SCALLOP ASSESSMENT WORKING GROUP (WGSCALLOP)

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Contents

i Executive summary

The ICES Scallop Assessment Working Group (WGScallop) collates, reviews and analyses scallop landings data, scallop surveys and methods, scallop ageing procedures and advances in technology to further develop and improve appropriate stock assessment methods.

Data from the fifth year of the WGScallop data call were collated and compared with an extraction from the Regional Database Estimation System (RDBES) for the second year. A comparison of the two data calls highlighted issues that will be resolved intersessional. Once all issues have been resolved it will be decided whether the RDBES data can replace the WGScallop data call.

The systematic overview table of the geographic range of scallop stocks, current data availability and assessment methods produced in 2023 was updated. Presentations on the application of stock synthesis (SS3) using Isle of Man and Welsh stocks as case studies were given. Intersessional work on stock assessment and survey themes are scheduled for 2025.

Fisheries independent surveys provide a fundamental basis for stock assessment for many institutes. Multiple staff survey exchanges occurred in 2024, sharing knowledge and expertise. Exchanges will continue in 2025. The WG discussed EU project Aquarius and combining surveys across case study areas using ships and other equipment.

During the ICES WGScallop 2024 meeting, final outcomes of the genetic studies on king scallop in Scotland were presented by Heriot-Watt University, alongside updates from Strathclyde University, the Agri-Food and Biosciences Institute (AFBI), and Bangor University on larval dispersal modelling in Scotland, Northern Ireland, and the North Irish Sea, respectively.

Presentations on gear modifications, including work from the Irish Institute (BIM) on assessing the affects of increased belly ring sizes, and remote electronic monitoring (REM) from the Scottish Marine Directorate were discussed.

The WG will compile an ageing manual collating the knowledge and discussions from the age reading workshops. Partner institutes will be identified to validate reference sets of scallop shells for each management area.

The queen scallop subgroup will be expanded in 2025 with the aim of reviewing and collating all existing relevant data for publication.

ii Expert group information

Expert group name	Scallop Assessment Working Group (WGSCALLOP)
Expert group cycle	Multiannual
Year cycle started	2022
Reporting year in cycle	3/3
Chair(s)	Lynda Blackadder, UK
	Isobel Bloor, UK
Meeting venue(s) and dates	4–7 October, Hafnarfjörður Iceland (28 participants)
	9–13 October, Tromsø, Norway (26 participants)
	8–10 October 2024, Bayeux, France (31 participants, 15 in person and 16 online)

1 ToR A: Compile and present data on scallop fisheries in ICES Subareas 2, 4, 5, 6, and 7 by collating available fishery statistics

Term of Reference A addresses data collation for the Scallop Assessment Working Group (WGScallop). This was the fifth year of WGScallop receiving data from a data call made by ICES to member states, focused on king and queen scallops. This year’s data contained landings and effort data from 2023 and species, month of year, member state, métier (Level 5), and various ICES area classifications are provided for both these metrics. These data were added to the data from the previous data calls, and the dataset now spans 2000 to 2023. Known issues in the dataset are documented in the 2020 and 2021 WGScallop reports. The most noteworthy point about the 2023 data were that the England and Wales and the UK Crown Dependency nations effort data were provided twice, with the new method including effort from trips that did not catch king or queen scallops. It was decided at the WGScallop 2024 annual meeting that the group prefer the previous method that only includes effort for fishing trips where scallop landings were reported. The caveat here is that the métier DRB_MOL, which represents dredge gears targeting molluscs, should have all effort provided, as this métier accounts for over 90% of king scallop landings and is likely to represent effort targeting scallops in most cases. The WGScallop group agreed that more communication is required with the institutes that provide national data to the ICES data call to ensure that the effort data are prepared as preferred by WGScallop and are meaningful for the fisheries being assessed.

Landings data were also obtained from the Regional Database Estimation System (RBDES) for member states, as an alternative dataset to compare to the ICES data call. The rationale behind this is to examine other datasets to potentially avoid some of the known issues with the landings and effort data in the ICES data call in future. The RDBES dataset provided contained only landings, not effort data, and spanned 2021 to 2023. The landings in the two datasets, ICES and RBDES, were compared across these three years after standardizing each dataset to ensure they covered the same areas and member nations. Differences in landings were examined by species, year, area, member nation, and métier. Overall, the landings were very close between the two datasets for both king and queen scallops. After examining the data across more detailed aggregations, some discrepancies were identified that pertained to the member state and year that landings were recorded under. These differences need examined in future years. Furthermore, it needs to be explored whether the RBDES data can go further back in time to match the years in the entire ICES data call. Another important step will be to obtain effort data through the RBDES data call and compare those to the ICES effort data.

King scallops dominated the landings, with the majority coming from ICES Subarea VII (Table 1). Total landings increased steadily from 2000 to 2012 to approximately 64 500 tonnes landed for the subareas reported (Figure 1.1). Landings fell slightly between 2014 and 2020 but have been increasing again and were reported as 75 315 tonnes in 2022, which was the highest for the time-series. Total king scallop landings for the reported areas in 2023 were 74 494 tonnes. Further data tables and plots from the WGScallop data call are available in Annex 3.

Table 1 Provisional landings (live weight (including shell), tonnes) of king scallops (Pecten maximus) for 2000–2023 by ICES subarea as submitted through the ICES data call. Data for the Isle of Man are not available prior to 2011 and data for Scotland are not available prior to 2002.

	ICES Subarea							
Year	**I**	**II**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
2000	0	0	147.9	0	122.5	23 964.1	783.2	25 017.7
2001	0	0	814.8	0	79.5	26 965.4	1 048.5	28 908.2
2002	0	0	3 174.9	0	6 651.1	32 104.6	788.7	42 719.3
2003	0	0	4 222.3	0	5 968	32 866.9	973.3	44 030.5
2004	0	0	5 674.5	0	5 145.5	40 618.7	902.9	52 341.6
2005	0	666.5	4 916.3	0	4 409.7	44 238.9	1 038.4	55 269.8
2006	0	788	4 889.9	0	3 392.7	41 710.6	1 189.3	51 970.5
2007	1.2	864.1	5 458.2	0	3 028.3	42 888.6	1 340.6	53 581
2008	0	896.7	4 805.4	0	3 909.4	45 841.5	1 288.7	56 741.7
2009	0	742.8	5 361.4	0	3 545.7	44 982	906.1	55 538
2010	0	748.5	4 829.2	0	3 438.8	51 334.3	479.4	60 830.2
2011	0	715.3	3 800.8	0	3 503	53 267.7	260.7	61 547.5
2012	0	664.3	5 532.2	0	5 300	52 219.2	874.6	64 590.3
2013	0	678.4	7 596.5	0	4 536.7	49 769.1	826.7	63 407.4
2014	0	747.8	7 072.5	0	5 306.7	41 465.4	348.2	54 940.6
2015	0	555.7	9 027.8	0	4 357.1	39 803.9	496.6	54 241.1
2016	0	545.6	7 706.9	1.6	4 737.4	43 802.5	677.2	57 471.2
2017	1.3	486.6	7 669	0	3 569.3	46 145.7	716.2	58 588.1
2018	0	559.2	6 249.4	0	2 938	50 794	718	61 258.6
2019	0	447.9	5642	0	2 900.8	52 402.1	617.1	62 009.9
2020	0	0	6 469.3	0	2 165.6	48 121.5	678.4	57 434.8
2021	0	1.5	7 274.2	0	2 309	61 930	288.6	71 803.3
2022	0	0	4 910.2	0	2 207.1	67 870.6	327.8	75 315.7
2023	0	0.8	5 447.3	0	2 676.7	66 079.2	290.6	74 494.6

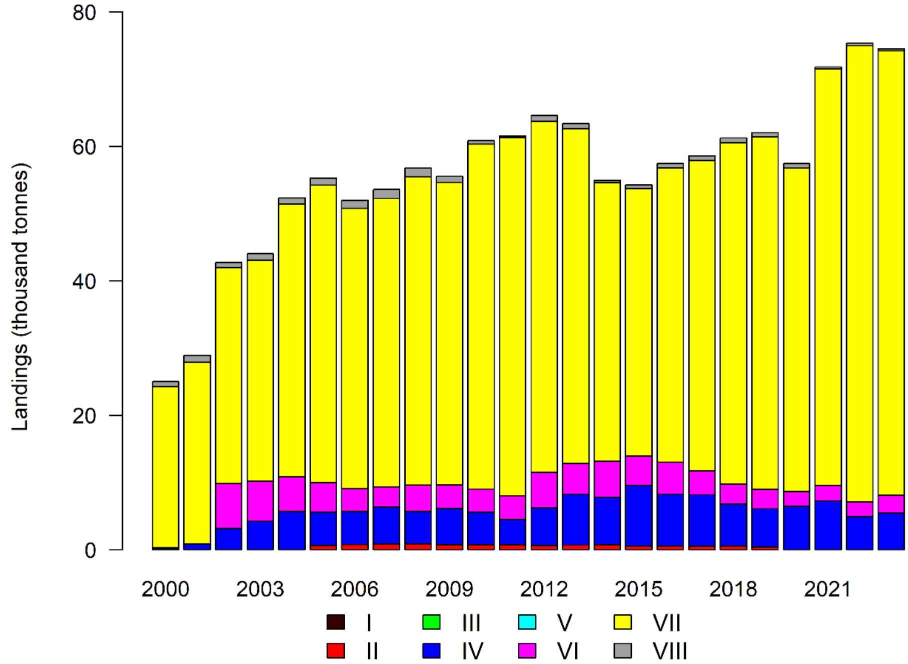

Figure 1.1 Annual landings (live weight (including shell), thousand tonnes) of king scallops (Pecten maximus) from 2000–2023. Landings are divided by ICES subarea within each year, as coloured by the legend. Data for Isle of Man are not included prior to 2011, and Scotland are not included prior to 2002.

2 ToR B: Review and identify stock assessment methods for scallop species. Consider available data (at stock level) for stock assessment input indices and/or for review of stock trends.

To establish a systematic accounting of scallop stocks represented in the WG and their status in terms of stock assessment and advice, an overview table was created in 2023 and updated this year (Table 2). The resulting overview includes 27 stocks and reflects the wide range of scallop stocks in the WG in terms of species, geographical distribution, and assessment methods. The table also highlights substantial data and capacity needs, as many scallop stocks are currently considered data-limited and often lack an analytical assessment. Currently, outside Canada and the US, only several stocks in Scottish waters and the Irish Sea are assessed with analytical assessment models such as SAM. Most other stocks rely on biomass estimates from surveys or similar approaches. Ongoing work to implement analytical assessments, using frameworks such as stock synthesis (SS3), were presented during the meeting.

The diversity of stock assessments that exist and current knowledge gaps underlined the importance of aligning and sharing assessment approaches and capability within the WG. Although there are common underlying challenges - notably data limitations, estimating stock indices from fisheries-independent or -dependent data, uncertainties related to stock structure and life history/gear parameters, spatio-temporal variation, and patchiness - the discussion revealed often distinct stock, or country-specific, obstacles to progress in stock assessments, typically related to input data. In addition, lack of capacity and resources were identified as further hindrances to improved assessments and advice.

During the meeting in 2023, workshops on scallop stock assessment and creating a road map to guide scallop stock assessors to the most suitable assessment and advice methods given were identified as relevant measures to improve collaboration and competence of stock assessments. A survey prior to the 2024 meeting determined that producing standardized stock indices and other input data for stock assessment remains a major bottleneck for many members of the group and therefore is a key interest for a possible workshop. Input data as main issue was followed by stock assessment methods in general. Most participants indicated their willingness to contribute to a workshop, ideally as hybrid multi-day activity. However, availability for taking a leading role was very limited, underlining the challenge for most members to dedicate significant amounts of time to the development of stock assessments. The WG concluded to proceed with a focus on assessment case studies that aim to integrate several stock areas, notably the Irish Sea and, possibly, the English Channel. The work presented on tentative SS3 assessments for the Isle of Man and Wales may facilitate this work, as SS3 allows for area-based assessment models that combine several stock components into a (meta-)stock assessment.

Table 2 Overview table of scallop stocks represented in WGScallop and their respective status in terms of stock assessment, advice and issues.

Species	Stock ID	Available input data	Assessment	Advice	Basis of advice	Reference points	Management measures	Environmental data	Issues/knowledge needs
Chlamys islandica	Iceland scallops in the Svalbard area	Survey estimates (2019-20, 2022), commercial CPUE (2022-2023)	Abundance/biomass estimation from geostatistical model	National/IMR (irregular)	Data-limited MSE (age-based, short cut)	Fmsy = 0.25, Fpgy = 0.19	TAC (15000t), MLS (60mm shell height), spatial restriction to 3 scallop beds in Bear Island area, impact assessment/reporting requirements	Temperature at survey stations, physical variables from ocean models (TOPAZ4/Copernicus, SVIM)	1. Very recent trial fishery, lack of time-series for stock assessment 2. Spatial stock structure uncertain, not accounted for in MSE 3. Limited knowledge of life-history parameters
Pecten maximus	Celtic Sea	Inconsistent survey time-series (2000-2005; 2019). From 2023 onwards, every 2-year survey Commercial CPUE (VMS/logbooks; dredge per boats) Port-Sampling data	Biomass estimation from geostatistical model	National	None	None	Scallop fishing license required. Total annual effort restrictions for the Scallop fleet. MLS (100mm shell width)	Backscatter data available. Physical variables from ocean models	1- Spatial variability of growth indicates need for a spatially explicit approach to assessment. 2- Age-based assessment limited by available data 3- Catchability is known to vary according to the ground type
Pecten maximus	Irish Sea	Inconsistent survey time-series. From 2023 onwards, every 2-year survey Commercial CPUE (VMS/logbooks; dredge per boats) Port-Sampling data	Biomass estimation from geostatistical model	National	None	None	Scallop fishing license required. Total annual effort restrictions for the Scallop fleet. MLS (100mm shell width); North of 52.2 degrees is 110mm shell width	Backscatter data available (sections). Physical variables from ocean models	1- Spatial variability of growth indicates need for a spatially explicit approach to assessment. 2- Age-based assessment limited by available data 3- Catchability is known to vary according to the ground type
Pecten maximus	French waters in Eastern Channel	Surveys time-series (1976-2023, standardized since 1992); catches and effort time-series	Direct biomass estimation from survey indices; CMSY++	National		None	Scallop fishing license required. Length, power and number of dredges limited. Effort restrictions (fishing allowed from October to mid-May, mid-November to end of March in the bay of Seine, 3 or 4 days per week, 2 to 6hours/day, rotational closure in the Bay of Seine). High selectivity of gear (97mm inside diameter for dredge rings). MLS=110mm. Limitation of catches/trip	Backscatter data available (sections). Physical variables from ocean models	
Pecten maximus	NI waters in VIa and VIIa	Survey time-series (1992-2024); observer program; commercial	Trend based	National	ICES category 3	None	Scallop fishing license required. Total annual effort restrictions for the Scallop fleet. MLS 110mm. Irish sea closure. Weekend closure. Fishing is only allowed	Backscatter and habitat maps; oceanology data;	

Species	Stock ID	Available input data	Assessment	Advice	Basis of advice	Reference points	Management measures	Environmental data	Issues/knowledge needs
		CPUE based on kw-days (no dredge information available)					between the hours of 0600-2000. Gear restrictions, 6-per-side. Spatial closures for scallop enhancement. MLS (100mm shell width); North of 52.2 degrees is 110mm shell width	larval dispersal model for scallop enhancement sites and MPAs.	
Pecten maximus	Irish Sea: IoM 12 nm miles	Research survey time-series (1992-2024); Industry survey time-series (2019 - 2024). VMS data for whole fleet regardless of vessel size - since 2015 15 min pings. Daily Catch Returns for all vessels for TS landings with gear information and fishing time etc.	Trend based, working on an SS3 model	National	ICES category 3	None	IoM scallop fishing license required. Limit on licenses. Annual TAC. Daily Catch Limits, MLS 110mm. Irish sea closure. Fishing only allowed between the hours of 0600-1800. Gear restrictions, 5-per-side (0-3 nm), 6-per-side (3-12 nm). Permanent and temporary spatial closures.	Habitat map for territorial sea (2008)	Grounds are very distinct in Isle of Man with variable recruitment, growth rates and densities both spatially and temporally which need to be incorporated into a model. We manage more and more on a fishing ground level so an overall stock assessment would need to be complemented with a finer-scale assessment for management. We also have the complication of being part of a wider Irish Sea stock.
Aequipecten opercularis	Irish Sea: IoM 12 nm miles	Research survey time-series (1992-2024); Industry survey time-series (2019 - 2024). VMS data for whole fleet regardless of vessel size - since 2015 15 min pings. Daily Catch Returns for all vessels for TS landings with gear information and fishing time etc.	CSA (length based)	National	ICES category 3	Use of LPUE thresholds and swept-area	IoM scallop fishing license required. Limit on licences. Annual TAC. Weekly Catch Limits, MLS 110mm. Irish sea closure. Weekend closure. Fishing only allowed between the hours of 0600-1800. Permanent and temporary spatial closures.	Habitat map for territorial sea (2008)	Grounds are very distinct in Isle of Man with variable recruitment, growth rates and densities both spatially and temporally which need to be incorporated into a model. We manage more and more on a fishing ground level so an overall stock assessment would need to be complemented with a finer-scale assessment for management. We also have the complication of being part of a wider Irish Sea stock.
Pecten maximus	Shetland	Inconsistent survey time-series from 2007 (9 years of data); observer programme (Factories and vessel); commercial LPUE (log sheets since 2000)	VPA (length based), Trend based, direct biomass estimations from survey indices	Regional out to 6nm		LPUE thresholds	SSMO fishing licence required. Night-time curfew (0600-2100) and dredge limits. MLS 100mm. Spatial closures for ETP species. Moratorium on additional effort since 2019.		Looking at developing SSB reference point. Resolving VPA approach or develop new reference points based on survey data.
Aequipecten opercularis	Shetland	Commercial LPUE (log sheets since 2000)	Trend based	Regional out to 6nm		None	SSMO fishing licence required. Night-time curfew (0600-2100) and gear specifications. MLS 50mm. Spatial closures for ETP species.		Mostly a bycatch fishery but varies year-to-year.

Species	Stock ID	Available input data	Assessment	Advice	Basis of advice	Reference points	Management measures	Environmental data	Issues/knowledge needs
Pecten maximus	Shetland	Catch-at-age data (Ages 3-10+, Final year 2022 (start year dependent on area)) Survey indices (Ages 3-9 (age 10+ often very noisy so exclude), Final year 2022) Indices are vessel specific due to differing catchability (observed in previous assessments), Trialling weighting of input data- use of number of survey tows/commercial samples Weight at age and maturity-at-age (all assumed mature)to calculate spawning biomass	SAM (previously TSA)	National		None	Licensed fishery. MLS 105 mm. Gear restrictions (no. dredges and bar length capped) depending on area fished. Requirement for REM. Some areas subject to seasonal closures.		Sampling levels are low for most assessment areas. Requirement for more regular assessment updates. Survey stations at risk due to spatial squeeze (closed areas for MPAs and renewables).
	Northeast		SAM (previously TSA)	National		None			
	East Coast		SAM (previously TSA)	National		None			
	Orkney		NA	NA		NA			
	Northwest		SAM (previously TSA)	National		None			
	West of Kintyre		SAM (previously TSA)	National		None			
	Clyde								
Aequipecten opercularis	Scotland	Landings. Survey data (king scallop survey). Sporadic market sampling.	NA	NA. No advice issued.	NA	NA	NA	NA	Relatively small fishery for Scotland.
Pecten maximus	Division 27.4.b, inshore along Yorkshire/Durham coast	Scientific dredge survey conducted annually by Cefas; swept-area estimates with substrate-specific gear efficiency parameters	Catch size distributions; harvestable biomass; below minimum size abundance (~ recruitment index). Spatial interpolation between survey sites within fixed assessment areas	None yet; UK Fisheries Managem ent Plan in developm ent	Spawner-per-recruit population model, based on sampling data from annual dredge surveys	MSY-proxy, harvest rate consistent with 35%VSpR	UK scallop fishing license; MLS of 100 mm shell length	None	Uncertainties about gear efficiency parameters for different substrate types and weather conditions
Pecten maximus	Division 27.7.d, north of 50ºN, UK waters	Scientific dredge survey conducted annually by Cefas; swept-area estimates with substrate-specific gear efficiency parameters	Catch size distributions; harvestable biomass; below minimum size	None yet; UK Fisheries Managem ent Plan in	Spawner-per-recruit population model, based on	MSY-proxy, harvest rate consistent with 35%VSpR	UK scallop fishing license with restrictions under UK Western Waters Effort Regime; MLS of 110 mm shell length; UK EEZ closed season July - September (in 2023, under review), under-10-m vessels exempt; French EEZ	None	Uncertainties about gear efficiency parameters for different substrate types and weather conditions

Species	Stock ID	Available input data	Assessment	Advice	Basis of advice	Reference points	Management measures	Environmental data	Issues/knowledge needs
			abundance (~ recruitment index). Spatial interpolation between survey sites within fixed assessment areas	developm ent	sampling data from annual dredge surveys		closed season 15 May - 30 September for all vessels fishing for scallops		
Pecten maximus	Division 27.7.e northern part	Scientific dredge survey conducted annually by Cefas; swept-area estimates with substrate-specific gear efficiency parameters	Catch size distributions; harvestable biomass; below minimum size abundance (~ recruitment index). Spatial interpolation between survey sites within fixed assessment areas	None yet; UK Fisheries Managem ent Plan in developm ent	Spawner-per-recruit population model, based on sampling data from annual dredge surveys	MSY-proxy, harvest rate consistent with 35%VSpR	UK scallop fishing license with restrictions under UK Western Waters Effort Regime; MLS of 100 mm shell length; Lyme Bay closed season July - September (in 2023, under review), under-12-m vessels exempt	None	Uncertainties about gear efficiency parameters for different substrate types and weather conditions
Pecten maximus	Division 27.7.e southern part Granville bay including the Bay of Saint-Brieuc	Surveys time-series (1974-2023, standardized since 1990); catches and effort time-series	Direct biomass estimation from survey indices; CMSY++	National		None	Scallop fishing license required. Length, power and number of dredges limits. Effort restrictions (fishing allowed from October to mid-May, 3 or 4 days per week, 1 to 6hours/day). Annual TAC in the Bay of Saint-Brieuc. High selectivity of gear (97mm inside diameter for dredge rings). MLS=105mm.	Backscatter data available (sections). Physical variables from ocean models	
Pecten maximus	Division 27.7.f, inshore along northern Cornwall coast	Scientific dredge survey conducted annually by Cefas; swept-area estimates with substrate-specific gear efficiency parameters	Catch size distributions; harvestable biomass; below minimum size abundance (~ recruitment index). Spatial interpolation between survey sites within fixed assessment areas	None yet; UK Fisheries Managem ent Plan in developm ent	Spawner-per-recruit population model, based on sampling data from annual dredge surveys	MSY-proxy, harvest rate consistent with 35%VSpR	UK scallop fishing license; MLS of 100 mm shell length	None	Uncertainties about gear efficiency parameters for different substrate types and weather conditions
Pecten maximus	Welsh waters	2012-2023 annual scientific dredge survey swept-area densities with no gear efficiency	Looking at methods that don't need catch	Will need to advise when FMP			110 mm MLS inside 12 nm, 100 mm outside. Closed season inside 12 nm. Dredge limits inside 12 nm.		Poor catch data - difficulties with VMS data to allow linking of landings to VMS. This needs to be

Species	Stock ID	Available input data	Assessment	Advice	Basis of advice	Reference points	Management measures	Environmental data	Issues/knowledge needs
		correction. Size, age, maturity data collected.	data due to difficulties/uncertainty with VMS/Landings	comes into effect					done due to the ICES rectangles crossing different management regimes (MLS, gear and season).
Placopecten magellanicus	United States east coast	Multiple annual fishery-independent surveys. Landings and observer data. Catch efficiency parameters. Growth rates and size-weight curves.	State-space length-based statistical model (CASA) combined with a forward projection model (Scallop Area Management Simulator (SAMS))	Rotational area quotas and number of fishing days at sea.	Fishing mortality rates.	Fmsy-proxy	Spatial management includes permanent closures, rotational management, and open bottom. Series of restrictions on dredge configurations. Ban of automatic shucking machines and crew size limit of seven people.	Depth and latitude used as predictors in size-weight equations.	Forward projection model scheduled to be replaced by a spatially explicit version.
Pecten novaezelandiae	New Zealand	Scientific dive and dredge survey data (various areas surveyed 1990-2021), and camera survey data in 2022; length-green weight and meat weight recovery from green weight data; dredge efficiency/selectivity parameters for NZ ring-bag and box dredges, derived from modelling of paired gear (dive-dredge) sampling data.	The most recent assessments were in 2021 (Northland SCA1, Coromandel SCACS, Southern SCA7) and 2022 (Coromandel SCACS). Biomass estimation from swept-area survey data corrected for dredge efficiency. An assessment model has not been developed.	National	Series of recruited (harvestable) biomass estimates for the areas surveyed, at a range of threshold densities. Series of prerecruit abundance estimates.	Targets: Fishing mortality at or below Fmsy as approximated by F0.1; Empirical target harvest (exploitation rate) Umsy = 0.07 for Marlborough Sounds (substock within SCA7). Limits: soft limit = 20% B0; hard limit = 10%B0.	The main NZ scallop fisheries (SCA1, SCACS, SCA7) are currently fully closed due to sustainability concerns about overall low abundance. Scallops are managed under the NZ Quota Management System. Multiple management measures include catch limits (TAC for each QMA, comprises a TACC and allowances for customary, recreational, and other sources of mortality); MLS of 90 mm or 100mm depending on area and fisher type (customary/recreational or commercial); spatial and temporal restrictions (no-dredging areas, fishing seasons); effort controls (gear type/size, fishing hours/days).	Various environmental data are available but have not been used in assessments to date.	Priority work in 2023-24 is: 1) to review and develop appropriate reference points for NZ scallops; 2) to investigate and evaluate the utility of fine-scale CPUE data; 3) to develop camera and AI-based survey methods. Reanalysis of historical survey data are also needed to better address temporal changes in the spatial extent and stratification of the areas surveyed and produce more robust time-series. Other issues include habitat degradation from the effects of fishing (dredging) and non-fishing factors (e.g. land-based sedimentation) on habitat suitability.
Pecten maximus	Jersey, Channel Islands	Dredge Survey data, initial dive survey data, Age data (1 yr), daily fishery landings and VMS data	2023 will be the third year of data collection for initial stock assessment	for Jersey Waters, produced 2024			MLS 102, Dredge ring size and construction regs, no shucking at sea	Various camera surveys	Need to determine if MLS move can improve fishery through additional spawning cycle. Need to develop an intelligent method for managing fishery by area with realistic harvest control limits
Aequipecten opercularis	NI waters in Via and VIIa	Survey time-series 2013-2024; Commercial CPUE	Trend based	National	ICES category 3; plan to	None	Fishing license required. MLS.	Backscatter and habitat maps; oceanology data	

Species	Stock ID	Available input data	Assessment	Advice	Basis of advice	Reference points	Management measures	Environmental data	Issues/knowledge needs
					trial RFB in 2025				
Aequipecten opercularis	Faroe Islands	Commercial CPUE (2001-2023). Poor-sampling data	Trend based	National	None	None	Scallop fishing license required. Seasonal closures		Estimates of catch rates need fine tuning. Ideally conduct a proper survey
Pecten maximus	Norway	Commercial data, diver-based survey data	None	None	None	None	Minimum landing size	Camera surveys, description of survey stations in situ by divers, backscatter data in some areas	Lack of data to complete assessment

2.1 Faroe Islands: Queen scallops (*Aequipecten opercularis)*

Identification of stock and management unit

The commercial fishery for queen scallops (*Aequipecten opercularis*) within the Faroe Islands territorial waters (ICES 5b) began in the early 1970's in the eastern area (E) relatively close to shore, about 1–15 nm from the coast on sandy, rocky or soft bottom habitats. The fishery expanded to the north coast (N) in the 1990s but pressure from the traditional longline fishing for gadoids resulted in the interruption of further exploitation of the resource in this area (Figure 2.1).

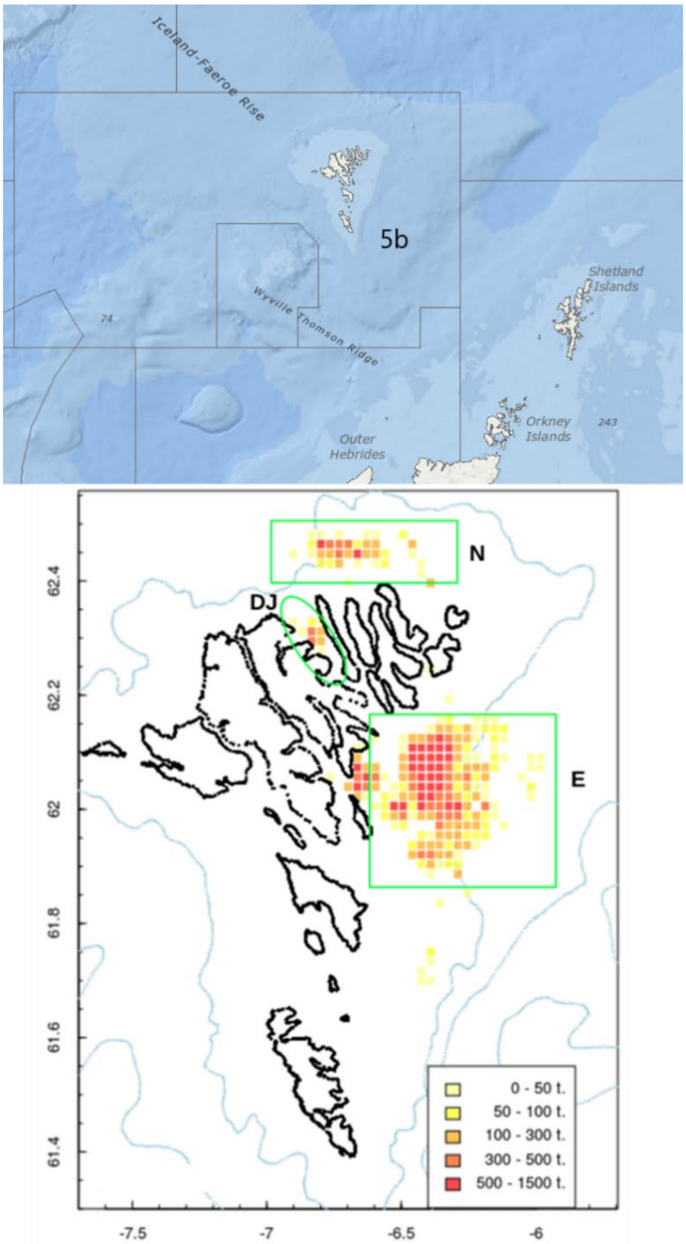

Figure 2.1 Location of the main scallop fishing grounds in the Faroes (ICES 5b). Eastern (E), North (N) and fjord areas (DJ).

The fishing grounds cover around 400 km² and 100 km² in the east and north respectively. In recent years the northern fishing ground has focused on a narrow fjord situated in the northwest (DJ) of the islands with limited success. The fishery operates at depths ranging from 60 m to

110 m in the east and 90 m to 110 m in the north whereas the northwest fjord is sightly deeper than the latter. All fishing operations are conducted within the 12 nm Exclusive Economic Zone (EEZ).

The fleet consists of a single domestic vessel that is around 30 m long and uses a double dredge typically around 3.7 m wide and 1 m height. The dredge was modified in 2014 by omitting the covernetting above the dredge and using chains instead. This facilitated the cleaning of the dredge after each haul and made the dredge slightly more efficient since the water stream through the dredge was blocked less by bottom material.

The fishery is regulated by fishing licenses with a seasonal closure from April to July and rotational management. The fishery is managed through a harvest control rule based on real-time catch. If a threshold (1.5 tons gross per fishing hour) is not exceeded the fishery will automatically move to other fishing areas while allowing for the recovery (typically two years) of over exploited grounds.

As a condition of the licenses issued by the Ministry of Fisheries, fishers are required to provide detailed records of landings and fishing effort. The fishery has Marine Stewardship Council (MSC) accreditation.

Distribution of fishing effort and landings

Landings and effort data are available from official statistical sources and logbooks respectively.

Since 2001 landings have fluctuated between 2300 and 7500 metric tons (Figure 2.2). Landings in 2023 were estimated at 5306 t. which is above the historical average (4536 t.). Landings were dominated by the fishery in the eastern grounds (>90% of the total).

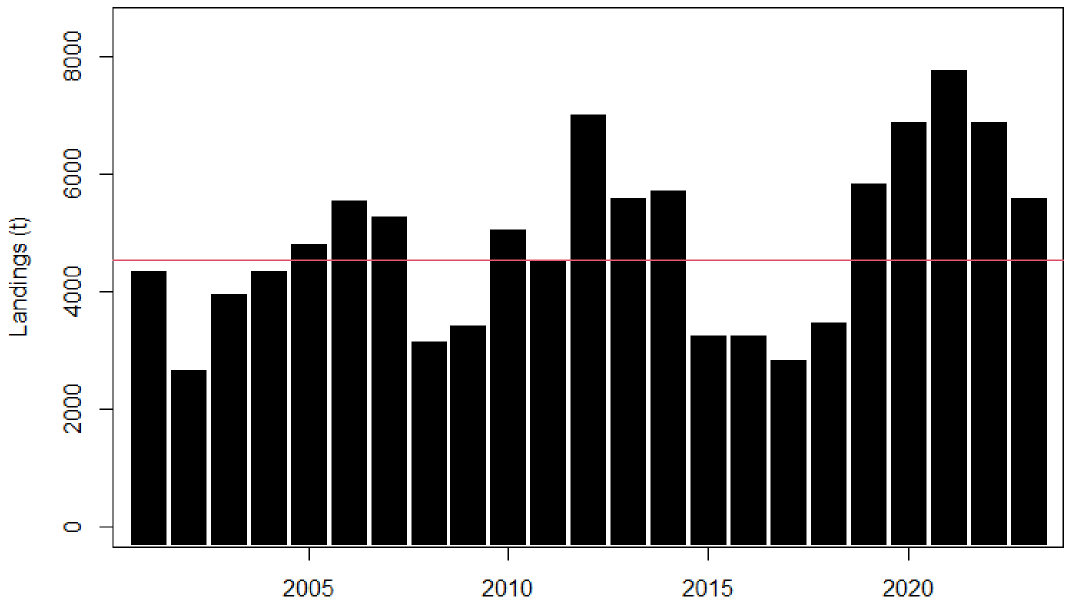

Figure 2.2 Landings (t) of queen scallops in the Faroes (2001–2023). Horizontal red line shows average landings.

