Isles of Scilly IFCA Stock Status Report 2023: European lobster (Homarus gammarus)

S Morcom, T Hooper, C Pender-Frazer & T Stamp

Isles of Scilly Inshore Fisheries & Conservation Authority

Suggested citation format:

Morcom, S., Hooper, T., Pender-Frazer, C. and Stamp, T. (2023) Isles of Scilly IFCA Stock Status Report 2023: European lobster (Homarus gammarus). Isles of Scilly Inshore Fisheries and Conservation Authority.

Acknowledgements

The authors thank all the fishers who contributed to data collection.

Isles of Scilly Inshore Fisheries & Conservation Authority
Porthmellon Enterprise Centre
St. Mary's
Isles of Scilly
Email: ifca@scilly.gov.uk
Website: www.scillyifca.gov.uk

Table of Contents

List of Figures

List of Tables

Contents

Executive Summary

The European lobster (Homarus gammarus) range extemds across the eastern Atlantic, from Morocco to North of the Arctic Circle in Norway. European lobsters are a large, long-lived crustaceans with relatively long life cycles They live in complex, hard environments from shallow inshore depths to, less commonly, 50 metres or more and have distinct local populations

Lobsters are a high value shellfish and are exploited via trap fisheries throughout the UK. Lobster is the most economically important commercial species in the Isles of Scilly, targeted by almost all of the current commercial fleet and accounting for 39 percent of landings in 2022. It is worth around £300,000 annually.

Lobster fishing is important economically and socially within the Isles of Scilly. Initial fisheries were unpowered and used withy pots which were hauled several times a day, the current fishery supports ~2000 pots. Landings increased by 9% from 2019 to 2022. Management in 2023 is a minimum size of 90mm CL and a ban on landing berried, v notched or mutilated individuals.

This stock status report is based on 2023 catch recording onboard commercial vessels in the Isles of Scilly fleet, compared with the last stock assessment, where appropriate, from 2019 and 2016. Beyond this there is an aim to continue onboard catch recording every 3 years, with the aim to increase the data set on the fishery to monitor for changes and ensure timely and effective management.

List of Abbreviations

IoSIFCA	Isles of Scilly Inshore Fisheries and Conservation Authority
IoS	Isles of Scilly
District	Refers to Isles of Scilly IFCA 6 nautical mile boundary
CMR	Catch-mark-recapture
CL	Carapace length – from the eye socket to mid-point of distal edge
MLS	Minimum landing size – 90mm CL in the District
BRUVS	Baited remote underwater video systems

1 Species Description

1.1 Life Cycle

European lobster (Homarus gammarus), hereafter referred to as 'lobster', have a relatively long life cycle for a crustacean, with the entire reproductive cycle taking around 2 years. Research on the European lobster is not as comprehensive as it is for the American lobster (Homarus americanus). Larvae hatch at 5 -8 mm after a 9 -11-month incubation period on the female and spend 4 to 5 weeks at the planktonic larval stage, before settling and growing to sexual maturity. Research shows that a smaller range of environmental temperature increases fecundity, by improving both production and retention of eggs. In the Atlantic stable temperatures are likely maintained by the North Atlantic Drift (Ellis et al. 2015).

Mating is complex in lobster. It can occur in the Spring, Summer and Autumn, with female lobsters choosing a male and coinhabiting his shelter prior to moulting. After the female moults, the male places the spermatophore internally in the seminal receptacle of the female. There is then a period of mate guarding (Phillips, 2013). Sperm can be stored for several years (Talbot & Helluy, 1995), and although multiple paternity in a brood has been identified in American lobsters (Jones et al. 2003), studies suggest this is highly unlikely in European lobster (Ellis et al. 2015). Fertilisation occurs as the eggs are released from the oviduct and pass over the seminal receptacle and stored sperm.

1.2 Size at Maturity

Sexual maturity is more challenging to study in males than in females. Some studies have used maturity metrics to improve understanding of male functional maturity, such as crusher claw length and thickness (Lizarraga-Cubedo et al. 2001) or the crusher propodite index (CPI) (Aiken and Waddy, 1989). In reality, behavioural and environmental factors such as density and size of the male population, influencing intrasexual competition are likely to impact the size at which males viably enter the breeding population (Conan et al. 2001). As female lobster choose their initial mate comparable to their post moult size, it may be possible to infer size at maturity for males based on female size at maturity (Conan et al. 2001).

Female functional size at maturity can be determined through a number of different methods including abdominal width and carapace length ratio (Simpson, 1961), or studying the number of berried females in a size stratified sample to find the length at with 50% of the population are ovigerous (L_{50}).

In Scotland ratios of abdominal width and carapace length were compared for females, and crusher propodite length, width and thickness for males to determine size at functional maturity. There appeared to be large differences between areas with size of maturity (SOM)

varying from 110mm CL in the Hebrides to 79mm CL in the Firth of Forth for females, and 80mm CL for males in the Firth of Forth and 98mm CL in the Hebrides (Lizarraga-Cubedo et al. 2003). A study carried out in 2009 in France found not only can size of functional maturity vary with location, but also with each year and month (Laurens et al. 2009).

In Ireland L_{50} varied from 92.5 to 96mm CL, depending on location (Tully et al. 2001). On the North East coast of the UK L_{50} ranged between 78.4 to 94.1mm CL (Coleman et al. 2023). Early studies in the Bay of Biscay and Iroise sea found L_{50} ranged 98 to 99mm CL (Latrouite et al. 2001), however a much larger data set from self-sampling fishers found L_{50} to be 103 – 106mm in the Bay of Biscay (Laurens et al. 2009).

1.3 Growth

Growth can be determined through tag and recapture events and aging of individuals. The process of ageing crustaceans is challenging due to periodic moulting, however lipofuscin accumulation in the eyestalk ganglion can be studied to give an estimate of age. When age classes are integrated with size data it shows that with current methods there is limited ability to determine annual cohorts using size composition due to multiple age classes being the same length ie. at least seven age classes enter the fishery at 85mm CL (Sheehy et al. 1999).

Growth during juvenile development can be affected by numerous factors such as temperature (Small et al. 2015) and electromagnetic current (Harsanyi et al. 2022), and later in life can be influenced by food availability (Mente et al. 2001).

Studies which have used tagging to determine growth with each moult have found similar growth increments in different geographic locations. In Norway the average female increased by 7.1mm per moult (Agnalt et al. 2007), in Cornwall and Yorkshire moult increments of 8.4mm for females and 9.8mm for males were found (Hepper, 1967). Growth slowed at as animals grew larger (Hepper, 1967).

In the Isles of Scilly a 3 year tagging study (Holt and Kelly-Fletcher, 2016) also found that growth increments were smaller for larger lobsters. Lobsters grew between 10 and 20% of their previous length with each moult.

1.4 Movement

Most European lobsters exhibit homing behaviour and do not travel large distances (Smith et al. 2001, Agnalt et al. 2007, Moland et al. 2011, Schmalenbach et al. 2011). In the Western English Channel larger lobsters that do exhibit long range movement, often do so against the tide, in a South West direction (Smith et al. 2001).

