MRV *Scotia*

Survey 0623S

SURVEY REPORT

18 May – 13 June 2023

Ports

Loading:	Aberdeen	16 May 2023
Sailing:	Aberdeen	18 May 2023
Port call	Aberdeen	24 May 2023
Half Landing:	Stornoway	30 May 2023
Unloading:	Aberdeen	13 June 2023

Gear

2 x towed UWTV sledges
2 x 600m fibre optic/copper hybrid umbilical towing cables and associated TV equipment (analogue, standard definition systems, including back up)
1 x 600m copper umbilical towing cable
2 x Scotia BT175 80 mm prawn trawls, with Vee 25/26 and Vee 41/42 trawl doors
2 x USBL transponders
2 sets SS4 Scanmar door sensors and chargers
SPAN moorings: VEMCO deck box, transponder and charging unit for acoustic release;
100 kg clump weight, two sensors, mooring line, shackles (one for each of the six mooring sites)

Estimated Days per Project: 27 Days 20724

Objectives

1. To obtain estimates of the distribution and abundance of *Nephrops* burrows at Fladen, the Devils Hole, the North Minch, South Minch, Sound of Jura, Clyde, Moray Firth and at the Noup using underwater television (UWTV) video cameras.

2. To use the video footage to record occurrence of other benthic fauna and evidence of commercial trawling activity.

3. To collect trawl caught samples of *Nephrops* for comparison of reproductive condition and morphometrics.

4. If trawling occurs, record and retain marine litter obtained from trawling as part of the UK Marine Strategy.

5. To collect sediment samples at each UWTV station

6. If time and conditions allow, to recover and deploy Scottish Passive Acoustic Network (SPAN) moorings in the Clyde and along the North coast

Narrative

With additional tasks added to the programme just prior to sailing, this survey needed to maximize the time at sea, and so all Marine Directorate (MD) staff were onboard MRV *Scotia* by 23:00 hours

on 18 May and the vessel caught the tide at midnight. Heading east, the vessel arrived at the first station in the south west area of Fladen at 07:00 hours on 19 May. The umbilical cable used to tow the sledge and which connected the TV sledge to the vessel was then streamed behind the vessel, with a large buoy attached to the sea going end of the cable. Once the vast majority of the cable had been deployed, the recovery process began, and with the buoy attached this created back tension on the winch. This resulted in the cable being wound tightly onto the winch, which would result in reducing the potential for loose turns of cable developing during the course of the survey, which could cause serious damage to the cable. After connecting the sledge to the cable and testing all the equipment was functioning as expected, a metal grid was attached to the underside of the sledge. The sledge was then submerged just below the surface of the water and a recording of the grid from the camera's perspective was made. This provided a practical calibration of the camera's field of view (FoV) to compare with the modelled FoV used in the data work up process using camera and sledge parameters. This first deployment and recovery of the sledge also acted as a refresher for all onboard before the higher priority abundance deployments began.

The first scheduled underwater television (UWTV) station was reached by 09:30 hours on 19 May and with long distances between stations whilst working east, only seven stations were completed that first day. In foggy but calm sea conditions the survey continued east, through the central Fladen area arriving at the stations on the east side of the Fladen ground late on 20 May. During the day, the vessel was informed Ullapool was no longer a possible destination for the half landing and so alternative options were investigated and the impact on the survey design was considered.

Whilst working north east from the central Fladen on the 21st, issues occurred regarding the motor on the rear of the sledge that raised and lowered the odometer wheel. Several attempts were made to address the problem, involving deploying the sledge, and eventually the motor was replaced. However this motor also seized and ultimately the decision was made that the wheel would have to remain uncontrollable (with regards to raising it off and lowering on to the seabed). However this did not affect the data gathering requirements, and the wheel continued to produce the data as expected.

By 22 May the survey had reached the most northerly stations in the Fladen area, and by 21:00 hours the vessel began to work south west down through the easterly stations. Progress continued along the eastern edge of the grounds until 03:00 hours on 23 May, when it was agreed that UWTV operations needed to be halted to provide sufficient time to return to Aberdeen to allow a crew change the following day. So with 53 stations in Fladen completed the vessel headed to Aberdeen, arriving at the marker buoy at 15:00 hours on 23 May, and after a short wait the vessel finally docked at 18:00 hours.

During the time in port on 24 May, the ship carried out essential tasks and completed the hand over to the new crew, and all data entry, reviewing of footage and further training was completed by the scientists.

The vessel returned to sea at 08:00 hours on 25 May and in flat calm conditions headed back to Fladen to complete surveying the remaining 17 stations. UWTV work began at 14:00 hours and all stations were completed by 16:00 hours on 26 May.

After a five hour steam to the Pentland Firth, work began at the Noup at 00:30 hours on 27 May and by 11:00 hours ten stations had been completed in deteriorating weather conditions. By this time the sea swell had increased to the point it was too difficult to operate the UWTV sledge safely or effectively, so the vessel headed to the most sheltered of the two Scottish Passive Acoustic Network (SPAN) mooring sites nearby. However by 15:30 hours the sea state was too poor to consider recovering a mooring, yet deployments were more manageable and three SPAN moorings were put in place.

During this time of poor weather one member of the team sustained an injury and by 17:30 hours it was agreed that treatment ashore was required. Plans were made to transfer the affected member of staff ashore at Ullapool, but with limited berth facilities available in Ullapool, this was not possible until 09:00 hours on 28 May. So a new route was designed so that the vessel was in port ready to tie up at 09:00 hours but *en route*, as many UWTV stations as possible were surveyed.

After arriving at the first station in the North Minch at midnight, six stations were completed by 06:00 hours when the vessel made way for Ullapool, where the injured colleague was assisted off the ship at 09:00 hours. After modifying the survey's shift patterns and work allocations, the vessel then continued the survey in the North Minch with one person less than before. To permit working through the hours of darkness, and still provide the confidence that the presence of creels was not a concern, the imminent sites were surveyed during daylight hours, which then allowed the survey to continue on through the night until early on the morning of 29 May without incident, by which time the vessel was situated to the west of Loch Torridon. At this point there was a hydraulic oil leak and survey operations were halted for a short time whilst this was rectified, after which the survey continued around the Isle of Skye and into a creel free Loch Dunvegan, before heading to Harris by 19:30 hours. Here creels presented a real hazard and several stations were relocated to avoid any potential for entanglement with the UWTV sledge. However, by 06:30 hours on 30 May, all bar one station in the area had been completed and the vessel made way for Stornoway, arriving there at 09:00 hours. At this point the 24 hour half landing began and a staff change took place.