Bycatch data are available since 2020 (Figure 2.3). Starfish dominated bycatches while other species such as whelks and horse mussels contribute to a lesser extent to total bycatch. The average bycatch of starfish and whelks is below 3% of the scallop catch.

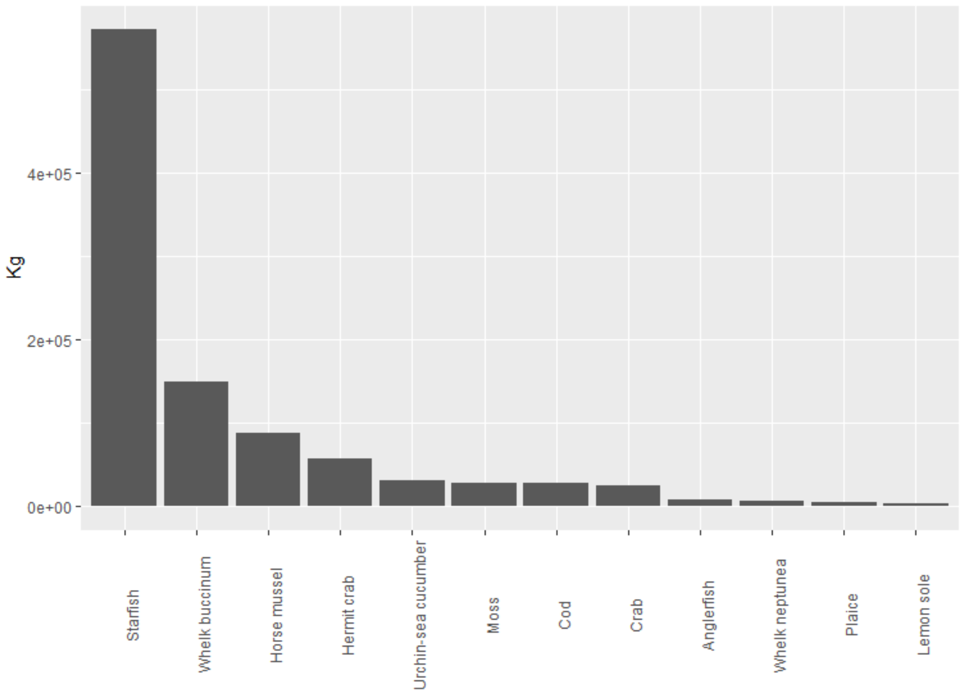

Figure 2.3 Bycatch (kg) in the queen scallop fishery (2020-2023).

Biological parameters

Biological data have been collected, although they are geographically and seasonally sparse in nature. Length, weight and age parameters are available for this stock but have not yet been fully analysed (Figure 2.4). Results suggest differences in the size composition and growth patterns of scallops between the N, DJ and E grounds. Average heights of one-year old scallop (recruits) in the DJ and N areas were estimated at around 50 mm and 40 mm respectively. No significant differences in size were found for older age groups between the two areas. Growth rate is size-dependent with younger individuals growing 10–20 mm per year. Larger scallops tend to grow slowly at rates of 0–5 mm per year. Maturity data (gonad staging) have also been collected. Currently 100% maturity is assumed at age two.

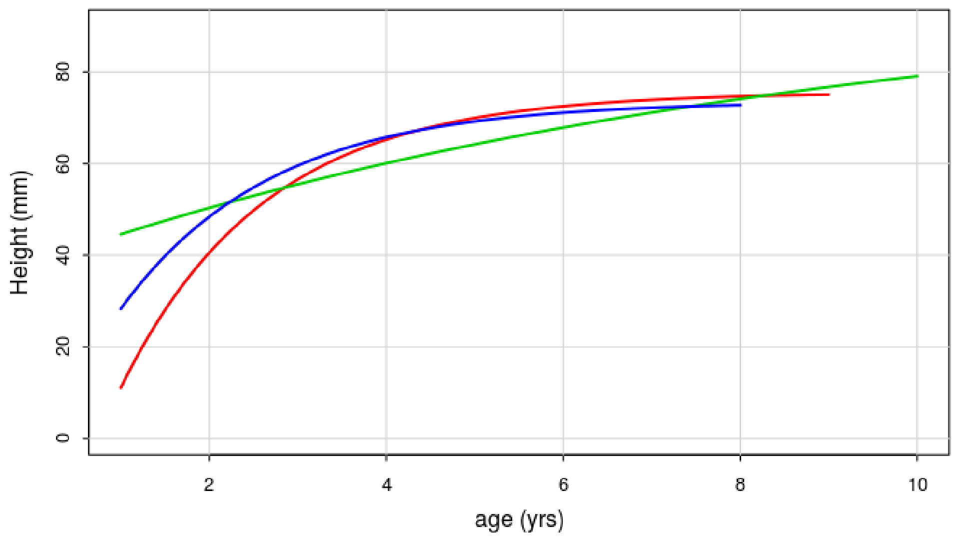

Figure 2.4 Relation between age (years) and height (mm) of queen scallops in three different locations.

Stock assessment

No analytical assessment of queen scallops is available. Surveys are not conducted in the main fishing areas and the only source of information is provided by the one vessel conducting the fishery. A swept-area survey was carried out in 1991 in the east and north coast. Similar surveys were conducted in the northern area as well as in the northwest ford in 2012 and 2013, respectively.

A catch rate index (kg per hour fishing) based on logbook data are available for the eastern fishing grounds (Figure 2.5). The index is standardized with both GLM and mixed-effects models. The compiled series mimic trends in total catches, but there are no indications of long term trends in the time-series. The index has been above average since 2018 while effort (measured in fishing hours) has declined, and it is below average since 2020. Recorded catches have dropped from a peak of 7475 t in 2021 to 5306 t in 2023. Total landings are well above the historical average (4232 t) since 2019.

In 2016 an experiment with underwater camera was performed in fished and relatively unfished grounds to assess the effect of dredging on the seabed. Unfortunately, the results of the experiment cannot be used quantitatively but rather as a visual indicator of effects of dredging in both historical and contemporary fishing grounds.

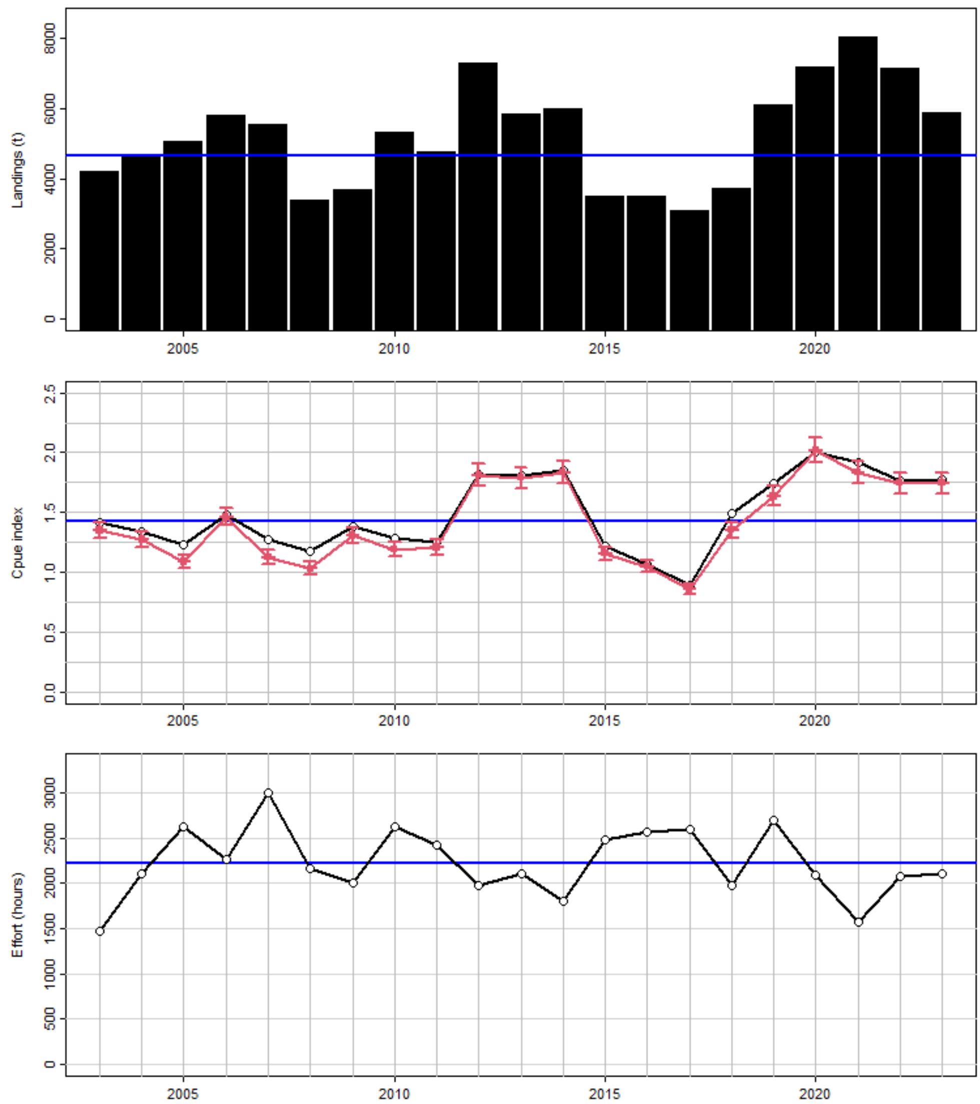

Figure 2.5 Landings (tons)(top), CPUE index (catch/hr) (middle), and effort (hours)(bottom) of queen scallops in the eastern fishing grounds.

2.2 Norway: Iceland scallop (*Chlamys islandica)*

A substantial fishery for Iceland scallops emerged in the Svalbard area in the late 1980s, but unsustainable fishing resulted in a stock collapse and a subsequent closure of the fishery in the early 1990s. After conducting surveys around Bear Island and on Spitsbergen bank in 2019 and 2020, it was concluded that the stock has recovered and a MSY of 15 000 tonnes round weight for three major scallop beds was advised based on a data-limited management strategy evaluation (MSE) (Sundet and Zimmermann 2020). In connection with the development of new suction-based gear technology that is supposed to reduce the affects on the seabed compared to traditional dredging (Sundet *et al.*, 2019), a trial fishery with currently one active vessel has harvested scallops in the Svalbard area from December 2022 to the beginning of 2024. The trial fishery has been approved initially for five years and is regulated through a total allowable catch (TAC), minimum landing size of 60 mm shell height, and comprehensive reporting requirements. The reported data are meant to support the monitoring of the fishery and establishment of a stock assessment and advice framework.

No fisheries-independent survey was conducted in 2023 or 2024. The scallop beds in the trial fishery area were last surveyed in 2019 and 2020 (Sundet and Zimmermann, 2020). In 2022, IMR surveyed two significant scallop beds north of Svalbard that are currently not open to fishing (Zimmermann *et al*., 2024). The survey was conducted with video transects and dredge stations outside the protected areas parallel with video transects to collect biological samples for size and age composition, and tissue samples for contaminant, nutrient and population genetic analysis.

A generalized additive mixed model (GAMM) including spatial-random field correlation was implemented in sdmTMB (Anderson *et al*., 2022) to estimate density and abundance (Zimmermann *et al*., 2023). The estimates covered both the areas around Bear Island and on Spitsbergen bank surveyed in 2019 and 2020, and the areas north of Svalbard surveyed in 2022. The analysis included model selection to evaluate potential environmental covariates, showing a clear link between scallop density and bottom depth, whereas the relationship with other environmental variables (mixed layer depth, current velocity, temperature, salinity) was not relevant. Furthermore, the role of uncertainty introduced by subjective human counting of scallops was explored by annotating scallops in all images in triplicate and including the variation into the stock estimates through resampling. Video and dredge observation aligned well between parallel stations and could be integrated into a joint estimate (Zimmermann *et al*., 2023), improving the resolution and historic comparability.

Historic data of comprehensive mapping surveys in 1986 and 1988, mostly conducted before the onset of commercial fishing, were included in an analysis in 2024 to estimate jointly the density and abundance during the historic and recent periods (Figure 2.6). The results revealed a good alignment between the two periods, indicating that density (in numbers) is comparable or higher on most scallop beds than in the pristine state during the 1980s (Figure 2.7). The analysis confirmed previous results that the stocks on both scallop beds have recovered, with higher estimated scallop abundance at the two scallop beds north of Svalbard than on the scallop beds currently open for trial fishing. However, the scallops on Moffen and Parryflaket tended to be smaller and therefore the proportion above minimum legal landing size was lower. For the updated stock estimates, scallop densities from video stations based on human counts were replaced by densities estimated by object detection models. The approach was implemented to increase the efficiency of both analysis of existing data and future surveys for a stock that is generally capacity- and resource-limited. The object detection approach is detailed in the following section.

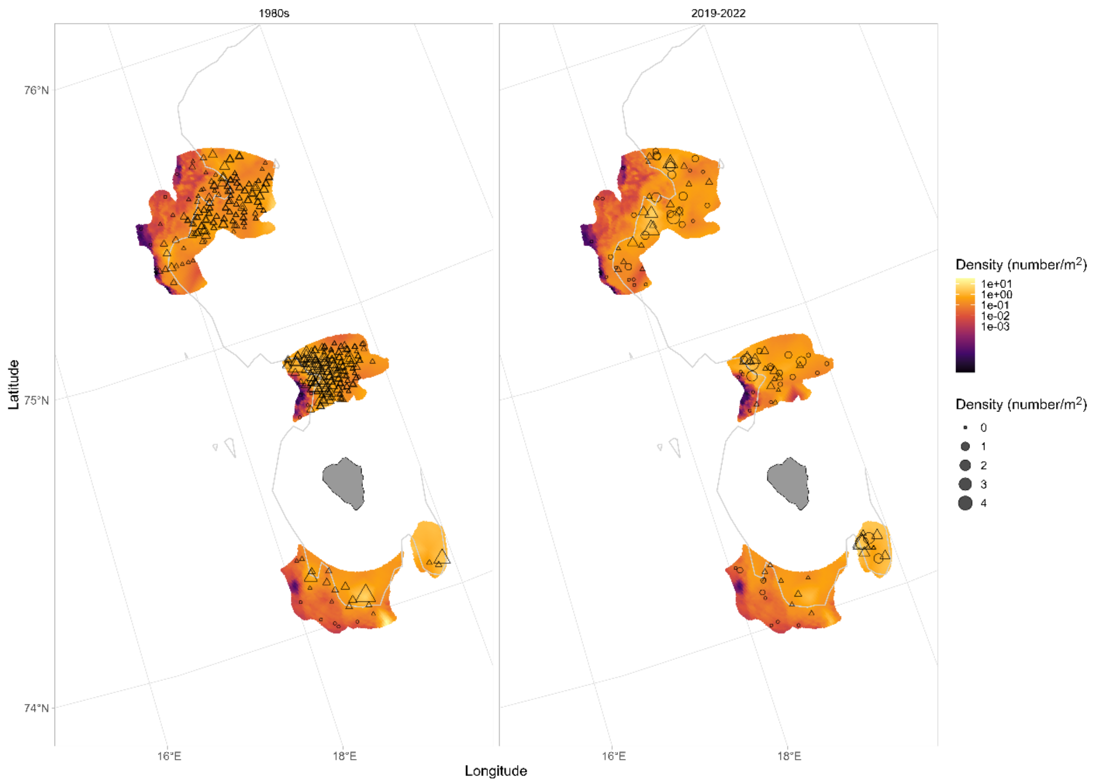

Figure 2.6 Density of scallop beds around Bear Island and on Spitsbergenbank. Shown are observed densities from video transects and dredge stations (circles and triangles, respectively, with size scaled to density) overlaid on predicted densities from a spatial GAMM including weighted video and dredge observations used to estimate density from historic (1986–1988) and current data (2019–2022) (color scale). Land masses are indicated in grey and 100 m depth contour with solid grey lines. Note that densities are on log10-scale.

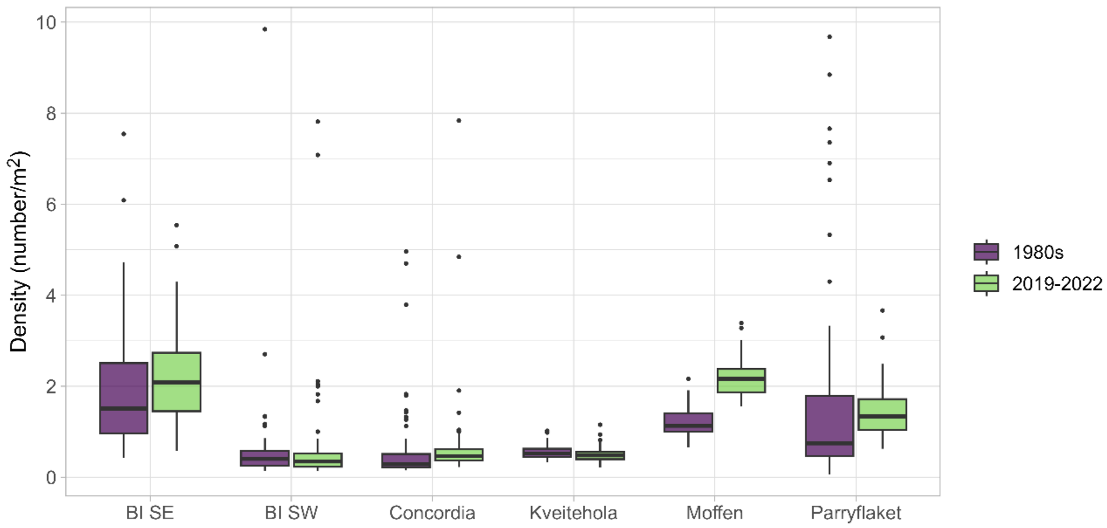

Figure 2.7 Estimated scallop density outside protected areas on six scallop beds in the Svalbard area: Bear Island southeast and southwest, Kveitehola north of Bear Island, Concordia on Spitsbergen bank, and Moffen and Parryflaket north of Svalbard. Shown are boxplots of estimated densities based on 1,000 iterations of the selected GAMM configurations using video and dredge data weighted with the number of images per station (dredge fixed). Each iteration represents a simulated density across the integration grid based on means and standard errors estimated with the spatial GAMM. Boxplots show median (solid lines), 25% and 75% percentiles (boxes), 1.5 interquartile range (whiskers), and outliers (dots).

Image analysis with object detection models

Object detection and tracking models using the Ultralytics Python package (Jocher, Qiu, & Chaurasia, 2023) were trained and applied to still images and unprocessed video transect data from the 2022 survey. The labelled dataset consisted of 3357 images, of which 1493 or 44% had scallop presence. The images were manually selected stills from 62 scallop stations, with the number of images per station ranging between 3–135. Each image was labelled by three human annotators. When comparing the quality of annotations, differences in the number of living scallops identified per image ranged from 0 to 70, with similar variation in the size of bounding boxes drawn. Considering the differing levels of expertise of the annotators, a final set of labels was obtained for use, but it is expected that errors in misidentification and misdrawn bounding boxes persist.

This dataset was randomly divided into train, test and validation datasets, consisting of 64%, 20% and 16% of the images. The training set was enhanced through duplicating the presence of the images with highest scallop densities, consisting of an additional 62 images. Automated augmentation techniques were applied within the model training.

All sizes of models within YOLO versions 7 through 10 and RT-DETR were trialled on the dataset using default hyper parameters. The three best performing models were YOLO versions 8m, 9c and 9e. These three models were tuned and applied in combination with two different tracking algorithms BoT-SORT and ByteTrack to a subset of the video data. All parameters within the user configuration files of both trackers were modified. When selecting the optimum combination, accuracy was prioritized above speed, with a YOLOv9c model first trained on scallop-presence only data followed by training on the full dataset, in combination with the BoT-SORT tracker providing the best results. The evaluation metrics from model training were as follows: F1: 0.64 at 0.382, mAP@0.5 0.649 (same as F1 as only 1 class), precision-confidence: 1 at 0.764, recall-confidence: 0.95 at 0.00. When aggregating model predictions to station-level, there was an average difference of 0.006 scallops per m^2 to the human counts (Figure 2.8). This suggests that despite the low quality of annotations, the model was consistent in its predictions, and image-wise discrepancies between annotators and model predictions even out when applied to entire stations. The next steps are to apply computer assisted labelling to re-draw bounding boxes tightly to each scallop and re-tune the selected model to increase training evaluation metrics. The analysis will be expanded to video data from surveys in 2019 and 2020.

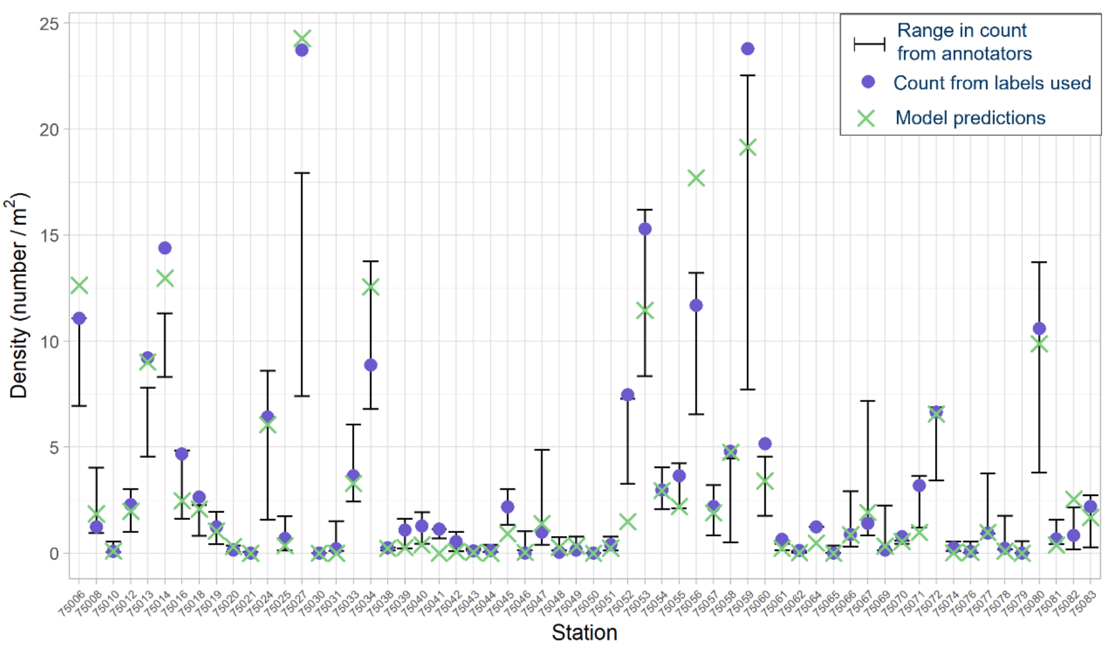

Figure 2.8 Comparison of scallop density per station during the 2022 survey within the Moffen and Parryflaket scallop beds situated north of Svalbard. Solid blank lines denote maximum and minimum scallop densities estimated by human counters, with the scallop densities calculated from the amalgamated labels and used in model training denoted by purple dots. YOLOv9c model predictions on still images represented by green crosses.

Stock assessment and advice

There is currently no analytical estimate of the stock due to limited data, specifically because of the short time-series (<2 years) of commercial catches and irregular surveys. Advice on reference points and a TAC for the area around Bear Island and Spitsbergen bank was provided in 2020 using a data-limited MSE approach (Sundet and Zimmermann, 2020). The MSE framework used survey estimates of abundance, growth and age structure in combination with empirical data on natural mortality to parameterize an age-structured population dynamics model with stochastic natural mortality and recruitment. The results proposed a precautionary target fishing mortality of 0.19 that corresponded to a long term TAC of 15 000 tonnes for the trial fishery area.

A revised data-limited MSE that includes all surveyed scallop beds and accounts for the estimation uncertainty is planned for 2025. The goal is to develop the data-limited MSE framework from 2020 further by i) linking it better to FLR formats and functions, ii) including area-based dynamics and management strategies, iii) introducing observation uncertainty and an implementation model that may account for imperfect management, and iv) ideally expanding to a full-loop framework that includes a stock assessment. The latter will also serve as testing ground for suitable assessment models that can be implemented if after five years the trial fishery is converted into a regular fishery.

2.3 Scottish king scallop stock assessments

Scottish scallop stock assessments have recently been updated. Analytical assessments utilizing catch and survey data to 2022 are available for five assessment areas: East Coast, Northeast, Northwest, Shetland and West of Kintyre. The assessments use SAM which is an age-structured state-space stock assessment model (Nielsen and Berg, 2014) and provides estimates of recruitment (at age three), stock biomass and fishing mortality over time. Provisional precautionary reference points have also been defined based on the outputs of the stock assessments: $F_{0.1}$ derived from yield-per-recruit analysis, and B_{pa} derived from the lowest stock biomass and the application of a precautionary multiplier.

Assessment model configurations are broadly similar across stocks and typically include:

- Fishing mortality coupled at older ages (either 8 to 10+ or 9 to 10+)
- Survey catchabilities coupled at older ages
- Observation variance parameters are uncoupled at younger/older ages to allow additional uncertainty in these data
- To account for the variation in catch sampling levels over time, data are weighted by sampling intensity

In most cases, model predictions of catch and survey numbers-at-age track the observations relatively well across ages (the exceptions being those ages which are estimated to have greater observation uncertainty). In addition, there are no major patterns or trends in one step ahead or process residuals. All assessments show some degree of retrospective revisions. This is most apparent in the assessments for Shetland and the Northwest which have Mohn's rho values for both spawning-stock biomass (SSB) and fishing mortality out-with the ICES guidelines of -15% to 20% (ICES, 2020). In both cases the SSB is revised downwards and F revised upwards with the inclusion of additional years of data.

For most stocks, the assessments show a general reduction in recruitment and stock biomass in recent years (and with the exception of Northwest are still above B_{pa}). However, catches have reduced substantially in recent years and therefore despite most areas seeing a reduction in stock size, the fishing mortality has also fallen (and is below $F_{0.1}$, or only just above, for all stocks). The exception to this is Shetland where there appears to be increasing recruitment (resulting in increasing biomass) which is supporting an increase in landings.

The assessments will be made publicly available on the stockassessment.org website on publication of the final assessment report.

2.4 Development and progress of SS3 stock assessment for Isle of Man king scallop

During 2024, work has been progressed by Bangor University (Isobel Bloor –Isle of Man and Natalie Hold – Wales) in collaboration with Massimiliano Cardinale (Swedish University of Agricultural Sciences) to develop a stock assessment for Isle of Man and Welsh king scallop stocks using Stock Synthesis (SS3) (Methot *et al.*, 2013). A series of working models for Isle of Man king scallops using SS3 were presented to the WG. All three models presented (which different mainly in the recruitment deviation or selectivity assumptions) successfully converged and performed similarly based on model diagnostics. The main difference in the outputs was how the current stock trend compared to the historic "virgin" stock biomass (Figure 2.9). For model one (Logistic selection) the current stock biomass levels were similar to historic "virgin" biomass. For Model 2 (Reference) the current stock estimates were higher that historic "virgin" biomass levels. Finally, for Model 3 (Recruitment Deviation 1) the current biomass was significantly lower than the historic "virgin" biomass. Additional work will be undertaken in 2025 to verify historic landings, explore the affects of selectivity and recruitment deviation on the model outputs and to explore an area-based model for the Isle of Man king scallop fishery.

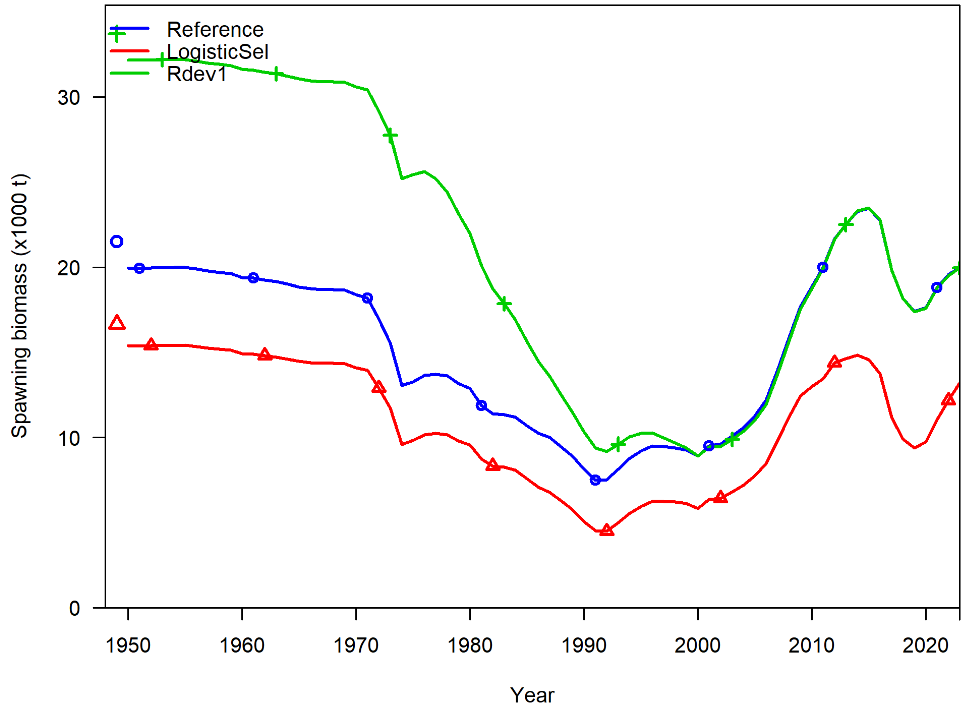

Figure 2.9 Comparison of SSB trends among the three models initially run for Isle of Man king scallop stock which mainly different in either selectivity or recruitment deviation patterns.

2.5 Development and progress of SS3 stock assessment for Welsh king scallop

Development of a stock assessment for the Cardigan Bay fishery in Welsh waters has been started. Input data includes:

- Annual Catch 2000–2022 from ICES data call
- Length from annual survey
- Age Length Key from annual survey
- Abundance Index from annual survey

Initial key model specification:

- Split into two areas – open and closed
- Von Bertalanffy growth parameters fixed from data
- Weight at length parameters fixed from data
- 50% maturity fixed from data
- Natural mortality fixed at 0.2
- Beverton and Holt stock recruitment curve

Initial results show poor model fit, primarily a conflict between length frequency data and the age length key. Future work within SS3 is planned and listed in Table 3.

Table 3 Issues identified and potential solutions from initial runs utilizing SS3 stock assessment on Cardigan Bay king scallop fishery.

Data type/ Parameter	Issues	Possible Solutions / discussion
Commercial length data are not currently collected so using commercial dredges from annual survey as a proxy	Single time point in year and this time point varies among years	Variable single time point of survey and therefore commercial length data means that a seasonal model will be needed. This is possible in SS3, but it then also requires the catch data to be quarterly. Current ICES data call is annual and national statistics available at finer resolution are missing some international catch. Wales are starting a commercial length data collection scheme for future. How does model work with seasonal growth patterns – is that an option in SS3?
Age Length Key (ALK) is developed from age data collected on annual survey	ALK from annual survey is not from the same time point each year. This appears to have caused a conflict between the length frequency data and the ALK.	Seasonal model may help – same issue with catch data Could we use decimal ages in the ALK?
Model estimated selectivity curves	Dome shaped vs. senescence	Dive survey Port Erin MNR (IoM)?
Historical catches	Spatial splitting of the data	Area proportion allocation
Historical underreporting	Introduction of UK/IoM Buyers and sellers legislation	Fisher logbooks spanning this period to help scaling of underreporting
Historical catches	Seasonal model – how do you split catches seasonally, especially with introduction of closed seasons	When did close season start?
Growth model	Variable growth morphs – would need area-based model.	Data resolution, survey, catch etc.
Survey index	Standardization of survey indices (standardize the standardization).	Intersession workshop
Commercial CPUE	Standardization?	Intersession workshop
Stock recruitment	Currently no relationship	Clustering, connectivity, environmental

3 ToR C: Review and report on current scallop surveys and share expertise, knowledge and technical advances.

A database of all members annual scientific scallop survey dates, scope and opportunity for volunteers to join has continued to be kept. This resulted in two exchanges where ICES WGScallop members experienced and joined the scallop survey from another location. The consensus was that these opportunities should continue to be offered and taken up as they have proven very beneficial, as demonstrated by the feedback below.

"As part of the WGSCALLOP initiative to encourage exchange places on research surveys, a Cefas scientist joined the French RV Côtes de la Manche for COMOR2024 (Bay of Seine assessment survey, leg 2). Working on a shift basis, experience was gained within the dry lab capturing data and largely on deck processing hauls. The opportunity to work with colleagues from another organization provided an opportunity to strengthen relationships, exchange knowledge, build species knowledge and practical skills such as otolith removal of flatfish, discuss and compare survey methods and the practical approaches taken. Overall, a very valuable and enjoyable experience – thank you for IFRAMER for hosting!"

"Participating in the Marine Scotland scallop survey, even for just one day, was beneficial as it provided a unique opportunity to observe their methodologies and compare them with our own. The experience offered insights into key operational similarities and differences, allowing us to assess potential improvements or efficiencies for our own practices. We gained first-hand knowledge of Marine Scotland's sampling protocols, data recording methods, and equipment setup. Observing these elements in action also highlighted potential areas for cross-collaboration in future surveys, where aligning certain practices could yield more consistent and comparative data across the Shetland scallop surveys."

Due to time constraints, it was not possible to arrange an intersessional meeting on survey design this year, however there was a consensus that this would be well attended if offered in 2025.

