

Spatiotemporal distribution and composition of mixed stock fishery of Atlantic cod (*Gadus morhua*) in West Greenlandic waters based on retrospective genetic analysis

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INTRODUCTION

During the last century Atlantic cod *Gadus morhua* stocks have declined dramatically in West Greenlandic waters (Fig1). The depletion of stocks has been ascribed to failure of sustainable fishery management but potentially also to mismatch between management and biological units.

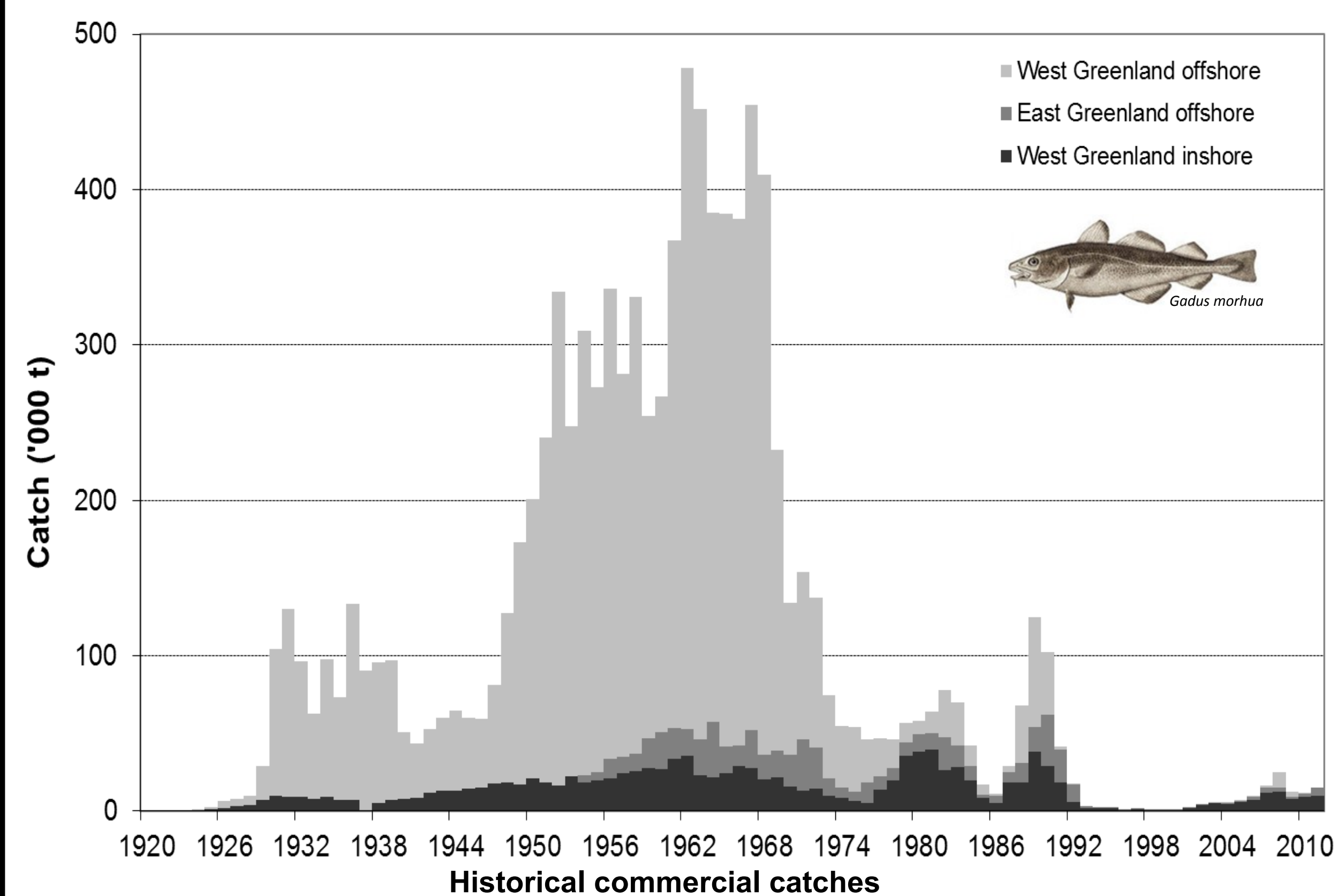


Fig1. Historical commercial catches of Atlantic cod (*Gadus morhua*) in Greenlandic waters (ICES Advice 2011).

