

1 Supplementary Figures and Tables

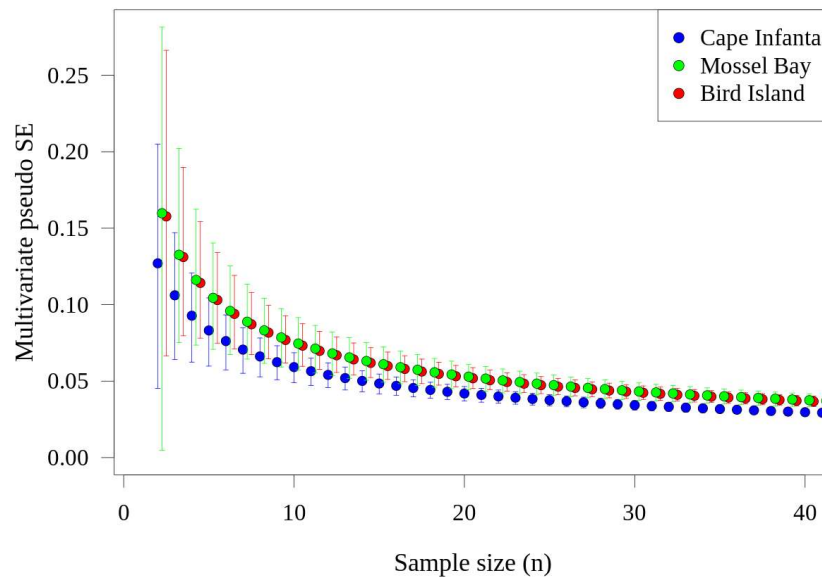


Figure S1. Multivariate pseudo standard error (MultSE) plotted against sample size for the historical trawl samples at each of the three sites. MultSE calculations used Bray-Curtis dissimilarities calculated on square-root transformed, standardized catch data. Error bars represent 2.5 and 97.5 percentiles from 10 000 bootstrap samples.

