

Sustainability Ranking of North Atlantic Fisheries

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Abstract

This paper describes a scaling method employed to aggregate three independent rankings of the sustainability of fisheries from eleven countries in the North Atlantic. These fisheries were first scored and ranked using three measures, (a) *Rapfish* assessment of sustainability, (b) compliance of fisheries with the FAO Code of Conduct, and (c) compliance of nations with the international fisheries agreements. These rankings were then tested for significant correlations and the aggregation of scores were performed accordingly. The ranking of sustainability based on the aggregated scores, while allowing the comparison of different fisheries through the same unit, serves as an additional perspective for a thorough discussion on the sustainability issues of North Atlantic fisheries.

Introduction

The question “how sustainable are North Atlantic fisheries?” is one important aspect of the Sea Around Us Project (SAUP). The answer, however, is not a simple one since sustainability has many definitions and can be measured in various ways, for example, ecologically, socially and economically. There is also no single measure or approach to assessing sustainability and therefore a range of measures is used depending on the nature of the ecosystem and the management objectives. In the SAUP, four approaches to assessing sustainability have been used. One is the direct valuation of the state of the resource, as in Christensen et al. (2001). The other three are indirect approaches, i.e. *Rapfish*, the FAO Code of Conduct, and International Instrument, which measure different aspects of sustainability. As there is currently no single measure reflecting the overall level of sustainability for North Atlantic fisheries, we develop a method to aggregate the scores obtained from the three indirect approaches into a single measure of relative sustainability of fisheries at the national scale. This paper focuses on the description of the aggregating method using fisheries from eleven countries in the North Atlantic as an illustration, and provides a discussion on the use of this information in policy design. Similar to the Brundtland Commission and Agenda 21 (United Nations, 1994), the three ap-

proaches employed in this study use environmental, economic, social and institutional criteria to measure sustainability. *Rapfish* is a rapid appraisal technique for evaluating the sustainable of fisheries, using attributes related to ecological, economic, technical, social and ethical considerations (Pitcher & Preikshot 2001; Pitcher 1999; Pitcher et al. 1998). The FAO Code of Conduct addresses the responsibility for the practices of fisheries. The International Instrument focus on compliance on fifteen articles, including the Convention on Biological Diversity, the Common Fisheries Policy, and the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (see complete listing in Alder et al., this volume).

The first step in the analysis is to standardise the scores obtained from the three measures such that they are comparable. As the *Rapfish* and the FAO Code of Conduct scores are reported on the scale of zero to 100, we use a simple proportional procedure (Dunn-Rankin, 1983) to normalise the International Instrument scores, also to the scale of zero to 100, where 0 indicates relatively low sustainability and 100 indicates relatively high sustainability. Next, we develop an independent ranking of sustainability based on these scores and use the nonparametric statistics to test the agreements of these rankings. Finally, we aggregate the scales, based on this analysis, to present an overall ranking of the eleven North Atlantic countries. This aggregation facilitates an interpretation of the ranking results, such that they become useful information to fishery managers, policy makers and the general public.

It should be noted that the resulting analysis is based on preliminary unadjusted scores and is only indicative of the relative sustainability. These results may change as *Rapfish* and FAO Code of Conduct scores are finalised for different fisheries and International Instrument scores (e.g. Iceland has just returned to the International Whaling Commission) are revised.

Sustainability Measures

Rapfish

Rapfish uses multidimensional scaling, an ordination method, to appraise the relative sustainability of fisheries (Pitcher et al. 1998; Pitcher and Preikshot 2000). *Rapfish* relies on a scoring of a number of easy-to-score attributes in five dimensions, i.e., ecological, economic, social, technological and ethical. Attributes in each dimension are chosen and defined to reflect the notion

of sustainability (Pitcher and Preikshot 2000). All criteria may be refined or substituted as improved information arises. Two hypothetical reference entities, which are scored at the extreme lower end (minimum scores for all attributes, 0%) and extreme upper end (maximum score for all attributes, 100%) for all evaluation fields also provide reference points for comparing the sustainability scores. Separate ordinations are performed on each set of sustainability attributes (evaluation fields) and the results expressing the relative sustainability in each of the fields are reported on a scale from zero to 100%.

FAO Code of Conduct Compliance

Compliance with the FAO Code of Conduct uses the multidimensional scaling approach employed in Rapfish. In this case, six different sets of attributes articulate the clauses in the Code are used (Pitcher, 1999). These evaluation fields reflect national management intentions and management practices for each fishery that is assessed. Two hypothetical reference entities are also used as reference points for comparing compliance on a scale from zero to 100%.

