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Monkfish Catch Rates by Shetland Fishing Boats in 2021 and 2022

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A Report for Shetland Fishermen's Association

October 2022

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Summary

A basic analysis of logbook data from nine Shetland fishing boats has been carried out to investigate whether they provided any evidence to confirm anecdotal reports from fishermen of an increase in catch rates of monkfish in the waters around Shetland during the early part of 2022. Statistical analyses found that the monkfish catch rates of three of the boats included in the analysis were significantly higher during the first six months of 2022 than during the same period of 2021. The catch rates of five of the remaining boats were not significantly different (and not significantly less).

If the monkfish catch rate is assumed to reflect their abundance, then these results suggest that monkfish were at least as abundant (certainly no less abundant) around Shetland during the first half of 2022 as during the same period of 2021.

Monkfish are caught within a mixed demersal fishery and data from this fishery reflects its complexity. In addition to variations in fish movements, aggregations and abundances, there are multiple factors that may influence the fishing choices of individual skippers who work to maximise their fishing opportunities within the restraints of multiple limited quotas. As a result, they may switch between target species or fishing areas in response to any of the catch related variations and/or in response to many other factors including fluctuating market prices, weather conditions and fuel prices.

Bearing in mind that quota availability for Shetland whitefish boats is managed over periods of between one and three months and that available quota will limit total catches, there is a suggestion that fishermen responded to the perceived increase in monkfish abundance by altering their fishing behaviour. As a result, higher catch rates did not necessarily translate into substantially greater total catches of monkfish over the period studied.

Contents

Introduction

Monkfish (or anglerfish; principally *Lophius piscatorius*) are one of the most important species caught by Shetland whitefish fishing boats. In 2021 Shetland boats landed a total of 2,094 tonnes (live weight) of monkfish worth some £6 million. That was about 20% by value of all the whitefish landed by Shetland boats and made monkfish the most valuable species that they landed.

Given the importance of the monkfish fishery, its management is a cause of concern to Shetland fishermen. The North Sea and West of Scotland monkfish stock remains 'data deficient' and the quota has been cut by more than half since 2019 (from 31,690 tonnes in 2019 to 14,116 tonnes in 2022, a reduction of 55%).

During the early part of 2022 there were anecdotal reports from some Shetland fishermen of relatively high catch rates of monkfish in the waters around Shetland, which were seen as possible evidence of an increase in the abundance of monkfish in this area. There was also an increase in the quantity of monkfish landed in Shetland during that period, and sales through the Shetland Auction from January to June 2021 were higher than in the same period of any of the preceding fifteen years.

This analysis was carried out at the request of Shetland Fishermen's Association to determine if the information available from fishermen's catch records would confirm the fishermen's perception of higher monkfish catch rates during the early part of 2022.

Data & Analyses

The principal aim of this analysis was to compare the catch rates of monkfish by Shetland fishing boats during the first half of 2022 (January – June) with those during the same period of 2021. Other information, such as landings of monkfish, were also compared between these two time periods.

The analysis was primarily based on data from Marine Scotland's Compass database together with additional data published by the UK Marine Management Organisation (MMO) and Shetland Seafood Auctions.

Information on monkfish quota availability and uptake was provided by the Shetland Fish Producer's Organisation (SFPO) and by Marine Scotland.

General (anecdotal) information on fishermen's perceptions of changes in monkfish catch rates and their responses to them was provided by Shetland Fish Producer's Organisation (SFPO) and Shetland Fishermen's Association (SFA).

Catch Rates

Average catch rates (weight of monkfish caught per hour of fishing time) were calculated for selected fishing boats using data from Marine Scotland's Compass database which were made available by the Shetland Fish Producer's Organisation.

Data in the Compass database includes 'logbook' data on fishing activities and catches recorded by fishing boat skippers via their electronic logbooks. These include 'Fishing Activity Records' (FARs) which record information on fishing activities and catches, usually on a daily basis.

From each Fishing Activity Record the quantity of monkfish reported as caught and the reported time spent fishing were collated along with the area fished (ICES rectangle) and fishing gear used. The catch rate of monkfish was calculated for each record as the weight caught divided by the time spent fishing (kg caught per hour fished).

To reduce the potential effects of differences in the spatial patterns of fishing activity from 2021 to 2022 the analyses included records only from the area around Shetland (Figure 1).

For each boat, the average catch rate of monkfish (kg per hour) in the area around Shetland was determined for each month from January to June in 2021 and 2022.

Selection of Boats

Nine Shetland whitefish fishing boats were included in the analysis of catches per unit effort. Eight of these were amongst the 11 Shetland boats with the highest reported catches of monkfish during the first six months of 2022 (as calculated from fishing activity records in the Compass database). Three boats in the top-11 were excluded from the analysis[1].

The ninth boat was chosen at random from those with smaller catches of monkfish.

The selected boats are identified in this report by the letters A to J (excluding 'I'). Where a boat used a twin-trawl its identification letter is doubled (for example 'JJ'). A single letter indicates that the boat used a single-trawl.

Statistical Analysis

Basic statistical tests were used to compare the fishing times, quantities of monkfish caught, and monkfish catch rates of the selected fishing boats during the first six months of 2021 and 2022 (paired samples t-tests).

For individual boats the average catch rates of monkfish during the first six months of 2021 and 2022 were compared using a paired samples t-test or, if the conditions of the F-test for variance were not met, Wilcoxon tests for matched pairs.

Landings

The weights of monkfish landed at (and sold through) Shetland's fish markets during the first six months of 2021 and 2022 were calculated from data published by Shetland Seafood Auctions[2]

The total weight of monkfish landed in Shetland during the first six months of 2021 and 2022 was calculated from data published by the UK Marine Management Organisation[3]. (Not all the whitefish landed in Shetland is sold through the local fish markets; some is shipped directly South through contract sale agreements with Mainland processors.)

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1 One boat was new and had not fished in 2021, one had changed hands between 2021 and 2022, and there were difficulties in interpreting the records of the third.

2 'Daily Fish Prices' spreadsheet available at: https://www.shetlandauction.com/ssa-today.