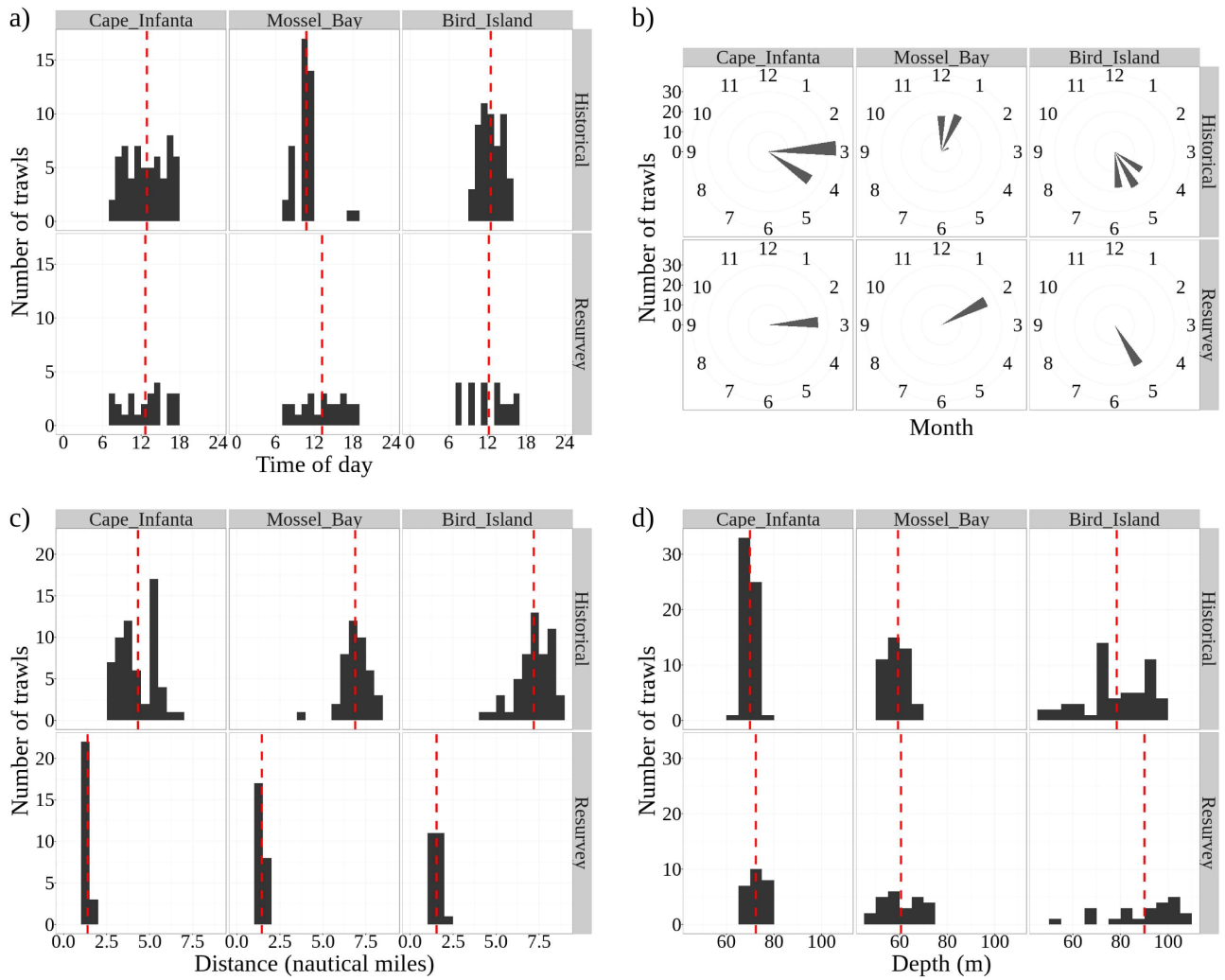


Figure S2. Histograms contrasting historical and re-survey trawl sample a) mid-trawl times, b) months, c) trawl distance and d) trawl depths for the data used in analyses. Vertical red lines indicate mean values.

Table S1. SIMPER results showing the contribution of all taxa towards dissimilarity between periods. Average dissimilarity between periods was 81.7%. Standardized catches (count·nautical mile⁻¹) were square-root transformed prior to analysis.

Taxon	Historical average	Re-survey average	Dissimilarity (D)	Ratio (D/sd)	Cumulative contribution to D
<i>Argyrosomus spp.</i>	6.68	0.00	12.06	1.89	14.76
<i>Pterogymnus laniarius</i>	6.61	0.34	11.28	2.35	28.56
<i>Austroglossus pectoralis</i>	6.62	1.21	9.94	2.09	40.73
<i>Chelidonichthys spp.</i>	0.64	5.53	8.32	1.46	50.90
<i>Argyrozona argyrozona</i>	3.39	0.02	5.99	0.98	58.23
<i>Trachurus trachurus</i>	0.39	3.20	5.27	0.86	64.68
<i>Squalus spp.</i>	0.89	3.68	5.09	0.78	70.91
