

Large-scale oceanic forces controlling a top predator in a marine ecosystem ?

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INTRODUCTION

Since 1875 Atlantic Puffins (*Fratercula arctica*) have been hunted in Iceland with a pole net, a technique where mainly nonbreeders (2 - 4 yr) are caught, sparing breeding birds (>5 yr). Breeding failure in the Vestmannaeyjar archipelago (Figure 1) has been evident 2005-7, apparently due to food shortage, but annual puffin harvest has also decreased. Past decades oscillations in the catch records are evident.

AIMS

- Analyse the harvest records with environmental parameters
- Propose a demographic model linking puffins to the marine ecosystem

RESULTS & DISCUSSION

A correlation was found between the Sub-polar gyre index¹ (Figure 2) and puffin catch index 3 - 5 years later (Figure 3 and 4). Thus, indicating an effect of oceanographic dynamics on the reproductive output and later expressed in number of 2-4 yr old puffins present near the natal colonies after certain SPG conditions (Figure 5).

Theoretically the link between ocean conditions and puffin catch index is availability of food, i.e. the sandeel (*Ammodytes* sp.) (Figure 5).

Inter-annual variation in puffin harvest is high and it is hypothesized that a local prevalence by nonbreeders is in direct relation to local food availability around the Islands. This is based on the observation that puffin harvest is highly correlated to fledglings' mean body mass (Figure 6)². This behaviour is likely to intensify both the downward oscillations, when nonbreeders are absent in poor sandeel years and not huntable, and the upward oscillations when unharvested cohorts become available.

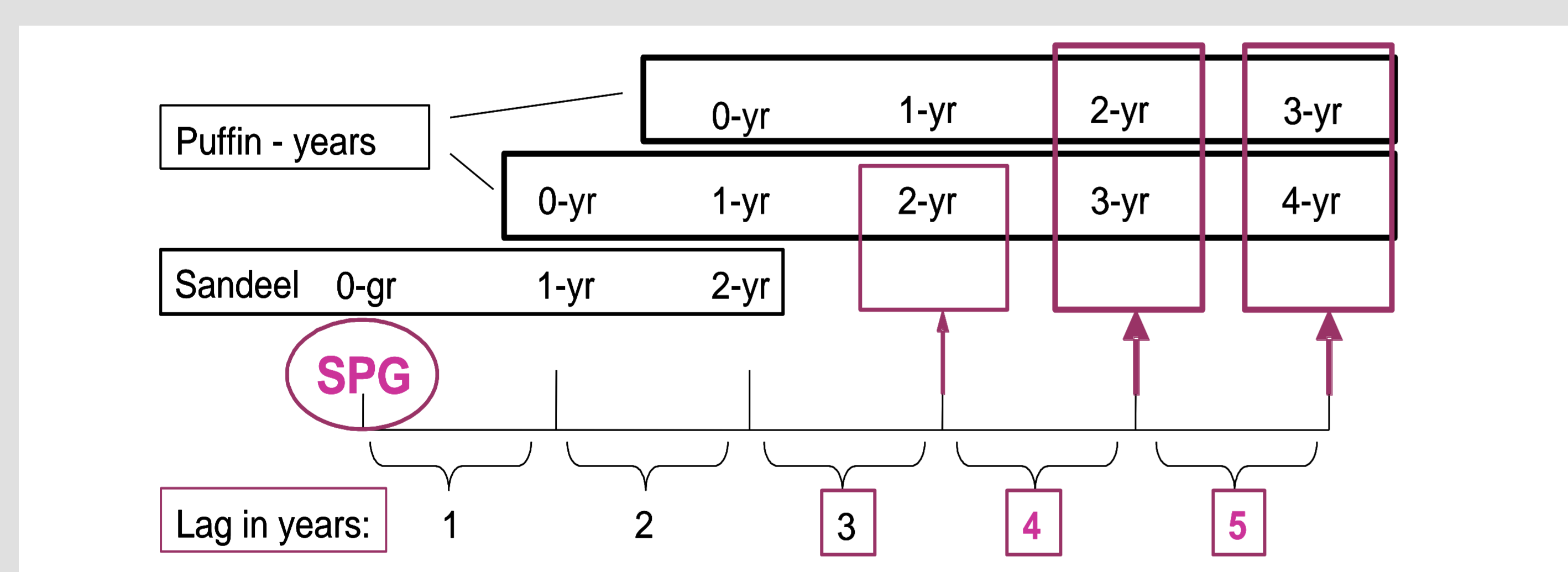


Figure 5. Flowchart demonstrating the possible scenario of the relation of the Subpolar Gyre (SPG) and the puffin harvest