3 Available at: https://www.gov.uk/government/collections/monthly-uk-sea-fisheries-statistics

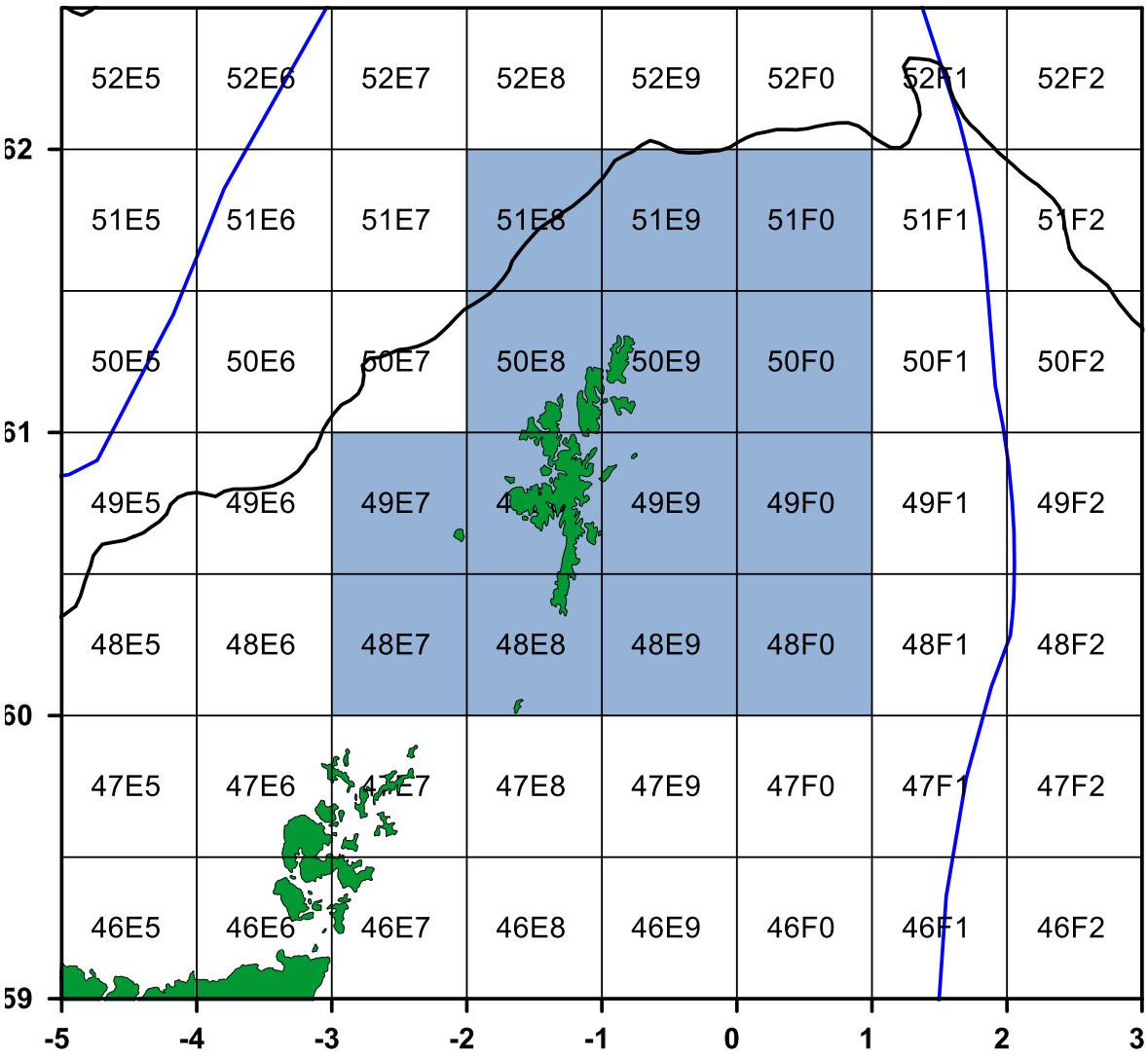

Figure 1 Map showing the area around Shetland (shaded) for which average monkfish catch rates in 2021 and 2022 were compared. The 200-metre depth contour and the limits of the UK Exclusive Economic Zone are also shown.

Results

Monkfish Quota Availability

Scotland

The agreed total allowable catch (TAC) of North Sea monkfish in 2022 is one-quarter (25%) less than it was in 2021, while that for West of Scotland monkfish is 20% less (Table 1). That equates to an overall reduction in the TAC of the two stocks of just under one-quarter (23%).

The resulting reductions in the monkfish quotas available to Scottish fishing boats in 2022 broadly reflect these figures: 24% less in the North Sea and 17% less in the West of Scotland area, or 23% less overall (Table 1).

These reductions in monkfish quota come on top of a series of cuts in recent years with the total quota for North Sea and West of Scotland monkfish having been cut by 55% since 2019 (Figure 2)

Table 1 The agreed total allowable catches (TACs) of monkfish and the Scottish quota allocations in 2021 and 2022 for monkfish in the North Sea and West of Scotland areas and the % changes in each. (Source: Information from Marine Scotland.)

	Agreed Total Quota (tonnes)			Scottish Quota Alloc' (tonnes)		
	2021	**2022**	**% change**	**2021**	**2022**	**% change**
North Sea	11,972	9,014	-25%	8,244	6,273	-24%
West of Scotland	6,377	5,102	-20%	1,804	1,504	-17%
TOTAL	**18,349**	**14,116**	**-23%**	**10,048**	**7,777**	**-23%**

