be high with estimates of 0.2%–33% of the population actively participating, depending on the country (Estimates sourced from European Countries—Hyder et al. 2018). As a result, the sector is thought to contribute significantly to economies at regional and national scales, with total expenditure ranging from £1.57 to £4.12 million (combined) per year (Hyder et al. 2018). MRF is therefore increasingly being recognised as an important sector due to its social and economic significance, and explicitly recognised within fisheries management policies, for example, UK Fisheries Act 2020 (UK regulation, 2020 c. 22) and Reformed Common Fisheries Policy (EU regulation, 1380/2013).

Despite high rates of catch-and-release within many MRF (~50% in Europe, Cooke and Schramm, 2007; Ferter et al. 2013, 57% in USA; Curtis et al. 2019), post-release mortality is a key evidence gap widely cited within the peer reviewed literature (Ferteret al. 2015; Wegner et al. 2021). In particular, barotrauma has been specifically highlighted as a pervasive issue which is common in physoclistous species—those with closed swimbladders (Curtis et al. 2019; Wegner et al. 2021). Barotrauma is caused by a decrease in pressure when a fish is caught in water depths generally exceeding 10 m and brought to the surface with symptoms worsening with increasing capture depths (Tytler and Blaxter 1973). This is a result of gas expansion within the swim-bladder, which will increase in volume and may rupture inside the peritoneal cavity resulting in a variety of physical symptoms, for example, stiff body and/or bloating; protrusion of the stomach from the mouth (oesophageal eversion, Figure 1); blistered skin; ocular embolisms (Figure 1); seizures and direct mortality. As a result, specific management actions have been implemented in several areas to mitigate the risk of barotrauma and associated mortality, for example, fishing-depth restrictions for rockfish (*Sebastes* spp.) within California, USA (Bellquist et al. 2019), or requirement to carry a venting tool or descending device in the Gulf of Mexico, USA via the Descend act, 2022 (USA regulation, H.R.5126).

To mitigate the impacts of barotrauma, two methods are cited within the literature: (1) venting, or (2) releasing at depth via the use of descending devices. Venting is the process of releasing gas from the swim bladder and/or peritoneal cavity by inserting a hypodermic needle or a specific 'venting tool' to allow gas to escape (Wilde 2009). While the technique has been shown to be successful in some cases (Eberts and Somers 2017), fish survival rates are generally seen as variable and likely impacted by other sub-lethal effects, for example, infection (Wilde 2009) and/or unseen internal damage caused by inserting the venting tool (Wilde 2009). An alternative method is releasing the fish at depth (with a descending device), where the fish is attached to a weighted release mechanism and rapidly returned to the capture depth before release (Figure 1). Descending devices therefore allow the internal pressure within the body cavity of the fish to return to that of pre-capture without the need for venting (Wegner et al. 2021). Recompression techniques like descending devices are considered a more popular and less invasive barotrauma mitigation tool (Curtis et al. 2019) and have been associated with high post-release survival rates, for example,*Lutjanus campechanus* 50%–87% (Bohaboy et al. 2020; Runde et al. 2021), *Sebastes* spp. 45%–89.5% (Wegner et al. 2021). Despite the overall positive message on the efficacy of descending devices, studies often report species-specific responses; therefore further validation is required for barotrauma-sensitive and highly-exploited species.

Pollack (*Pollachius pollachius*) is a species of concern with this regard, which is both highly exploited and barotrauma sensitive (Figure 1). With a distribution across the North-East Atlantic, this demersal gadoid is a key target for commercial (MMO 2020) and recreational fishers (ICES 2024). Despite the relative importance of this species, significant knowledge gaps persist in: (1) population status and (2) biological parameters, for example, growth, mortality, fishing pressure (ICES 2024). Over the past 20 years, pollack catches across the English Channel, Celtic and Irish Seas (ICES area 6 & 7) have declined by ~72%, indicating a rapid and severe population decline across the region (ICES 2024). As a result, ICES recommended zero commercial catches in 2024 and 2025 to encourage stock recovery (ICES 2024). This was followed by the UK Government introducing a by-catch only commercial fishery, limiting commercial catches to 100 kg per month per vessel in 2024 and further reduced to 75 kg in 2025 (UK GOV 2025). In 2024, the Angling Trust—the National Governing Body for recreational fishing in England—published a voluntary code of conduct to promote responsible angling

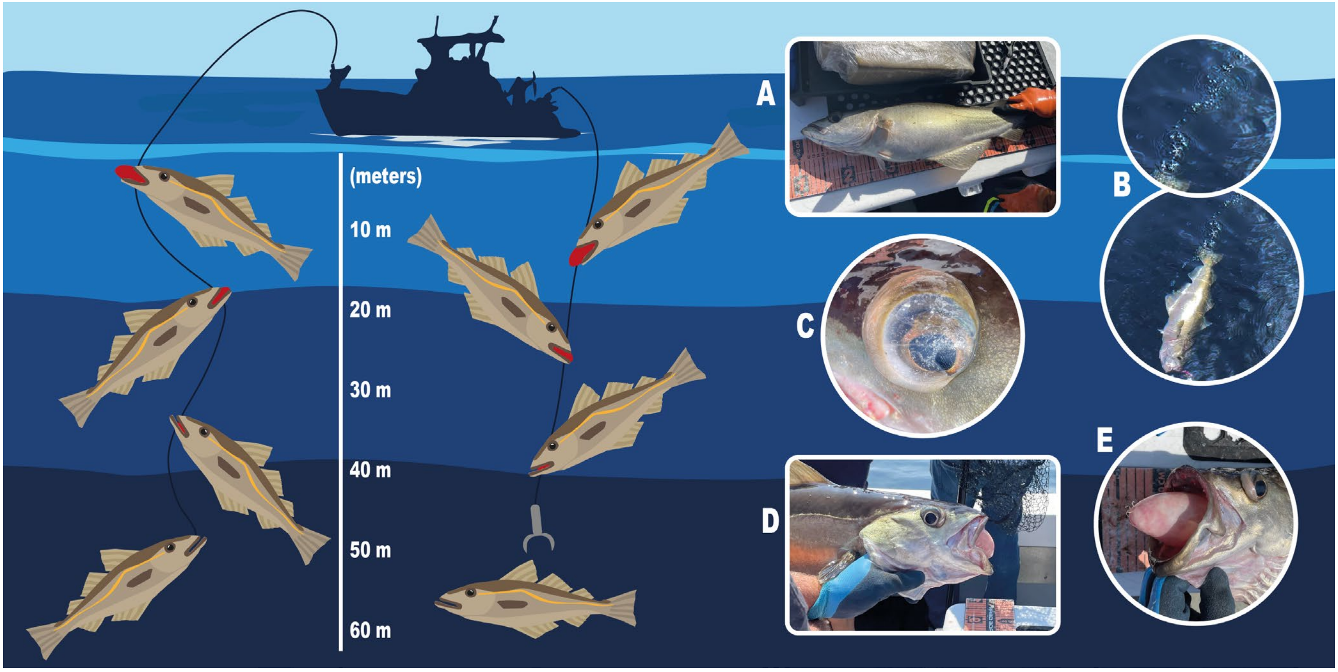

FIGURE 1 | Infographic demonstrating the capture and release of barotrauma sensitive species, for example, pollack (Pollachius pollachius), using descending devices (left). Common barotrauma injuries/symptoms experienced by pollack (right) (A) Bloating; (B) Gas leakage from the body; (C) Ocular embolism; (D, E) Oesophageal eversion.

for pollack in light of the stock status (Angling Trust 2025). In 2026 the UK government also introduced a limit of 3 Pollack per person per day for recreational anglers. Given the importance of pollack fishing within MRF, a major evidence gap to support stock recovery is estimates of post-release mortality and mitigation measures. As part of the Pollack Fisheries Industry Science Partnership (FISP) project (Pollack FISP), we therefore aimed to provide an initial assessment of post-release survival of Pollack under different MRF capture conditions (capture depths and fish lengths), and assess the use of recompression as a barotrauma mitigation method to improve release success. More specifically our research questions were:

1. Can releasing Pollack at depth improve release success in recreational fisheries relative to individuals released at the surface
2. Are there any biological (e.g., fish size) and capture conditions (e.g., capture depth) that correlate with release success in Pollack?

