Ecological Footprint of Icelandic Fisheries

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Introduction

The negative impact of human endeavour on the biosphere has becoming increasingly clear in recent decades. In response we have seen a big push towards creation and use of various indicators aimed at quantifying the impact and defining a "safe zone" for humanity to operate in. One such indicator is the Ecological Footprint (EF). According to Binningsbo et al (2007) EF is the most widely used sustainability indicator in the world. In spite of this only one study on the EF of Iceland can be found (Wackernagel et al, 1997) in the literature. This study does not include fisheries since this is a relatively recent component of the methodology. Hence, there is a gap in the literature on the size of the Ecological Footprint of Icelandic fisheries.

The aim of this project is to measure the Ecological Footprint of Icelandic fisheries.

Methods

The project utilizes the standard methodology for EF as indicated in relevant literature from the method's main authors at the Global Footprint Network. The method attempts to trace consumption of goods and services flowing through the economy back to the size of the area of the relevant land (and sea/water) type that provides the raw materials to make the goods in question. The use of two conversion factors then convert the area into an equivalent area of average global productivity, called global hectares. By adding up the areas needed to support the consumption for the six different land types – cropland, grazing land, forest land, built-up land, carbon footprint (carbon uptake land) and fisheries – the size of the EF is found, measured in global hectares.

The methodology for fisheries is based on the work of Pauly and Christensen (1995) and aims to quantify the mass ratio between harvested fish to the annual primary production required (*PPR*) to sustain said species. This is highly dependent on the species trophic level (TL). Bycatch discard rate (*DR*) is assumed 1.27 as a global average for all species and transfer efficiency a constant 10%.

$$PPR = CC \bullet DR \bullet \left(\frac{1}{TE}\right)^{(TL-1)}$$

An integral part of the EF methodology is measuring the earth's productive capacity - or biocapacity - in order to give meaning to the size of a given Footprint. This is done using productivity and area sizes of the different land types.

Calculations for marine yields are based on John Gulland's work (1971). Estimates of a sustainable harvest of 19 species groups are used to calculate the equivalent primary production and these then summed up to find the assumed total primary production that global fisheries may sustainably harvest. The sustainably harvestable primary production is therefore:

$$PP_S = \sum \left(Q_{S,i} \bullet PPR_i\right)$$

Where is the estimated sustainable catch for species *i*. This total sustainable primary production is then divided by the total global continental shelf area since the methodology only takes into account primary production that takes place on the continental shelf areas. This is because 95% of all harvested fish from the world's oceans is caught there, according to Kitzes et al (2007).

During the project a continual assessment of the fisheries calculation methodology will be conducted.

Results

The calculations yield results for the Ecological Footprint of Icelandic fisheries of 54.61 global hectares per Icelander per year. Production is responsible for 62.67 global hectares, imports for 1.32 and exports (distracted from production and imports) for 9.38 global hectares.

Land type	Production	Imports	Exports	Consumption	Biocapacity
[-]	[gl. hectares]	[gl. hectares]	[gl. hectares]	[gl. hectares]	[gl. hectares]
Cropland	0.06	0.25	0.02	0.29	4.22
Grazing land	0.13	0.00	0.02	0.11	0.13
Forest land	0.00	0.54	0.00	0.54	0.03
Fisheries	62.67	1.32	9.38	54.61	17.32
Carbon Ftpr.	2.77	8.71	13.19	0.00	0.00
Built-up land	0.44	-	-	0.44	
Total	**66.06**	**10.83**	**22.60**	**56.00**	**22.13**

Discussion

When the standard EF methodology is applied to Icelandic fisheries the results yield the world's largest footprint. To put this into context, no other country´s Footprint has ever exceeded 12 global hectares. This is including the other five land types along with fisheries. The Footprint for Icelandic fisheries alone - excluding the other land types - based on the standard methodology, amounts to over 54 global hectares.

We seriously doubt these results and suspect major defiencies in the Footprint methodology for fisheries. The main errors seem based around aggregation of species and how this affects trophic levels. Other concerns include data accuracy and boundary settings.

The next steps in the project's development is to look deeper into these methodological issues with the aim to seek a more accurate portrayal of the EF of Icelandic fisheries and suggest improvements to the standard methodology. A new food-web approach to calculating PPR, suggested by Luong et al (in print) will be tested in this respect.

In light of the widespread use of the Ecological Footprint it is imperative to make the indicator as accurate as possible in order for it to be a viable tool for decision-making. The case of Iceland seems to lend itself particularly well to highlighting the flaws of the current methodology and the project hence has the possibility to provide a much-needed clarity on where the problem areas lie and how they may best be rectified. The study therefore holds promise of significant scientific advancement in the field.

Accurate calculations of the Ecological Footprint will align perfectly with the aims of GreenMar of efficient usage of marine resources without risking systems resilience and functionality.

References

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