On resuming the survey, the vessel headed to the South Minch on 31 May, arriving at the first station at 14:30 hours, working off the south west edge of Skye by the late evening. The morning of 1 June was spent off Canna and Rhum, where stations were relocated again due to the presence of creels. Later in the day the central South Minch was surveyed before heading south west towards Barra.

In warm, calm conditions 2June was initially spent in the vicinity of Coll and Tiree, (where the presence of creels required some stations to be relocated), and then off north west Jura by evening. All South Minch stations were completed by 21:00 hours when the vessel headed for the Sound of Islay (22:00 hours) and then a long seven hour steam to the Clyde.

Arriving at the UWTV stations to the south of Arran at 04:00 hours on 3 June, the vessel made way north through the Kilbrannan Sound, where a number of stations were relocated due to yachts, submarine cables and the very high density of creels throughout the whole area. Between stations a further SPAN mooring was deployed, followed at 18:30 hours by a fishing trawl. The survey then continued in the east and to the south of the Clyde and completed all stations in the area by 14:00 hours on 4 June. After a one hour steam, the vessel was at the site of another SPAN mooring, yet despite the perfect conditions, a recovery could not be completed, so only a deployment could be undertaken. After this, the vessel made way for the Sound of Jura, arriving at 19:30 hours and began working north, being very aware of the potential of rocks and creels in the northern part of the Sound. All ten stations in the Sound of Jura were completed by 05:00 hours on 5 June, and then the vessel headed north, returning to the North Minch.

Arriving off the east of Skye at 16:30 hours on 5 June, the vessel began to survey the last of the remaining North Minch stations. However, the density and proximity of creels to the UWTV station sites required a number of stations to be relocated, which notably delayed the process. By 04:00 hours on 6 June all the North Minch stations had been completed and the vessel then carried out a fishing trawl before heading back to Ullapool for 12:00 hours. Once in port there was a change in both science staff and crew. The vessel then headed north to the site of another SPAN mooring, however on arrival it was deemed too dark to see if the mooring had surfaced if released from the seabed successfully, so the vessel remained on site till 05:30 hours for daylight.

A significant amount of time was spent trying to recover the mooring on the morning of 7 June, and despite some contact with the mooring, it failed to surface. The vessel the returned to the area west of Orkney where it had been too rough to attempt a mooring recovery earlier in the survey. However, on this occasion both a recovery and a deployment was achieved. By 17:00 hours in breezy conditions the vessel was then off Dornoch in the eastern Moray Firth, and worked south then east overnight and throughout 8 and 9 June, completing all the Moray Firth stations without incident by midnight on 9 June.

Following a ten hour, steam the vessel arrived at the first station at Devils Hole on 9 June in flat calm conditions. Beginning the survey in the north east part of the grounds, the vessel generally worked westwards with a trawl in the evening of 10 June, followed by another in the morning of 11 June. All stations at the Devils Hole were completed by 18:00 hours on 11 June, and so the vessel made way for Aberdeen.

Arriving in port in the afternoon of 12June, all preparations were made for unloading the following morning, as well as processing the final data gathered during the trip. All scientific equipment was unloaded on the morning of 13 June, after which staff disembarked the vessel.

Results.

At Fladen, the Noup, in the Moray Firth, the South Minch, in the Clyde and the Sound of Jura, the survey design was based on a stratified random approach. Within these geographical areas there are patches of muddy sediments that are suitable for *Nephrops* habitation. The distribution of these sediment types is derived from British Geological Survey (BGS) data. The stratification is based on these defined sediment types, with each area spatially sub-divided to avoid clustering of the randomly generated survey sites.

Due to the topography and benthic composition at the Devils Hole (i.e. long, very narrow, deep gouges with rocky outcrops), the stations here are fixed, having established safe areas to work over previous surveys.

In the North Minch, the extent of the survey area is based on merged Vessel Monitoring System (VMS) data from the period 2007 through to 2011, within which random stations are generated anywhere within this area. In addition there are ten fixed stations, a legacy from when the survey design was based on sediment distribution. This has resulted in three of these historical stations being located outside of the VMS boundary (i.e. these positions are found on muddy areas with little or no fishing effort during the sample period 2007-11).

Following guidance set out by ICES Working Group on *Nephrops* Surveys (WGNEPS), burrow and complex recognition training was carried out in advance of the survey with further assistance provided by an experienced member of staff whilst at sea, as and when required. The standard definition video footage collected at sea (Objective 1) was reviewed in accordance to various established protocols, which stated the footage had to be reviewed by two reviewers, independently of each other. As data became available, it was analysed using Linn's concordance correlation coefficient (Lin's CCC) statistical package in R. Where significant differences between the values from the two original reviewers occurred, the footage was reviewed a third time by an alternative experienced reviewer.

Whilst at sea all the available data generated from the 281 successful TV deployments were entered in to various spread sheets and Word documents, in a format suitable to be uploaded directly in to the Data Collection Group's bespoke UWTV survey database. This included: survey summary; camera parameters; sediment sample data; station information for each TV site; video observations at each site (Objective 2) and all reviewed and finalised burrow counts. Following analysis, several runs required to be reviewed a third time, and although a number of third counts were achieved whilst at sea, due to limited time and the reduced number of experienced reviewers

on board, especially during the second half of the trip, all relevant footage was put ashore at the half landing for completion at the Marine Laboratory. Those stations generated during the second half of the survey that were not reviewed a third time whilst at sea, were also reviewed at the Laboratory following the end of survey. The final results will be used at future ICES assessment Working Groups to help provide stock management advice. A summary of the survey activity within each area is illustrated in Table 1 below.

Trawling (Objective 3) took place on four occasions within three Functional Units with mixed results. All but one haul in the Devils Hole provided sufficient *Nephrops* that were suitable for biological analysis. From each haul, two clusters of measurements were taken: sex and carapace length from a random sample to provide an illustration of length frequency distribution at that site; and from a selected sample, a suite of morphometric measurements, which included sex, carapace length, claw length and orientation, female ovary staging, the length of the male appendix masculine, whole and tail weights when possible, as issues with the sea going balances were encountered. These morphometric measurements add to the ever increasing volume of similar data to provide information on length/weight relationships as well as size at maturity, a key element of stock management. Initial data was reported on in 2013 (Queiros, A., Weetman, A., McLay, H. Anne, Dobby, H., 2013. Geographical variation in size at the onset of maturity of male and female Norway lobster *Nephrops norvegicus,* in Scottish waters. Fisheries Research 139 (2013) 132-144) with a follow up study employing updated methodologies and additional data from more recent surveys, was initiated in 2021. However, despite good progress this work was halted due to staff changes, although revival of this project has been discussed.

