Pen Llŷn a'r Sarnau Special Area of Conservation

Acoustic Telemetry Technical Report 2024-2025

March 2026



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The Partnership

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Commercial operators: Abersoch Moorings Ltd., and Genesis Fish

Project SIARC Lead Partners:

Project SIARC Delivery Partners:

Project SIARC Collaborative Partners:

Executive Summary

Aquatic acoustic telemetry (hereby referred to as 'acoustic telemetry') is a method for tracking the movements of aquatic animals, such as sharks and fish. Acoustic telemetry involves two main components: an acoustic transmitter or tag, and an acoustic receiver. The acoustic transmitter is attached or surgically implanted in an animal and emits a unique 69 kHz sound pulse sequence at regular intervals. When a tagged animal passes close to an underwater receiver, the unique sound sequence transmitted from the tag is detected and the receiver creates a log of when the tagged animal was present.

Between July 2024 and July 2025, Project SIARC deployed an array of 20 acoustic receivers within Pen Llŷn A'r Sarnau (PLAS) Special Area of Conservation (SAC), North Wales. The array was co-designed with local fishers and deployed in collaboration with commercial fishers in Abersoch and Aberdyfi and covered areas of Annex 1 habitat including 'Reefs', 'Large Shallow Inlets and Bays', and 'Sandbanks which are slightly covered by sea water all the time'. The array was deployed to allow the tracking of Critically Endangered tope sharks (*Galeorhinus galeus*) within the SAC, and to establish links between Annex 1 habitat features and movements of tope. Between August 2024 and June 2025, we worked with local charter skippers and volunteer fishers to catch 28 tope sharks, which then had an acoustic tag surgically implanted in their intraperitoneal cavity to track their movements for ~18-months.

The acoustic array in PLAS SAC recorded 2,546 detections between July 2024 and July 2025 from 13 of the 28 tope tagged during the project. The array highlighted two areas within the SAC where tope were most frequently detected – the Annex 1 reef features in the north of Tremadog Bay, between Criccieth and Saint Tudwals, and the Annex 1 sandbanks west of Barmouth. Connectivity between areas within the Irish Sea were also highlighted with an additional 630 detections from 7 tope tagged within PLAS SAC being detected on receiver arrays located in the Bristol Channel and between Northern Ireland and the west coast of Scotland.

Alongside detections of tope tagged by Project SIARC, the acoustic array also detected animals tagged in other areas. This included four tope sharks tagged on the east coast of Ireland in 2024, a spurdog (*Squalus acanthias*) tagged in the Bristol Channel in spring 2024, nine twaite shad (*Alosa fallax*) tagged in the Rivers Wye, Towy, and Usk in 2023 and 2024, and an Atlantic Bluefin Tuna (*Thunnus thynnus*) tagged in Nova Scotia, Canada in 2022. The findings of the acoustic array highlight the importance of PLAS SAC for multiple species of conservation importance and provide evidence for connectivity between Annex 1 habitats across Wales SAC

network. In July 2025, the acoustic array was serviced, re-deployed and expanded to 30 units in the SAC to continue collecting vital information on movements and habitat use of species in PLAS SAC. Tagging and tracking of tope, as well as nursehound (*Scyliorhinus stellaris*) and angelshark (*Squatina squatina*), will continue in PLAS SAC between 2026 and 2029 as part of a Nature Networks Fund 5 grant awarded to Project SIARC.

Key Findings

- An array of 20 acoustic receivers was deployed in Pen Llŷn a'r Sarnau (PLAS) Special Area of Conservation (SAC) from July 2024 to July 2025.
- 28 critically endangered tope sharks (*Galeorhinus galeus*), 19 female and 9 male, were tagged in the SAC between July 2024 and June 2025.
- 2,546 detections from 13 tagged tope were made by the acoustic array in PLAS SAC
- Three tope tagged in 2024 were re-detected in PLAS SAC in 2025 – providing the first evidence of interannual site fidelity by tope in Wales
- Tope were most frequently detected on Annex 1 reef features and sandbank features
- The array detected other species with the SAC including Annex II Twaite shad (*Alosa fallax*), Vulnerable spurdog (*Squalus acanthias*) and an Atlantic Bluefin Tuna originally tagged in Canada

Crynodeb Gweithredol

Mae telemetreg acwstig ddyfrol (a elwir o hyn allan yn ‘delemetreg acwstig’) yn ddull ar gyfer tracio symudiadau anifeiliaid dyfrol, er enghraifft siarcod a physgod. Mae dwy brif elfen i delemetreg acwstig: trosglwyddydd neu dag acwstig, a derbynnydd acwstig. Mae’r trosglwyddydd acwstig yn cael ei gysylltu neu ei fewnblannu drwy lawfeddygaeth mewn anifail ac mae’n allyrru dilyniant curiad sain unigryw a rheolaidd ar 69 kHz. Pan fydd anifail wedi’i dagio yn mynd yn agos at dderbynnydd tanddwr, mae’r dilyniant sain unigryw a drosglwyddir gan y tag yn cael ei godi ac mae’r derbynnydd yn creu cofnod o pryd roedd yr anifail â’r tag yn bresennol.

Rhwng Gorffennaf 2024 a Gorffennaf 2025, gosododd Prosiect SIARC aráe o 20 o dderbynyddion acwstig yn Ardal Cadwraeth Arbennig (ACA) Pen Llŷn A’r Sarnau (PLAS), Gogledd Cymru. Cafodd yr aráe ei chyd-gynllunio gyda physgotwyr lleol a’i gosod mewn cydweithrediad â physgotwyr masnachol yn Abersoch ac Aberdyfi, mewn ardaloedd o gynefinoedd Atodiad 1 gan gynnwys ‘Riffiau’, ‘Cilfachau a Baeau Mawr Bas’, a ‘Banciau tywod sydd dan orchudd tenau o ddŵr môr drwy’r adeg’. Gosodwyd yr aráe er mwyn gallu tracio Cŵn glas (Galeorhinus galeus), siarcod sydd mewn Perygl Difrifol, yn yr ACA, ac er mwyn sefydlu cysylltiadau rhwng nodweddion cynefinoedd Atodiad 1 a symudiadau’r Ci glas. Rhwng Awst 2024 a Mehefin 2025, buom yn gweithio gyda chapteiniaid siarter lleol a physgotwyr gwirfoddol i ddal 28 o Gŵn glas, gan fewnblannu tag acwstig yn llawfeddygol yn eu ceudod mewnberitoneaidd er mwyn tracio’u symudiadau am tua 18 mis.

Cododd yr aráe acwstig yn ACA PLAS 2,546 o signalau Cŵn glas rhwng Gorffennaf 2024 a Gorffennaf 2025 o 13 o’r 28 Ci glas a dagiwyd yn ystod y prosiect. Amlygodd yr aráe ddwy ardal o fewn yr ACA ble canfuwyd y Ci glas amlaf – y nodweddion riff Atodiad 1 yng ngogledd Bae Tremadog, rhwng Cricieth ac Ynysoedd Tudwal, a banciau tywod Atodiad 1 i’r gorllewin o’r Bermo. Amlygwyd hefyd y cysylltedd rhwng ardaloedd ym Môr Iwerddon, gyda 630 yn ychwanegol o signalau o 7 Ci glas a dagiwyd yn wreiddiol yn ACA PLAS yn cael eu codi ar araeau wedi’u lleoli ym Môr Hafren a rhwng Gogledd Iwerddon ac arfordir gorllewinol yr Alban.