Previous investigations have revealed the presence of four genetically distinct spawning groups of cod in Greenlandic waters: West offshore, Nuuk inshore, East offshore and Iceland inshore (Therkildsen et al. 2013).

The aim of this study was to use historical and recent samples of Atlantic cod to estimate the spatiotemporal contribution of the four different spawning components to the mixed stock fishery in West Greenlandic waters.

MATERIALS AND METHODS

On the basis of the historical commercial catches of Atlantic cod (Fig1) in Greenlandic waters, DNA was successfully extracted from archival otoliths from hundred individuals randomly selected per year during the mixed stock fishery of 1962, 1980 and 2012 in West Greenland offshore. DNA was extracted following the procedure described in Therkildsen et al. (2010). All individuals were genotyped for the 81 selected gene associated SNPs (Hemmer-Hansen et al. 2011) on a Fluidigm BioMark HD System chip and assigned to the most likely population of origin with the GeneClass2 software and DAPC using the *adegenet* package for the R software.

RESULTS

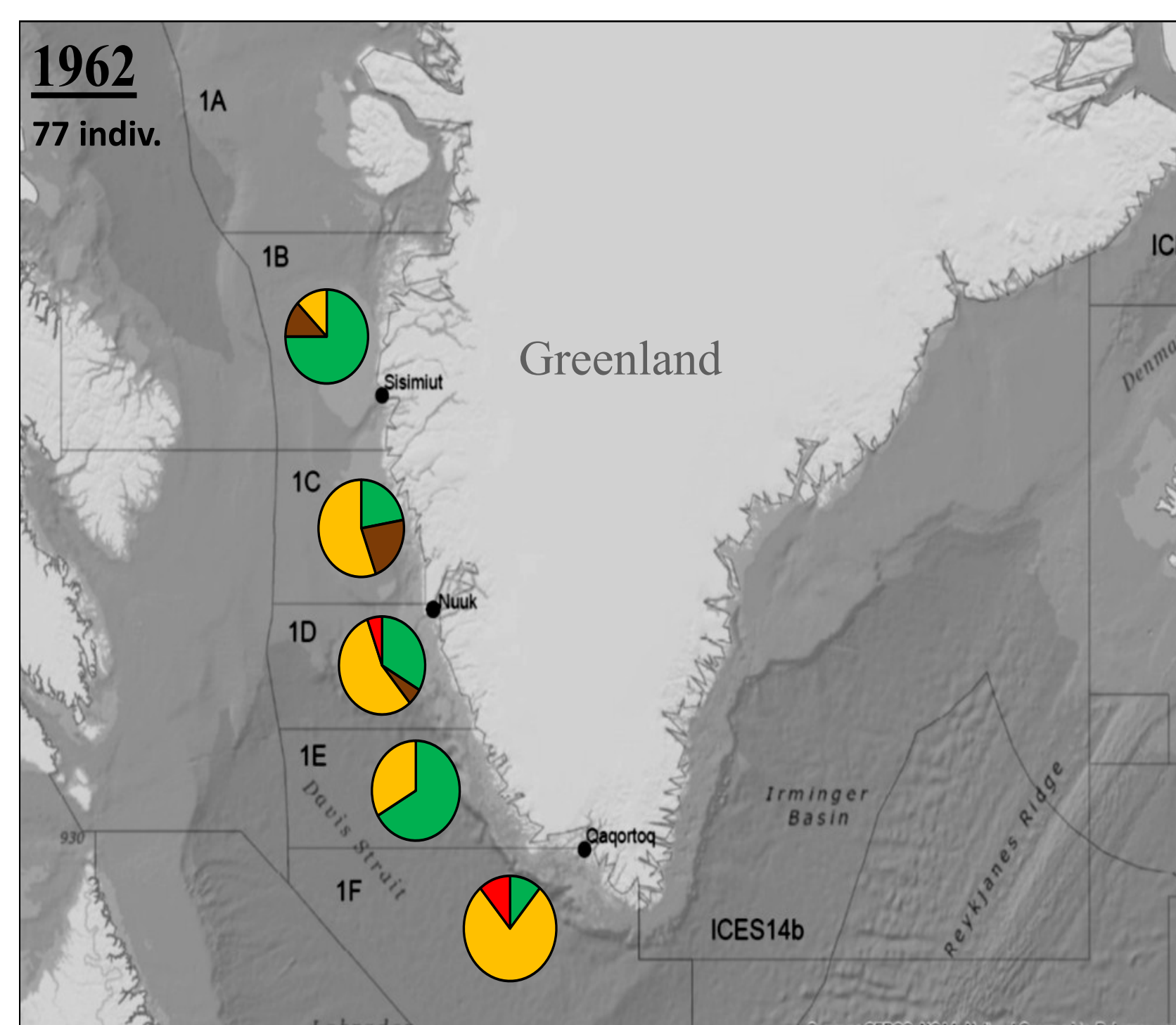


Fig2.