Detailed records were also created regarding all litter caught in the trawls (Objective 4) which feeds into a MD database to track the location, volume and type of litter found around Scotland at different times of the year. This data supports the UK Marine Strategy and is reported annually to ICES.

Sediment samples were gathered using a mini van Veen grab mounted on the UWTV sledge (Objective 5). At the end of each run and once the video footage had been gathered, the grab was remotely released from onboard the vessel, and the grab attempted to obtain a sample; however due to the benthic conditions this was not always possible. These samples were frozen and will be processed in a Particle Size Analyser at a later date.

The SPAN mooring project continues the work begun with the EU INTERREG COMPASS programme. A number of passive acoustic moorings are situated around the coast of Scotland (Figure 8), where they monitor the monitor the abundance, distribution and movement of cetaceans using Soundtrap units to record passing broadband (e.g. whale song) and C-POD units to record the echolocation clicks of odontoceti (typically that of dolphins and porpoise). The devices are moored to the seabed with the recording devices buoyed a short distance above. When the vessel arrived on site, an acoustic signal was sent to the mooring and the sound recorders were released, ready to be recovered from the surface by the vessel. During this survey it was hoped to retrieve three moorings and deploy a further six (Table 3) but despite revisiting sites and spending a considerable amount of time on location, two of the three devices could not be contacted with a sufficiently strong enough signal to release the moorings. However, all deployments were achieved regardless of weather conditions, which ensures the data being collected at those sites remains uninterrupted; although this does now require two moorings at some locations to be collected at time point in the future.

No digital photographs were taken during this survey. However, images can be obtained from the video footage if required, using Squared 5, VLC or similar software.

As a safeguard incase the sledge ever parted from the umbilical cable during a deployment, the recovery device (as described in the 0714S survey report) was attached to the sledge throughout

the survey. The working time permitted before the device was activated was set at a precautionary 90 minutes.

To supplement the recovery device, a ultra-short baseline (USBL) system was utilised. This involved a transceiver on the hull of the ship communicating with a transponder mounted on the towed sledge. This also provided geo-referencing if the sledge parted from the towing umbilical cable, albeit digitally rather than visually (the buoy from the recovery device would be seen on the surface of the water). The USBL provided a live data stream of the location of the sledge at any given time. These data, backed up locally on a daily basis, could then be plotted, and illustrated both the path at which the sledge was towed and the distance over ground.

This survey was staffed by a number of colleagues new or relatively new to UWTV work. This was due to staff relocation and availability, and so created new challenges for both individuals but also for survey planning and execution. Additional and ongoing intense training was provided throughout the survey, both as refresher sessions for those with previous experience, but also to ensure those new to the survey were brought up to speed with various allocated tasks as soon as possible, and that they felt confident and comfortable with what was being asked of them. This diverted a noticeable amount of time away from reviewing, which in turn resulted in some analysis being required to be undertaken on-shore following the completion of the trip. However, all involved showed great aptitude and potential, and with a requirement to rebuild a core UWTV team that can be relied on for future trips, all those involved in the survey showed great promise that they could be involved in the forthcoming surveys.

In summary, this survey, which had many iterations, changing start dates, varying requirements and staffing challenges, ultimately completed surveying all the areas planned, providing sufficient data to successfully undertake analysis and provide the essential advice needed for various stock assessment working groups. This was quite an achievement considering the demands put on all involved, especially those new to the survey. By the end of the survey all the video footage gathered at sea had been reviewed at least twice, analysed, and all the generated data were entered into the various spreadsheets ready for uploading to the bespoke UWTV survey database. Where the footage required a third reviewer, the majority of these stations were analysed whilst at sea, with the remainder completed within a few weeks of the survey ending. Sediment samples were collected at each suitable station and the limited trawling provided the required data for biological requirements. Although recovering the SPAN moorings was only 33% successful, deployments had a 100% pass rate - a pattern similar to other surveys. Overall, this was a very successful, busy, enjoyable survey, with all priority objectives fully met. Although it was very unfortunate that a member of staff had to leave the vessel early in the trip due to medical incident, that person has now fully recovered. The introduction of new staff on this survey showed great promise and reassurance for future surveys, and with their help, all the data was made available and worked up well ahead of the ICES working groups.

MD staff on this survey would like to thank all those on Scotia for the friendly and professional service they provided throughout this hugely successful survey. Those thanks are extended to shore side staff who played an essential part in ensuring the survey went ahead with all the required equipment, despite the pre-sailing challenges faced at the time.

A Weetman
15 September 2023

Tables.

Area	Number of TV Deployments	Number of Fishing Trawls	Number of Sediment Samples
Fladen	70	0	62
Noup	10	0	7
North Minch	48	1	45
South Minch	41	0	32
Clyde	30	1	27
Sound of Jura	10	0	10
Moray Firth	55	0	48
Devils Hole	17	2	16
Totals	**281**	**4**	**247**

Table 1: A summary showing the number of TV stations surveyed, number of fishing tows and sediment samples obtained by survey area, for survey 0623S.

Area	a) Number of *Nephrops* sampled for length frequency distribution only	b) Number of *Nephrops* sampled only for morphometric measurements	c) Number of *Nephrops* sampled for morphometric measurements and LFD	Total number of *Nephrops* measured
North Minch	235	100	0	**335**
Clyde	199	84	0	**283**
Devils Hole	99	0	53	**152**
Totals	**533**	**184**	**53**	**770**

Table 2: A summary table of the data obtained from the fishing trawls undertaken during the survey 0623S.

ID	NAME	To Retrieve	Lat- Retrieval	Long-Retrieval	To Deploy	Lat-Deployment	Long-Deployment	Date
10a	Totegan_5	Not achieved	58° 37.330' N	003° 59.989' W	Achieved	58° 37.338' N	004° 00.012' W	27th May
10b	Totegan_10	NA	NA	NA	Achieved	58° 40.116' N	003° 59.964' W	27th May
10c	Totegan_15	NA	NA	NA	Achieved	58° 42.678' N	003° 59.940' W	27th May
18	Portencross	NA	NA	NA	Achieved	55° 37.512' N	005° 03.918' W	3rd June
19	Kilbrannan Sound	Not achieved	55° 22.878' N	005° 23.559' W	Achieved	55° 20.844' N	005° 23.634' W	4th June
9	Orkney West	Achieved	58°52.734' N	003°42.471' W	Achieved	58° 52.734' N	003° 42.468' W	7th June

Table 3: Details of the one COMPASS mooring devices visited during survey 0722S.