Yn ogystal â signalau gan Gŵn glas a dagiwyd gan Brosiect SIARC, canfu’r aráe acwstig hefyd anifeiliaid a oedd wedi’u tagio mewn ardaloedd eraill. Roedd hyn yn cynnwys pedwar Ci glas a dagiwyd ar arfordir dwyreiniol Iwerddon yn 2024, Ci pigog (Squalus acanthias) a dagiwyd

ym Môr Hafren yng ngwanwyn 2024, naw Gwangen (Alosa fallax) a dagiwyd yn afonydd Gwy, Tywi ac Wysg yn 2023 a 2024, a Thiwna Asgell Las (Thunnus thynnus) a dagiwyd yn Nova Scotia,

Canada yn 2022. Mae canfyddiadau'r arâe acwstig yn tanlinellu pwysigrwydd ACA PLAS i nifer o rywogaethau o bwys cadwraeth ac yn cynnig tystiolaeth o gysylltedd rhwng cynefinoedd Atodiad 1 ar draws rhwydwaith Ardaloedd Cadwraeth Arbennig Cymru. Ym mis Gorffennaf 2025, cafodd yr arâe acwstig ei gwasanaethu, ei hailosod a'i hehangu i 30 uned yn yr ACA er mwyn parhau i gasglu gwybodaeth hanfodol am symudiadau a defnydd rhywogaethau o'r cynefinoedd yn ACA PLAS. Bydd y gwaith o dagio a thracio'r Ci glas, yn ogystal â'r Morgi brych (Scyliorhinus stellaris) a'r Maelgi (Squatina squatina), yn parhau yn ACA PLAS rhwng 2026 a 2029 fel rhan o grant Cronfa Rhwydweithiau Natur 5 a ddyfarnwyd i Prosiect SIARC.

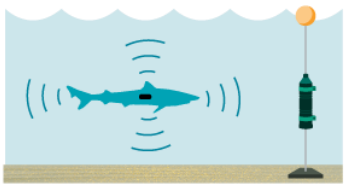
<u>Y prif ganfyddiadau</u>

- Gosodwyd arâe o 20 o dderbynyddion acwstig yn Ardal Cadwraeth Arbennig (ACA) Pen Llŷn a'r Sarnau (PLAS) rhwng Gorffennaf 2024 a Gorffennaf 2025.
- Tagiwyd 28 o Gŵn glas (Galeorhinus galeus), siarc sydd mewn Perygl Difrifol, yn cynnwys 19 benyw a 9 gwryw, yn yr ACA rhwng Gorffennaf 2024 a Mehefin 2025.
- Cododd yr arâe acwstig yn ACA PLAS 2,546 o signalau gan 13 Ci glas wedi'u tagio.
- Cafodd tri Chi glas a dagiwyd yn 2024 eu canfod eto yn ACA PLAS yn 2025 – dyma'r dystiolaeth gyntaf o ffyddlondeb Cŵn glas yng Nghymru i safle o un flwyddyn i'r llall.
- Canfuwyd y Ci glas fwyaf aml ar nodweddion riff Atodiad 1 a nodweddion banciau tywod.
- Cododd yr arâe rywogaethau eraill yn yr ACA gan gynnwys Gwangod (Alosa fallax), rhywogaeth Atodiad II, y Ci pigog (Squalus acanthias), rhywogaeth sydd Dan Fygythiad, a Thiwna Asgell Las a dagiwyd yn wreiddiol yng Nghanada.

Summary Infographic

Tracking Tope in Pen Llŷn a'r Sarnau Special Area of Conservation

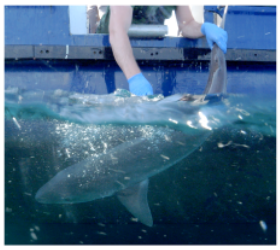
Aquatic acoustic telemetry is used to track animal movements. When a tagged animal swims near a fixed receiver the tag is detected, providing a record of when animals are found at each location.



20 Acoustic receivers were deployed in Pen Llŷn a'r Sarnau (PLAS) Special Area of Conservation (SAC).

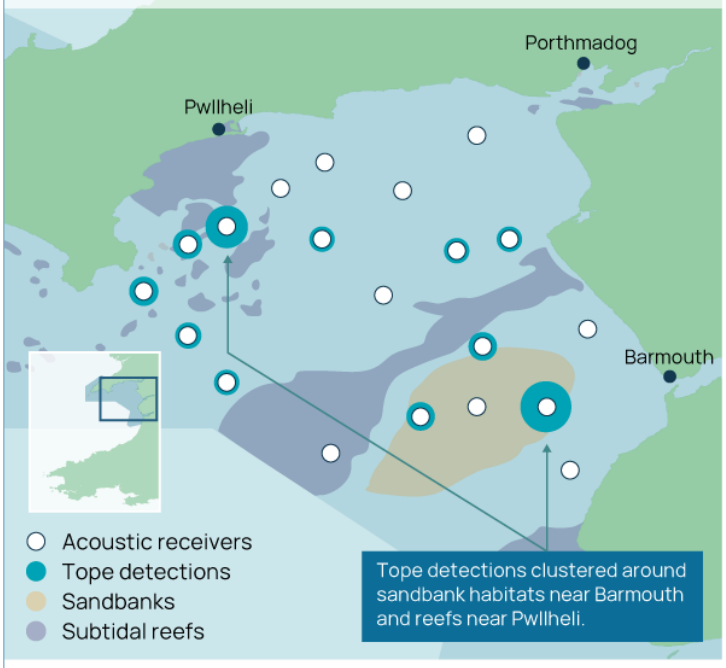
28 tope were tagged with acoustic transmitters between July 2024 and June 2025.

Working with charter fishers we tagged Critically Endangered* tope sharks (*Galeorhinus galeus*) with acoustic transmitter tags to understand movements within the SAC.

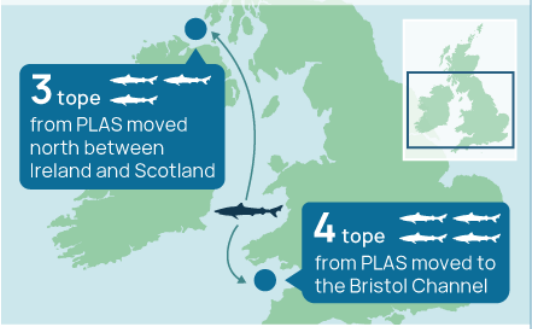




Project SIARC deployed an array of acoustic receivers in PLAS SAC in July 2024. Data from the receivers was downloaded in July 2025.



18 of the 28 tope tagged have been detected across receivers located in PLAS SAC, the Bristol Channel, and northern Ireland/West of Scotland. Additionally, 4 tope tagged on the east coast of Ireland in 2024 were detected in PLAS SAC in 2025.



The acoustic array in PLAS SAC also detected spurdog and twaite shad tagged in South Wales, and a bluefin tuna originally tagged in Canada!



3 of the 9 tope tagged in PLAS SAC in 2024 were detected in the SAC again in 2025 – this is the first evidence that the same individuals use the area each year.