The Isles of Scilly lobster tagging report (Holt and Kelly-Fletcher, 2016) corroborates these findings. The majority of lobsters showed high site fidelity even after 2 to 3 years (*n*=461, 0 -

14.2km from release site). There were no differences between sexes and no correlation with the number of days until capture (days at large).

On a small scale, lobsters exhibit different movements dependant on the season, with lobster home ranges increasing in size in the Autumn. They can vary with sex, with males moving more than females, and with substrate, with lobsters displaying high directionality over soft substrate (Skerritt et al. 2015).

1.5 Distribution and Habitat

The European lobster inhabits coastal regions from Norway to the Mediterranean. Throughout their range in the Atlantic lobsters exhibit a genetic cline. This regional sub structuring is likely due to reduced connectivity between stocks, caused by short pelagic larval duration, reducing gene flow. The Mediterranean stock has greater genetic structuring than the Atlantic stock, likely due to geographical differences such as strong gyres, topographical differences with the Atlantic and increased temperatures (Ellis et al. 2023).

Juvenile lobsters prefer to settle on sheltering habitats, such as cobbles and mussel beds, rather than exposed sediment such as sand. When settled on suitable habitat they tend to grow larger than on unsuitable habitat (Linnane at al. 2000a). It is expected that juvenile lobsters will favour any habitat which enables them protection from predators and larger lobsters, including intertidal crevices (Linnane et al. 2000b). Habitat suitability mapping suggests adult lobsters preferred habitat includes hard, rocky ground with depressions from a sloping seabed from shallower to deeper waters and that this faces medium to high wave energy (Galparsoro et al. 2009). More recent research into lobster movements within offshore wind farms suggest that adult lobsters will also favour hard, reef like substate created near turbines (Thatcher et al. 2023).

1.6 Diet and Predators

Lobster are both predators and scavengers. They have a wide ranging diet of molluscs, echinoderms, cnidarians and fish (Leiknes, 2023). There is limited research on lobster predation and it is likely that European lobsters have a limited number of predators in the Isles of Scilly.

1.7 Parasites and Disease

For the most recent review of parasites and disease in European lobster please see Davies and Wootton, 2018: Current and emerging diseases of the European lobster (Homarus gammarus): a review. Lobsters in the Isles of Scilly are found to occasionally have signs of ‘black spot’ shell

disease, however these incidences are relatively rare. There is little know about the causes of shell disease in lobster (Rowley and Coates, 2023).

This lobster was found to have a colonial sea squirt (*Botrylloides leachii*) living on its carapace. Although not a parasite or disease and entirely harmless, it did on first appearance look like epizootic shell disease. It is worth noting that these encrusting ascidians can form on lobsters found in shallow waters in the District.

Figure 1. Lobster with a colonial sea squirt (*Botrylloides leachii*) on its carapace found in 2023.

1.8 Inherent vulnerability

The life history of European lobster gives them a moderate to high vulnerability rating (46/100) (sealifebase, 2023). Lobster have numerous offspring, and show no parental care after eggs have been brooded and hatched. Lobster take time to become sexually mature (~7 years) and live until very old ages. On average 54 years for females and 41 years for males (Sheehy et al. 1999). Lobsters do not show senescence and continue to breed and grow their entire lives (Klapper et al. 1998). They have a natural mortality rate of 0.15 for males and 0.08 for females (Sheehy et al. 1999).

Lobsters small home ranges and short pelagic larval duration increase the vulnerability of local populations to overfishing, however this also means that well managed stocks are likely to be highly sustainable.

1.9 Behaviour

There are a number of studies which have investigated the effect of electromagnetic fields on the behaviour and reproduction of lobster has been found to be altered when exposed to electromagnetic fields during embryo development, these caused deformities which could go on to have a significant impact on the population in the long term (Harsanyi et al. 2022).

Research looking at factors influencing the catchability of lobster found water temperature, wind speed and sea pressure to alter catch rates (Lizárraga-Cubedo et al. 2015).

2 Fishery

2.1 Gear and Methods Used

Lobsters are removed from pots as pots come aboard. Undersize and berried individuals are returned, and fish are banded before being placed in a container or vivier.

Most fishers use parlour pots. These range in size, number and type of eyes. Some fishers use escape gaps (these were a requirement on pots bought with a government funding scheme). A small number use inkwell pots.

2.2 Current Fishery

There are 26 registered vessels is in the Isles of Scilly, ranging from 11 to 4 metres in length, with 23 boats operating regularly in 2023; 22 of these target lobster. Lobster is the most economically important fishery in the Isles of Scilly in terms of value of catch landed. The number of commercial fishing vessels landing into Scilly has remained relatively stable in recent years. Landings show a steady increase of 9% from 2019 to 2022.

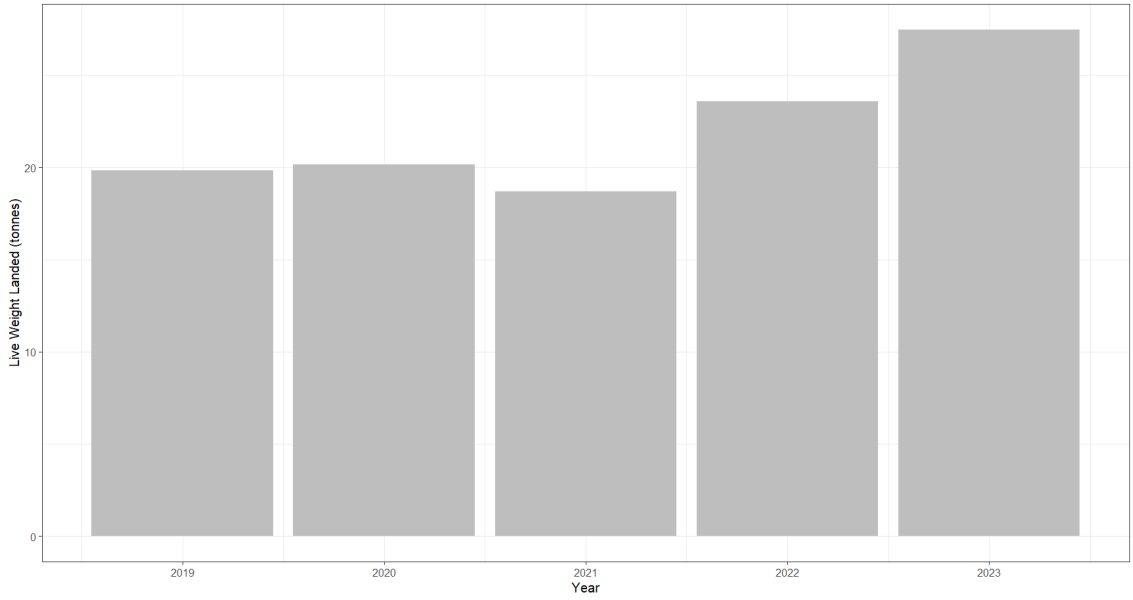

Figure 2. Live weight (tonnes) of lobster landed into the Isles of Scilly 2019 to September 2023.