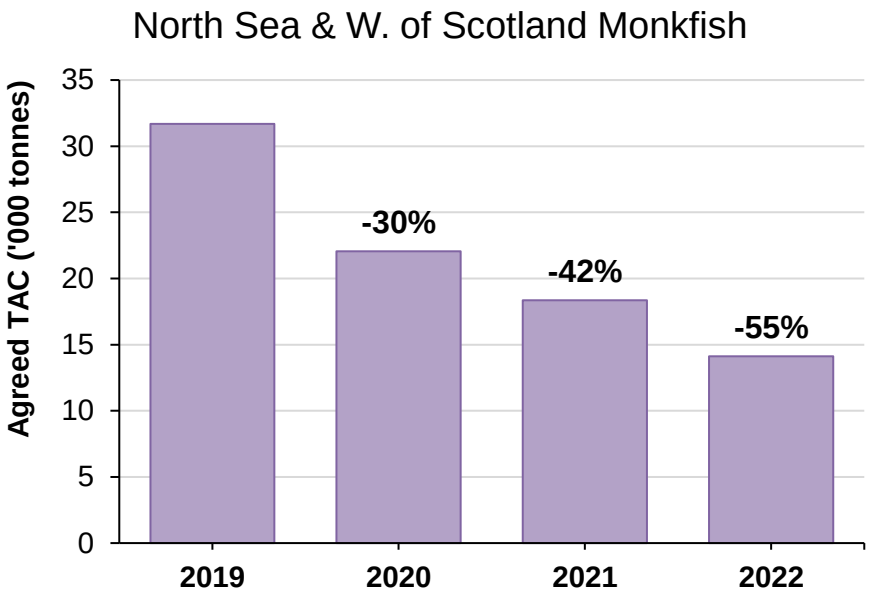

Figure 2 The agreed annual Total Allowable Catches (TACs) for North Sea and West of Scotland monkfish from 2019 to 2022. Percentage figures show the cumulative reductions in the TAC from 2019.

Shetland

Just over 2,000 tonnes of North Sea monkfish quota are available to members of the Shetland Fish Producers' Organisation in 2022, compared to more than 2,500 tonnes in 2021. That is a reduction of 20% (Table 2).

Only about three-quarters of the North Sea monkfish quota available to SFPO members was taken up (caught) in 2021. The available quota in 2022 is only slightly (8%) more than the total amount caught in 2021.

About one-third of the North Sea monkfish quota available to SFPO member boats in 2021 was taken up during the first six months of the year compared to 40% during the first six months of 2022 (Table 2). The amount of quota (tonnes) taken up during the first six months of 2022 was slightly less than during the same period of 2021.

Table 2 The amount of North Sea monkfish quota (tonnes) available to members of the Shetland Fish Producers' Organisation at the start of 2021 and 2022 and the % change, and the amounts of quota taken up (caught) in 2021 and during the first six months of 2021 and 2022. (Source: Information from Shetland Fish Producers' Organisation.)

	2021	2022	% change
Quota Available to SFPO members	2,543	2,026	-20%
Quota Taken Up – Year	1,882	---	---
uptake as % of quota available – Year	74%	---	
Quota Taken Up – Jan-Jun	861	805	-6%
uptake as % of quota available – Jan-Jun	34%	40%	
uptake as % of quota taken up – Jan-Jun	46%	---	
Quota Remaining – Jul-Dec	1,682	1,221	-27%
remaining as % of quota available – Jul-Dec	66%	60%	

Landings of Monkfish

Just under 1,100 tonnes of monkfish were landed in Shetland (by all boats) and sold through the local fish markets in the first six months 2022 (Figure 3). That was almost one-quarter (23%) more than the weight landed in the first six months of 2021 and more than in the same period of any year since at least 2008. It was also almost double the weight landed in the first six months of 2020.

The total quantity of monkfish landed in Shetland by all boats in the first six months of 2022 (including fish not sold through the local markets) was also higher than in the same periods of 2021 and 2020 (Figure 3) although the magnitudes of the increases were not as great (13% and 43%, respectively).

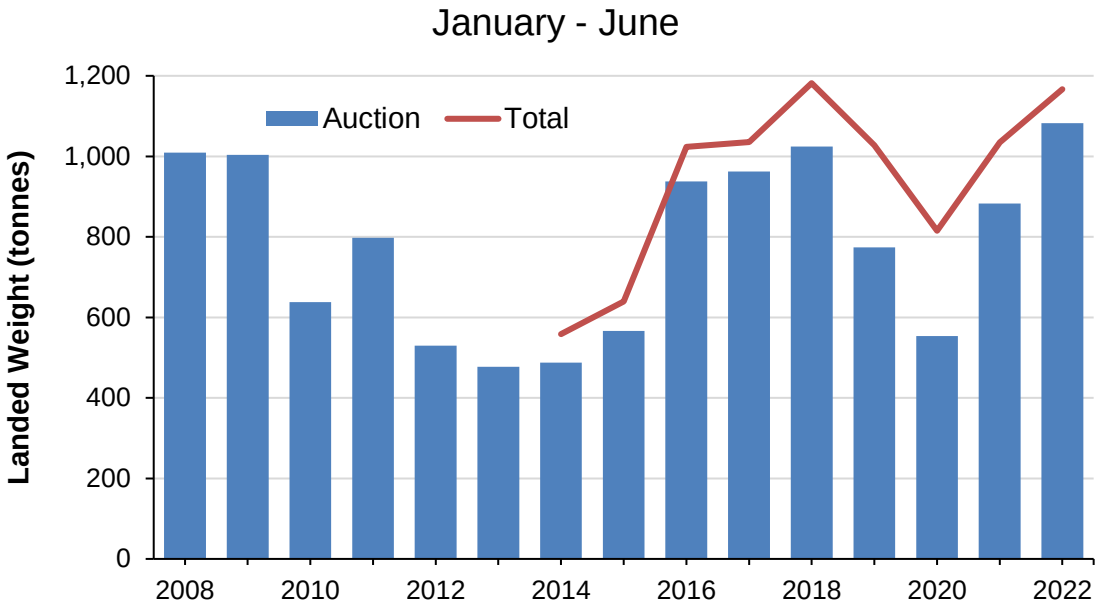

Figure 3 The total weight of monkfish landed at Shetland's fish markets and sold through the Shetland Seafood Auction in the first six months of each year from 2008 to 2021 (bars) and the total weight landed in Shetland during those months from 2014 to 2021 (line; MMO data). Note: Landings of monkfish in Shetland include landings by both Shetland and non-Shetland boats and potentially from the North Sea and West of Scotland areas.

Catches of Monkfish by Selected Boats

The nine boats included in the analysis of CPUE reported catching a total of 680 tonnes of monkfish (everywhere) during the first six months of 2022. That accounted for almost two-thirds (63%) of the total reported monkfish catch by all Shetland whitefish boats during that period (Figure 4)[4]. Individual boats accounted for between 2% and 11% of the total catch of monkfish. Four boats each accounted for 8% or more of the total.