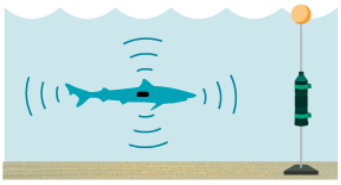
The array also measures water temperature

- **12.5°C** average water temperature
- **19.4°C** peak water temperature in August
- **5.7°C** lowest temperature in February

*on the IUCN Red List of Threatened Species

Tracio'r Ci glas yn Ardal Cadwraeth Arbennig Pen Llŷn a'r Sarnau

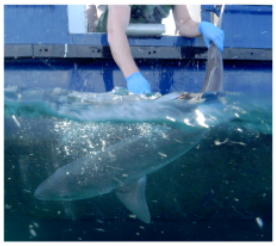
Caiff telemetreg acwstig ddyfrol ei defnyddio i dracio symudiadau anifeiliaid. Pan fydd anifail wedi'i dagio yn nofio ger derbynnydd sefydlog, mae signal y tag yn cael ei godi, sy'n rhoi cofnod o pryd mae'r anifeiliaid wedi bod ym mhob lleoliad.



20 o dderbynyddion acwstig wedi'u gosod yn Ardal Cadwraeth Arbennig (ACA) Pen Llŷn a'r Sarnau (PLAS).

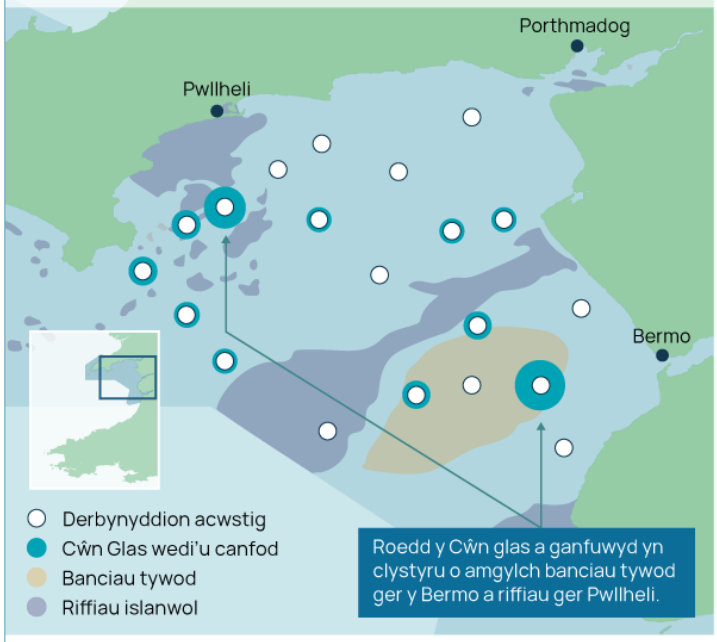
28 Ci glas wedi'u tagio gyda throsglwyddwyr acwstig rhwng Gorffennaf 2024 a Mehefin 2025.

Gan weithio gyda physgotwyr siarter, rhoddwyd tagiau trosglwyddo dyfrol ar Gŵn glas (*Galeorhinus galeus*), siarc sydd mewn Perygl Difrifol*, i ddeall eu symudiadau yn yr ACA.

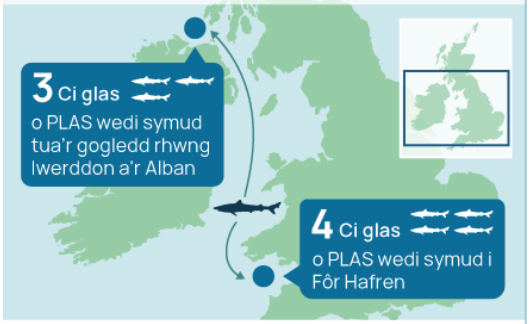




Gosododd Prosiect SIARC aráe o dderbynyddion acwstig yn ACA PLAS ym mis Gorffennaf 2024. Lawrlwythwyd data o'r derbynyddion ym mis Gorffennaf 2025.



Canfuwyd 18 o'r 28 Ci glas a dagiwyd ar dderbynyddion wedi'u lleoli yn ACA PLAS, Môr Hafren a Gogledd Iwerddon/gorllewin yr Alban. Yn ogystal, cafodd 4 Ci glas a dagiwyd ar arfordir dwyreiniol Iwerddon yn 2024 eu canfod yn ACA PLAS yn 2025.



Roedd yr aráe acwstig yn ACA PLAS hefyd wedi codi Ci pigog yn ogystal â Gwangod a oedd wedi'u tagio yn ne Cymru, a thiwna asgell las a oedd wedi'i dagio'n wreiddiol yng Nghanada!



3 o'r 9

Ci glas a dagiwyd yn ACA PLAS yn 2024 wedi'u canfod yn yr ACA eto yn 2025 – dyma'r dystiolaeth gyntaf bod yr un unigolion yn defnyddio'r ardal bob blwyddyn.

Mae'r aráe hefyd yn mesur tymheredd y dŵr

12.5°C oedd tymheredd cyfartalog y dŵr

19.4°C oedd y tymheredd uchaf ym mis Awst

5.7°C oedd y tymheredd isaf ym mis Chwefror

*ar Restr Goch IUCN o Rywogaethau Dan Fygythiad

Introduction

Aquatic acoustic telemetry (hereby referred to as acoustic telemetry) is increasingly being used to track movements of animals in underwater environments (Hussey *et al.*, 2015; Hellström *et al.*, 2022). This technology uses acoustic transmitters (or tags) attached to animals that broadcast unique sound pulse sequences at set intervals. When tagged animals move within range of an underwater acoustic receiver, the unique pulse sequence is detected and logged, providing both spatial and temporal record of an individual animal. By deploying an array of receivers, records of individual animals can be linked, movements identified, and habitat use and connectivity inferred (Donaldson *et al.*, 2014). In doing so, telemetry can provide information to address a variety of questions related to both fundamental ecology of animals and applied topics such as fisheries management, spatial management, and conservation science (Jacoby and Piper, 2025).

Elasmobranchs are one of the most highly threatened taxonomic families (Stein *et al.*, 2018) with over one-third of species thought to be threatened with extinction (Dulvy *et al.*, 2014) and evidence shows that many populations in UK waters have suffered declines (Ellis *et al.*, 2005). There are 27 elasmobranch species present in coastal waters of Wales, including rare species such as tope (*Galeorhinus galeus*), which are listed as Critically Endangered on the IUCN Red List of Threatened Species (Walker *et al.*, 2020). Commercial fishing for tope in Welsh waters was prohibited in 2008 (*The Tope (Prohibition of Fishing) (Wales) Order 2008*). However, tope are still regularly encountered by charter boat fishers and recreational anglers where it is a primary target "sportfish" for catch and release angling. Despite this, there is limited information about the ecology of tope in Welsh waters, particularly regarding their seasonal movements and habitat use within coastal ecosystems.

Tope are considered a highly migratory species, with previous studies utilizing satellite tagging and mark-recapture methods providing evidence of individuals making long-distance seasonal movements between coastal areas of north-west Europe and areas as far away as the Azores and North Africa (Thorburn *et al.*, 2019; Schaber *et al.*, 2022). Through previous surveys and engagement with local fishers, PLAS SAC has been identified as a key area supporting tope populations in Wales. Yet major gaps remain in our understanding of how tope use Annex 1 habitat features in PLAS SAC and what role current management measures play in building long-term resilience of the population. Given tope are globally susceptible to overfishing due to complex life-history traits and reliance on specific sites for reproduction, these data deficiencies are severely inhibiting tope conservation in the North-East Atlantic.

In this project, we used acoustic telemetry to investigate movements, seasonal residency, and habitat use of tope within PLAS SAC. The aim of the project was to link movements and residency of tope with Annex 1 habitat features within the SAC, to improve understanding of biological communities associated with protected features and wider ecosystem benefits of the SAC protected site network. In addition, we sought to provide evidence to support theories from local fishers that tope use habitats within PLAS SAC for reproduction.