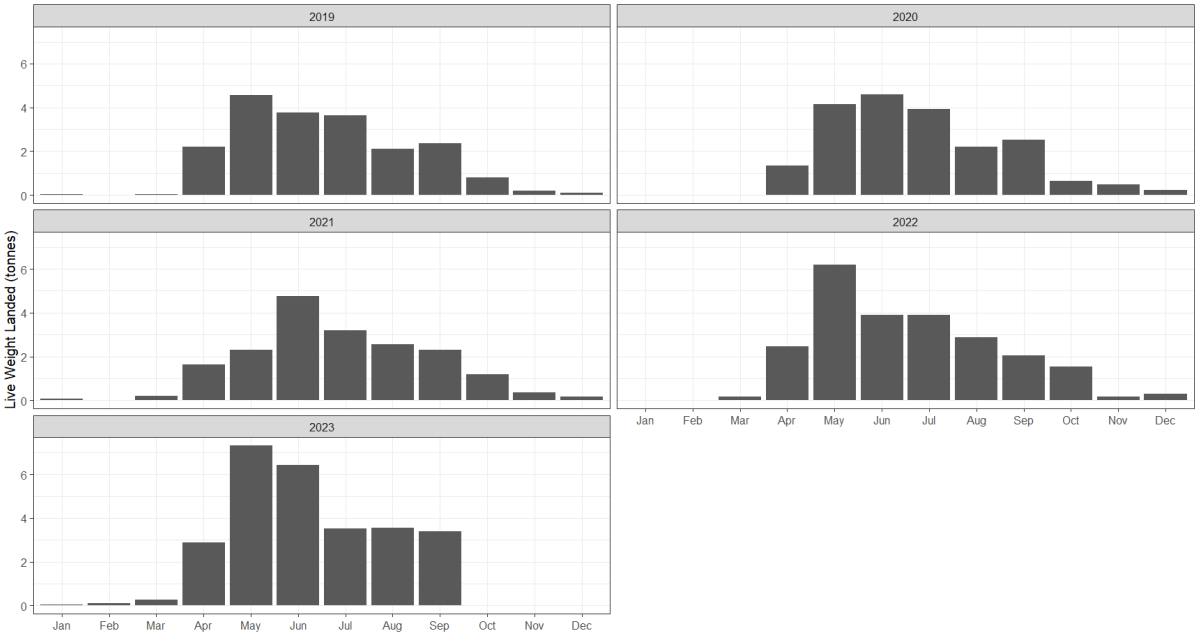

Figure 3. Live weight (tonnes) of lobster landed from the Isles of Scilly by month from 2019 to September 2023.

Fishing effort for lobster is mostly inshore, in shallow coastal waters. Only one vessel targets lobster further offshore. Lobsters are targeted over a variety of habitat types. Fishing remains within the six nautical miles of the IFCA boundary. String length (total length of pots deployed at one time) varies depending on vessel size and pot size (range 1 to 50). The size of pot and type of bait used varies both within and between vessels. The number of strings set depends on boat size and capability. Soak times vary with weather and tide and range from 1 to 14 nights. There is usually a 3 month hiatus towards the end of December until the end of March when conditions are poor and fishing opportunities are limited.

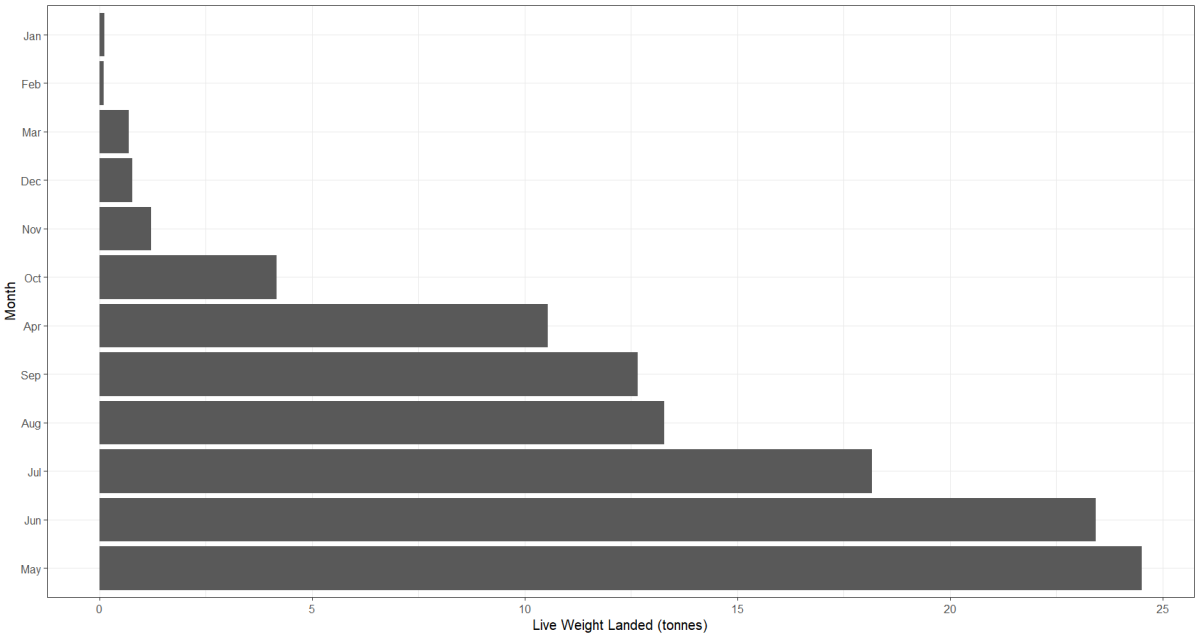

Figure 4. Live weight (tonnes) of lobster landed from the Isles of Scilly from 2019 to September 2023 grouped by month.

2.3 Susceptibility

Pots are used to target lobster across the IoSIFCA 6 mile District. Research (eg Holt and Kelly Fletcher, 2016) shows that the majority of lobsters are resident and larvae settles close to where it is released. In the Isles of Scilly this enables the fishery to be managed locally. There are a number of fishers who use voluntary V notching to protect large, breeding females which helps protect the future of the fishery.

2.4 Fishery regulation

Isles of Scilly IFCA has a lobster minimum landing size byelaw which requires all commercial and hobby fishers to ensure that no lobsters with a carapace length of less than 90 mm carapace length are landed. The Byelaw is designed to help protect populations of lobsters by increasing the minimum conservation reference size. The 2017 National Statutory Instrument prohibits the landing of berried, v-notched or mutilated lobsters.

The minimum landing size byelaw applies to Devon and Cornwall Districts, but not to areas outside of the 6 nautical mile (nm) limit. Currently outside of the 6nm (outside IFCA management), the MLS for lobster has remained at the European size of 87mm CL. The European MLS is unlikely to be large enough for European lobster to breed sustainably. Although the majority of lobster fishing is carried out by small, inshore vessels, this creates a potential enforcement risk to determine at landing point whether an individual lobster was caught

Landings are inspected as lobsters are prepared to go into bins used to transport them to the mainland. Checks also take place at shellfish merchants on the mainland by Cornwall IFCA.