3.1 Norway update. King scallop (*Peten maximus)*: Fishery, monitoring and new harvest technology

A commercial diver-fishery for king scallop *Pecten maximus* was developed in Norway during the early 1990s with the main fishing area at Frøya/Hitra in Trøndelag County (ICES assessment area IIa). Since 2013, a new fishing area was established at Helgeland (Nordland County), north of Trøndelag. In the period 1999 to 2023 the total landings ranged between 400–900 tonnes (Figure 3.1) and while the landings in Trøndelag County have fluctuated since 1999, with a maximum of 892 tonnes in 2008 to a minimum of 136 tonnes in 2021, landings in Nordland County have varied between 85–235 tonnes per year since 2013. In 2023 the total landings were 359 tonnes (value 1.2 million Euro), where 198 tonnes were landed in Trøndelag County and 161 tonnes landed in Nordland County. The low and decreasing harvest rates since 2009 suggests that the scallop stocks in Trøndelag County are underexploited and that there is a potential of increasing the commercial fishing activity without depleting the stocks.

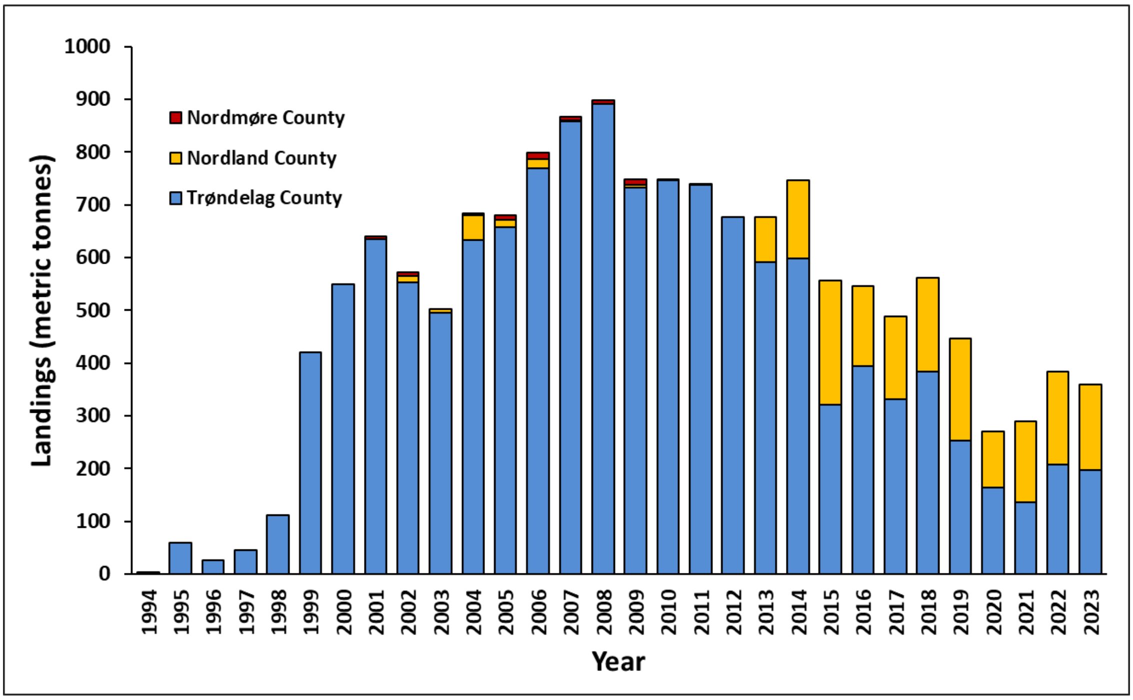

Figure 3.1 Landings of king scallop (*Pecten maximus*) in Norway by commercial scallop divers in the period 1994-2023. Data from the Norwegian Fishermen's Sales Organization.

The decrease in landings in Trøndelag County is assumed to be a result of the economic depression (2009), implementation of new diver regulations (2015) and lately the Covid-19 pandemic (2020–2021). In Helgeland, the fishery has developed over the last decade and is assumed to be a result of increased scallop stocks mainly due to increased seawater temperature since the late 1990s. The decrease in prolonged periods with water temperatures close to lethal temperature (<4 ^{o}C), seems to correspond to the expansion of scallop populations in the area (Johnsen and Grefsrud, submitted). The landing data from Nordmøre (mainly at Smøla Island, Møre and Romsdal County) in 2001–2009 were underestimated due to a lack of a processing facility close to the harvesting area. The scallops harvested in the area were transported and delivered in Trøndelag County. According to the main actor in the area, Seashell AS, about 10–30 tonnes of king scallop were harvested yearly in the period 2007–2014. Lately there has been a renewed interest of harvesting scallops around the Smøla Island, this time using a remotely operated vehicle.

Based on information of a renewed interest, the Institute of Marine Research (IMR) decided to conduct their annual diver-based king scallop monitoring at Smøla, Møre and Romsdal County, in 2024. As a part of the "National marine habitat mapping program" (2007–2019), targeting high abundance areas, king scallop were mapped in Norwegian coastal areas using a vessel-towed camera platform collecting real-time video along survey lines. In 2017 a total of nine video stations were surveyed at the south and southwestern part of Smøla Island (Figure 3.2). Video analysis showed that the scallops had a highly patchy distribution and that scallop abundances in general were moderate compared to the main fishing area at Frøya/Hitra. In June 2024, eleven stations were first examined using an underwater drone (Blue Eye) (Figure 3.2). At eight of the stations, scallops were present and were further surveyed by scientific divers collecting live scallops for measuring size and determine age and yearly growth (sampling dives).

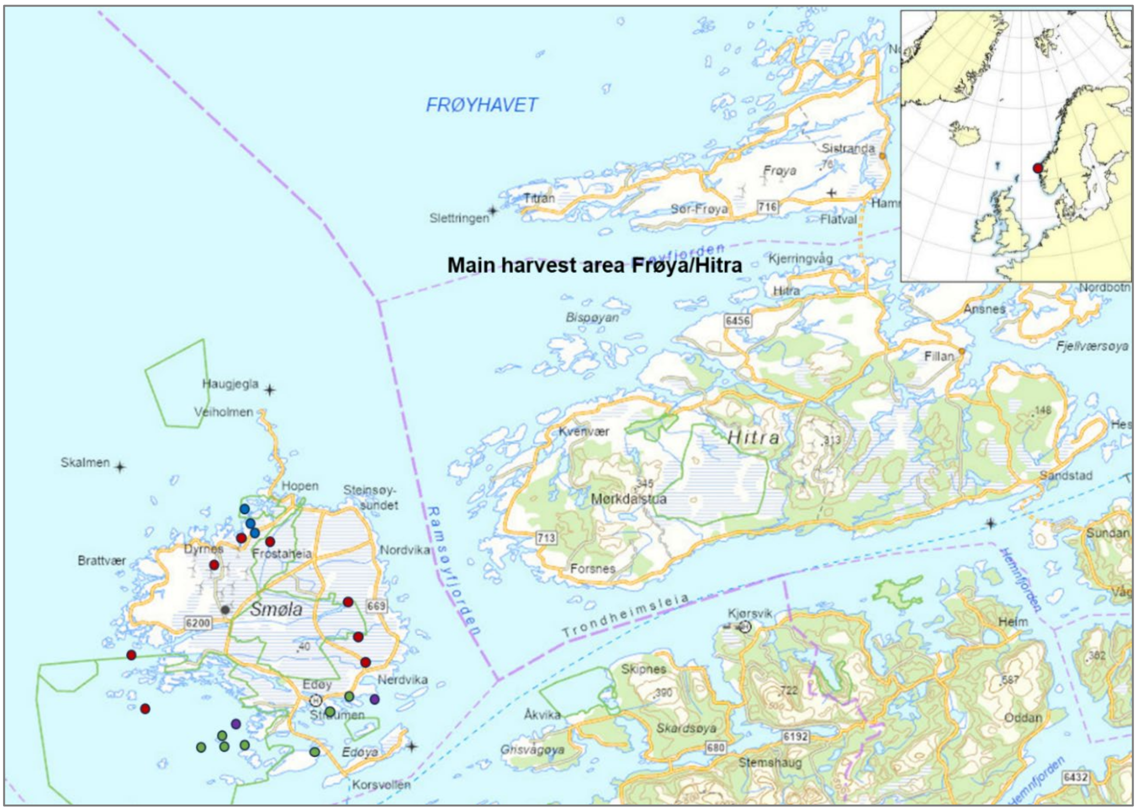

Figure 3.2 Summary of results from the king scallop (*Pecten maximus*) video survey in 2017 (green and purple dots) and the monitoring survey in 2024 (red and blue dots) around Smøla Island (63°N, Møre and Romsdal County), close to the main harvest area Frøya/Hitra in Trøndelag County. Green and red dots show stations with king scallop present and blue and purple dots represent stations where no scallops were observed. The red dot in the upper right corner map shows the placement of Smøla Island in Mid Norway.

Divers also conducted underwater transects at all eight stations. A 25-meter-long rope was placed on the seabed and the diver held a 1.5-meter-long pole in front while swimming slowly along the rope, sliding the pole from one side to another. The number of scallops within the 3x25 meter wide transect were counted, the habitat was described, and flora and fauna were recorded. On average, divers collected 42 scallops per sampling dive and observed 32 scallops per transect dive (total of 40 transects). Scallop densities at Smøla were comparable with results from the 2022-survey at Frøya/Hitra (0.09 vs.0.1 respectively). Also, scallop age distribution was quite similar between the two areas, with all year classes (age 2–8) being represented (Figure 3.3). Likewise, yearly scallop growth showed the same pattern in both areas (Figure 3.4).

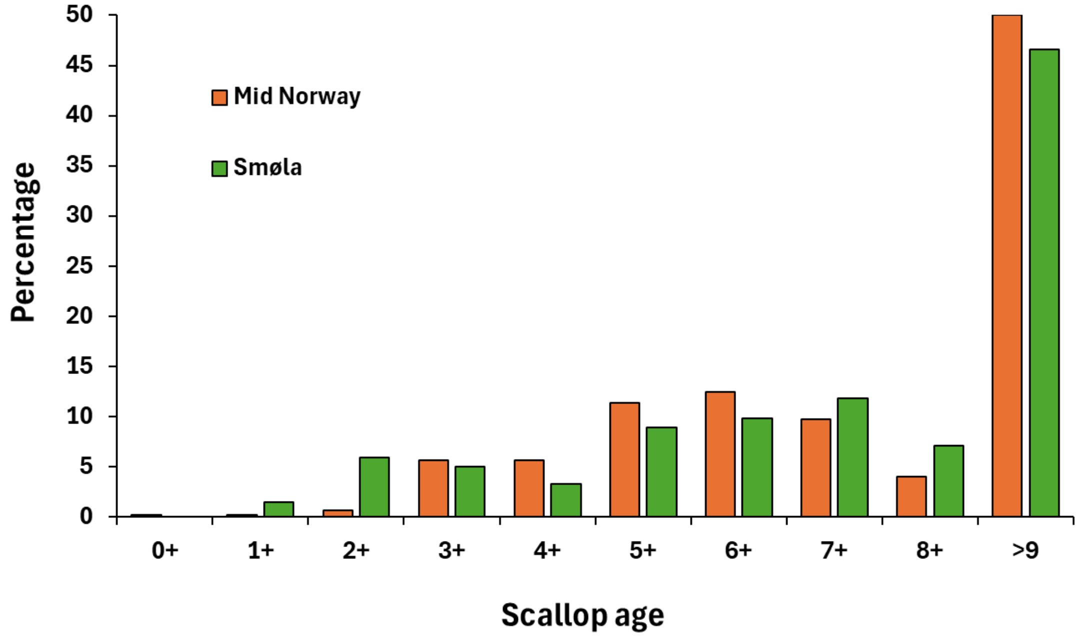

Figure 3.3 King scallop *Pecten maximus* age distribution at Smøla (Møre and Romsdal County) and Mid Norway, (Trøndelag County) (ICES assessment area 2a) in percentages.

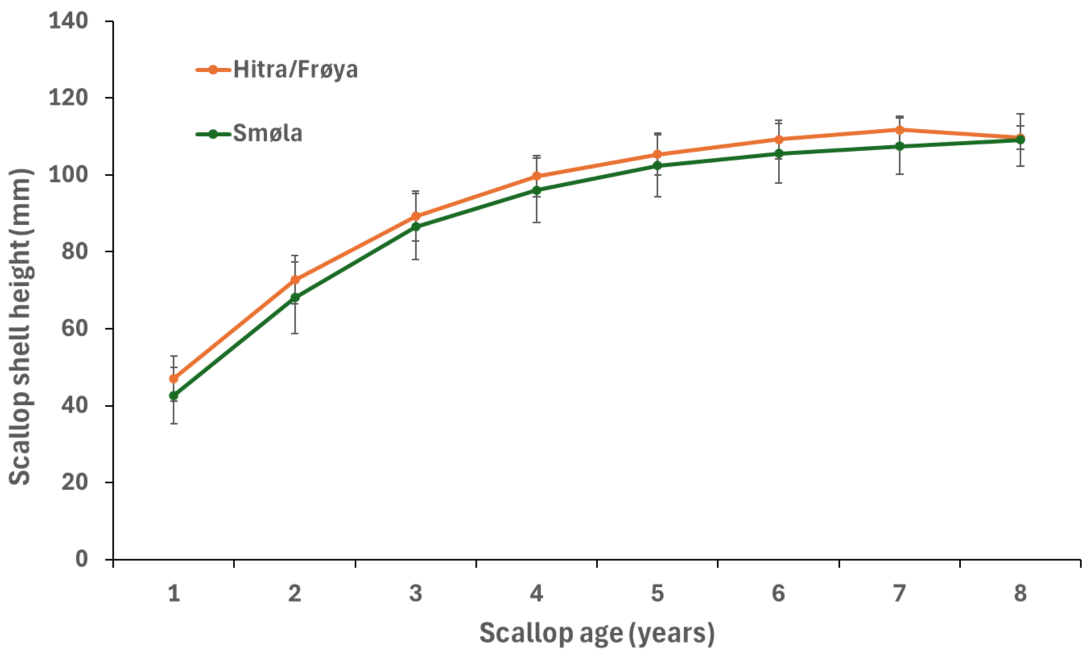

Figure 3.4 King scallop *Pecten maximus* shell height at age one to seven years at Hitra/Frøya in Trøndelag County (main fishing area) and Smøla Island in Møre and Romsdal County.

Since the Norwegian scallop fishery developed, the possibility of overexploitation of the harvestable stock has been an issue of concern. The fishery was initially unregulated, although the sale of scallops was regulated through licensed distributors. The increase in diver participation in the commercial scallop fishery between 1998–2000 encouraged the Norwegian Labour Inspection Authority to set new certification requirements for commercial scallop divers. This restricted the recruitment of diver-fishers and contributed to regulating the fishing effort. Based on input from a reference group representing industry, management authorities and research, a minimum landing size of 100 mm shell length was implemented in 2009 for both commercial and recreational fishery. Suggested management measures on the introduction of closed areas were rejected based on cost–benefit considerations of enforcement and an appraisal of the existing rotational fishery between areas pursued by the main harvesters. The anecdotal experience was that the harvestable stock was restored after two to four years. It is unclear to what extent restoration of the stock is caused by growth into legal size and/or migration of scallops from deeper beds, the latter considered dominant by the fishers. Today, the diver-based scallop fishery is considered sustainable.

Due to several fatalities, scallop diver regulations have become stricter and have hampered the development of the fishery in Trøndelag County. Since 2022, the technology company C Robotics and the main scallop harvesting actor, Seashell AS, have collaborated to develop a new and sustainable harvesting method using a tracked remotely operated vehicle (ROV) named C Bud. The C Bud harvests the scallops by suction and according to their home page, filtrates the bycatch and returns it instantly and unharmed. The harvested scallop is sent directly to the vessel for storage. The ROV is operated from the boat and the operation can follow the harvest operation via a video feed on a screen in the operating room. The C Bud can harvest in areas below diver depth but is less adapted to harvest in shallow areas with more diverse bottom substrata and many obstructions such as rocks and vegetation. This may result in an increased fishing pressure on scallop stocks below 15–20 meters depth, while fishing pressure on scallop stocks located in shallow areas or areas with complex bottom structure may decrease. How this affects the recruitment, growth pattern and distribution of the scallop populations in the area is unknown.

Sætervågen AS, partly owned by Seashell AS, has applied to the Norwegian Directorate of Fisheries for a king scallop trial fishery license using the C Bud to harvest scallops from Smøla (63°N) to Træna (66°N). As a part of this process, the research institutes Møreforskning and IMR have established a collaboration with C Robotics and Sætervågen AS and applied for funding to look more into the potential effects on king scallop populations around Smøla Island using the C Bud for large-scale scallop harvesting. Also, Møreforskning and IMR will evaluate the potential of using the C Bud for mapping and monitoring purposes, supplying todays diver-based monitoring with valuable information from areas not accessible to divers.

3.2 United States update. Sea scallop (*Placopecten magellanicus*)

A drop camera survey of sea scallops on Georges Bank and in the Gulf of Maine, in the Western Atlantic, was conducted by the University of Massachusetts Dartmouth, School for Marine Science and Technology (SMAST) as planned in 2024. This is one of a suite of surveys of US sea scallops that feeds into a length-based stock assessment model with forward projection capabilities run by the National Oceanographic and Atmospheric Administration (NOAA). The SMAST Georges Bank survey was completed in six separate week-long trips using six different commercial scallop vessels (Figure 3.5). The Gulf of Maine survey was conducted in two trips using two vessels. Survey stations followed a systematic grid design with stations 0.5, 0.85, 1.5 and 3 nautical miles apart in different management zones. The choice of these grid sizes in each area was driven by funding decisions and local priorities guided by an external panel of scientists. At each station the camera system was dropped to the seabed four times to take four photographs. The vessel drifted with the tide when conducting the quadrats and therefore the distance between each drop was typically 50 m. The photographs were digitized on land by staff and then quality checked by experienced researchers before being stored in a local database. This process obtained counts of sea scallops and approximately 50 other species and species groups, as well as identifying the seabed substratum.

This year the survey observed strong recruitment in the southern parts of Georges Bank (Figure 3.6). As a result, scallop abundance and biomass both increased since 2023. However, exploitable biomass decreased from 2023, and this is a cause for concern for the commercial industry in 2025. There is much hope that the strong recruitment on Georges Bank observed in 2024 will become fruitful in future years. The Gulf of Maine represents a much smaller biomass than Georges Bank. The scallop densities and spatial patterns were similar to the 2023 survey for this area, and some recruitment was detected throughout the banks. These estimates were largely consistent with the data from the other surveys.

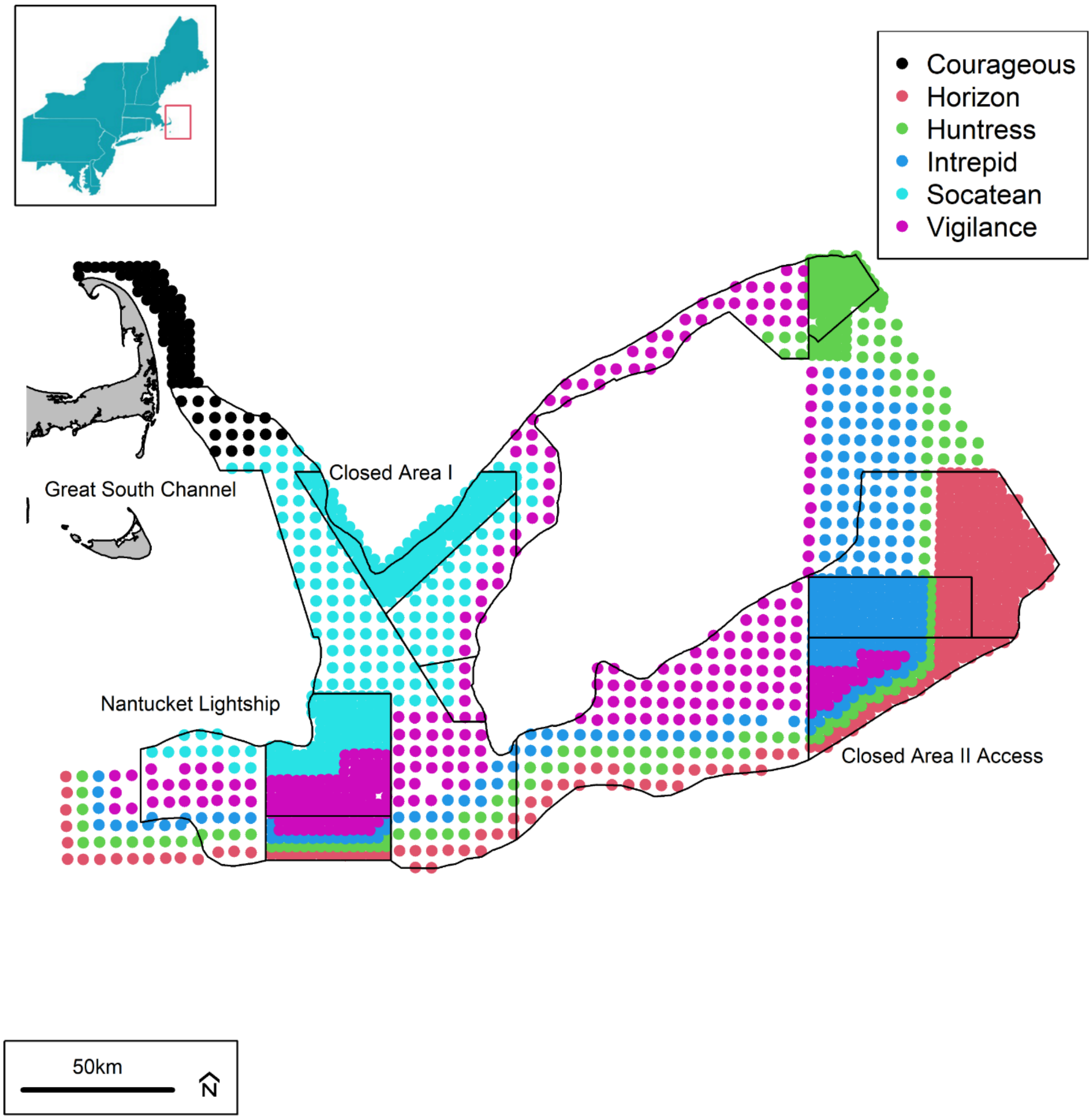

Figure 3.5 School for Marine Science and Technology Drop Camera Survey station locations by sampling vessel on Georges Bank in 2024. Stations were attempted to be 5.6, 2.8, 1.6, or 1 km apart depending on management requirements in specific areas. The land depicted in grey is the southeast coast of Massachusetts, USA.

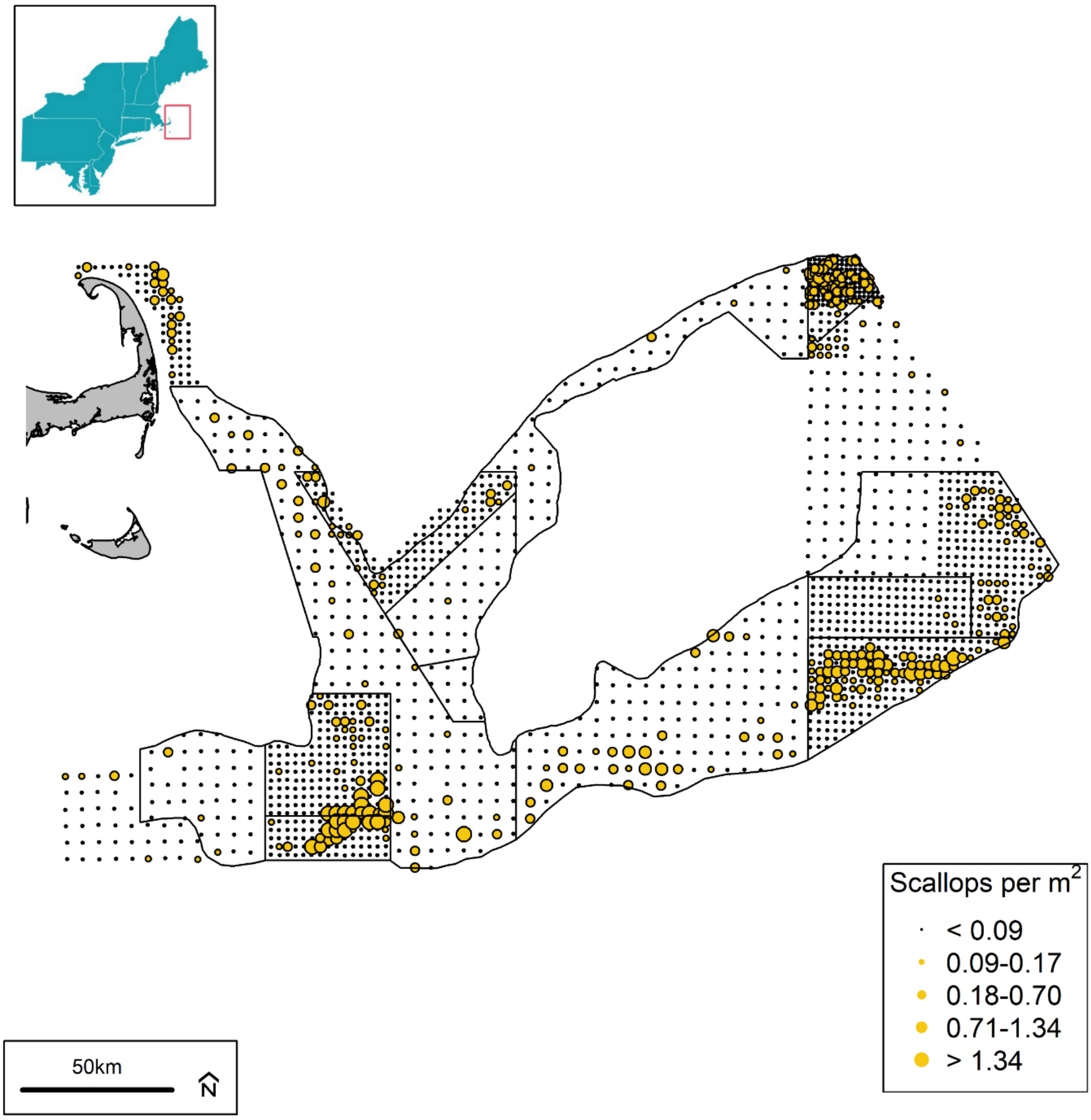

Figure 3.6 Mean prerecruit scallop density (scallops less than 35 mm shell height per m²) at each station from the 2024 School for Marine Science and Technology Drop Camera Survey on Georges Bank.

3.3 Ireland update: Celtic Sea King scallop survey (*Pecten maximus*)

Scallop grounds in the Celtic Sea have been sporadically surveyed, with the latest surveys carried in 2005 and 2019. In 2024, the survey area was re-defined based on analysis of the most recent VMS data from the commercial Irish scallop boats, which showed activity further south than the area covered during the survey in 2019. This report summarizes the outputs from the 2024 survey.

Scallop densities have been previously found to be up to five times higher on coarse sediments compared to sandy grounds. Survey effort during 2024 was therefore designed following a stratified random sampling protocol based on the backscatter data from multibeam acoustic surveys classified over a grid of 1,500 x 1,500 meters (Figure 3.7, Figure 3.8), with 90% of survey effort assigned to coarse sediment survey cells and 10% to sandy cells. The survey was carried onboard a commercial scallop boat, carrying eleven dredges a side, nine king scallop 30-inch-wide Newhaven spring-loaded dredges and two queenie dredges. A total of 64 tows were carried in the southern (offshore) area and 50 tows in the northern (Inshore) area. Scallop weight and by-catch was recorded, and individuals measured. GPS data for each tow was recorded on a Trimble GPS survey unit, and effort per tow calculated based on track length and dredge width. Biomass at each station was estimated as the product of density (number of individuals caught per meter squared towed area) and mean individual weight calculated from the size distribution of scallops at the station and a weight-length relationship. Biomass was then interpolated over a 100 m x 100 m grid for the surveyed areas, and total biomass across the areas estimated using two geo-statistical methods, universal kriging and sdmTMB. Both methodologies account for the spatial structure of observed biomass and how density changes relative to the distance between stations, and the relationship with given covariates (e.g. classified backscatter layers). Areas classified as rocks in the seabed layer or where backscatter data were not available were excluded from interpolations. A set of samples from each area was also brought back ashore for biological data collection.

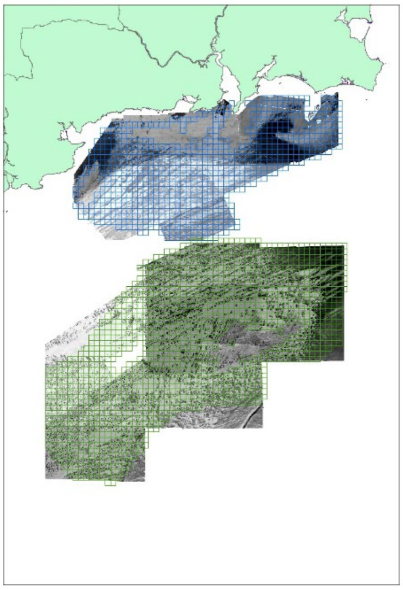

Figure 3.7 Survey area in the northeast Celtic Sea off the south coast of Ireland.

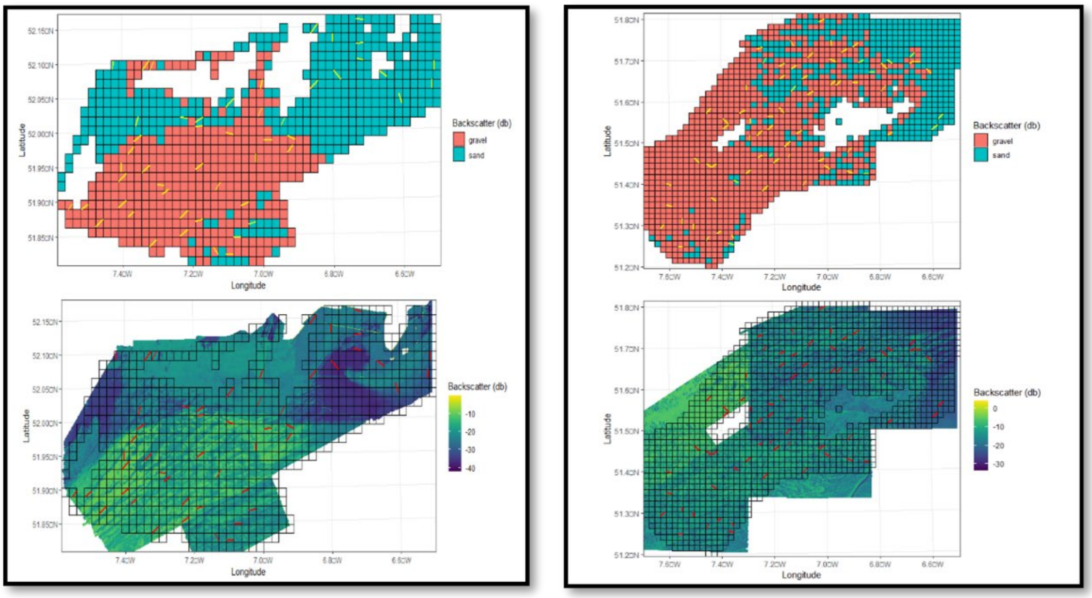

Figure 3.8 Raw backscatter data (bottom) and classified sediment type (top) for the Inshore (left) and offshore (right) areas of the Celtic Sea.

Total estimates biomass of scallops without considering the effects of dredge efficiency and selectivity was 1065.5 and 456.2 tonnes for the offshore and inshore areas respectively (Table 4). The biomass of commercial size scallops (above 100 mm shell width) would comprise 76% in the offshore area and 42% in the inshore area. Ground type (coarse sediment vs. sand) was found to be an influential factor when modelling scallop densities, with higher densities of scallops found in coarser ground as previously reported in the surveys carried 2005 and 2019. In the inshore area, higher densities of scallops were found towards the northern limit of the study region, closer to the coastline (Figure 3.9 a). In the offshore region, scallop densities were higher at the mid-south end of the survey area and would suggest that scallops could be found further south than the study area although VMS data does not show significant activity (Figure 3.9 b).

Table 4 Estimates of scallop biomass (uncorrected for dredge efficiency) in the 2024 Celtic Sea survey area.

	Offshore			Inshore		
	Mean	95% low	95% up	Mean	95% low	95% up
Total Biomass (T)	1,065.5	957.2	1,186.1	456.2	358.6	580.4
Biomass > MLS (T)	810.1	675.4	971.8	195.6	146.5	262.1

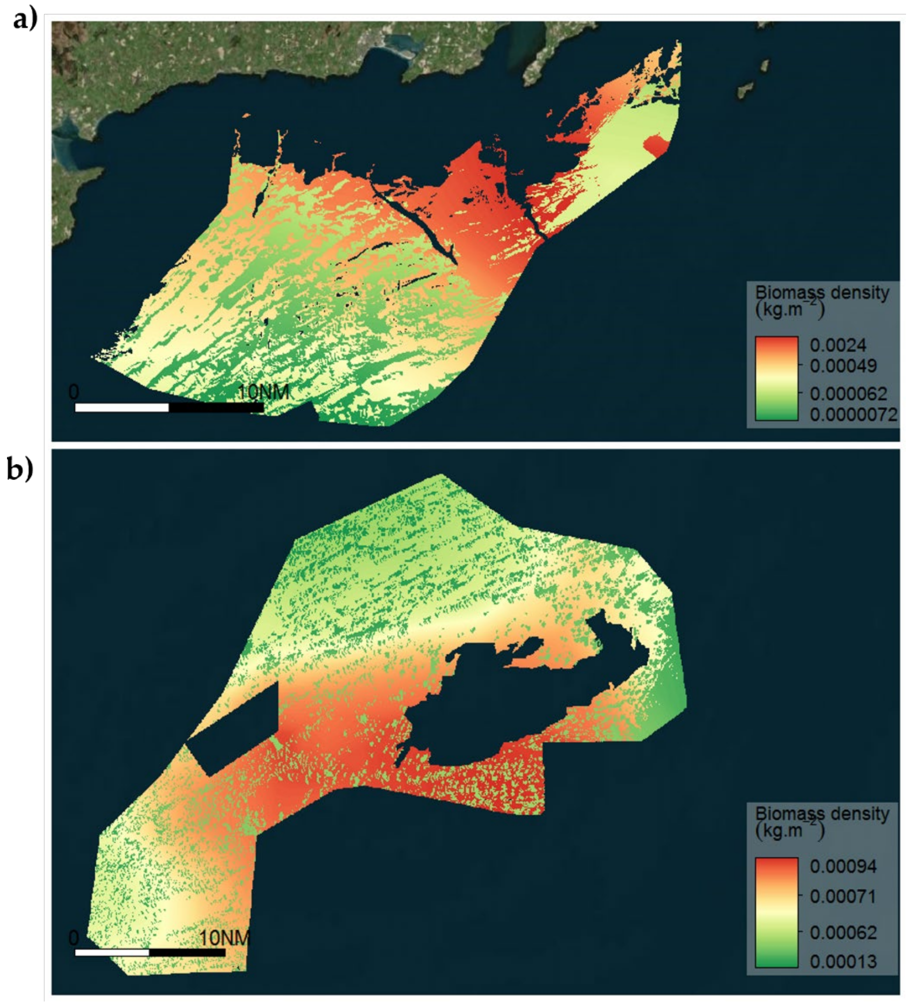

Figure 3.9 Spatial distribution of estimated total biomass of scallop (uncorrected for dredge efficiency) in the 2024 a) inshore and b) offshore Celtic Sea survey area.

