FISHERIES DEVELOPMENT NOTE

NO. 28

DATE: AUGUST 2010

Is there a relationship between tidal state and catches during jig fishing?

BY PAUL MACDONALD & CHEVONNE LAURENSON

ABSTRACT

Based on the perceptions of some local fishermen, we investigated whether tidal state is related to catch rates of saithe (*Pollachius virens*) and pollack (*Pollachius pollachius*) caught using automated handlines (jigging machines). Fishing occurred at two locations to the northwest of Shetland and catch rates at both locations were variable. Although catch rates did change at around high water on a number of occasions, in line with the given hypothesis, no statistically significant relationship between tidal state and catch rate was found at either location. This suggests that tidal state was not the main factor affecting catch rates and that one or more other factors contributed to the catch rates recorded.

INTRODUCTION

A limited amount of fishing using jigging machines (automated hook and line) targeting demersal whitefish occurs around Shetland. Although there has been some interest in developing this fishery further this has been limited by both the availability of quota and the variability in catches. The main target species for this fishery are saithe, pollack (a.k.a. lythe), cod (*Gadus morhua*) and ling (*Molva molva*) (Figure 1.)

Figure 1: Jig caught saithe being hauled aboard.

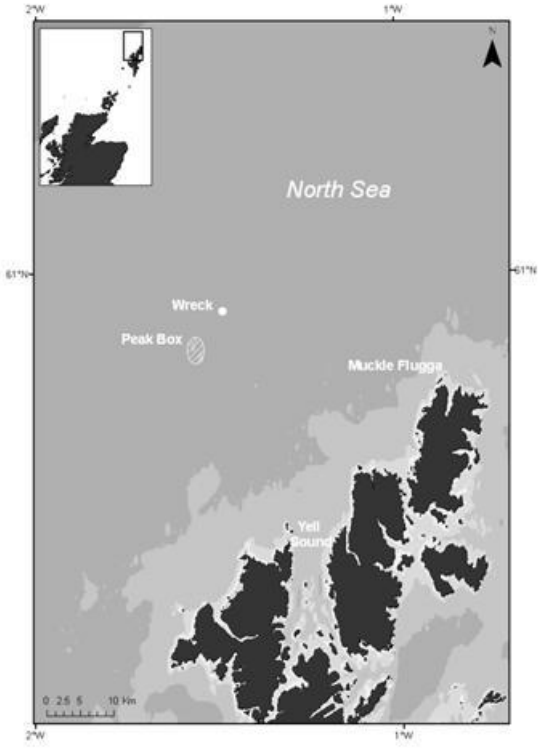

Figure 2: Locations of fishing positions at the wreck and the 'Peak Box' to the northwest of Shetland.

Hook and line fisheries rely on the target species becoming sufficiently motivated to take the fishing gear, either a baited hook or an artificial lure. Success is related to, amongst other things, feeding behaviour and therefore an understanding of this behaviour in response to changes in environmental conditions could have the potential to improve returns to commercial fishermen.

A large number of environmental variables are known to have an effect on the feeding ecology of fishes. The most obvious include temperature, light levels and time of day and there have been numerous studies where these factors have been investigated. For example, cod and haddock (*Melanogrammus aeglefinus*) display increased feeding activity at dawn and dusk (Lokkeborg *et al.*, 1989) and ling have been observed to exhibit little or no reaction to baits at night (Lokkeborg, 2000).

There is an expansive list of other factors that affect fish behaviour, however relatively few studies have investigated the effects of tides and currents on fish feeding. As fish are known to use currents to detect food, tides and current can have a relatively high impact on fish catchability (Stoner, 2004). An odour plume from bait can attract fish from considerable distances down-current. However, during periods of high current

Is there a relationship between tidal state and catches during jig fishing?

BY PAUL MACDONALD & CHEVONNE LAURENSON

velocity, some species e.g. cod and plaice, may seek refuge on the seabed and therefore not exhibit feeding behaviour (Gerstner, 1998; Gerstner and Webb, 1998).

Among commercial hook fishermen and many anglers there is a common belief that specific periods in the tidal cycle produce higher catches, while returns can be negligible at other times; published scientific evidence for this is lacking. In Shetland there seems to be a general perception amongst hook and line fishermen that to the north of Shetland catch rates are typically highest when the tide is flowing, especially during the last 1-2 hours of flow. Consequently, fishing activity is often timed to coincide with this period.

In order to test this hypothesis we investigated the relationship between tidal state and the catch rates of commercially important fish species during jig fishing trials on two fishing grounds to the north of Shetland.