Figures.

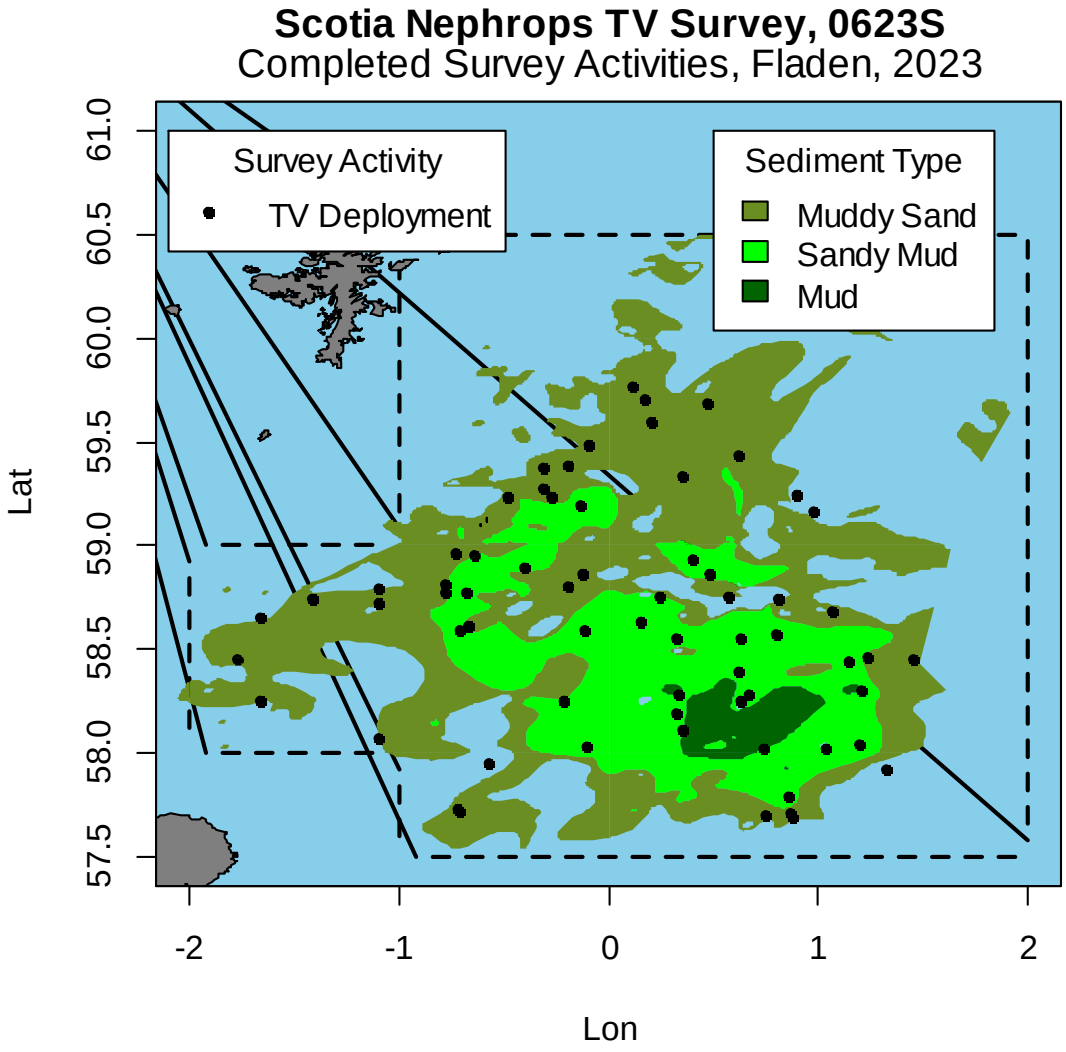

Figure 1: A plot of the Fladen ground (Functional Unit 7) showing the location of activities undertaken during the survey 0623S. The areas shaded green illustrate the extent of the muddy sediments, as defined by BGS, suitable for *Nephrops* habitation.

