Sea Around Us

Energy Consumption By North Atlantic Fisheries

By Peter Tyedmers

As a result of rising fossil energy prices, we have all been reminded in recent months that western industrial society is profoundly dependent on the availability of cheap, abundant energy. Unfortunately, the world's major industrial energy resources are not only finite, but globally their per capita availability has been in decline since the late 1970s. Furthermore, it is now widely recognised that the scale of humanity's industrial energy use contributes to major environmental problems including global climate change and biodiversity loss.

Like all human activities, commercial fishing entails the dissipation of energy in support of their primary activity, the harvesting of aquatic organisms. And although energy consumption by fisheries receives less attention than the direct impact that fishing has on targeted stocks and associated marine ecosystems, it is precisely the availability of abundant energy that enables most contemporary fisheries to continue even when stocks are in decline. In addition, from a management perspective, energy consumption provides a means of comparing fishing effort between diverse fisheries, and changes in effort over time within fisheries.

Not surprisingly, most research into the energy consumed by commercial fisheries followed the oil price shocks of the 1970s. The results of this and more recent research indicate that:

- Direct fuel inputs to fisheries typically account for between 75 and 90% of total industrial energy inputs. The remaining 10 to 25% are typically comprised of direct and indirect energy inputs associated with vessel construction and maintenance, the provision of fish gear and ice, and labour.
- The energy intensity of a fishery, or the amount of energy consumed per kilogram of fish or shellfish landed, is affected by both biological factors, such as resource abundance and distribution and by the technological aspects of a fishery. For example, the type of fishing gear employed, and to a lesser extent the size of vessel used, can influence the energy intensity of a given fishery. In general, trawling and longlining tend to be more energy intensive than seining, purse seining or more passive techniques, such as gillnetting and trapping.

As part of the *Sea Around Us Project* at the University of British Columbia, I have undertaken an analysis of the energy intensity and total energy consumed by contemporary North Atlantic fisheries. In addition, where data permits, I am also evaluating changes in

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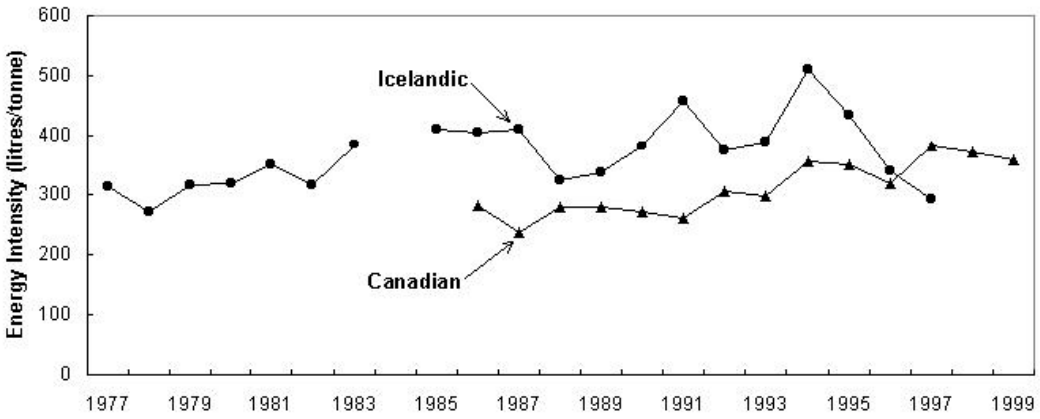

Figure 1: Energy intensity of Icelandic and Canadian scallop dredge fisheries.

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energy consumption over time for specific fisheries. As direct fuel inputs account for the lion's share of energy inputs, and because indirect inputs to vessel construction, fishing gear, etc., are difficult to quantify, this analysis is focussing exclusively on fuel inputs.

Two methods are being used to quantify the fuel consumed by fisheries. The first entails soliciting fuel consumption, fishing effort, vessel characteristics and catch data directly from fishing companies. While this method yields robust results, it is a relatively slow, labour intensive process. As a result, a second technique is being employed that uses data provided by fishing companies to establish generic fuel consumption rates, in terms of litres of diesel burned per horsepower•sea-day of effort expended, for various gear sectors. These generic fuel consumption rates are then used to estimate total fuel consumption and energy intensity for fisheries for which fleet-wide catch, average fleet horsepower and total days at sea data are available through the efforts of *Sea Around Us Project* collaborators and consultants from around the North Atlantic.