2 | Methods

2.1 | Fish Capture and Tagging

Here we combined data from Pollack that were captured across a range of conditions using standard MRF practices—rod and line with artificial lures. Pollack were captured in water depths ranging 28–76 m on shipwrecks and rocky reefs. Upon capture the following information was recorded: depth the fish took the lure (estimated from reel turns off the seabed; capture depth), the time to bring the fish to the surface (fight time), the duration of time the fish was held at the surface (time on deck) and fork length.

To assess variability in the ability of Pollack to swim away when released on the surface (referred to as release success), observers on charter fishing vessels recorded capture information. Once released, pollack either immediately reacted when placed in the water and swam to depth where they were lost from view, or showed lethargic behaviour and were either completely unable to swim below the surface or made shallow dives of 1–2 s and then floated to the surface. If unable to swim below the surface rapidly, fish were immediately vulnerable to avian predation in combination with further barotrauma-related injuries. Therefore, once released, fish were typically allowed ~1–2 min to swim below the surface. If the fish could not swim below the surface within this time, they were re-captured, euthanized and that release was defined as 'unsuccessful'. If fish were able to swim below the surface the release was defined as 'successful'. Observers maintained watch to assess if fish later appeared at the surface: if this occurred, fish were immediately re-captured and euthanized and the release defined as unsuccessful.

To assess variability in the ability of Pollack to swim away when released at depth, a further subset of fish were either internally acoustically tagged or externally floy tagged. For individuals that were internally acoustically tagged, each was anaesthetized with an induction dose of 80–100 mg/L MS-222 (tricaine methanesulfonate). Fish were then positioned dorsally on a V-shaped cradle, and a single Innovasea V13 or V13 pressure-sensor transmitter tag was implanted within the peritoneal cavity via a small incision (10–15 mm) made between the pelvic fin and anus. Transmitter tags were programmed to emit a randomised uniquely-coded ping once every 90–150 s. Following tag implantation, the surgical site was closed using dissolvable sutures and/or medical grade adhesive. Each externally tagged fish was immediately placed on a V-shaped cradle and an external ID tag was attached via a subcutaneous T-bar anchor at the base of the dorsal fin. All tagging procedures were conducted under a UK Home Office licence (PP8554952).

Internally and externally tagged fish were then immediately returned to as close to the capture depth as possible using a custom designed weighted cage (Figure 2). Attached to the cage was a live-feed camera to remotely monitor fish recovery at depth. The cage was suspended from the vessel via a length of rope with bungee cord attached at each end to minimise movement as a result of swell at the surface. Fish behaviour was then monitored via the live-feed camera for a period of approximately 10–30 min until the following criteria were achieved: the fish is able to freely swim within the cage or respond to physical stimuli, for example, avoiding contact with the cage. Once the criteria were achieved, the bottom of the cage was opened via an acoustic release mechanism (Innovasea VR2AR receiver) controlled from the surface, and the fish allowed to swim free of the cage. This was achieved for all depth-released fish; however, if this didn't occur, the fish would have been brought to the surface and euthanized. The release cage allowed the ability to hold the fish at or near the capture depth until recovery was achieved, as well as provide a rigid frame for cameras to be attached and allow video footage collection. If fish showed an active swimming response away from the cage when it was opened, the release was defined as 'successful', if swimming behaviour was slow or lethargic, the release was defined as 'unsuccessful'.

Recovery of depth released Pollack was also further investigated by monitoring the video footage from within the weighted cage to identify when important reflexes were first observed. The reflexes monitored were: Vestibulo-Ocular Reflex (VOR) and Equilibrium Maintenance (EM) (Table 1). These two recovery metrics were selected because they are easily identifiable and cited within the literature to be impaired after stress (Lennox et al. 2024).

The survival of fish beyond the immediate release from the weighted cage was assessed using re-capture of tagged fish (reported by local fishers), and detections from acoustic tags (ID and depth sensitive transmitters) on a regional acoustic telemetry receiver array—the Fish Intel Network (Hall et al. 2025). Transmitter tags were coded to transmit unique signals for each individual for an expected battery life of 1–4 years. The receiver network was strategically placed across shipwrecks and rocky reefs within the immediate release location (Plymouth, UK) (Figure 3). Providing presence/absence data on a continuous basis, when a tagged fish was within ~300 m (determined via tag drags) of a deployed receiver. As part of the FISH INTEL network, further receivers were deployed across the English Channel in the UK, France and Belgium (~600 km) (Figure 3) (Hall et al. 2025). When combined with wider tracking

