Fisher Interviews

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SIARC

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Executive Summary

Project SIARC works closely with fishers from all sectors across Wales, building on learnings and relationships developed through Angel Shark Project: Wales (ASP:W). Fishers in Wales are stewards of elasmobranch conservation, providing vital data on current and historic encounters and collaborating on co-designed research.

Fishers can provide valuable insights into spatiotemporal changes in fish communities. Between August 2018 and November 2019, ASP:W conducted 27 semi-structured interviews with fishers based in North Wales to improve our understanding of how elasmobranch distribution, fishing efforts and other relevant factors have changed over time and what may have influenced any changing trends, with a focus on angelsharks.

The information gathered during interviews focused on the period between 1968 and 2019. The analysis identified key socio-economic, ecological, and legislative factors that have driven changes in fishing effort in Wales, that to date have been omitted from current modelling approaches for *angelshark* populations. Our findings suggest that hypothesised population declines of *angelshark* may be exaggerated due to a net reduction in the detectability of angelsharks over the past several decades, having important implications for conservation and understanding historic trends. Our findings imply that the decline of thornback ray (*Raja clavata*) populations in the 1990s, spatiotemporal changes to fishing locations and target fisheries, in addition to the gradual reduction of charter fishing in Wales, likely influenced the probability of fishers encountering angelsharks, especially in Cardigan Bay, identifying key knowledge gaps for future research.

Our results highlight the importance of incorporating fisher perspectives and local ecological knowledge (LEK) into fisheries research, providing the wider narrative on how changes to the sector over 51 years have influenced the likelihood of encountering a Critically Endangered shark species. Furthermore, we emphasise the importance of quantifying these spatiotemporal changes in future analyses, to aid the improvement of current management strategies to conserve vulnerable shark populations within this region.

Key Findings

- All participants interviewed had recollections of catching angelsharks before the 2000s.
- 74% of fishers indicated that angelsharks were often caught by fishers targeting thornback ray (*Raja clavata*), in both commercial and recreational fisheries.
- The decline of thornback rays in the 1990s in Cardigan Bay, had important consequences for commercial and recreational fishing effort which resulted in widespread changes to target fisheries, fishing location and gear selectivity.
- Changes to charter fleet angling effort from fishing locations with high spatial overlap with angelsharks, to focusing effort at wrecks/reefs, likely reduced the probability of sighting and/or landing angelsharks due to a potential reduction in the spatial overlap.
- Commercial fishers used to group and record shark, skate and ray catches as 'miscellaneous' or in general categories, which has implications for our understanding of historic angelshark commercial records in mixed fisheries.
- Today, the Welsh fleet is mainly comprised of potting fisheries, usually for shellfish and/or whelk (*Buccinum undatum*), reducing the chance of fishers encountering angelsharks.

Crynodeb Gweithredol

Mae Prosiect SIARC yn cydweithio'n agos â physgotwyr o bob sector ar draws Cymru, gan adeiladu ar wersi a pherthnasoedd a ddatblygwyd trwy Brosiect Maelgi: Cymru. Mae pysgotwyr yng Nghymru yn allweddol o ran gwarchod elasmobranciaid, gan ddarparu data hanfodol ar achosion cyfredol a hanesyddol o'u gweld a chydweithio ar waith ymchwil sydd wedi'i ddylunio ar y cyd.

Gall pysgotwyr roi gwybodaeth werthfawr ar newidiadau gofod-amser mewn cymunedau o bysgod. Rhwng mis Awst 2018 a mis Tachwedd 2019, cynhaliodd Prosiect SIARC 27 o gyfweliadau lled-strwythuredig gyda physgotwyr yng ngogledd Cymru i wella ein dealltwriaeth o sut mae dosbarthiad elasmobranciaid, ymdrechion pysgota a ffactorau perthnasol eraill wedi newid dros amser a'r hyn a allai fod wedi dylanwadu ar unrhyw dueddiadau cyfnewidiol, gan ganolbwyntio ar Faelgwn.

Roedd yr wybodaeth a gasglwyd yn y cyfweliadau yn canolbwyntio ar y cyfnod rhwng 1968 a 2019, a nododd dadansoddiad ffactorau economaidd-gymdeithasol, ecolegol, a deddfwriaethol allweddol sydd wedi ysgogi newidiadau ym maes pysgota yng Nghymru, sydd hyd yma wedi'u hepgor o ddulliau modelu cyfredol ar gyfer poblogaethau *angelshark*. Mae ein canfyddiadau'n awgrymu y gallai'r rhagdybiaethau o ran dirywiad poblogaethau *angelshark* fod yn ormodol oherwydd gostyngiad net o ran y gallu i ganfod maelgwn dros y degawdau diwethaf, gan arwain at oblygiadau pwysig o ran rheoli pysgodfeydd a deall tueddiadau hanesyddol. Mae ein canfyddiadau'n awgrymu bod dirywiad poblogaethau o forgathod styds (*Raja clavata*) yn y 1990au, newidiadau gofod-amser i leoliadau pysgota a physgodfeydd targed, yn ogystal â'r gostyngiad graddol mewn pysgota siarter yng Nghymru, yn debygol o fod wedi dylanwadu ar y tebygolrwydd y bydd pysgotwyr yn dod ar draws maelgwn, yn enwedig ym Mae Ceredigion, gan nodi bylchau gwybodaeth allweddol ar gyfer ymchwil yn y dyfodol.