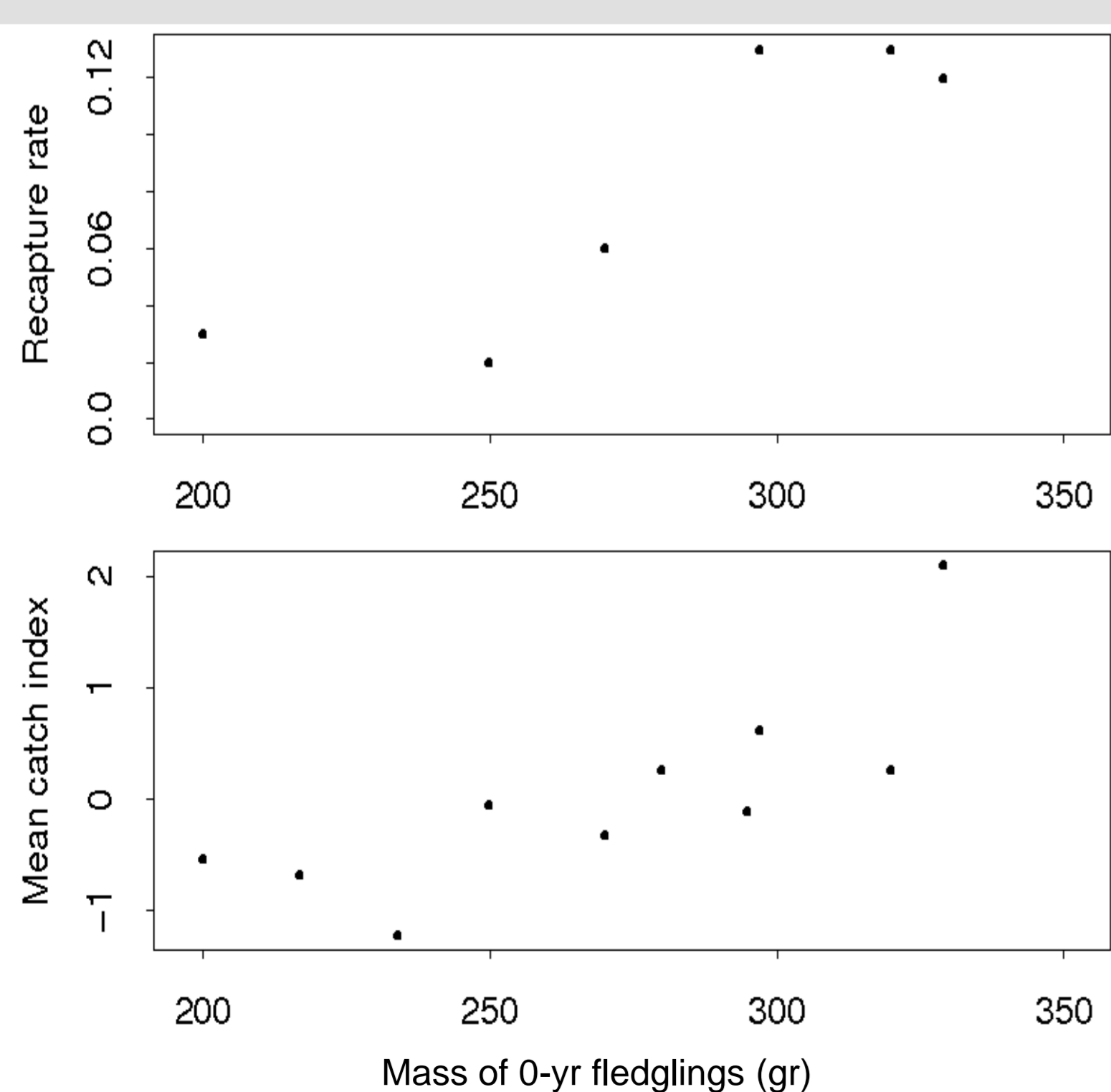


Figure 6.

a) Correlation of annual mean body mass of fledglings at nest departure and the recapture rate at the islands

b) Annual mean body mass of fledglings at nest departure and mean catch index

For more detailed information on figure 6 see Hansen *et al.* 2008²

METHODS

Independent records from seven islands were used, with the longest time series dating back to 1944. Each island's catch record was standardized and detrended. Comparable islands were then fitted with a GAM model (df=30).