Using both of these techniques, to date I have estimated the energy intensity and total fuel consumed by approximately 50 North Atlantic fisheries. Taken together they account for almost 5.5 million tonnes (live weight) of fish and shellfish landed annually and range from the high-tonnage purse seine fisheries for Atlantic menhaden, and capelin, to mixed stock groundfish trawl fisheries, to high-value trawl and dredge fisheries for shrimp, lobster and scallop. Notably, for almost half of the fisheries analysed, time series estimates of energy intensity and total fuel consumption have also been possible for periods ranging up to 20 years. For example, Figure 1 illustrates recent changes in energy intensity of both Icelandic and Canadian scallop fisheries.

Peter Tyedmers is a Research Consultant with the Sea Around Us Project. He recently received his Ph.D. in Resource Management and Environmental Studies at UBC.

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Our mailing address is: UBC Fisheries Centre, 2204 Main Mall, Vancouver, British Columbia, Canada, V6T 1Z4. Our fax number is (604) 822-8934, and our email address is SeaNotes@fisheries.ubc.ca. All queries (including reprint requests), subscription requests, and address changes should be addressed to Melanie Power, *Sea Around Us* Newsletter Editor.

The Sea Around Us website may be found at www.fisheries.ubc.ca/projects/saup, and contains up-to-date information on the project.

Presenting the Sea Around Us Approach

By Daniel Pauly and Reg Watson

Two international conferences, the Annual Science Conference of the International Council for the Exploration of the Sea (ICES), held in Bruges, Belgium, from Sept 27-30th, and the IX Annual PICES (North Pacific Marine Science Organization) meeting, held in Hakodate, Japan from October 20-28th, recently provided opportunities for presenting the concepts underlying the Sea Around Us project, as also described in our recently released 'Methodological Report' (Pauly and Pitcher 2000). (See Page 5 for the table of contents of the report.)

The first of these two ICES presentations was the invited 'Open Lecture' entitled "Fisheries and Conservation: a Program for their Reconciliation", given by the senior author.

This presentation, which started by contrasting the key features and 'clients' of fisheries biology and conservation biology, went on to outline the enormity of the challenge caused by relentless overexploitation of fisheries resources, and their impacts on ecosystems, both culminating in 'fishing down marine food webs'.

The elements of reconciliation between fisheries and conservation biology were then outlined. They included recognizing the legitimacy of the key tenets of each (that fishing should remain a viable occupation; that the ecosystems and their biodiversity are allowed to persist).

This presentation – the first time conservation issues were addressed in the context of an Open Lecture – was apparently very well received, and provided a neat starting point for the mini-symposium that followed up on that lecture, devoted to biodiversity issues, to which several speakers, notably Dr Jake Rice, referred to, suggesting that ICES should give far more attention to this than it has so far.

The ICES governing body, composed of national delegates from around the North Atlantic decided, two days after these events, to create a new, high-level Advisory Committee on Ecosystems (ACE), on par with its fisheries-orientated Advisory Committee on Fisheries Management. It tempting to believe that the contents of this year's Open Lecture nudged a few delegates toward this positive, potentially very important decision.

We also used the opportunity at the ICES Annual Science conference to present another contribution, outlining our vision for a consensus taxonomy of the world's marine ecosystems (Pauly et al. 2000). The goal of this taxonomy is to bring together the extensive information and expertise available in the fields of oceanography and in fisheries science into a compatible framework to produce the synergism required to tackle pressing global issues of over-fishing and other impacts on marine ecosystems. The joint paper was presented by Dr Ken Sherman, the main architect of the Large Marine Ecosystems (LME) (Sherman et al., 1990; Sherman and Duda 1999) which are now defined for most of the world shelf and adjacent oceanic areas, and whose integration with the system of 'Biogeochemical Provinces' (BGCP) developed by A. Longhurst, T. Platt and S. Sathyendranath (Longhurst, 1998) form the core of this paper.

This presentation deepened the interactions between Ken Sherman's group and the FC, and the commitment to develop compatibility of global LMEs where possible with the BGCP of Longhurst and colleagues. This collaboration was strengthened by a recent visit by Peter Celone from NOAA.

It is very pleasing to see the interest that has been expressed in forming a framework for describing marine areas which can hopefully transcend what have been traditional boundaries between research fields.