Mae ein canlyniadau'n tynnu sylw at bwysigrwydd ymgorffori safbwyntiau pysgotwyr a gwybodaeth ecolegol leol i ymchwil pysgodfeydd, gan ddarparu'r naratif ehangach ar sut mae newidiadau i'r sector dros 51 mlynedd wedi dylanwadu ar y tebygolrwydd o ddod ar draws siarc anghyffredin sy'n prinhau yn ein dyfroedd. Ar ben hynny, rydym yn pwysleisio pwysigrwydd mesur y newidiadau gofod-amser hyn mewn pysgodfeydd yn y DU gan dargedu elasmobranciaid mewn dadansoddiadau yn y dyfodol, i helpu i wella'r strategaethau rheoli presennol i warchod poblogaethau o siarcod sydd mewn perygl yn y rhanbarth hwn.

Canfyddiadau Allweddol

- Roedd gan yr holl gyfranogwyr a gafodd eu cyfweld atgofion o ddal maelgwn cyn y 2000au.
- Nododd 74% o bysgotwyr fod maelgwn yn aml yn cael eu dal gan bysgotwyr sy'n targedu'r forgath styds (*Raja clavata*), mewn pysgodfeydd masnachol a hamdden.
- Arweiniodd dirywiad morgathod styds yn y 1990au ym Mae Ceredigion at ganlyniadau pwysig i'r ymdrech bysgota fasnachol a hamdden a arweiniodd at newidiadau eang i bysgodfeydd targed, lleoliad pysgota a dewis offer.
- Roedd newidiadau i ymdrech genweirio'r fflyd siarter o leoliadau pysgota a oedd yn gorgyffwrdd yn fawr ag ardaloedd maelgwn, i ganolbwyntio ymdrech ar longddrylliadau/riffiau, yn debygol o fod wedi lleihau'r tebygolrwydd o weld maelgwn a/neu lanio maelgwn oherwydd gostyngiad posibl yn y gorgyffwrdd gofodol.
- Arferai pysgotwyr masnachol grwpio a chofnodi dalfeydd siarcod a morgathod fel rhai 'amrywiol' neu mewn categorïau cyffredinol, sydd â goblygiadau i'n dealltwriaeth o gofnodion masnachol, hanesyddol o faelgwn mewn pysgodfeydd cymysg.
- Heddiw, mae fflyd Cymru yn cynnwys pysgodfeydd potio yn bennaf, fel arfer ar gyfer pysgod cregyn a/neu gregyn moch (*Buccinum undatum*), gan leihau'r siawns y bydd pysgotwyr yn dod ar draws maelgwn.

Introduction

Recreational and commercial fishing in Wales has a long cultural, social and economic history within coastal regions. Many communities rely on fisheries resources to support their livelihoods and local economies. Fishers have detailed knowledge of the seas, and developing good relationships and appropriate tools enables them to share accurate data on species they encounter. By working together, we can better understand and improve conservation to safeguard the future of elasmobranchs (sharks, skates and rays) and sustainable fishing in Wales.

Throughout ASP:W and Project SIARC (2018 – 2023) the team worked closely with fishers and relevant associations from the commercial, recreational and charter sectors to gather essential local ecological knowledge on the ecology, distribution, and perceived abundance of angelsharks within this region, and provide opportunities to feed this back to the wider community (see 2022 paper).

However, the fishing sector has undergone a drastic transformation over the past three decades, due to various complex socio-economic, ecological, and legislative factors that have resulted in significant declines in the Welsh fleet size and widespread changes to the overall fishing effort. Consequently, characterising how the sector has modernised and how effort has changed through generations is important for understanding subsequent changes in species records and ensuring fisheries' long-term sustainability.

Using a systematic approach through semi-structured interviews with fishers working in Wales from 1968 - 2019, we collated important anecdotal information on perceived drivers of changes to the fishing sector in Wales, to assess how these could influence our understanding of historic angelshark records. In addition, information and questions about other Welsh elasmobranchs were shared, with species such as tope, spurdog and common stingray regularly mentioned. As such, the project expanded to incorporate those species with the launch of Project SIARC, and future fisher engagement will systematically gather data on this wider group of species and fishing ecology in Wales. Alongside being of interest to fishers, all these species are listed within a category of threat on the IUCN Red List (Vulnerable, Endangered or Critically Endangered), are bentho-pelagic species and are extremely data-poor in Welsh waters.