International Instrument Compliance

A specific set of criteria based on the provisions or work program of each instrument is used and is described in this volume (Alder et al., this volume). The assessment criteria focused on measuring either qualitatively or quantitatively the level of compliance with the fisheries management provisions contained within an instrument. Generally criterion scores ranged from 0 (low compliance) and 3 (high compliance) and the total criteria were limited to approximately six per instrument. Only those countries where the instrument applied were assessed, irrespective of whether they were party to the instrument or not. Published reports, scientific papers and telephone contact with staff from the various secretariats of the conventions, as well as stock assessments from ICES were used to obtain scoring information

The North Atlantic Case Study

This analysis includes eleven fishing nations in North Atlantic, each was scored three times, using Rapfish (RAP), FAO Code of Conduct (FAO) and International Instrument (II) as criteria. Table 1 shows the scores and the assigned ranking of '1' for the country with highest score and '11' for that with the smallest score. Independent ranking of these fisheries based on each criterion, while informative on its own, does not allow direct com-

parisons within nations in terms of the overall sustainability. For example, Greenland has the highest score when evaluated using Rapfish, but is ranked fourth on FAO score and second on AGR score (figure 1). Germany, on the other hand, is ranked first on the FAO score, but seventh on RAP and AGR. Although it might be possible to conclude at this point that Greenland is doing better on the measure of sustainability than Germany, further analysis of these rankings based on various methods of aggregations will provide additional support for such statement.

Aggregation of rankings

Nonparametric tests, such as rank correlation analysis, are generally performed to determine if the two sets of rankings are related. In this paper, we employ the Kendall rank-order correlation coefficient (T), which is a measure of correlation between two variables that are measured on at least an ordinal scale (Siegel and Castellan, 1988). The coefficient T determines the degree of correspondence between the two sets of rankings, such that T would equal +1 for perfect agreement and -1 for perfect disagreement. Increasing values from -1 to 1 thus correspond to increasing agreement between the two sets of ranks (Kendall and Gibbons, 1990). Test of significance of the value of rank correlation indicates if the two sets of ranks are unrelated. When the null hypothesis is rejected, it can be concluded that the two ranks are related at a certain level of significance.

The first step in our analysis involves the rank correlation test of the three rankings, RAP, FAO and II. The result indicates that these three rankings are not significantly correlated. This is not surprising as the distribution of the nations along the sustainability scale is rather different in each sustainability measure (Figure 1). With an exception of the Faroe Islands, the top three countries on the sustainability scale vary from one criterion

Table 1. Scores and rankings of fishing nations, based on Rapfish (RAP), FAO Code of Conduct (FAO) and International Instrument (II) criteria.

Country	RAP	FAO	II
Greenland	60.8 (1)	51.1 (4)	73.5 (2)
Faroe Is.	60.3 (2)	55.7 (2)	77.0 (1)
Norway	57.9 (3)	44.5 (6)	69.3 (4)
Iceland	56.1 (4)	53.4 (3)	54.6 (10)
USA	52.1 (5)	50.7 (5)	55.3 (9)
UK	50.5 (6)	31.8 (11)	61.1 (6)
Germany	45.2 (7)	57.5 (1)	58.3 (7)
Denmark	45.2 (7)	38.9 (8)	69.4 (3)
Spain	45.1 (9)	38.1 (9)	52.9 (11)
Canada	41.4 (10)	41.3 (7)	63.8 (5)
Netherlands	34.1 (11)	36.7 (10)	57.8 (8)

to the next. The scores on the RAP scale and on the FAO scale cover both below and above 50% point (i.e. from 34 to 61 on RAP scale and from 32 to 58 on FAO scale). On the contrary, all scores on the II scale are above 50%, i.e., from 53 to 77. It should be noted, however, that in all three cases, the range of the scores is comparable with the smallest range of 24.1 on II scale and 26.7 on the RAP scale.

We next examine the possibility of combining the scores between any two sets of criteria. Based on the rank correlation coefficients in Table 2, the correlation between RAP and FAO is highest ($T = 0.404$), followed by that of RAP and II ($T = 0.330$), while the correlation coefficient between FAO and II is 0.164. This suggests that RAP scores may share common characteristics with the other two scores. It is thus not surprising that we find a significant correlation at $P = 0.05$ between the combined score of FAO and II; and RAP. No significant correlation is found between any other combinations of scores (Table 2).