1. Acoustic array deployment

Prior to the deployment of an acoustic array in PLAS SAC, we held meetings with local water users, fishers, and community members (n = 10 individuals) to co-design the array layout and design. Local Ecological Knowledge of tope habitat use within the SAC, information of commercial fishing activities, and areas of high boat traffic were used to inform acoustic receiver positioning and mooring designs. A total of twenty acoustic receivers were deployed in July 2024 covering core areas of the SAC including Annex 1 'Reef' features near Pwllheli and along Sarn Badrig, the 'Large Shallow Inlet and Bay' feature covering Tremadog Bay, and the 'Sandbanks which are slightly covered by sea water all the time' feature located west of Barmouth (Figure1). The deployment of acoustic receivers on the seabed was permitted under a Crown Estate Seabed Survey Licence (SSL_NRW_10). A scientific exemption for the deployment of the acoustic receiver array was granted by Natural Resources Wales under Part 3 of The Marine Licensing (Exempted Activities) (Wales) Order 2011, Section 16.-(1)(a)

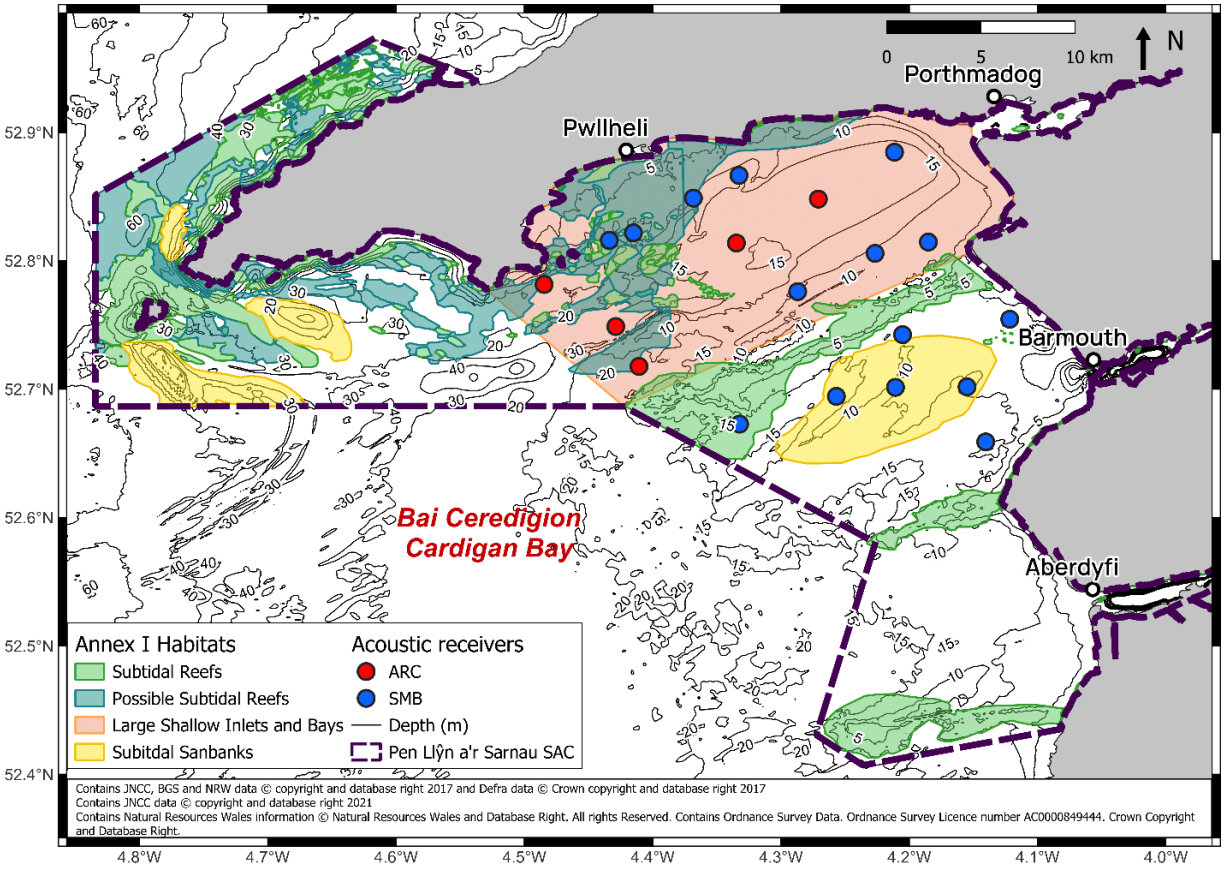


Figure 1: The position of receivers in the acoustic array deployed in Pen Llyn A'r Sarnau Special Area of Conservation, North Wales between July 2024 and July 2025 in relation to Annex 1 habitat features.

Two types of mooring were used for the acoustic array; 1. RS Aqua Acoustic Release Cannister (ARC) moorings with Innovasea VR2AR acoustic receivers (Figure 2A); and 2. Surface-marked buoy (SMB) moorings with either Innovasea VR2W or VR2Tx acoustic receivers (Figure 2B). ARC mooring systems were comprised of a bottom mooring (~80 kg of large diameter ship chain), an ARC unit with subsurface floats and a VR2AR receiver, and an acoustic release mechanism allowing retrieval of units upon activation by an Innovasea VR100-300 deckbox and transponding hydrophone. SMB moorings were comprised of a bottom mooring, a subsurface line (12 mm polysteel rope, Ropes Direct Ltd.) to a non-compressible float (BPB Bacell™ Purse Seine Float, Gael Force Marine) to which an Innovasea VR2W or VR2Tx receiver was attached, and a riser line to a surface marker buoy (A2 Polyform Net Buoy, Gael Force Marine). The riser line was comprised of 12 mm polysteel rope until the last 5 meters where it changed to 10 mm leaded polysteel rope. In both ARC moorings and surface buoyed moorings, the acoustic receivers were held upright ~1-2 m above the seabed (Figure 2C). An additional security line between the receiver and the anchor was attached for each SMB mooring to reduce risks of the mooring breaking free of the anchor and being lost. Information about the array was circulated widely to commercial and recreational fishers, local RNLI stations, and through Project SIARC social media accounts to increase the likelihood that any receivers which were lost would be returned to the project.