The fisher engagement network continues to be a vital tool for ensuring that any protected elasmobranchs accidentally caught and released, can be reported to Project SIARC, with information and findings shared back to the fishers involved.

Method

A fisher engagement strategy was designed a led by Angel shark Project: Wales and used to identify fishers to interview and snowball sampling was used to broaden sample size.

Between August 2018 and November 2019 semi-structured interviews and participatory mapping exercises took place with fishers identified. Fishers were asked about:

a) Angelshark sightings and historic catch records

b) Angelshark ecology and distribution,

c) Fisher background including years fished, size of fisher vessel, gear type used, target species and seasonality changes

d) Other elasmobranchs targeted/caught

e) Observed changes in the fishing industry over time.

Interviews were then transcribed and digitised to identify socio-economic, ecological and political themes influencing perceived changes in fishing pressure and effort in Wales from 1968 – 2019.

Results were then used to make inferences about how these changes could have influenced our understanding of historical angelshark records, to further contextualise the innate link between fisher knowledge and angelshark sightings/records.

Detailed methods have been written up in a scientific manuscript – Mason *et al*. In prep – to be published in 2023.

Results

A total number of 27 fishers were interviewed, 10 were commercial fishers, eight fishers were either skippers or crew on charter boat operations, five were recreational anglers, three had worked on both commercial and charter boats, and one individual had experience working as crew on a charter vessel but mainly recreationally fishes.

On average, fishers had 28 years of experience (range 1- 55 years) working in fishing vessels in Wales, spanning from 1968 to 2019.

48% of the fishers interviewed were employed full-time, with the majority of full-time employees working on commercial vessels. In contrast, the majority of charter fishers interviewed in this study were only actively fishing during the summer season between April and October. Shore and boat-based recreational anglers often fished all year round, although effort (number of days fished) was often heavily dependent on weather and fisher availability (i.e., weekends, after-work excursions).

All commercial fishers interviewed worked on polyvalent fleets operating multiple gear types and targeting different species (i.e., potting for crustaceans/whelk and tangle netting for thornback rays concurrently).

All interviewees had caught angelsharks prior to the 2000s.

Fishers inferred that the likelihood of sighting or catching angelsharks depends on target species, fishing location and gear selectivity. The majority of fishers recalled catching angelsharks when targeting other species, including thornback rays, tope, bream, or skate populations by recreational anglers or in mixed demersal fisheries for commercial fishers.

Factors fishers perceived as responsible for changing Welsh fisheries are examined under three overarching themes: socio-economic, ecological, and legislative drivers.

Socio-economic Changes (Table 1)

Thematic and qualitative data analysis from fisher interviews identified seven potential social and economic factors that fishers perceived to have influenced fleet size and fishing effort in Wales. Vessel size and category was the most frequently mentioned factor impacting the Welsh fishing fleet (70% of respondents), followed by reductions in charter fleet size (30%), market value and competition (26%), non-UK vessels fishing within the Welsh Zone (19%), industry collapses (7%), and operating costs of fishing (7%), respectively.

Socio-Economic factors influencing changes to fisheries operating within Wales.