Based on the above analysis, we combine the FAO score and the II score to a single scale using simple averages. We then compare this combined scale (FAO-II) with the RAP scale, as in Figure 2. Here we find that we can roughly separate the eleven countries analysed into two groups of a high-level sustainability (greater than 50%) and a low-level sustainability (less than 50%). Those always on the high end are Greenland, the Faroe Islands, Norway, Iceland, and USA, and those always on the low end include Spain and the Netherlands. On the *Rapfish* scale, however, Germany, Denmark and Canada fall below the medium score of 50, while the score for UK & Wales is higher at 51. The reverse is found in the FAO-II scale where Germany, Denmark and Canada are ranked higher on the scale (all above 50), while the UK score is below 50.

As the correlation between RAP and COMBINE FAO-II rankings is significant, we are able to combine these two scales into one scale illustrating the distribution of countries according to their sustainability rankings. As seen in figure 3, the Faroe Islands and Greenland remain on the top of the scale, while the Netherlands is lowest on the scale. Of those in the medium level, we have one group with scores above 50%, including Norway, Iceland, USA and Germany. The other countries, namely Denmark, UK & Wales, Canada, and Spain, fall slightly below the 50% point, although their scores are in the medium range.

Table 2. Correlation Tables, Kendall T correlation coefficient ($n = 11$).

1) Rank correlation of individual criteria

	RAP	FAO	II
RAP	1		
FAO	0.404	1	
II	0.330	0.164	1

2) Rank correlation of RAP with the average of FAO and II

	RAP	FAO-II
RAP	1	
FAO-II	0.550*	1

3) Rank correlation of FAO with the average of RAP and II

	FAO	RAP-II
FAO	1	
RAP-II	0.309	1

4) Rank correlation of II with the average of RAP and FAO

	II	RAP-FAO
II	1	
RAP-FAO	0.257	1

* Correlation is significant at $p = 0.05$

Discussion

As stated above, while the range of sustainability scores measured using the three sets of criteria is approximately the same, the distribution of the scores, however, is rather different. In using the scaling method, we normally expect the distribution of the scores to follow the pattern observed on the RAP and FAO scales, i.e. some countries are scored above the 50% point and some below. When all or most scores are either above or below the mid-point, it prompts us to examine the scoring method and its validity. In the case of II scores, where all countries score higher than 50, we note that the scores are obtained from applying fifteen international agreements to the fisheries, but not all countries are evaluated for each agreement.

While on average, about seven out of eleven countries are scored under each agreement; the number of countries considered can be as low as two (as in the Fishing Cooperative Agreement), three (as in the Capelin and Herring Agreements) and four (as in the Northeast Atlantic Fisheries Commission). Further, the number of criteria applied for each agreement varies from two to six. It is thus possible that either the number of countries involved or the number of criteria used influenced the final II scores. Rapfish and FAO scores are less subjected to this problem because of its total of 47 and 44 criteria respectively, and because all countries were evenly assessed. In any case, as the II scores are consistently high for all countries considered, their contributions to the final aggregated scores are evenly distributed.

On its own, the three independent scales are not significantly correlated. Thus, the direct aggrega-