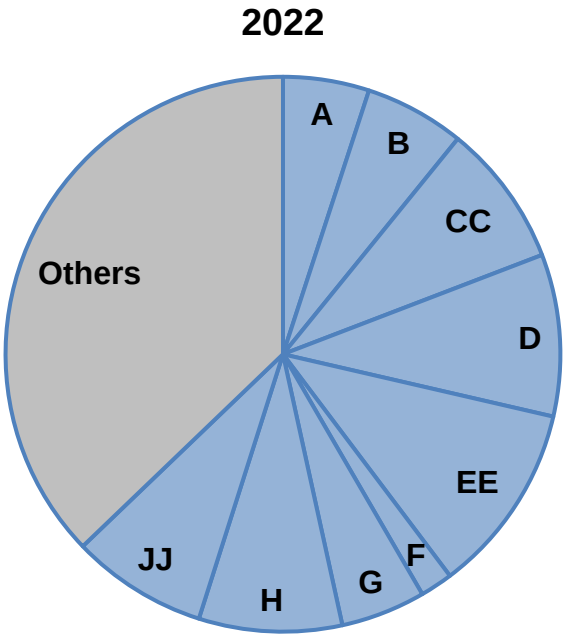

Figure 4 The reported catches of monkfish (everywhere) during the first six months of 2022 by the nine boats included in the analysis of catch rates (A – J) as proportions (%) of the total reported catch of monkfish by all Shetland whitefish boats. Double letters indicate boats using twin-trawls; all other boats used single-trawls. (Reported catches from Fishing Activity Records in Compass database.)

[4] A comparable figure cannot be given for the first six months of 2021 as the total reported catch of monkfish by all Shetland whitefish boats during that period was not available.

Catches in the Shetland Area

Overall, slightly more than half of the total reported catch of monkfish by the nine boats included in the analysis during the first six months 2021 were caught in the area around Shetland (see Figure 1). For individual boats, the proportion caught in this area varied widely, from 100% to less than 20% (Figure 5).

For six of the boats the proportion caught in the area around Shetland was more than two-thirds, and for two it was slightly less than half. Only one boat caught substantially less than half its 2021 catch in the area around Shetland.

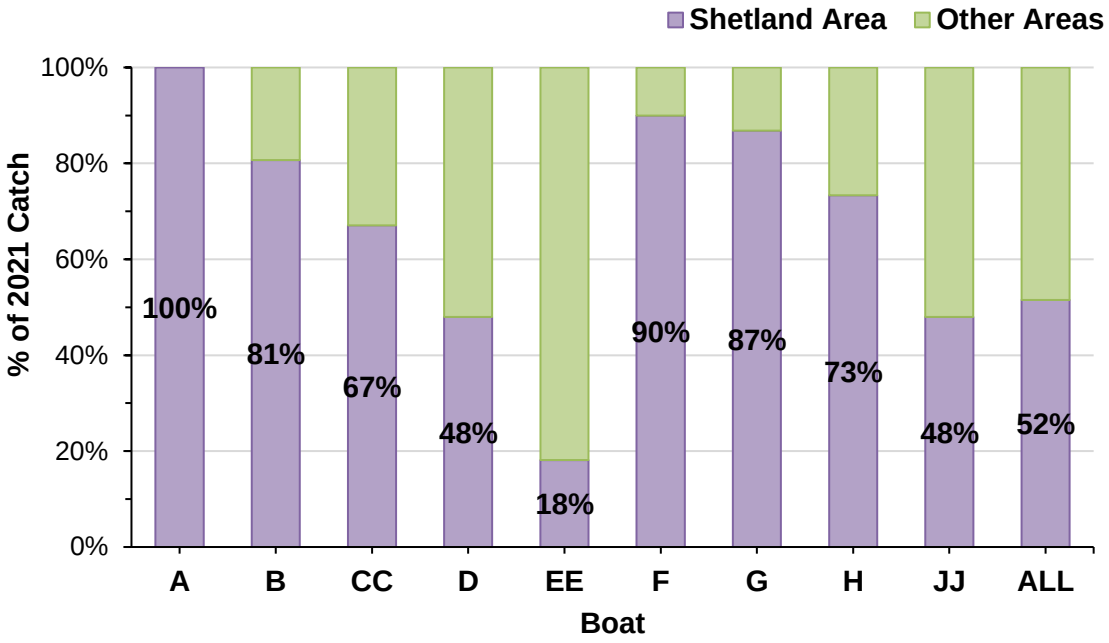

Figure 5 Breakdowns for nine Shetland whitefish boats, and for all boats combined, of the proportions of their reported 2021 monkfish catches caught in the Shetland area (Figure 1) and elsewhere. (Note, the figure for All boats is based on the total reported catches of all nine boats; it is not an average of the individual boats' figures.)

Fishing Times, Catches and Catch Rates

For the nine Shetland whitefish boats included in this analysis the total reported fishing time in the Shetland area in the first six months of 2022 was not significantly different to that during the same period of 2021 ($t = 1.17$, df 8, $P > 0.05$). In real terms the overall difference was about 9% (Table 3), with four boats having higher reported total fishing times and five with lower fishing times.

The total reported catch of monkfish by these boats from the Shetland area was numerically higher in 2022 (434 tonnes) compared to 2021 (400 tonnes), but across the nine boats the difference was not statistically significant ($t = -0.53$, df 8, $P > 0.05$). Five of the boats reported catching more monkfish in 2022 and four caught less (Figure 8 and Figure 9).

Using monkfish catch rates as an indicator of abundance, the average catch rates of the nine boats were compared between 2021 and 2022. Overall, the catch rates did not differ significantly (Table 4). For the January to June period as a whole the average catch rates of the boats ranged from 13 to 98 kg/hr in 2021 and 20 to 68 kg/hr in 2022 (Figure 11).

However, when the data were investigated by individual boat and compared on a monthly basis some statistically significant differences in catch rates did exist (Table 5). Comparison of the monthly average catch rates indicated that three of the boats included in the analysis had a significantly higher catch rate of monkfish during the first six months of 2022 compared to the same period of 2021 (Table 5). On average, the overall monkfish catch rate of these three boats during the first six months of 2022 was 75% greater than in the same period of 2021 (see Figure 11). For five of the boats the catch rate of monkfish in 2022 was not significantly different from that in 2021. (The 9th boat could not be tested statistically as only three months of data were available for both 2021 and 2022).

