Short Communication

Change and stability in landings: the responses of fisheries to scientific advice and TACs[1]

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Stability in total allowable catch (TAC) and landings is a principal demand from the fishing sector, and sufficient experience has now been gained in applying the Common Fisheries Policy in European Atlantic waters to allow an initial review of the stability in landings across stocks. Available information is compared across a large number of stocks to determine the relative influence of scientific advice on relative changes in landings, on the decision-making process, and on resulting rates of fishing mortality. The approach differs from the conventional model approaches based on population dynamics, but allows conclusions to be drawn based on recent experience in management. The conclusion is that the most important factor enhancing long-term stability is a low rate of fishing mortality, but that following scientific advice on a year-to-year basis would decrease stability. Unless TACs varied considerably, they did not appear to affect variations in landings significantly.

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Introduction

Policy demands from stakeholders in fisheries do not align very well with the traditional benefits that might be achieved from classical science-based management. Whereas traditional management can offer bigger landings, lower costs, lesser risks of collapse, more valuable landings, and lower discard rates, stakeholders have a different set of priorities, foremost of which is typically the maintenance of employment. Allied to this is a desire to maintain stability in landings as a proxy for stable profits. Large variations in landings may be undesirable, because both increases and decreases can disrupt market chains and result eventually in less profitability (Patterson, in press).

The traditional approach to evaluating stability is by stochastic population modelling, making specific assumptions about the implementation of management measures. In contrast, we take a simple empirical approach based on experience in the ICES Area and concentrating on stocks of interest to the European Community. A number of simple questions about stability are developed from first principles. ICES data on landings are used together with data on historical total allowable catches (TACs) and previous ICES advice to examine recent outcomes in the light of the following:

(i) Question 1: Do decision-making processes improve stability of the situation when only scientific advice is followed? Fisheries ministers are often reluctant to reduce TACs to the extent recommended in scientific advice, *inter alia* owing to other policy inputs from the fishing sector. On average, agreed TACs are some 30% higher than recommended catch options (Hammer and Zimmermann, in press). If stability were a policy objective, one might expect that interannual changes in agreed TACs would be smaller than in recommended catch options.

(ii) Question 2: Are commercial landings more stable than TACs? Fishing industries are constrained by the capacity of their fleets (the effort they can deploy does not change rapidly) and by the capacity of their markets to absorb the products landed at a reasonable price. There may be good reasons for the industry to adapt production to market demands and to catching capacity. TAC limitations may have only a minor or secondary effect.

(iii) Question 3: Does variability in landings increase if scientific advice is followed? Quantitative stock assessments, and especially stock projections, are surrounded by considerable uncertainty caused by observation and process errors in recruitment and to stochastic processes associated principally with collecting survey data. This uncertainty might well lead to unnecessary and unwanted variability in landings.

[1]The views expressed are those of the authors. This paper does not express a position of the European Commission.

Table 1. Synopsis of stock data used in the analysis. Note that forecasts of catch that would be discarded or taken as bycatches in industrial fisheries were excluded from the analysis.