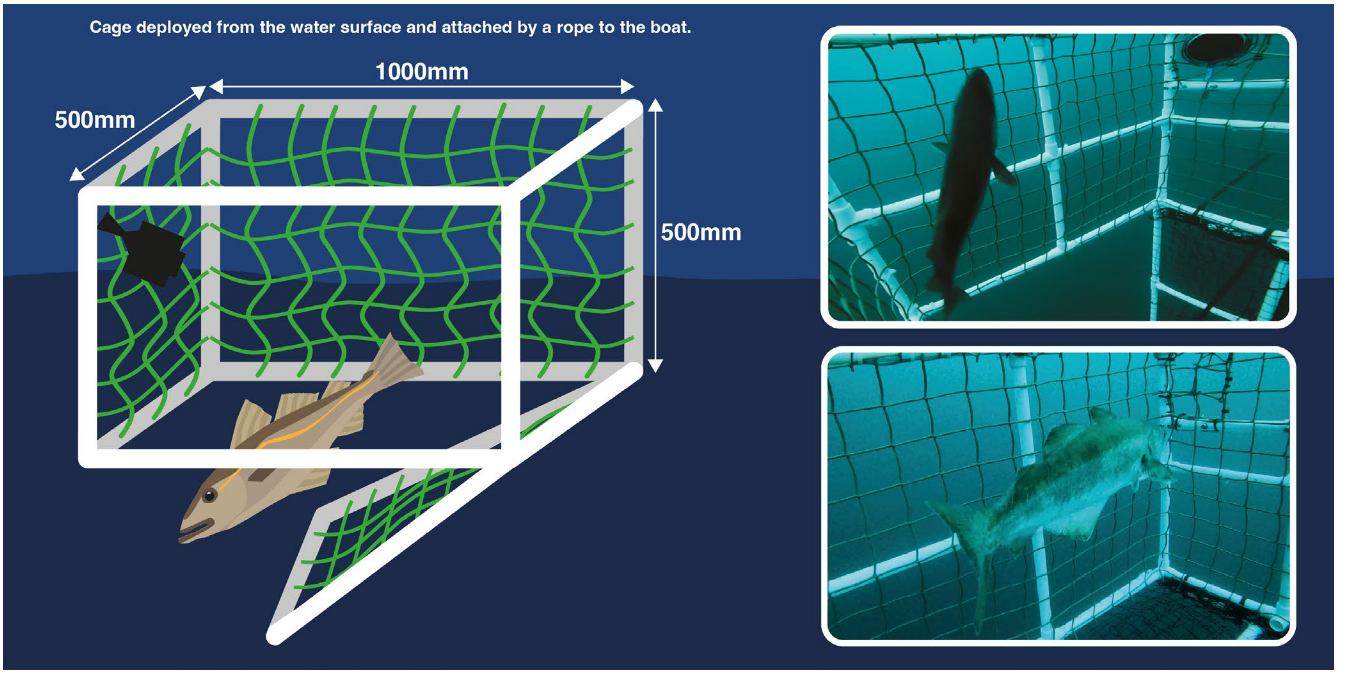

FIGURE 2 | Schematic of weighted cage used to return captured Pollack to depth, then record recovery via surface-feed camera (left). Image of recovered Pollack with trap door open (top right) and closed (bottom right).

TABLE 1 | Behaviours observed to define recovery of depth and surface released *Pollachius pollachius*.

Behaviour	Definition	Release method
Vestibulo-ocular reflex (VOR)	Definition: Active pupil movement. When impaired the pupil shows no movement in relation to the environment or body orientation. Variable recorded: The time when active eye/pupil movement was observed. Response variable: Numeric	Depth release
Equilibrium Maintenance	Definition: Upright swimming. When impaired the fish may swim upside down or rock lazily from side to side. Variable recorded: The time when upright swimming was observed. Response variable: Numeric	Depth release
Active swimming/release success	Definition: Did the fish actively swim away. Variable recorded: Confirmation the fish actively swam away. Response variable: Binary (yes/no)	Surface and depth release

effort provided by the European Tracking Network (European Tracking Network 2025), this provided telemetry capacity to detect tagged Pollack across European coastal seas (Figure 3).

2.2 | Statistical Analysis

A logistic Generalised Linear Model (GLM) (R package 'stats', Family = binomial (link: logit), R Core Team, 2025) was used to define the likelihood of release success, that is, visual evidence of active swimming response upon release, in relation to surface or depth release, capture depth and fork length (refer to Table 1). Externally Floy tagged fish experienced the closest to real world fishing conditions. By comparison, implantation of the acoustic tag involved surgically opening the peritoneal cavity and may therefore allow gas release, which would otherwise not happen under normal fishing conditions (Curtis et al. 2019). Therefore, three release treatments were initially specified: Surface release (no tag); Depth release (Internal tag); Depth release (External tag). To assess if there was a detectable difference in the release success for externally and internally tagged fish, models were fit including both depth release treatments separately then combined, that is, all depth released fish combined. A chi squared test was then used to assess any statistically significant improvement in GLM fit with tagging type separated or combined. If no difference was detected, the release success for all depth released Pollack was combined and compared to surface release. An additional GLM (R package 'stats'. Family = Gamma (link: log), R Core Team, 2025) was then used to define relationships between recovery metrics (Vestibulo-Ocular Reflex, Equilibrium Maintenance), capture depth and fish fork length for depth released fish only.

The same modelling framework was used to assess covariates for both the immediate release GLM and recovery metrics GLM. Initially, the most complex version of each model was fit, that is, included all possible explanatory variables and interactive effects (Table 2). Model simplification was then conducted using Akaike's Information Criterion (AIC) from the full model to select the optimal set of predictor terms. The model with the lowest AIC score was selected as the best fitting model. If a simpler model (i.e., with fewer fixed effects) was within 2 AIC units of the lowest scoring model, this was selected (Zuur et al. 2013). Partial effects were then plotted and described.

To confirm survival beyond the immediate release from the weighted cage, recaptures of both externally and internally tagged fish (reported by local fishers) were plotted, dispersal distance and time at liberty (release date: re-capture date) were qualitatively described. To infer survival from the acoustically tagged fish, acoustic detections on telemetry receivers were described. Due to the open nature of the environment the study was conducted within combined with variability in fish capture locations relative to the receiver network, an initial logistic GLM was used to define a relationship between proximity of release location to the nearest receiver and the likelihood of that fish being detected (R package 'stats'. Family = binomial (link: logit), R Core Team, 2025). This relationship was used to define a spatial threshold. If fish were released beyond this threshold, detections from those fish would not be used to define movement characteristics and infer survival. For individual fish released within the defined threshold, their movement characteristics (dispersal distance, number of receivers detected on) were qualitatively described. The detection of a fish was considered an indication of survival. To examine changes in the number of fish detected with time, the number of fish detected 0–180 days after tagging were plotted and qualitatively described. Depth profiles for all Pollack equipped with pressure sensitive transmitter tags were also presented and qualitatively described. All statistical analyses and data manipulations were conducted in R version 4.4.2 (R Core Team 2024).

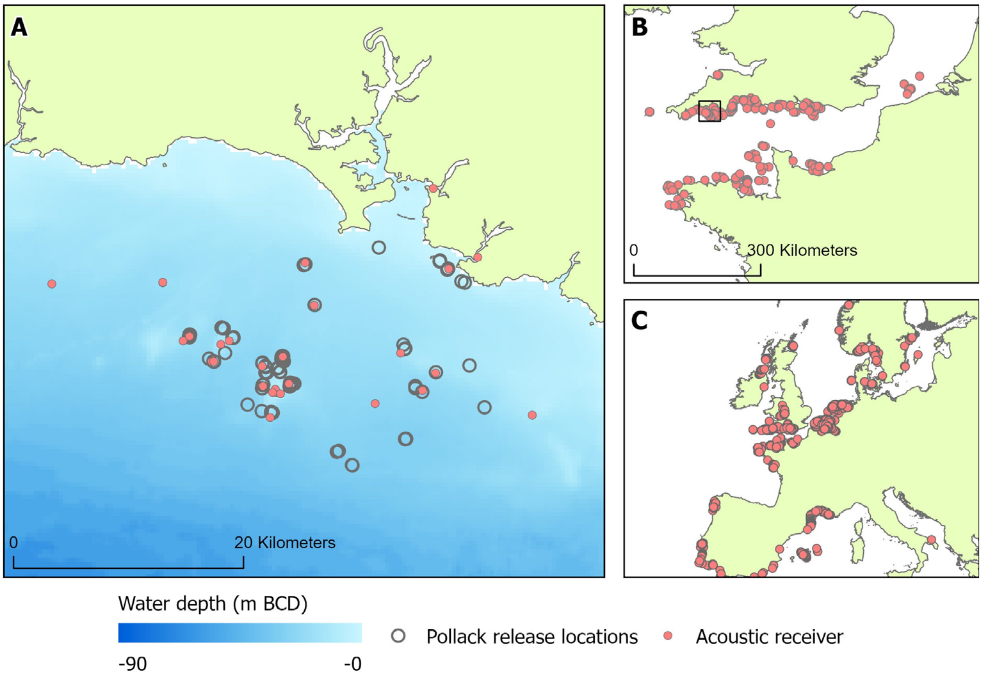

FIGURE 3 | Capture locations of Pollack and the acoustic telemetry receiver network located off Plymouth (A). Regional scale FISH INTEL receiver network deployed across the English Channel (B) with extent rectangle showing scale of box A. All receiver deployment locations across the European Tracking Network (C).