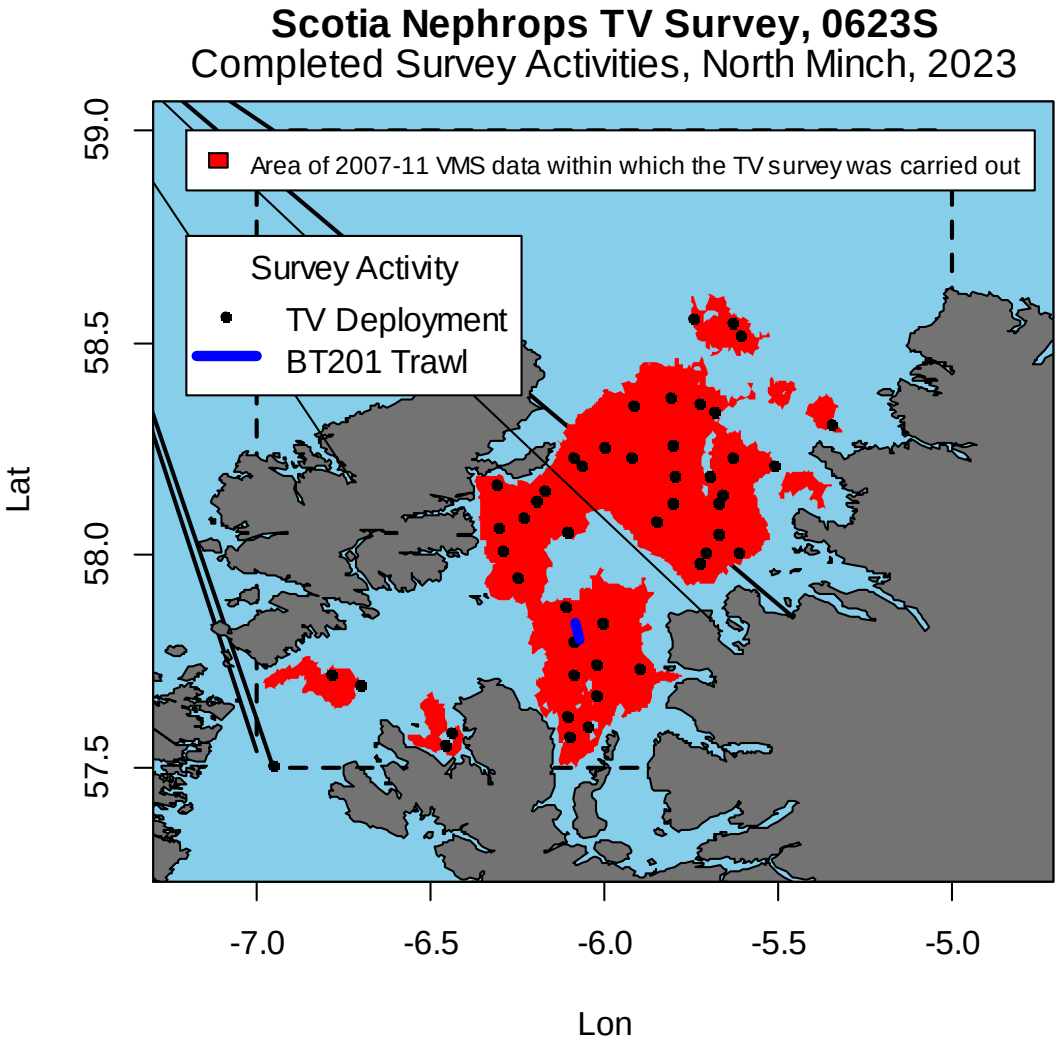

Figure 2: A plot of the North Minch (Functional Unit 11) showing the location of activities undertaken during the survey 0623S. The areas shaded red illustrate the extent of the study area based on 2007-2011 VMS data.

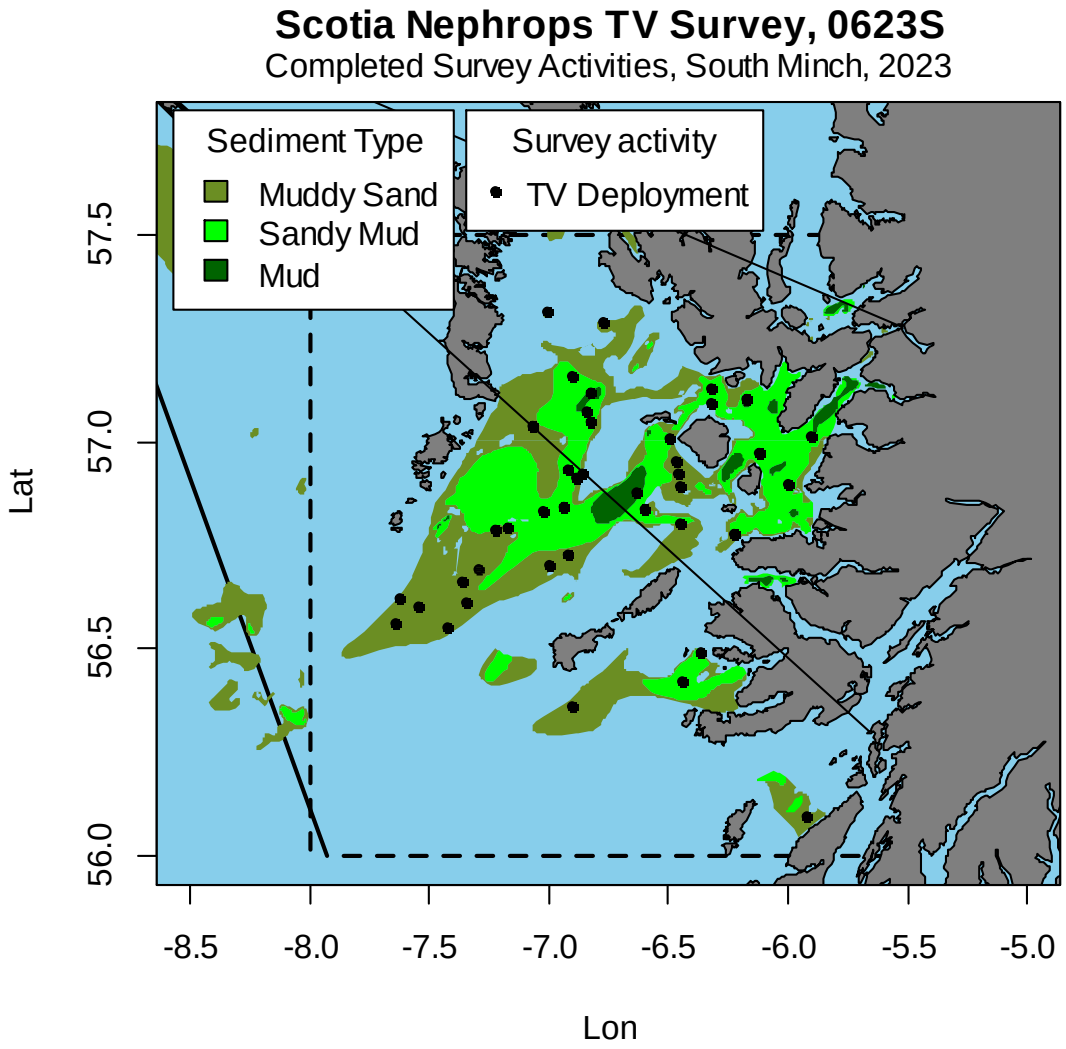

Figure 3: A plot of the South Minch (Functional Unit 12) showing the location of activities undertaken during the survey 0623S. The areas shaded green illustrate the extent of the muddy sediments, as defined by BGS, suitable for *Nephrops* habitation.