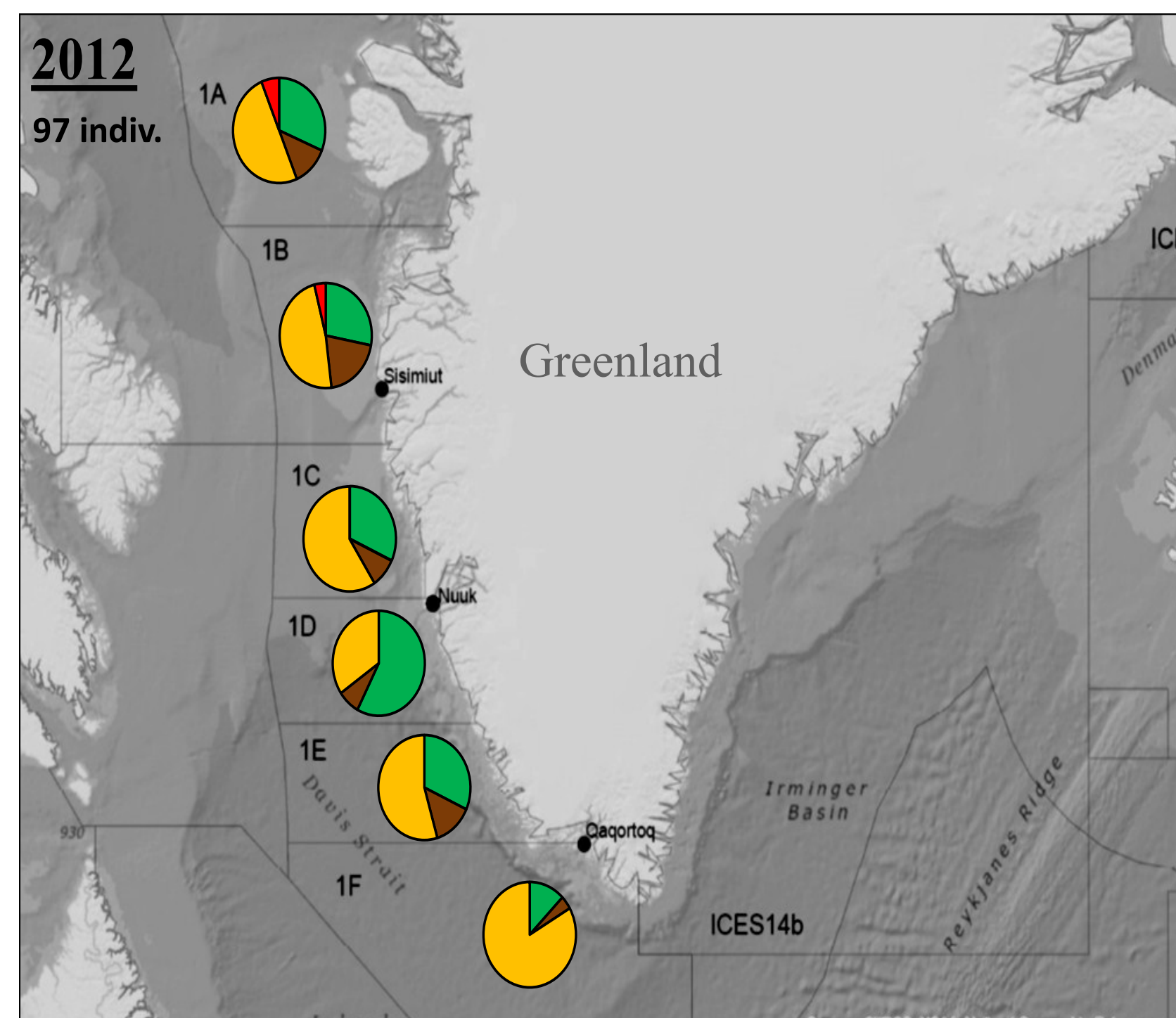


Fig3.