<i>Merluccius capensis</i>	1.06	2.72	3.74	1.29	75.49
<i>Rhabdosargus globiceps</i>	1.62	0.01	3.03	0.84	79.20
other	0.28	1.90	2.76	1.35	82.58
<i>Galeichthys feliceps</i>	0.03	1.69	2.61	0.62	85.77
Torpediniformes	1.27	0.11	2.17	0.94	88.43
<i>Umbrina canariensis</i>	1.25	0.03	2.13	1.21	91.03
Rajidae	1.25	1.35	2.12	1.60	93.63
Myliobatiformes	0.25	1.03	1.47	0.66	95.43
<i>Cynoglossus spp.</i>	0.42	0.78	1.17	0.97	96.87
Carcharhiniformes	0.20	0.47	0.77	0.98	97.81
<i>Paracallionymus costatus</i>	0.20	0.06	0.41	0.49	98.31
<i>Atractoscion aequidens</i>	0.29	0.02	0.39	0.51	98.78
<i>Lithognathus lithognathus</i>	0.17	0.00	0.27	0.64	99.11
<i>Pomatomus saltatrix</i>	0.17	0.00	0.26	0.51	99.43
<i>Chrysoblephus gibbiceps</i>	0.05	0.00	0.11	0.26	99.56
<i>Genypterus capensis</i>	0.07	0.00	0.1	0.36	99.69
<i>Petrus rupestris</i>	0.06	0.00	0.1	0.35	99.80
<i>Polysteganus undulosus</i>	0.06	0.00	0.08	0.30	99.90
<i>Pachymetopon aeneum</i>	0.03	0.01	0.07	0.25	99.99