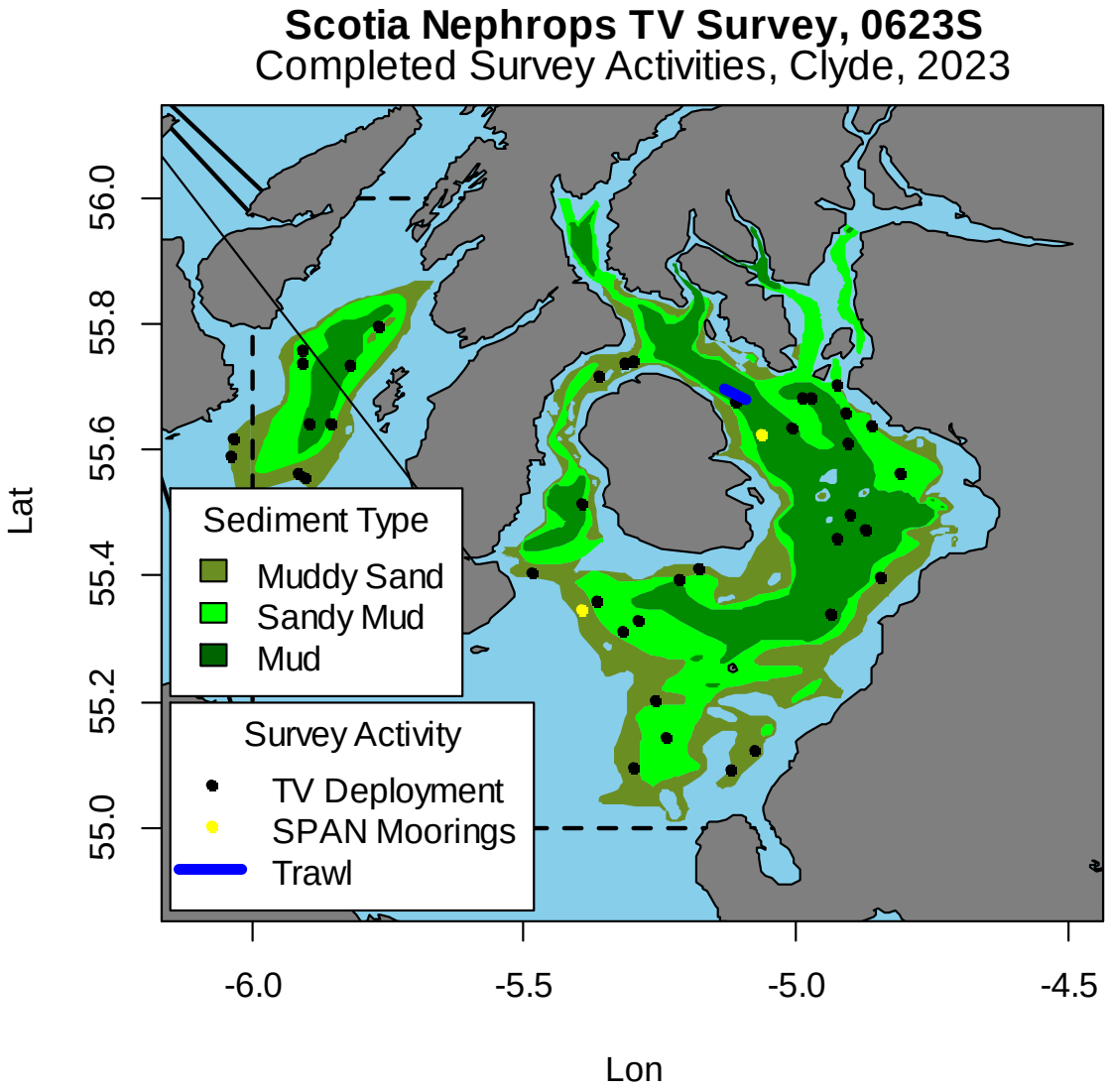

Figure 4: A plot of the Clyde and the Sound of Jura (Functional Unit 13) showing the location of activities undertaken during the survey 0623S. The areas shaded green illustrate the extent of the muddy sediments, as defined by BGS, suitable for *Nephrops* habitation.

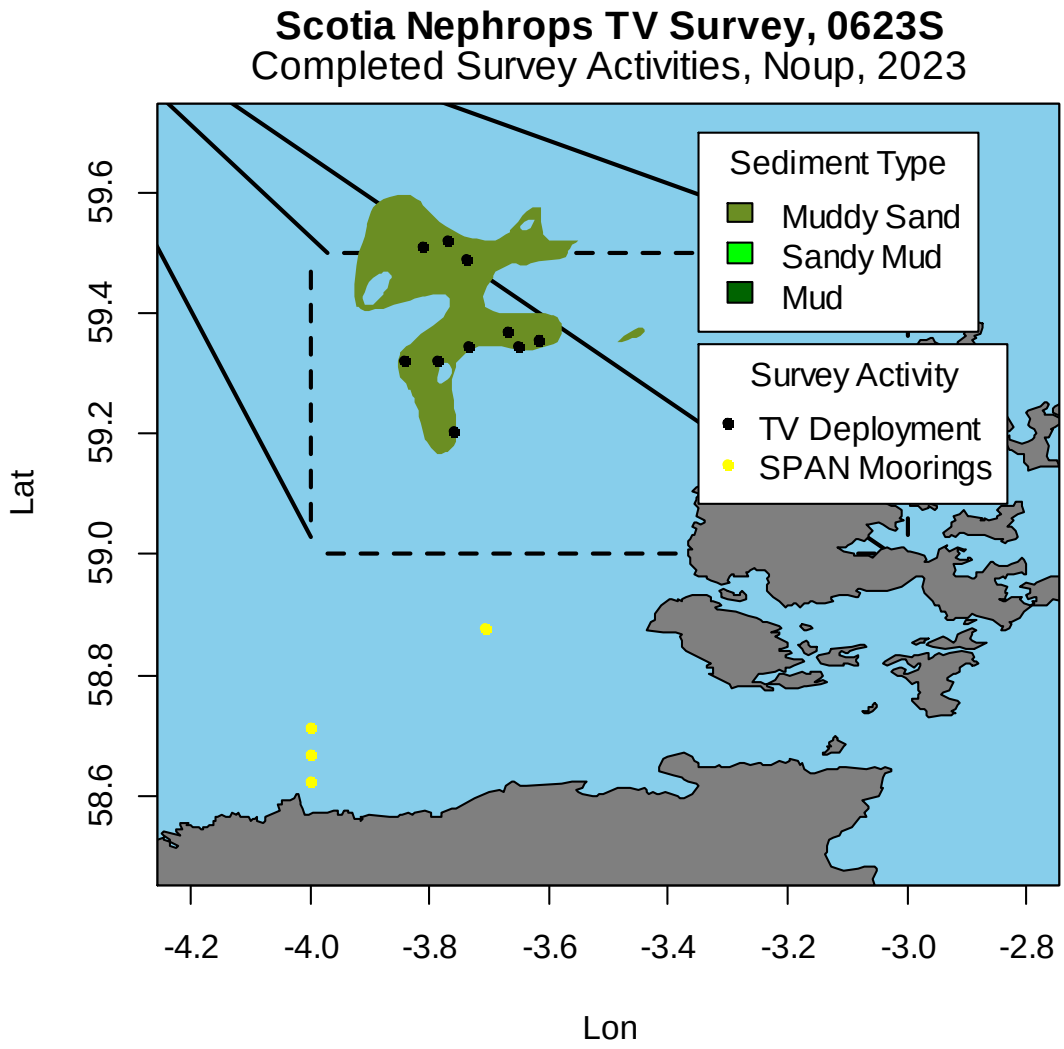

Figure 5: A plot of the Noup (Functional Unit 10) showing the location of activities undertaken during the survey 0623S. The areas shaded green illustrate the extent of the muddy sediments, as defined by BGS, suitable for *Nephrops* habitation.