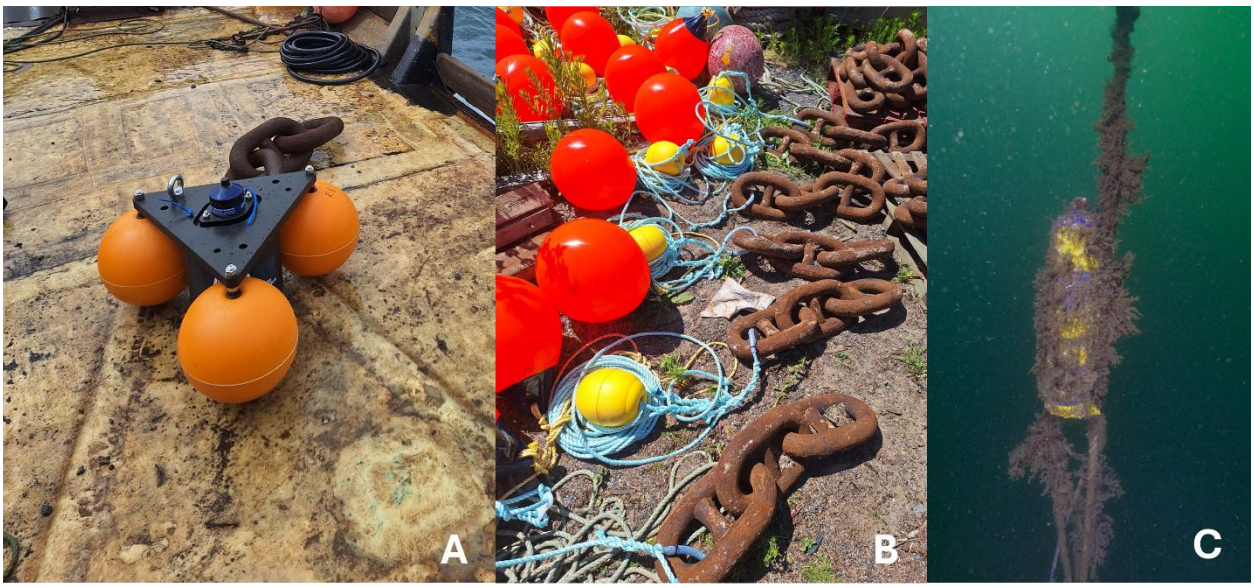


Figure 2: A. an ARC mooring unit, **B**. surface marker buoy moorings, **C**. an acoustic receiver held vertically ~1-2 m above the seabed on a SMB mooring.

2. Tope tagging surveys

Tagging surveys were conducted with three charter skippers in PLAS SAC in July-September 2024 and April-June 2025. During trips, skippers invited volunteer anglers to assist with catching tope for tagging. All animals were caught by rod-and-line using hooks baited with mackerel (*Scomber scombrus*) or pollack (*Pollachius pollachius*), which was provided by the charter skippers as bait from previous trips. Once tope were hooked they were quickly brought to the charter vessel where they were boarded and placed inverted into a custom built V-shaped tagging cradle (Figure 3A) to induce tonic immobility (Kessel and Hussey, 2015). Once sharks entered tonic immobility, standard length and fork length measurements were taken and a small ~5 cm incision was made into the intraperitoneal cavity through which an Innovasea V9 acoustic transmitter was inserted (Figure 3B). The acoustic transmitters used had an approximate battery life of 581 days and transmitted tag ID's at a nominal delay of 120-180 seconds. The incision was then closed using two interrupted sutures using an absorbable braided suture (Coated VICRYL Plus Antibacterial Suture, Ethicon US LLC). Tope were then fitted with a visual ID tag at the base of the dorsal fin (Figure 3C) and a small section of skin from the anal fin was collected for future genetic analysis prior to animals being released. During procedures a small submersible pump was used to provide oxygenated seawater to the gills of sharks. All procedures were completed within 15 minutes, were conducted under a Home Office license (PP1872648), and were approved by the Zoological Society of London's Animal Welfare and Ethical Review Board.

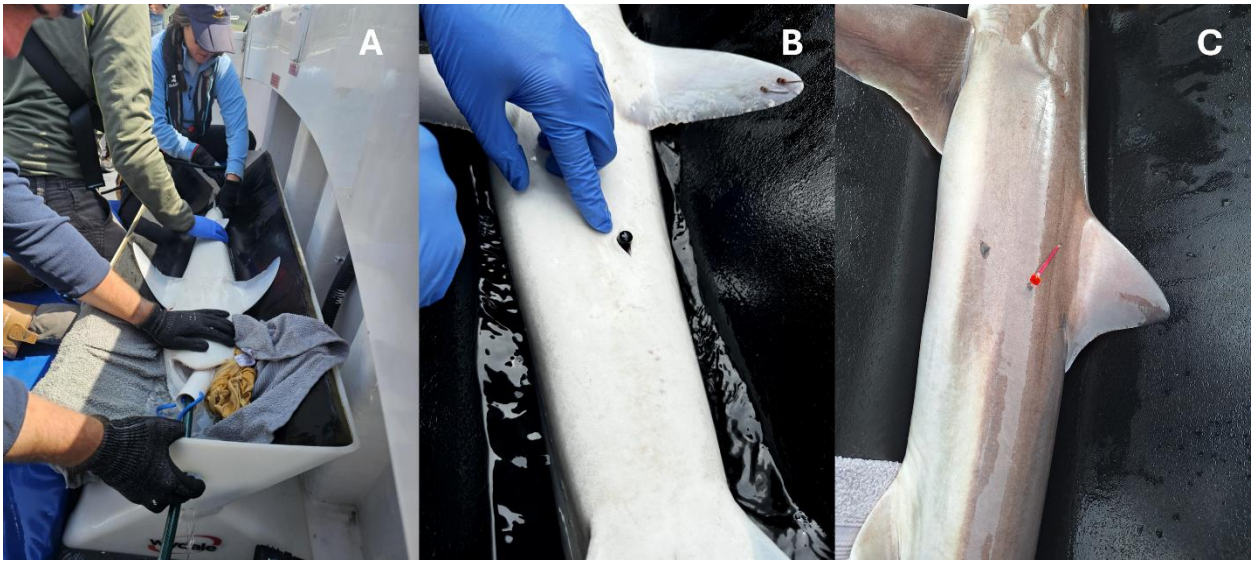


Figure 3: A. Captured tope sharks are transferred to a custom made V-shaped cradle where they are placed upside down to induce tonic immobility, **B.** An acoustic tag is then surgically inserted into the intraperitoneal cavity, **C.** The shark is then ID tagged and a fin clip taken for genetic analysis before release.

3. Array retrieval and download

The acoustic array was serviced in July 2025. Eighteen of the twenty receivers were recovered with 2 receivers unable to be located. This is in line with expected loss rates of ~10% annually that have been reported in other acoustic telemetry arrays (Hall *et al.*, 2025). Of the 18 receivers recovered, we downloaded detection data from 15. Unfortunately, the remaining three receivers experienced hardware failures during deployment and did not record any data. Alongside tag detections, hourly records of environmental temperature were downloaded from 10 acoustic receivers (VR2AR and VR2Tx models). During array retrieval, drift tests were conducted on three receivers to estimate detection radius using a V9 range test tag with a nominal delay of 1 s. All three receivers showed >80 % detection of range test tags up to an approximate distance of 500 m (the maximum drift distance from receivers that we tested). After data download, all receivers were fitted with new batteries and redeployed to allow tracking of tope until Spring 2026.

Results

In total, 28 tope were tagged by the Project team. Nine tope were tagged in 2024 and 19 in 2025 (Table 1). Tagged tope ranged in size from 100-142 cm fork length. Fork lengths (L_F) of tope were converted to an approximate total length (L_T) using the equation from Cameron et al. (2025):

$$L_T = L_F/0.882$$

Total lengths of tope were then used to estimate age and maturity status based on von Bertalanffy growth curves and maturity thresholds for the North East Atlantic sub-population calculated by Dureuil & Worm (2015). All tope tagged in 2024 were considered to be juvenile females, with 4 individuals not yet reaching the minimum recorded length at first maturity (LT_{min} = 140 cm) and the remaining 5 individuals under the recorded length at which 50 % of individuals are likely mature (LT_{50} = 155 cm). In 2025 10 female and 9 male tope were tagged. Nine of the female tope tagged in 2025 were considered to be juveniles (four were below LT_{min}, and five were below LT_{50}) and one female considered as mature (above LT_{50} of 155 cm). Of the 9 male tope tagged in 2025 only 1 was considered to be a juvenile (below LT_{min} of 114 cm) with the remaining 8 male tope all considered to be adults (above LT_{100} of 127 cm).