2.5 Conclusion

Landings are slowly increasing. Current fishing effort appears to be sustainable with the management of minimum sizes and the return of berried and v notched individuals.

3 Fishery Management

3.1 Objectives and principles

The objectives and principles of the fishery need to be developed from the research carried out in 2023 and 2019 and from MMO landings data. Management of the fishery is suitable at a District level. Effort within the District should be monitored and impacts of other fisheries (such as tangle netting or trawling) on the lobster population should be considered.

4 Research and Monitoring

Research on the lobster population was first carried out in 2013 for 2 years, this included onboard catch recording and floy tag data. In 2019 data collection continued with volunteers collecting data over 4 weeks in the summer. In 2023 onboard catch monitoring was carried out over 6 months between April and October. This data will be compared across years where possible. Onboard monitoring of catch will be carried out every 3 years to ensure management is effective and proportionate.

4.1 Fishery research

Data collection has primarily been fisheries dependant. There is currently no additional reporting required of fishers other than that required nationally by the MMO in their catch app, which includes ICES sub rectangle area caught, live weight estimate and gear used. There is no effort data for the District. The introduction of iVMS in 2024 should improve understanding of spatial pattern of activity.

4.1.1 Onboard catch monitoring

Onboard recording of commercial catch in this report was carried out in 2023. Prior to this, data was collected from May 2013 to December 2015 and over a 4 week period in June and July 2019. Data in 2023 was collected onboard 9 different vessels (40% of fleet), over 63 trips totalling ~4000 pots and collecting data on 5369 lobsters from April to September.

Information on each individual is recorded: length of carapace to nearest mm, sex, breeding condition (berried, recently moulted) and any notes on health to gain an understanding on the demography of the catch. Alongside this data was recorded on vessel, weather conditions, depth, string length, soak time, and position. The same data was collected for any non-target species caught.

Data was not collected on pot size, number of eyes or bait type due to the variability in these factors both day to day on the same vessel and between vessels. These factors were included in notes where possible.

4.1.2 Spatial pattern of effort

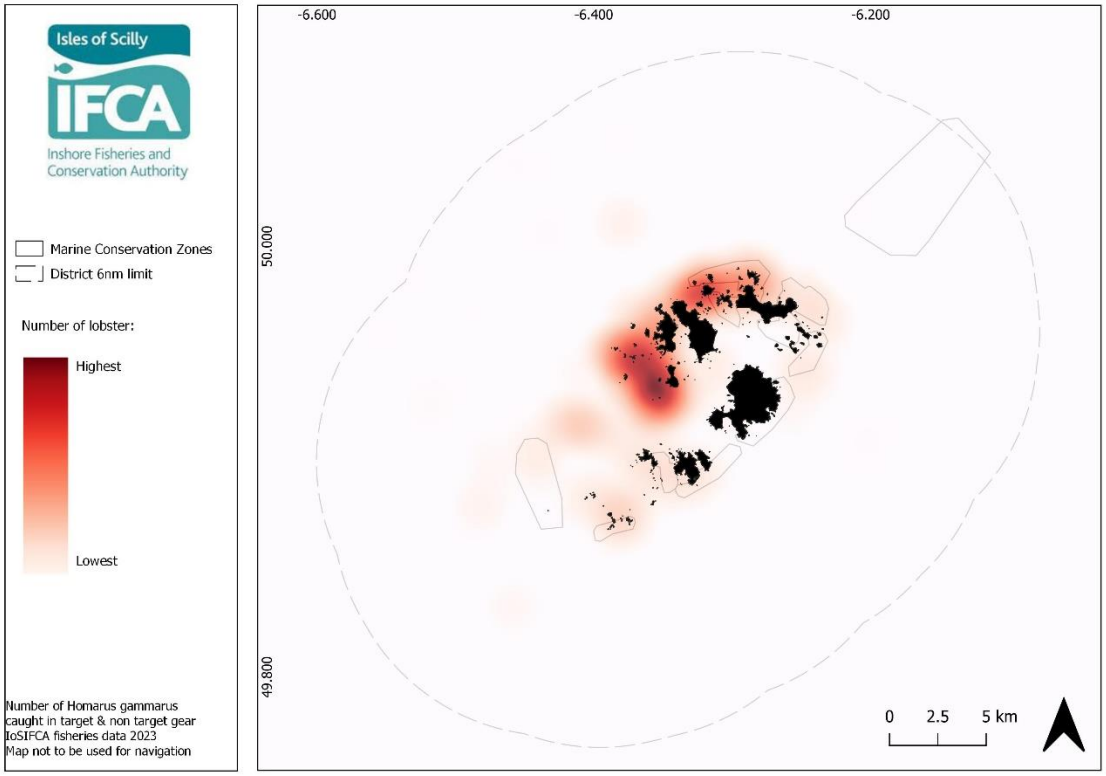

Figure 5. Heatmap with a 3km radius showing target and accidental catch effort of lobster in the Isles of Scilly of onboard catch data 2023.

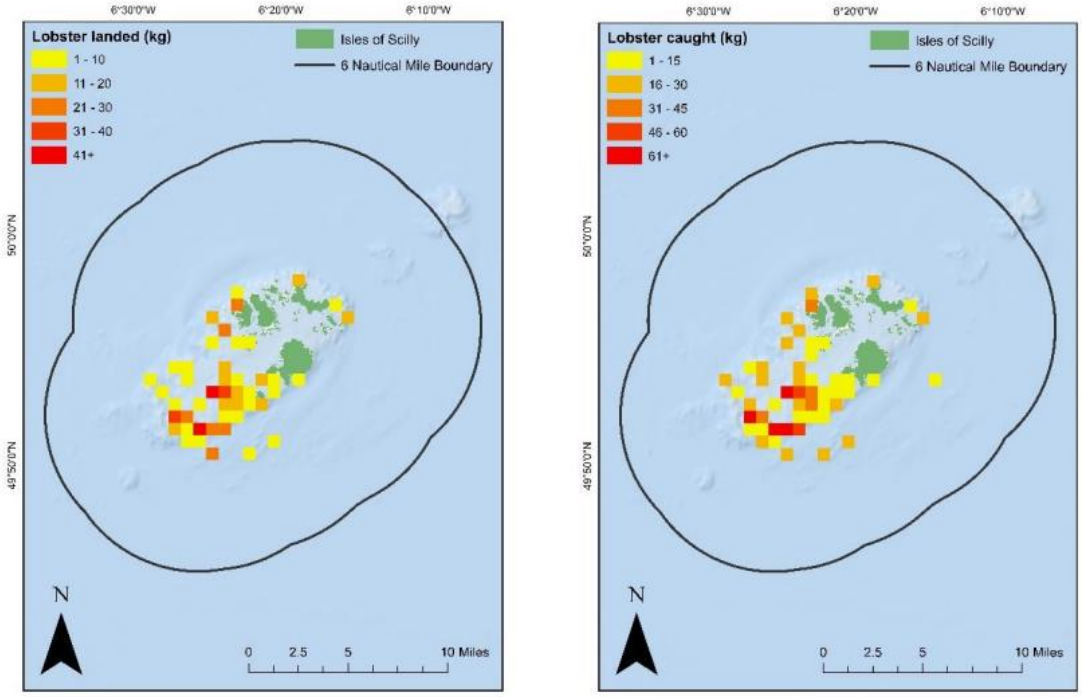

Figure 6. Spatial data from onboard catch recording of lobster in 2019 in the Isles of Scilly IFCA District.