Table S2. Site-disaggregated summary statistics (mean $\pm$ *SD*) for catches of all taxa analysed. CI Cape Infanta, MB Mossel Bay, BI Bird Island.

Taxon	Historical numbers (count·nautical mile ⁻¹)			Re-survey numbers (count·nautical mile ⁻¹)		
	CI	MB	BI	CI	MB	BI
<i>Argyrosomus</i> spp.	97.15 $\pm$ 76.36	35.02 $\pm$ 26.85	28.61 $\pm$ 25.7	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0
<i>Argyrozona argyrozona</i>	43.88 $\pm$ 57.75	24.84 $\pm$ 36.21	3.65 $\pm$ 7.63	0 $\pm$ 0	0 $\pm$ 0	0.05 $\pm$ 0.26
<i>Atractoscion aequidens</i>	0.12 $\pm$ 0.95	0.01 $\pm$ 0.04	0.96 $\pm$ 1.47	0 $\pm$ 0	0 $\pm$ 0	0.06 $\pm$ 0.21
<i>Austroglossus pectoralis</i>	71.06 $\pm$ 27.1	48.99 $\pm$ 28.06	24.64 $\pm$ 13.44	2.79 $\pm$ 2.39	2.23 $\pm$ 3	1.58 $\pm$ 2.55
Carcharhiniformes	0.06 $\pm$ 0.15	0.15 $\pm$ 0.17	0.13 $\pm$ 0.19	0.02 $\pm$ 0.11	0.26 $\pm$ 0.55	1.67 $\pm$ 1.11
<i>Chelidonichthys</i> spp.	2.09 $\pm$ 4.1	1.46 $\pm$ 4.76	0.34 $\pm$ 0.75	18.8 $\pm$ 9.87	16.73 $\pm$ 17.98	110.91 $\pm$ 92.2
<i>Chrysoblephus cristiceps</i>	0 $\pm$ 0	0.01 $\pm$ 0.03	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0
<i>Chrysoblephus gibbiceps</i>	0.03 $\pm$ 0.16	0.1 $\pm$ 0.34	0.01 $\pm$ 0.06	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0
<i>Cynoglossus</i> spp.	0 $\pm$ 0	0.28 $\pm$ 0.67	1.2 $\pm$ 0.87	0.39 $\pm$ 0.51	2.01 $\pm$ 2.26	1.08 $\pm$ 1.12
<i>Galeichthys feliceps</i>	0 $\pm$ 0	0.24 $\pm$ 0.96	0 $\pm$ 0	0 $\pm$ 0	0.59 $\pm$ 1.09	32.16 $\pm$ 33.53
<i>Genypterus capensis</i>	0 $\pm$ 0.03	0.02 $\pm$ 0.05	0.09 $\pm$ 0.23	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0
<i>Lithognathus lithognathus</i>	0.03 $\pm$ 0.08	0.09 $\pm$ 0.14	0.2 $\pm$ 0.33	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0
<i>Merluccius capensis</i>	2.75 $\pm$ 3.39	1.1 $\pm$ 1.18	1.67 $\pm$ 2.9	12.67 $\pm$ 6.7	16.73 $\pm$ 13.17	1.16 $\pm$ 1.79
Myliobatiformes	0.01 $\pm$ 0.04	0.19 $\pm$ 0.33	0.26 $\pm$ 0.19	0 $\pm$ 0	0.09 $\pm$ 0.24	12.86 $\pm$ 14.71
<i>Pachymetopon aeneum</i>	0 $\pm$ 0	0.03 $\pm$ 0.12	0.04 $\pm$ 0.12	0 $\pm$ 0	0 $\pm$ 0	0.03 $\pm$ 0.15
<i>Paracallionymus costatus</i>	0.04 $\pm$ 0.18	0.69 $\pm$ 1.26	0.07 $\pm$ 0.27	0 $\pm$ 0	0.08 $\pm$ 0.22	0.06 $\pm$ 0.21
<i>Petrus rupestris</i>	0.02 $\pm$ 0.07	0.06 $\pm$ 0.13	0.01 $\pm$ 0.06	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0
<i>Polysteganus undulosus</i>	0 $\pm$ 0	0 $\pm$ 0	0.13 $\pm$ 0.32	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0
<i>Pomatomus saltatrix</i>	0.01 $\pm$ 0.09	0.1 $\pm$ 0.19	0.29 $\pm$ 0.68	0 $\pm$ 0	0 $\pm$ 0	0 $\pm$ 0
<i>Pterogymnus lanarius</i>	52.55 $\pm$ 24.53	51.13 $\pm$ 30.62	46.02 $\pm$ 39.54	0.06 $\pm$ 0.2	0 $\pm$ 0	3.57 $\pm$ 9.43
Rajidae	2.38 $\pm$ 1.68	2.21 $\pm$ 1.35	0.91 $\pm$ 0.51	0.6 $\pm$ 0.76	1.63 $\pm$ 2.11	8.22 $\pm$ 5.46
<i>Rhabdosargus globiceps</i>	1.91 $\pm$ 1.81	19.89 $\pm$ 16.38	0.49 $\pm$ 1.18	0.03 $\pm$ 0.14	0 $\pm$ 0	0 $\pm$ 0
<i>Squalus</i> spp.	0.23 $\pm$ 0.39	1.59 $\pm$ 1.9	2.52 $\pm$ 2.92	0.09 $\pm$ 0.25	4.19 $\pm$ 14.49	130.31 $\pm$ 116.73
Torpediniformes	1.84 $\pm$ 1.53	5.38 $\pm$ 14.89	1.68 $\pm$ 1.28	0.03 $\pm$ 0.16	0.06 $\pm$ 0.19	0.24 $\pm$ 0.5
<i>Trachurus capensis</i>	0.03 $\pm$ 0.13	0.07 $\pm$ 0.11	1.71 $\pm$ 3.09	19.95 $\pm$ 28.34	31.26 $\pm$ 87.47	33.28 $\pm$ 78.86
<i>Umbrina canariensis</i>	1.59 $\pm$ 3.15	4.54 $\pm$ 7.81	2.41 $\pm$ 4.44	0 $\pm$ 0	0 $\pm$ 0	0.16 $\pm$ 0.67
other	0.01 $\pm$ 0.05	0.43 $\pm$ 0.46	0.33 $\pm$ 0.53	2.5 $\pm$ 4.61	3.1 $\pm$ 3.22	11.37 $\pm$ 7.23

