Time series for Blue Shark captures for the SW of England from 1953-2019:

How data derived from recreational angling can drive science.

The Pat Smith database for Blue Shark captures from the SW of England has now reached over 100,000 captures with the reports from this year, which makes it the second largest time series of shark captures in the world after the NOAA dataset. None of this work is possible without recreational anglers and skippers and the data collected is pretty much gold standard. Fortunately, the founders of the Shark Angling Club of Great Britain had the foresight to record this data .

There are a few missing years, as can be seen in figure 1, but fortunately the data set is large enough to cope with these and as you can identify the factors which affect blue shark numbers, which I will explain later, you can model for missing data.

You often think that things were better in the past, but with Blue Sharks, this is not the case. Figure 1. indicates that the numbers of fish caught today are higher than the supposed heyday of shark fishing in the 1950s. This might not reflect real abundance of the sharks though and might just be that we are more efficient at catching them, with faster boats, improved tackle etc. However, this comes back to one of the central questions of fisheries management, how do you ensure you are comparing apples with apples when equating catches of a fish species across time.

For example, when you calculate Catch per Unit Effort, which is basically fish caught divided by the amount of time (or effort) you spend fishing for them, how do you ensure that your result actual represents abundance of a species and this is where catchability comes into it.

Catchability basically add a constant which you multiply your results by. For commercial fishermen this may represent, how efficient your gear is, how many hooks your longline has or how big or powerful your boat is. It may also include factors such as season, area, temperature etc and the latter three variables still apply to indices derived from recreational catches.

Other scientists have shown the effects of local environmental conditions of Blue Shark captures in the UK, and we all know the day to day conditions that affect catches, but what a long term data sets allows you to do is look how big climatic cycles change the number of Blue Sharks which reach our shores. Although it is often said that the strength of the Gulf Stream determines Blue Shark numbers, the ocean currents in the Atlantic are surprisingly difficult to define and changes in them more so.

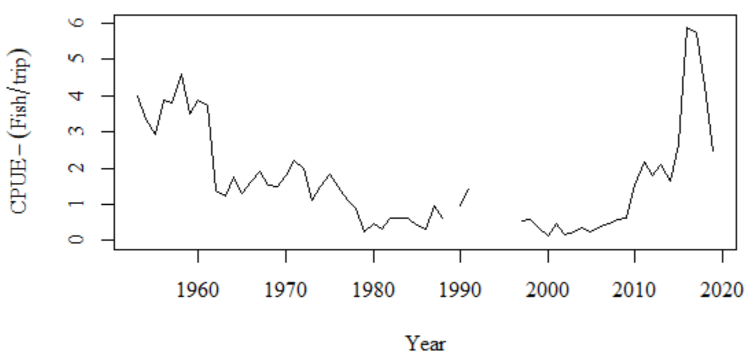

Figure 1 Average yearly catches of Blue sharks from the SW of England from the Pat Smith database.

These currents are affected by long term natural oscillations in the climate, such as the North Atlantic Oscillation (NAO) which is derived from the relative position of the Icelandic low pressure and Azores high pressure system, the Atlantic Multidecadal Variation (AMV), which is the changes to Sea Surface Temperature (SST) not accountable by climate change etc, and the Gulf Stream North Wall index (GSNW). These interact with many other factors to change the Atlantic Meridional Overturning Circulation (AMOC), the conveyor belt of warm salty water the heads towards polar regions, cooling as it goes before sinking to the depths before heading southwards again to complete the circuit.

If the waters in the arctic become less salty, the AMOC slows down and a cascade of effects change the strength and directions of the North Atlantic currents systems. I noticed that a recent report on salinity anomalies in the North Atlantic produced a time series that looked similar to that of Blue Shark captures (Figure 2.), so to produce a true representation of Blue Shark abundance, rather than just a measure of what proportion of sharks reached our waters, I modelled the relationships and removed these effects from the time series.

What surprised me of the results was how well the salinity time series in the North Atlantic explained the variations in Blue Shark captures in the UK (Figure 2.). Just this one factor explained 24.5% of the variation in yearly captures, to put this into context, the AMO and NAO accounted for about 4% of variation each.

So, once you take away these effects, what do you see? well figure 3. Illustrates a truer representation of Blue Sharks stocks over time and although there are similarities, we can now say that it is more likely that stocks have recovered rather, than many scientists and the Shark Trust say, just moved.