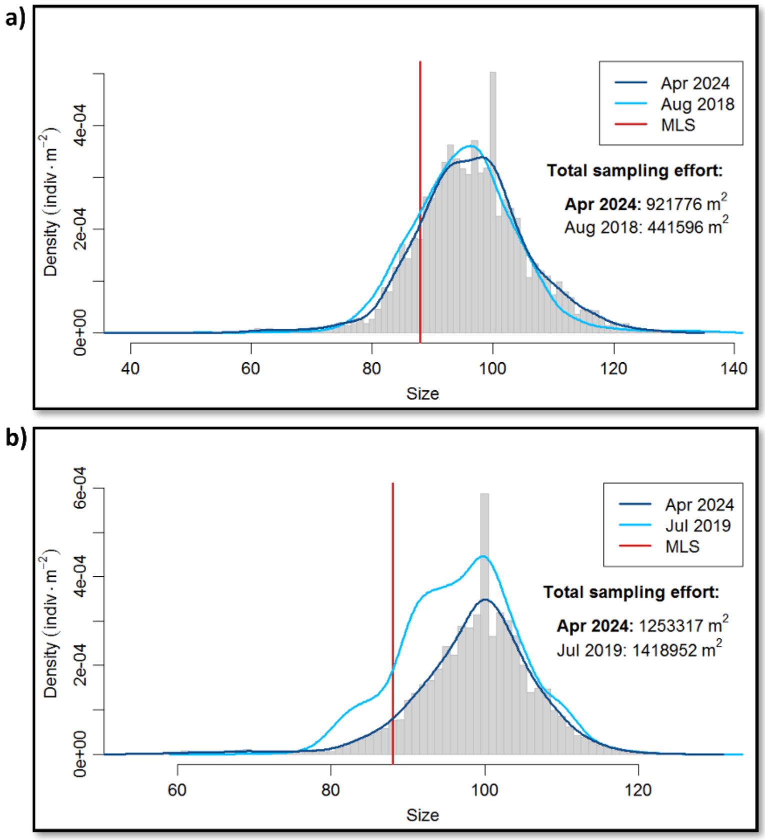

Figure 3.10 Size distribution and densities of scallop from the 2024 a) inshore and b) offshore Celtic Sea survey area. Vertical red line at 88 mm corresponds to the MLS of 100 mm shell width in this area. Data are standardized to sampling effort regardless of its spatial distribution.

3.4 Northern Ireland update: King scallop (*Pecten maximus*)

In 2023, 629 tonnes of dredge caught scallops were landed by UK vessels fishing within NI waters (ICES rectangles 37E3, 37E4, 38E4, 39E3, 39E4). While this is an increase in landings from recent years, landings are down from a peak of 1633 tonnes in 2014 (Figure 3.11). Most landings taken from NI waters in 2023 were landed by NI registered vessels (80%), with landings also taken by Scottish (11%), Isle of Man (8%) English (1%) and Welsh (<1%) vessels.

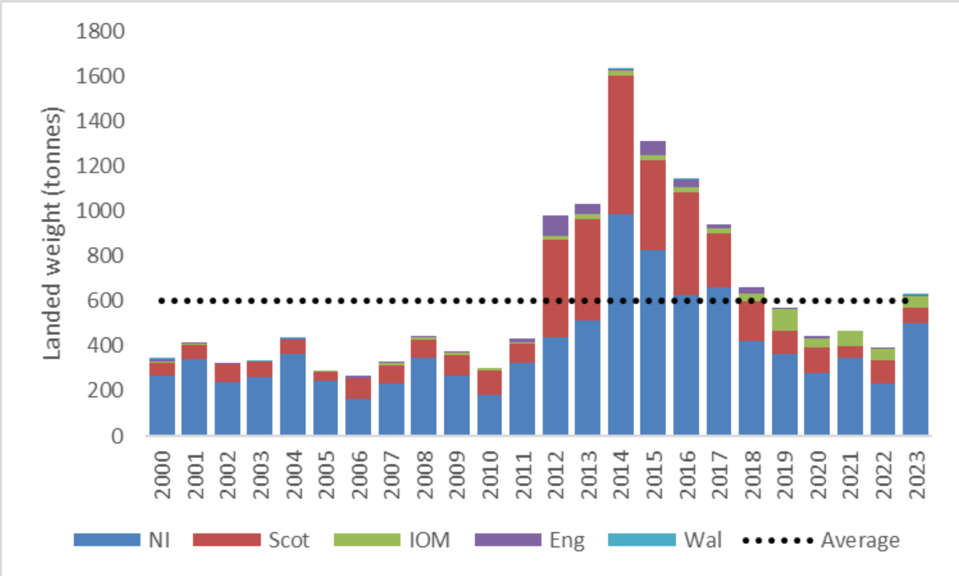

Figure 3.11 Landings of king scallops from Northern Ireland waters (ICES rectangles 37E3, 37E4, 38E4, 39E3, 39E4), by vessel nationality. The dashed line indicates the average annual landings (603 tonnes).

The effort exerted on the fishery is quantified as the vessel power (in kilowatts) multiplied by the number of days active per trip. Overall effort by vessels fishing for king scallops in NI waters showed an increasing trend between 2007 and 2015, peaking at 290 700 kwDays, but has since declined, with a total of 135 000 kwDays spent fishing scallops in 2023.

The average LPUE (kg/kwDay) showed an increasing trend up to a peak in 2014, before decreasing (Figure 3.12). However, since 2021 LPUE has been increasing. From 2012–2023, ICES rectangle 39E4 had the greatest decrease in LPUE, going from having the highest LPUE to the lowest. Rectangles 39E3 and 38E4 tended to have the highest LPUE over this period.

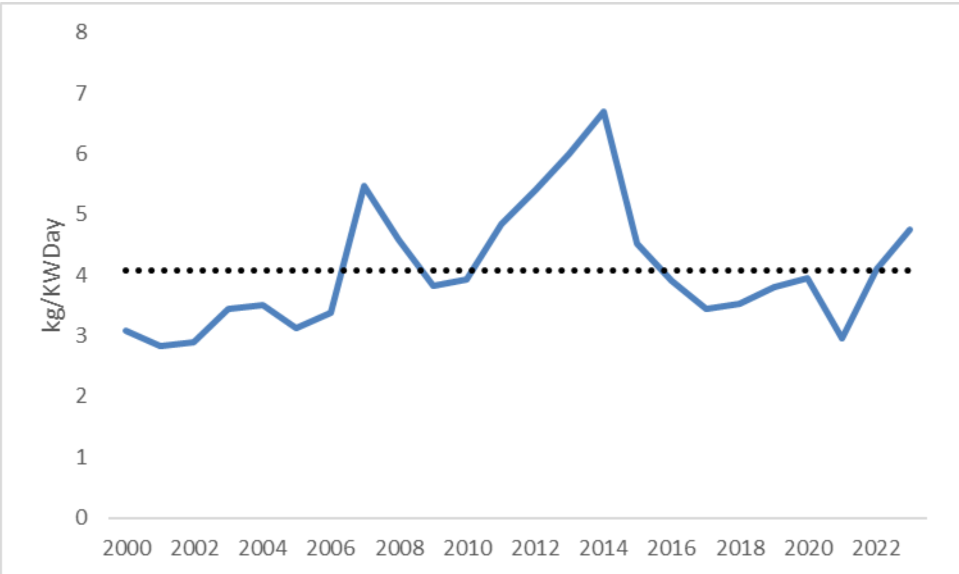

Figure 3.12 Landings-per-unit-effort (LPUE) for king scallops landed from Northern Ireland waters. The black dashed line represents the average LPUE over the analysed period.

The Agri-Food and Biosciences Institute (AFBI) carry out an annual scallop survey which covers NI waters. During the survey, which is a random stratified design, four 75 cm dredges, are used. A mesh liner is placed in one of the dredges to retain juvenile scallops and small bycatch. The dredges are towed for 30 minutes at each station. The total catch is processed, with the biologicals collected for individual scallops including age, total weight, length, breadth, gonad weight and muscle weight. The number of scallops caught during each tow is recorded and, with known distance of the tow, the catch is standardized to give a CPUE as the number of scallops per 100 m^2.

In February 2024, 43 stations were sampled during the survey. The highest CPUE was reported west of Rathlin Island (2.6 scallops per 100 m^2). During the 2024 survey the age structure had shifted from previous years, with more scallops in the 3–6 year-class.

Overall, the survey CPUE peaked in 2012. However, this peak was partly driven by the introduction of the North Coast to the survey footprint (before this the survey was only carried out along the east coast of NI). The CPUE at Irish Sea stations peaked in 2014. Since both these peaks, average CPUE had been on a downward trend. However, in recent years CPUE has begun to increase, particularly for the North Coast areas (Figure 3.13).

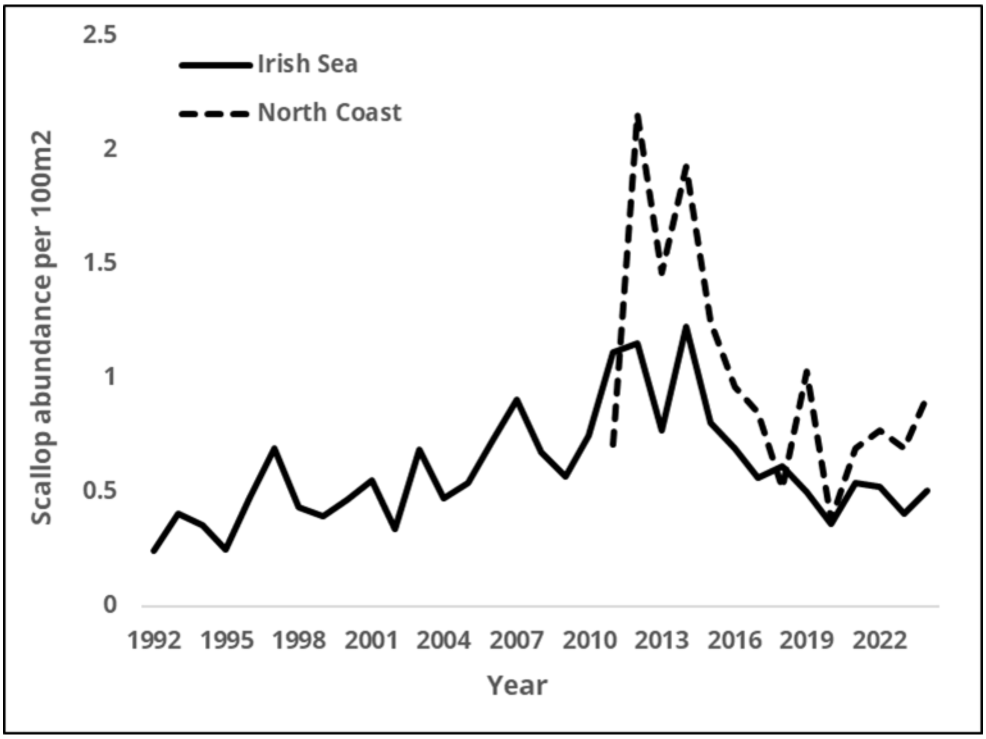

Figure 3.13 Survey catch-per-unit-effort (CPUE) for the North Coast and Irish sea areas.

During the 2024 survey, AFBI welcomed a member of Cefas through the WGScallop survey exchange programme. This proved positive to both sides of the exchange, showing the differences in survey techniques and analysis, with both parties gaining ideas that could be incorporated into their own surveys.

AFBI provide advice to the Department of Agriculture, Environment and Rural Affairs (DAERA) on an annual basis through a series of inshore advice sheets. The latest advice can be found at Inshore fisheries | Agri-Food and Biosciences Institute. A dashboard for scallops has also been created to inform stakeholders of the process from data collection to provision of the advice (https://eservices.afbini.gov.uk/fisheriesandaquaticecosystems/scallop-stock-assessment.html).

3.5 Northern Ireland update: Queen scallop (*Aequipecten opercularis*)

In 2023, 447 tonnes of queen scallops were landed by UK vessels fishing within NI waters (ICES rectangles 37E3, 37E4, 38E4, 39E3, 39E4). This is a decrease in landings from 2022 when over 1000 tonnes were landed. Landings of queen scallop peaked in 2012 at 6581 tonnes (Figure 3.14). In 2023, all landings of queen scallops from NI waters were by non-NI vessels and were caught by dredge.

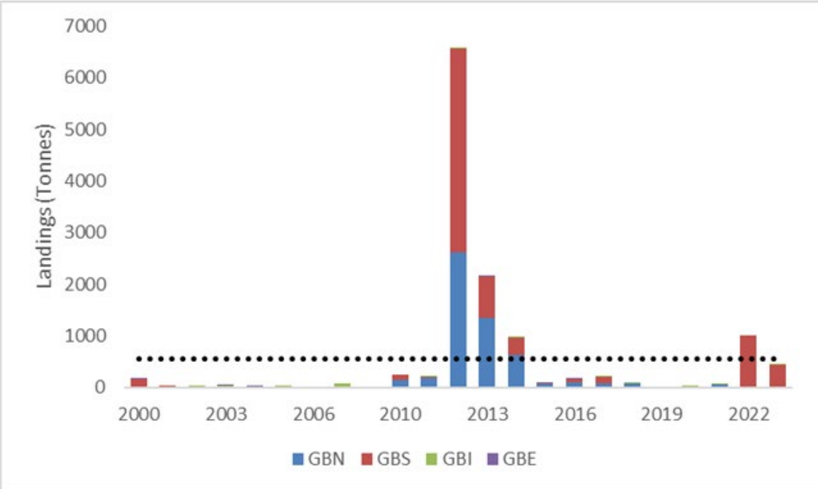

Figure 3.14 Landings of queen scallops from NI waters (ICES rectangles 37E3, 37E4, 38E4, 39E3, 39E4), by vessel nationality. The dashed line indicates the average annual landings.

The average LPUE (kg/kwDay) for queen scallops increased to a peak in 2011, before decreasing until 2020. In 2021, LPUE increased slightly and in 2022 LPUE increased to its highest value of 54.6 kg/KWDays (Figure 3.15). However, LPUE decreased again in 2023, although LPUE stayed above the time-series average.

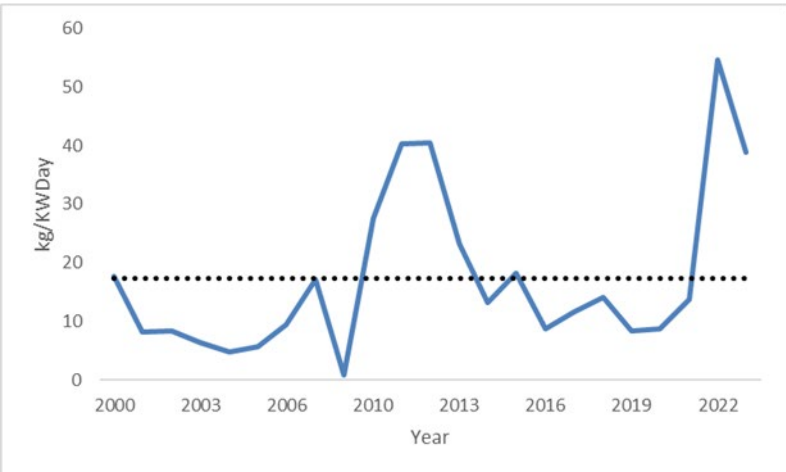

Figure 3.15 LPUE for queen scallops landed from NI waters. The black dashed line represents the average LPUE over the analysed period.

AFBI carry out an annual queen scallop survey which covers ICES rectangles 39E3 and 40E3, along the NI north coast, and rectangles 36E5, 36E6 and 37E5 in the Irish Sea. Underwater Towed Video (UWTV) was deployed at predetermined stations selected from a defined grid. The UWTV was towed for 15 minutes. The number of queen scallops displayed in the footage was counted by a minimum of two trained team members. Based on the counts, stations were selected for further sampling. Stations were fished using either a queen scallop net or a tow bar fitted with two queen scallop dredges, a king scallop dredge and a king scallop dredge with a mesh liner. The total catch was processed, with the biologicals collected for individual queen scallops including total weight, length, breadth, gonad weight and muscle weight.

During the 2024 survey, 52 camera tows were carried out in the Irish Sea. The highest reported abundance of queen scallops was reported to the south of the Isle of Man where there was an abundance of 30.9/m² counted from the UWTV. Thirteen dredge tows were completed in the Irish Sea. The queen scallop dredge was the most efficient at catching queen scallops, followed by the lined king scallop dredge and then the unlined king scallop dredge. The length of queen scallops caught ranged from 13–84 mm with a single peak at 65 mm. Very few queen scallops under 40 mm were caught, with 98.6% of queen scallops being greater than the 40 mm MLS (Figure 3.16).

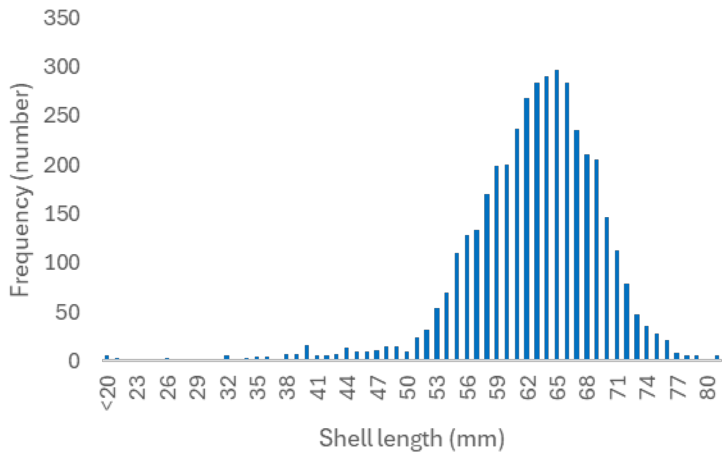

Figure 3.16 Length frequency of queen scallops caught in the Irish Sea, during the 2024 Northern Ireland survey.

Along the north coast of NI, 50 camera tows were completed. The highest abundance of queen scallops recorded through the UWTV was 3.01/m². Seventeen trawl tows were completed in the area. The greatest abundance recorded was 74.4 queen scallops per 100 m². The length of queen scallops caught ranged from 24–84 mm, with a peak at 51 mm and a smaller peak at 69 mm (Figure 3.17). Up to 42.7% of queen scallops made at the fished stations were under the MLS of 40 mm.

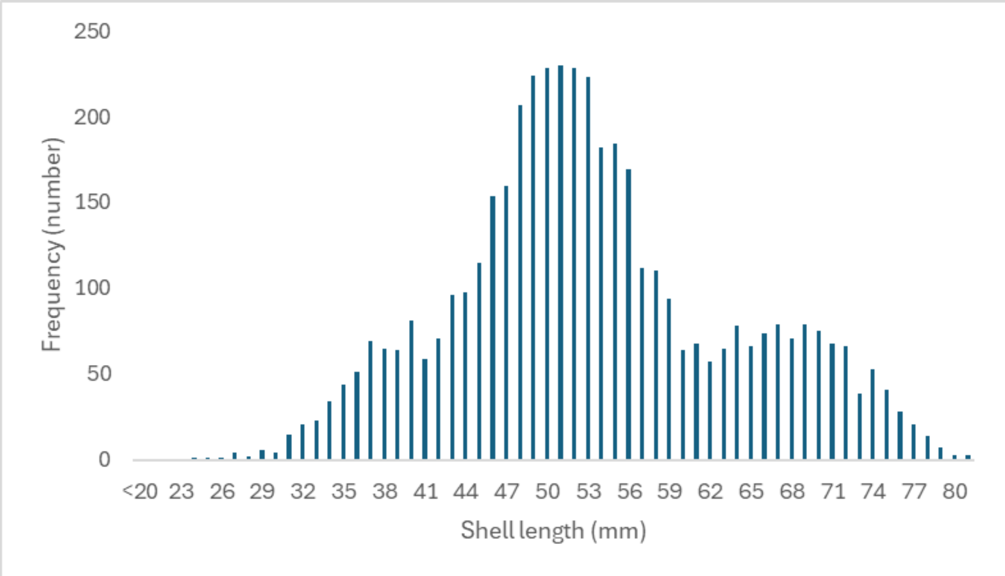

Figure 3.17 Length frequency of queen scallops caught along the Northern Ireland north coast, during the 2024 survey.

Biomass estimated from the survey show an increase for both areas from the 2023 estimated biomass (Figure 3.18).

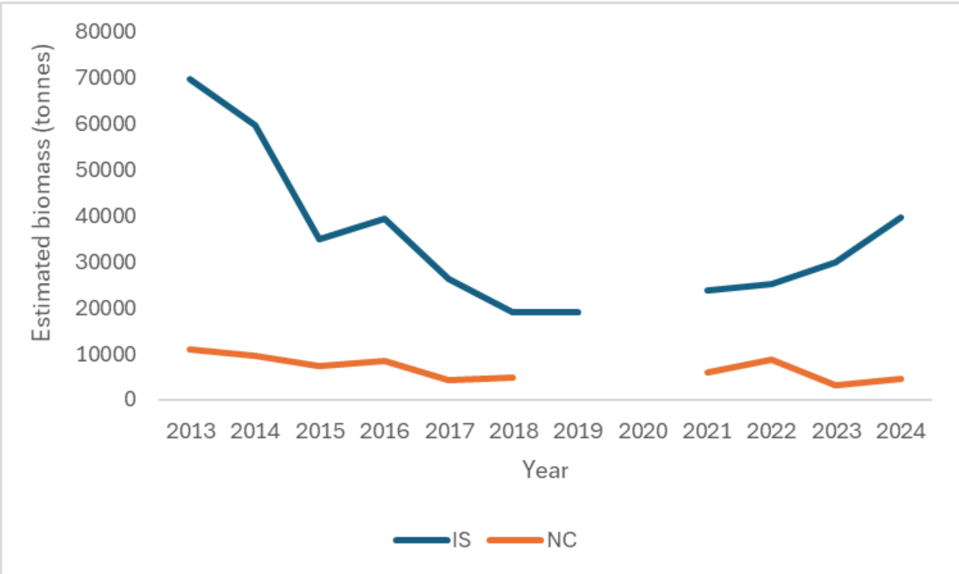

Figure 3.18 Estimated biomass for queen scallops in the Irish Sea (ICES rectangles 39E3 and 40E3) and Northern Ireland north coast (rectangles 36E5, 36E6 and 37E5).

3.6 Isle of Man update: King scallop (*Pecten maximus*)

The Isle of Man currently operates two annual scallop surveys (assessing both king and queen scallops) both of which are undertaken in Spring. A long standing (1992–2024) coarse-scale, fixed station survey is undertaken onboard a research vessel and a more recently developed (2019–2024), fine-scale, stratified random survey is undertaken by industry, in collaboration with scientists, onboard fishing vessels.

For king scallops, both surveys show very similar trends for 2024 and indicate very good densities of post-recruits (scallops over MLS of 110 mm) spread among the main fishing grounds. For both surveys the post-recruit and recruit indices are the highest recorded in the time-series (six years for industry survey and a 33-year time-series for research vessel survey). The industry survey indicates that recruitment is strongest on the south coast at the Chickens fishing ground and the west coast at the Targets fishing ground. The post-recruit abundance is high island-wide (except for Point of Ayre and the south end of the East Coast 0–3 nm area; Figure 3.19). Following the ICES Category 3 data-limited approach the TAC for 2024/2025 king scallop fishing season has been set at 2352 t (a 20% increase on 2023/2024 landings). The 2024/2025 Isle of Man king scallop fishing season opened on 1 November 2024.

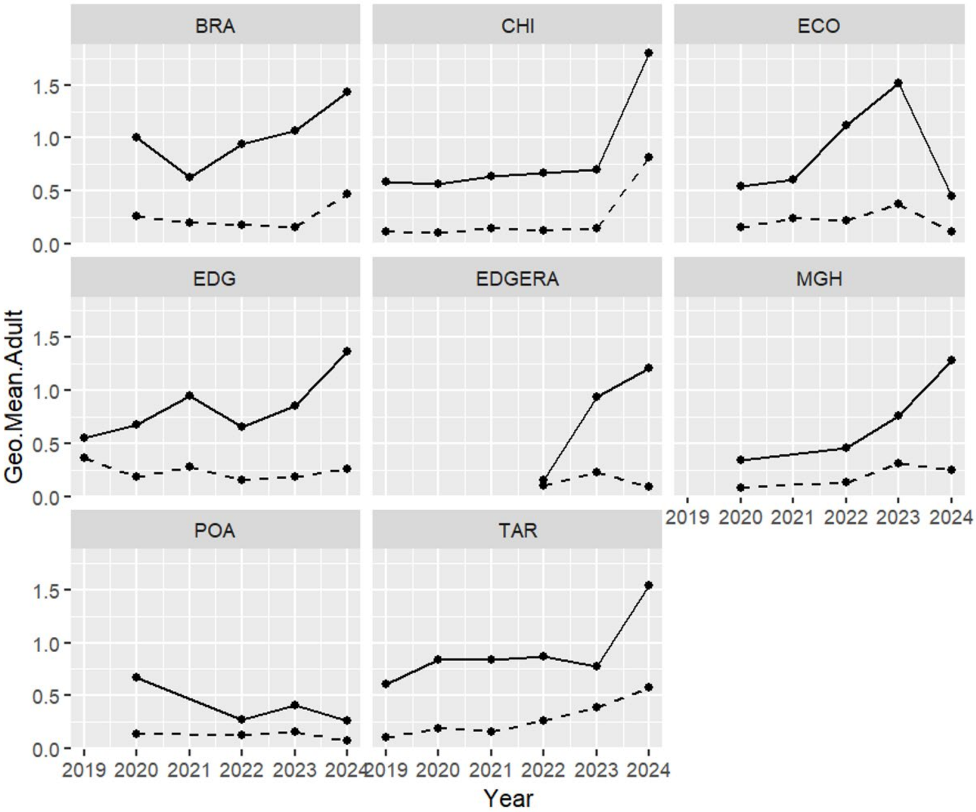

Figure 3.19 Abundance index for king scallops (post-recruits = solid black line; recruits = black dashed line) for Isle of Man territorial waters displayed by fishing ground using data from the Annual Industry Vessel Spring Scallop Survey.

3.7 Isle of Man update: Queen scallop (*Aequipecten opercularis*)

The Isle of Man currently operates two annual scallop surveys (assessing both king and queen scallops) both of which are undertaken in Spring. A long standing (1992–2024) coarse-scale, fixed station survey is undertaken onboard a research vessel and a more recently developed (2019–2024), fine-scale, stratified random survey is undertaken by industry, in collaboration with scientists, onboard fishing vessels.

The long-standing survey showed the highest densities of queen scallops on the north coast (Point of Ayre POA) with the next three highest densities on the east (East Douglas EDG and ST21) and west coast (ST6). The research survey data showed that recruit biomass is lower in 2024 than 2023, but this value remains the third highest value in the time-series since 2011 (Figure 3.20). There was an increase in the post-recruit biomass for 2024 compared to 2023, with the 2024 value the highest estimated since 2014 (Figure 3.20). The industry survey indicated the highest densities of recruits were on the west coast (near the 12 nm line), while high density isolated patches of post-recruits were found at POA, Targets (TAR) and Chickens (CHI). Following the ICES Category 3 data-limited approach the TAC for 2024 queen scallop fishing season was set at a lower range of 726 t (a 20% increase on 2023 landings) and an upper range of 1144 t (20% of estimated stock biomass).

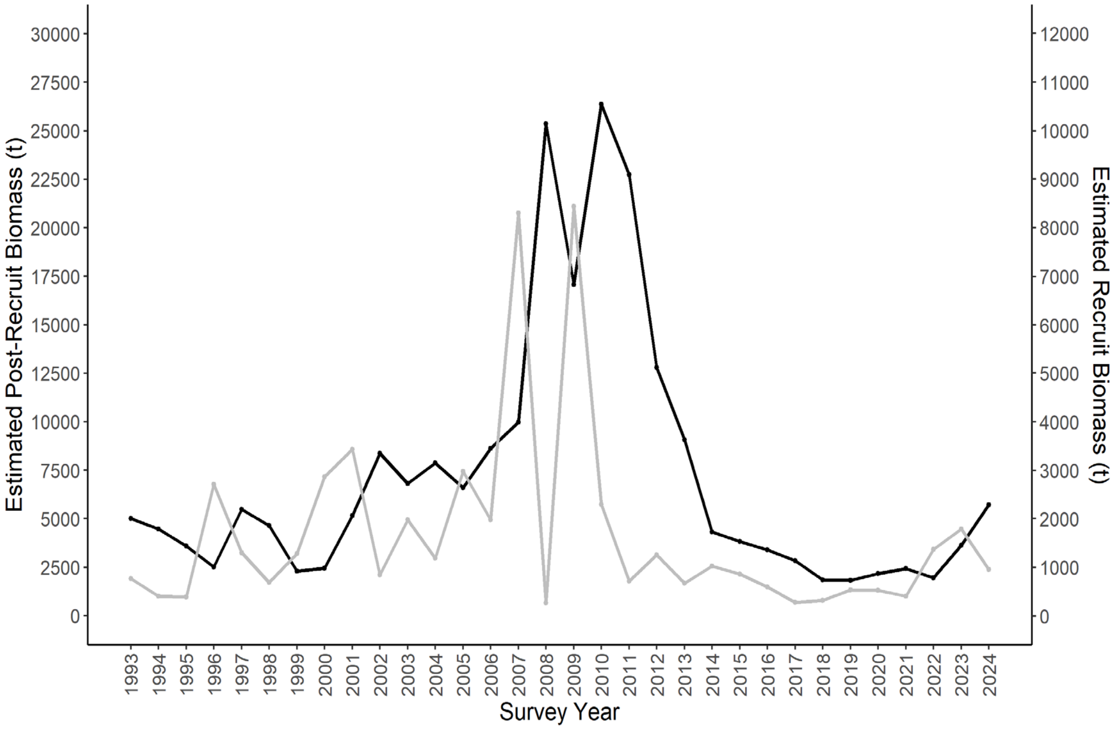

Figure 3.20 Estimated post-recruit (black line; left y axis) and recruit (grey line; right y axis) biomass for queen scallops within Isle of Man territorial waters using the CSA model.

3.8 Scotland update: King scallop (*Pecten maximus*)

Marine Directorate scallop dredge surveys

King scallop dredge surveys have been conducted in Scotland since the mid-1990s, and now cover six assessment areas with four surveys covering the east coast of Scotland, the west coast, Shetland and the Clyde. The 396 fixed station positions are based on historical fishing patterns and areas of suitable sediment from British Geological Survey sediment maps. Additional stations have been recently added using Vessel Monitoring Systems (VMS) data from the commercial fishing fleet to ensure coverage representative of industry fishing areas, while the accessibility of other stations is being revised due to wind farms, pipelines, PMFs and marine protected areas (MPAs).

The data collected are used in the scallop stock assessment and feeds into Scotland's national marine plan. This plan covers the management of both Scottish inshore waters (out to 12 nautical miles) and offshore waters (12 to 200 nautical miles).

The current vessel used for the surveys is Alba na Mara, which is 27 m long. Alba is fitted with deployable scallop arms that allow the vessel to tow two sides of six standard dredges, one per side. The vessel is also fitted with a novel tray system for dumping stones and other debris from the dredges overboard. This reduces the work in clearing debris from the deck and speeds up operations when fishing.

Spring loaded Newhaven type dredges are used on the surveys, with a total fishing width of 9 m. The starboard side has 6 x 9 toothbar and 80 mm bellyrings, similar to commercial king scallop dredges and the port side has sampling gear made up of 6 x 11 toothbar and 60 mm bellyrings, similar to that used for queen scallop fishing. The latter sampling gear is utilized to catch undersized scallops and smaller bycatch.

At each station, the dredges are towed at a speed of about 2.5 knots for approximately 30 minutes, and all king scallops caught are aged and measured. Other objectives for the surveys have included: assessing scallop shell damage, identification and length measurements of bycatch, recording and retaining marine litter (monitoring as part of the Marine Strategy Framework Directive) and the collection of frozen scallops for heavy metal testing as part of the OSPAR assessment of hazardous substances in the marine environment.

Surveys 2023/2024

Four surveys were undertaken since WGScallop 2023 (Figure 3.21).

The Clyde survey was carried out in October and November, four statistical rectangles were surveyed, and 43 stations were fished. During the survey 3,896 scallops ranging from 5 cm to 16 cm and age two to 10 plus years old were recorded. In addition, 3242 bycatch individuals were recorded, measured and identified.

The Shetland survey was carried out in Jan and February, three statistical rectangles were surveyed, and 15 stations were fished. During the survey 3134 scallops ranging from 6.5 cm to 15 cm and age two to 10 plus years old were recorded. In addition, 1561 bycatch individuals were recorded, measured and identified. Only 2.5 days of fishing were carried out in Shetland due to inclement weather. However, on the second day, a visiting scientist from Shetland University of the Highlands and Islands (UHI) joined the vessel to observe and take part in operations. The decision was taken to return to the Moray Firth and carry out seasonal comparison trials in a bid to gain data to assess if switching the annual timing of the surveys would be a feasible option. Options are also being explored to work with UHI Shetland to conduct the Shetland survey in future (possibly to combine resources for Shetland survey work).