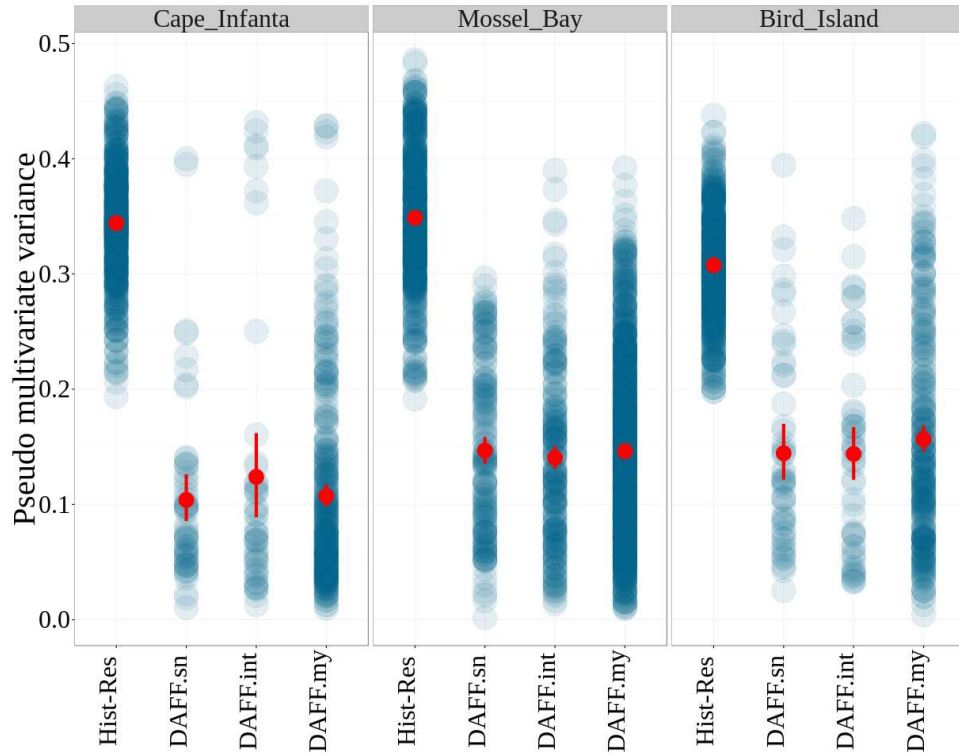


Figure S3. Comparison of multivariate pseudo variance calculated between pairs of randomly chosen samples from historical and repeat surveys (Hist-Res; N=500 for each site), as well as all possible combinations of DAFF samples that were separated by ≥ 2 month but < 12 months (DAFF.sn), ≥ 12 months but < 18 months (DAFF.int) and ≥ 18 months but ≤ 60 months (DAFF.my). Mean and non-parametric 95% confidence intervals are indicated in red. See Methods for details.

