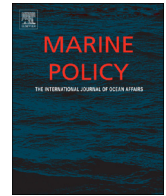




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Short Communication

# Incorporating carbon footprints into seafood sustainability certification and eco-labels

Elizabeth M.P. Madin<sup>a,b,\*</sup>, Peter I. Macreadie<sup>c,d</sup><sup>a</sup> Department of Biological Sciences, Macquarie University, Sydney, NSW 2109, Australia<sup>b</sup> School of the Environment, University of Technology, Sydney, PO Box 123, Sydney, NSW 2007 Australia<sup>c</sup> Plant Functional Biology and Climate Change Cluster, University of Technology, Sydney, PO Box 123, Sydney, NSW 2007, Australia<sup>d</sup> Centre for Integrative Ecology, School of Life and Environmental Sciences, Faculty of Science Engineering and Built Environment, Deakin University, Burwood, VIC 3125, Australia

## ARTICLE INFO

## Article history:

Received 16 December 2014

Received in revised form

10 March 2015

Accepted 13 March 2015

Available online 22 April 2015

## Keywords:

Seafood

Eco-label

Sustainability certification

Carbon footprint

Climate change

Life cycle analysis (LCA)

## ABSTRACT

The seafood industry has become increasingly interconnected at a global scale, with fish the most traded commodity worldwide. Travel to the farthest reaches of the oceans for capture is now common practice, and subsequent transport to market can require hundreds to thousands of miles of travel by sea and air. Refrigeration of seafood products is generally required at all stages of the journey from ocean to dinner plate, resulting in substantial energy expenditure. Energy input for aquaculture (including mariculture) products can also be high, namely due to the large amounts of feed required to support fish growth. As a result of these factors, the seafood industry has a substantial carbon footprint. Surprisingly, however, carbon footprints of seafood products are rarely integrated into assessments of their sustainability by eco-labels, sustainability certification, or consumer seafood sustainability guides. Suggestions are provided here for how carbon footprints could be incorporated within seafood sustainability schemes.

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## 1. Introduction

The seafood industry has become increasingly interconnected at a global scale [1], with fish the most traded commodity worldwide [2]. Travel to the farthest reaches of the oceans for capture is now common practice [3], and subsequent transport to market can require hundreds to thousands of miles of travel by sea and air. Refrigeration of seafood products is generally required at all stages of the journey from ocean to dinner plate, resulting in substantial energy expenditure. Energy input for aquaculture (including mariculture) products can also be high, namely due to the large amounts of feed required to support fish growth (Fig. 1). As a result of these factors, the seafood industry has a substantial carbon footprint [4]. Surprisingly, however, carbon footprints of seafood products are rarely integrated into assessments of their sustainability by eco-labels, sustainability certification, or consumer seafood sustainability guides. Suggestions are provided here for how carbon footprints could be incorporated within seafood sustainability schemes.

## 2. How big is the seafood carbon footprint problem?

A seafood product's carbon footprint represents the amount of greenhouse gas (GHG) emissions released during its production, transport and consumption, calculated as carbon dioxide equivalent (CO<sub>2</sub>e), calculated via established methodologies (e.g., life cycle assessments [LCA] [4]). Carbon footprints vary widely among seafood products (Fig. 1). A study of more than 20 Norwegian seafood products delivered to various endpoints globally found a range of carbon footprints from 0.7 to 14.0 kg CO<sub>2</sub>e per kilogram edible product [4]. In addition to fuel use in fishing and feed production in aquaculture, key inputs to carbon production in this study were refrigerants used on fishing vessels, product yield, and by-product use [4] (Fig. 1). These findings demonstrate that seafood products can have carbon footprints that are extremely large (i.e., up to 14 times that of the product's own weight) and, importantly, that some seafood products have much lower carbon footprints than others – a characteristic that could potentially be selected for by consumers and/or sustainability certification criteria (Fig. 2a). The seafood industry's carbon emissions may contribute to an adverse positive feedback loop whereby climate change-induced changes to marine ecosystems and fisheries stocks lead to decreased catchability of some species [5] and increased energy input needed to produce a given amount of seafood [6].