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Factor	Description	Examples from fisher interviews	Implication for fisheries	Predicted impact on angelshark records
 **Changes in Vessel Size or Category** (n=19, 70%)	Size of the vessel (over or under 10m) and vessel category (i.e., commercial, recreational or charter).	*'The Viking left from Barmouth but carried 94 people and underwent 15-hour trips in the 1960s.'* *82% of fishers worked on vessels <10m.*	The fishing capacity of a fleet is measured by vessel size, fleet size in gross tonnage (GT) and engine power (kW). The number of vessels in the Welsh fleet has reduced since 1968. Quotas given to vessels depend on vessel size and characteristics.	Temporal changes to the number of vessels and size of vessels operating in the Welsh fleet could either increase or decrease the probability of catching angelsharks depending on the vessel category and type of fishery. Overall, this has an unknown impact on angelshark populations.
	Changes to vessel/fisher characteristics (i.e., number of rods, time at sea).	*'1976 Started fishing on a boat that had 10 rods with a 3-mile licence. 1978 Boat IP23 called Nissan. 8 people with a 3-mile licence offshore and 15 miles North & South. 1981 got a new boat Aquastore, an offshore vessel that was able to go 10-12 miles out with a 10 - 12 rod licence.'*	Fisher respondents owned and/or worked on different vessels over time. Fishing effort (a standardised unit) is measured by either the number of days or hours at sea and/or the gear type used on the vessel, with many fishers working on polyvalent fleets.	Changes to vessel/fisher characteristics could either increase or decrease the probability of fishers catching an angelshark depending on the number of hours spent fishing and the likelihood of the gear used to catch an angelshark. While angling effort targeting angelsharks has reduced, understanding changes to commercial fishing effort impacting angelsharks is still poorly understood. Given the complexity surrounding these changes, overall, we conclude that there is an unknown impact on angelshark populations.
	Full-time/Part-time employment and fishing activity is dependent on vessel category and seasonality.	*48% of fishers interviewed were employed full-time.* *Charter fishers were only actively fishing between April and November.*	Fishing effort does not stay constant throughout the year. Most charter fishers interviewed were only employed during the summer months.	Charter fishing effort is higher during the summer months increasing the probability of fishers encountering angelsharks during seasons that align with hypothesised angelshark migrations (only increased prior to their protected status in 2008).
 **Reduction in charter vessels.** (n=8, 30%)	Fishers explained there has been a reduction in trip demand from anglers and angling clubs.	*'The Viking used to fish every Sat, Sun and Wednesday in its hay day, but as demand declined Wednesday trips stopped and we struggled to fill weekend trips'.*	Fewer charter vessels targeting elasmobranchs. Reduction in angling effort (rod & line) in inshore/offshore fishing locations.	Decrease the probability of catching or sighting angelsharks. The reduction in the number of days at sea would reduce the number of active recreational anglers fishing for elasmobranchs by boat.
	Since 1970, there has been a gradual decline in the number of charter vessels operating in Wales due to regulations, licencing, and operating costs.	*'In the mid- 1980s, used to be 87 boats from Aberystwyth (charter and commercial), today there are no charter vessels in Aberystwyth.'* *'23 charter boats in the early 80s. The late 80s was a coal strike that caused a reduction in the number of charter vessels.'*	Reduction in fishing effort (number of charter vessels, days at sea, reduction in anglers on charter vessels). Social and economic loss to coastal communities.	Decrease the probability of recreational fishers encountering or catching an angelshark.
	Increase in private boat ownership.	*'While private boats and recreational anglers increased this wasn't reflected in charter vessels, as the industry decreased.'*	More private boats on the water. Catch data unknown unless fishers reported 'trophy' catches to angling magazines.	Unknown impact on angelshark populations.
 **Market value and competition** (n=7, 25.9%)	Historically, local markets were oversaturated with fishers in competition to sell catches. Only profitable to the first boats to arrive.	*'Price of rays decreased as everyone started fishing rays. Problem for the market, as more fishers fished certain species there was competition that drove market price down. Had implications for whether fishing certain species was economically viable.'*	Market drove targeted species fished. Competition for catches had implications for the value of fish.	As market value for thornback rays declined, this would reduce the probability of commercial fishers catching angelsharks as individuals were commonly caught by fisheries targeting thornback rays.
	No commercial value for angelsharks, however catches would be sold to local restaurants.	*'No value in the markets for angelsharks (called angelsharks 'fiddler fish').'* *'All three angelsharks caught in the 1980s were sold to a Manchester market and were worth £200 -£300.'*	Angelsharks historically sold to local markets, if caught. However, the species had no real commercial market value.	Not commercially targeted in the UK, decreasing the probability of fishers catching an angelshark and/or recording the catch.
	Fishing competitions had implications for fishing effort targeting shark species.	*'The 1980s used to have large fishing festivals such as the Tope festival with 30/40 fishing boats in attendance.'*	Increase in recreational sea angling effort targeting elasmobranchs.	Increase probability of anglers catching angelsharks in the 1980s.
 **Non- Welsh Vessels** (n=5, 19%)	Non-UK registered vessels (i.e., beam trawlers) and vessels from other UK administrations (i.e., Scotland, England, Northern Ireland) and member nations used to fish within the Welsh Zone.	*'1989-1993 much bigger Dutch beam trawlers were around Cardigan Bay impacting seabed.'*	Competition for catches with foreign vessels. Ecological ramifications for habitats within the Welsh Zone.	Decrease probability of sighting or catching an angelshark. Large beam trawlers could have negative impacts on seabed habitats that are important for angelsharks in Cardigan Bay, reducing, displacing, or fragmenting angelsharks populations in the impacted regions.
	In 1980s, Non-UK based angling clubs used to visit coastal towns for large fishing festivals (e.g., tope festival).	*'The 1980s used to have large fishing festivals such as the Tope festival with 30-40 fishing boats in attendance. A Belgium fishing group were a big group that regularly attended.'*	Economic contribution to coastal communities reduced. As the number of non-UK based angling clubs reduced fishing effort targeting elasmobranchs would have decreased.	Reduction in the number of recreational anglers would decrease the probability of fishers sighting or catching an angelshark.
 **Industry collapses** (n =2, 7%)	Coal mine strikes and industry collapse in the midlands resulted in fewer angling club trips with charter vessels.	*'Factories disappeared in the midlands around 1979, so a lot of angling clubs stopped coming to Wales because they couldn't afford prices, so had fewer holidays – this had a huge impact on charter vessels.'*	Collapse of industry and closure of factories had implications for charter vessel demand, contributing to the reduction in operational charter vessels.	Decrease probability of catching and/ or sighting an angelshark due to a reduction in charter fishing effort.
	Fishers suggested a potential link between industrial workers and recreational angling.	*'The late 1980s coal strike caused a reduction in the number of charter vessels.'*	Reduction in fishing effort due to declines in trip demand by industrial workers.	Decrease probability of catching and/ or sighting an angelshark due to a reduction in charter fishing effort.
 **Cost of fishing** (n=2, 7%)	Increase in fuel prices resulting in shorter trips (fishing effort reduction).	*'In 1970, the Viking used to do 2hour trips in the evenings to muddy hollow but then due to fuel prices in 1978 had to fish closer to shore.'*	Fishing effort reduction due to fewer boats out fishing. Time on the water changed from longer fishing trips in the 1970s to shorter trips closer to shore.	Decrease probability of catching an angelshark, due to spatiotemporal changes in fishing location dependent on operational costs and reduction in time spent fishing.
	Licencing costs increased contributing to reductions in the number of charter vessels.	*'Changes in regulations over the years and licencing costs have resulted in a reduction of charter vessels operating.'*	Licencing costs contribute to overall operational costs of charter vessels. Fishers suggested this was the reason for the overall reduction in the size of the charter vessels in Wales.	Decrease probability of catching and/ or sighting an angelshark due to a reduction in charter fishing effort.