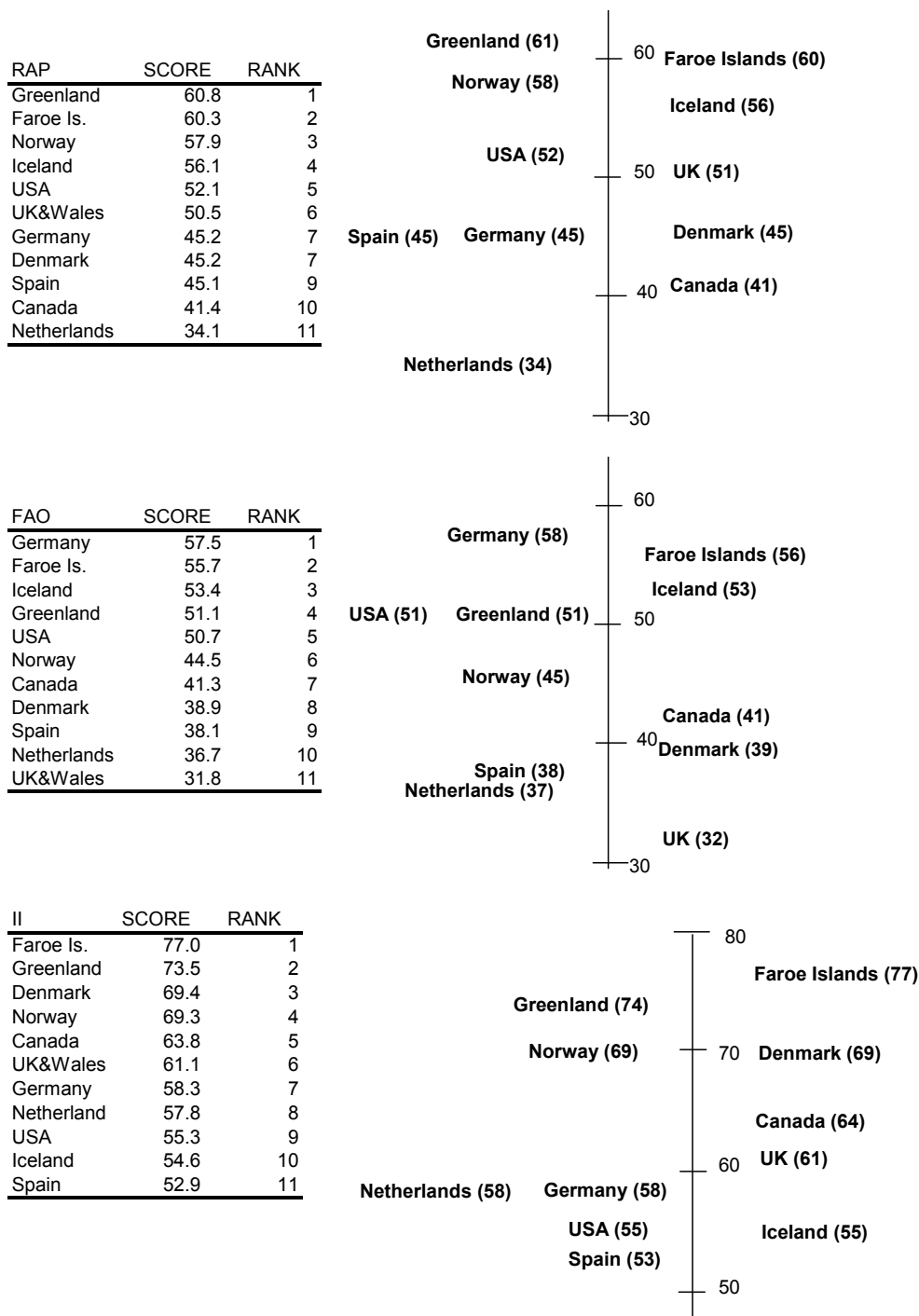


Figure 1 Ranking of fisheries sustainability based on (a) Rappfish; (b) FAO Code of Conduct and (c) International Instrument (II) criteria.

tion of scores is not warranted. Further scrutiny of these scores, however, suggests that it is possible to combine some of them, which then result in significant correlations as seen in the above analysis. The aggregated scores described here are different from the direct average of the three sets of scores, which we cannot do prior to the rank correlation analysis. The single aggregated scale and ranking of sustainability, as in Figure 3,

allows the interpretation of the results to be more informative for policy makers. Yet, careful considerations of other factors that might contribute to the rankings, particularly those associated with individual scoring system, must be taken into account.

The sustainability scores for all three measures as well as the aggregated measure place a number of