TABLE 2 | Terms included in saturated models for each response variable.

Response	Model family	Saturated model
Release success	GLM—Logistic	Fork length * Capture depth * Release method (surface, depth release—internal tag, depth release—External tag) * Fight time
Vestibulo-ocular reflex	GLM—Gamma (link: log)	Fork length * Capture depth * tag type (Internal/External) * Fight time
Equilibrium reflex	GLM—Gamma (link: log)	Fork length * Capture depth * tag type (Internal/External) * Fight time

Note: Two-way interactions were included between every term.

TABLE 3 | Metadata and sample size for Pollack in different release treatments (surface release, Depth release internal and depth release external included in different analyses).

Fish metadata	Release loc	Sample size	Mean ± SD	Range (min–max)
Biological info				
Fork length (cm)	Surface	166	62 ± 9.4	41–90
	Depth: I	97	58 ± 9.1	39–76
	Depth: E	20	58 ± 9.1	38–76
	All	283	60 ± 9.6	38–90
Capture info				
Capture depth (m)	Surface	166	45 ± 14	11–70
	Depth: I	97	34 ± 8.9	15–55
	Depth: E	20	46 ± 11	25–63
	All	283	41 ± 13	11–70
Fight time (min)	Surface	134	2.1 ± 1.3	0–8
	Depth: I	97	2.1 ± 4.1	0–20
	Depth: E	9	1.5 ± 0.7	1–3
	All	240	2.1 ± 2.7	0–20
Time on deck (min)	Surface	166	0.7 ± 0.5	0–2
	Depth: I	97	2.1 ± 1.1	0–5
	Depth: E	20	1.4 ± 0.5	1–2
	All	283	1.3 ± 1.1	0–5
Recovery metrics				
Time to VOR (min)	Surface	—	—	—
	Depth: I	96	3.2 ± 3.9	0.1–27
	Depth: E	20	2.2 ± 3.3	0.1–14.1
	All	116	3.1 ± 3.9	0.1–27
Time to equilibrium (min)	Surface	—	—	—
	Depth: I	97	4 ± 5.1	0.1–27
	Depth: E	20	2.4 ± 3.3	0.1–14.1
	All	117	3.7 ± 4.8	0.1–27

3 | Results

In total, 337 individual Pollack were captured from 22/01/2022 to 05/02/2025, in coastal waters 10–20 km from Plymouth, United Kingdom. That included 166 surface released and 171 depth released (123 internally tagged, 48 externally tagged). Of these, 329 fish were included in the barotrauma analysis: 166 surface-released fish and 163 depth-released fish (115 internally tagged, 48 externally tagged). The reduction in sample size is due to refinement of the release cage at an early stage of the study resulting in non-comparable release conditions for eight individuals. Furthermore, as a result of various logistical (e.g., fish capture and release locations away from a receiver) and technological constraints (e.g., camera failures), the number of fish used within different analyses presented here varied; sample size is specified in the text; however, also within Table 3.

3.1 | Immediate Release Success

No difference could be detected between the release success for Pollack, which were externally or internally tagged (Chi^2: 0.332, $p = 0.846$) (Figure 4). The data from these fish were therefore combined and compared to surface released fish; the resulting model reported that release success was predicted by fork length, capture depth, and if a fish was released at depth or on the surface, with an interaction between capture depth and depth versus surface release (explained deviance—25%) (Table S1).

Overall, releasing Pollack at depth resulted in a likelihood of release success of 0.83 ± 0.04 [$\beta \pm$ SE], which when compared to surface released fish was 0.56 ± 0.04, representing a 48% increase (Figure 5A and Table S2). For surface released

Pollack, increasing capture depth had a negative effect on the release success (Figure 5B and Table S2), which declined from 0.85 ± 0.05 to 0.25 ± 0.05 when captured in water depths from 20 m–60 m. By comparison the release success of Pollack at depth (Internal & external tagged combined) varied from 0.85 ± 0.06–0.79 ± 0.14 over the same capture depth range. Larger fish also had a lower diving success (Figure 5C), which declined from 0.95 (±0.01) to 0.40 (±0.6) and 0.86 (±0.05) to 0.15 (±0.06) for depth and surface release fish respectively.

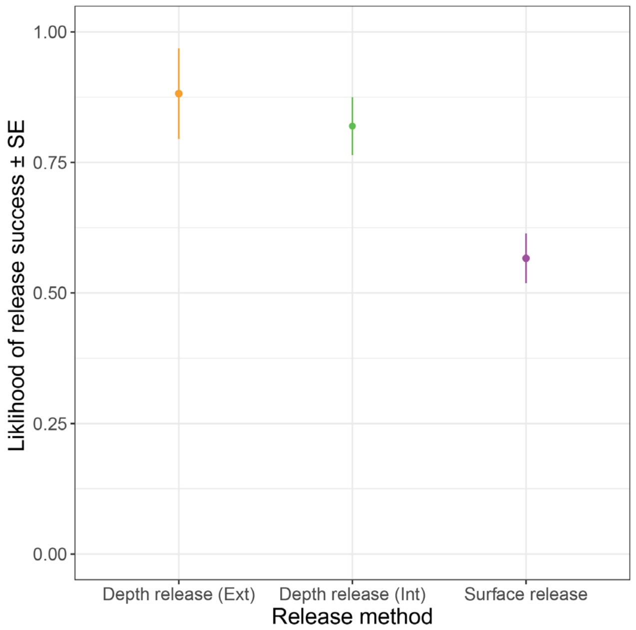

FIGURE 4 | Partial effects of binomial GLM assessing the effects of Pollack release method on release success: Depth release (external tag), Depth release (internal tag), Surface release.

3.2 | Recovery Metrics

Due to difficulties in filming Pollack behaviour within the release cage, that is, fish remaining out of the field of view and/or camera failures, variable sample sizes were used to statistically assess the timing of recovery metrics (Vestibular ocular reflex—VOR, Equilibrium maintenance—EM). Time to VOR was available for 116 Pollack, time to EM for 117 fish (Table 3). On average the time on deck for internally tagged fish was 42 s shorter than externally tagged fish; therefore, time on deck was not included as an explanatory variable within further analysis. Fight time was also not included due to inconsistencies in reporting. These variables are however reported (Table 3) for reference. AIC based model simplification suggested that time to VOR (Table S3) and EM (Table S5) were both explained by tagging type (internal vs. external), capture depth and fork length (Figure 6, Tables S4–S6). No interactive effects were included because they did not result in a meaningful increase in model performance (Tables S3 and S5).