Stock	Latin name	Year range	Range in interannual % change (max/min)			
			F range	Recommended landings	ACFM landings	TAC
Cod, Kattegat	*Gadus morhua*	1988–2005	0.96–1.64	+15/−100	+56/−52	+11/−55
Plaice IIIa	*Pleuronectes platessa*	1999–2003	0.67–1.47	+116/−20	+33/−26	+68/−38
Sole IIIa	*Solea vulgaris*	1990–2005	0.43–0.61	+70/−40	+82/−28	+100/−30
Saithe III IV	*Pollachius virens*	1988–2005	0.20–0.71	+55/−35	+30/−28	+55/−29
Cod in Baltic (both stocks)	*G. morhua*	1990–2005	0.83–1.59	+48/−59	+13/−27	+0/−28
Herring IIIa + WB	*Clupea harengus*	1992–2005	0.39–0.56	+15/−50	+32/−21	+32/−39
Herring 25–29, 32, GoR	*C. harengus*	1992–2005	0.15–0.46	+62/−37	+62/−37	+0/−24
Sprat in Baltic Sea	*Sprattus sprattus*	1990–2005	0.12–0.44	+108/−37	+108/−37	+78/−18
Cod in North Sea and Skagerrak	*G. morhua*	1988–2001	0.88–1.27	+18/−100	+20/−36	+22/−4
Haddock in North Sea and Skagerrak	*Melanogrammus aeglefinus*	1988–2003	0.24–1.16	+76/−100	+19/−31	+70/−63
Whiting, North Sea	*Merlangius merlangus*	1999–2002	NA	−100/+100	+8/−21	+6/−31
Plaice, North Sea	*P. platessa*	1988–2005	0.48–0.87	+100/−100	+12/−16	+17/−30
Sole, North Sea	*S. vulgaris*	1988–2005	0.36–0.70	+78/−36	+61/−33	+78/−21
Herring, North Sea ("A" fleet)	*C. harengus*	1988–2005	0.23–0.74	+60/−63	+60/−64	+60/−65
Megrims VI	*Lepidorhombus* spp.	2000–2005	NA	0/−17	0/−30	0/−20
Cod VI	*G. morhua*	1988–2000	NA	+2/−56	+7/−29	+7/−36
Haddock VIa	*M. aeglefinus*	1988–2002	0.52–0.90	+25/−40	0/−39	+9/−31
Whiting VIa	*Merlangius merlangus*	1988–2001	NA	0/−33	0/−35	0/−33
Herring VIa(S)	*C. harengus*	1988–2005	0.18–1.10	+80/−26	+48/−42	+42/−33
Herring VIa(N)	*C. harengus*	1988–2005	0.18–0.41	+36/−52	+32/−36	+29/−38
Cod VIIa	*G. morhua*	1988–2002	0.96–1.56	+66/−100	+65/−54	+52/−62
Haddock VIIa	*M. aeglefinus*	1999–2002	1.14–1.30	+133/−39	+74/−65	−20/−75
Whiting VIIa	*Merlangius merlangus*	1988–2002	0.78–1.58	+51/−100	+18/−53	+12/−47
Plaice VIIa	*P. platessa*	1988–2005	0.09–0.76	+86/−35	+27/−39	+20/−30
Sole VIIa	*S. vulgaris*	1988–2005	0.20–0.51	+64/−47	+40/−30	+50/−26
Herring VIIa	*C. harengus*	1988–2005	0.12–0.59	+144/−48	+175/−56	+133/−43
Haddock VIIb-k	*M. aeglefinus*	2000[a]	NA	−10	+24	−12
Sole VIIIab	*S. vulgaris*	1989–2005	0.35–0.78	+145/−78	+18/−25	+20/−36
Megrims VII	*Lepidorhombus* spp.	1997–2005	NA	+25/−14	+9/−11	+26/−20
Plaice VIId	*P. platessa*	1988–2005	NA	+70/−22	+24/−22	+30/−15
Plaice VIIe	*P. platessa*	1988–2005	0.43–0.80	+120/−77	+30/−29	+30/−20
Cod VIIe-k	*G. morhua*	1994–2005	0.76–1.05	+642/−82	+18/−43	+17/−34
Plaice VIIfg	*P. platessa*	1991–2005	0.35–0.72	+19/−68	+28/−28	0/−21
Herring Celtic Sea and VIIj	*C. harengus*	1988–2005	0.27–0.94	+155/−38	+23/−41	+20/−45
Anglerfish VIIIc IXa	*Lophius* spp.	2000–2005	0.10–0.27	+75/−100	+78/−32	−11/−42
Megrims VIIIc IXa	*Lepidorhombus* spp.	1999–2005	0.16–0.28	+50/−21	+20/−24	0/−44
Hake VIIIc IXa	*Merluccius merluccius*	1988–2005	0.40–0.78	+137/−100	+22/−17	+9/−25
Hake, Northern	*Merluccius merluccius*	1989–2005	0.24–0.41	+139/−100	+8/−18	+11/−46
Mackerel, Northeast Atlantic	*Scomber scombrus*	1988–2005	0.17–0.42	+47/−36	+38/−23	+38/−23

[a]Single pair of data-years available.
NA Not available.

(iv) Question 4: Are landings more stable when fishing mortality is low? Population dynamics predict that low fishing mortality generates a large reserve of fish and smoothes out fluctuations caused by high or low recruitment, whereas high fishing mortality results in a smaller stock and a greater dependence on recruitment. Whether evidence for these effects can be found in empirical information remains to be seen.