Table 1: Tagging date, sex, fork length (L_F), total length (L_T), age, and maturity status of tope tagged with acoustic transmitters during 2024 and 2025. Total length and age are estimated from measured fork length based on equations from Cameron et al. (2025) and Dureuil & Worm (2015) respectively.

ID	Date tagged	Sex	L_F (cm)	L_T (cm)	Age (y)	Maturity Status
T1 'Jo'	2024-07-18	F	124	141	14	(2) reached only the minimum LT at first maturity (LT_{min}; male=114 cm; female=140cm)
T2 'Chessie'	2024-07-18	F	132	150	16	(2) reached only the minimum LT at first maturity (LT_{min}; male=114 cm; female=140cm)
T3 'Sarah'	2024-07-18	F	127	144	15	(2) reached only the minimum LT at first maturity (LT_{min}; male=114 cm; female=140cm)
T4 'Lily'	2024-07-18	F	112	127	11	(1) not yet reached the minimum LT at first maturity
T5 'Angel'	2024-08-01	F	118	134	12	(1) not yet reached the minimum LT at first maturity
T6 'Dani'	2024-09-04	F	125	142	14	(2) reached only the minimum LT at first maturity (LT_{min}; male=114 cm; female=140cm)

T7 ‘Hannah’	2024-09-04	F	126	143	14	(2) reached only the minimum LT at first maturity (LT_{min}; male=114 cm; female=140cm)
T8 ‘Jess’	2024-09-04	F	121.5	138	13	(1) not yet reached the minimum LT at first maturity
T9 ‘Kate’	2024-09-04	F	114	129	12	(1) not yet reached the minimum LT at first maturity
T10 ‘Nia’	2025-04-29	F	137	155	18	(3) reached the LT at which 50% of sharks are likely mature (LT_{50}; male=121cm; female=155cm)
T11 ‘Llywelyn’	2025-04-29	M	133	151	21	(4) reached the LT at which 100% of sharks are likely mature (LT_{100}; male=127cm; female=182cm)
T12 ‘Luke’	2025-04-30	M	128.5	146	19	(4) reached the LT at which 100% of sharks are likely mature (LT_{100}; male=127cm; female=182cm)
T13 ‘Aled’	2025-05-01	M	129.5	147	20	(4) reached the LT at which 100% of sharks are likely mature (LT_{100}; male=127cm; female=182cm)
T14 ‘Tracy’	2025-05-01	F	129.5	147	15	(2) reached only the minimum LT at first maturity (LT_{min}; male=114 cm; female=140cm)
T15 ‘Tamara’	2025-05-01	F	119.5	135	13	(1) not yet reached the minimum LT at first maturity
T16 ‘Barbara’	2025-05-13	F	133	151	16	(2) reached only the minimum LT at first maturity (LT_{min}; male=114 cm; female=140cm)
T17 ‘Deborah’	2025-05-13	F	130	147	15	(2) reached only the minimum LT at first maturity (LT_{min}; male=114 cm; female=140cm)
T18 ‘Glinda’	2025-05-20	F	135	153	17	(2) reached only the minimum LT at first maturity (LT_{min}; male=114 cm; female=140cm)
T19 ‘Tom’	2025-06-09	M	142	161	27	(4) reached the LT at which 100% of sharks are likely mature (LT_{100}; male=127cm; female=182cm)
T20 ‘John’	2025-06-09	M	128	145	19	(4) reached the LT at which 100% of sharks are likely mature (LT_{100}; male=127cm; female=182cm)
T21 ‘Charlie’	2025-06-09	M	130	147	20	(4) reached the LT at which 100% of sharks are likely mature (LT_{100}; male=127cm; female=182cm)
T22 ‘Mikatcha’	2025-06-09	M	133	151	21	(4) reached the LT at which 100% of sharks are likely mature (LT_{100}; male=127cm; female=182cm)
T23 ‘Jaws’	2025-06-09	M	128.5	146	19	(4) reached the LT at which 100% of sharks are likely mature (LT_{100}; male=127cm; female=182cm)
T24 ‘Essie’	2025-06-10	F	133.5	151	16	(2) reached only the minimum LT at first maturity (LT_{min}; male=114 cm; female=140cm)
T25 ‘Lynda’	2025-06-10	F	119.5	135	13	(1) not yet reached the minimum LT at first maturity
T26 ‘Ripley’	2025-06-10	F	133	151	16	(2) reached only the minimum LT at first maturity (LTmin; LT male=114 cm; LT female=140cm)
T27 ‘Sue’	2025-06-10	F	124.5	141	14	(2) reached only the minimum LT at first maturity (LTmin; LT male=114 cm; LT female=140cm)
T32 ‘Osian’	2025-06-10	M	100	113	10	(1) not yet reached the minimum LT at first maturity

2. Tope seasonal residency and habitat use

From the 28 tope tagged, 2,546 detections of 13 individuals were recorded on the acoustic array. In addition, the array recorded a further 767 detections of 4 tope which had been tagged on the east coast of Ireland. Tope showed evidence of seasonal movements away from PLAS SAC in winter with no detections of tope occurring between 22nd October 2024 and 18th April 2025 (Figure 4). Detections of tope tagged in 2024 suggested that animals moved south after leaving PLAS SAC - with four of the nine tope tagged in 2024 being detected on acoustic receivers in the Bristol Channel between 30th August 2024 and 25th October 2024. One of these individuals was again detected in the Bristol Channel on 17th April 2025 before then returning to PLAS SAC on April 23rd 2025. In total, three tope tagged in 2024 were redetected in PLAS SAC during 2025. Of the 19 tope tagged in 2025, 8 were detected by receivers within PLAS SAC between May 2025 and July 2025 when the receivers were serviced and data downloaded. There appeared to be a difference in the probability of tope being detected in the SAC in relation to the date they were tagged, with 6 of the 9 tope (i.e. 66 %) tagged in April and May 2025 being detected in the SAC after tagging whereas only 2 of the 10 tope (i.e. 20 %) tagged in June 2025 where subsequently detected in the SAC. This corresponds to detection records from tope tagged in 2024, tope tagged in April/May 2025, and the 4 tope detected in PLAS SAC which were tagged in Ireland. All these animals showed regular detections within the SAC between mid-April and early June 2025, after which the number of detections decreased. Three of the 10 tope tagged in June 2025 were subsequently detected on the SEAMONITOR receiver array (which stretches between Malin Head, Ireland and the Isle of Islay, Scotland) in July and August 2025.