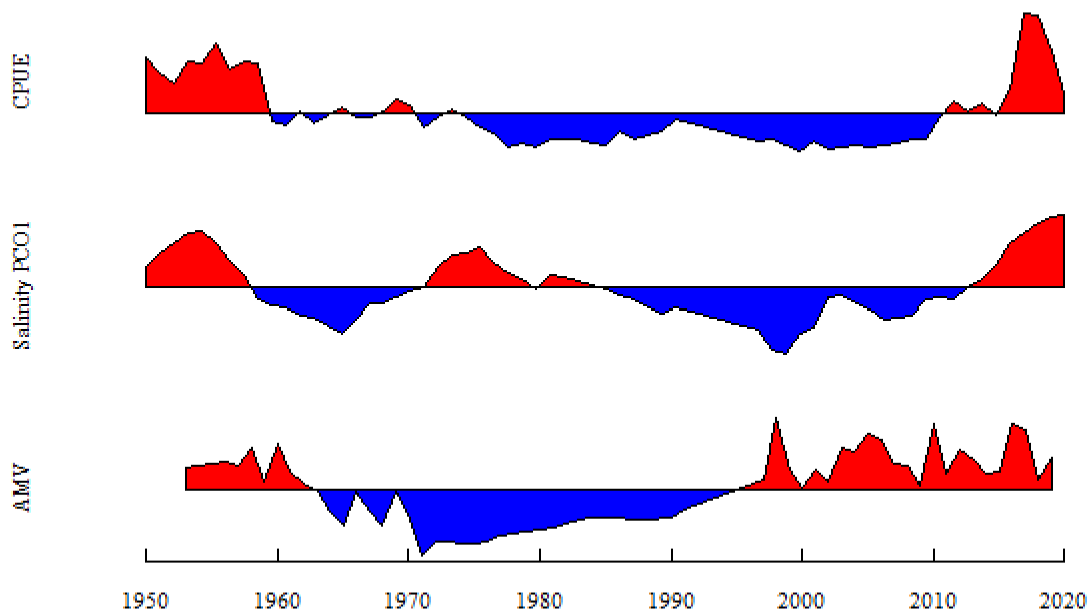

Figure 2 Time series of Blue Shark captures (top), salinity anomalies in the North Atlantic and the AMV. Values are normalised around zero to make comparisons easier.

As stated previously, data set is now the second largest times series for Blue Sharks in the world, behind NOAA and probably the only one that provides data back to the 1950s. Without this coverage it would not be possible to link shark numbers with climatic cycles that change over decades rather than months

How does salinity change effect Blue Sharks, well firstly they have been shown to change the location and strengths of the various elements of the North Atlantic currents? For example, low salinity events in the sub-polar regions of the North Atlantic weaken the northern arm of the North Atlantic current and strengthens the southern arm which supplies warm water from the sub-tropics to the UK. As there is no lag between the salinity anomaly and increased catches in the UK, it is likely that the changes in currents are directly driving fish into our waters. The relationship between changes in the NAO and AMV and Blue Shark numbers show a lag of several years, which suggest that these changes may be due to changes in prey distribution and numbers or by improving breeding conditions for the sharks. Changes in the AMV have been shown to change mackerel, pilchard and anchovy populations and distributions, which relate right back to changes in plankton. These relationships are probably only pronounced when the population is high, and the effects of overfishing have probably obscured the signals of these natural cycles. For example, the return of Bluefin tuna to UK waters correlate with the largest low salinity event in the North Atlantic for 150 years but could only happen if the stock had recovered enough from the effects of years of overfishing.

As you would expect, blue shark numbers correlate well with the mackerel stocks in the North Atlantic, but the situation is far more complicated than that, with shark captures correlating positively with mackerel captures around Iceland and Greenland (areas too cold for the sharks), but negatively related to mackerel captures in the English Channel (Figure 4). There is limited accurate data for captures of sardine and anchovy in the English Channel, but the recent surge in blue shark numbers coincided with large numbers of these prey species present in waters off the SW of England as did the return of bluefin tuna to our waters.