Externally tagged fish achieved VOR and EM faster than internally tagged fish (Figure 6A and Table S4), which for VOR varied from 1.5 to 4.1 min, and, EM varied from 1.9 to 4 min for externally and internally tagged fish respectively. Increased capture depth (11-70 m) was also found to increase the time for VOR to be visually observed from 2.11 (±0.6) to 8.54 (±3.1) min, and 0.79 (±0.1) to 3.1 (±1.1) min for internally and externally tagged fish (Figure 6B and Table S4). For EM the increase was from 2.3 (±0.63) to 7.2 (±2.41) min, and 1.2 (±0.51) to 3.5 (±1.21) (Figure 6B and Table S4). Increases in fork length (38–90 cm) resulted in further delays in the time for VOR to be visually observed from 2.3 (±0.7) to 6.7 (±1.9) min, and 0.8 (±0.4) to 2.5 (±0.94) min for internally and externally tagged fish (Figure 6C and Table S4). For EM the increase was from 2.7 (±0.7) to 5.5 (±1.45) min, and 1.3 (±03.53) to 2.7 (±0.98) (Figure 6C and Table S4). Ultimately however, these models explained a low amount of variability which for VOR was 12.9% and EM 7%. Combined these results suggest high variability in the timing of

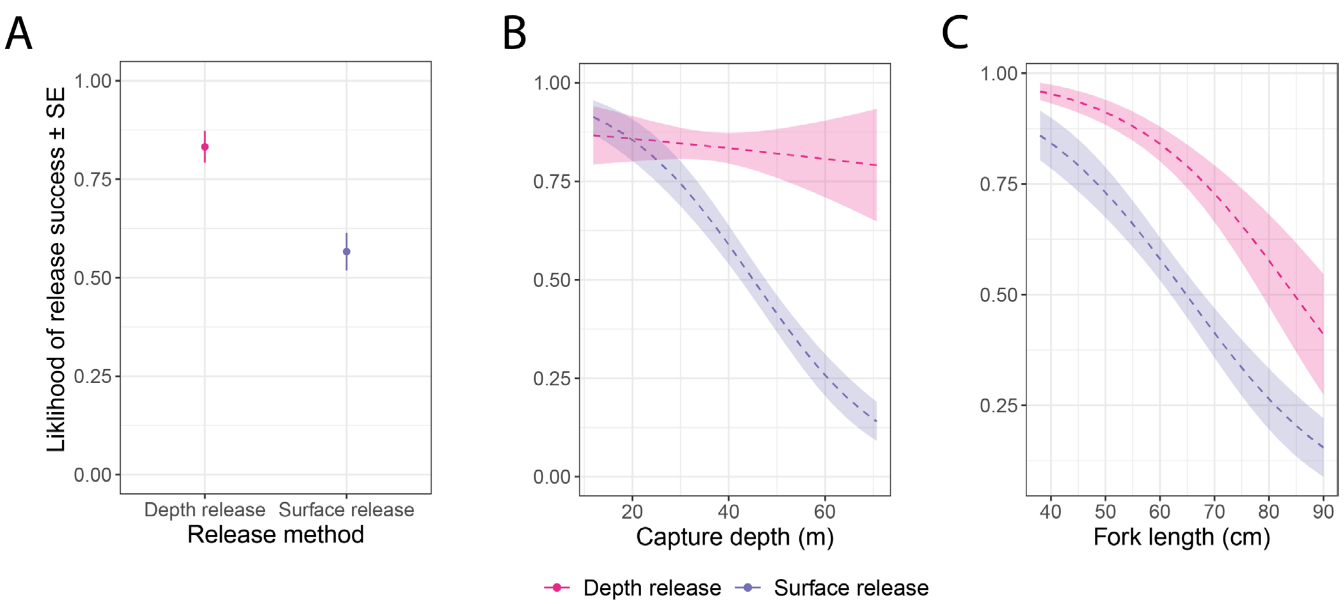

FIGURE 5 | Partial effects of binomial GLM assessing the effects of release method (surface vs. depth) (A), capture depth (B) and fork length (C) on release success for Pollack.

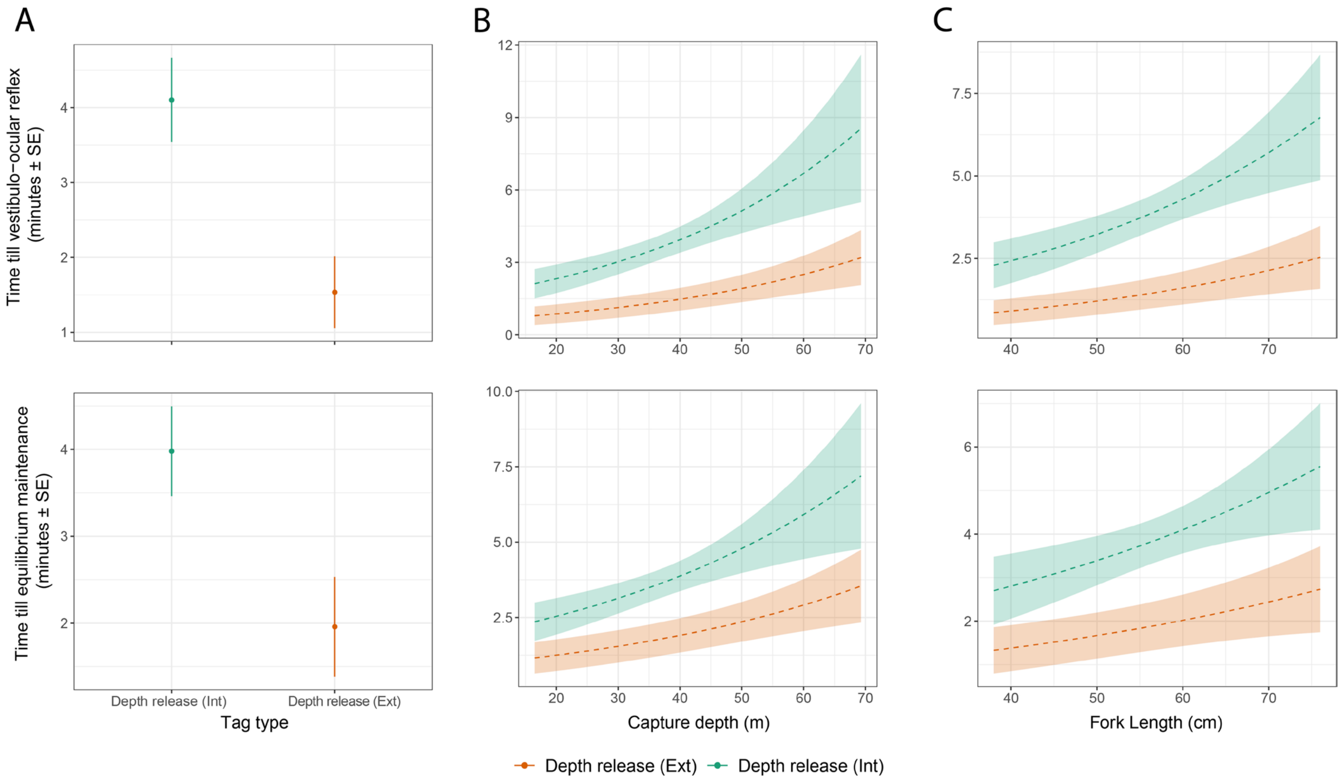

FIGURE 6 | Partial effects of Gamma GLM assessing the effects of tagging method (Internal vs. External) (A), capture depth (B) and fork length (C) on the duration of time for depth released Pollack to display equilibrium maintenance and Vestibul-ocular reflex.

the selected recovery metrics across individuals however some weak relationships were detected with capture depth and fork length (Tables S5 and S6). Across all the fish tagged and released, the cage was deployed on average 89% ± 11% [mean ± SD] (Range: 43%–122%) of the capture depth. Across this range of deployment depths cage depth was not found to explain time take to achieve VOR or EM.

3.3 | Long Term Survival

Across both the external/floy and internal/acoustic tagged fish, four (Acoustic tagged: two, Floy tagged: two) were recaptured via fishers in the local area (Figure 2). For one individual, an acoustic tag was recovered; however, the tag was no longer active (battery dead), and no external markers were attached to the fish. At the time of writing, no other researchers were tagging Pollack in the UK; therefore, this individual was highly likely to be tagged within the project, though the individual ID was unknown. For the remaining three individuals, the distance between the original release and recapture ranged from 0.3 to 7.3 km, and the time at liberty ranged from 43 to 219 days (Figure 7).

