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Assessing the impact of fisheries on demersal fish assemblages of the Mauritanian continental shelf, 1987–1999, using dominance curves

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The assemblages of demersal fish and associated species of the Mauritanian continental shelf are characterized on the basis of annual trawl surveys conducted during the period 1987–1999. Species composition is dominated by exploited species (*Dentex* spp., *Pagellus bellottii*, and *Octopus vulgaris*). Dominance curves (Abundance Biomass Comparison plots) were used to evaluate the impact of fisheries, which have increased in magnitude over several decades. The diagnosis of a "stressed" assemblage seems to converge with the results of a similar study conducted off Senegal, but here there was no trend in impact during the period of study. The sensitivity of the present results to the various ways of considering the available taxonomic information is also analysed.

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Introduction

The demersal communities of the Mauritanian continental shelf have been fished at increasing levels for several decades (Jouffre, 1998; Inejih, 2000; Chavance *et al.*, in press). Assessing the impact of the fishery on the local ecosystem is of great interest (Jouffre *et al.*, 2004, in press), as it is in many other parts of the world (Pauly *et al.*, 1998, 2000). The Abundance Biomass Comparison (ABC) method (Clarke and Warwick, 1994) has been used to assess community stress and represents a potentially suitable tool for paving the way towards an ecosystem approach for fisheries. Jouffre *et al.* (2004) applied the approach to marine fish assemblages off Senegal, and our aim is to complement those results with similar analyses for the demersal communities off Mauritania. For the purpose, we used data derived from annual trawl surveys carried out on the shelf (Inejih, 2000), which represent one of the most extensive and homogeneous data sets for the area.

Material and methods

The study area is located off the west coast of Africa (16–20°N), covering the entire continental shelf of Mauritania (7–100 m deep). Data were collected during 12 scientific bottom-trawl surveys carried out between 1987 and 1999 (there was no annual cruise in 1997), each covering the entire area (about 100 stations per survey), as described by Inejih (2000). The sampling strategy on each cruise followed a stratified-random design and a standard protocol (standardized high-opening bottom trawl, fixed haul duration and speed, etc.; Jouffre, 1998; Inejih, 2000). Most organisms were identified to species level, but of the 50 most frequently observed taxa, six were assigned a higher taxonomic level: *Arnoglossus* spp., *Dentex* spp., Ommastrephidae, *Merluccius* spp., *Microchirus* spp., *Uranoscopus* spp. The effect of this inconsistency on the results was taken into account using a sensitivity analysis.

Community structure was investigated using ABC plots, computed with Primer software (Clarke and Warwick, 1994). This method provides a diagnosis of the ecological state of the community investigated along a continuum from unstressed to grossly stressed. The diagnosis depends on the value of the w-statistic, based on the relative position of the two K-dominance curves (Lambshead *et al.*, 1983) for biomass and abundance, respectively (Clarke and Warwick, 1994; Yemane *et al.*, this issue). The primary analysis was based on all available information, i.e. using

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all taxa recorded, as suggested by Jouffre *et al.* (2004). However, because not all taxa were identified to species level, a sensitivity analysis for the effect of the non-exhaustive species identifications included the following approaches: (i) elimination of higher taxa; (ii) selection of the 50 most abundant species (excluding rare species); (iii) grouping all taxa by genus (to improve taxonomic homogeneity); (iv) grouping all taxa by family (to achieve taxonomic homogeneity).

Results

The average composition of the demersal assemblages is presented in Table 1, with species ranked according to their frequency of occurrence in the catches (the 50 most frequently observed taxa only). *Octopus vulgaris* was caught most often, and *Pagellus bellottii* (a coastal species belonging to the Sparidae) was the most abundant species. The 15 most frequently observed species are all exploited commercially.

According to the theory, and based on the w-statistic (Figure 1), the diagnosis for the community is that it is "grossly stressed" or "moderately stressed", with little variation among years. This suggests no significant change in the state of the Mauritanian demersal community throughout the study period.

The results of alternative approaches, in terms of temporal trends in the w-statistic, are summarized in Figure 2. Although the level of the w-statistic depends on the level of identification and the selection made, all values were negative, and there is no trend over time. Therefore, the method seems not to be affected by a partial lack of identification to the species level (at least not in a proportion that is not uncommon in scientific surveys).

Discussion

The two main conclusions are that the Mauritanian continental shelf demersal fish assemblage is at least "moderately stressed", and that there is no indication of a significant temporal trend in the stress level observed over time. Both conclusions are consistent with the development of fishing intensity in recent decades (Jouffre, 1998; Inejih, 2000). They also broadly agree with recent assessments of the resources, even if those have generally been made on a single-species basis (Chavance *et al.*, in press).