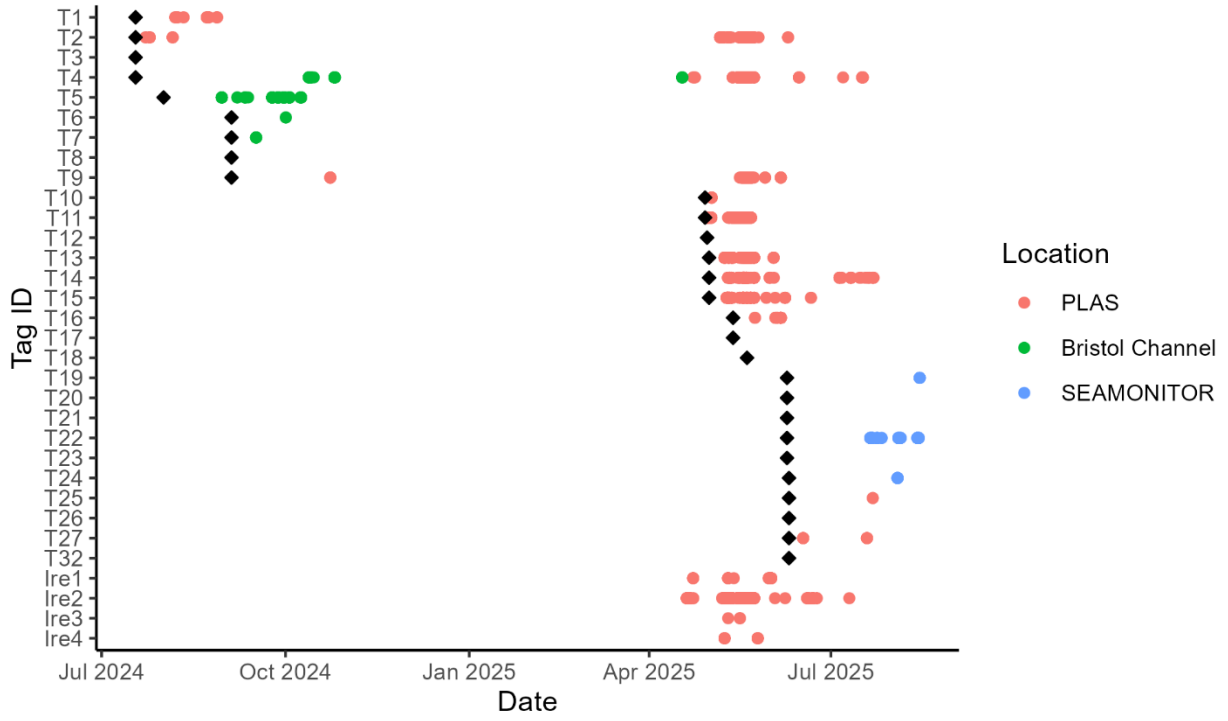


Figure 4: Abacus plot showing detections of all tope tagged by the project within PLAS SAC (Pink), the Bristol Channel (Green), and the SEAMONITOR array (Blue). Additional detections of tope detected in PLAS SAC which were tagged in Ireland are shown at the bottom of the figure (Tag IDs Ire1-4). Black triangles indicate the date of tagging for tope tagged by Project SIARC within PLAS SAC.

Detections of tope within PLAS SAC were clustered within two main areas (Figure 5), on receivers near reef features in the north of Tremadog Bay or on receivers surrounding the subtidal sandbank feature located south of Sarn Badrig and west of Barmouth. Approximately 69 % of all tope detections within PLAS SAC came from receivers located on the 'Sandbanks which are slightly covered by sea water all the time' feature, with 27 % of detections from receivers on 'Subtidal Reefs' or 'Possible Subtidal Reefs' features, and <2 % of detections coming from receivers within the 'Large shallow inlets and bays' feature.

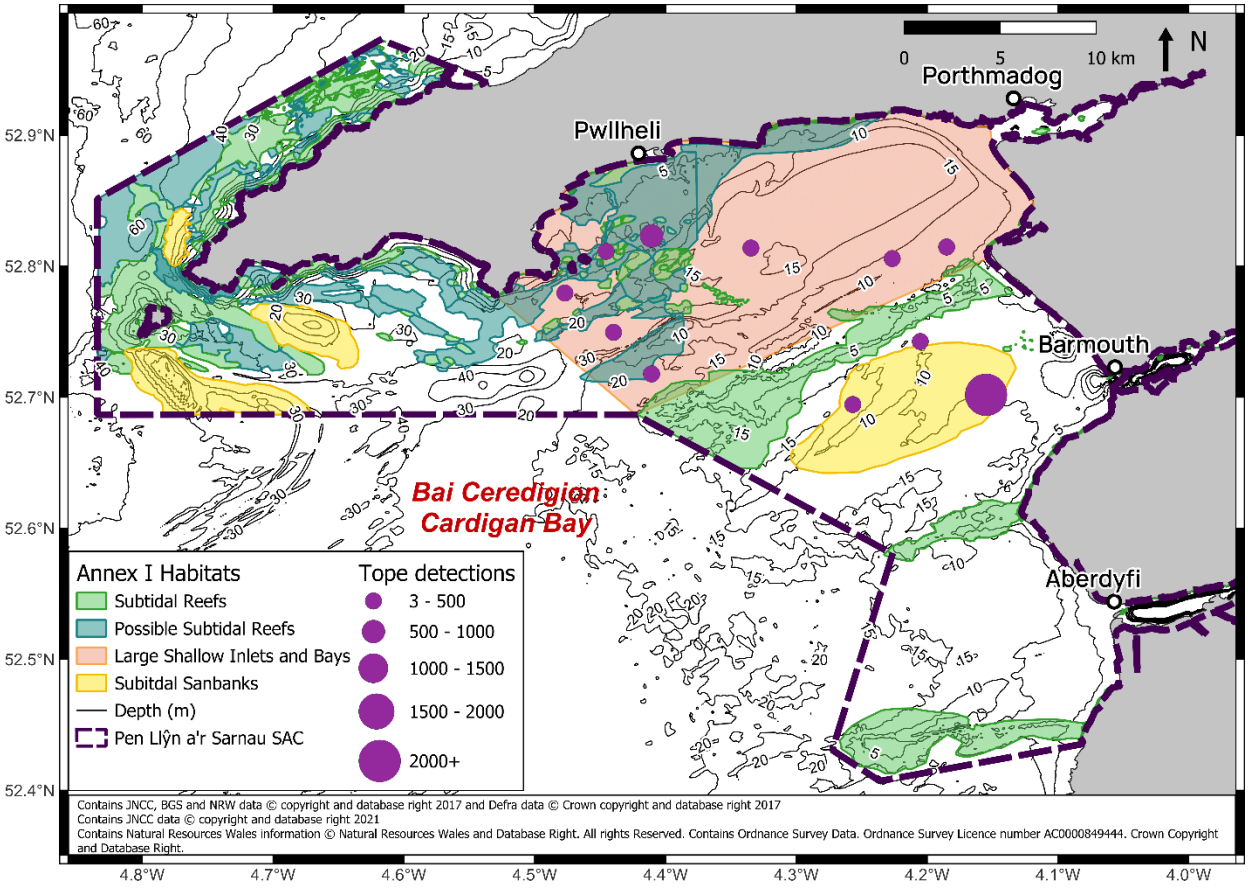


Figure 5: Detections of tope on the acoustic array within PLAS SAC between July 2024 and July 2025 in relation to Annex 1 habitat features.

3. Other species

Alongside detections of tope, the receiver array also detected presence of several other species. Most prominently this included twaite shad (*Alosa fallax*), an Annex II species on the Conservation of Habitats and Species Regulations (2017). There is currently a large scale tagging programme for twaite shad taking place in rivers and estuaries within the Bristol Channel and nine individuals tagged by this programme during 2023 and 2024 were detected within PLAS SAC between 2024 and 2025. Other species detected by the array include a spurdog (*Squalus acanthias*) originally tagged in the Bristol Channel, and an Atlantic Bluefin Tuna (*Thunnus thynnus*) which was tagged in Nova Scotia, Canada in 2022.

4. Environmental data

As well as data on movements and residency of species, the acoustic array also recorded environmental bottom temperatures within PLAS SAC. Recorded temperatures in PLAS SAC ranged from 5.7 °C (February 2025) to 19.5 °C (July 2025) (Figure 6).