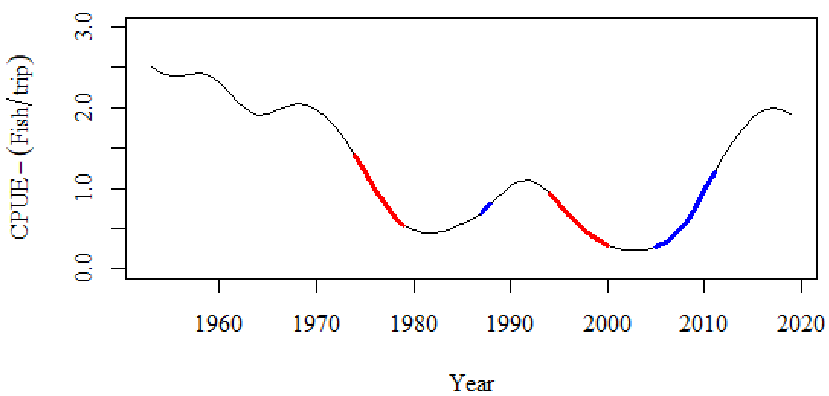

Figure 3 A time series of Blue Shark stocks with the effects of the North Atlantic salinity anomaly, the NAO and AMO removed. Blue lines indicate statistically significant increases of Blue Shark populations, red lines indicate significant periods of decrease.

How these populations of these small pelagic fish vary over time is surprisingly complicated and although commercial fishing does have a big effect. Changes in the environment and even in the microscopic zooplankton communities have a massive impact, complicated by the reduction in numbers of other predators such as cod and pollack in the English Channel, which also feed on these smaller prey species.

It is really difficult to connect all these strands together to try and get a better picture of how the ecosystem works but hopefully, with the assistance of some fellow ecologists, we can address this in further publications. However, this initial work does give some glimpses into some of the factors that contribute to the distribution of the incredible oceanic wander that frequents our waters during the summer months, the blue shark.

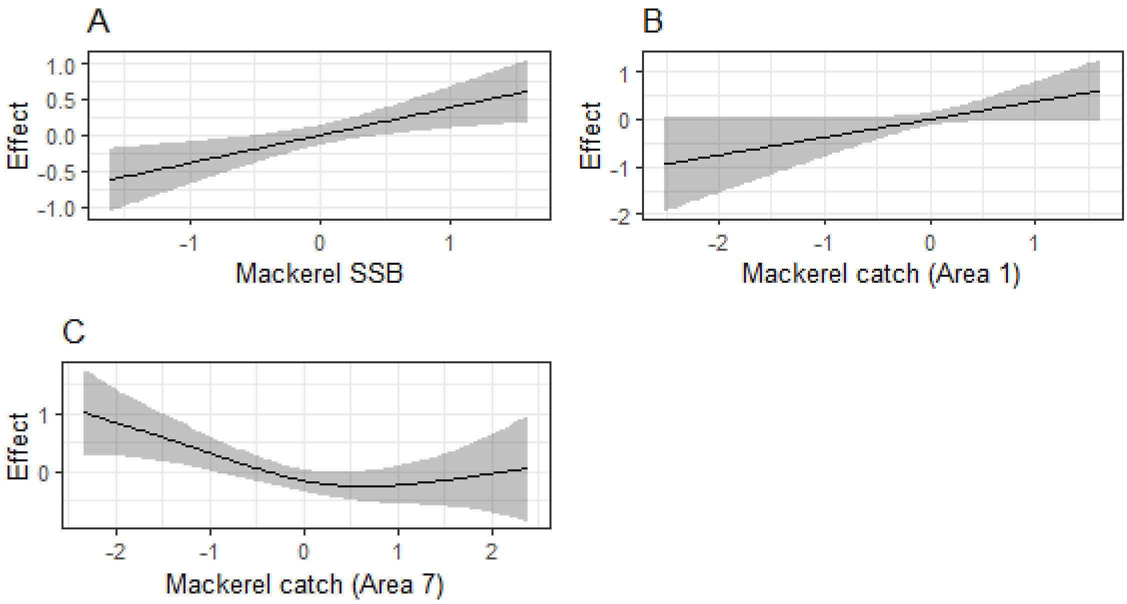

Figure 4 The relationship between blue shark CPUE and A: Standing Stock Biomass of mackerel in the North Atlantic, B: Mackerel captures in ICES sea areas 1,2,5 and 14 (Iceland and Greenland) and C: mackerel catches in sea areas 7, (English Channel, Irish Sea and SW Eire).