The lack of evidence of increasing community stress during the period of study suggests some resilience of the ecosystem against continued exploitation. Other studies on Senegalese (Jouffre *et al.*, 2004; Domalain *et al.*, in press) and Guinean (Lobry *et al.*, 2003; Domalain *et al.*, in press) fish assemblages also concluded that these related ecosystems were resilient. In a study on a regional scale from Mauritania to Guinea, Jouffre *et al.* (in press) suggested that fishing impacts on the multispecies composition of the

Table 1. List of the 50 most common species (ranked by decreasing frequency of occurrence in the samples out of a total of 214 taxa reported), with their percentage abundance in terms of biomass (%B) and numbers (%n), averaged over the period 1987–1999.

Rank	Scientific name	%B	%n
1	*Octopus vulgaris*	4.0	0.3
2	*Pagellus bellottii*	6.4	4.7
3	*Trachurus trecae*	4.3	4.6
4	*Zeus faber*	1.5	0.4
5	*Sepia officinalis*	1.2	0.2
6	*Raja miraletus*	2.1	0.3
7	*Citharus linguatula*	2.1	4.2
8	*Pseudupeneus prayensis*	1.6	1.1
9	*Decapterus rhonchus*	1.7	1.3
10	*Loligo vulgaris*	0.5	0.4
11	*Dentex canariensis*	0.8	0.3
12	*Penaeus notialis*	0.1	0.5
13	*Torpedo torpedo*	0.4	0.1
14	*Scorpaena stephanica*	0.5	0.4
15	*Syacium micrurum*	0.3	0.3
16	*Chelidonichthys gabonensis*	0.5	0.5
17	*Halobatrachus didactylus*	0.8	0.3
18	*Sepia bertheloti*	0.1	0.1
19	*Sparus caeruleostictus*	2.3	0.4
20	*Pomadasys incisus*	3.8	2.1
21	*Microchirus theophila*	0.3	0.2
22	*Epinephelus aeneus*	1.2	0.1
23	*Dentex macrophthalmus*	2.1	2.6
24	*Plectorhyncus mediterraneus*	4.2	0.8
25	*Umbrina canariensis*	2.2	0.8
26	*Brotula barbata*	1.1	0.2
27	*Trachurus trachurus*	1.1	0.8
28	*Solea senegalensis*	0.3	0.1
29	*Trichiurus lepturus*	0.4	0.2
30	*Grammoplites gruveli*	0.2	0.2
31	*Brachydeuterus auritus*	3.1	3.9
32	*Raja straeleni*	0.6	0.0
33	*Sphoeroides spengleri*	0.0	0.1
34	*Serranus cabrilla*	0.3	0.2
35	*Dicologoglossa cuneata*	0.1	0.1
36	*Boops boops*	0.4	0.5
37	*Pterothrissus belloci*	1.0	1.0
38	*Scorpaena normani*	0.3	0.5
39	*Spondyliosoma cantharus*	0.2	0.2
40	*Diplodus bellottii*	4.7	6.6
41	*Branchiostegus semifasciatus*	0.5	0.2
42	*Monolene microstoma*	0.1	0.2
43	*Bothus podas*	0.0	0.1
44	*Mustelus mustelus*	1.5	0.1
45	*Zanobatus schoenleinii*	0.9	0.1
46	*Trachinus draco*	0.1	0.1
47	*Argyrosomus regius*	0.5	0.1
48	*Epinephelus alexandrinus*	0.2	0.0
49	*Sardinella aurita*	0.1	0.2
50	*Penaeus kerathurus*	0.0	0.1