The west coast survey was carried out in May. During the survey 13 ICES statistical rectangles were sampled with 77 stations fished. During the survey 10 246 scallops ranging from 4.5 cm to 16.5 cm and age 2 to 10 plus years old were recorded. In addition, 4669 bycatch individuals, were recorded, measured and identified. Unfortunately, 6.5 days were lost due to vessel issues.

The east coast survey was carried out in July. During the survey 12 ICES statistical rectangles were surveyed with 105 stations fished. During the survey 10 358 scallops ranging from 6.5 cm to 15 cm and age three to 10 plus years old were recorded. In addition, 2880 bycatch individuals were recorded, measured and identified.

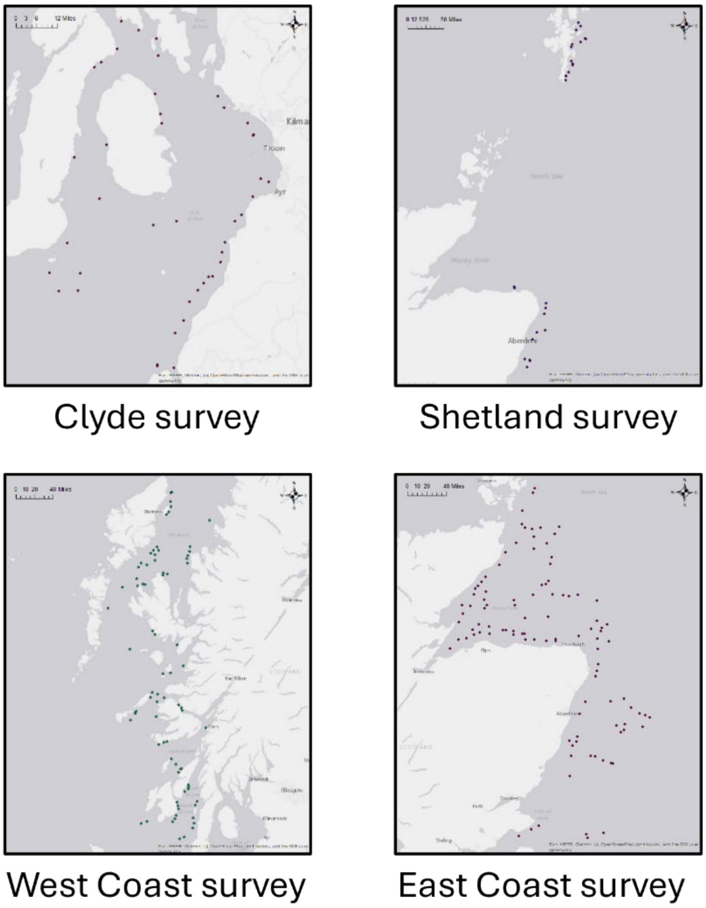

Figure 3.21 Marine Directorate scallop dredge stations surveyed in 2023/2024.

Deformed scallops

Concerns were raised about several deformed scallops caught by commercial fishers at a location in Scotland. Survey staff were requested to record and retain any deformed scallops during the east coast survey. Three scallops were noted in two of the 105 stations that we surveyed as being deformed (Figure 3.22). They matched the description of the ones previously found that caused concern, that is, with the "wave" continuing all the way round the shell. Scallops with slight deformities have previously been seen, usually limited to one side of the shell, often thought to be caused by trauma or disturbance.

The WG members have agreed that all scallop surveys will record and retain instances of these scallops, and this will be further discussed at the next meeting.

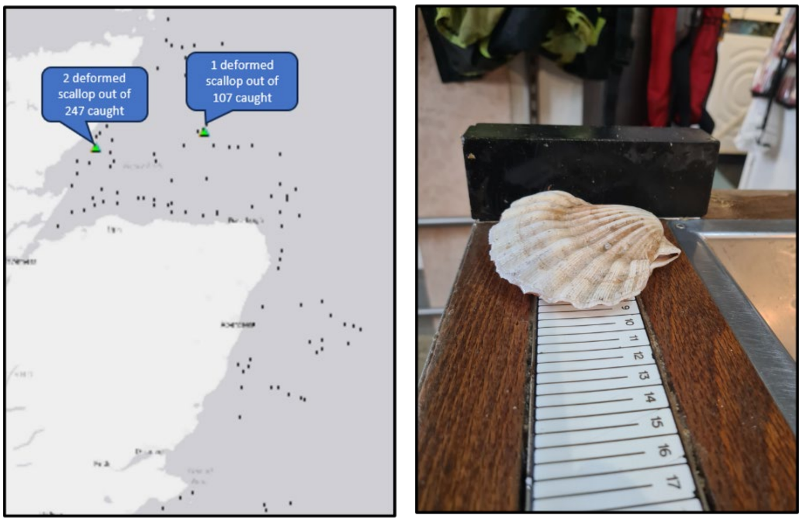

Figure 3.22 Locations and photo of deformed scallop caught on the 2024 East Coast Marine Directorate scallop dredge survey.

3.9 France, Bay of Saint-Brieuc update: king scallop (*Pecten maximus*)

Survey COSB 2024 (September 4th-18th). Results and management projections. King scallop indices.

Ifremer carried out the annual directed stock assessment for the inshore King Scallop fishery of the Saint-Brieuc Bay (VIIe, 26e7) extended to 634 km² of total surface divided in six spatial strata (survey COSB 2022; French RV "Thalia"). The COVID-19 emergency affected a lot of stock surveys although the one planned for the Saint-Brieuc Bay was undertaken in the initially scheduled periods from 2020 onwards. This constraint did not impact the stock assessments in 2023 and 2024.

The onboard operations, usually undertaken in the late summer, involve sampling 115 stations by dredging a constant distance of 200 m using an experimental dredge of 2 m width equipped with a pressure plate (Breton dredge), teeth of 8.5 cm length and belly and back ring diameter of 50 mm. The very high densities of scallop beds in the Bay of Biscay implies that for the majority of tows the dredge bag (height of 22 rings) is systematically half or completely filled after 200 m of distance (2'15-2'45 of duration against current or against the bisecting current/wind direction). The dredge efficiency is calibrated owing to previous references (Fifas and Berthou, 1999; Fifas *et al.*, 2004). Caught individuals are either exhaustively aged or on the basis of subsampling design a length frequency distribution by age group and by tow is obtained.

The inshore King Scallop fishery of the Saint-Brieuc Bay probably records the highest density levels in European. For the period 1962–2024, landings usually oscillated in a range of 4000–6000 t with some extreme values as high as 12500 t (season 1972/73) and as low as 1300 t (season 1989/90). Recent fishing seasons (2021/22 and 2022/23) were noticeable because of a steep increase of nominal landings compared to preceding ones (8031 t and 8367 t respectively) whereas in the last fishing season 2023/24 the minimum level of fishing effort throughout the time-series was observed, hence the resulting nominal landings were reduced (7180 t). In recent years, the exploitation has been undertaken by 220–240 vessels (≈95% dredgers, ≈5% divers). Throughout more than a half century of exploitation (from the early 60's onwards) the introduction of various management changes reflect the leading position of this stock for the scallop French fisheries: licence system by pair skipper/vessel (1973), global quota/TAC (1974), obligation of landings at auction (1978), improvement of selectivity pattern (ring diameter for dredges: 72 to 85 mm in

1985, 85 to 92 mm in 1997, 92 to 97 mm in 2017). In 2024, a new MLS of 105 mm replacing the previous 102 mm was adopted in Saint-Brieuc Bay as well as for the whole Western Channel scallop fisheries. Under the new regulation, the exploitable biomass for 2024, initially estimated at 64 240 t, is reduced by -9% (58 250 t) which remains the historical record for this fishery.

The main stock indices are summarized in Figure 3.23. The adult biomass includes all age groups two and above, it provides an index of the potential fecundity of the stock. The historical exploitable biomass corresponds to individuals larger than 102 mm (MLS in VIIe French waters), thus it is a fraction of the adult one. The same index under the new MLS of 105 mm is also provided. Those indices show cyclical pattern with a downwards trend in the period 2006-2013 (respectively -53% and –57% for adult and exploitable biomass). Afterward, an increasing phase is evident. Since 2018, the stock dynamics have steeply increased. In 2020–2024, the absolute records for adult and exploitable biomass were reached (respectively +54% and +43% between 2019 and 2020, +11% and +19% between 2020 and 2021, +24% and +5% between 2021 and 2022, +13% and +33% between 2022 and 2023, -1% and +5% between 2023 and 2024).

The recruiting class abundance is estimated at 146 million, lower than the cohorts 2021's and 2020's values (respectively 208 and 286 million). Despite this decrease, this year-class is represented by the fifth highest value throughout the whole time-series (34 years). It is noticeable that the five highest abundances are observed in the last five years. The total biomass is equal to 13 940 t *vs.* 20 020 t in 2023. Among them the immediately exploitable fraction is 3300 t against 4890 t in 2023 under the previous MLS of 102 mm whereas this value is 1890 t under the new MLS of 105 mm.

The management policy aims to preserve more than one significantly abundant age group to reduce fluctuations between yearly total abundance as much as possible independently of the annual recruitment variability. Four already harvested age groups are significantly abundant in the fishery: 3–6 years (respectively 22 920 t, 20 150 t, 14 730 t, 10 030 t). The total remaining biomass was estimated at 67 820 t (62 690 t in 2023, 48 830 t in 2022, 43 990 t in 2021, 39 220 t in 2020 and 26 930 t in 2019). The cohort 2021 is represented by a total abundance of 181 million (against 197 million for the same age group a year ago), among them 71% reached the historical MLS=102 mm (58% with MLS=105 mm). Under those regulations the exploitable biomass is 17 740 t and 14 830 t respectively on a total biomass of 22 920 t).

In September 2024, the age group 1 was estimated equal to 336 million individuals (this abundance is expected to provide a total of 149 in the 2025's survey accordingly to the relationship abundance GR2 *vs.* GR1 for a same cohort between two subsequent years). This value is higher than the one estimated last year although in regression compared to the three preceding cohorts 2019–2021 when the maximum historical level was reached year after year (respectively 417, 430 and 487 million). The currently assessed abundance for this age group remains high as it is the fourth highest value throughout the overall time-series. It is noticeable that the majority of historically high reproductions (threshold of 200 million) occurred in the period from 2015 onwards: 8 reproductions on 10 (apart from cohorts 2015 and 2018) against only 5 on 42 during the remaining time-series years 1973–2014).The year-class abundances (2024–2026) are not yet known. The 2024's cohort abundance will be reliably estimated not before the late summer 2025 as the spat collectors used in spring/summer 2024 has provided a minor part of explanation for the future class strength. The input values for the three cohorts 2024–2026 will be simulated. The simulation takes into account that Beverton & Holt S/R model explains a very low ($\varrho^2 \approx .10$) part of the predicted cohort abundance. The uncertainty in this relationship can be expressed by a lognormal probability. On this basis, recruitments for cohorts 1989–2023 (surveys 1990–2024) are assigned to probability levels against the spawning biomass[1] of the birth year. Prediction scenarios are performed either on the basis of constant probability or using cyclical lognormal pattern (Table 5).

There is no other surveyed species or stocks in French fisheries with the possibility of reliable projections on three years. The partnership scientists/fishing industry (project FEAMP 28 on years 2017–2019 and 2020–2022) aims to guarantee the durability of the whole study. In this partnership, the survey at sea provides accurate estimates for GR1+ whereas the age-size structured stratified biological sampling on landings allows to calculate all fishing mortality components for GR2+ and the spat collectors for GR0 gives the first semi-quantitative estimate by cohort. After an intermediate funding scheme for 2023 and 2024 (FEAMPA) on the basis of the same partnership, it should be judicious to ensure the continuity of the survey which has provided valuable tools for reliable and efficient development of stock management scenarios as well as for the comprehension of the ecosystem processes as this King Scallop population is located near the southernmost limit for the species.

The management regulations allow to smooth decreasing patterns when the unavoidable weak cohorts arrive, although they cannot completely change either the cyclical phenomena or the global warming trend.

Table 5 Numerical application for the 2024/25 season's proposed quota. second column: proposed quota(t); 3rd column: actual nominal landings (t); 4th column: Δf=% variation for fishing effort between 2023/24 and 2024/25; 5th to 7th columns: ΔY1, ΔY2, ΔY3=% variation of landings between subsequent fishing seasons; 8th to 10th columns: ΔBf1, ΔBf2, ΔBf3=% variation of spawning biomasses between springs/summers of subsequent years.

ΔY	*P=0.5*		*Δf*	*ΔY1*	*ΔY2*	*ΔY3*	*ΔBf1*	*ΔBF2*	*ΔBF3*
5%	6950	7561	-34.1%	5.4%	2.1%	-3.1%	-2.5%	-1.2%	-5.8%
10%	7350	7908	-30.8%	10.1%	1.3%	-3.6%	-3.2%	-1.6%	-6.2%
15%	7800	8293	-27.1%	15.4%	0.4%	-4.2%	-3.8%	-2.1%	-6.6%
ΔY	*P = variable*		*Δf*	*ΔY1*	*ΔY2*	*ΔY3*	*ΔBf1*	*ΔBF2*	*ΔBF3*
5%	6950	7561	-34.1%	5.4%	2.1%	-3.2%	-2.5%	-0.1%	-3.5%
10%	7350	7908	-30.8%	10.1%	1.3%	-3.7%	-3.1%	-0.5%	-3.8%
15%	7800	8293	-27.1%	15.4%	0.4%	-4.2%	-3.8%	-1.0%	-4.2%

[1] The spawning biomass differs from the adult one because it is calculated by weighing accordingly to the number of eggs potentially produced which is a function of the scallop size.

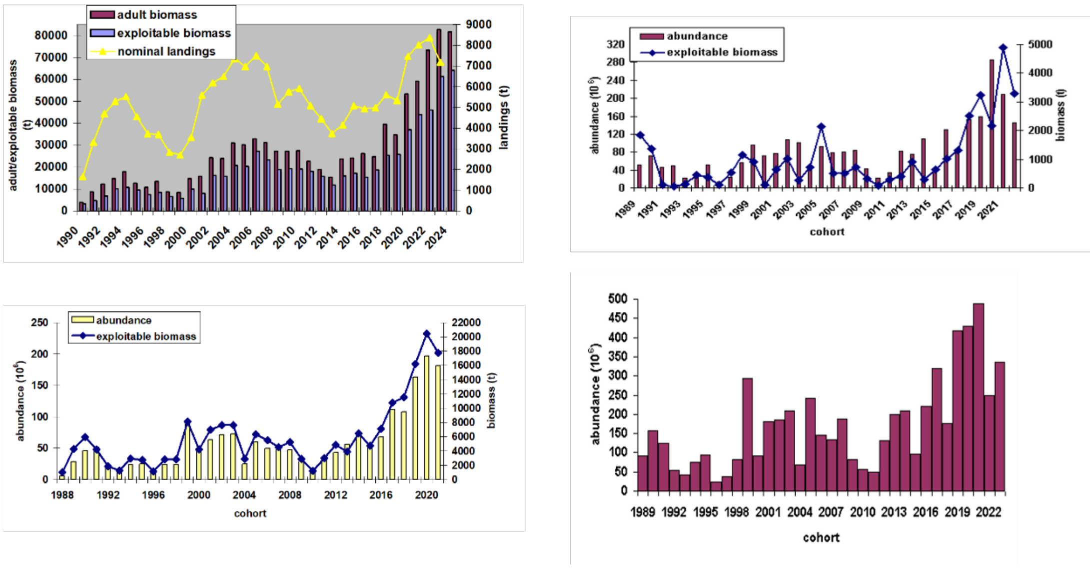

Figure 3.23 Saint-Brieuc Bay King scallop (1) Adult (yrs 2+) and exploitable biomass (≥previous MLS 102 mm), nominal landings. (2), (3) and (4) age group 2, 3 and 1 indices.

American slipper limpet indices

The main macro-fauna or sediment composition associated with scallops are reported by dredge tow. Five main types of seabeds are often observed as viewed according to filling of the dredge bag: (1) beds of bittersweet (*Glycymeris glycymeris*); (2) American slipper limpet (*Crepidula fornicata*); (3) broken shells; (4) stony/rocky seabed and (5) beds of the calcareous red alga *Lithothamnium corallioides*. For years 2001–2023, on 2649 sampled stations, 767 (29%) are characterized by slipper limpet grounds.

Usual methods for counting slipper limpet numbers of individuals are unrealistic because of extremely high volumes for some areas, chains of many individuals complicate the situation as well as the coexistence of huge quantities of dead slipper limpet individuals, which usually participate in the whole chains.

Volume index is investigated. For sampling units affected by slipper limpet seabed, the volume of the total load of the dredge bag is measured. This volume is obtained by multiplying the total height of the bag load (given by the number of metal rings of the dredge) by the maximum layer of the bag (measured at the middle of the total height of bag load). Reference on the third dimension *i.e.* the width of the dredge can be neglected as constant (2 m). Equation between volume and total weight of caught slipper limpets (including alive and dead individuals) is afterwards established. The maximum layer of bag load cannot be systematically measured by dredge tow. In this case, a relationship between the height which is more easily estimated as independent variable and the maximum layer of dredge bag as dependent one can be proposed (Figure 3.24a). Furthermore, a relationship of total weight (alive+dead individuals) vs. volume is obtained (Figure 3.24 b).

The total weight of caught slipper limpets is afterwards converted into the total number of alive individuals. In the Bay of Saint-Brieuc, the ratio of alive/total number fluctuates a lot (range 10-90%) according to the geographic position and mainly *vs.* year as the recent period is represented by greater mortality rate. The West coast is denoted by higher rate of dead individuals; that could be explained by the configuration of the current. The residual movement of seawater occurs in the direction East towards West. Furthermore, seabed near the West coast was occupied earlier by slipper limpet (Dupouy and Latrouite, 1979) whereas colonization of the Eastern part became relevant after the mid-90's (Hamon *et al.*, 2002); therefore, near the West coast, there is less available space for more recent recruited year classes of slipper limpet, and so fewer alive recruits can settle. The ratio has been occasionally sampled for several sampling units since 2003. In the basis of that, the ratio for each dredge tow was calculated by linear interpolation according to geographic position (latitude/longitude). This ratio significantly decreased throughout the time-series 2001–2023 (Figure 3.24 d).

The conversion by sampling unit of numbers of alive slipper limpets to weights on the basis of size/weight relationships (for alive as well as for dead individuals: Hamon *et al.*, 2002) is possible by using data on LFDs harvested during surveys 2002 and 2003 (Figure 3.24 c). The LFDs reveal a typical skewness of unexploited population (*i.e.* dominance of large sized individuals). It was assumed that the averaged LFD reflects the actual population state. Therefore, the total slipper limpet biomass on years 2001-2023 is estimated (Table 6).

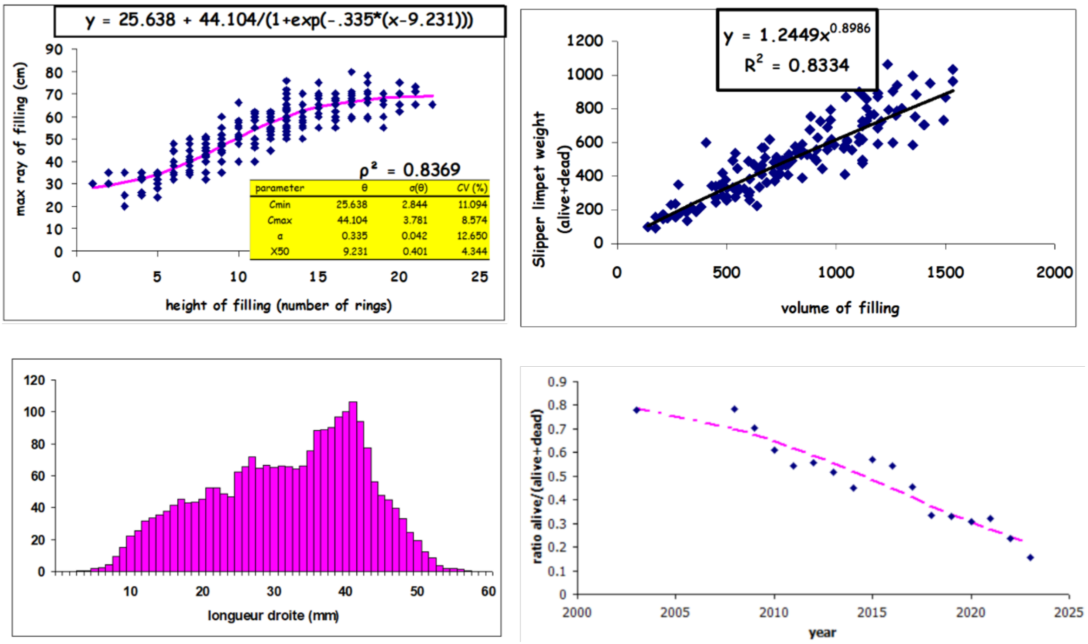

Figure 3.24 Saint-Brieuc Bay American slipper limpet (a) Relationship of maximum layer vs. height of the dredge bag load. (b) Relationship of weight of slipper limpets caught by the experimental scallop survey dredge vs. total volume of bag load (height*maximum layer). (c) Size structure for the slipper limpet population established during scallop surveys in the Bay of Saint-Brieuc (years 2002 and 2003; numbers are smoothed by mobile mean of 3 mm). (d) Ratio alive/total individuals against year of survey.

Table 6 Biomass (.000 t) estimated during King scallop surveys in Saint-Brieuc Bay. Years 2001–2023.

year	biomass (.000 t)	year	biomass (.000 t)
2001	125.4	2013	154.0
2002	188.3	2014	88.2
2003	282.7	2015	115.3
2004	193.0	2016	185.4
2005	261.1	2017	117.5
2006	331.6	2018	99.6
2007	227.8	2019	58.2
2008	354.8	2020	98.0
2009	273.3	2021	86.7
2010	140.1	2022	69.4
2011	160.9	2023	31.6
2012	174.8		

Those estimates are assigned to high variability (CV ±70%). Furthermore, some factors for uncertainty (*e.g.* volume/weight of dredge load) are considered as deterministic. Moreover, the "actual" dredge efficiency *vs.* slipper limpets is approximated by the asymptotic parameter of the dredge efficiency model *vs.* King scallop (Fifas and Berthou, 1999) although this assumption is not currently verified.

The results highlight a significant decrease of the slipper limpet population in recent years mainly due to apparently very strong mortalities. The current slipper limpet/King scallop is estimated at ≈0.3 whereas its value was ≈10 in the middle of 2000's. The causality of this event is not investigated here.

3.10 France, Eastern Channel and Bay of Seine update: king scallop (*Pecten maximus*)

Assessment survey of the king scallop stock in the Bay of Seine (Eastern Channel, France): results of COMOR2024 survey (July 2024)

Since the end of the 1970s, Ifremer has led an annual stock assessment survey using a research vessel from the French Oceanographic Fleet. For more than 20 years, the vessel used was the RV Thalia, but this vessel is supposed to leave the national fleet at the end of 2025. Therefore, this year the scientific team changed the vessel to, RV Côtes de la Manche, which will be used in the coming years. This survey is in the extended Bay of Seine area, between the French coast in the south and parallel 49°48 line in the north (Figure 3.25). This area is divided into two parts, a northern part called "Extérieur baie de Seine" from the limit of French territorial waters (12 nautical miles) to parallel 49°48N and a southern part called "Baie de Seine" corresponding to French territorial waters (from the coast to the 12 miles limit).

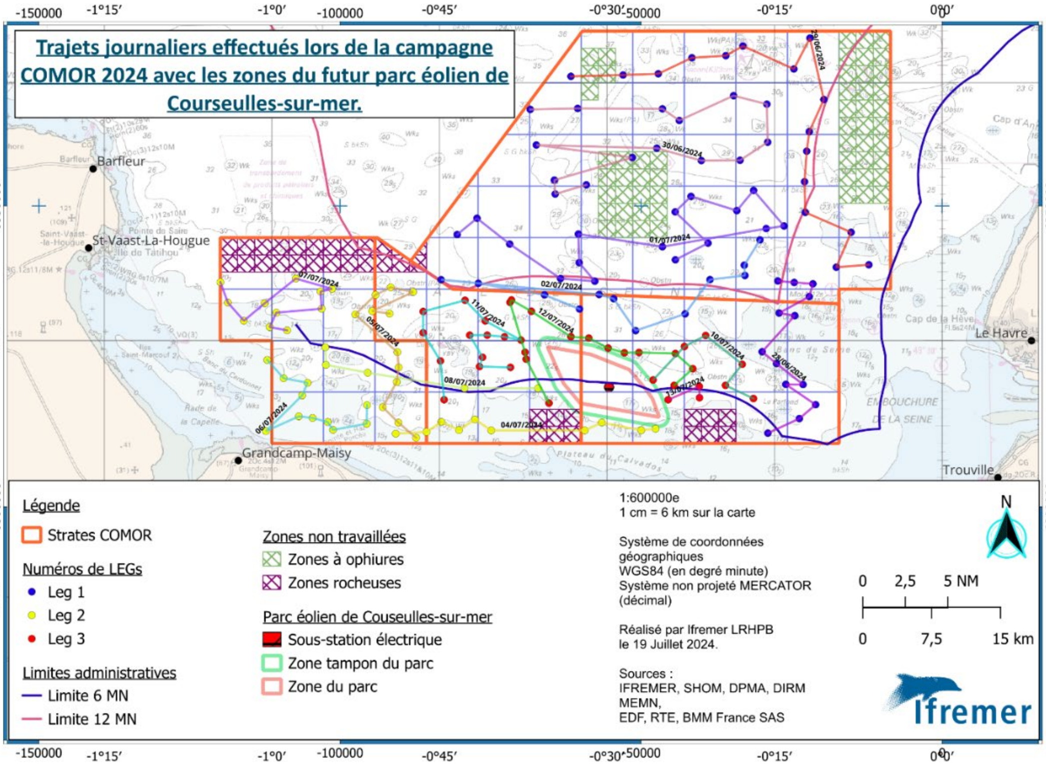

Figure 3.25 Scientific survey area (form Normandy coast in the South to 49°48 parallel in the North), and sampling units in 2024.

The scientific survey follows a stratified random sampling plan. It has been standardized (protocol, equipment, and data) since 1992.

In the area "Extérieur baie de Seine", the 2024 abundance indices for two-year-old scallops (recruitment) and those aged three years and over (age classes already exploited in previous fishing seasons) are the highest ever seen in the whole time-series. for the large recruitment was expected because the 2023 abundance index for juveniles was also the highest of the series. The abundance index for one-year-olds (prerecruitment), on the other hand, is lower than 2023, however; it remains the fifth highest in the series, so we expect a strong recruitment in 2025 (Figure 3.26).

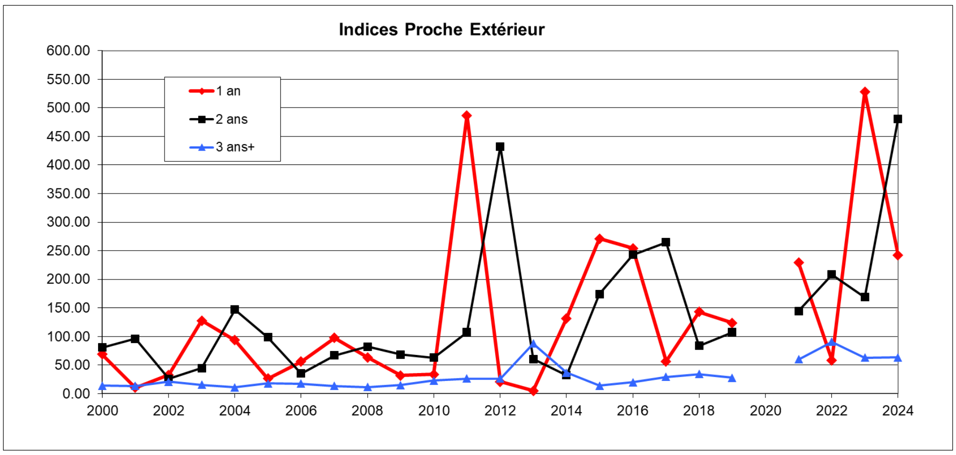

Figure 3.26 Trends of abundance indices by year class in the area "Extérieur Baie de Seine".

The exploitable biomass (when all individuals of age two and over have reached the minimum catch size of 11 cm) is thus estimated to be the highest ever observed, and a huge increase compared to 2023 (Figure 3.27): 34 947 tons compared with 15 418 tons, i.e. a biomass increase of 126%. This exploitable biomass value is 3.5 times higher than the 2000–2023 average.

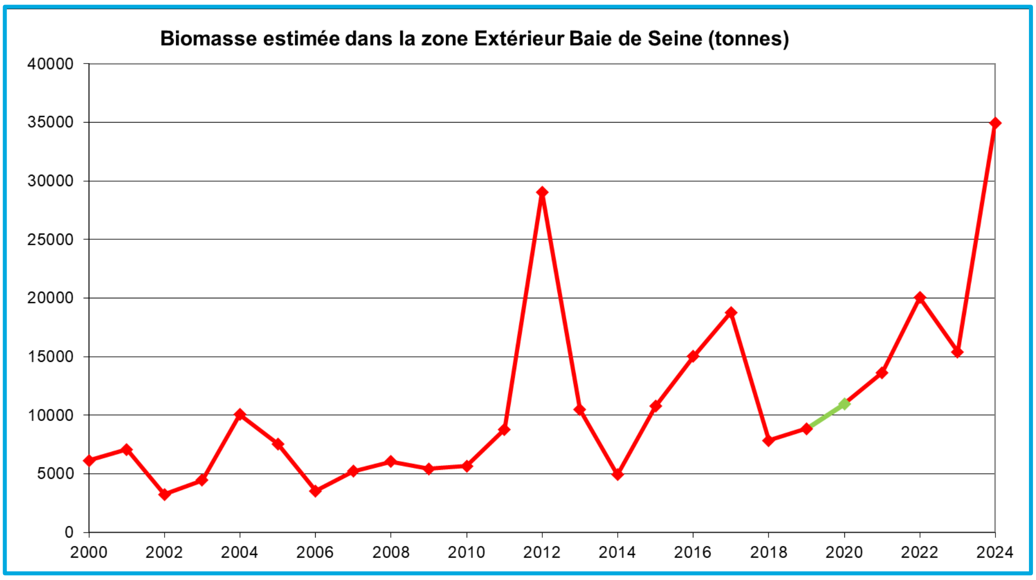

Figure 3.27 Trend of exploitable biomass in the area "Extérieur baie de Seine".

In the Bay of Seine, the abundance index of two-year-old scallops continues to be very high and to increase year after year. This is the highest value in the historical series. The abundance index for three-year-olds and older is the second highest value of the time-series. The juvenile abundance index is smaller than the 2023 index (which is the best of the time-series), but the second highest observed since the beginning of these surveys (Figure 3.28).

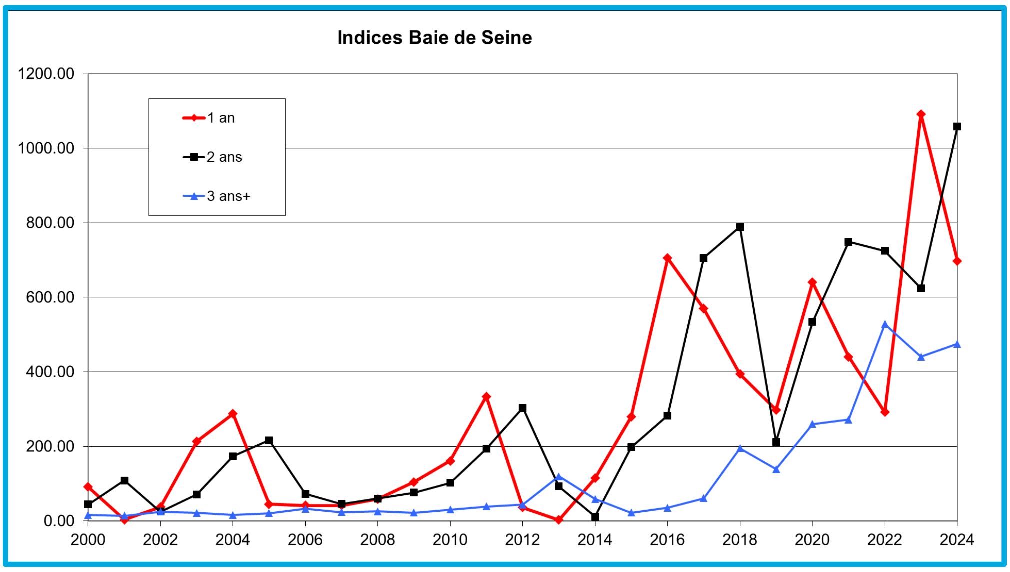

Figure 3.28 Trend of abundance indices by year class in the area "Baie de Seine".

As a result, the total exploitable biomass remains at very high levels, surpassing the record set in 2022 (Figure 3.29) to reach the highest level of biomass in the bay of Seine. The stock continues to be considered in good ecological condition.

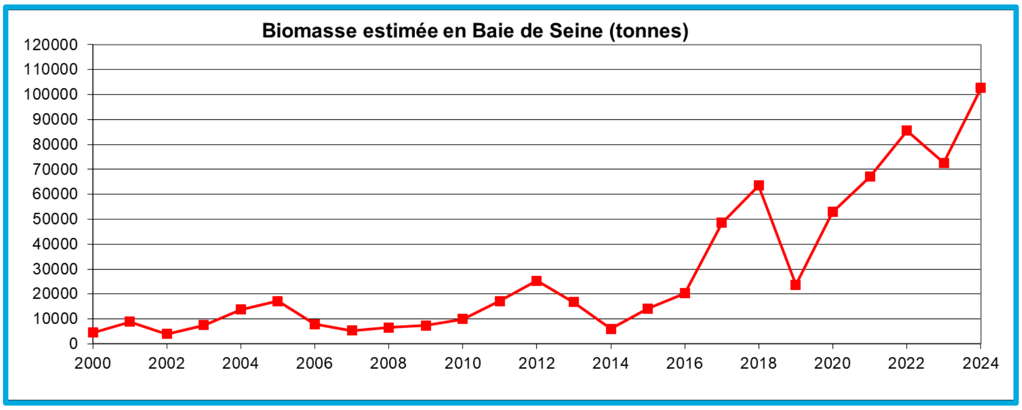

Figure 3.29 Trend of exploitable biomass in the Bay of Seine.