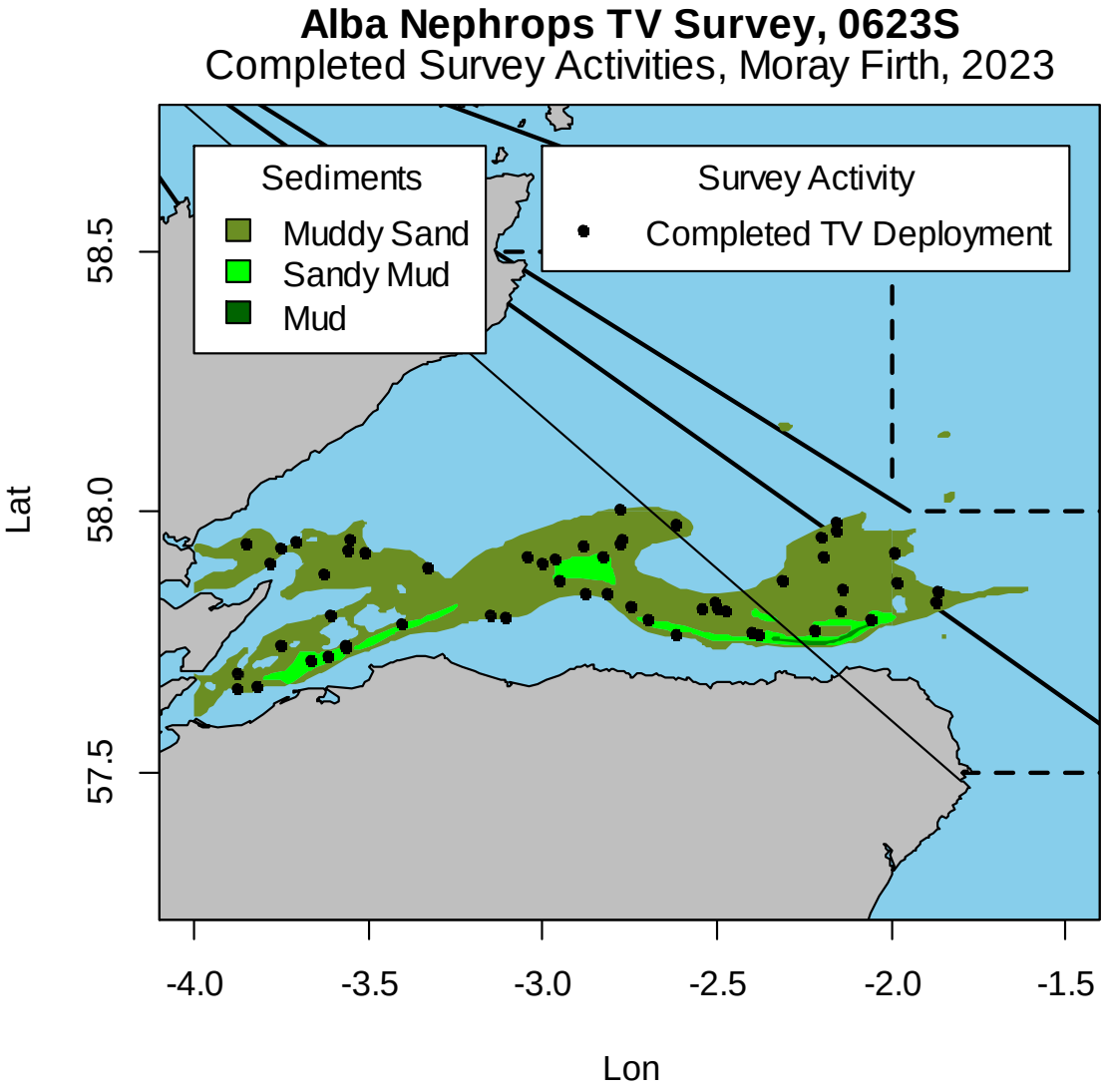

Figure 6: A plot of the Moray Firth (Functional Unit 8) showing the location of activities undertaken during the survey 0623S. The areas shaded green illustrate the extent of the muddy sediments, as defined by BGS, suitable for *Nephrops* habitation.