METHODS

Fishing trials were undertaken on the *Atlantia*, a 10m GRP hulled fishing vessel and *Atlantia II*, a 12m wooden hulled fishing vessel. Six Oilwind automated jigging machines were used throughout the study which took place between 11 August 2005 and 28 March 2007 on an area of peaky rock seabed known as the 'Peak Box' (060° 54'N 001° 32'W), depth 95 – 120 m and at a wreck (060° 57'N 001° 29'W), depth 120 m, off the northwest coast of Shetland (Figure 2). The six jigging machines were rigged and fishing was undertaken as described in Macdonald *et al.* (2009). Lures used were Mustad rubber eels and size 1/0 hooks. A diagram of the arrangement of the lure rigs is shown in Figure 3.

At each visit to the fishing sites, the weight (kg) of each species caught was recorded during the time spent fishing. Catches were then determined in relation to the time (hours) before or after high water.

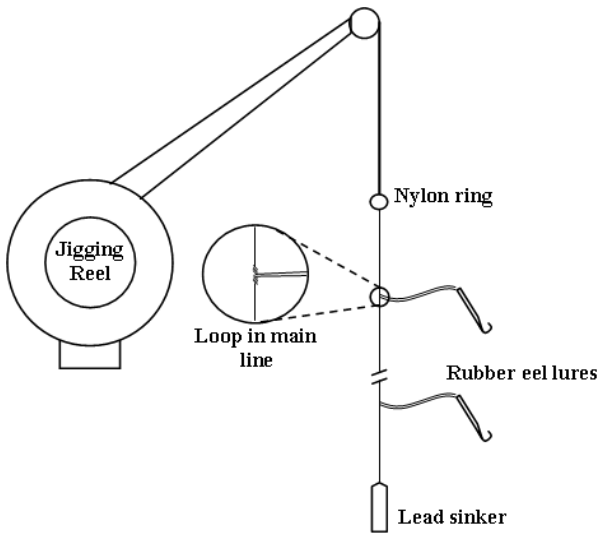

Figure 3: Arrangement of lure rigs used during the study.

RESULTS

At the area known as the 'Peak Box' a total of 63 hours fishing were spread over 16 separate days and at all stages of the tidal cycle. Pollack accounted for 94% of the overall catch of 4466kg. Relatively small quantities of saithe, cod, ling and tusk (*Brosme brosme*) were also caught (Table 1).

Table 1: Total catch (kg) and overall catch rate (kg/hr) of each species caught at the 'Peak Box'

Scientific name	Common name	Total catch (kg)	CPUE (kg/hr)
Pollachius pollachius	Pollack	4202	67.0
Gadus morhua	Atlantic cod	11	0.2
Pollachius virens	Saithe	124	2.0
Molva molva	Ling	25	0.4
Brosme brosme	Tusk	104	1.7
	All species	4466	71.2

Catch-per-unit-effort (CPUE) in kg/hour is shown for each hour during the tidal cycle as a box and whisker plot[1] in Figure 4. Catch rates were variable, ranging from zero to 287 kg/hour. Although there were several outlying points of very high CPUE, the data were skewed towards the lower end of the range with the overall median catch rate being 20 kg/hr. A Kruskal-Wallis test indicated that median catches did not differ significantly during the tidal cycle ($H = 9.73$, d.f. = 12, $P = 0.55$). The skewed positions of the medians in the boxes representing fishing times during the three hours after HW reflect the relatively high occurrences of zero catches during these time periods. The dataset was

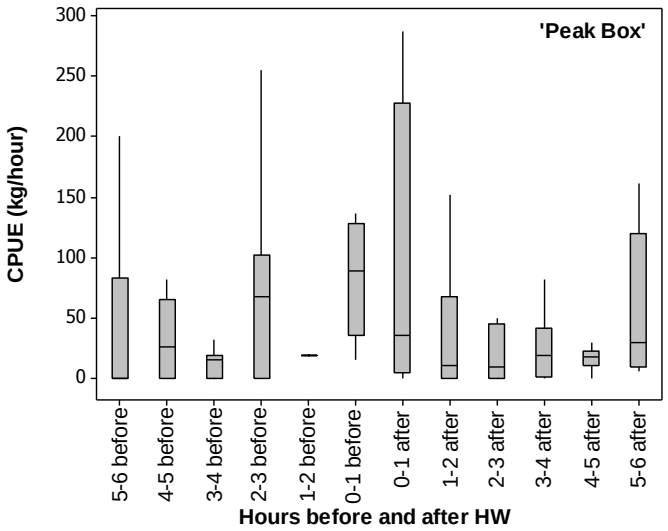

Figure 4: Box and whisker plot[1] of catches at the 'Peak Box' during the tidal cycle

[1] Boxes represent 50% of observations, whiskers represent upper and lower 25% of observations, and line shows median. (Median is the mid-point of the data, i.e. half the observations less than and half greater than this value. When data are skewed by many zeros or a large outlying point the median is used rather than the average).

