

## The large fish indicator is responsive to trawling pressure, and to reductions thereof

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The large fish indicator (LFI), or ‘proportion of fish greater than 40 cm length in bottom trawl surveys,’ is a frequently debated indicator of Good Environmental Status in European regional seas. How does the LFI respond to changes in fishing pressure? This question is addressed here through analysis of fine-scale spatial trends in the LFI within the North Sea, compared between periods of contrasting fisheries management: 1983–1999 and 2000–2012, i.e., before and after the onset of the European Union’s fleet reduction scheme. Over the entire period, the LFI has decreased in large parts of the North Sea. However, most of the decline was from 1983–1999; since 2000 the LFI has improved in much of the North Sea, especially in UK waters. Comparison with international effort data shows that those western areas where the LFI has improved correspond with regions where otter trawl effort has decreased since 2000 (and previously was highest in the 1990s), and also with decreases in beam trawl effort. This study provides strong support that recent European effort reduction schemes are now beginning to result in an improved ecosystem state as indicated by the regional-scale improvement in the LFI.

### Introduction

<b>What is the large fish indicator (LFI)?</b>	Under the MSFD, the LFI is defined as the <i>proportion of large fish (40 cm+) in the biomass of standard bottom trawl survey catches</i> (EC 2010/477/EU)
<b>Why is the LFI important?</b>	There are many reasons why large fish are important! <ul style="list-style-type: none"> <li>• As top predators they play a key role in the ecosystem</li> <li>• As main target for fisheries (commercial and recreational), while also being more vulnerable than small fish</li> <li>• Charismatic, have cultural value, speak to people’s minds</li> <li>• Perhaps most importantly, a healthy mixture of large and small fish is indicative of a <i>balanced ecosystem</i></li> </ul>
<b>What is the target?</b>	For the North Sea, the MSFD considers an LFI of 0.3 or 30% as ‘target’ for Good Environmental Status (GES)
<b>What is the central problem?</b>	<ul style="list-style-type: none"> <li>• In the North Sea, the LFI <i>declined substantially</i> during the late 20<sup>th</sup> century while trawling effort was high, but since the early 21<sup>st</sup> century has improved moderately well</li> <li>• The year 2000 was also when the <i>EU fishing fleet reduction</i> scheme commenced</li> <li>• Were <i>high levels of fishing</i> in the 1980s–1990s a cause in the declining LFI?</li> <li>• And – of no less significance – has <i>reduced trawling pressure</i> contributed to the improvement in the LFI?</li> </ul>

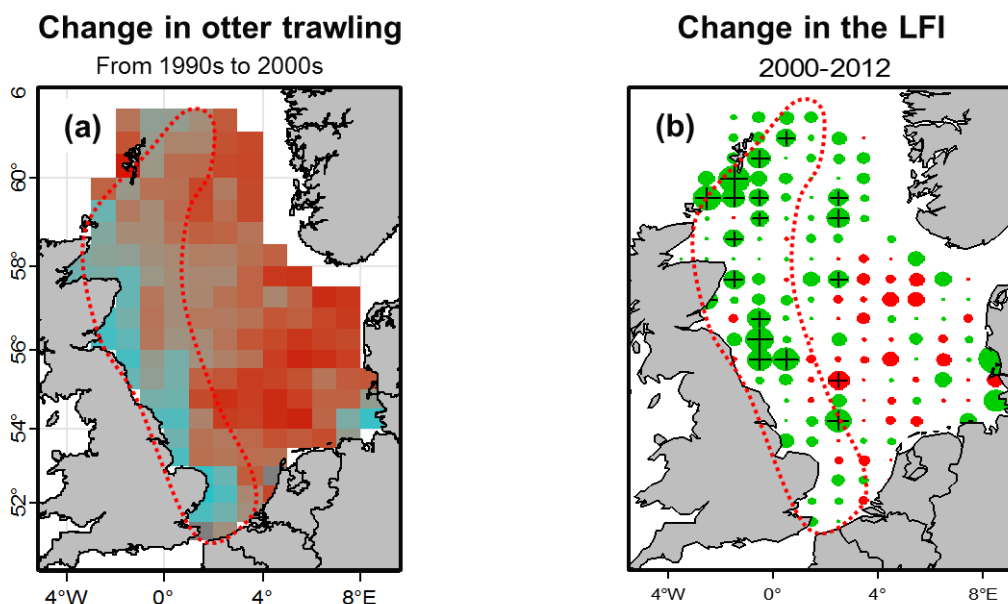
### Materials and methods

For a full description, see our recently published, peer-reviewed, open access paper in *Environmental Conservation*, of which the present, extended abstract highlights the key findings and policy relevance: <http://dx.doi.org/10.1017/S0376892915000077>. This work was supported by UK Defra project MF1228 (‘Fizzyfish’) and EU FP7 project 308392 (‘Devotes’).

## Results and discussion

*What are the key findings and their relevance?*

1. For the first time, spatial patterns of change in the LFI are compared *between two contrasting periods of fisheries management: 1983–1999 and 2000–2012*, before and after the onset of EU fleet reduction schemes, respectively.
2. Over the entire period, the LFI has gone down in most rectangles of the North Sea, particularly in the central areas, however...
3. Most of the general decline occurred from 1983–1999. Since 2000, the LFI has improved in much of the North Sea, especially in UK waters.
4. Where trawling was highest in the 1990s, the LFI declined most.
5. Where trawling effort was reduced from the 1990s to 2000s, the LFI improved most. The relationships were statistically significant.
6. This supports that reduced fishing pressure since the millennium is beginning to result in an improved ecosystem state as indicated by the regional-scale improvement in the LFI.



**Figure 1.** (a) Change in international trawling effort (fishing hours by ICES rectangle) from 1990s to 2000s, shown by shading from blue (reduced effort) to red (increased effort). (b) Change in LFI from 2000 to 2012: size of green and red symbols indicates strength of positive and negative Kendall's tau correlations, respectively, and + denotes significance ( $p < 0.05$ ). Note close correspondence between areas where effort was reduced, and where LFI improved after 2000 (dotted red line).

*What is the impact on policy and uptake into advice?*

- There is strong evidence that reductions in fishing pressure can pay off in terms of improvements in a key indicator of GES, within the reasonably short time-span of c. 10 years.
- This is a promising signal that EU effort reduction schemes aimed at improving profitability of fisheries and moving towards GES, are beginning to pay off.

## References

Engelhard, G.H., Lynam, C.P., García-Carreras, B., Dolder, P.J., and Mackinson, S. (2015) Effort reduction and the large fish indicator: spatial trends reveal positive impacts of recent European fleet reduction schemes. *Environmental Conservation*, 42: 227-236. doi: 10.1017/S0376892915000077.