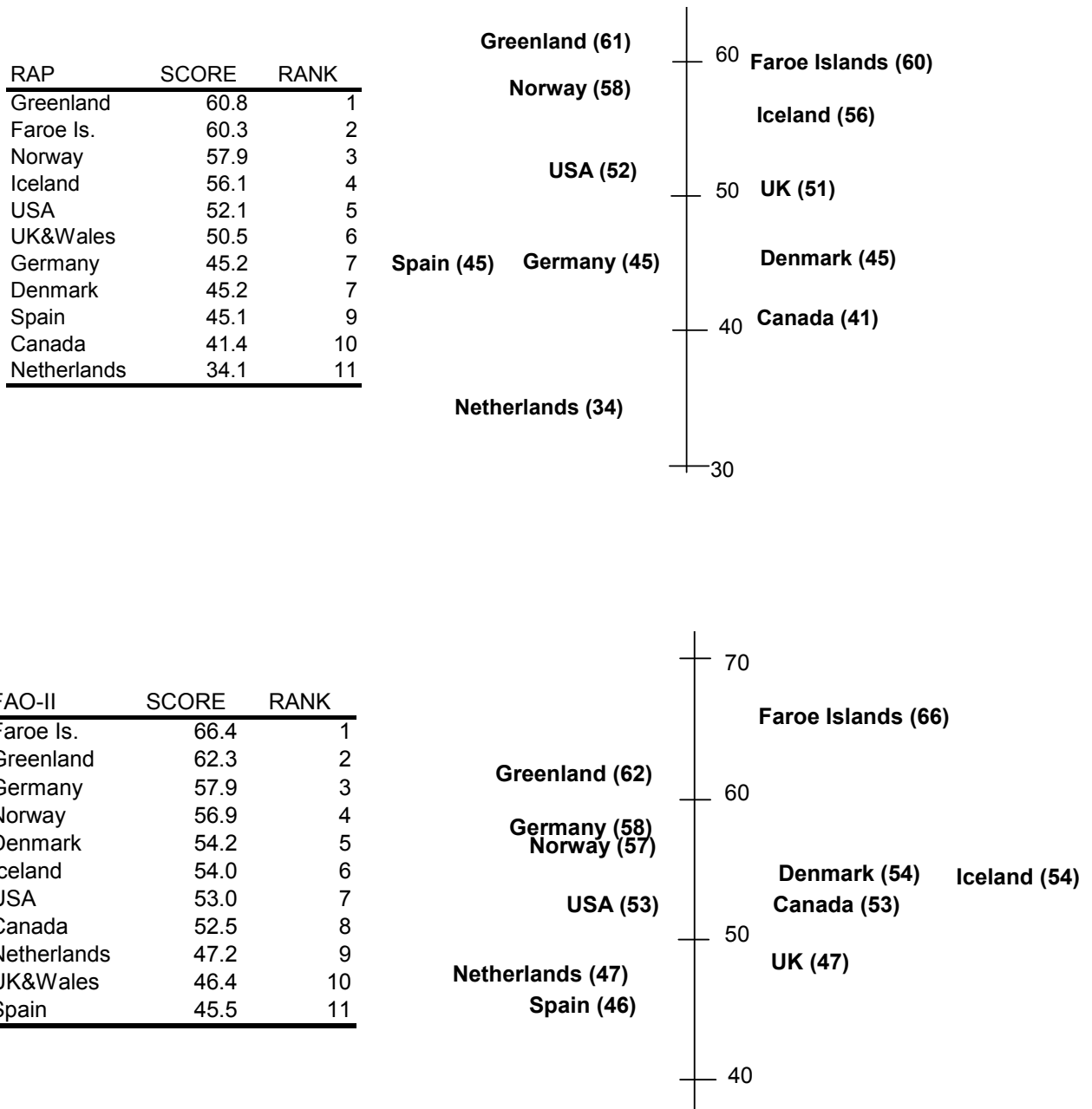


Figure 2. Ranking of fisheries sustainability based on RAPISH and on a combined score between FAO and FAO-II.

countries in the upper or positive zone (score greater than 50) of sustainability, especially for compliance with international instruments. Those countries in the lower or less sustainable zone still perform positively for international instrument compliance. Reports from management agencies and conservation organizations, however, indicate that many of national fisheries are over-exploited and fisheries are under threat. This is in contrast to the study outcomes and published reports, highlighting the fact that high Rapfish, FAO and international instruments scores, singly or combined, do not always necessarily imply sus-

tainable fisheries. Further analysis is needed, in particular to compare the ranking indicated in this study with the direct evaluation of the fisheries resources performed by Christensen et al. 2001. For the time being, we can however state that we might worry less about the fisheries of Greenland and the Faroe Islands, but we should be concerned more about the fisheries of the Netherlands, and of the other eight countries included in this study.

Finally, we recommend that further research on the scoring of the sustainability using different

methods should be pursued. As shown in Chuenpagdee et al. (2001), various groups of people can provide useful information to develop rankings of importance, which can be used to formulate appropriate resource use policies. The ‘damage schedule’ approach employed by Chuenpagdee et al. (2001) can be easily modified to measure the sustainability of fisheries, with the most important feature being the involvement of experts, i.e., scientists, researchers and managers, and user groups in the scoring of the fisheries under various criteria. The rankings obtained from such application will also be an interval rather than ordinal ranking, which can provide further insights. More importantly, involving experts and user groups in the process enhances the transparency of the results and consequently facilitates policy implementation.