In 2023 effort for lobster was primarily focused in shallow waters surrounding the islands. The spatial distribution of effort does not appear to have changed from 2019. All spatial data is currently biased to when observers were onboard vessels and does not accurately reflect all fishing activity. Wind direction can also influence fishing locations. The installations of iVMS on the inshore fleet in 2024 will provide a better quality of spatial data for the fleet.

4.1.3 Bycatch

Bycatch was recorded on all vessels apart from one, (on their request this vessel's data was excluded from bycatch analysis). Wherever possible bycatch was measured and sexed. There were 799 non target (bycatch) individuals caught, this was 15.2% of the total catch. Of this 15.2%, 72.6% (581 individuals) were commercial species (table 1). Commercial species were considered as species targeted in the SW UK commercially, not all species considered commercial are landed in the Isles of Scilly (pollack, spider crab, brown crab, crawfish).

The most commonly caught commercial species were brown crab, followed by spider crab and crawfish. The most commonly caught non-commercial species were ballan wrasse, velvet swimming crabs and small spotted catsharks. The majority of bycatch was returned to the sea alive (86.7%), 0.75% of bycatch was dead in the pot, 9.1% was landed and 3.5% was kept for bait. Wrasse were sometimes injured when in pots. Our results are very similar to those found by Moore et al. 2023 in Wales when examining pot fishing bycatch.

Species Group	Species	Number caught	Commercial	Non commercial
Ray-finned fish	Ballan wrasse *Labrus bergylta*	70		•
	Cuckoo wrasse *Labrus mixtus*	5		•
	Corkwing wrasse *Symphodus melops*	2		•
	Unidentified wrasse sp.	6		•
Demersal fish	Long spined sea scorpion Taurulus bubalis	2		•
	Three bearded rockling *Gaidropsarus vulgaris*	4		•
Crustacean	Crawfish *Palinurus elephas*	10	•	
	Spider crab *Maja squinado*	66	•	
	Brown crab *Cancer pagurus*	504	•	
	Velvet swimming crab *Necora puber*	81		•
Elasmobranch	Nursehound *Scyliorhinus stellaris*	4		•
	Small spotted catshark *Scyliorhinus canicula*	20		•

Semi pelagic fish	Pollack *Pollachius pollachius*	1	•	
Eels	Conger eel *Conger conger*	11		•
Octopus sp.	Common octopus *Octopus vulgaris*	7		•
	Octopus sp.	1		•
Birds	European shag *Gulosus aristotelis*	1		•
Echinoderms	Cotton spinner sea cucumber *Holothuria forskali*	1		•
	Edible sea urchin *Echinus esculentus*	3		•
	Starfish sp.	Unrecorded small number		•
Total individuals		**799**	**581**	**218**

Table 1. Recorded bycatch from onboard observer data of lobster pot fisheries in 2023 in the Isles of Scilly

4.2 Ecological research

There has been minimal fishery independent research. Future research could include control pots used by the IoSIFCA within the District to monitor control CPUE across years and sites.

5 Stock Health

There is currently no formal stock assessment in place for lobster in the Isles of Scilly. The data from 2016, 2019 and 2023 provide a baseline from which to develop future assessments. In order for a stock assessment to be developed there needs to be adequate information on abundance, mortality, reproduction and growth. There are challenges associated with gathering this information on crustaceans, including lobster. Creating accurate ageing methods is difficult due to the loss of tissue during moults. However, of all the economically important crustaceans in the Isles of Scilly, lobster are the most well researched with a reasonably good understanding of mortality, reproduction and growth. Future data collection efforts to help create stock assessments are included in the recommendations section of this report.

5.1 Length frequency distribution

Data included for length frequency analysis includes incidental captures of lobsters in crab pots and nets targeting crawfish. Lobster catch was 49% female (n=2652) and 51% male (n=2710). The mean carapace length for lobster was 88.4mm (±11.7 SD, range 20 – 167mm), for males 87.5mm (±11.3 SD, range: 52 – 146mm), and for females 89.4mm (±12 SD, range: 20mm – 167mm). The mean size of berried females was 97.6 (±10.8 SD, n=211, range 75 to 167mm CL).

There are some small differences from catch sampling carried out in 2019, where males were 45% of catch total, this suggests the sex ratio may have evened out slightly, or perhaps the larger sample size is able to produce a more accurate picture. The mean carapace length has also decreased, from 91.3mm ± 0.24 SE for males and 92.04mm ± 0.23 SE for females in 2016, and 90mm for males and 91.6mm for females in 2019. Maximum size has decreased from 183mm CL in 2019 to 167mm CL in 2023. Although the mean carapace length could be being reduced by an increased number juveniles being measured, the reduction in maximum size suggests that the smaller mean carapace length is indicative of a decreasing in size of all individuals.

The percentage of catch above MLS (90mm CL) was 41.5%, 3.9% were berried (n=210), therefore 37.6% of catch was landed. In 2016 50% of the catch was landed, the decrease in 2023 is likely due to the increased minimum size and high number of smaller individuals.