Methods

These four questions are addressed primarily by visual examination of scatterplots of the corresponding variables. Data for

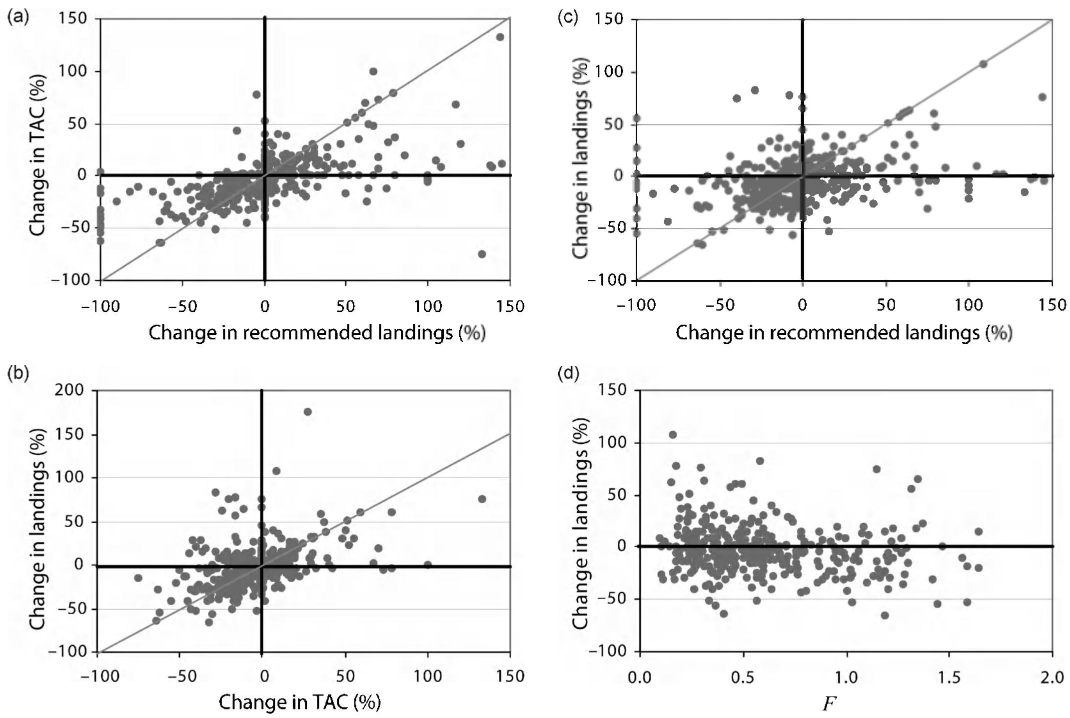

Figure 1. Relationship between interannual percentage changes (value in year t divided by value in year $t-1$) in (a) agreed TAC and recommended landings by ICES (-100% means closure of a fishery), (b) ACFM landings and agreed TAC, (c) ACFM landings and recommended landings, and (d) ACFM landings and the absolute value of fishing mortality rate (F). See also note to Table 1.

the period 1987–2005 have been extracted from ICES (2006) for pelagic and demersal stocks in ICES Areas III, IV, V, VI, VII, and VIII that are of principal interest to the European Community, but excluding atypical species (the short-lived species anchovy and sandeel, and long-lived deep-sea species). Also, shellfish were not included in our analysis.

Data retrieved include Advisory Committee on Fishery Management (ACFM) estimates of landings, recommended landings (forecasts of catch that would be discarded or taken as bycatches in industrial fisheries were excluded from the analysis), agreed TACs, and fishing mortality rate (F). A first-order difference was calculated as the percentage interannual change in each parameter except F. Records for which one of the three first-order differences could not be calculated were excluded from the analysis. If an estimate of F was not available, this parameter was treated as missing, but otherwise the record was retained. This left 436 records for analysis (summarized in Table 1). Where quantitative mixed-fisheries considerations have been included explicitly in stock-specific advice, this was treated as the recommended catch option, otherwise such considerations were not taken account of. Results are presented as pairwise scatterplots.

For presentational purposes, when a non-zero catch and landing was advised in a year after a recommendation for a zero catch, this was treated as a missing value. A single case where the recommended catch increased by >600% (for cod in the Celtic Sea) is also treated as an outlier and does not appear on the scatterplots.

Results

Management decisions have been moderately responsive to the ICES advice in setting TACs, at least in terms of the direction of change, if not in absolute levels (Figure 1a). Advice to close a fishery has never been followed in this data set, although TACs were reduced by up to 65% in some cases. However, if the advice corresponded to a decrease in landings relative to the advice for the previous year, there were relatively few cases where managers decided to increase the actual TAC (a few points in the upper left quadrant). TACs were rarely reduced by more than 60%. Changes in TACs were generally smaller than interannual changes in the advice, even if the latter were positive.

Overall, the average magnitude (irrespective of direction) of the change in scientific advice from one year to the next was 27% (median 16%), and the average change in adopted TAC was 15% (median 12%). This broadly supports the view that TACs are more stable than the corresponding ICES advice, and that the direction of change is generally respected.