Ecological Changes (Table 2)

Analysis of qualitative data collated from fisher interviews identified five potential ecological variables that could have driven changes in Welsh fisheries over the past several decades. Thornback rays were mentioned by the majority of fishers (81% interviewed fishers), with fishers indicating that they commonly caught angelsharks when targeting thornback rays (74% of interviewed fishers), with half of the fishers targeting thornback rays suggesting the collapse of thornback ray populations in the 1990s had widespread implications for targeted fisheries in Wales, with one fisher suggesting the implementation of quotas for the population after its collapse was responsible for the reduction in fleet size. Changes to target species and fisheries was the second most popular ecological variable mentioned by respondents (48% of interviewed fishers), gear changes (44% of interviewed fishers) followed by spatiotemporal changes in fishing location (33% of interviewed fishers) and species composition changes (22% of interviewed fishers).

Ecological Factors influencing historic changes to fisheries in Wales.

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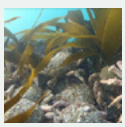
Factor	Description	Examples from fisher interviews	Implication for fisheries	Predicted impact on angelshark records
 **Thornback ray (R. clavata) population** (n=22, 81%)	Popular target species by commercial and recreational fishers. 74% of all fishers interviewed mentioned they caught angelsharks while actively targeted thornback rays.	*'1990s thornback rays declined and were outfished.'*	Overexploitation of thornback ray populations by fisheries in the 1980s-1990s.	Decrease in the probability of catching an angelshark after 1990s as the target fishery was overfished and less fishers would try and catch thornback rays.
	52% of fishers interviewed mentioned in the late 1980s/1990s, thornback ray populations declined, due to targeted and non-target fishing pressures (tangle netting, rod &line, bycatch in demersal fisheries).	*'Charter was out targeting thornback rays and tope when they caught the angelsharks.'* *'Tangle netting effort for rays increased in 1995 in Aber, therefore due to changes in bottom fishing because of the reduction in rays.'*	Thornback rays are caught in multiple fisheries. Population declines in the 1990s, resulted in changes to target fisheries in the Welsh fleet, reducing fishing effort for thornback rays.	Decrease in the probability of catching an angelshark. Increased fishing pressure on thornback rays could have reduced the species abundance. However, the resulting shift in target fisheries due to depleted thornback ray populations could have reduced the probability of fishers encountering angelsharks.
	Fishers suggested reductions in the abundance of thornback rays resulted in target species and habitat changes for both commercial and charter fishers operating in Cardigan Bay.	*'Saw a decrease in thornback rays during the 1990s due to tangle netting in the bay. Fishing areas changed due to changes in species i.e., fewer thornbacks. Fishing areas changed as a result of decreased thornbacks to fishing on reefs for bream and tope.'*	The decline in the population of thornback rays resulted in a fleet-wide change in target species and habitats, which shifted to more offshore and wreck fishing in the late 1990s.	Decrease the probability of catching an angelshark. Changes to target species and habitat to offshore, wreck fishing and potting would reduce the probability of fishers encountering an angelshark due to a lack of spatial overlap.
	No quota for catching thornback rays in the 1980s/90s. Fishers suggested that this was the reason so many were landed.	*No quota for thornback rays and that was the reason for landing so many in the 80s/90s.'*	Implications for species composition. Increased fishing effort had implications for the abundance of thornback rays.	Decrease the probability of catching an angelshark after the decline in abundance of thornback rays, reducing fishing effort in locations that overlap with angelshark predicted habitat use.
 **Changes in target species and fisheries** (n=13, 48%)	Spatiotemporal changes to target fisheries. Today majority of fishing is potting compared to nomadic fisheries in the 1970s.	*'The reason for switching target species was due to decline in the number of rays because of tangle netting in the bay. Switched target species but still caught thornbacks up to 2008.'*	Fishing effort has not stayed constant over the past three decades.	The probability of fishers catching angelsharks is highly dependent on target species, location and fishing gear used. There is a decreased probability of fishers encountering an angelshark as fisheries have changed to target species that rarely overlap with angelsharks populations.
	Fishers implied that fleets were dynamic. Reductions in abundance of target species would result in fleet-wide changes in target fisheries.	*'Tangle nets to target thornback rays and spurdog till 1993. Then potting for crustaceans and whelk.'*	Likelihood of catching target species is dependent on gear type used, fishing effort and fleet capacity.	Angelsharks were often caught as bycatch in mixed demersal fisheries and targeted fisheries. Fleet-wide changes in target fisheries to more offshore, wreck and reef, decreased the probability of fishers detecting angelsharks.