Although the total fishing times did not differ significantly between years (Figure 6 and Figure 7), the data suggests that the monthly patterns of fishing activity did vary from 2021 to 2022. Overall, the reported fishing time by these nine boats was 25 to 31% less during February, March and April 2022 (Figure 6), which coincided with when the monthly monkfish catch rates were highest (Figure 10).

Table 3 The total reported fishing times, the reported catches of monkfish, and the overall average catch rates of monkfish in the Shetland area in the first six months of 2021 and 2022 by the nine boats included in the analysis. The % change in each from 2021 to 2022 are also shown as are the standard errors of the average catch rates.

Jan - June	**2021**	**2022**	**% diff.**
Reported Fishing Time (hours)	10,328	9,443	-8.6%
Reported Catch of Monkfish (tonnes)	400	434	+8.5%
Average Monkfish Catch Rate (kg/hr ± SE)	37.3 ± 1.3	44.6 ± 3.7	+19.4%

Table 4 Summary of the results of the statistical comparison of the overall monkfish catch rates by nine boats in the Shetland area over six months in 2021 and 2022.

Year	**Average Catch Rate**	**Test**	**t**	***P***	**df**	**Comments**
2021	37.3 kg/hr	Paired samples t-test	0.55	>0.05	8	Average catch rate not significantly different.
2022	44.6 kg/hr					

Table 5 Summary of the results of the statistical comparisons of the monthly average catch rates (kg/hr) in the first six months of 2021 and 2022. Statistically significant results are highlighted (shaded). Double letter in boat ID indicates twin-trawl; all others used single trawls.

Boat	Test	t	*P*	df	Comments
A	Paired samples t-test	6.12	<0.01	5	Average monthly CPUE significantly higher in 2022.
B	Paired samples t-test	1.46	>0.05	5	Average monthly CPUE not significantly different.
CC	Wilcoxon matched pairs	5	<0.05	5	Unequal variances (F-test). Median CPUE significantly higher in 2022.
D	Paired samples t-test	0.14	>0.05	5	Average monthly CPUE not significantly different.
EE	---	---	---	---	Unequal variances (F-test). N=3, too low for Wilcoxon test. No conclusion possible. (Only 3 months data from both years.)
F	Paired samples t-test	0.45	>0.05	5	Average monthly CPUE not significantly different.
G	Paired samples t-test	1.44	>0.05	5	Average monthly CPUE not significantly different.
H	Wilcoxon matched pairs	21	<0.05	5	Unequal variances (F-test). Median CPUE significantly higher in 2022.
JJ	Paired samples t-test	0.11	>0.05	5	Average monthly CPUE not significantly different.

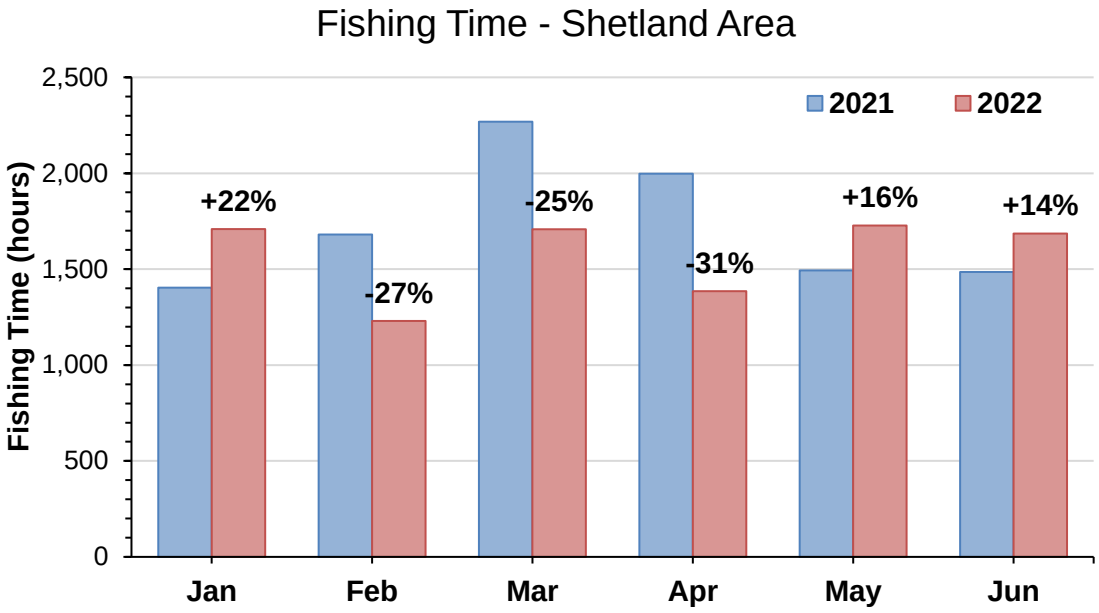

Figure 6 The total monthly fishing time by nine Shetland whitefish boats in the Shetland area during the first six months of 2021 and 2022. The % change from 2021 to 2022 is shown for each month. (Reported fishing time – Compass database.)