Acoustically tagged fish were released between 0 and 10.5 km from a receiver; however, no fish released beyond 4.1 km were ever detected. Generalised Linear Modelling (GLM) further highlighted that if a Pollack was released at 0 km from a receiver, the predicted likelihood of detecting that individual was 0.75 ± 0.04. If this distance extended to 2 km, the predicted detection likelihood decreased further to 0.48 ± 0.09. Finally, at 5 km, the predicted likelihood of detection was 0.13 ± 0.12 (Figure S1 and Table S7). In order to infer survival via acoustic detections of tagged Pollack, further analysis was restricted to the 102 individuals that were released within 1 km of a receiver. Of these, 74 individuals were detected 2,726,915 times. The number of detections was highly variable between individuals, ranging from 2 to 255,986 (37,873 ± 49,477 [mean ± SD]). The duration of time fish were tracked was also highly varied, ranging from 1 to 595 days ($212^{\text{ind-1}}$ ± 17.65). All fish detections were from the local receiver array (~30 km from Plymouth, UK), and no long-range movements were detected from the FISH INTEL or wider European Tracking Network. The proportion of these fish that were detected dropped steadily in the first 7 days from 0.73 (74 ind) to 0.66 (67 ind). From 7 to 60 days, the rate of fish loss remained relatively low and constant at ~0.35 individuals per week. At 180 days/6 months after release, the proportion of fish detected was 0.52 (54 ind) (Figure 8).

Detailed analysis of horizontal and vertical movement characteristics will be conducted within separate manuscripts. However, Pollack were detected at an average of 2.3 receiver stations ±1.2 [mean ± SD] (Range: 1–6) and had a horizontal dispersal distance between their release location and the most distant receiver of 3.76 km ±4.8 (Range: 0.1–23.8). Of the 30 Pollack tagged with pressure sensitive tags 28 were detected (n detections: 1.3 million). One fish had depth patterns representing the tidal cycle (i.e., the fish was not moving) for a period of several months until the tag was no longer detected: this has been considered a mortality and data for the fish has been removed once the depth usage resembled the tidal cycle (Figure 9; Fish ID: 71771). All remaining depth tagged Pollack demonstrated high

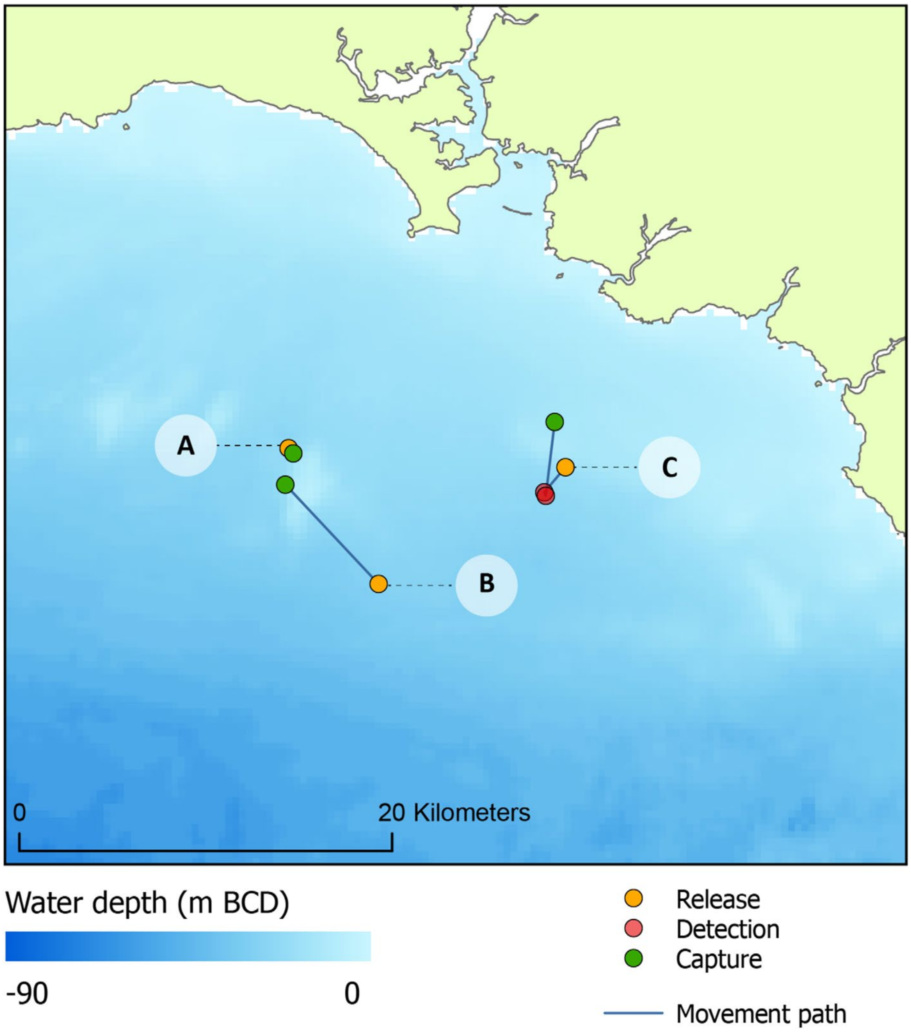

FIGURE 7 | Original release, acoustic detection (tag ID: 3766/C) and re-capture location for: Fish A (Floy tag: 130; 59 cm fork length), B (Floy tag: 39; 64 cm) and C (Acoustic tag: 3766; 44 cm fork length). Time at liberty: 219 days (A), 43 days (B), 95 days (C). Distance travelled: 0.4 km (A), 7.3 km (B) and 5.9 km (C).

vertical activity within the water column (Figure 9). The water depth occupied by individuals was dependent on the maximum water depth at the receiver station; however, the mean depth was ~2.5m^{ind-1} ± 1.2 [SE] above the bottom depth (range: 17–55 m BCD), with individuals making repeated and regular ascents into shallow water (range: 20.9–39.1 m).

4 | Discussion

As recreational fisheries gain recognition in management frameworks, understanding their impacts on fish populations is critical. A key aspect of sustainable management is assessing post-release mortality, which can be intrinsically linked to barotrauma in sensitive species. Pollack are widely distributed, inhabiting rocky reefs and shipwrecks across the northeast Atlantic (Cohen et al. 1990; Alonso-Fernández et al. 2014). Given that roughly 80% of European coastal seas are deeper than 40 m (GEBCO 2025), the results reported here highlight the significant and widespread risk of barotrauma in wild-caught pollack. We, however, demonstrate that releasing Pollack at depth has the potential to mitigate some barotrauma-related issues and improve the likelihood of Pollack actively swimming away at release. Pollack tracking data also confirmed that once Pollack are released, they then displayed active horizontal and vertical movements, and/or may then be re-captured by fishers. While these results are promising and demonstrate some survival potential for Pollack in catch-release fisheries, further work is required to define sub-lethal effects and better quantify/estimate mortality.