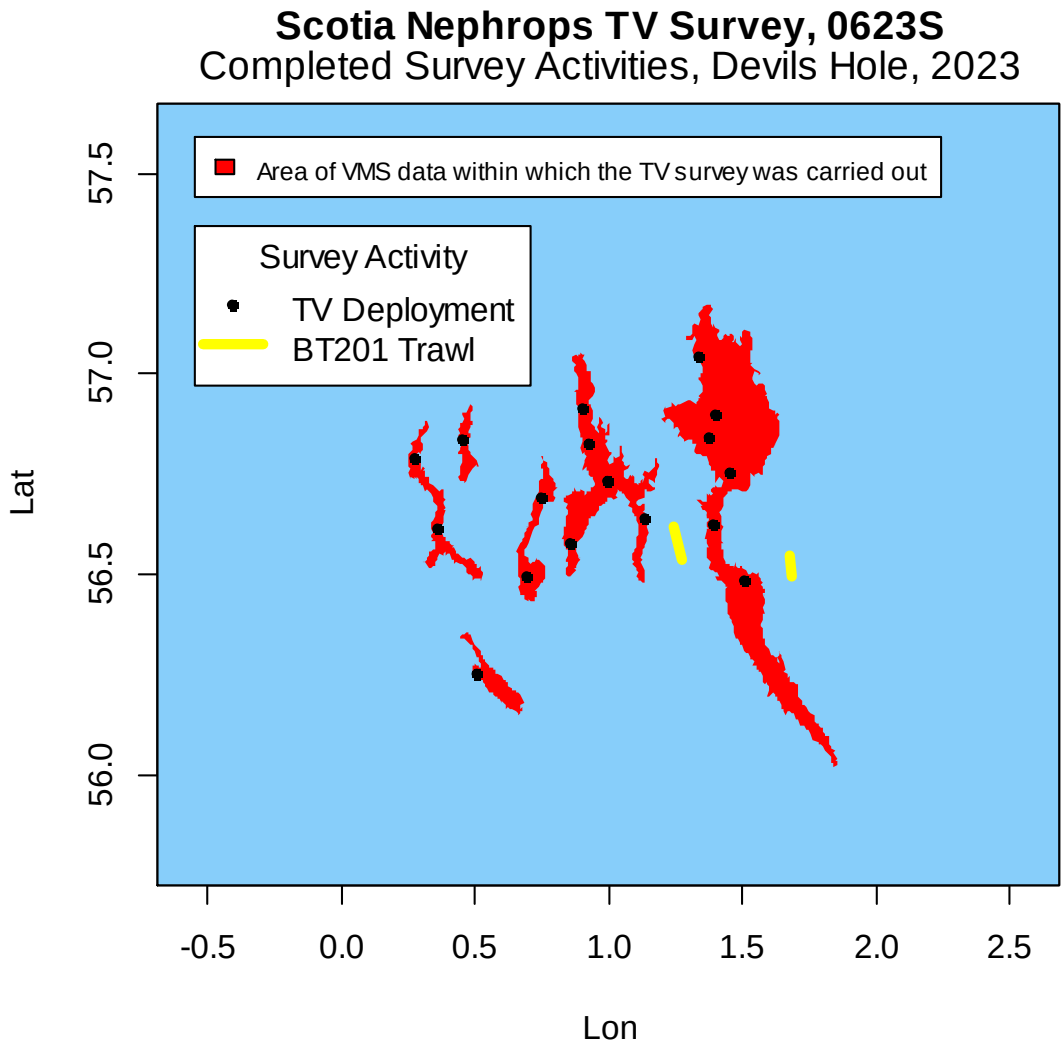

Figure 7: A plot of Devils Hole (Functional Unit 34) showing the location of activities undertaken during the survey 0623S. The areas shaded red illustrate the extent of the study area based on 2007-2011 VMS data.

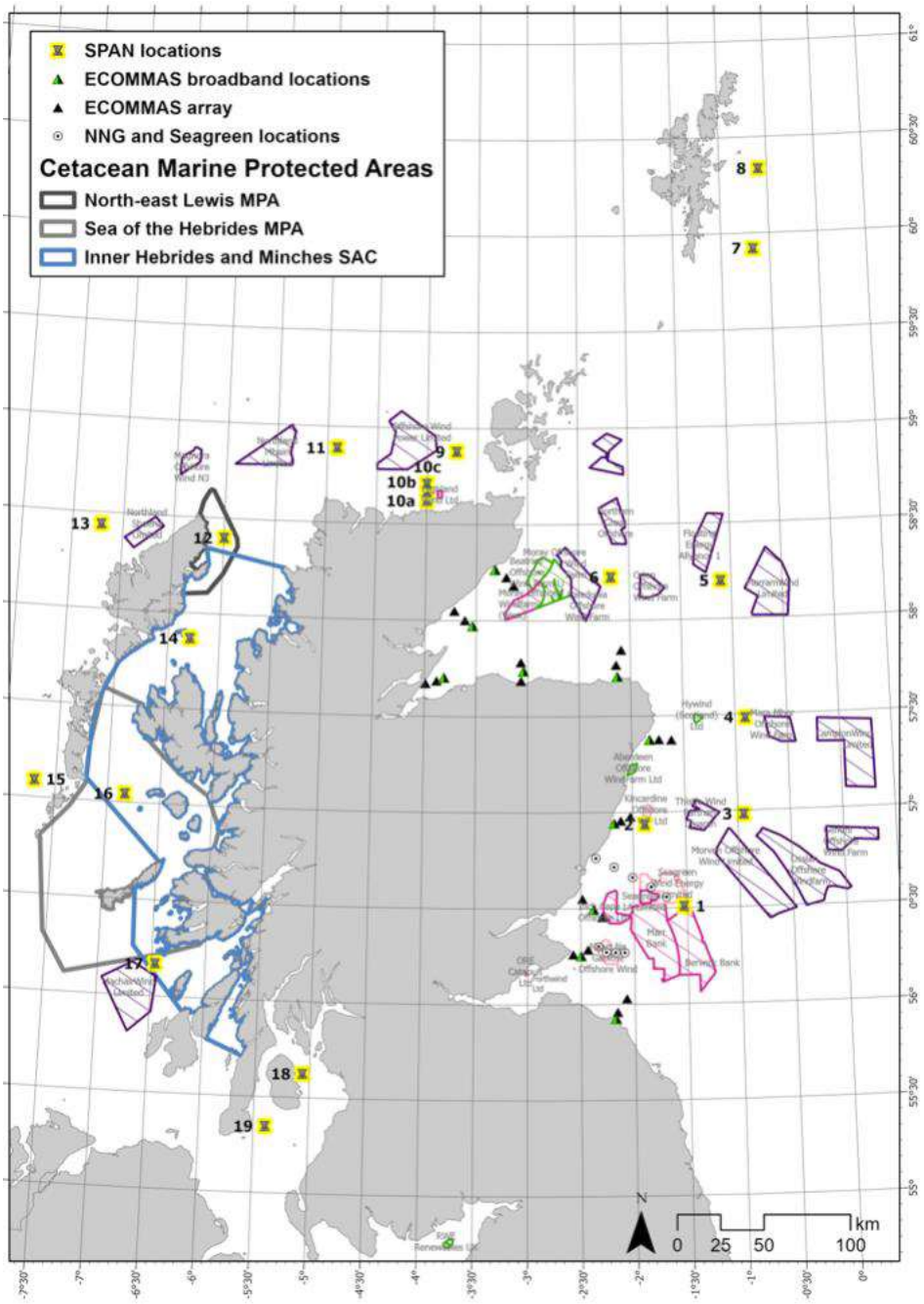

Figure 8: A plot illustrating the network of SPAN moorings around the Scottish coast, 2023.