The population structure between the different age classes is well balanced (Figure 3.30), and makes it possible to envisage sustainable commercial exploitation, provided that the environmental conditions remain favourable and that the fishing effort remains stabilized at the current level.

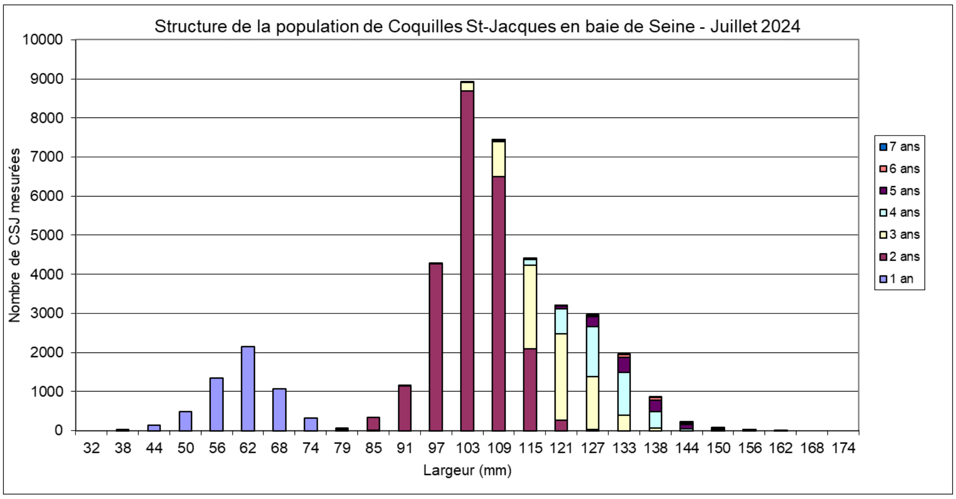

Figure 3.30 Scallop population structure in the Bay of Seine.

The growth deficit that had been observed in the last four to five years continues. The average size of two-year-old scallops is just below the average size for the period 1992–2023, and this pattern is the same for one-year-old juveniles (Figure 3.31).

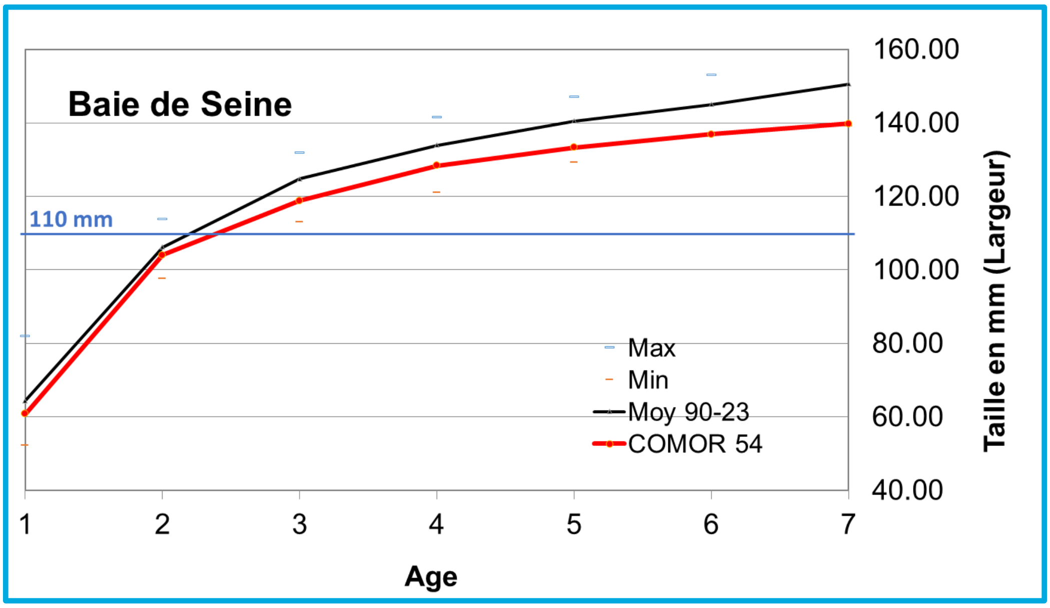

Figure 3.31 Growth curve observed in July 2024 for king scallop in the Bay of Seine.

Finally, the total exploitable biomass in the two areas was a total of 137 686 tons, well above the previous record of 2022 (105 625 tons) (Figure 3.32).

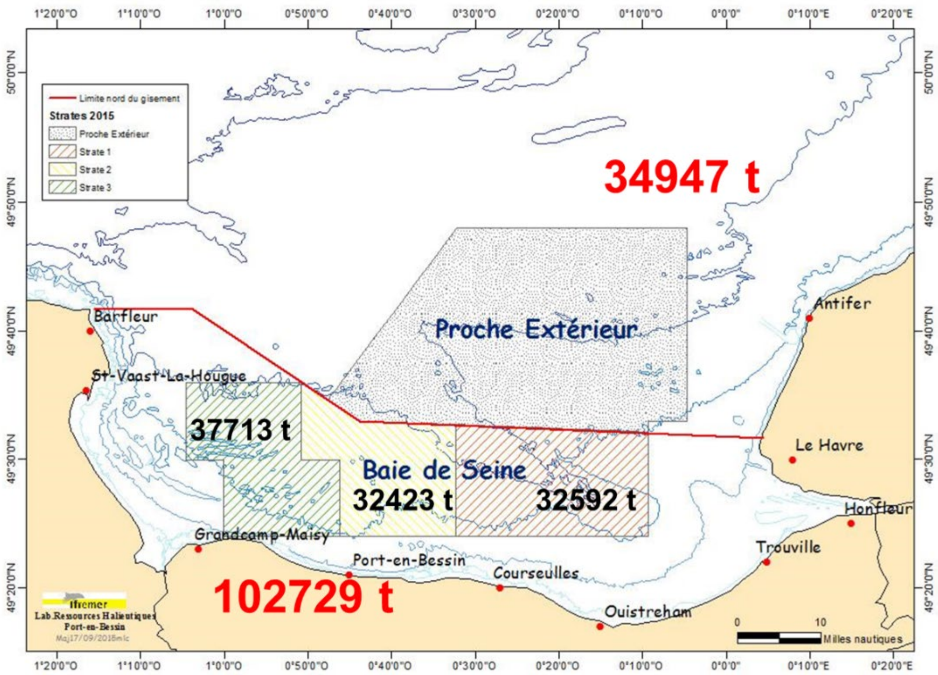

Figure 3.32 Exploitable biomass distribution per area in 2024.

The distribution of scallops on the seabed is relatively homogeneous in all areas of the Bay of Seine, although new juveniles were mainly found in the western part (Figure 3.33). As the central-western area (area B2) was closed last year, as part of the rotational closure system put in place, the western area B1 will be proposed this year for closure for the 2024–2025 fishing season.

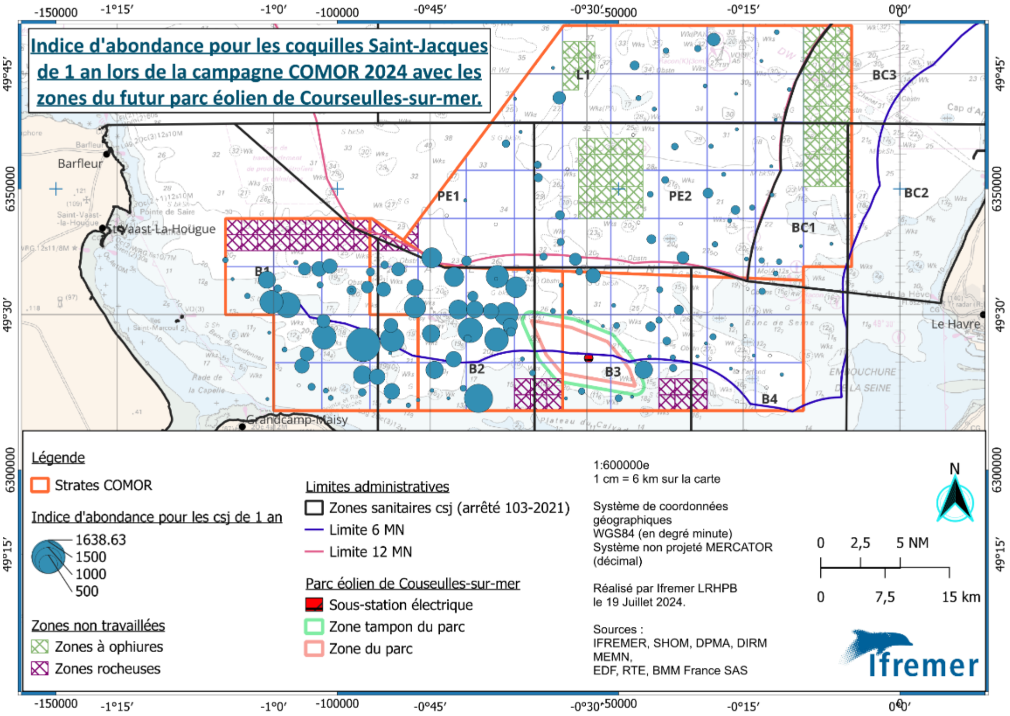

Figure 3.33 Geographical distribution of one-year-old juveniles in 2024.

3.11 Jersey: King scallop (*Pecten maximus*)

The 2024 king scallop survey was conducted over three days in October. Jersey is covered by four ICES rectangles, two of which include seas inside and outside Jersey's exclusive territorial waters (0–3 miles). Differentiating the exclusive waters from those shared with foreign vessels within the ICES rectangles gave six survey zones. For each survey zone a sampling area was defined based on VMS dredge fishing records, known suitable habitats and fisher advice. Within each sampling area seven sample points were randomly generated using QGIS with the aim of providing five usable sample points per sampling area. This resulted in a total of 32 randomized samples (Figure 3.34).

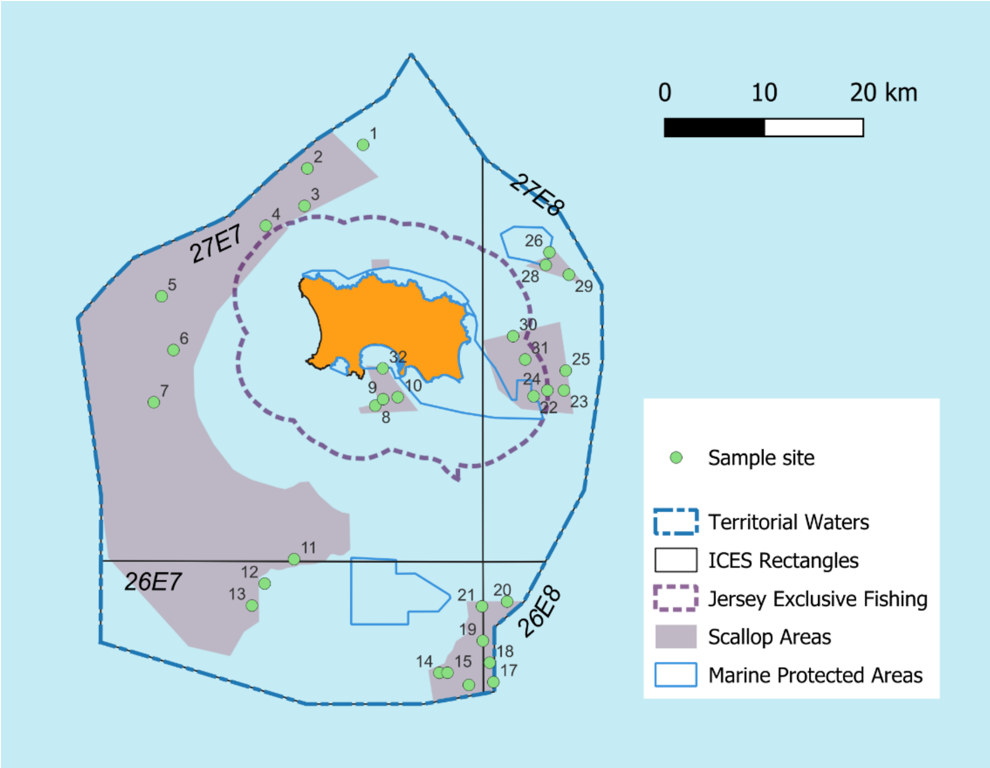

Figure 3.34 Scallop dredge survey sites in fishable areas across Jersey's territorial waters. Marine Protected Areas are shown as dredging is not permitted in this areas.

This is the fourth year of surveying these areas using the same sampling method that was used in 2021 see WG Scallop 2021 report (ICES,2021) and again stemmed from the method used by Normandy (France) to survey king scallops. 2021 was a trial year and sample sites have only been consistent since 2022.

Mean catch (scallops per sample) was greatest in 2024 in the 85 mm ring size dredges, whereas mean catch was greatest in 2023 when considering the 50 mm ring size dredges. The 50 mm ring size dredges caught consistently fewer scallops than the 85 mm ring size. This is most likely due to the smaller ring size filling with debris before the completion of the tow, resulting in lower catches see WG Scallop 2022 report (ICES, 2022) for debris comparisons between ring sizes). Despite this, the 50 mm ring size caught more below Minimum Landing Size (MLS) scallops than the 85 mm ring size in all years.

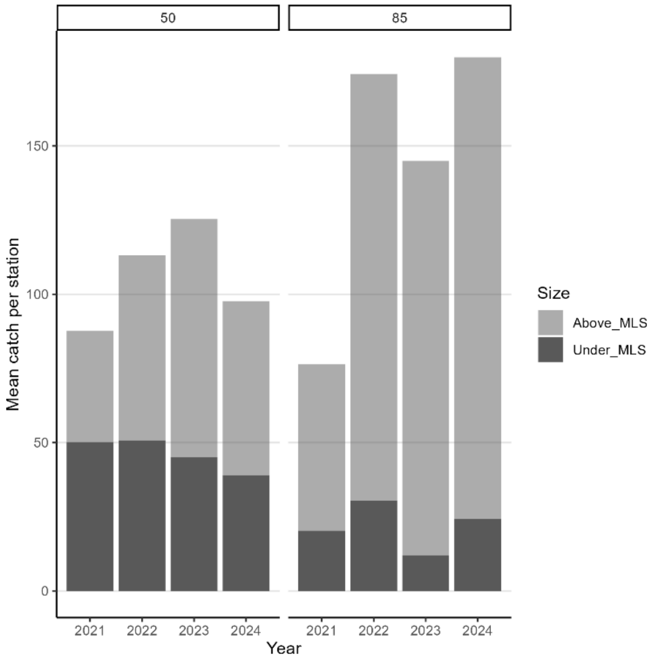

Figure 3.35 Mean catch per year in each ring size (50 and 85 mm) split for size (above or below Minimum Landing Size).

Size structure has only been compared for 2022 to 2024 as not all the same site locations were surveyed in 2021. In all three years, a similar double bell curve can be seen in scallop size distributions for the 50 mm ring size and a single bell curve for the 85 mm ring size. There was a greater number of small scallops (<40 mm) in 2024 compared to previous years. However, the overall number of small, below MLS, scallops caught was lower in 2024 compared to previous years (Figure 3.36).

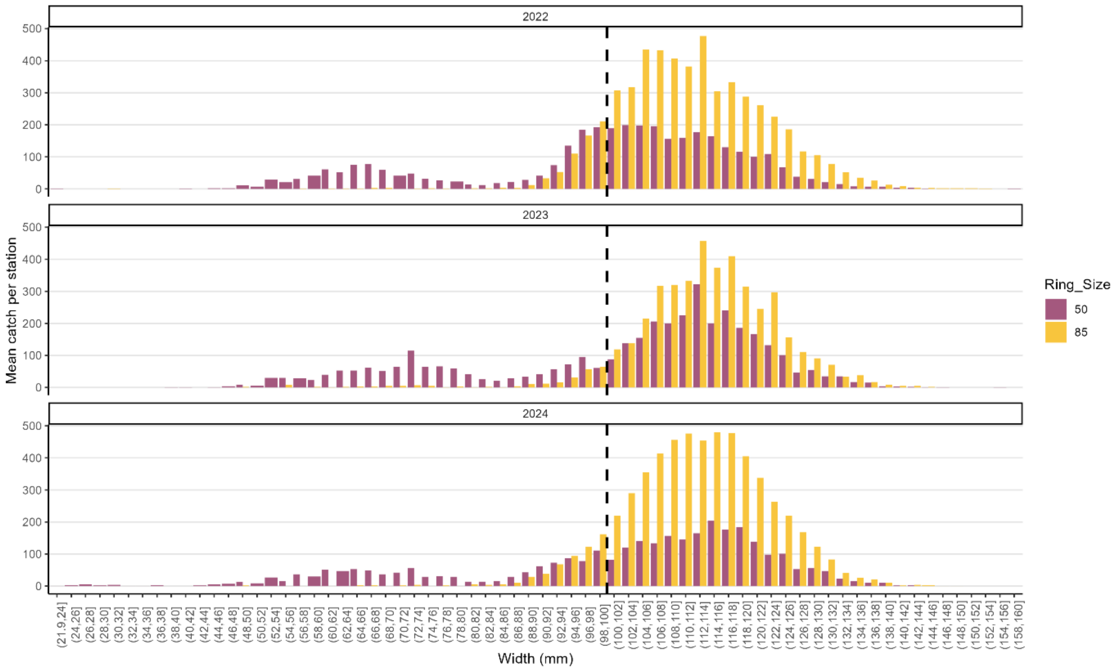

Figure 3.36 Size structure of scallop catch in the 55 and 85 mm ring sizes between 2022 and 2024.

3.12 England update: King scallop (*Pecten maximus*)

Cefas annual King Scallop stock assessment covers seven survey areas: five in the western channel, one in the approaches to the Bristol channel and one in the North Sea off the Yorkshire coast. The assessment uses four data streams: two dredge surveys, our Industry Self-Sampling Scheme (ISSS), an underwater video system survey and international landings. It aims to produce three outcomes: length distribution, estimates of harvestable biomass, and estimates of harvest rates relative to maximal sustainable yield (MSY).

Length distribution from the dredge surveys, recorded in 5 mm bins of the round shell length, was within the ranges seen within previous years. The Lyme Bay area (27.7.e.L) continued to experience the highest exploitation levels, consistently above the MSY target since 2017. Exploitation rates in the inshore (27.7.e.I) and offshore (27.7.e.O) areas of the western English Channel have consistently been below the respective MSY target since 2017.

3.13 Wales update: King scallop (*Pecten maximus*)

The Fishery

The scallop fishery in Wales is currently undergoing development of a Fisheries Management Plan (FMP) under the UK Fisheries Act 2020. This FMP is being jointly developed by England and Wales, but each nation will be responsible for translating the high-level plans into local implementation. The Marine Management Organisation (MMO) statistics shows that scallops (kings and queens) are the third most valuable species group landed into Welsh ports at a value of £2.1 million in 2022. However, the fishery is also exploited by vessels landing into non-Welsh ports such as in Scotland and Northern Ireland.

Currently management measures vary spatially and are very fragmented. This is generally a result of historical jurisdictions, such as the Welsh Government jurisdiction out to 12 nm prior to UK's EU Exit, and historical North and South Wales Sea Fisheries Committees. Homogenization of management is a key objective of the FMP, unless biological relevant stock structure indicates spatial management differences are needed. Current management across key scallop grounds inside 12 nm from shore include a Minimum Landing Size (MLS) of 110 mm shell length, an open season from November 1–30 April, areas closed to towed gear (e.g. Cardigan Bay Special Area of Conservation (SAC)), gear limitations and boat power limitations that vary between 3 nm, 6 nm and 12 nm from shore, and VMS on all boats with a 15 minute ping rate.

Landings data are currently available back to 2000, by ICES rectangle through the WGScallop data call, although the quality of these data in earlier years is debated There are specific concerns around under reporting prior to the introduction of "buyers and sellers" legislation in 2006/07, and data from Scottish vessels are missing in 2000 and 2001. The "buyers and sellers" legislation made it a requirement for first sale of landings to be reported, with boat details, date of landing, and weight of catch. Other sources of fishery-dependent data include e-logs, paper logbooks, monthly shellfish returns and recently Catch App – depending on size of boat. There was a large increase in landings after 2006, up to a maximum of over 4000 t in 2008, with rapid decline to a low of 287 t in 2017 in the main Cardigan Bay fishing ground (Figure 3.38). Recent catches have shown an increasing trend. Current effort data are of poor quality, with effort reported differently depending on the size of the boat. This makes a landings per unit effort index difficult to calculate.

Fishery-independent Survey

There has been an annual fishery-independent survey in Welsh waters since 2012 (except 2015). The timing of this survey within the year has been opportunistic and has varied considerably.

The survey is undertaken on the RV Prince Madog and uses a single dredge bar with four Newhaven dredges. Two of these are “king” dredges that replicate the commercial dredges used in the fishery, with 80 mm belly ring size, and the other two are smaller “queen” dredges with 60 mm belly ring size. The dredges are towed for 20minutes at each station. No dredging is allowed inside 1 nm in Wales, so some camera work is undertaken inside this area, although these data are not currently utilized as more research is needed to understand how camera data compares to dredge catches. Total survey effort (100 tows) was allocated using spatial management strata. Within each strata a minimum of five stations were required, and the historical variance in density estimates within each stratum was used to allocate the number of stations per strata via Neyman allocation. These stations were then randomly spread, with a minimum of 2 km between stations. The strata include spatial areas that were both open and closed to commercial fishing. The closed area in Cardigan Bay had a peak in mean density in 2022, at over 11 scallops per 100 m^2 (from queen dredges, so including smaller scallops) (Figure 3.39). The densities inside the closed area in Cardigan Bay were 1.85–7.1 times the density of the scallops in the fished areas (from queen dredges). The densities across the closed area were very patchy (Figure 3.39) with much of the high densities being seen in an area called the “experimental box” and increasingly higher densities have been observed in the western part of the SAC in the last two years (see Figure 3.41 for map of areas).

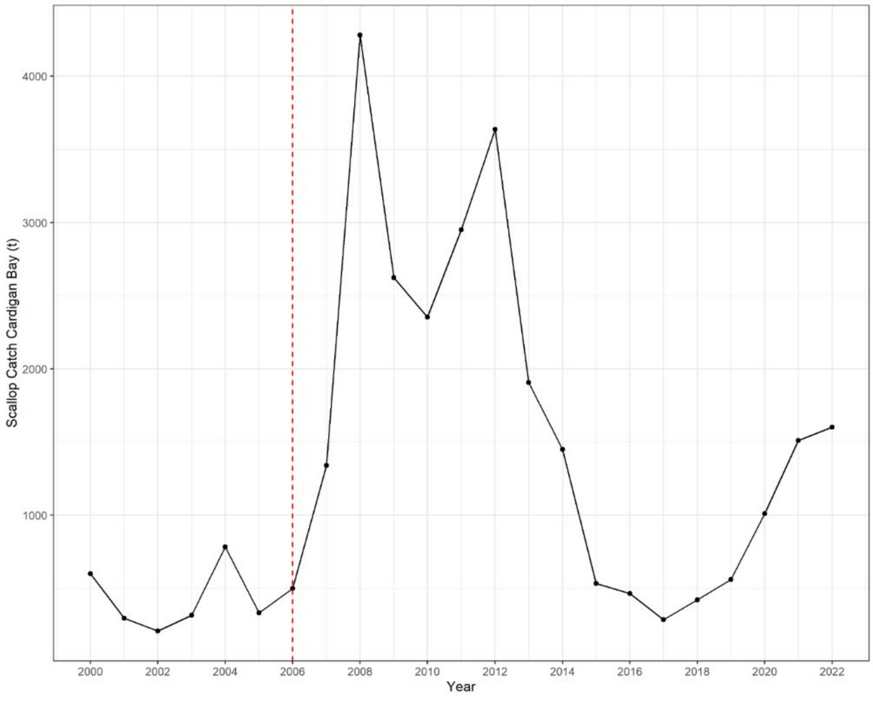

Figure 3.37 Landings of scallops from Cardigan Bay, Wales. Data from ICES WGScallop data call, by ICES rectangles, apportioned to Welsh waters using representative area to proportionally allocate catch where rectangles are not fully inside Welsh waters. Vertical red line indicates the start of “Buyers and Sellers” landings reporting in addition to fisher logbooks.

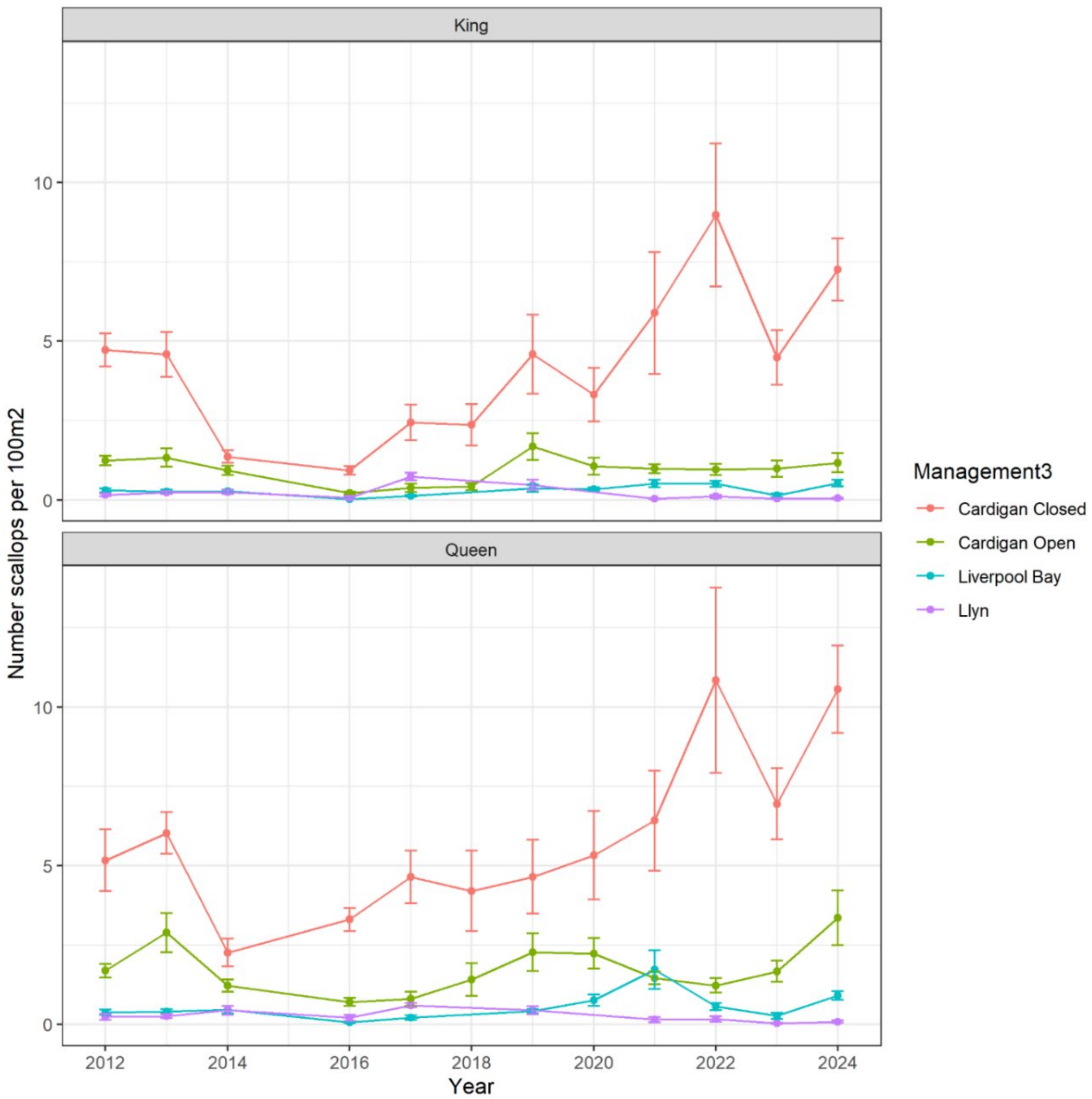

Figure 3.38 Density estimates of King Scallops by area in Welsh waters. The top panel shows densities (number of scallops caught – no correction for catchability) from "king" Dredges (80 mm belly ring size) and the bottom panel using "queen" dredges (60 mm belly ring size, catching larger number of undersized scallops). For map of areas see Figure 3.41.

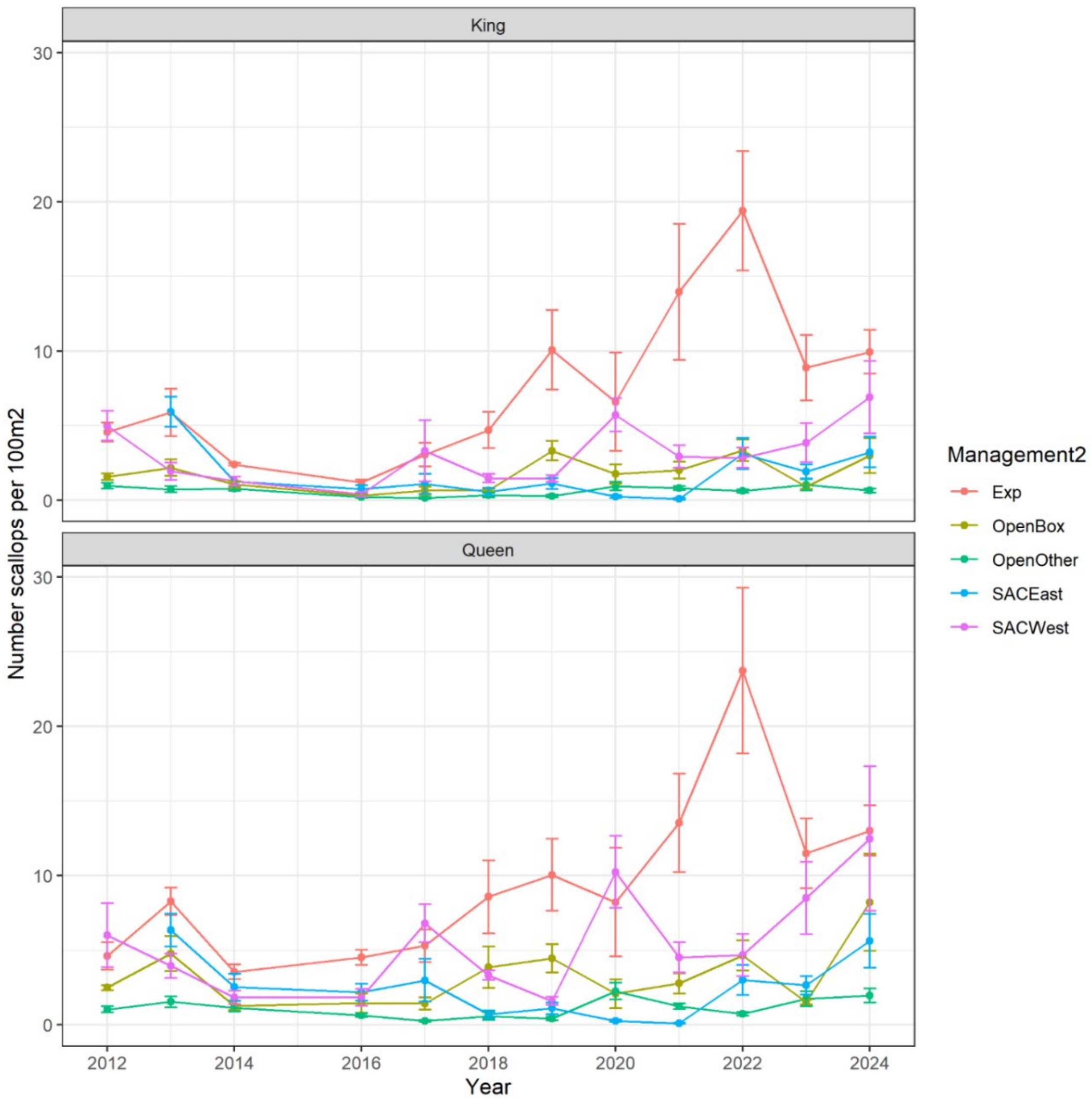

Figure 3.39 Density estimates of King Scallops by fine spatial scale areas in Cardigan Bay, Wales. The top panel shows densities (number of scallops caught – no correction for catchability) from "king" Dredges (80 mm belly ring size) and the bottom panel using "queen" dredges (60 mm belly ring size, catching larger number of undersized scallops). For map of areas see Figure 3.41.

Size frequency data showed temporal and spatial variation (Figure 3.40). For some years in some locations, large recruitment peaks can be seen (e.g. "Open Box" 2019), although overall there is little difference between the size structure in fished and closed areas.