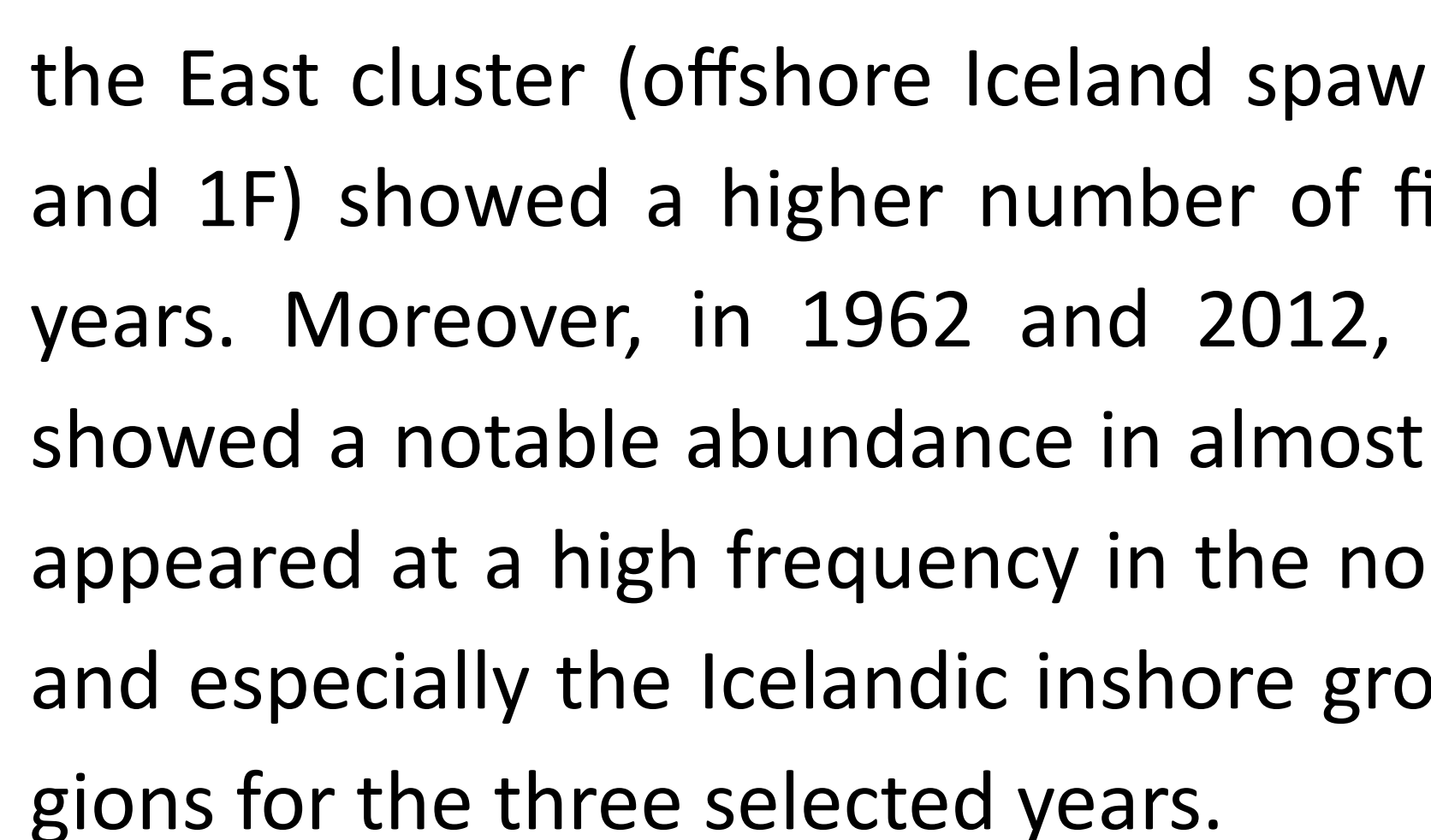


Fig4.