The relationship between annual changes in ACFM estimates of landings and changes in TAC is weak (Figure 1b). A cluster of points within ~20–25% of the origin of the scatterplot suggests that, generally within this range, a change in TAC does not affect the variation in landings. Farther from the origin, a clearer pattern suggesting that a TAC change of >30–40% is likely to be accompanied by a change in landings in the same direction. Overall, variations in TAC do not seem to constrain annual variations in landings to any great extent.

Figure 1c shows an extremely weak relationship (if any) between recommended landings and subsequent estimates of landings for the corresponding year (the "actual" landings). Although the average absolute change in recommended landings is 27% (median 16%), the average absolute change in actual landings is 17% (median 12%). The variability in actual landings is of the same order as the variability in TACs, although the changes may not be related directly to changes in TACs. Overall, it seems

Table 2. Summary of average (AACL) and median (MACL) annual changes in landings by *F* category.

F	Number of records	AACL (%)	AACL (absolute) (%)	MACL (%)	MACL (absolute) (%)
0.2	25	17	27	0	20
0.2 – 0.3	53	3	15	0	12
0.3 – 0.4	58	−3	18	−4	14
0.4 – 0.5	50	0	15	−3	10
0.5 – 0.6	61	−3	15	−5	11
0.6 – 0.7	32	−4	12	−4	10
0.7 – 0.8	22	−5	15	−6	15
0.8 – 0.9	14	−14	18	−13	14
0.9 – 1.0	16	−8	13	−8	10
1.0 – 1.1	13	−15	20	−13	14
1.1 – 1.2	14	−15	30	−23	26
> 1.2	25	−3	22	−4	18

that the implementation of fisheries advice, in terms of annual adjustments of landings, is extremely weak. This happens mostly from a lack of correspondence between changes in annual landings and changes in TACs.

Figure 1d may suggest a generally declining trend in landings with increasing *F*. However, this is difficult to interpret because the distribution appears heteroscedastic and the amplitude of changes in landings is larger at higher *F*. To investigate this pattern further, data were tabulated by increments in *F*, and some simple diagnostics were calculated (Table 2). Indeed, the median absolute interannual change in landings has been larger at higher *F*, but only for values above about 0.7. Also, both average and median annual changes become persistently more negative at higher *F*.

There are anomalous results at both the highest and the lowest *F*, where these trends seem to be reversed. The reasons for this are unknown, but they may be linked to the inclusion of some stocks where catch misreporting is a serious problem at both the lower and higher mortality ranges.

Conclusions

At least in the short term, commercial landings are substantially more stable than the landings corresponding to ICES advice. This means that if TACs were set more closely in accordance with scientific advice, and if those TACs were respected, the short-term stability of the landings would be less.

The variability in TACs is substantially less than the variability in the advice, although TACs are generally adapted in the same direction as the advice. This suggests a tendency by managers to follow the direction of scientific advice, but to limit interannual variations. Short-term changes in TACs less than ~25% are not reflected in short-term changes in landings. Large changes in TACs appear, however, to affect landings.

Lower short-term stability in landings occurs when *F* is more than ~0.7 (±). Within the range of $F < 0.7$, there is little noticeable improvement in short-term annual TAC stability at lower *F*. However, landings only show long-term stability and sustainability at *F* less than ~0.3, where there are no negative average or median annual changes in landings.

There is little apparent correlation between the level of landings advised by ICES and the subsequent level of landings estimated by ICES. This suggests that, at least on a year-to-year basis, the ICES advice is not implemented. This lack of implementation of the annual advice seems to have been mostly attributable to the TACs not being an instrument that restricts landings. Unless very large changes in TACs are made (>25%), changes in TAC appear to have had little effect on changes in landings.

References

Patterson, K. R. Social resistance to the obvious good. A review of responses to a proposal for regulation of European Fisheries. *In* Proceedings of the Fourth World Fisheries Congress, 1–6 May 2004, Vancouver. American Fisheries Society Symposium (in press).

Hammer, C., and Zimmermann, C. European attempts to reconcile fisheries, science and management. *In* Proceedings of the Fourth World Fisheries Congress, 1–6 May 2004, Vancouver. American Fisheries Society Symposium (in press).

ICES. 2006. Report of the ICES Advisory Committee on Fishery Management, Advisory Committee on the Marine Environment and Advisory Committee on Ecosystems, 2006. ICES Advice, 1–10.

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