Is there a relationship between tidal state and catches during jig fishing?

BY PAUL MACDONALD & CHEVONNE LAURENSON

also characterised with several outlying points where very high catch rates were obtained. Overall, 26.5% of the fished hours produced a zero catch; however none of these occurred during the two hours before HW. On a number of occasions it was noted that a period of high catch rates could suddenly change to a period of zero catch rather than there being a gradual decrease in the catch rate over a given period. It was also noted that this sudden change did occur at or around HW on a number of occasions.

At the wreck site a more limited amount of data was collected with 18 hours fishing occurring over seven days between April and August 2006. However the wreck was a more productive fishing location in terms of CPUE than the 'Peak Box'. At the wreck a total of 3454 kg of fish, predominantly saithe, were caught at various stages during the tidal cycle (Table 2).

Table 2: Total catch (kg) and overall catch rate (kg/hr) of each species caught at the wreck

Scientific name	Common name	Total catch (kg)	CPUE (kg/hr)
Pollachius pollachius	Pollack	422	23.8
Pollachius virens	Saithe	3029	170.1
Molva molva	Ling	3	0.1
	All species	3454	194.6

CPUE is shown as a box and whisker plot in Figure 5. No fishing occurred between four and five hours before HW or between three and five hours after HW. Catch rates varied between 118 and 475 kg/hour. None of the hours fished produced a zero catch and for the data that were collected highest catch rates occurred during the two hours before HW, however it should be noted that more time was spent fishing closer to HW than close to LW. As was the case at the 'Peak Box', the catch rates recorded were skewed, with most being towards the lower end of the distributions and with only a few very high catch rates. A Kruskal-Wallis test indicated that median catches did not differ significantly during the tidal cycle ($H = 4.3$, d.f. = 8, $P = 0.829$).

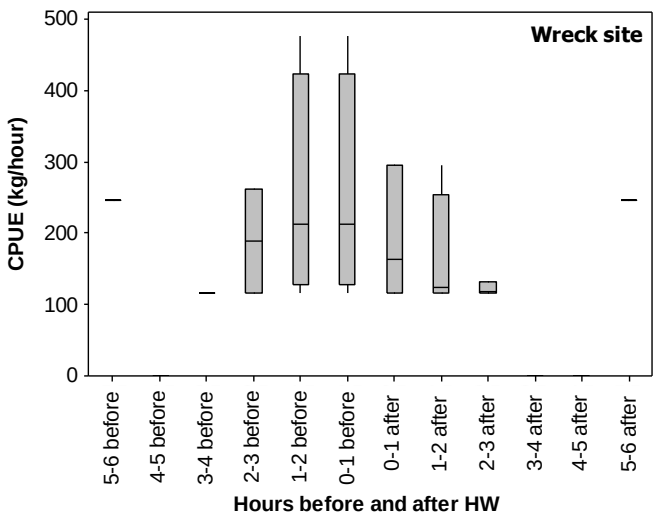

Figure 5: Box and whisker plot[1] of catches at the wreck during the tidal cycle

DISCUSSION

We have investigated whether in automated handline fisheries (jig fishing) catch rates differ significantly over the tidal cycle to the north of Shetland. From the data collected no statistically significant difference was detectable at either location. Catches (CPUE) and catch composition was markedly different between the two sites.

At the 'Peak Box' the main catch was pollack, while at the wreck the main catch was saithe. Saithe and pollack are closely related and are pelagic to benthopelagic species, i.e. they inhabit the water column down to just above the seabed. However, they are known to exhibit different feeding strategies. Saithe are very active foragers, often moving vertically in the water column and are often found up through the water column during the night (Bergstad, 1991). Pollack in contrast are typically found over rocky seabed (Cohen, 1990), tending to remain close to the seabed (Sarno, 1994). Pollock are typically less active than saithe and adopt a concealed ambush strategy rather than active foraging (Potts, 1986).