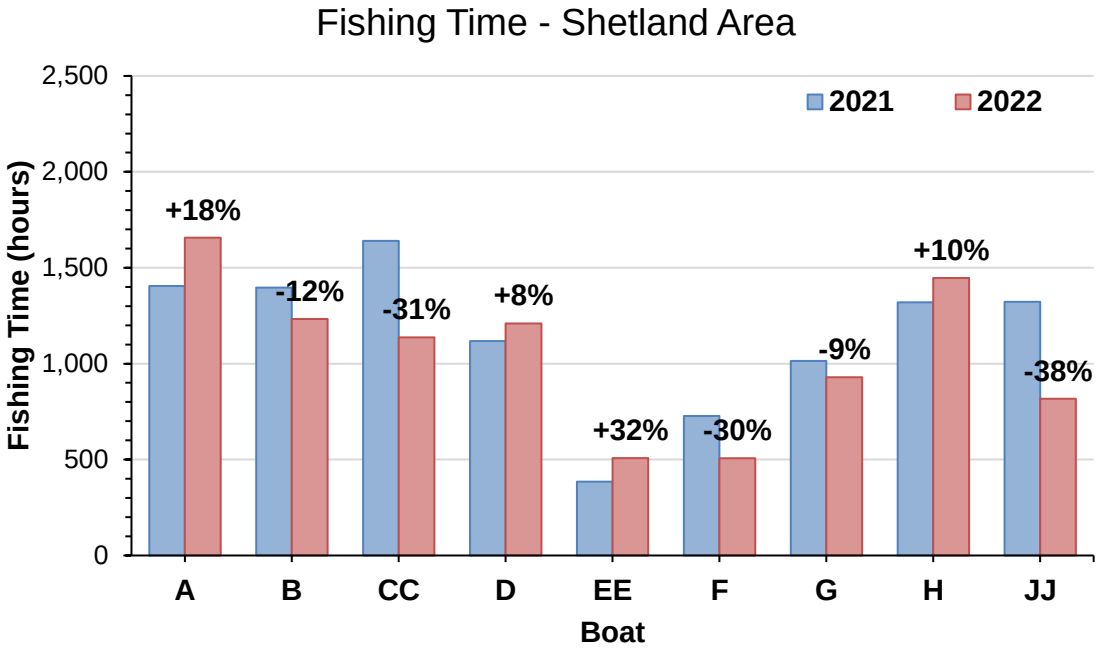

Figure 7 The individual total fishing times by nine Shetland whitefish boats in the Shetland area during the first six months of 2021 and 2022. The % changes from 2021 to 2022 are shown for each boat. (Reported fishing times – Compass database.)

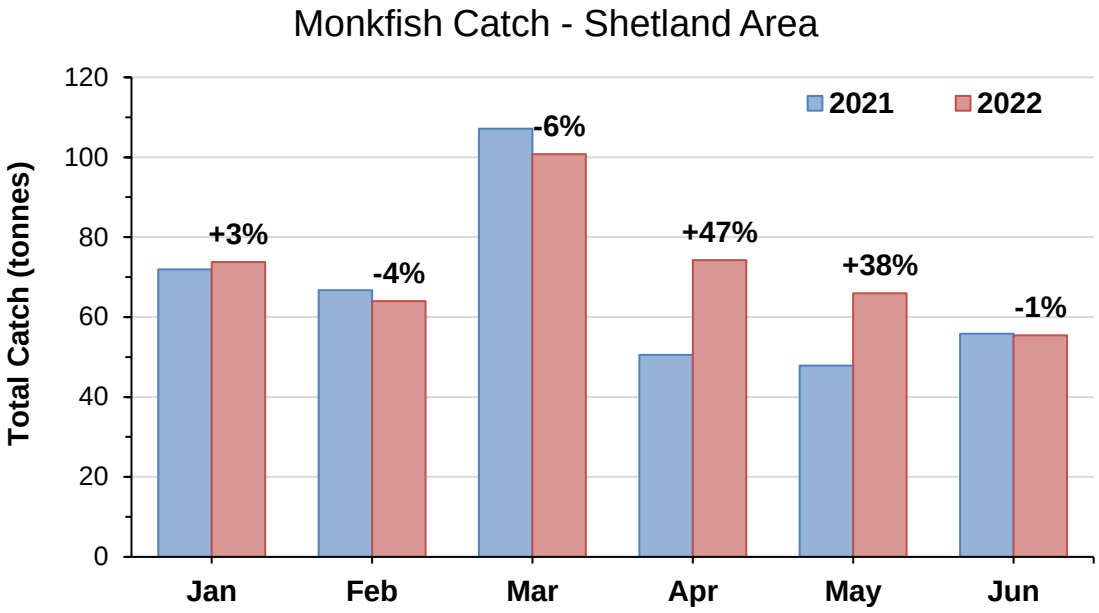

Figure 8 The total monthly reported catches of monkfish by nine Shetland whitefish boats in the Shetland area during the first six months of 2021 and 2022. The % changes from 2021 to 2022 are shown for each month. (Reported catches – Compass database.)

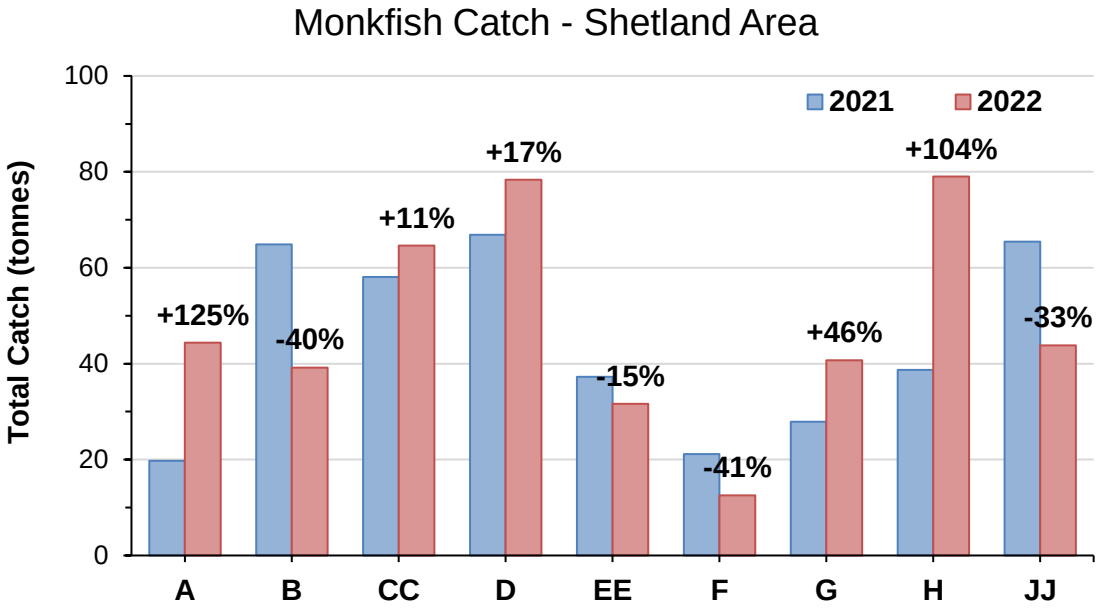

Figure 9 The individual total reported catches of monkfish by nine Shetland whitefish boats in the Shetland area during the first six months of 2021 and 2022. The % changes from 2021 to 2022 are shown for each month. (Reported catches – Compass database.)