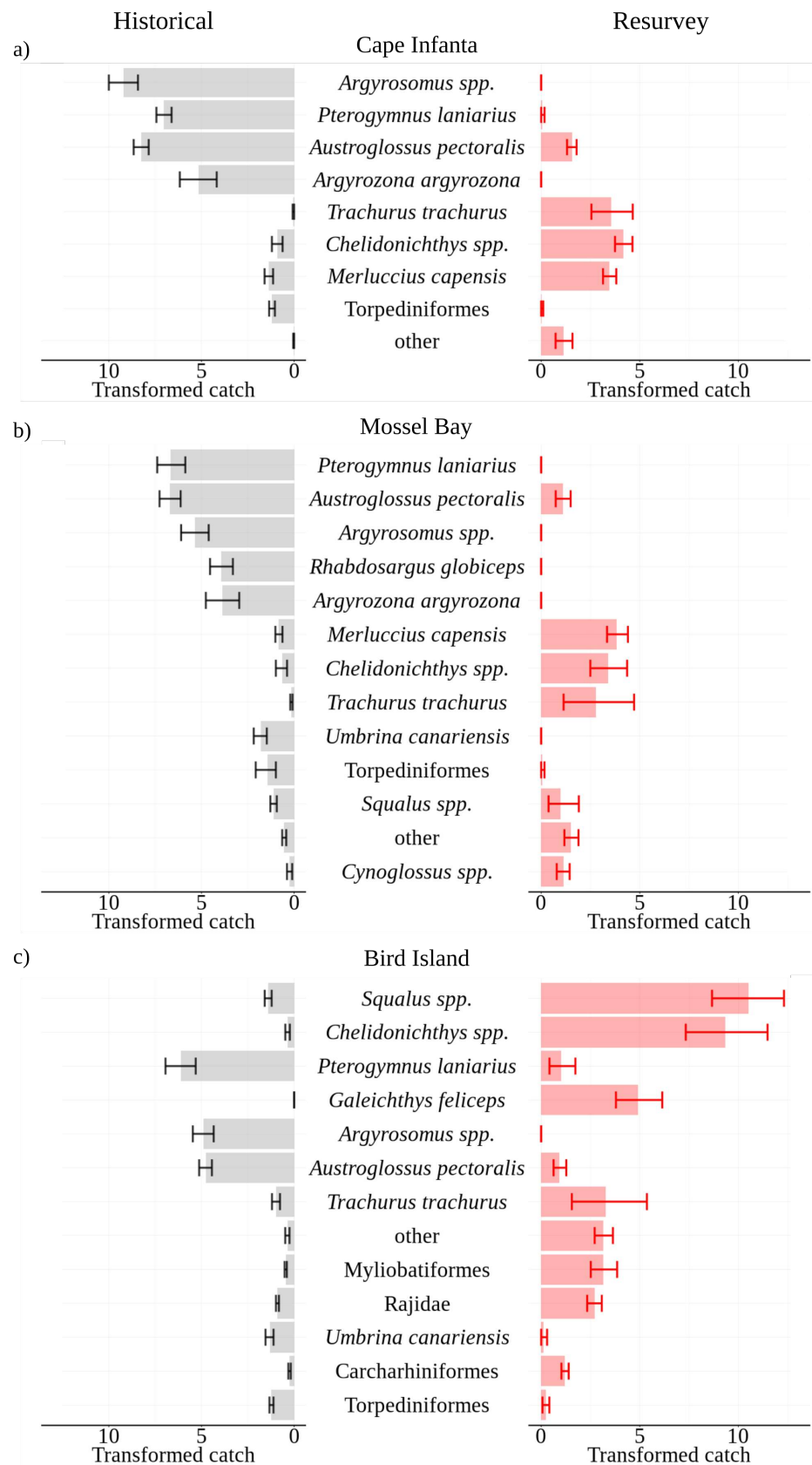


Figure S4. Same as Fig 3, but showing taxa that distinguished periods at individual sites a) Cape Infanta, b) Mossel Bay and c) Bird Island, using a pairwise SIMPER analysis.

2 Examination of Assumptions

2.1 Trawl gear performance

The historical trawl gear was carefully imitated in design, materials and function and the resultant gear selectivity and catching power are expected to be closely related to those of the historical trawl gear (Currie et al., 2018). Although the range of realistic values is conscribed, the exact dimensions of the historical trawl net were not certain. Similarly, there is some uncertainty around the trawling speed attained by the Pieter Faure. Therefore, the most likely figures were used for analyses, assuming that they represent historical fishing power. Trawling speeds and net headline lengths are central to the standardisation of catches and incorrect assumptions about them may result in biased catch rates. Assessment of the most extreme bias that might result from the combination of these two variables in the calculation of standardized catches confirmed that they would have negligible effect on the results and interpretations reported here. The adjustments effectively inflated historical standardized catches by 25% or reduced them by 37%, and changed the sequence of species distinguishing between periods (reported by SIMPER and plotted in Figs 4, S4) in a few cases. Therefore, even though some uncertainty remains in relation to the replication of the historical trawl gear and methods, the results of analyses appear robust to such uncertainty and did not have material impact on interpretations or conclusions drawn from the results.

2.2 Trawl Duration

The trawl duration and resulting distance covered under tow is considered to be the largest operational difference between periods contrasted. The historical trawl samples were of typical commercial duration at that time (~1-3 hours), likely because their surveys were subsidized by sale of the catch, creating incentive for relatively large, commercially-profitable catches. Recent research surveys typically use shorter tows (Battaglia et al., 2006; Walsh, 1991; Wieland and Storr-Paulsen, 2006) that balance efficiency with attaining ecologically-meaningful samples. Due to economic (time) constraints, the repeat survey employed ~30 minute trawls, similar to the national and some international trawl survey protocols (ICES, 2012).