Figure 1. The Vestmannaeyjar archipelago holds the world's largest breeding population of the Atlantic Puffin, around 1.3 million breeding pairs.

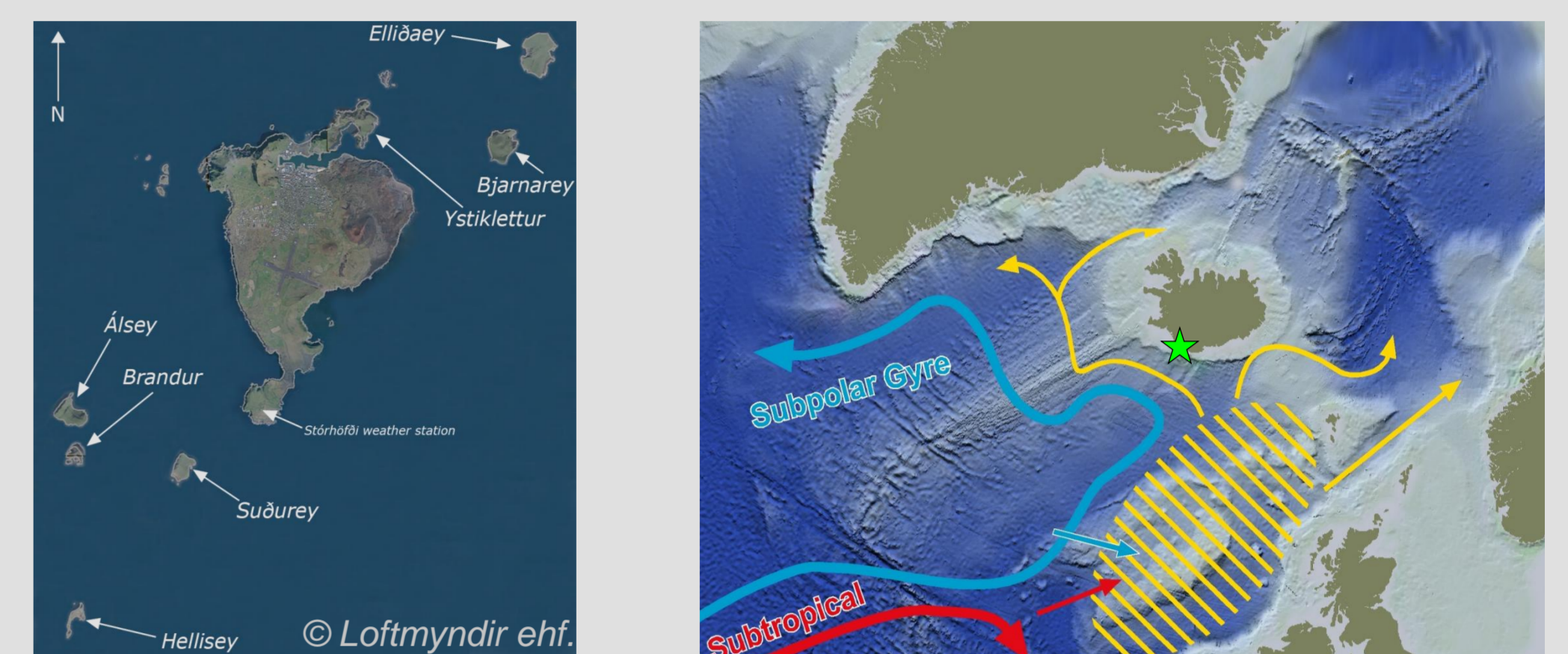


Figure 2. (right) Main features of the surface circulation in the North Atlantic. The yellow hatched area marks the region where the subpolar and the subtropical waters mix and flow into the Arctic ocean. Modified from Hátún *et al.*¹ Location of Vestmannaeyjar is shown (green star).