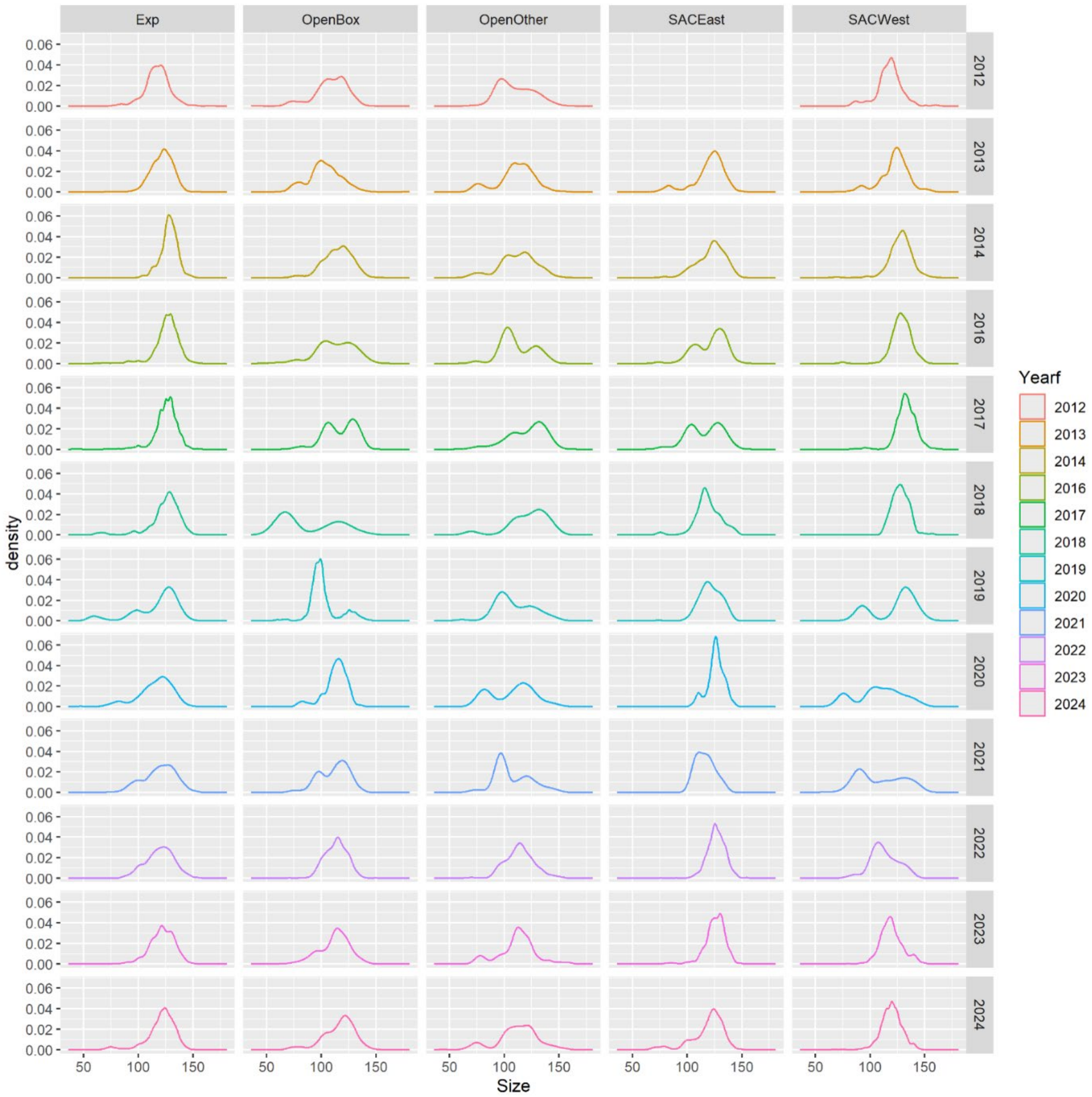

Figure 3.40 Length density plots for king scallops in Welsh waters. Size is the shell length in mm. For a map of areas see Figure 3.41.

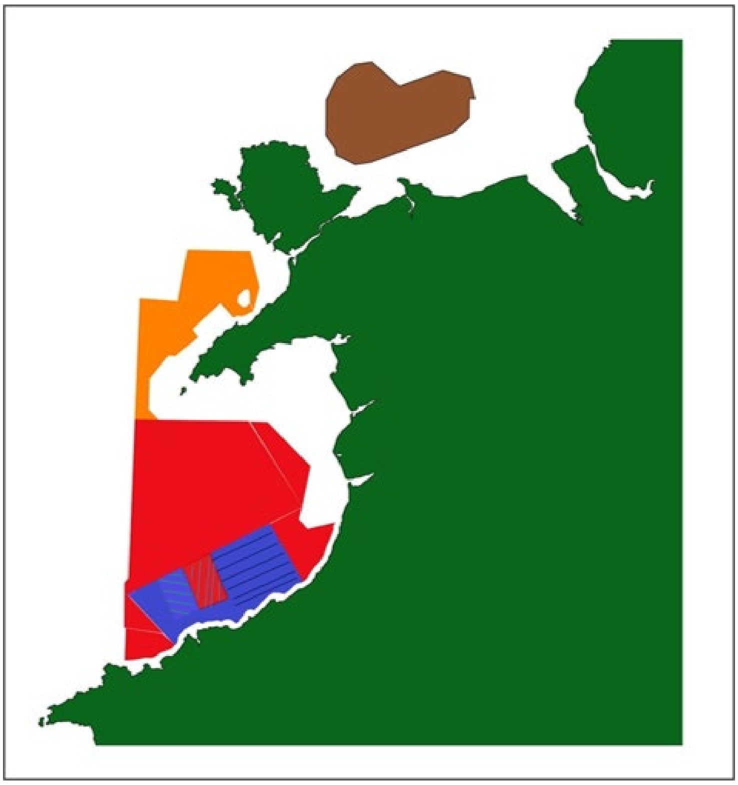

Figure 3.41 map of areas utilized in data analyses for the Welsh king scallop fishery. Brown represents survey area for Liverpool Bay, orange = Llyn Peninsula, red = Cardigan Bay Open (blue lines is Open Box), Blue = Cardigan Bay Closed (black lines = SAC East, purple lines = Experimental Box, no lines = SAC West).

Life-history parameters have been calculated for each area and are shown in Table 7. Length at infinity is generally lower in closed areas, although whether this is due to fishing adaptation or differences in habitat and environment is unknown. There has not been enough data to calculate size at maturity for the Llyn Peninsula fishery. In the northly Liverpool Bay fishery, the size at which 50% of scallops are mature (L50) is 95 mm shell length and in Cardigan Bay 87 mm shell length.

Table 7 Life-history parameters for king scallop in Welsh Waters. See Figure 4 for map of areas. L_{inf}, k, and t_0 are parameters from von Bertalanffy growth curves, wbeta and walpha are parameters from the length-weight relationship ($w = a+L^b$) and L_{50} and L_{95} are the size at which 50% and 95% of the scallops are expected to be sexually mature respectively.

Management Area	Linf	k	t0	wbeta	walpha	L50	L95
Liverpool	149.7	0.30	-0.87	2.65	0.0005	95	117.4
Llyn	154.9	0.21	-2.50	2.40	0.0020	NA	NA
Open Box	146.1	0.29	-1.04	2.68	0.0005	87.4	106.6
Open other	166.4	0.18	-2.07	2.58	0.0008	87.4	106.6
SAC West	141.4	0.42	0.34	2.65	0.0006	87.4	106.6
Exp	137.1	0.43	-0.01	2.63	0.0006	87.4	106.6
SAC East	137.8	0.46	-0.06	2.48	0.0013	87.4	106.6

4 AQUARIUS: Horizon EU Project

WG members discussed options to be involved in a joint project. AQUARIUS is a Horizon Europe funded project providing funded transnational access to a wide portfolio of marine and freshwater infrastructures ranging from research vessels to fixed mobile facilities, drones to satellites and river super-sites. Full access to the research infrastructures including logistical, technological and scientific support and a budget towards Users' own Travel and Logistics budgets is available.

The first call for proposals is now open from 11 November until the 20 January 2025 (Figure 4.1) and is seeking proposals prioritizing the themes, scientific and societal challenges in the EU Mission Lighthouse Regions as specified in the AQUARIUS Call Priority Report and Design and Definition of Transnational Access Calls report. Certain eligibility criteria applies.

All of the call documents including guidelines for applicants are available on the TA Calls section of the AQUARIUS website.

Figure 4.1 Funding call details for AQUARIUS.

5 ToR D: Continue to refine stock structure using best available information on genetics and larval dispersal and improve current mapping of scallop stocks. Establish links with WGOOFE to collaborate on specific work area.

To refine stock structure and improve mapping of scallop stocks, studies on genetics and larval dispersal have been conducted to identify connectivity between scallop beds and settlement patterns of scallop larvae. At the ICES WGScallop 2023 meeting, updates were provided by two PhD students from Heriot-Watt University and Strathclyde University, focusing on genetic analyses and larval dispersal modelling for Scotland. The WG was also introduced to MerMADE, a larval dispersal model implemented in Northern Ireland to support recovery plans for local fisheries facing low scallop densities.

During the ICES WGScallop 2024 meeting, final outcomes of the genetic studies on king scallop in Scotland were presented by Heriot-Watt University, alongside updates from Strathclyde University, the Agri-Food and Biosciences Institute (AFBI), and Bangor University on larval dispersal modelling in Scotland, Northern Ireland, and the North Irish Sea, respectively.

- Heriot-Watt University presented genetic findings on *P. maximus* in Scotland, revealing no complete reproductive isolation across Scottish scallop beds, though evidence of genetic isolation within specific genomic regions was observed. The project, scheduled for completion in November 2024, will have its findings circulated among the working group members in early 2025.
- The University of Strathclyde presented updates on their larval dispersal model, which aims to address the question of connectivity among Scottish scallop beds. The model, originally introduced to the WG in 2023, has been explored under different settings and preliminary results were shown at the 2024 meeting. It is expected that finalized outcomes will be reported at the next ICES WGScallop meeting, as the relevant PhD project will come to an end shortly after that.
- AFBI presented the results of the NI scallop larval dispersal model which was prepared to address the question on where scallop larvae spawned from NI scallop enhancement sites would settle. The MerMADE model, developed at the University of Aberdeen, was used to show the expected location of settlement.
- Bangor University are undertaking a king scallop larval dispersal modelling study to investigate connectivity among scallop grounds in the North Irish Sea, with a particular focus on Isle of Man stocks. The outputs from this project, which is due to be completed by summer 2025, will be presented at the next ICES WGScallop meeting (October 2025).

5.1 Genetic findings on *Pecten maximus* in Scotland

The WG received an update on an ongoing PhD project at Heriot-Watt University, focused on understanding genetic connections among king scallop populations across Scottish and North English waters. This research is part of the Project UK Fisheries Improvements (PUKFI), a collaborative effort with the Marine Stewardship Council to improve the environmental sustainability of UK scallop fisheries.

Recent studies on the genetic structure of king scallops across the North Atlantic have revealed a complex pattern, with two main genetic groups separated by the Norwegian Trench: one in Norway and the other across the rest of the North Atlantic (Hold *et al*., 2021; Morvezen *et al.*, 2016; Vendrami *et al*., 2019). Within the Atlantic group, a weak genetic structure was observed from Spain to the UK (Morvezen *et al.*, 2016) and in the Irish Sea and English Channel (Handal *et al.*, 2020; Hold *et al.*, 2021). This genetic landscape has been interpreted as a result of the mixing of scallop populations by larval dispersal, low genetic drift due to large effective population sizes, and possible cohort effects driven by temporal variability of reproductive success (Eldon *et al*., 2016; Morvezen *et al*., 2016; Hold *et al*., 2021). Identifying specific areas in the genome where these differences occur is crucial to understanding the genetic processes that affect population dynamics and fisheries management (Hauser and Carvalho, 2008; Hohenlohe *et al*., 2021).

In the project at Heriot-Watt University, a population genomic approach using whole-genome sequencing was used to identify two main patterns in scallop populations in northern UK waters. The first pattern showed 15 specific structural variations, called chromosomal inversions, which grouped individual scallops independently of where they were sampled (Figure 5.1). Chromosomal inversions, where segments of chromosomes are rearranged, are known to help species adapt to local environments and form different ecotypes (Johannesson *et al.*, 2024; Wellenreuther and Bernatchez, 2018 and references therein). These findings align with work by Hollenbeck *et al.* (2022), who linked chromosomal inversions to sea temperature in *P. maximus*, suggesting that these structural variations may influence the timing of oocyte maturation and larval spawning. When these chromosomal inversions, which represent 9% of the dataset, were excluded from the analysis, a secondary pattern emerged, showing a shallow geographical gradient consistent with previous studies (e.g. Harringmeyer and Hoekstra, 2022; Mérot *et al*., 2021) (Figure 5.2). These chromosomal inversions, which comprised 9% of the whole dataset, collectively contribute to strong genetic differentiation in specific genomic regions without preventing complete reproductive isolation across scallop populations.

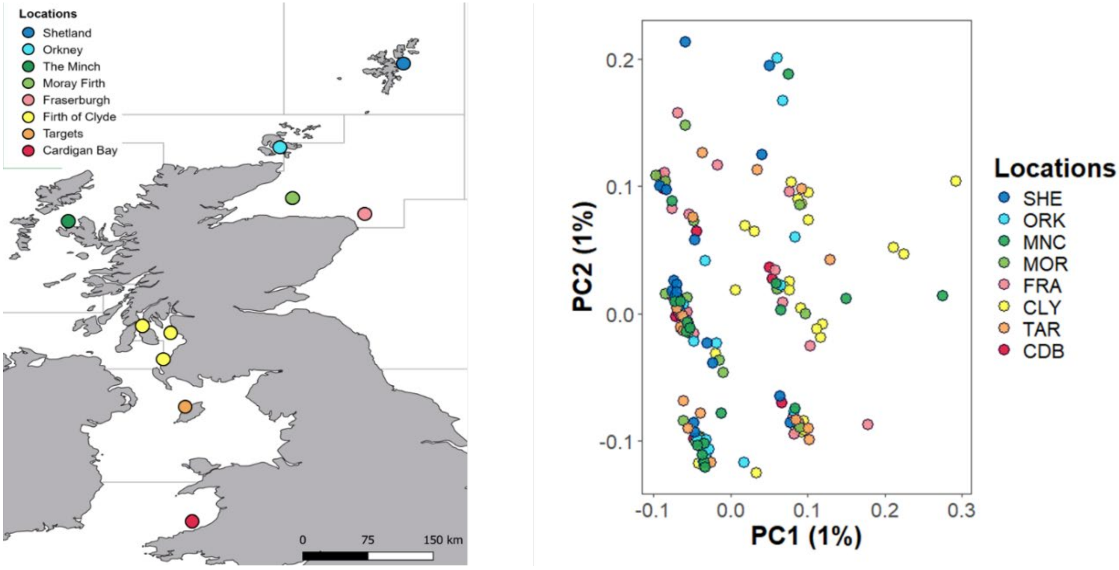

Figure 5.1 (Left) Sampling locations for genetic analysis (Right) Plot of the firstvs.the second Principal Component for 160 scallops coloured by locations and 3,024,287 single nucleotide variants (SNPs). Each point represents one individual; the percentage variance explained by each axis is shown in parenthesess.

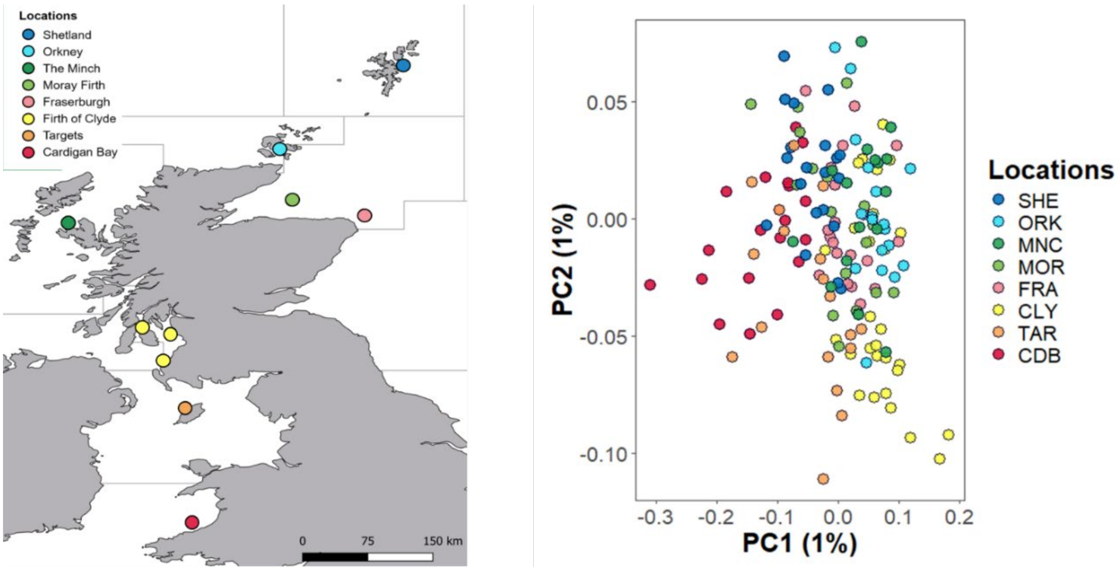

Figure 5.2 (Left) Sampling locations for genetic analysis (Right) Plot of the firstvs.the second Principal Component for 158 scallops coloured by locations and 2,730,287 single nucleotide variants (SNPs). Each point represents one individual; the percentage variance explained by each axis is shown in parenthesess.

5.2 Scallop Larval Dispersal, Scotland

In 2023 the WG received an update from a PhD student based at the University of Strathclyde who has been working on larval dispersal modelling applied to Scottish scallop beds. The domain of their study encompasses the whole of Scotland, and their release zones can be found in Figure 5.3. As explained in more detail in the 2023 WG report, the student derived these zones by combining publicly available fishing intensity data as well as declared locations of Scottish scallop surveys.

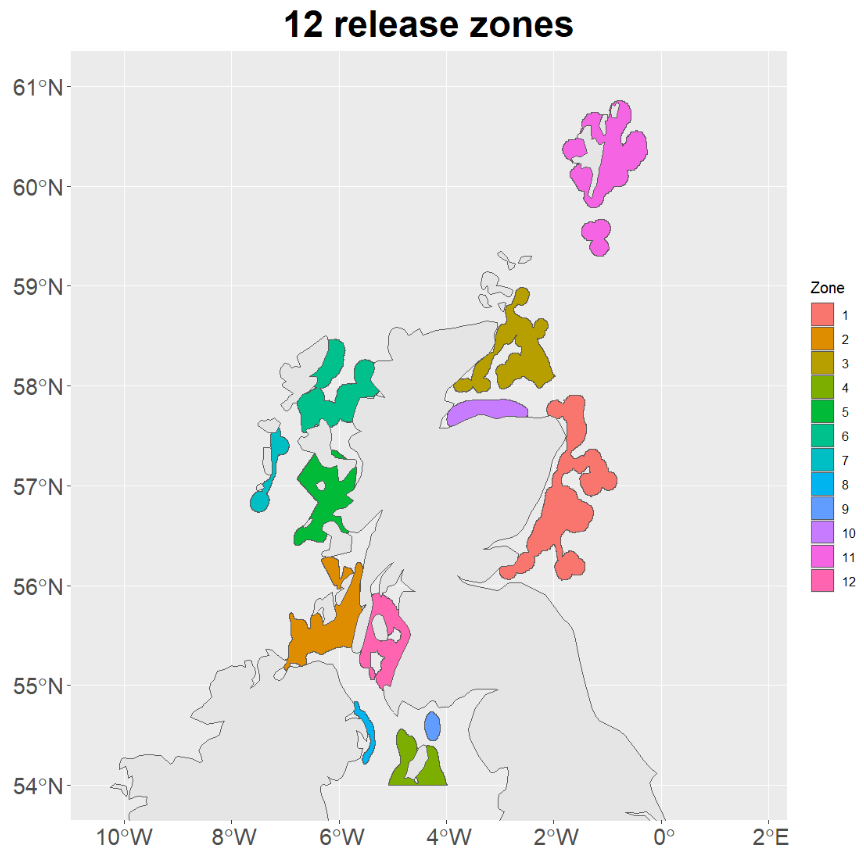

Figure 5.3 12 zones from which particles are released for each simulation.

The larval dispersal model used (FISCM) and was originally developed for salmon and subsequently adapted to scallop larvae. FISCM calculates particle paths based on local hydrodynamics, for which it requires forcing flowfields as input. In this case, climatological outputs from the Scottish Shelf Model were used. The tracker included both advection and diffusion processes, with the latter modelled as a random walk. In this version of the program, particles were transported passively by the currents and were kept at a fixed depth with respect to the sea surface.

FISCM accepts user defined parameters that are used to run the simulations. A list of parameters whose effects on the model have been explored can be found in Table 8.

Table 8 List of parameters explored for sensitivity analysis.

Parameter name	Range tested	Function
Time-step	5 min–24 h;	Determines the integration time-step.
Diffusion coefficient	5 m^2/s – 100 m^2/s	Determines the diffusion.
Release depths	5 m-40 m	Specifies depth at which to release particles.
Number of particles per grid point	5–20	Captures effects of diffusion.
Grid spacing	0.1–0.05 degrees lon/lat	Improves resolution of flowfields.
Timing of spawn	May/August	Specifies the times when to release particles.

The time-step for the integration of the particle location was set to 15 minutes, as a compromise between computational costs and accuracy of the model. Transport was assumed to be in a low diffusivity environment, with a diffusion coefficient of $10m^2/s$.

A sensitivity analysis was performed for depths between 5 m and 40 m. Outputs from simulations show that particles kept at 40 m tend to remain in their zone of origin more than particles released at 5 m or 10 m. Particles released in shallower depths tend to mix more between zones. An example of comparing outputs between 5 m and 40 m release depths can be seen in Figure 5.4.

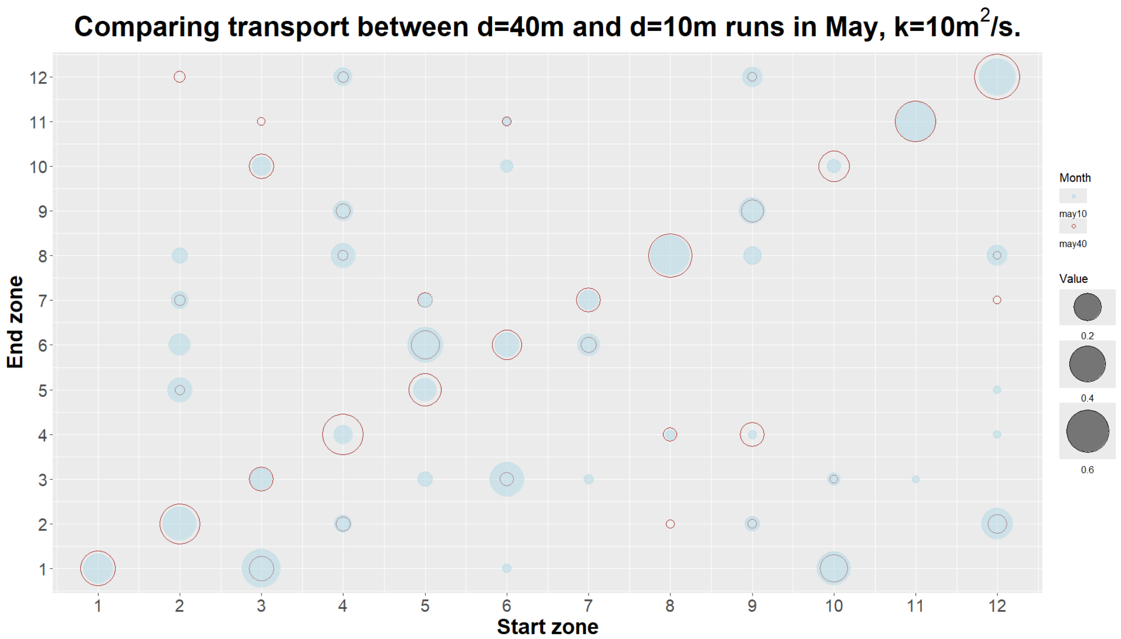

Figure 5.4 Connectivity matrices for runs at 10m (blue fill) and 40m (red circle) in May. Each circle represents the number of particles released from zone A which settle in zone B, divided by the number of particles released from zone A. The release location A is indicated by the column number and the settling zone B is indicated by the row number. The area of each circle scales with the proportion of particles recorded in each matrix cell, so that a larger circle indicates a larger proportion of particles exchanged between two zones. Notably, for 40 m, the circles on the diagonal are larger for all zones except zone 9, suggesting higher retention for simulations with deeper release depth.

Preliminary results (Figure 5.5) from a single run at higher resolution seem to indicate that there is little difference between a simulation run with a 0.1 degrees lon/lat spacing and one with a 0.05 degreed lon/lat spacing. The lower bound for these would be determined by the resolution of the forcing flowfields, which is variable and has a median resolution of 2 km (~0.01 degrees lon/lat).

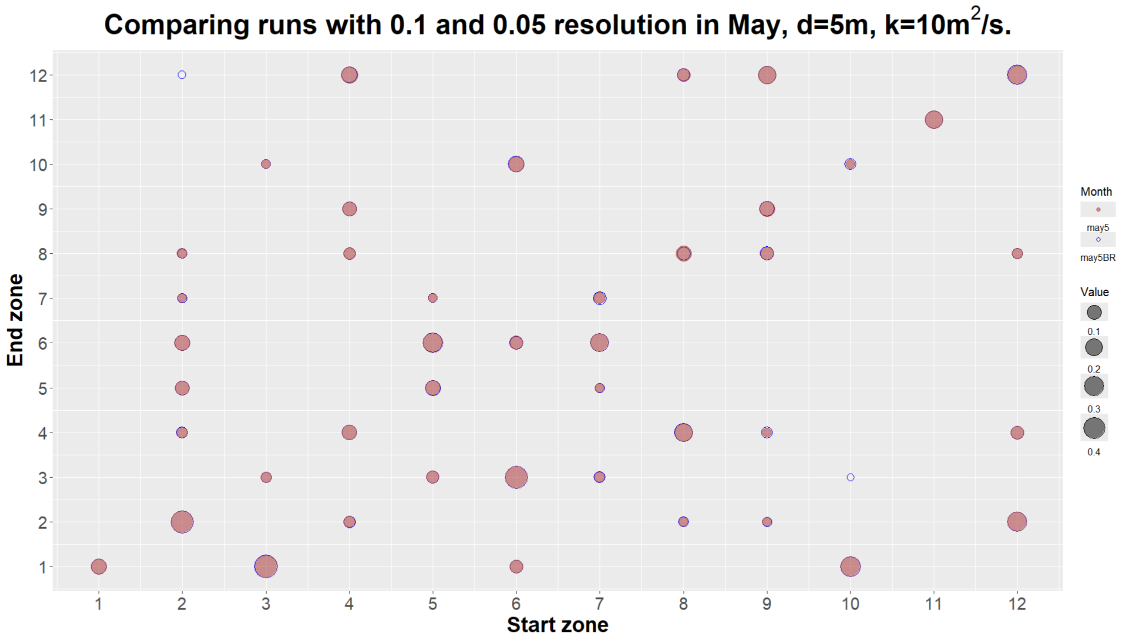

Figure 5.5 Comparison of runs at higher and lower grid spacing resolution.

The effect of varying spawning time was also explored. Two release times, one for Spring and one for Summer were picked. For a release depth of 10 m, larvae spawning in May seem to experience more mixing between zones than those spawning in August. Further investigation on the effects of different release time is underway.

Looking at the overall picture, for release depth of 5 m and release time May 1st, zones 1, 2, 4, 8, 11, and 12 show higher rates of retention than exchange with other zones, with zones 2, 8 and 11 having the highest retention overall. Moreover, zones 2, 4, 7, 9, and 12 (which are located to the west of Scotland, and near the Clyde and the North Irish Sea) display higher amount of exchange than in other areas.

It is expected that the analysis of the tracker outputs will be finalized in the next few months. Once completed this will be coupled with a Dynamic Energy Budget model to mathematically represent scallop stocks around Scotland.

5.3 Scallop Larval Dispersal, Northern Ireland

In 2017 the Northern Ireland Scallop Fisherman's Association (NISFA) were proactive in approaching the Agri-Food and Biosciences Institute (AFBI) to examine the possibility of reseeding scallops to enhance the NI scallop stock. A study carried out by AFBI showed that four sites had potential for future scallop enhancement (Figure 5.6). At the time of site selection there were no models available to determine the potential location of settlement of the larvae produced from the scallops within the enhancement sites. With scallop larvae drifting in the water column for 3–4 weeks before becoming able to swim, larvae can potentially move great distances from the location where they were spawned. AFBI partnered with Dr Rebekka Allgayer (University of Aberdeen), the developer of the MerMADE model, to address the question on where scallop larvae spawned from the scallop enhancement sites would settle.

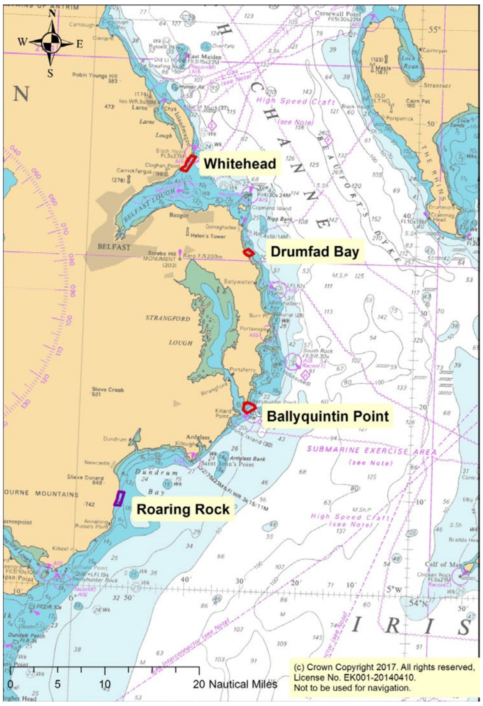

Figure 5.6 Sites selected for scallop enhancement. Sites in red were identified as most suitable during the reseeding study and engagement with the NISFA. Roaring rock was added following engagement with NISFA as a site with reseeding potential.

MerMADE is a coupled biophysical, eco-evolutionary modelling software for predicting population dynamics, movement, and dispersal evolution in aquatic environments (more details available at [MerMADE: Coupled biophysical, eco-evolutionary modelling for predicting population dynamics, movement and dispersal evolution in the marine environment | bioRxiv]). Following developments to the model functionality to account for the life history of scallops, the model was applied to the four scallop enhancement sites using dates chosen to cover both spring and autumn spawning periods. Of the four enhancement sites, larvae spawned from Whitehead had the highest incidence of settlement within Northern Ireland waters (Figure 5.7). Larvae from the other three enhancement sites was shown to have lesser or no settlement within Northern Ireland waters.

Based on these model outputs, the NISFA requested other sites be examined as potential enhancement sites that would show settlement within NI waters. It was decided that current Marine Protected Areas (MPAs), which are already closed to scallop fishing, be examined. The suggested sites were:

1. Skerries and Causeway MPA
2. Rathlin Island MPA
3. The Maidens MPA
4. Outer Belfast Lough MPA

The additional sites, which were modelled only for spring dispersal, showed a higher success in terms of scallop larval settlement within NI waters. The Maidens showed settlement aggregations throughout NI waters on each of the dates modelled (Figure 5.8). The area of Muck Island/Moyle Interconnector, close to the Maidens MPA, was investigated during the 2017 site selection scoping exercise. This area was shown to be suitable for scallop settlement and survival scoring favourably across all site characteristics. However, discussions with NISFA led to the current four sites being selected above this area at that time. Based on these model outputs, it is recommended that the Maidens MPA is the most suitable site, of those investigated during this study, for survival of scallops (juvenile and adult) and because dispersal of the scallop larvae from this site showing successful settlement within NI waters.

The full report for this larval dispersal study is available at [Final Scallop Enhancement Report 2024 | Agri-Food and Biosciences Institute](#).

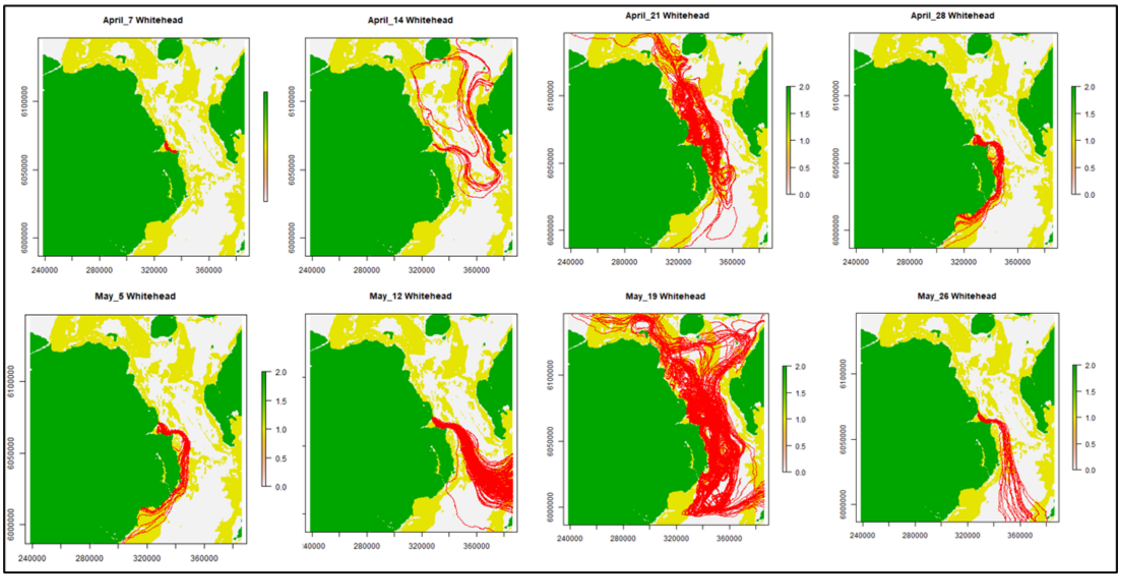

Figure 5.7 Modelled movement of larvae released from Whitehead between 7th April and 26 May 2022 and predicted sites of successful settlement (red dots) occurring within the model study area.

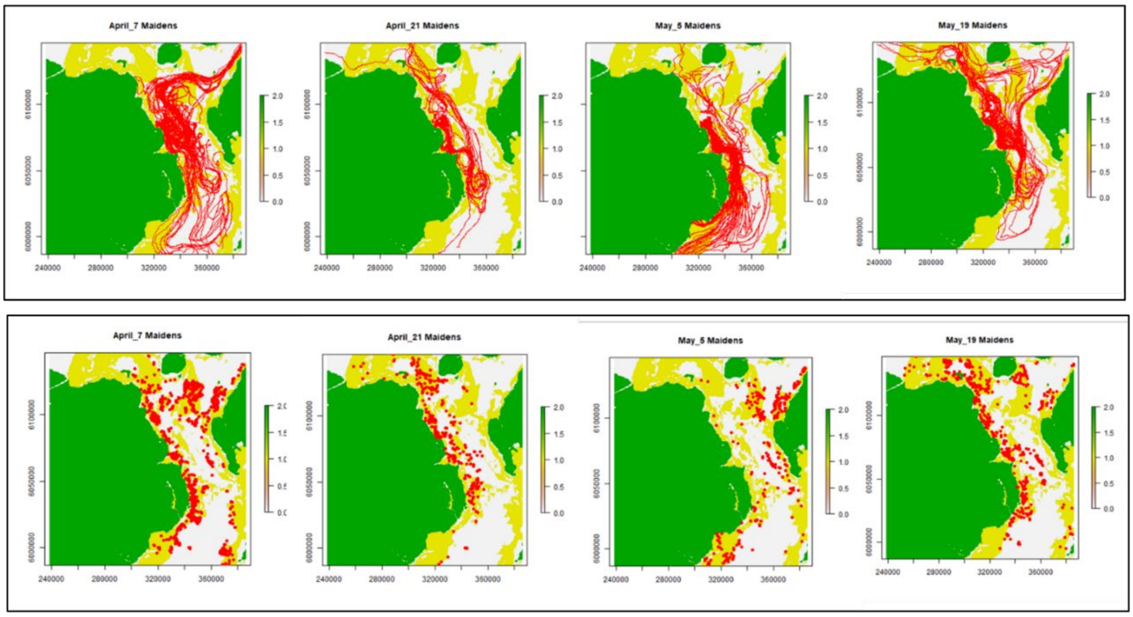

Figure 5.8 Modelled movement of larvae released from Maidens MPA between 7th April and 19th May and predicted sites of successful settlement (red dots) occurring within the model study area.