Although there are theories to explain changes in catch rates with changing trawl length, empirical support of such effects seem limited and predominantly shown from short trawl tows (≤ 15 minutes). Walsh (1991) and Godø et al. (1990) found greater catch per unit effort (CPUE) for various demersal fish in the shortest (5-minute) trawls, but not when they compared 15- and 30-minute trawls. Wieland and Storr-Paulsen (2006) concluded there was no effect on shrimp or halibut CPUE in their comparison of 15- and 30-minute trawls. Investigating three crab species, Somerton et al. (2002) showed that CPUE was significantly greater in 15-minute tows compared to 30-minute trawls for two of their taxa. Elevated catch rates in short-duration trawls are likely due to a proportionally greater impact of the 'end effect' - catches taken during shooting and hauling of the net, the time of which is frequently excluded from the tow duration (Battaglia et al., 2006). Such potential end effects were removed from the re-survey catches here and were assumed to have minimal effect on the longer-duration historical trawls.

Sala (2018) compared 30- and 60-minute tow durations in a single area with similar depths in the Central Adriatic Sea. In contrast to the studies cited above, their results suggested greater CPUE for longer duration trawls, although their limited sample size (7 trawls per length category) meant that

differences were significant only for lobster (*Nephrops norvegicus*) and for summed catches. The author suggested that longer tows were more efficient than shorter tows because a greater proportion of fish swimming ahead of the moving net would become fatigued and fall back into the net. None of the above studies demonstrated an effect of trawl length on the sizes of individuals caught.

A related assumption implicit in comparison of the historical and re-survey catches is that the magnitude of catches did not bias selectivity or catch rates. It is likely that as a trawl net fills with catch, its geometry and water flow through the net are affected (Battaglia et al., 2006; Somerton et al., 2002), thereby influencing the escapement of fish. The assumption was made that catch rates and selectivity remained approximately constant across different trawl durations and catch sizes. Although an impact of catch size on net performance cannot be discounted, such potential bias is expected to be relatively small in that it likely biased few samples (that had the largest catches) and was most likely to affect only a small proportion of the entire trawl tow (once the net had filled to a capacity where its catch rate was affected). Somerton et al. (2002) found no evidence that differences between 15- and 30-minute catch rates were related to the total catch size.

2.3 Bird Island Depth Bias

As repeat trawl locations were chosen randomly from the grounds surveyed historically, depths were expected to be similar between periods. However a difference in depth distribution was found at Bird Island (Fig S2) and an effect of depth on assemblage composition was evident (Table 2). Causes of the unexpected Bird Island bias in depth are unclear but appear to be due to error in historical measurements. The depths recorded for many of the Bird Island historical trawl samples appear to be too shallow compared to nearby re-survey trawls and a 10-m resolution GIS bathymetry layer (not shown). The location of historical trawls may have been estimated inaccurately (with a systematic bias of overestimating the distance to shore), or the depth measurement may have been negatively biased, perhaps due to exaggerated correction of sounder measurements that had been affected by currents and/or wind drift. The currents experienced in this area are generally stronger than at the other two sites (Less, personal communication 2015). In case this bias was real and to assess its impact on results, analyses were repeated with a dataset that excluded seven Bird Island re-survey samples deeper than 100 m. Although the results had reduced statistical power, they did not show material differences to those presented.

2.4 Long-term Signal vs Short-term Variability

Trawl catches are potentially affected by multiple sources of variability over relatively short time-frames (Arreguín-Sánchez, 1996). These could include natural- or anthropogenic-driven abundance changes over interannual time-frames, catchability variation due to changes in weather/oceanography (influencing behaviour of fish or fishing gear), and seasonal changes in their catchability due to altered reproductive or feeding behaviour. An experimental design contrasting long-term changes would therefore be more powerful at isolating long-term differences from such shorter-term variability if it included multiple years of data for each period. Unfortunately neither the historical data nor repeat survey constraints allowed comparison of multi-year data. It might be argued that had the surveys taken place in another year, the results may have looked different. To address this point, the magnitude of seasonal, interannual and multi-year variability was compared to that between historical and re-survey periods. Those results (Fig S3) confirmed that the magnitude of change documented between periods was substantially (2-3.3 times) greater than shorter-term seasonal and

interannual variability captured in DAFF trawl survey data. The sampling of three geographically distinct sites in different months is also expected to reduce the impact of potential short-term bias. The major part of observed between-period differences are therefore attributed towards long-term change that has occurred in the studied assemblages.