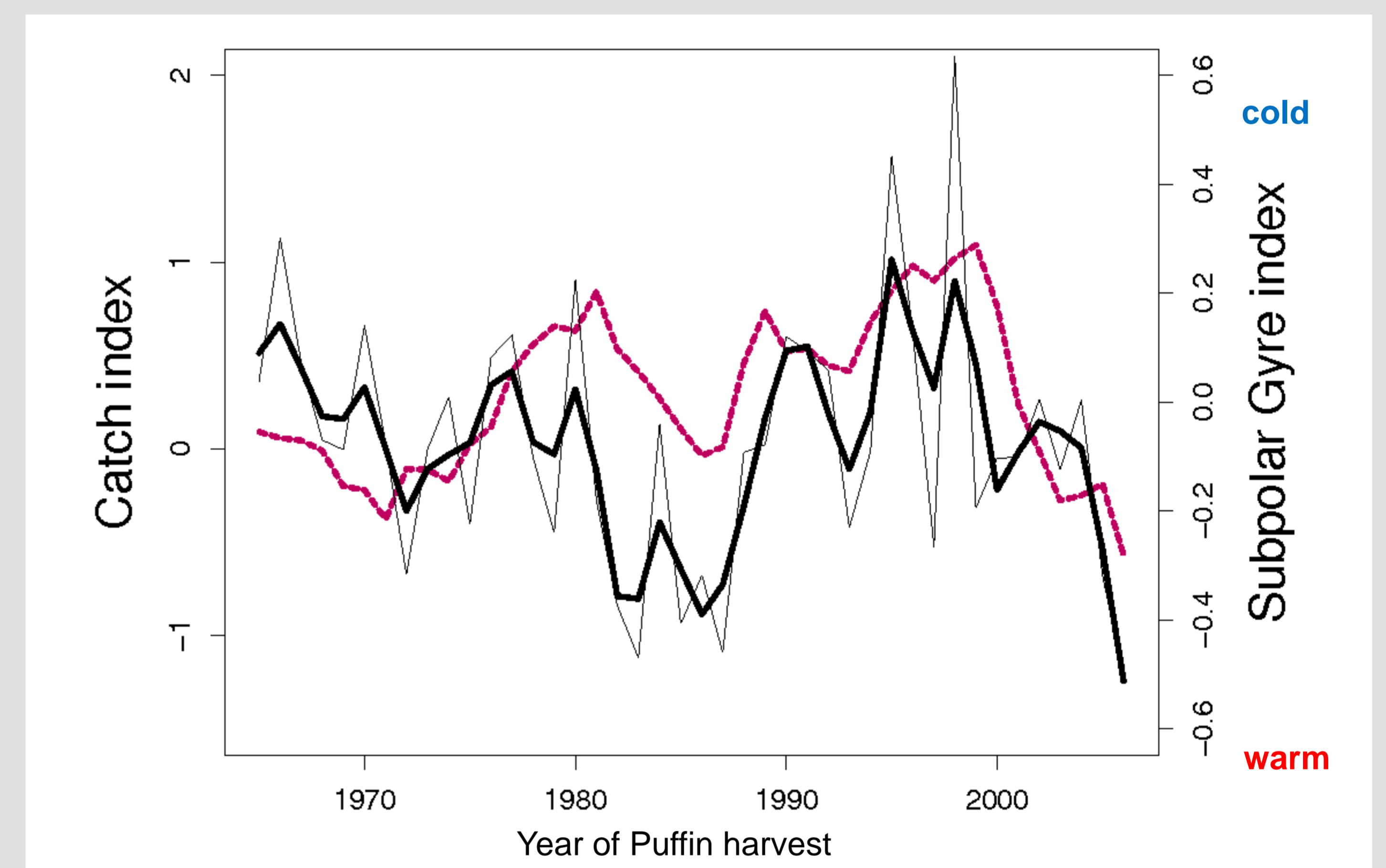


Figure 3. The Puffin catch index (black) compared with The Subpolar Gyre index 5 years earlier (dotted red). There was an overall positive correlation ($r=0.64$, $n=29$) between the two indices.