5.4 Scallop Larval Dispersal, Isle of Man

A larval dispersal model for king scallops in the north Irish Sea is under development by Bangor University. The main objective of the project is to understand the connectivity among king scallop beds within the north Irish Sea with a particular focus on Isle of Man king scallop stocks. The key questions that it is hoped the project will answer include:

- To what extent is scallop larvae released from grounds within Isle of Man territorial waters retained or exported.
- To what extent are Isle of Man king scallop fishing grounds reliant on scallop larvae exported from outside Manx territorial waters.
- Where is the end location of scallop larvae released from within closed areas within the 0–3 nm limit and a new area for lease for a windfarm within the 3–12 nm limit.
- Do fundamental differences in the dispersal of larvae between the 0–3 and 3–12 nm zones of the Isle of Man territorial waters exist?

Scallop beds within the north Irish Sea have been defined using existing polygons created by WGScallop and updated VMS and survey data from the Isle of Man and adjacent jurisdictions. Once defined a fishing effort index was also applied to each bed as a proxy for scallop density (i.e. areas with higher fishing intensity are assumed to have higher scallop density) and the index was then optimized using survey data. For beds with a higher index (i.e. higher assumed scallop density) a larger proportion of particles will be released when compared to beds with a lower index (i.e. lower scallop density assumed). For hydrodynamic forcing the model will use the operational Northeast Atlantic Model (NEATL), and a ROMS model was used with a horizontal resolution of 2 km and 40 sigma layers to provide currents and temperature fields. For the particle tracking model the OceanParcels model was used to simulate larvae transport. Particles motion will be driven by advection using a fourth order Runge-Kutta scheme with a 10-minute time-step, diffusion using a stochastic component with Kh = 10 m2 s-1 and vertical larvae behaviour. Particles will have the following properties with growth and size of larvae based on the temperature experienced. Larval stage and pelagic larval duration defined by larval growth and settlement status defined by whether larvae encounter a 'good' ground between reaching competency (i.e. achieving 240 microns within 50 days) and two weeks later. Seasonality will be explored by incorporating monthly releases from April to September (larvae will be released over one week to incorporate spring and neap tides). Annual variability will also be explored by running the model over multiple years (i.e. 2019–2022). It is anticipated that the results of this project will be presented at the next ICES WG Scallop meeting (October 2025).

6 ToR E: Review current biological parameters and any gear modification, technological advances, including electronic monitoring (EM) for scallop fisheries

6.1 Assessment of scallop dredge ring size selectivity in the western English Channel fishery

The king scallop (*Pecten maximus)* fishery in the English Channel/ La Manche is economically important to the Irish scallop dredge fishing fleet. The area encompasses ICES division 7.d (eastern Channel) and 7.e (western Channel). EU technical measures are in place in both ICES divisions including closed areas and different minimum conservation reference sizes (MCRS): 110 mm in 7.d; and 100 mm in 7.e.

Irish scallop vessels currently use 85 mm ring size and requested BIM to carry out a trial to assess the effects of increasing ring size in the western Channel (7.e) using representative fishing gear and practices. BIM conducted a trial in November 2023 on board the scallop dredger MFV Willie Joe from Co. Wexford. We assessed catches using 85, 92, and 97 mm ring sizes in relation to the scallop MCRS of 100 mm.

A total of 36 valid hauls were completed over 4 days in EU waters of 7.e. Less than 1% of the total number of scallops retained by all ring sizes measured less than the MCRS of 100 mm. There was no reduction in scallops ≥ 100 mm in 92 mm compared with 85 mm rings. There was however a significant reduction in scallops ≥ 100 mm up to ~ 110 m in the 97 mm compared with 85 mm rings. Although very few scallops < 100 mm were retained, catch curves demonstrated significant reductions in scallops < 100 mm in 92 and 97 compared with 85 mm rings. Link to report: https://bim.ie/wp-content/uploads/2024/03/Scallop-Ring-Size-Report-2024.pdf. An additional trial has been carried out in ICES 7.d, the eastern Channel, and the report is pending.

6.2 Remote Electronic Monitoring (REM) update, Scotland

Helen Holah presented an overview of the Scottish Government's (SG) Remote Electronic Monitoring (REM) programme on Scottish registered scallop dredging vessels and more latterly all scallop dredging vessels fishing in Scottish waters. REM is an integrated system composed of a central computer, GPS, suite of sensors and cameras, and is used as a compliance and scientific data collection tool. Data are collected onboard and transmitted over cellular/Wi-Fi/Satellite networks to SG servers from where it is accessed by the Fully Documented Fisheries unit team of trained British Sea Fisheries Officers in Peterhead. Since 2017 these officers have monitored: (1) that the number of dredges deployed by scallop vessels are compliant with The Sea Fisheries (REM and Regulation of Scallop Fishing) (Scotland) Regulations 2024; (2) that fishing activity is not undertaken in Marine Protected Areas; and (3) collected evidence where applicable to support gear conflict cases. These virtual inspections are risk based and are typically conducted retrospectively but systems also facilitate live views. To minimize the quantities of data transmitted a set of still images is requested to cover a gear deployment or retrieval event. The benefits of camera-based monitoring over other data sources such as VMS are that they can prove or disprove fishing activity on location, prove mitigating circumstances, and act as a deterrent. Equipping vessels with REM systems helps to increase transparency of fishing activity and modernise data collection for both regulators and fishers (who are the data owners in this programme). Research and development is also ongoing into artificial intelligence applications that allow privacy masking of fishers in camera views and automating analysis processes such as dredge counting and subsequently highlighting priority trips for review.

7 ToR F: Compare age reading methodologies and develop common practices and determine precision and bias of scallop age reading data derived from different readers

To address ToR F, the WKSA (Workshop on Scallop Aging) workshop series were undertaken to provide a platform to enhance information flow and progress shell aging processes across diverse fisheries, stocks and populations, vital for use in fisheries stock assessments and to inform any future ecosystem-based fisheries management.

The practical WKSA workshops explored age determination techniques and methodologies across institutes and populations. They examined the levels of agreement and consensus across both experienced and inexperienced agers. Participants received training in microscope age determination techniques for shells and resilia in the focal species of *Pecten maximus* as well as *Aequipecten opercularis* and *Placopecten magellanicus*. Overall outcomes included standard principles for exchanges, documentation of methodologies, confirmation of the issues of variability and suggested progress of partner institutes for aging reference sets and agreement to develop QC and age consensus parameters in line with methods for accredited otolith aging. The workshops promoted knowledge sharing to improve techniques and explored aging in other species such as queen scallop. The virtual scallop aging platform SmartDots (https://www.ices.dk/smartdots.aspx), was trialled to examine its use for future shell exchanges, feeding back suggestions that improve its use for exchanges.

Workshop reports and presentations are found in the ICES WKSA and WKSAII sites. https://www.ices.dk/community/groups/Pages/WKSA2.aspx . The executive summary and recommendations are described below. The WKSA2 group have made a series of recommendation to WGScallop for age determination in Scallops including:

a) Progress TOR a (3.1) 'consensus age a reference collection of scallop shells' with local 'partner-institutes'
b) The initiation of a draft document for scallop aging methodologies to record current methodologies used by each institute.
c) WGScallop stock assessors to identify and advise the acceptable percentage concordance rate needed in age reading for an age-based stock assessment. This will feed into QC parameters for scallop aging and training.
d) Future WKSA meetings to continue biennially, alternating between virtual and in-person meetings. Virtual meetings can be focused on method and QC development and in-person meetings on consensus aging and methods training.

TOR F will continue to examine age reading methodologies and common practices to provide a platform for information exchange and development of best practice. Most institutes undertake aging within their surveys to provide important age structure information for stock assessment. Over the next three years, the ToR will look to create and output an overarching age methods manual documenting current techniques applied at the different institutes. The ToR will also look to progress partner institutes for aging reference sets and define age consensus parameters in line to methods for accredited otolith aging. The focal species is king scallop (*Pecten maximus*), however other species are included as dictated by the group needs, such as *Aequipecten opercularis* and *Placopecten magellanicus*.

8 ToR G: Identify, list and collate all available data for queen scallops and agree on appropriate stock assessment areas. Share knowledge, draft a review paper and attempt stock assessments where possible.

A presentation was given that summarized the history of work within this ToR from its formation in 2020 to its current status. Progress has been made on various ToR elements through compiling a summary of the data held by the WG members (survey, monitoring, other), subgroup meetings and work towards drafting a review paper was reinstated. A review will be drafted for ICES areas (likely 4a,6a and 7a) to act as a template for other WG members to populate over the next ToR cycle. Themes may include an overview of the fishery, monitoring and surveys, identifying assessment / monitoring requirements, biology and growth. There is an existing unpublished report that can be used as a basis for the review paper contents but the aims of the review will be determined within the subgroup and then wider WG for input.

In addition, as part of ToR A, landings and effort data were collated for queen scallops (Table 9; Figure 8.1) with the majority of landings reported from ICES subarea VII. Note that data for the Isle of Man are not available before 2011 and data for Scotland not available prior to 2002.

Table 9 Provisional landings (live weight (including shell), t) of queen scallops for 2000–2023 by ICES subarea as submitted through the ICES data call. Data for the Isle of Man are not available prior to 2011 and data for Scotland are not available prior to 2002.

	ICES Subarea				
Year	**IV**	**VI**	**VII**	**VIII**	**Total**
2000	105.4	2.1	5104.3	19.4	5231.2
2001	159.1	100.3	9625	17.6	9902
2002	61	4688	11437.6	49.1	16235.7
2003	22.8	1253.5	11507	43.2	12826.5
2004	33	1494.4	7140.7	63.5	8731.6
2005	18.5	1284	9028.1	74.4	10405
2006	21.7	1413.4	8971.4	110.7	10517.2
2007	12	80	13123.6	60.1	13275.7
2008	9.2	203.9	5260.8	51.6	5525.5
2009	16.2	1851.2	5607	91.5	7565.9
2010	11.3	2972.3	12691.8	116.3	15791.7
2011	11.1	3002.1	23520.1	130	26663.3
2012	36.4	4927	17335.9	35.4	22334.7
2013	20.9	2041.2	18864.8	25.2	20952.1
2014	8.8	1022.6	11003.3	47.7	12082.4
2015	17.5	90.2	14535.3	75.8	14718.8
2016	1238	136.3	11090.5	175.8	12640.6

2017	141.2	215.8	10480.4	197.6	11035
2018	66.4	75.9	9272.2	134.6	9549.1
2019	34.1	1.8	6170.8	78.5	6285.2
2020	6	0.7	5220.8	14.9	5242.4
2021	5.3	87.9	5265.6	31.6	5390.4
2022	6.3	1019.3	7949.3	69.4	9044.3
2023	21	564.1	7752.4	76.2	8413.7

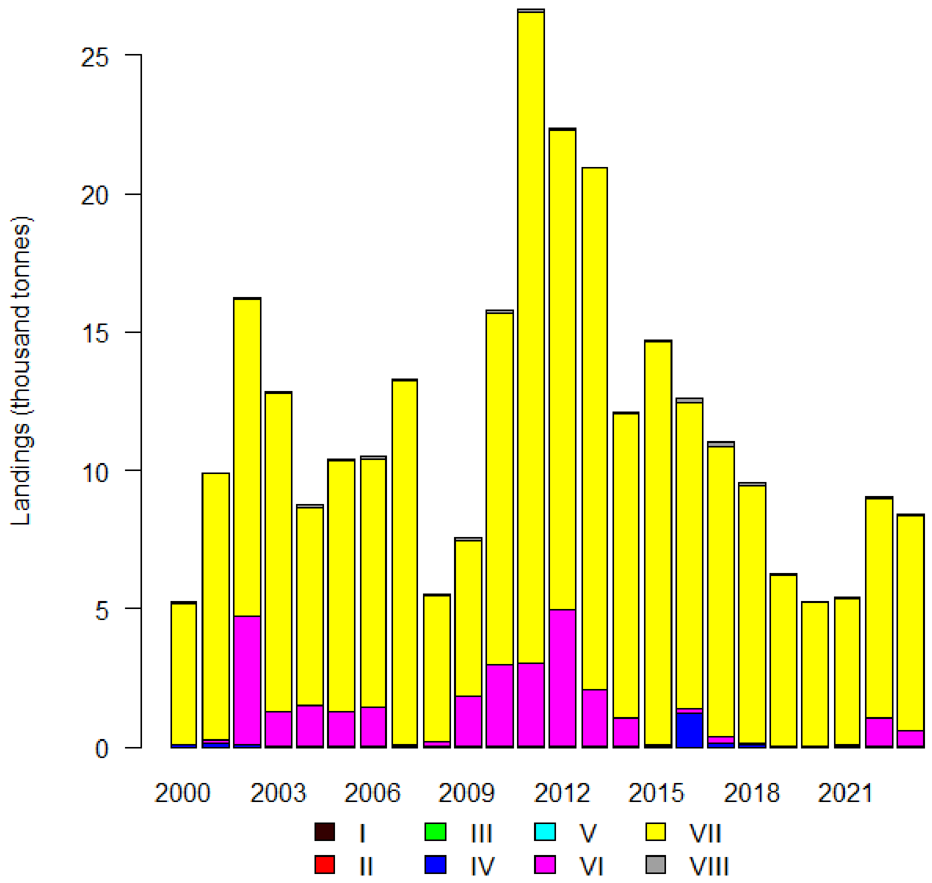

Figure 8.1 Annual landings (live weight (including shell), thousand tonnes) reported for queen scallops. Landings are by ICES subarea within each year as coloured by the legend. Data for Isle of Man are not included prior to 2011, and Scotland are not included prior to 2002.

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Annex 1: List of participants

Name	Institute	Country (of institute)
Adam Delargy	University of Massachusetts Dartmouth	United States
Bernadette Ni Chonghaile	Marine Institute	Ireland
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Karen Vanstaen	Cefas	England, UK
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Luis Ridao Cruz	Faroe Marine Research Institute	Faroe Islands
Lynda Blackadder	Marine Directorate, Scotland	Scotland, UK
Marija Sciberras	Heriot-Watt University	Scotland, UK
Massimiliano Cardinale	Swedish University of Agricultural Sciences	Sweden
Natalie Hold	Bangor University	Wales, UK
Rhei Ammaturo	University of Strathclyde	Scotland, UK
Samantha Blampied	Government of Jersey	Jersey
Shona Kinnear	Marine Directorate, Scotland	Scotland, UK

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Soizic Garnier	Bangor University	Wales, UK
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Annex 2: Resolutions

2022/FT/EPDSG01 The **Scallop Assessment Working Group (WGScallop)**, chaired by Lynda Blackadder, Scotland, UK and Isobel Bloor, UK will work on ToRs and generate deliverables as listed in the table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2022	3-7 October	Iceland	E-evaluation and interm report by November 2022	Lynda Blackadder
Year 2023	9-13 October	Tromso, Norway	E-evaluation and interm report by November 2023	New co-chair-Isobel Bloor
Year 2024	8-10 October	Bayeux, France	Final report by November 2024	New co-chair – Adam Delargy for next term

ToR descriptors

ToR	Description	Background	Science Plan Codes	Duration	Expected Deliverables
a	Compile and present data on scallop fisheries in ICES areas II, IV, V, VI and VII by collating available fishery statistics.	The WG established a data call but will address known issues and improve and streamline the process. Data reporting, presentation and options for long-term storage will be reviewed.	5.1	3 years	Include updated figures and tables in annual WG reports. Upload scripts to GitHub. Report on possible database options.
b	Review and identify stock assessment methods for scallop species. Consider available data (at stock level) for stock assessment input indices and/or for review of stock trends.	The WG has made considerable progress to develop stock assessment methodologies for scallop species and this work should continue. Links have been established with WGNSSK to further consider SPiCT for scallop stock assessment, and with WGOOFE.	5.1,6.3	3 years	Report on stock assessments methodologies and results for all stock areas and consider reference points. Formalize the checking process for stocks. Establish working relationships with WGNSSK and WGOOFE.
c	Review and report on current scallop surveys and share expertise, knowledge and technical advances.	Surveys continue to be important for data collection for scallop stocks and sharing knowledge of methodology and advances in technology is important as electronic monitoring	1.5, 4.4, 5.4	3 years	Dredge efficiency review paper (link with ToR f). Scientific staff exchange on surveys. Report on EM and collaborate with WGSFD.

		and camera systems become more common.			
d	Continue to refine stock structure using best available information on genetics and larval dispersal and improve current mapping of scallop stocks. Establish links with WGOOFE to collaborate on specific work areas.	Undertsanding the biological stock area to determine if the assessment areas are apropriate. A number of new members have recently joined the WG and it is hoped the PhD projects can support this ToR.	1.4, 1.8	3 years	Report on PhD progress. Maps for each of the scallop stock areas.
e	Review current biological parameters and any gear modification, technological advances, including electronic monitoring (EM) for scallop fisheries.	Several biological parameters are important for analytical assessments. Differences in growth rates will be examined in detail. The group are reviewing dredge efficiency.	5.1, 5.2	3 years	Dredge efficiency review paper (link to ToR d). Report on growth studies.
f	Compare age reading methodologies and develop common practices and determine precision and bias of scallop age reading data derived from different readers.	Most institutes rely on aging methods and so this work is still important to continue.	4.4, 5.1	3 years	Attend WKSA. ICES TIMES document on aging methodologies.
g	Identify, list and collate all available data for queen scallops and agree on appropriate stock assessment areas. Share knowledge, draft a review paper and attempt stock assessments where possible.	The WG would like to focus more attention on this species. A subgroup will be formed to lead on this. Data are already collected through the data call and surveys.	5.1, 6.3	3 years	Report on progress. Draft a review paper. Create maps of stock areas.

Summary of the Work Plan

Year 1	Linked to ToR; a) Refine data call, highlight and address issues. b) Continue to explore index standardization and stock assessment methodologies including surplus production model for scallop stocks (and establish closer links with other assessment WGs (WGNSSK) c) Apply a SPiCT model for the Isle of Man, using survey and CPUE (VMS/logbook) indices standardized with VAST. Continue to explore other alternative models and establish communications with WGOOFE. d) Continue to report and share knowledge of surveys and plan for scientific staff exchange. f) Dredge efficiency review paper h) Form subgroup for queen scallop work Establish links with WGNSSK, WGSFD and WGOOFE with regular communications

Year 2	Linked to ToR; a) Data call - streamline and document checking process (upload scripts to GitHub) b) Review scallop ICES stock categories and discuss possible reference points (following ICES guidelines from WKREF2) c) Incorporate other spatial areas and environmental variables from the Irish Sea (collaborative work with WGOOFE) d) Undertake scientific staff exchange on scallop surveys. g) TIMES document on aging methodologies in collaboration with WKSA
Year 3	Linked to ToR; a) Data call – need to consider long-term storage options (central database/RDB) b) Set up a more formal checking and review process for stock assessments c) Produce Viewpoint and Management Strategy Evaluation of Irish Sea scallops. d) Report on electronic monitoring (EM) for scallop fisheries and collaborate with WGSFD to produce mapping products. h) Queen scallop review paper

Supporting information

Priority	The current activities of this Group will lead ICES into issues related to the ecosystem effects of fisheries, especially with regard to the application of the Precautionary Approach. Consequently, these activities are considered to have a very high priority.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are already committed. The resource required to undertake additional activities in the framework of this group is negligible.
Participants	The Group is normally attended by 25–30 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and grou[under ACOM	There are no obvious direct linkages as this WG does not currently provide advice but we have discussed the possibility of developing a Viewpoint in cooperation with ACOM leadership for the work we are progressing for an Irish Sea stock assessment for king scallops.
Linkages to other committees or groups	There is a very close working relationship with WKSA, and we have provisionally agreed to work with members of WGOOFE, WGSFD and WGNSSK. Communication links have been established and the chair will seek to formalize agreements.
Linkages to other organizations	None

Annex 3: WGScallop Data

Table 10 Landings of king scallops (live weight, tonnes) by ICES statistical rectangle and year within ICES Subarea VIIa (Irish Sea). 2023 data are provisional.

Year	33E2	33E3	33E4	33E5	34E3	34E4	34E5	35E3	35E4	35E5	35E6	36E3
2000	16.5	92.2	396.1	298.5	0	58.7	37.8	33.8	34	111.4	43	27.9
2001	4.5	90.9	248.3	126.6	1.1	31.5	2.5	15.8	30.2	83.3	109.2	31.9
2002	0	40.5	133.4	102.6	0	51.1	1	2	3.2	111	58.1	3
2003	18.6	89	90.3	250.8	0	16.3	1.6	5.2	5.3	25.6	66.2	23
2004	24.1	160.8	154.1	645.4	8	15.4	45.3	4.3	0.9	61.3	24.4	5.3
2005	26.8	180.9	13.2	319.8	0	0.3	4.4	0	0	87.2	49.1	7.6
2006	43.7	330.4	54.9	446.9	0	0.3	24	3.2	0.5	22.4	6.9	0
2007	18.1	345.9	160.1	1167.4	4	1.9	89.4	6.1	2	95	11.2	7.4
2008	43.7	241.7	220.3	3961.9	0	25.4	215.4	0	0.2	111.8	3.3	8.6
2009	47.9	100.8	180.1	2309.5	0	0	249.8	0	1	116.7	217.6	2.8
2010	6.4	135.7	84.2	2014.2	0.5	5.3	353.6	0	0.5	223	48.7	11.3
2011	31.8	325.3	67.3	2613.1	4.5	3.9	365.2	0.9	91.1	245.8	67.3	37.9
2012	48.6	479.3	59.3	3392.5	0	0.7	258.1	2.7	4.6	189.5	59.6	26
2013	141.9	475.5	49.2	1369.8	0	9.6	624.4	4.2	8	238.2	20.6	5
2014	67.6	605.6	118.2	1041.5	4.1	26.7	401.6	3.5	101.2	96.5	18.3	7.1
2015	9.1	238.5	63.3	387.6	11.1	22.6	119.9	9	75.9	76.5	58.1	28.2
2016	33.3	114.1	146.8	178.2	9.3	38.2	223	36.4	137.7	65	58.2	15.9
2017	59.1	92.3	21.3	184.3	3.8	10.9	105.6	0	105.8	82.4	15	0.1
2018	45.4	76.5	30.8	293.5	2.5	0.2	137.2	3.9	77	115	139.3	1.3
2019	3.2	205.3	22.7	451	3.6	11.8	113.4	0	35.6	78.9	103.7	1.5
2020	0.7	109.8	75.1	838.4	0	2.7	156.6	14.9	5.6	46.6	57.6	4.9
2021	0	44.6	22.1	1366.2	0.3	1.5	162.7	5.3	3.8	56.4	13.4	0.5
2022	0	4.8	4.4	1447.7	8.9	0.4	188.9	2.1	3.7	53.2	65	10.1
2023	5	151.8	32.8	764.8	0.2	0.4	110.1	20.2	7.6	56.3	17.7	8.3

Table 10 continued.

Year	36E4	36E5	36E6	36E7	37E3	37E4	37E5	37E6	37E7	38E4	38E5	38E6
2000	17.1	100.7	268.4	0	0	104.7	167.5	6	0	176	31	5.7
2001	40.8	219.4	287.3	0	4.7	191.5	269.3	0.5	0	165.5	2.6	0
2002	22.4	369.5	225.6	0	0	138.3	556.6	30.6	0	183.9	105.1	14.3
2003	21.7	604.1	139.8	0	0	97.4	530.6	3.3	0	195.5	144.3	3.6
2004	31.9	425.8	89.7	0	4.4	239	283.2	16.5	0	198.7	347.5	30
2005	15.9	363.6	48.5	0	9.7	165.4	715.2	10.3	0	119.1	231	36.9
2006	22.2	304.7	47.5	2	0	119.8	631.2	5.1	0	150.1	167.2	2.1
2007	33.4	424.7	187.2	0	0.2	248.4	878.3	12.2	1.7	97.1	206.2	11.9
2008	63.4	820.3	96.9	0.1	0	288	658.5	52.1	0	155.1	246.3	14.3
2009	39.1	950.4	278.2	0	0.4	224.5	1489.6	64	0	147.8	237.6	3.3
2010	14.9	1561.6	98.5	0	3.5	186.8	1369.7	130.8	3.4	123	197.6	3.1
2011	65.5	1341.6	99.1	1.7	1.8	221.6	2301.6	53.4	0	207.7	179.1	1.9
2012	63.6	1392.2	205.7	3.6	0	263.7	2562.6	57	1.5	133.3	392.5	19.1
2013	76.8	1792	147.2	0	5.2	230.3	2485.7	45.1	0	374.9	214.9	5.1
2014	74.4	1739.4	156	0.9	1.6	275.2	2677.1	33.5	0	376.2	285	2.1
2015	43.7	1513.8	214.7	0.1	4.7	371.2	2940.5	32.2	0.1	416.3	212.7	16.1
2016	109.8	2293.9	195.2	0	28.2	258.1	3571	7.6	0	402.2	319	2.9
2017	73.6	1378.7	154.3	0	3.9	293.2	2252.1	13.9	0	468.5	247.2	2.1
2018	77.8	1507.9	209.6	0	0	190.4	1901.5	6.5	0	357	192.1	3.8
2019	35.4	799.8	182	0	0.9	259.3	1525.8	5.9	0	229.8	205.7	0.5
2020	40.3	711.1	356.2	0	1	113.3	1168.3	5.7	0	237.3	152.2	15.4
2021	31.7	673.9	242.9	0	13.2	205.9	1424	2.6	0	227.9	86.7	0.7
2022	37.8	746.2	556.8	0	1.8	104.4	1356.5	10.2	0.2	199	140.2	0.8
2023	37.5	904.2	595.2	3.6	7.9	171.8	1905.3	6.2	0	267	145.8	1.5

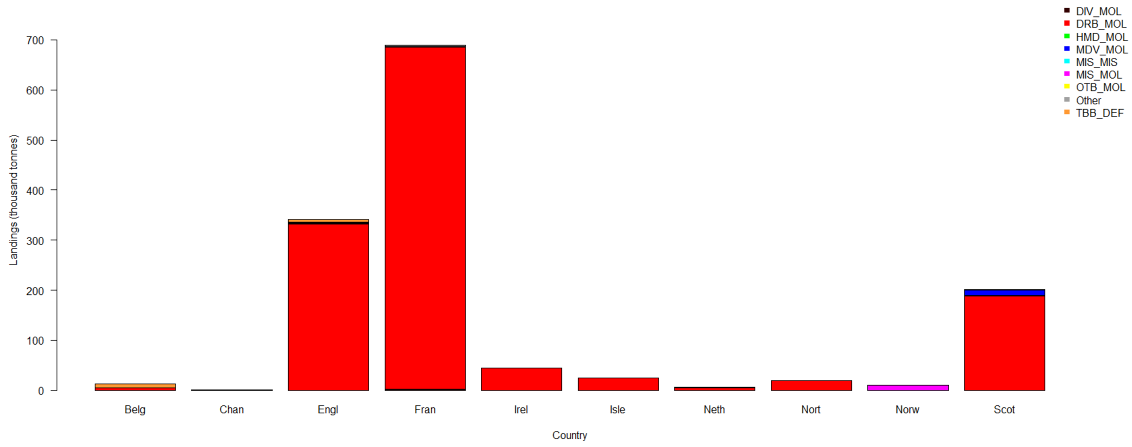

Figure 8.2 Landings of king scallops (live weight, thousand tonnes) in the data call by country and métier. Métier classified to Level 5. The métiers with the highest landings are shown, with all others classified in to 'Other'. Begl is Belgium, Engl is England and Wales, Fran is France, Irel is the Republic of Ireland, Isle is the Isle of Man, Neth is the Netherlands, Nort is Northern Ireland, Norw is Norway and Scot is Scotland. DIV_MOL is divers targeting molluscs, DRB_MOL is dredges targeting molluscs, HMD_MOL is hand mechanized dredges targeting molluscs, MDV_MOL is also divers targeting molluscs, MIS_MIS is miscellaneous gear targeting miscellaneous species, MIS_MOL is miscellaneous gear targeting molluscs, OTB_MOL is bottom otter trawls targeting molluscs and TBB_DEF is beam trawls targeting demersal fish.

Table 11 Landings of king scallops (live weight, tonnes) by ICES statistical rectangle and year within ICES Subarea VIIe. 2023 data are provisional.

	25E5	26E5	26E6	26E7	26E8	27E5	27E6	27E7	27E8
2000	249.41	28.77	537.31	3766.77	306.47	18.97	125.25	1201.79	236.18
2001	198.83	16.07	529.09	5836.08	453.69	0.9	420.68	931.25	175.77
2002	339.38	25.6	832.75	8490.22	477.39	4.32	436.51	825.68	109.61
2003	267.08	28.8	884.89	9108.94	274.27	39.67	780.91	1015.53	107
2004	190.47	27.22	1041.58	11625.43	537.18	1.29	534.39	920.81	277.6
2005	209.27	37.49	1192.59	10929.23	658.96	19.31	217.03	488.72	162.45
2006	230.57	32.11	1259.12	10562.95	839.32	192.47	214.26	542.52	104.83
2007	113.88	62.03	1150.63	10669.46	1371.29	287.69	830.36	1732.15	244.27
2008	293.4	42.02	1019.44	11892.33	1379.86	35.93	538.53	1169.42	224.15
2009	269.69	85.05	645.54	7826.18	859.76	21.96	562.91	852.81	183.58
2010	342.65	97.81	846.78	7523	1220.48	23.68	1232.16	1123.61	240.72
2011	260.66	109.62	592.29	9256.98	1074.28	24.78	572.57	888.09	265.23
2012	239.48	105.33	736.45	6927.54	856.31	18.68	1031.34	1030.98	211.81
2013	181.91	59.7	505.21	6444.75	839.89	19.74	1107.64	1016.23	261.8
2014	63.65	89.69	562.76	5862.68	703.59	51.85	314.41	1191.44	209.84
2015	33.32	59.72	627.73	6411.17	514.69	59.1	415.97	685.29	181.97
2016	237.45	20.37	433.54	6390.81	800.95	0.81	170.86	862.37	398.85
2017	214.91	29.07	464.63	5782.74	985.7	20.62	102.45	314.41	484.21
2018	205.92	30.04	360.74	6040.83	1198.63	1.8	401.6	305.34	733.63
2019	228.64	30.68	449.11	6647.36	1527.49	1.01	499.01	350.03	829.65
2020	198.86	62.26	526.24	6274.47	2003.22	3.1	994.36	383.89	908.85
2021	163.09	96.61	378.48	8892.78	3384.17	2.29	2454.3	1213.66	1197.87
2022	147.27	97.34	752	10051.43	4342.28	0.01	1749.3	1047.06	1506.13
2023	164.55	57.55	640.22	9412.61	4653.84	64.53	867.21	668.52	1894.55

Table 11 continued.

	28E3	28E4	28E5	28E6	28E7	29E5	29E6	29E7	30E6	30E7
2000	156.09	767.12	886.19	369.66	107.84	1816.04	1584.47	624.28	160.52	421.82
2001	474.77	602.81	468.52	129.66	72.03	987.6	840.27	230.74	63.2	410.66
2002	249.56	536.29	366.13	211.99	17.2	973.6	852.02	197.23	33.78	386.89
2003	128.17	1123.64	352.44	134.79	49.22	1115.79	547.96	131.42	116.17	184.95
2004	385.76	1260.21	508.53	110.66	98.97	1206.43	1050.1	356.02	258.14	136.72
2005	317.44	1632.03	839.98	225.79	47.26	969.32	1643.32	495.29	491.4	259.02
2006	326.3	1135.94	604.91	140.31	41.79	1225.71	1355.73	275.82	324.73	336.9
2007	31.41	288.54	227.18	702.82	375.23	1103.69	1130.95	344.12	169.33	406.19
2008	138.13	350.63	95.99	763.52	371.95	792.93	1016.75	195.17	147.56	397.71
2009	55.33	728.66	383.56	1053.13	538.28	1254.11	975.58	438.91	79.59	414.24
2010	117.55	198.96	145.8	832.58	824.67	667.08	1724.65	312.46	240.02	396.44
2011	5.61	62.31	316.57	485.31	338.3	1428.44	2521.27	702.99	292.39	350.14
2012	5.93	85.84	506.78	649.62	714.73	1893.89	1565.96	757.1	271.28	428.66
2013	115.89	273.38	574.58	1539.52	291.51	1206.78	1336.11	564.87	133	384.73
2014	16.74	190.07	405.99	683.43	316.3	1010.8	1219.07	424.59	85.52	190.35
2015	76.88	295.21	1195.02	339.23	203.4	2157.08	754.18	252.39	211.4	163.43
2016	11.43	259.07	1069.94	271.3	350.41	1477.95	651.03	328.9	301.08	287.69
2017	25.49	591.59	398.62	201.18	205.05	1243.16	779.58	285.43	290.95	364.54
2018	7.07	177.75	173.96	275.46	403.5	1446.96	1104.03	290.09	321.7	199.56
2019	36.9	562.68	363.12	287.33	162.34	1016.6	924.87	280.75	339.68	152.67
2020	11.44	67.24	97.53	397.23	282.58	760.71	746.09	327.26	271.43	135.48
2021	26.24	160.1	248.91	663.45	509.54	1553.46	909.24	408.8	403.11	313.77
2022	48	454.27	292.98	1258.21	1373.87	730.57	1085.56	237.65	332.96	200.61
2023	71.5	595.06	764.63	980.14	1431.78	740.34	1332.93	436.52	303.55	196.15