	Quotas would influence target fisheries.	*'1970s - No real Quotas.'*	Introduction of catch limits had implications for what fish were targeted commercially and fishing effort of the fleet.	Increased the likelihood of encountering angelsharks in the 1970s – 1980s due to limited fisheries management.
 **Fishing gear selectivity** (n=12, 44%)	Polyvalent fleet utilising multiple gear types to seasonally target different species.	*48% of all fishers interviewed operated different gear types to target different species.*	Potential catches of angelsharks dependent on gear type. Rod & Line fishing effort was higher in summer months.	Probability of fishers catching angelsharks is dependent on gear selectivity. Angelsharks are most likely to be caught in fisheries operating the following gear: static nets, trawling, rod & line. Overall, we suggest there is an unknown impact, as further analysis is need to assess the impact of gear type on angelshark catchability.
	Introduction of monofilament in 1970s.	*'Used to fish twine and then brought monofilament from St. Johns in Canada. Monofilament increased catch rates of thornback rays.'*	Increased catch rates due to advancement in gear type/design, increasing fishing efficiency.	Introduction of new gear types improves selectivity of fisheries and increases the likelihood of a fisher landing an angelshark.
	Multiple gear changes between 1968 and 2019. Today, the majority of the Welsh fleet is potting, with whelk and shellfish (Buccinum undatum) being the main fisheries.	*48% of fishers operated multiple gear tyoes.*	Modernisation of the Welsh fleet. Often species-specific gear type used to catch target species (i.e., leaders, monofilament, bait).	Overall, decrease in the probability of fishers encountering angelsharks as the majority of the fleet has shifted to potting. Little overlap of angelsharks with shellfish fisheries.
 **Spatiotemporal changes in fishing location and target habitat** (n=9, 33%)	Fishing effort changes depending on location impacting species caught.	*'Since 2005 changed fishing grounds, now fishes more east of Constable bank and doesn't pick up angelsharks.'*	Fishers commonly said they have changed fishing locations to target wreck and reef habitat instead of sand, mud & gravel.	Decrease in the probability of fishers encountering angelsharks due to a reduction in fishing effort in locations of importance for angelshark populations.
	Fishing effort in different locations is dependent on seasons. Charter fishers mainly active during April- October.	*48% interviewed fishers are employed all year, 33% where are active between April and October.*	Reduced fishing effort by charter fishers in winter months. Yet, there is still limited knowledge about seasonal habitat and space use of angelsharks in Wales.	Increased probability of catching an angelshark during summer months due to spatiotemporal overlap of charter vessels with angelshark populations.
	Spatial overlap of fisheries with angelshark habitat use.	*'In the 1990s there was a decline in thornback rays in the bay. In the late 80s anglers changed their fishing locations and therefore less likely to catch rays and angels.'*	Demersal trawls, static nets and rod & line fishing often targeted species in sand/gravel/mud habitats.	Angelshark distribution is still poorly understood, predicted habitat space use has identified Cardigan Bay as an important area. Fisheries in that region are more likely to detect angelsharks.
	Fishing effort and targeted fishing areas changed due to regulations.	*'Changes in fishing efforts and targeted fishing areas (overall changes in the fishing fleet) were due to regulation changes.'*	Fishing effort in different locations dependent on permits granted by local authorities.	Fishing effort not constant across Wales. Increase or decrease in the probability of catching an angelshark depending on fishing location and jurisdiction. Overall, unknown impact on angelshark populations.
 **Species composition changes** (n=6, 22%)	In the 1990s, fishers noticed an increase in the spider crab (*Maja brachydactyla*) population.	*'Noticed an increase in spider crab numbers as thornback rays decreased in the 1990s.'*	Fishers suggested that reduction of thornback rays resulted in an increase in the spider crab populations.	Decrease the probability of catching an angelshark due to little overlap with shellfish fisheries.
	Fishers suggested that spurdog (*Squalus acanthias*) populations decreased in the 1980-90s.	*'The early 1980s - early 1990s, boom and bust due to the decline of spurdog in the area.'*	Changes to target fisheries (both recreational and commercial) that caught angelsharks.	Unknown impact on angelshark abundance.