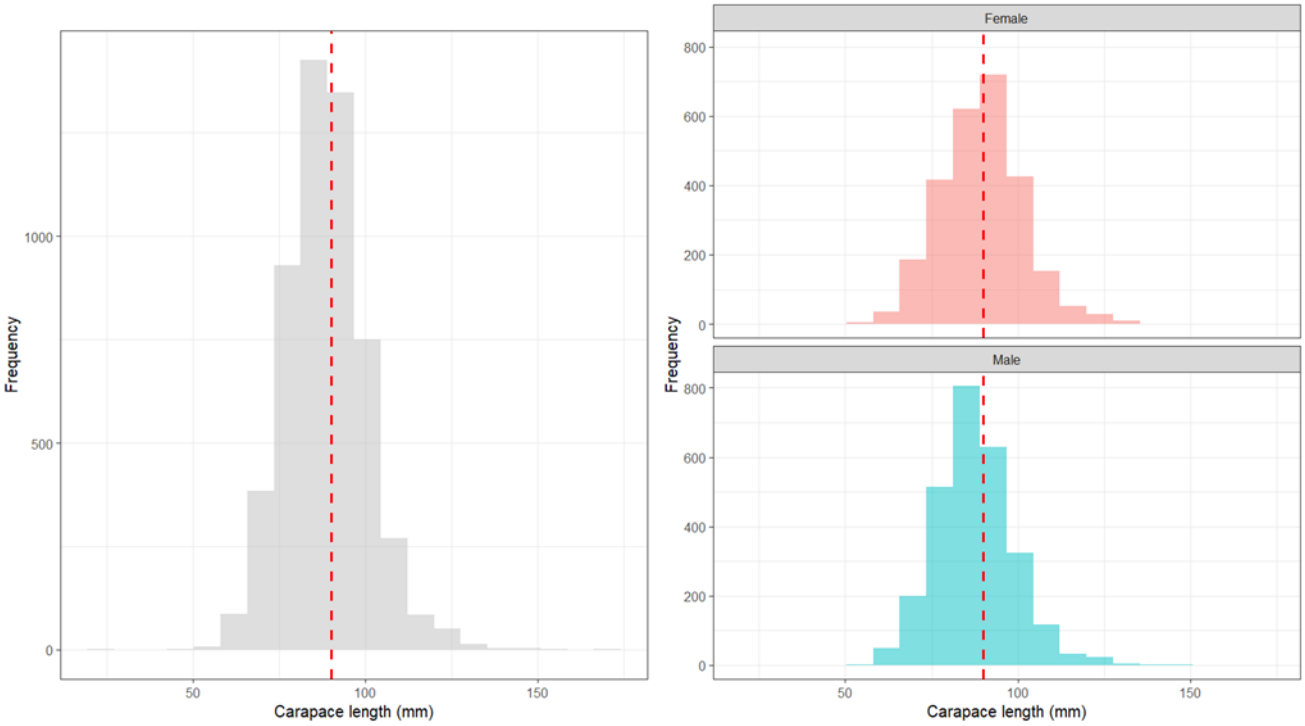

Figure 7. Length frequency of onboard catch records of lobster in the Isles of Scilly District in 2023. The red line shows the minimum landing size of lobster in the District (90mm CL).

5.2 Catch and effort trends

Catch per unit effort data was taken from 63 potting trips on 9 different vessels from April to September 2023. This data provides an initial indication of CPUE over the course of the summer, it is not comprehensive and does not account for differences which may arise seasonally or between different vessels. CPUE is an indicator of change in population biomass, however it cannot account of factors such as varying catchability between years or changes in

sex ratio or size of fish. Overall CPUE in the District was calculated as 0.4 lobsters per pot per night (±0.3 SD). This should act as a comparison for future data collection when taken from a range of vessels from April to September. In 2019 CPUE was found to be 35.26 kg of lobster per 100 pots hauled. Per pot this is 0.35kg of lobster and roughly equates to a similar measure as 0.4 lobsters per pot found this year in 2023, suggesting CPUE has not changed. These are similar figures to those recorded by Emmerson et al. in 2022.

5.3 Functional Sexual Maturity

There were 210 berried females recorded in 2023. The scope of current research has not allowed us to study sexual maturity, however size of females at functional maturity can be estimated from recordings of berried females. The smallest berried female was 75mm CL in 2023, with the mean CL of berried females 97.7mm CL (±10.8 SD, range 75 -167mm CL). 77.6% of berried females were over the MLS of 90m CL, this suggests the size at which 50% of females become functionally mature could be larger than 90mm CL. Functional maturity is determined by many factors, including behaviour, therefore functional maturity may vary within a small area. Only 3.9% of females measured were berried, therefore this estimate must be taken with caution.

6 Stock Health Summary

Lobster carapace length taken from fisheries samples appear to have gradually declined over the past 8 years. The spread of size classes seems similar and the catch per unit of effort appears stable. The stock appears to be healthy currently.

6.1 Summary

Category	Status
Landings	Landings have increased in recent years, this is likely due to an increase in effort from vessels within the District.
Catch distribution	Current spatial distribution can only be inferred from onboard catch recording and anecdotal evidence. Effort is concentrated in shallow inshore areas. Both soft sediment and rocky hard ground is targeted. The inclusion of iVMS data in future reports will give a clearer understanding of effort distribution.
Catch rates	CPUE in 2019 was recorded in kg and without a rate included (ie per night), this makes it hard to compare with 2023 CPUE which was recorded as number of individuals per pot per night. CPUE in 2019 was 0.35kg per pot, in 2023 CPUE was 0.4 lobsters per pot per night. If we infer that soak time was similar for pots sampled in 2019 and estimate a lobster to weigh around 1kg, we can estimate that CPUE has remained stable.

Ecological research	Not currently carried out.
Vulnerability	Life history and movement of lobster makes them vulnerable to being locally overfished. However, current management appears to be sufficient for the population to remain sustainable. Effort within the District should be monitored.
Size/sex composition	Mean carapace length is currently lower than minimum landing. There appears to be a continuous decline in size of lobsters over the past 8 years. Undersize lobsters currently make up 58.5% of catch. The sex composition of catch does not appear to have changed in the past 4 years and remains balanced for males and females.
Fishing mortality	Unknown. Natural mortality rate of 0.15 for males and 0.08 for females (Sheehy et al. 1999).
Spawning biomass	Unknown – further research needed.

Table 2. Summary of European lobster stock health in the Isles of Scilly.

6.2 Isles of Scilly IFCA lobster management

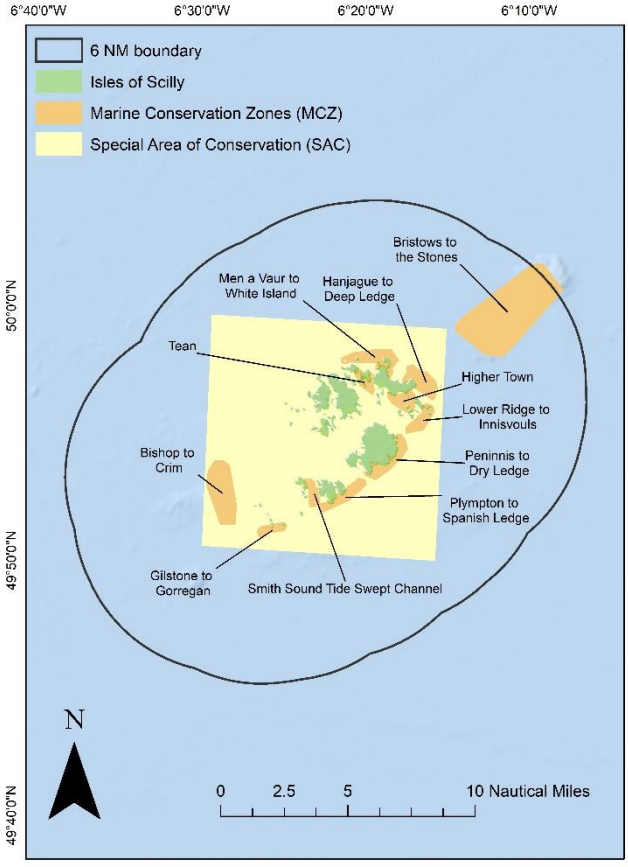

Figure 8. Map of the Isles of Scilly IFCA District including Marine Protected Areas.

Isles of Scilly IFCA has responsibility for management of Fisheries and the impact of fisheries activities on Marine Protected Areas within a district of 912km^2.

Under the Marine and Coastal Access Act, the IFCA is required to 'seek to balance the social and economic benefits of exploiting the sea fisheries resources of the district with the need to protect the marine environment from, or promote its recovery from, the effects of such exploitation.' (Section 153 paragraph 2b) and seek to ensure that the conservation objectives of any MCZ in the district are furthered.