The catch rate obtained from a specific location at a specific time will result from a combination of both the abundance of the target species and its willingness to exhibit feeding behaviour (hook taking) at that time. There are a large number of both environmental and biological variables that are known to affect feeding behaviour. As feeding behaviour is likely to be due to a combination of more than one factor at any one time, it may be difficult to accurately predict likely catch rates. There are a number of aspects of the tidal and lunar cycle that could potentially affect feeding behaviour. It can be speculated that at slack tide the decreased current speed would allow saithe to forage with minimal energy spent swimming against the current and therefor catches could be higher than at times of higher current velocities. Conversely, the ambush strategy of pollack could result in higher levels of feeding during periods of increased tidal flow if the pollock are feeding on prey items carried in the current.

Is there a relationship between tidal state and catches during jig fishing?

BY PAUL MACDONALD & CHEVONNE LAURENSON

It is not unrealistic to suggest that at some locations or at times of spring tides that a statistically significant relationship between tidal state (or current speed) and catch rate could occur but, from the data that we have collected to date, we conclude that catch rates are too variable for any relationship between a specific environmental factor and catch rate to be easily detected.

It was noted that changes in catch rates tended to be sudden, rather than gradual; either with fish suddenly taking or not taking the hooks. This usually occurred without any obvious change in the 'marks' of fish seen on the echosounder which indicates that there was perhaps a change in the fishes willingness to feed rather than a change in the presence or abundance of target fish. The shift from a good catch rate to a zero catch rate did occur at or around the time of high water on a number of occasions and on these occasions the change in tidal direction and / or strength may have been a contributing factor.

When there are several occurrences of a change in catch rate at, for example, a certain tidal state it is easy to see how the fisher can develop a hypothesis that a relationship between catch rate and tidal state exists. It is then probably human nature to place more emphasis on the times when changes in catch rate support the emerging theory than those times which do not. However, there are many factors which could affect the fishes willingness to feed and these many interacting factors probably account for the very variable catch rates that we recorded. Unless the factor that is being investigated has a much greater influence than all the other factors, then its effect is obscured and it is extremely difficult to find a statistically significant relationship between the factor in question and the recorded catch rates. In this study, from the statistical tests performed we had to conclude that, based on our data, the hypothesis being tested was not proven.

CONCLUSION

Although there were several occurrences when decreases in catch rates observed at or around the time of HW, the overall variability in catch rates resulted in no statistically significant differences in catch rate being found over the tidal cycle. Further work would be required to investigate the singular or combined effects of various environmental variables on the feeding behaviour of the species associated with this fishing method.

FURTHER READING

- Bergstad, O. A. 1991. Distribution and trophic ecology of some gadoid fish of the Norwegian Deep. 1. Accounts of individual species. *Sarsia*, 75: 269-313.
- Cohen, D. M., Inada, T., Iwamoto, T. & Scialabba, N. 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. *FAO Fish. Synop.*, 10(125): 442.
- Gerstner, C. L. 1998. Use of substratum ripples for flow refuging by Atlantic cod, *Gadus morhua*. Environmental Biology of Fishes, 51: 455-460.
- Gerstner, C. L., and Webb, P. W. 1998. The station-holding performance of the plaice Pleuronectes platessa on artificial substratum ripples for flow refuging by Atlantic cod, Gadus morhua. Canadian Journal of Zoology, 76: 260-268.
- Lokkeborg, S., Bjordal, Å., and Ferno, A. 1989. Responses of cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) to baited hooks in the natural environment. Canadian Journal of Fisheries and Aquatic Sciences, 46: 1478-1483.
- Lokkborg, S., Skajaa, K. & Ferno, A. 2000. Food-search strategy in ling (*Molva molva* L.): crepuscular activity and use of space. Journal of Experimental Marine Biology and Ecology, 247: 195-208.
- Macdonald, P., Laurenson, C. H., Johnson, A. & Tait, L. 2009. A comparison of catch rates of artificial lures from an automated handline fishery at Shetland, UK. Fisheries Research, 95: 379-385.
- Potts, G. W. 1986. Predator-prey interactions between Pollack and sandeels. Progress in Underwater Science, 11: 69-79
- Sarno, B., Glass, C. W., Smith, G. W. 1994. Differences in diet and behaviour of sympatric saithe and pollack in a Scottish sea loch. Journal of Fish Biology, 45(Supplement A): 1-11.
- Stoner, A. W. 2004. Effects of environmental variables on fish feeding ecology: implications for the performance of baited fishing gear and stock assessment. Journal of Fish Biology, 65: 1445-1471.

ACKNOWLEDGEMENTS

This study was carried out during a wider investigation into the commercial viability of jig fishing in Shetland coastal waters, partly funded by the European Union under the Financial Instrument for Fisheries Guidance (FIFG). We are grateful to all the local fishermen who provided information on fishing grounds.