Policy and Legislative Changes (Table 3)

Analysis of qualitative data from coded fisher interviews identified how legislative changes over the past 51 years could have influenced historical records and sightings of angelshark. Despite only one fisher naming specific policies and legislations that had widespread ramifications for how UK fisheries were managed over the past couple of decades, most participants spoke generally about how they impacted commercial and charter fisheries. 26% of fishers mentioned how licencing changes and increased associated costs contributed to the reduction of the charter fleet, inadvertently reducing fishing effort that targeted angelsharks. 11% anecdotally mentioned how shifting quotas under the EU Common Fisheries Policy influenced what species were targeted commercially and influenced fishing effort. 11% fishers noted the Fisheries Legislation and Jurisdiction influenced fishing effort in the Welsh fleet (Figure - Key Events Timeline). One fisher mentioned that insurance played an important role for charter vessels, contributing to overall operational costs and seasonally reducing fishing effort.

Legislative Factors influencing historic changes to fisheries in Wales.

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Factor	Description	Examples from fisher interviews	Implication for fisheries	Predicted impact on angelshark records
 **Licencing changes** (n=7, 26%)	Local authorities were responsible for licencing commercial activity in its respective port.	*'Licences were available from the local council to dock at the harbour.'*	Licences to target certain species and obtain permits dependent on local authorities.	Fishing effort impacting angelsharks will vary depending on location due to differences in licencing requirements and local by-laws. Decrease the probability of catching an angelsharks, due to more stringent protocols in certain areas.
	Council was responsible for licencing charter vessels to take out paying guests.	*'Licences were given from the tourist board to take out guests, but Health and safety became a big concern. This was council dependent with some areas tougher than others.'*	Certain council licences were more restrictive than others (e.g., Barmouth). Impacted the number of vessels actively fishing.	Restrictive councils (e.g. Barmouth) could impact the number of vessels fishing in Cardigan Bay, an area of importance for angelshark populations. Thus, decreasing the probability of fishers encountering an angelshark by influencing fishing effort in certain regions.
	Licencing costs increased.	*'Changes in regulations over the years and licencing costs have resulted in a reduction of charter vessels operating.'*	Reduction in the number of charter vessels due to operational cost increases.	Decrease probability of catching an angelshark due to a reduction in charter fishing effort.
 **Shifting quotas** (n=3, 11%)	Quota limits (total allowable catch (TAC)) are set annually by The European Commission under Common Fisheries Policy (CFP) based on area.	*'Shifting quotas (given to Welsh fishermen) changed every year. If the quota went down, effort went down.'*	Catch limits determine species-specific fishing effort which changes annually. If TAC limits are reduced, fishing effort in the respective fishery is reduced. Thus, fishing effort doesn't stay constant over time.	The probability of catching an angelshark is dependent on the type of commercial activity. For example, annual catch limits given to demersal fisheries could either increase or decrease the probability of fishers catching an angelshark dependant on fishing effort, capacity and location. Overall, unknown impact on angelshark populations.
	Quotas allocated to vessels by UK administrations.	*'Shifting quotas (given to Welsh fisherman) changed every year. Quota trading was also common.'*	Quotas given to vessels by UK administrations, quotas are often traded between fishers in different locations. Thus, influencing our understanding of historic landing records and species-specific fishing effort.	Unknown impact on angelshark catches, however, the lack of quotas for under 10m vessels could result in a decrease in the number of historical records for angelshark populations.
	Non-quota species are regulated by the Member States and do not have limits set at the EU level. Mainly includes shellfish (the main fishery in Wales).	*'No quota for thornback rays and that was the reason for landing so many in the 80s/90s.'*	Local by-laws apply for certain species within specific fishing areas. Article 15 of the CFP landing obligation (also referred to as 'discard ban') has implications for non-commercially targeted species that are caught as bycatch or discarded by fisheries.	Increased probability of fishers catching angelsharks when targeting thornback rays in the 1980s/90s. However, over time the introduction of quotas, discard bans and fisheries management plans would decrease the probability of fishers encountering angelsharks.
 **Fisheries legislation and jurisdiction** (n=3, 11%)	The first fisheries regulations were introduced under the Common Fisheries Policy (CFP) and its reforms in 1992, 2002 and 2013.	*'In the 1980s Common Fisheries Policy introduced - impact on quotas/catch limits. Lots of sea committee by-laws. Introduction of minimum landing sizes for certain species.'*	From 1983, the CFP was responsible for allocating fisheries quotas to its member states. These legislations have direct implications for fishing effort and target species in Wales.	Decrease probability of catching an angelshark as CFP reforms introduced catch limits, reducing fishing effort in fisheries catching angelsharks (i.e., thornback rays in the 1990s).
	Implementation of Exclusive Economic Zones (EEZ) in 1976.		Implementation of EEZ, and 6 -12 nautical limits, had implications for the number of non-UK vessels fishing around the Welsh and English Coast.	Unknown impact on angelshark populations.
	Devolution of UK fisheries and establishment of the Welsh Zone.		The devolution of UK fisheries has direct ramifications for our understanding of historical catch records and the capacity of the Welsh fleet, especially given that landing data for England and Wales was recorded together historically.	Unknown impact on the number of historic angelshark records.
	Commercial landing records and legislative protection for angelsharks.	*'2008 - Wildlife and Countryside Act 1981 (angelshark some rays). After this no records of angelsharks/rays. (Fisher opinion) once these species were put on this act, was there compliance? Did commercial fishers' throwback angelsharks and not reported it?* *Commercial operations didn't used to report sharks and rays. If an angelshark was caught it was normally labelled under 'misc.' This was more reliable after the implementation of the Wildlife Countryside Act 1981 (listed 2008) for angelsharks, as catch records were not species- specific.'*	Under Technical Measure Regulation (EU) No. 2015/812 and Article 15 (4) and (5) of Regulation (EU) No 1380/2013 of the European Parliament, over 10m vessels have to record all accidental catches (released) and estimated discards of angelsharks in vessel logbook. Until 2020 (when enforcement was introduced) there was no statuary requirement for under 10m vessels to complete logbooks.	Before the introduction of these legislations, there is a decreased probability of fishers recording angelshark catches.
 **Insurance** (n=1, 4%)	Insurance for charter vessels was only licenced from April-September.	*'Insurance for charters was only licenced from April-September.'*	Reduction in annual fishing effort for charter vessels due to seasonal insurance window.	Potential overlap of the charter fishing season with angelshark sightings in the summer months. Increased probability of charter fishers detecting an angelshark up till their inclusion in The Wildlife and Countryside Act in 2008.
	Health & Safety certificates needed for crews and licences on charter vessels (cost associated).	*'Accidents could have tightened up regulations by certain authorities, Health & safety was a big concern for insurance reasons.'*	A requirement that might have reduced the number of experienced skippers/ crew due to costs associated with training.	Reduction in the number of charter vessels operating due to costs associated with training, and requirements needed to take out paying guests, this would decrease probability of charter fishers encountering an angelshark.
	Insurance costs	*'Certificates need for crews and licences on charter vessels. Had a cost associated.'*	Contributed to an increase in operating costs for charter vessels. Potentially a reason for the decline charter vessels.	Decrease probability of catching an angelshark due to a reduction in the number of charter vessels operating.