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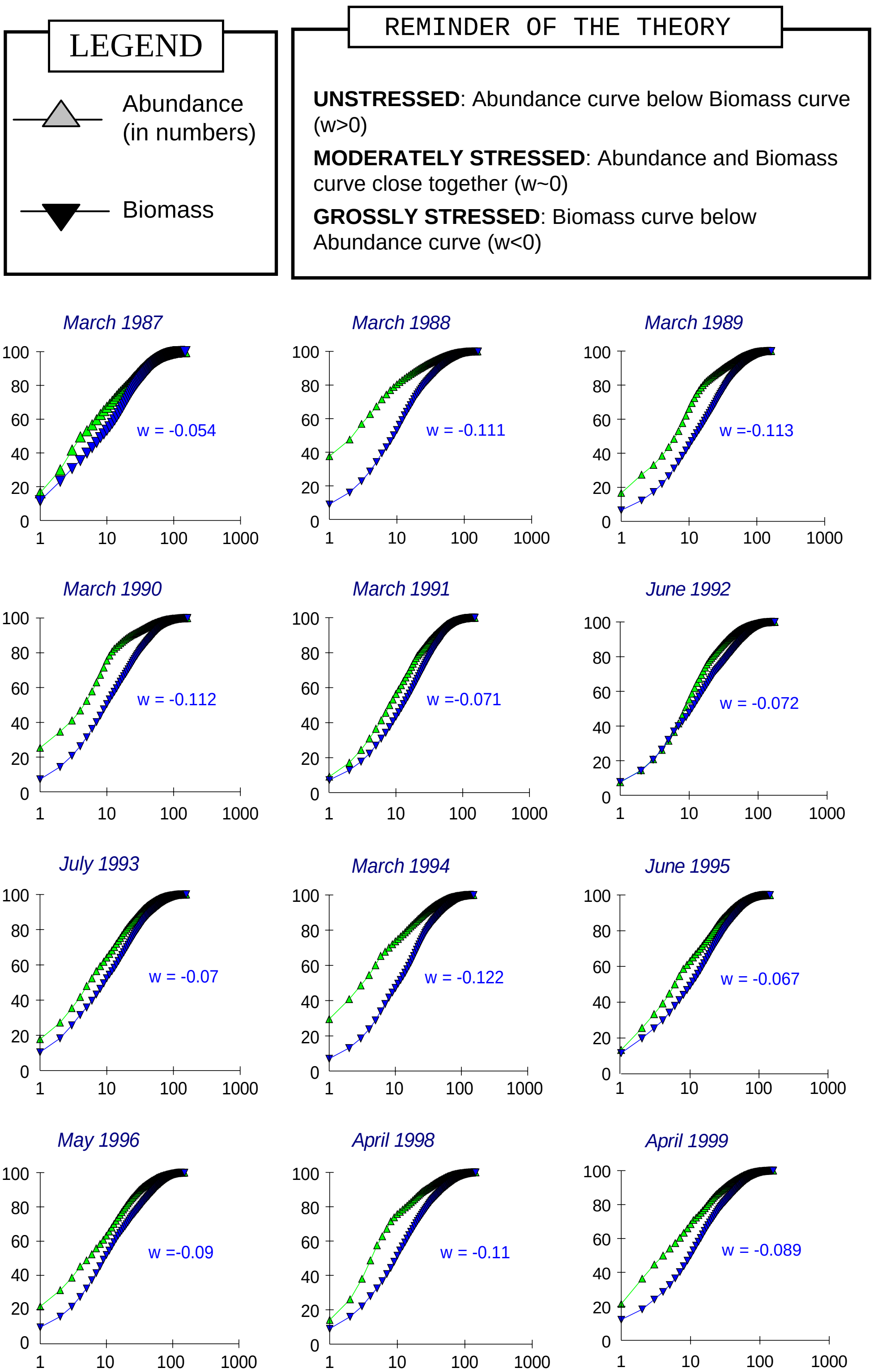

Figure 1. ABC plot for 12 surveys made on the shelf of Mauritania (1987–1999), based on all taxa recorded.

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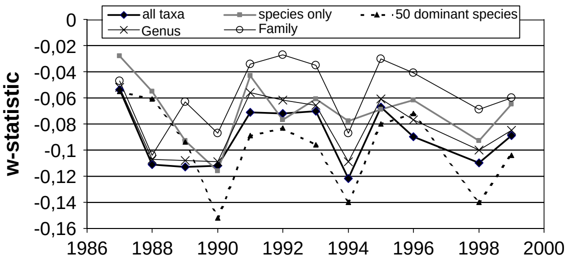

Figure 2. Comparison of temporal trends in the w-statistic for all taxa recorded, the 50 most abundant taxa, species only, taxa grouped by genus, and taxa grouped by family.

demersal assemblages are most perceptible during the early phases of exploitation.

Another result is the apparently high interannual variability in ABC plots. The variability observed is similar to that of other fish communities (Yemane *et al.*, 2005), but lower than that of macrobenthic communities subjected to organic enrichment (Pearson, 1975). In the present case, variations may be largely attributable to variation in year-class strength of the abundant species, causing discrepancies between their numerical abundance and their biomass. The rapid changes in species dominance between years may be interpreted as a community response to fishing pressure (Jouffre *et al.*, in press).

The observed temporal variability in the ABC plots should be linked to the more general question of their calibration against stress. The sensitivity analysis addresses one aspect of this question. The results show that the absolute value of the w-statistic depends on the taxonomic level (species, genus, and family), and therefore cannot be used sensibly as an absolute measure of stress. However, a more thorough calibration of the method is required to refine the operational diagnosis of the ecological state of the fish assemblages. As yet, it remains difficult to conclude which range of negative values of the w-statistic corresponds to an acceptable exploitation impact or to an unacceptable overexploitation. This situation may be partly due to the limited number of comparable studies, but also to the complexity of the question. In our opinion, progress on calibration may be aided by performing an analysis of time-series data that encompasses the whole range of ecological states (i.e. virgin state to overexploited), and by performing cross-comparisons among similar assemblages from different areas subject to different levels of stress. The latter should allow assessment of the influence of possible geographical differences in response to fishing stress, and also estimation of potential natural differences in the w-statistic among systems.

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