Here we show that, overall, when releasing Pollack at the surface there is approximately a 50% chance of the fish swimming away at release. These odds, however, worsen if the Pollack is captured in increasing water depths or individual Pollack is of a larger size. Hyperbaric chamber experiments conducted on Saithe (Pollachius virens) (Tytler and Blaxter 1973) demonstrated that if captured at a pressure exceeding 3 atm (ATA) a 50% reduction in ATA would be required for a period of 5 h to avoid a swim bladder rupture. In practical terms, a fish caught at 20 m would need a 5-h recompression stop at 10 m, with each additional 1 ATA/m increase in capture depth requiring further recompression stops at progressively shallower depths. The results reported here, therefore, further demonstrate the impact of barotrauma in wild capture conditions,

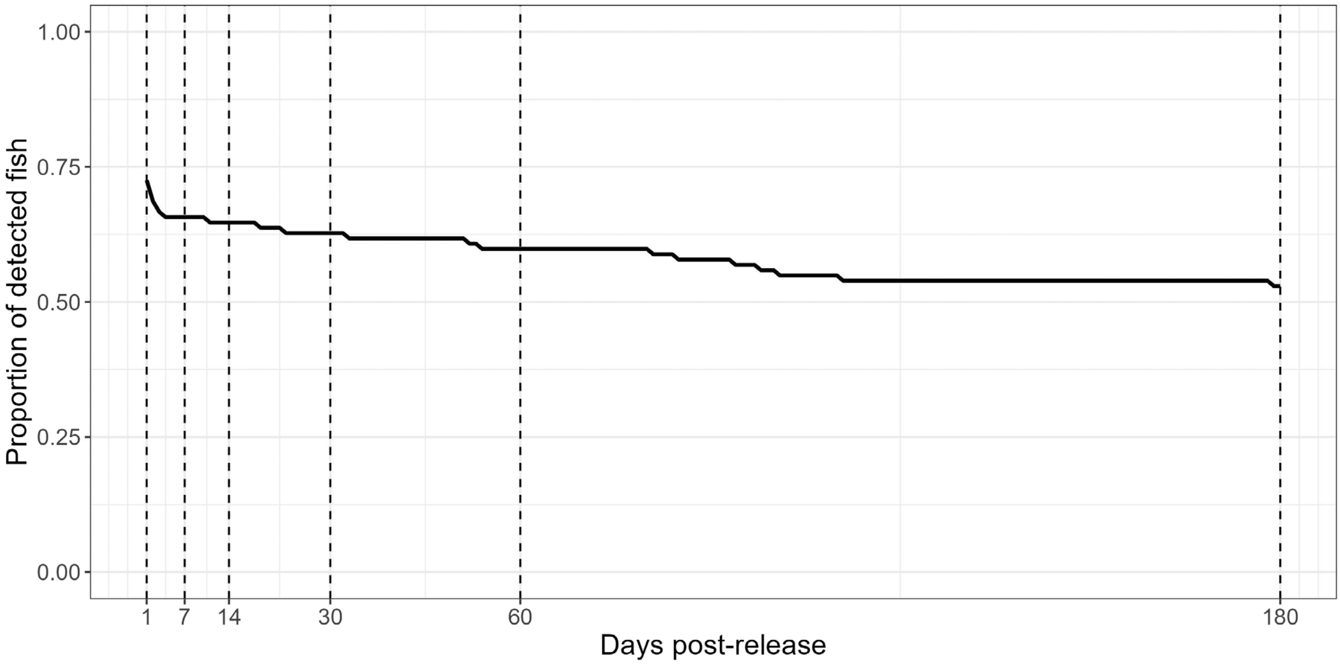

FIGURE 8 | Proportion of acoustically tagged fish detected at any time after 0, 1, 7, 14 30, 60 and 180 days after tagging and release.

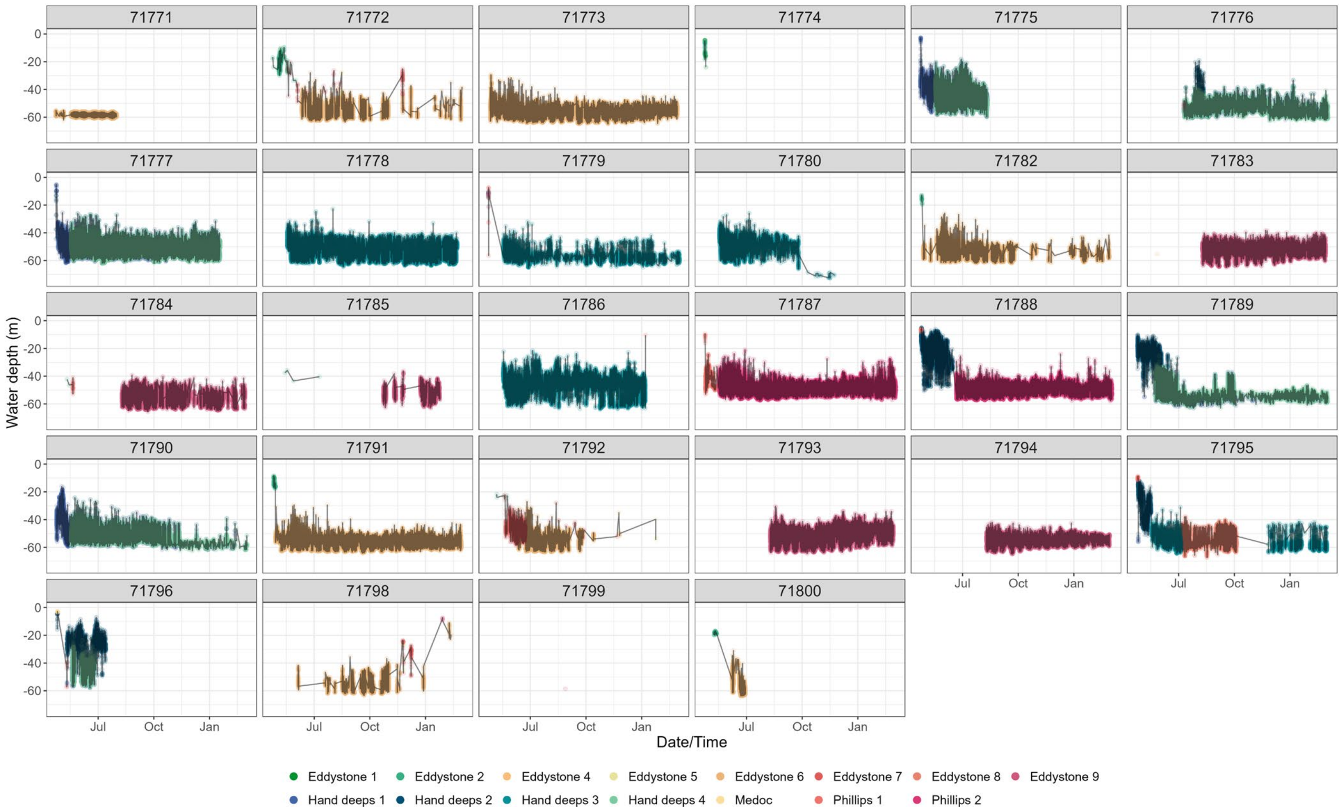

FIGURE 9 | Depth profiles of depth-released acoustically tagged Pollack with pressure-sensitive transmitters from May 2024—April 2025. Depth records colour coded by the receiver that detected the individual Pollack. The number above each panel is the unique fish tag ID.

but also demonstrate that in approximately 50% of Pollack captures individual fish can partially overcome the effects of barotrauma via active swimming below surface once released (Skomal 2007; Holder et al. 2022). This has similarly been observed in Black Seabass (*Centropristis striata*—Rudershausen et al. 2014), and snapper species (*Lutjanus* spp.—Sumpton et al. 2010) and further highlights the need for in situ studies to provide real world estimates of post-release survival.