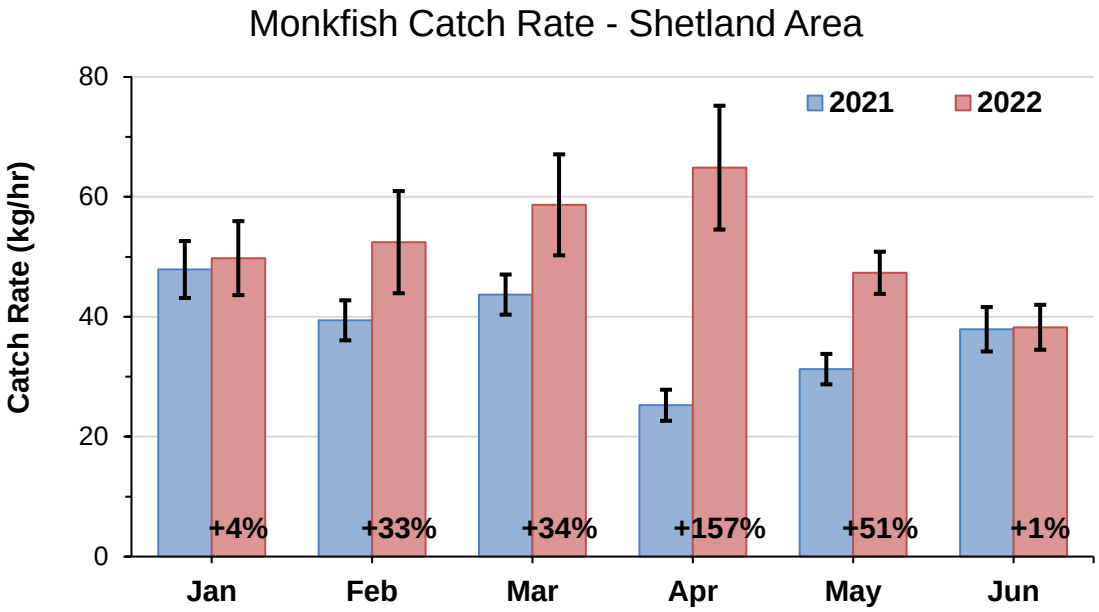

Figure 10 The average monthly catch rates of monkfish (kg/hr) by nine Shetland whitefish boats in the Shetland area during the first six months of 2021 and 2022. Error bars show the standard errors of the means. The % change from 2021 to 2022 is shown for each month.

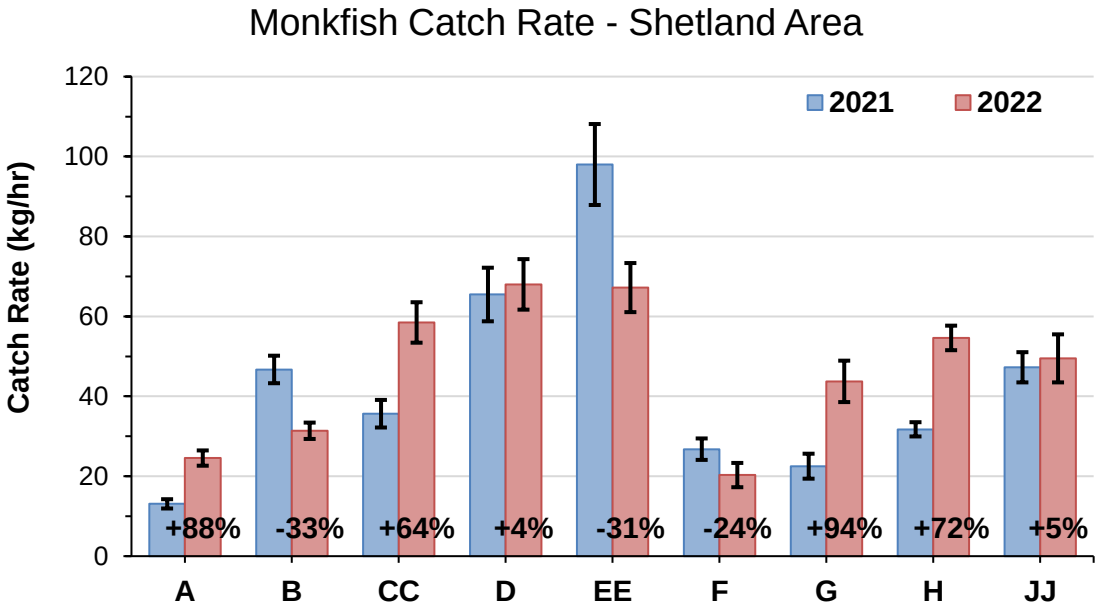

Figure 11 The individual overall average catch rates of monkfish (kg/hr) by nine Shetland whitefish boats in the Shetland area during the first six months of 2021 and 2022. Error bars show the standard errors of the means. The % change from 2021 to 2022 is shown for each month.

Differences Between Boats in Changes in Catch Rates

It is apparent that not all the fishing boats included in this analysis experienced the same changes in their monkfish catch rates from 2021 to 2022 (Figure 11). While some boats' monkfish catch rates were substantially higher during the first six months of 2022 than during the same period of 2021 others were similar, or even lower.

When examining the initial results of this analysis it was observed that some of the boats that saw the largest increases in their monkfish catch rates (for example, boats A and G) tended to have caught smaller quantities of monkfish in 2021 while boats that had caught larger quantities of monkfish in 2021 (for example, boats D and JJ) tended to see little if any increase in their catch rates in 2022 (see Figure 9 and Figure 11).

On average, the three boats with the smallest reported catches of monkfish in the first six months of 2021 (<50 tonnes) saw the largest increase in their monkfish catches in the area around Shetland in 2022, the three boats with intermediate catches in 2021 (50 – 100 tonnes) saw a modest increase in their catches in 2022, while the three boats with the largest catches (>100 tonnes) saw their catches fall (Figure 12).