2.5 Taxonomic Limitations

The taxonomic resolution imposed by the historical records (Table 1), requires consideration during interpretation of results. Clearly, changes in the composition of grouped taxa cannot be resolved here. The 'other' category of fish is especially problematic, as it has almost no taxonomic or ecological meaning to it. Although included in analyses, interpretation of changes in the 'other' taxon group was therefore not a focus. Assumedly this group was used to pool taxa that were relatively rare and not considered of economic interest.

The consequence of grouped taxa on comparisons of assemblage composition are expected to dampen differences among samples, because opposing species-level abundance changes within a group would be concealed (Dulvy et al., 2000). It is important to note, therefore, that long-term variability documented here may provide a conservative gauge and that it may have missed important declines or increases within the grouped taxa. Dulvy et al. (2000) document a case where the disappearance or decline of large skates was masked by the increase of two smaller species when skate (Rajidae) catches were not disaggregated. Such an explanation might contribute towards the lack of average declines seen in this study for Rajidae, Myliobatiformes and Carcharhiniformes, despite drastic alterations in several other taxa. Results reported here should not necessarily be interpreted as evidence that these elasmobranchs have escaped fishing or other impacts.

3 References Cited

- Arreguín-Sánchez, F. (1996). Catchability: a key parameter for fish stock assessment. *Rev. Fish Biol. Fish.* 6, 221–242. doi:10.1007/BF00182344.
- Battaglia, A., Trenkel, V. M., and Rochet, M.-J. (2006). Estimating end effects in trawl catches. *ICES J. Mar. Sci.* 63, 956–959. doi:10.1016/j.icesjms.2006.03.002.
- Currie, J. C., Sink, K. J., Attwood, C. G., Atkinson, L. J., and Engelhard, G. H. (2018). Reconstructing the past: design and function of Granton otter trawl gear at the turn of the twentieth century, as used in South Africa's first trawl surveys (1897–1904). *Marit. Stud.*, 1–16. doi:10.1007/s40152-018-0095-7.
- Dulvy, N. K., Metcalfe, J. D., Glanville, J., Pawson, M. G., and Reynolds, J. D. (2000). Fishery stability, local extinctions, and shifts in community structure in skates. *Conserv. Biol.* 14, 283–293. doi:10.1046/j.1523-1739.2000.98540.x.
- Godø, O. R., Pennington, M., and Vølstad, J. H. (1990). Effect of tow duration on length composition of trawl catches. *Fish. Res.* 9, 165–179. doi:10.1016/0165-7836(90)90062-Z.

ICES (2012). Manual for the International Bottom Trawl Surveys, Revision VIII. Copenhagen: International Council for the Exploration of the Sea.

Somerton, D. A., Otto, R. S., and Syrjala, S. E. (2002). Can changes in tow duration on bottom trawl surveys lead to changes in CPUE and mean size? *Fish. Res.* 55, 63–70. doi:10.1016/S0165-7836(01)00293-4.

Walsh, S. J. (1991). Effect of tow duration on gear selectivity. *Northwest Atl. Fish. Organ. Sci. Counc. Meet.* NAFO SCR Doc 91/84, 1–9.

Wieland, K., and Storr-Paulsen, M. (2006). Effect of tow duration on catch rate and size composition of Northern shrimp (*Pandalus borealis*) and Greenland halibut (*Reinhardtius hippoglossoides*) in the West Greenland Bottom Trawl Survey. *Fish. Res.* 78, 276–285. doi:10.1016/j.fishres.2006.01.004.