In situ experiments to estimate post release mortality are however challenging, and once fish are released as part of an experiment, mortality is difficult to directly measure (Lennox et al. 2024). Here we have instead relied on indirect proxies for survival: active swimming response at release, presence of reflexes, confirmed vertical and horizontal movement. In prior studies (e.g., Rudershausen et al. 2014) these have been successfully correlated with survival; however, sub-lethal effects and survival are not truly observable. Furthermore, practical difficulties such as observations of fish returning to the surface after release may be challenging in inclement weather. Therefore the results reported here should be treated with caution. Despite this, we found that releasing Pollack at depth increased the likelihood of active swimming behaviour at release to ~83%, and that capture depth has a far reduced effect on release success when Pollack were released at depth. This indicates that by returning fish to their capture depth mitigates the direct impact of gas expansion within the peritoneal cavity and reduces mortality risks caused by avian predation and thermal stress if fish were to remain at the surface (Skomal 2007; Wegner et al. 2021; Holder et al. 2022; Madden et al. 2024). The advantage of releasing fish at depth becomes particularly evident at capture depths exceeding 20–30 m, at which point the release success of surface released Pollack dramatically declines, underscoring the value of deep-water release in deeper water boat-based angling compared to shallower shore-based fishing (Wegner et al. 2021).

Observations of fish recovery metrics (Vestibulo-oculuar reflex—VOR, Equilibrium Maintenance—EM) demonstrated that the tagging method used (External vs. Internal), capture depth and fork length all had measurable impacts on recovery times. Notably, larger individuals captured in deeper water and internally tagged were more likely to require longer recovery times. By comparison, externally tagged Pollack (experiencing similar capture conditions to normal MRF) achieved VOR and EM within ~1.9 and 1.5 min, and is suggestive that Pollack may require a short acclimation period prior to release. These metrics are commonly used in fish condition assessments, though are typically measured by researchers physically manipulating fish at the surface (e.g., Lennox et al. 2024). Here these metrics were observed remotely and without physical handling, and may therefore partially explain the relatively poor ability to predict when these reflexes occur in barotrauma affected Pollack. Alternatively, methodological issues associated with Pollack moving in and out of the camera's field of view may obscure the exact timing of when these behaviours are displayed. Further studies should therefore investigate the timing and duration of recovery in released fish in order to provide further optimization for deep water release methods.

As with other studies, telemetry was a powerful tool to allow longer-term monitoring of depth released Pollack (e.g., Crossin et al. 2017). The increased loss of fish within the first 7 days post-tagging could suggest multiple outcomes. Firstly, this could be the result of a stress response of tagged fish moving away from the detection range of a receiver after capture and release (e.g., Wilson et al. 2017). Alternatively, some fish may experience sub-lethal effects which later prove fatal (Capizzano et al. 2016; Wegner et al. 2021; Rudershausen et al. 2023). When working in open marine systems and barotrauma sensitive species, as done here, it, however, remains challenging to entirely remove these biases from study designs. Some studies have mitigated these effects by tagging fish at depth/in situ as experimental controls and comparing associated survival to conspecifics captured via traditional methods (e.g., via SCUBA—Rudershausen et al. 2014; Specialised trawl—Sigurdsson et al. 2006). Further insight may also have been gained from acoustically tagging surface-released fish (e.g., Capizzano et al. 2016), to better assess long term survival of this release method. Within the current study, this was, however, not feasible due to the ethical concerns and the high cost of acoustic tags. Further work would also be required to better define sub-lethal effects (Wegner et al. 2021; Rudershausen et al. 2023). Despite uncertainties, the recapture of tagged and released fish in combination of complex vertical and horizontal movements after release highlights that sufficient recovery was achieved to allow feeding behaviour and movement (Wegner et al. 2021; Rudershausen et al. 2023).

To conclude, within catch and release Pollack fisheries, returning Pollack at depth can improve the success of their release and mitigate the immediate effects of barotrauma. In general however, estimating or recording mortality directly within the field is challenging. Here we have instead relied on estimating release success (the ability of fish to swim away), and/or recovery metrics, which in similar studies have been used as proxies for post release survival (e.g., Rudershausen et al. 2014). These findings therefore have potential management implications of a depleted and data-deficient fish stock (Pollack in the English channel and Celtic and Irish seas), by providing estimates of un-accounted mortality and potential mitigation measures. Further studies are however required to validate and refine deep-water release methods. Here a weighted cage was used to return fish to depth, while effective at improving release success this would not likely be a practical solution in typical MRF fishing conditions. Instead, commercially available descending devices, for example, Seaqualizers, would likely provide a viable low cost solution which could be adopted as part of normal fishing procedures (Bellquist et al. 2019). Initiatives like the 'Return "em" Right' (Return 'em' Right 2025) programme in the United States demonstrate the MRF sector's potential to actively reduce unwanted mortality. However, achieving widespread success may require further validation studies, improved fisher access to these tools and training in their use (Bellquist et al. 2019). Continued advocacy and education, alongside sustained stakeholder engagement will be vital to ensuring sustainable fishing practices and the long-term health of vulnerable and barotrauma sensitive fish such as Pollack.

Acknowledgements

We would like to thank all the fishers who have helped with the fish tagging, receiver maintenance and stakeholder engagement throughout the Pollack FISP project. We would also like to thank our funders Department for Environment, Food and Rural Affairs (DEFRA) FISP scheme, and the Interreg France (Channel) England (FCE) programme. All artwork associated with this manuscript was created by Kirstie Montague. Finally, equipment for the project was loaned to the University of Plymouth by the Isles of Scilly Inshore Fisheries and Conservation Authority (IFCA). We thank you for your contribution.

Funding

This work was supported by the Department for Environment, Food and Rural Affairs, UK Government (Ecm 66427) and INTERREG FRANCE-CHANNEL_ENGLAND (Award no. 256).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Table S1:** Akaike's Information Criterion (AIC) table for the Pollack release success modelling. The selected model is shown in bold. Model terms abbreviated: FL (Fork length), CD (Capture depth), RM (Release method). Top 6 performing models (lowest AIC) are shown plus the saturated model (SAT). **Table S2:** Model coefficients for the selected model for release success in Pollack. **Table S3:** Akaike's Information Criterion (AIC) table for modelling parameters affecting time to vestibulo-ocular reflex. The selected model is shown in bold. Model terms abbreviated: FL (Fork length), CD (Capture depth), TT (Tag Type). Top 6 performing models (lowest AIC) are shown plus the saturated model (SAT). **Table S4:** Model coefficients for the selected model for time to vestibulo-ocular reflex. **Table S5:** Akaike's Information Criterion (AIC) table for modelling parameters affecting time equilibrium maintenance reflex. The selected model is shown in bold. Model terms abbreviated: FL (Fork length), CD (Capture depth), TT (Tag Type). Top 6 performing models (lowest AIC) are shown plus the saturated model (SAT). **Table S6:** Model coefficients for the final model for time to equilibrium maintenance reflex. **Table S7:** Coeeficients from Generalised Linear Model predicting the liklihood of detecting tagged Pollack, with increasing release distance from the nearest receiver. **Figure S1:** Outputs from Generalised Linear Model predicting the liklihood of detecting tagged Pollack, with increasing release distance from the nearest receiver.