Other key indicators

During Project SIARC, between November 2021 – February 2022 the following additional records were collected:

- 11 records of angelsharks were shared by fishers to Project SIARC.
- Two common stingray records were shared by fishers, both from the Bristol channel.
- In December 2022, three fisher feedback events took place across North Wales; Two fishers attended Aberystwyth, one fisher in Barmouth and three in Pwllheli. Four of the fishers were charter boat skippers, one a recreational angler and one a commercial fisher.

Discussion / relevance to project / next steps

These results and more detailed analyses are currently being written up into a scientific manuscript, which we hope to be published in People and Nature during 2023.

This study has three main management implications for angelshark populations within Welsh waters. Firstly, our results highlight the importance of integrating and quantifying the widespread changes to historic fisheries in future studies looking to assess trends in abundance for data-poor elasmobranch populations within Wales. In addition, we show over the past 51 years there have been important changes to fishing effort and capacity within the fleet operating within Welsh waters, that have decreased the likelihood of fishers encountering angelsharks.

Secondly, our results suggest that the reduction of the thornback ray population in 1990 might have had broader-scale fleet-wide impacts on both commercial and recreational fisheries operating in Wales that catch angelsharks. Future work will aim to characterise the interactions between these fisheries within Cardigan Bay, which might have important implications for our understanding of historic angelshark distribution.

Finally, we advocate for the greater inclusion of fisher perspectives into traditional quantitative approaches within fisheries research and highlight the innovative value of LEK in regaining scarce data on historic fish populations. We also would like to emphasise that there is a limited window of opportunity to source LEK from fishers on historical fisheries and would encourage scientists to utilise this as a tool before much of this information is lost with a diminishing generation.

SIARC: Fisher Interviews

Future plans

We plan to expand our fisher engagement network over the next three years, with fisher partnerships a core part of the project. During Project SIARC, we have critically reviewed and updated our fisher engagement protocols, to enable a wider range of fishers to be involved in the project and greater focus on enabling fishers to co-design how their data will be used. Fisher interviews will be conducted more regularly, with a particular focus on engagement in South and West Wales and asking fishers how we can improve our two-way exchange of information. We will also start to collect more systematic data on fishing effort and challenges faced by fishers, whilst expanding the number of focal elasmobranchs to five species: angelshark (*Squatina squatina*), spurdog (*Squalus acanthias*), tope (*Galeorhinus galeus*),common stingray (*Dasyatis pastinaca*) and a further two which are the common skate complex – blue skate (*Dipturus batis*) and flapper skate (*Dipturus intermedius*).

SIARC: Fisher Interviews