\* Corresponding author. Present address: Department of Biological Sciences, Macquarie University, Sydney, NSW 2109, Australia.

E-mail address: [dr.elizabeth.madin@gmail.com](mailto:dr.elizabeth.madin@gmail.com) (E.M.P. Madin).

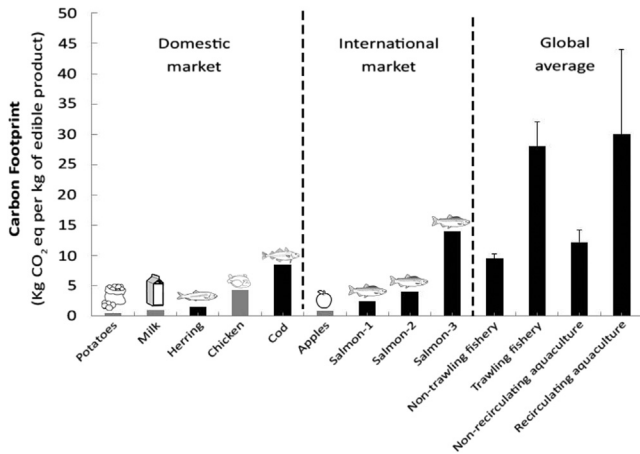
### 3. Incorporating carbon footprints into seafood sustainability

In recent years, sustainability certification, labels and guides, collectively referred to as “seafood awareness campaigns” [7], have become increasingly popular as a means of encouraging more sustainable industrial methods and consumer choices (Fig. 2b). These programs set voluntary sustainability standards for

industries and/or provide sustainability standards against which consumers and businesses can make choices. In the seafood industry, sustainability standards typically evaluate three key aspects of fisheries: (1) the level of harvesting pressure and fish stock relative to “safe” levels, (2) the use or exclusion of environmentally harmful fishing practices, and (3) the effectiveness of the fisheries’ management system(s) [8].

This study proposes another important way in which seafood awareness campaigns can be improved: through explicit consideration of the carbon footprint of seafood products. Including carbon footprints into their certification criteria would provide a more holistic basis for consumers and businesses to assess the sustainability of seafood products. This proposition is in line with recent calls by leaders in the field for seafood awareness campaigns to include the full seafood-production process into sustainability assessments [9] and has been suggested as a useful next step for wild-caught seafood eco-labels [10]. Explicitly considering carbon footprints would allow these campaigns to have a potentially far more powerful net effect by not only helping to mitigate specific environmental impacts of each fishery, as many currently aim to do, but would broaden their impact to confronting the global-scale problem of climate change. Given the substantial per-unit-product carbon emissions of fisheries, this is an area of environmental sustainability in which consumer and business choices could potentially have a large impact.

While a number of “single-issue” carbon footprint eco-labels for other industries have been implemented – i.e., those that specify the exact or relative carbon footprint of a product and rank it on this basis only – it is suggested that this measure should be considered alongside other key sustainability criteria to generate a robust measure of a seafood product’s overall sustainability. To our knowledge, only one



**Fig. 1.** Examples of carbon footprints for common seafood (black) and non-seafood (grey) products of Norway and Sweden (sections “Domestic market” and “International market”) and examples of global averages of various seafood industries (section “Global average”). Apples were imported from overseas by boat. Salmon products were all from aquaculture that underwent export from Norway via different transport methods: 1 = to Paris via truck; 2 = to Shanghai via boat; and 3 = to Tokyo by airfreight. Scandinavian data sourced from [4,20] and global averages from [21].



**Fig. 2.** Photos of (a) gummy shark *Mustelus antarcticus* being packed on ice for transport for the “fish and chip” industry; (b) popular seafood products found in Australian supermarkets containing sustainability certifications, including the Marine Stewardship Council’s “Certified Sustainable Seafood” products; (c) small-scale fisheries in Indonesia selling fresh, locally-caught fish; and (d) flowers grown in Holland are air freighted to Hong Kong. Photo credits: Peter Macreadie.

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