The Fishery Act (2021) has led to the development of Fisheries Management Plans (FMP) and eight objectives that are required to be met, of which three are most relevant to the management of lobster. These include the 'Sustainability Objective' that fish and aquaculture activities are managed so as to achieve economic, social and employment benefits and contribute to the availability of food supplies, but does not overexploit marine stocks. The sustainability objective is intended to highlight the need to draw together these three strands: environmental, social and economic; and over the long-term balance those related to fisheries (social and economic) and the environment on which they depend.

The ecosystem objective defines an approach in which the collective pressure of human activities is kept within levels compatible with the achievement of GES and does not compromise the capacity of marine ecosystems to respond to human induced changes. In the context of lobster fisheries, this objective would mean that bycatch would need to be minimised as well as any direct interaction between the fishing gear and protected habitats and other species.

The Crab and Lobster Fishery Management Plan was published in December 2023. The plan highlights the uncertainty and lack of data to inform stock status for lobster. There is sufficient data to carry out stock assessments in the South West, but 'challenges remain' in providing reliable assessments. The report also notes the fragmented and lack of a regional approach to deliver effective management. The proposed target reference point is defined as the exploitation rate that would produce 35% of virgin spawner per recruit, which is a proxy for the fishing rate that will tend to produce MSY. There is an acknowledgement of issues around a lack of appropriate fishing effort data and the representativeness of landings. The research undertaken on board fishing vessels on Scilly is designed to assist in filling these gaps.

Exploitation rates were above target MSY reference points in all England's Lobster Fishery Units (LFUs) in 2019; in the Channel however exploitation was 'moderate' and 'between the target and limit reference points.

The FMP has set out the following objectives for European lobster fishery management summarised below:

1. Develop and pilot an improved data collection programme for lobster fisheries
2. Establish methods to better assess stock status
3. Assess the impact of lobster fishing activity on the wider marine environment
4. Improve understanding of interactions between the English lobster fishery and other fisheries
5. Devise and implement a short-to-medium term management approach that considers the external regulatory environment

6. Establish a long-term management approach for lobster fisheries in line with improvements in data collection and stock assessment
7. Explore trade offs between access arrangements for lobster fisheries that will ensure long-term environmental sustainability and economic profitability
8. Mitigate emissions from shellfish supply chain and adapt/reduce environmental impacts of climate change

The overall aim for lobster management is to ensure that fishing mortality is managed at a level to deliver long-term sustainable stock health through a threefold approach: addressing data and knowledge gaps; improving stock assessment methodologies and implementing effective management that limits fishing effort in line with stock status.

Lobster are managed through a local byelaw for a Minimum Landing Size of 90mm that was introduced in 1996. The Lobsters and Crawfish (Prohibition of Fishing and Landing) (Amendment) (England) Order 2017 is a Statutory Instrument (SI) that requires berried lobster and lobster with a 'V' notch to be returned. Within the MCZ network there are voluntary agreements not to fish for shellfish between mid December and mid March, and for a prohibition of diving for shellfish.

6.3 Recommendations

Recommendation 1 - It was observed that a large number of undersize lobster lost legs or were damaged in pots. This only tends to occur with small lobsters and escape gaps are likely to reduce this harm, but would not allow size lobster or other valuable bycatch to escape.

Recommendation 2 - Collect data on effort and environmental changes such as sea temperature. This will aid in understanding biological outcomes, such as smaller carapace size, if they are a factor of fishing effort, environmental changes or both.

Recommendation 3 – Carefully monitor changes in size in 2026. Declines in size for males and females have been identified over the past eight years.

Recommendation 4 – Improve landings checks.

References

Agnalt, A.L., Kristiansen, T.S. and Jørstad, K.E., 2007. Growth, reproductive cycle, and movement of berried European lobsters (Homarus gammarus) in a local stock off southwestern Norway. *ICES Journal of Marine Science*, *64*(2), pp.288-297.

Bellchambers, L.M., Phillips, B.F. and Pérez-Ramírez, M., 2016. From certification to recertification the benefits and challenges of the Marine Stewardship Council (MSC): A case study using lobsters. *Fisheries Research*, *182*, pp.88-97.

Conan, G.Y., Comeau, M. and Moriyasu, M., 2001. Are morphometrical approaches appropriate to establish size at maturity for male American lobster, Homarus americanus?. Journal of Crustacean Biology, 21(4), pp.937-947.

Davies, C.E. and Wootton, E.C., 2018. Current and emerging diseases of the European lobster (Homarus gammarus): a review. *Bulletin of Marine Science*, *94*(3), pp.959-978.

Emmerson, J.A., Coleman, M.T., Bloor, I.S.M. and Jenkins, S.R., 2022. Enhancing fishery-dependent information in data-poor fisheries; integrating gear-in–gear-out sensors and mobile reporting technology in a mixed Irish sea static-gear fishery. ICES Journal of Marine Science, 79(7), pp.2126-2137.

Ellis, C.D., Knott, H., Daniels, C.L., Witt, M.J. and Hodgson, D.J., 2015. Geographic and environmental drivers of fecundity in the European lobster (Homarus gammarus). *ICES Journal of Marine Science*, *72*(suppl_1), pp.i91-i100.

Ellis, C.D., Hodgson, D.J., Andre, C., Sørdalen, T.K., Knutsen, H. and Griffiths, A.G., 2015. Genotype reconstruction of paternity in European lobsters (Homarus gammarus). *PLoS One*, *10*(11), p.e0139585.

Ellis, C.D., MacLeod, K.L., Jenkins, T.L., Rato, L.D., Jézéquel, Y., Pavičić, M., Díaz, D. and Stevens, J.R., 2023. Shared and distinct patterns of genetic structure in two sympatric large decapods. *Journal of Biogeography*.

Galparsoro, I., Borja, Á., Bald, J., Liria, P. and Chust, G., 2009. Predicting suitable habitat for the European lobster (Homarus gammarus), on the Basque continental shelf (Bay of Biscay), using Ecological-Niche Factor Analysis. *Ecological modelling*, *220*(4), pp.556-567.

Goñi, R., Quetglas, A. and Reñones, O., 2001. Diet of the spiny lobster Palinurus elephas (Decapoda: Palinuridea) from the Columbretes Islands Marine Reserve (north-western Mediterranean). *Journal of the Marine Biological Association of the United Kingdom*, *81*(2), pp.347-348.

Harsanyi, P., Scott, K., Easton, B.A., de la Cruz Ortiz, G., Chapman, E.C., Piper, A.J., Rochas, C.M. and Lyndon, A.R., 2022. The Effects of Anthropogenic Electromagnetic Fields (EMF) on the Early Development of Two Commercially Important Crustaceans, European Lobster, Homarus

gammarus (L.) and Edible Crab, Cancer pagurus (L.). *Journal of Marine Science and Engineering*, *10*(5), p.564.

Hepper, B.T., 1967. On the growth at moulting of lobsters (Homarus vulgaris) in Cornwall and Yorkshire. *Journal of the Marine Biological Association of the United Kingdom*, *47*(3), pp.629-643.