Acknowledgments

This paper was initiated based on a series of discussions between the authors and Dr. Daniel Pauly, whom we wish to thank for suggestions and for insightful comments. We also acknowledge the funding of this study by the Sea Around Us Project.

References

Alder, J., Lugten, G., Kay, R. and Ferriss, B. 2001. Compliance with International Fisheries Instruments. Pages 55-83 in Pitcher, T.J., Sumaila, U.R. and Pauly, D. (eds) Fisheries Impacts on North Atlantic Ecosystems: Evaluations and Policy Exploration. Fisheries Centre Research Reports 9 (5): 94pp.

Christensen, V. , S. Guénette, J. Heymans, C.J. Walters, R. Watson, D.Zeller and D. Pauly. Estimating fish abundance of the North Atlantic, 1950 to 1999. In Guénette, S., Christensen, V. and Pauly, D. (eds) (2001) Fisheries Impacts on North Atlantic Ecosystems: Models and Analyses. Fisheries Centre Research Reports 9 (4): *in press*.

Chuenpagdee, R., Knetsch, J.L., and Brown, T.C. 2001 Environmental damage schedules: community

AGGRE	SCORE	RANK
Faroe Is.	63.3	1
Greenland	61.6	2
Norway	57.4	3
Iceland	55.1	4
USA	52.6	5
Germany	51.6	6
Denmark	49.7	7
UK&Wales	48.5	8
Canada	47.0	9
Spain	45.3	10
Netherland	40.7	11

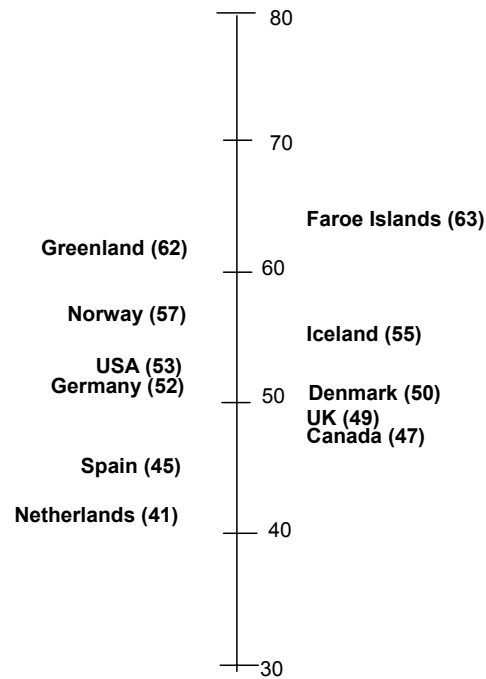


Figure 3. Aggregated ranking of fisheries sustainability of 11 countries, based on Rapfish scores and the Combined (FAO-II) scores.

judgments of importance and assessment of losses. *Land Economics* 77(1): 1-11.

Dunn-Rankin, P. 1983. *Scaling Methods*. Lawrence Erlbaum Associates. New Jersey.

Kendall, M. and Gibbons, J.D., 1990. Rank Correlation Methods. Fifth edition. Edward Arnold, London. 260 p.

Pitcher, T.J., Bundy, A., Preikshot, D.B., Hutton, T. and Pauly, D. (1998) Measuring the unmeasurable: a multivariate interdisciplinary method for rapid appraisal of health of fisheries. Pages 31-54 in Pitcher, T.J. Hart, P.J.B. and Pauly, D. (eds) Reinventing Fisheries Management, Kluwer Academic, Dordrecht. 435pp.

Pitcher, T.J. (1999) Rapfish, A Rapid Appraisal Technique For Fisheries, And Its Application To The Code Of Conduct For Responsible Fisheries. FAO Fisheries Circular No. 947: 47pp.

Pitcher, T.J. and Preikshot, D.B. (2001) Rapfish: A Rapid Appraisal Technique to Evaluate the Sustainability Status of Fisheries. *Fisheries Research* 49(3): 255-270.

Siegel, S. and Castellan, N. J., 1988. Nonparametric Statistics for the Behavioral Sciences. 2nd Edition. McGraw-Hill Book Company. 399 p.

United Nations, 1994. Agenda 21: Program of Action for Sustainable Development. Rio Declaration on Environment and Development. United Nations Publications, New York. 294 p.