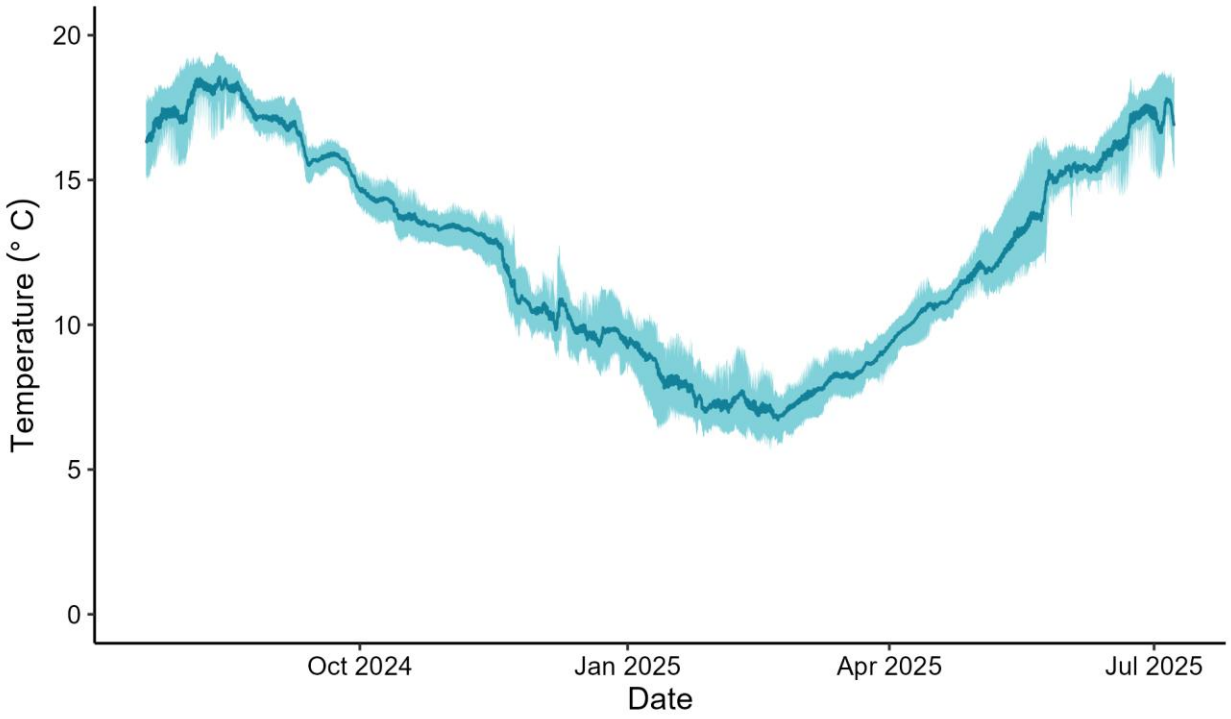


Figure 6: Environmental bottom temperature in PLAS SAC over the deployment period from July 2024 to July 2025. The dark line indicates the mean temperature from all ten recording stations within PLAS SAC, while the shaded ribbon indicates the range between minimum and maximum temperatures recorded each hour.

Next Steps

In its first year of operation, the acoustic array in PLAS SAC has provided new insight into movements, residency and connectivity of tope populations in Wales. Female tope tagged in 2024 displayed evidence of seasonal movements south during winter, transiting through areas of the Bristol Channel (including Carmarthen Bay and Estuaries Special Area of Conservation) in Autumn and Spring. These seasonal movement match findings from previous satellite tracking and mark-recapture tagging studies (Thorburn *et al.*, 2019; Schaber *et al.*, 2022; Cameron *et al.*, 2025), which suggest tope make migrations between north-west Europe and the sub-tropical Atlantic between summer and winter. Several tope tagged in 2024 were re-detected in PLAS SAC in 2025. This supports evidence from Cameron et al. (2025) indicating that tope caught in the Irish Sea show high levels of inter-annual site fidelity. The occurrence of inter-annual site fidelity suggests that habitats within the Irish Sea play a crucial role for tope populations. However, as the female sharks we tagged in 2024 were all considered to be immature it is unlikely these movements were directly related to reproduction. Tope appeared to prefer areas of the SAC in which Annex 1 'Subtidal Reefs' or 'Sandbanks which are slightly covered by sea water all the time' feature habitats were located. Although only 40% of receivers in the acoustic array were placed on these feature habitats, over 95% of tope detections within PLAS SAC were recorded in these areas. However, as the majority of tope detections on the array occurred in May and June 2025, shortly after 19 tope were tagged in the SAC, these results may not be fully representative of broader movements and habitat use by the tope population in PLAS SAC. Longer term monitoring of movements and tagging of additional animals (particular of mature female tope which are reported from fisher catches) are therefore needed to allow more detailed understanding of how and why tope use habitat features within the SAC.

The acoustic array has also highlighted the importance of PLAS SAC in the context of the wider Irish Sea and North Atlantic in providing vital habitat for mobile fish species. In particular, the detection of twaite shad is significant as they are an Annex II listed species. Currently twaite shad are not a designated species for PLAS SAC and the SAC is listed as having 'non-significant presence' of shad. While catches of shad in PLAS SAC have been reported previously by both recreational and commercial fishers, evidence from the acoustic array confirms that these individuals are from the spawning population of the Tywi, Usk, and Wye (David Clarke, pers. Comms). The need to improve understanding of migratory movements and habitat use for twaite shad is listed as a 'High Priority Evidence Need' by Natural Resources Wales. The acoustic array in PLAS SAC therefore addresses this evidence gap. Twaite shad which spawn in rivers in South Wales have been detected within estuaries in North Devon and Ireland where they made movements inland within rivers (Davies *et al.*, 2020). Further information is needed to confirm

whether shad detected within PLAS SAC use estuaries and inland areas of the Afon Dyfi, Mawdach, Drywyrn, and Glaslyn. To do this, additional acoustic receivers would be needed to be placed near entrances to estuaries to detect shad moving into and out of estuaries. Evidence for connectivity between the Bristol Channel and North Cardigan Bay was further strengthened by the detections of a spurdog in PLAS SAC in November 2024 which had originally been tagged in the Bristol Channel. This detection was noteworthy as it corroborated reports from local fishers to Project SIARC that Spurdog had been sighted within Tremadog Bay in November and December 2024. Reports of sightings or catches of spurdog in Tremadog Bay have been low for several decades after commercial fishing for spurdog caused a crash in the North-East Atlantic population in the1990's and early 2000's (Dobby *et al.*, 2005). Increases in the reports and detections of spurdog in the SAC may therefore provide evidence that the population is recovering in this area. Further monitoring of detections is needed to confirm this possibility.

In July 2025 an agreement was reached with the Ocean Tracking Network (Ocean Tracking Network) for the loan of 15 state-of-the-art NexTrak R1 acoustic receivers, to replace lost and faulty equipment and older VR2W acoustic receivers in the acoustic array. In addition, a further 10 moorings were added to the acoustic array to further expand coverage of important habitat features and expand the array to cover a greater spatial extent of PLAS SAC. Further expansions of the acoustic array will take place in 2026 as part of the Nature Networks Fund 5 project awarded to Project SIARC by Welsh Government in March 2026. During NNF5, the acoustic array will be upgraded to become an Ocean Observatory through the deployment of bespoke oceanographic instruments which will record environmental temperature, conductivity, and turbidity. This substantial infrastructure upgrade will allow tracking of movements across a larger range of SAC habitat features and provide detailed information of the status of environmental conditions in the SAC. We will continue tagging work with three species of shark (tope, nursehound, and angelshark) in 2026. Additional tissue sampling of sharks will allow us to assess health and reproductive status of sharks through analysis of tissue pollutant levels, circulating reproductive hormone concentrations, and ultrasound imaging to confirm pregnancy in mature females.

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