Jones, M.W., O'Reilly, P.T., McPherson, A.A., McParland, T.L., Armstrong, D.E., Cox, A.J., Spence, K.R., Kenchington, E.L., Taggart, C.T. and Bentzen, P., 2003. Development, characterisation, inheritance, and cross-species utility of American lobster (Homarus americanus) microsatellite and mtDNA PCR-RFLP markers. *Genome*, *46*(1), pp.59-69.

Klapper, W., Kühne, K., Singh, K.K., Heidorn, K., Parwaresch, R. and Krupp, G., 1998. Longevity of lobsters is linked to ubiquitous telomerase expression. *FEBS letters*, *439*(1-2), pp.143-146.

Leiknes, S.M., 2023. *The effect of Marine Protected Areas on the diet of Lillesand European lobster (Homarus gammarus): A DNA-based diet analysis approach* (Master's thesis, NTNU).

Linnane, A., Mazzoni, D. and Mercer, J.P., 2000. (a) A long-term mesocosm study on the settlement and survival of juvenile European lobster Homarus gammarus L. in four natural substrata. *Journal of Experimental Marine Biology and Ecology*, *249*(1), pp.51-64.

Linnane, A., Ball, B., Munday, B. and Mercer, J.P., 2000. (b) On the occurrence of juvenile lobster Homarus gammarus in intertidal habitat. *Journal of the Marine Biological Association of the United Kingdom*, *80*(2), pp.375-376.bster, Homarus gammarus. Fisheries Research, 65(1-3), pp.137-152.

Lizarraga-Cubedo, H.A., Tuck, I., Bailey, N., Pierce, G.J. and Kinnear, J.A.M., 2003. Comparisons of size at maturity and fecundity of two Scottish populations of the European lobster, Homarus gammarus. *Fisheries Research*, *65*(1-3), pp.137-152.

Lizárraga-Cubedo, H.A., Tuck, I., Bailey, N., Pierce, G.J., Zuur, A.F. and Bova, D., 2015. Scottish lobster fisheries and environmental variability. *ICES Journal of Marine Science*, *72*(suppl_1), pp.i211-i224.

Mente, E., Houlihan, D.F. and Smith, K., 2001. Growth, feeding frequency, protein turnover, and amino acid metabolism in European lobster Homarus gammarus L. *Journal of Experimental Zoology*, *289*(7), pp.419-432.

Moland, E., Olsen, E.M., Andvord, K., Knutsen, J.A. and Stenseth, N.C., 2011. Home range of European lobster (Homarus gammarus) in a marine reserve: implications for future reserve design. Canadian Journal of Fisheries and Aquatic Sciences, 68(7), pp.1197-1210.

Moore, A.B., Heney, C., Lincoln, H., Colvin, C., Newell, H., Turner, R., McCarthy, I.D. and Hold, N., 2023. Bycatch in northeast Atlantic lobster and crab pot fisheries (Irish Sea, Celtic Sea and Bristol Channel). *Fisheries Research*, *265*, p.106745.

Palomares, M.L.D. and D. Pauly. Editors. 2023. SeaLifeBase.
World Wide Web electronic publication.
www.sealifebase.org, version (04/2023).

Petetta, A., Vasapollo, C., Virgili, M., Bargione, G. and Lucchetti, A., 2020. Pots vs trammel nets: A catch comparison study in a Mediterranean small-scale fishery. *PeerJ*, *8*, p.e9287.

Phillips, B.F. (2013) *Lobsters biology, management, aquaculture and fisheries*. Chichester: Wiley-Blackwell. Online ISBN:9781118517444 |DOI:10.1002/9781118517444

Quetglas, A., Reñones, O. and Goñi, R., 2001. Trophic interactions among grouper (Epinephelus marginatus), octopus (Octopus vulgaris) and red lobster (Palinurus elephas) in the Western Mediterranean. *Rapports et Procès-Verbaux des Réunions. Commission Internationale pour L'Exploration Scientifique de la Mer Méditerranée*, *36*, p.310.

Ross, E.P., Behringer, D.C., Muñoz, A., Díaz, D. and Bojko, J., 2019. A histological atlas for the Palinuridae (Crustacea: Decapoda: Achelata): A guide to parasite discovery and spotting the abnormal in spiny lobsters. *Journal of invertebrate pathology*, *163*, pp.21-33.

Rowley, A.F. and Coates, C.J., 2023. Shell disease syndromes of decapod crustaceans. *Environmental Microbiology*.

Schmalenbach, I., Mehrtens, F., Janke, M. and Buchholz, F., 2011. A mark-recapture study of hatchery-reared juvenile European lobsters, Homarus gammarus, released at the rocky island of Helgoland (German Bight, North Sea) from 2000 to 2009. *Fisheries Research*, *108*(1), pp.22-30.

Sheehy, M.R.J., Bannister, R.C.A., Wickins, J.F. and Shelton, P.M.J., 1999. New perspectives on the growth and longevity of the European lobster (Homarus gammarus). *Canadian Journal of Fisheries and Aquatic Sciences*, *56*(10), pp.1904-1915.

Skerritt, D.J., Robertson, P.A., Mill, A.C., Polunin, N.V. and Fitzsimmons, C., 2015. Fine-scale movement, activity patterns and home-ranges of European lobster Homarus gammarus. *Marine Ecology Progress Series*, *536*, pp.203-219.

Small, D.P., Calosi, P., Boothroyd, D., Widdicombe, S. and Spicer, J.I., 2015. Stage-specific changes in physiological and life-history responses to elevated temperature and pCO2 during the larval development of the European lobster Homarus gammarus (L.). *Physiological and Biochemical Zoology*, *88*(5), pp.494-507.

Smith, I.P., Jensen, A.C., Collins, K.J. and Mattey, E.L., 2001. Movement of wild European lobsters Homarus gammarus in natural habitat. *Marine Ecology Progress Series*, *222*, pp.177-186.

Thatcher, H., Stamp, T., Wilcockson, D. and Moore, P.J., 2023. Residency and habitat use of

European lobster (Homarus gammarus) within an offshore wind farm. *ICES Journal of Marine Science*, p.fsad067.

Wallace, I.F., Lindner, R.K. and Dole, D.D., 1998. Evaluating stock and catchability trends: annual average catch per unit effort is an inadequate indicator of stock and catchability trends in fisheries. *Marine policy*, *22*(1), pp.45-55. – Catch per Unit Effort isn't always an accurate indicator of stock health.

Appendix 1 – Data collection form

Shellfish recording form

Date		**Vessel code**	
Observer		**Weather (beaufort 0-5)**	

String Number		**Pots on string (total)**		**Pots sampled (total)**	
Location	**Start Lat:**	**Lon:**	**End Lat:**	**Lon:**	
Soak time		**Habitat/depth**			

Species	**Length** (mm)	**Sex** (M/F)	**Notes** (berried, v notch, disease, claws, fate)	**Species**	**Length** (mm)	**Sex** (M/F)	**Notes** (berried, v notch, disease, claws, fate)