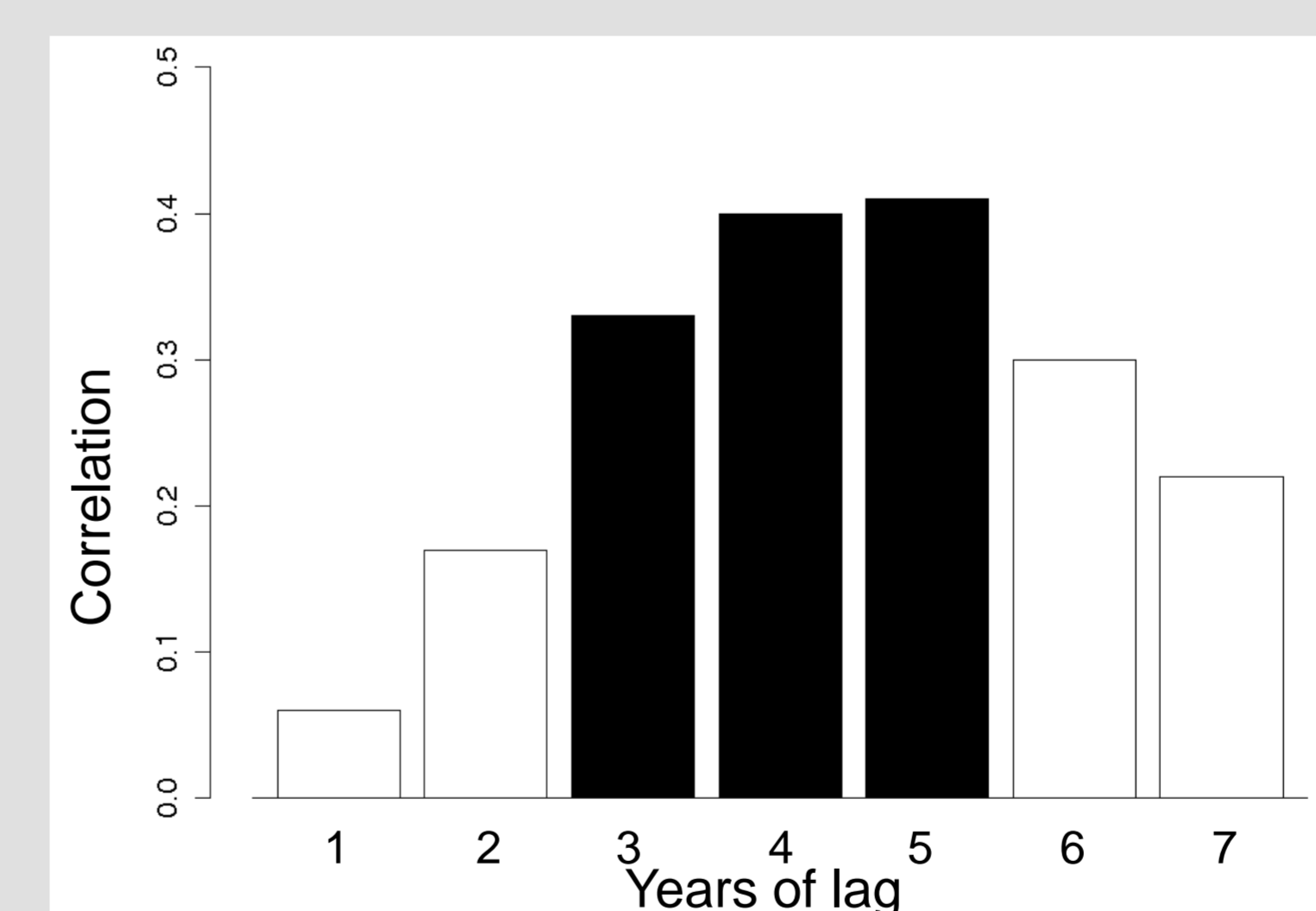


Figure 4. Correlogram of 1-7 years lag between the SPG index and puffin catch index. 3-5 year lag were significantly correlated ($P<0.05$, $v=40$).

CONCLUSION

The SPG, a large-scale oceanographic dynamic system, seems to be a controlling force in the ecosystem supporting a top predator, the Atlantic Puffin

The correlation of the SPG index and the puffin harvest index suggests a bottom up control of puffins breeding success

The large-scale oceanographic hypothesis is supported by the effect of food condition on the recapture rate of 2-5 year old puffins

The system is however complex as the non-breeders may stay away during years of food shortage

The records provide critical information on population trends allowing future predictions for the Atlantic Puffins' stronghold

¹ Hátún *et al.* 2005. Science 309: 1841-1844

² Erpur S. Hansen *et al.* 2008. Poster V90 in the Natural Science Symposium 14.-15 mars 2008