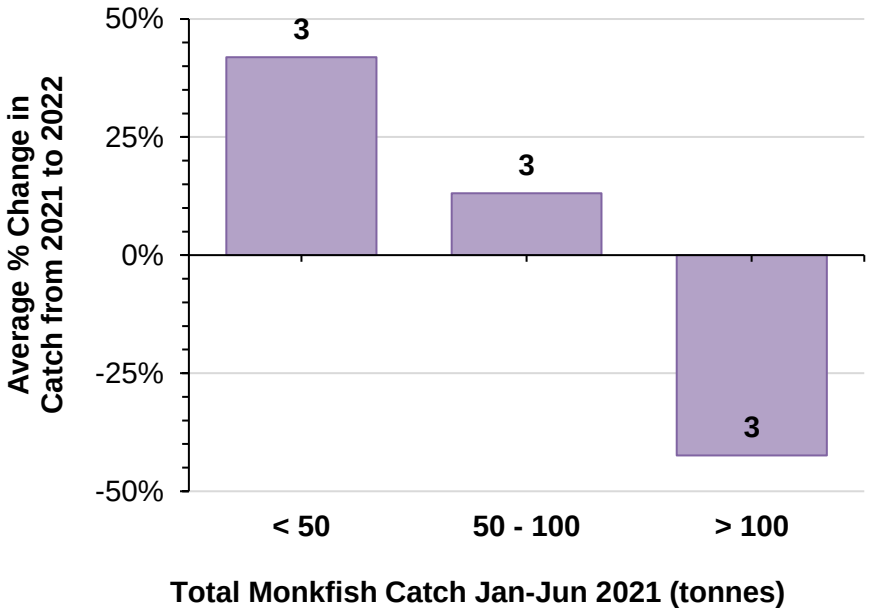

Figure 12 The average percentage change in total monkfish catches from 2021 to 2022 (Jan-Jun) for three groups of fishing boat boats with different sizes of monkfish catch (everywhere) in 2021. Numbers adjacent to bars show the number of boats in each category.

Discussion

This analysis was carried out at the request of Shetland Fishermen's Association following anecdotal reports from fishermen of relatively high catch rates of monkfish in the waters around Shetland during the early part of 2022. It was believed by fishermen that these higher catch rates reflected an increase in the abundance of monkfish in this area.

Additional evidence for a possible increase in the abundance of monkfish in the area around Shetland during the first half of 2022 is provided by the increase in the quantity of monkfish landed in Shetland and sold through the Shetland Seafood Auction.

The principal source of data used in this analysis was Marine Scotland's Compass database which contains the data on fishing activity recorded by fishing boat skippers through their (electronic) logbooks. These data were used to determine the average catch rates of monkfish (kg per hour) by selected Shetland whitefish fishing boats in the waters around Shetland during the first halves of 2021 and 2022 based on their reported catches and fishing times.

The results obtained were highly variable both between individual boats and over time. While some boats saw higher catch rates of monkfish in some months in 2022 than in the same months in 2021 others did not.

For the purposes of this analysis basic standard statistical tests were undertaken on the data which indicated that the catch rates of monkfish in the Shetland area by three of the boats tested were significantly[5] higher during the first six months of 2022 than in the same period of 2021. The overall average catch rate of these three boats was 75% greater in 2022 than in 2021.

For five of the boats tested the catch rates in 2022 were not significantly different to those in 2021. The ninth boat included in the analysis had only three months where paired data existed (from 2021 and 2022) so no statistical test could be carried out. None of the boats included in this analysis had a statistically significant decrease in their average monthly catch rates of monkfish from 2021 to 2022.

If the catch rate of monkfish is assumed to reflect their abundance, then these results suggest that monkfish were at least as abundant (and certainly no less abundant) around Shetland during the first half of 2022 as during the same period of 2021.

[5] A 'significant difference' means that the difference is unlikely to be due to chance variability in the two sets of results. Where a difference is not statistically significant the two sets of results cannot be said to be different.

The analysis of catch rates and the inference that changes in catch rates reflect changes in abundance of fish is considerably complicated by likely changes in fishermen's behaviour in response to increased catch rates in a mixed fishery where quotas are known to be restrictive.

While fishermen perceived that monkfish catch rates were higher around Shetland in the early part of 2022 they were also aware that the monkfish quota available for the year was substantially less than it had been in 2021. Although the quota available to Shetland fishing boats in 2021 had not all been caught, the amount that had been caught (1,882 tonnes) was close to the total quota available in 2022 (2,026 tonnes).

Given these facts, there was a concern amongst at least some fishermen during the early part of 2022 that the apparently higher catch rates of monkfish could result in the available quota being exhausted before the end of the year. It is likely that at least some fishermen consequently modified their behaviour to limit their uptake of monkfish quota during the early part of the year to try and ensure that the available quota would not be exhausted. (40% of the available quota was taken up during the first half of 2022 compared to 33% during the first half of 2021.)

It is perhaps notable in this regard that the total reported fishing time by the nine boats covered in this analysis was substantially less in February, March and April 2022 than during the same months of 2021 while the total reported catches of monkfish were relatively similar in February and March. While other factors could have contributed to this reduction in fishing time (including rising fuel costs or limited quotas for other species, such as cod) it may indicate that at least some of the nine boats had reduced their fishing time during these months to limit their uptake of monkfish quota. That is, rather than catching more monkfish in 2022 some boats at least appear to have been catching a similar quantity in less fishing time.

There is some evidence that the boats that saw the biggest increases in their monkfish catches in 2022 tended to be those that had smaller catches of monkfish in the first half of 2021, although more detailed analyses would be required to investigate this point more fully. If true, this may indicate that the boats with smaller monkfish catches were better placed to take advantage of the apparently increased catch rates of monkfish in the first half of 2022, possibly because they were less constrained (or felt less constrained) by the availability of monkfish quota.

While no analyses have been carried out of individual fishing boats' catch compositions or quota uptakes it seems likely that the boats with the largest catches of monkfish are to at least some extent 'specialising' in catching monkfish and may have a higher level of dependence on it than boats that normally catch smaller quantities. The latter boats may find it easier to significantly increase their catches of

monkfish when the opportunity arises (when monkfish are more abundant) as they will require only relatively small amounts of additional quota to do so. (A boat that normally catches 20 tonnes of monkfish would need 20 tonnes of additional quota to double its catch but a boat that normally catches 200 tonnes would need 10 times as much additional quota to increase its catch by the same amount.)