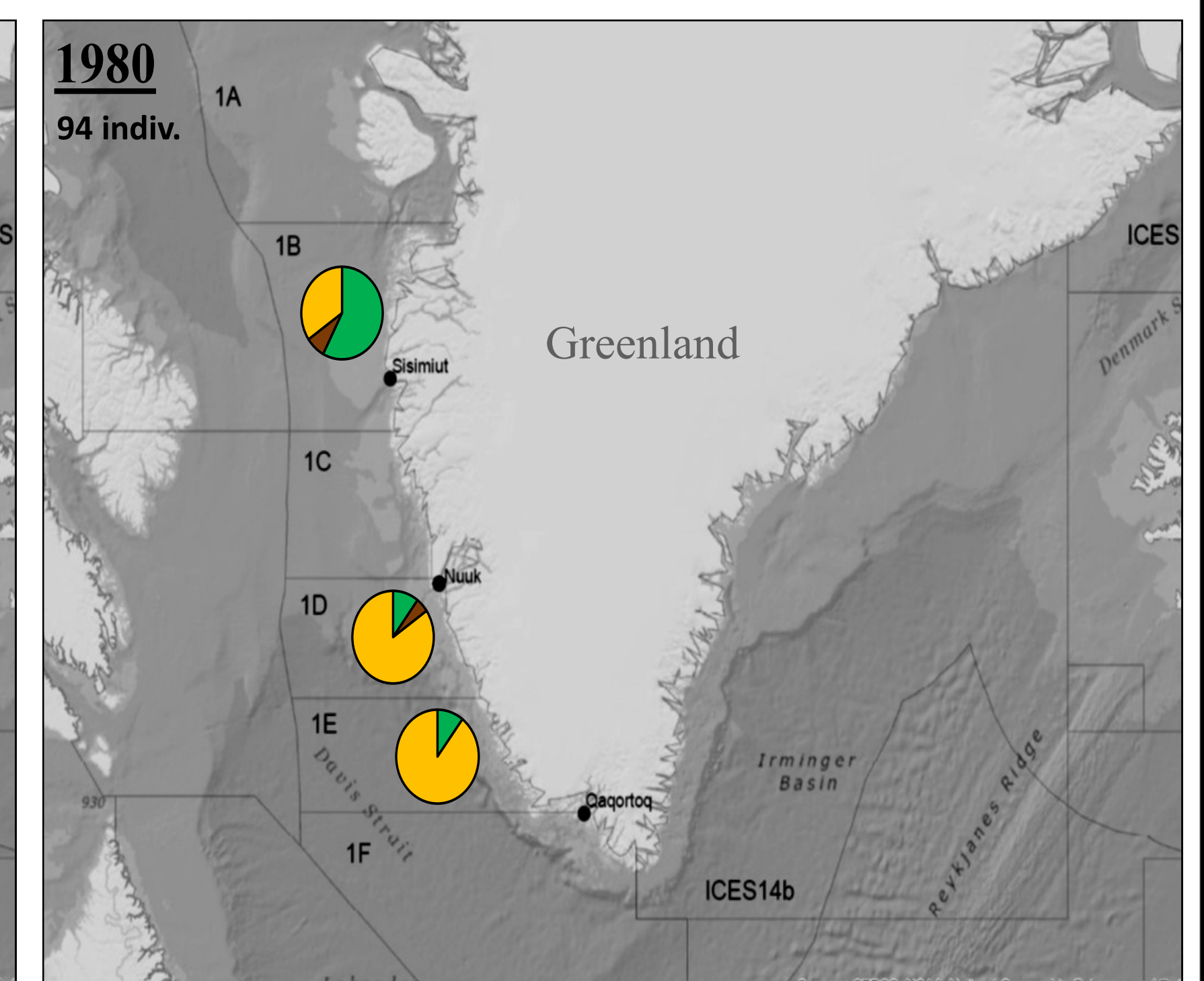


Fig3.

Fig2, 3, 4. Estimated proportional spawning origin of Atlantic cod individuals in each NAFO regions in West Greenland. Each individual was collected during the mixed stock fishery in 1962, 1980 and 2012. The composition was estimated with four baseline spawning samples: **West offshore**, **Nuuk inshore**, **East offshore** and **Iceland inshore**. We only plotted individuals genetically assigned with high probability (>90%) to one of the four genetic clusters (results from GeneClass2 and DAPC were comparable).

Considering all of the NAFO regions surrounding West Greenland, the majority of individuals were assigned (>58%) to the East cluster (offshore Iceland spawning group). The southern regions (1D, 1E and 1F) showed a higher number of fish belonging to this group in all selected years. Moreover, in 1962 and 2012, the West offshore spawning component showed a notable abundance in almost all NAFO regions. However, in 1980 it only appeared at a high frequency in the northern region 1B. Finally, the Nuuk inshore and especially the Icelandic inshore group showed low abundance in all NAFO regions for the three selected years.

CONCLUSIONS

This study genetically assigned cod to the four spawning groups during the West Greenland offshore mixed stock fishery in 1962, 1980 and 2012. It has revealed a majority of east offshore individuals in all selected years, but also a significant proportion of west offshore cod. In particular in the northern areas and at times when landings were high. Interestingly, at low abundance in 1980, the southern NAFO regions consisted almost exclusively of East offshore group. This dynamic pattern is consistent with previous observations (Therkildsen et al.2013).

LITERATURE CITED

Therkildsen ON, Hansen HJ, Hedeholm BR, Wisz SM, Pampoulie C, Meldrup D, Bonanomi S, Retzel A, Olsen MS, Nielsen EE (2013). Spatiotemporal SNP analysis reveals pronounced biocomplexity at the northern range margin of Atlantic cod *Gadus morhua*. *Evolutionary Applications* 6(4): 690-705.
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Therkildsen ON, Nielsen EE, Hüsey K, Meldrup D, Geffen JA (2010). Does DNA extraction affect the physical and chemical composition of historical cod (*Gadus morhua*) otoliths? *ICES Journal of marine Science* 67: 1251-1259.