Thanks to support by PICES, and in particular Dr Ian Perry, Dr Reg Watson had the opportunity to present an invited paper entitled "Mapping fisheries onto marine ecosystems: regional, oceanic and global integrations" at PICES IX in Japan. This paper presented our proposals for

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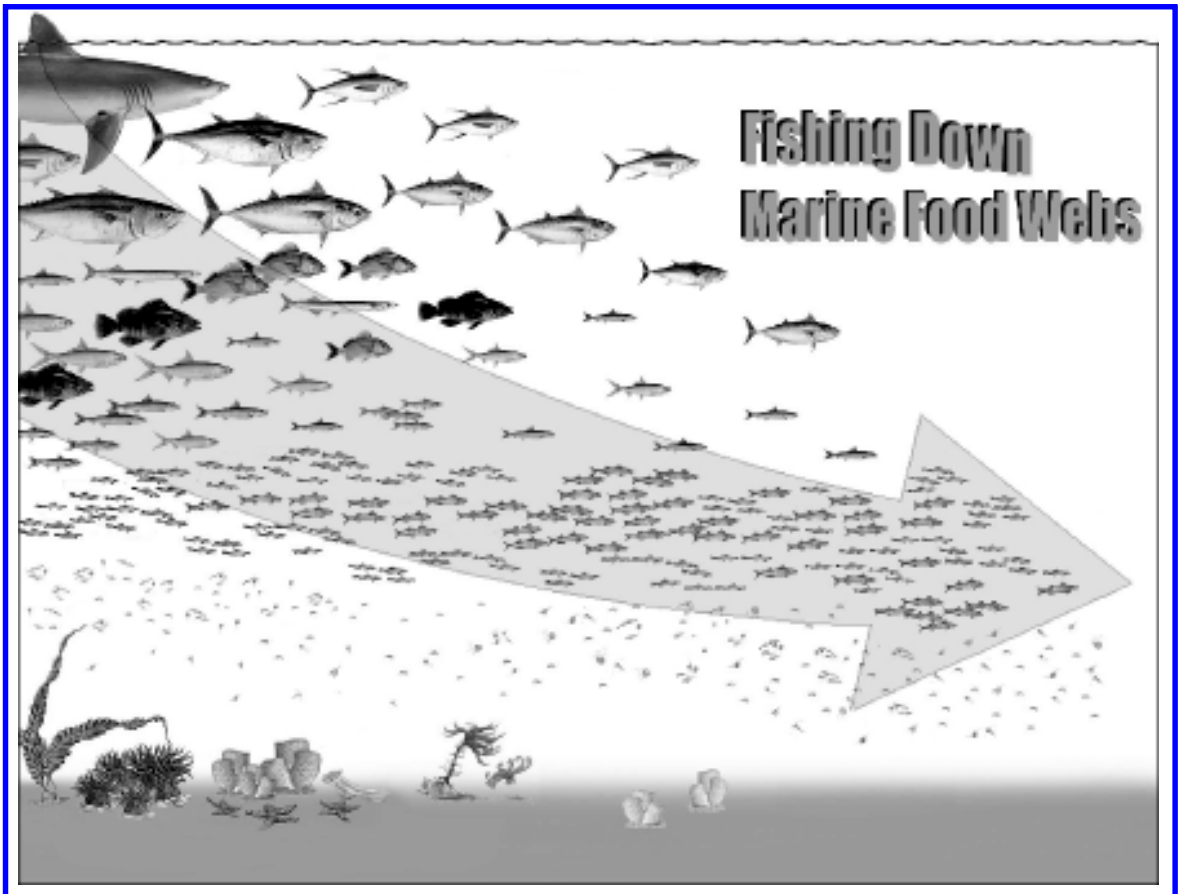

Fig 1. Schematic representation of 'fishing down marine food webs' as presented at the ICES 2000 Open Lecture. The horizontal axis represents both time and the sea bottom, the vertical axis the trophic level; the arrow represents global fishing, which increasingly concentrates on organisms of lower trophic levels, and depletes the large, long-lived species. Based on a colour drawing by Ms Aque Atanacio.

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harmonising the boundaries used by BGCP and LME areas. The talk was well attended and seemed of considerable interest to participants, particularly those involved with coordinating global studies combining oceanography and fisheries such as the GLOBEC program.

It is very pleasing to see the interest that has been expressed in forming a framework for describing marine areas which can hopefully transcend what have been traditional boundaries between research fields. Collaborations made possible by a common data basis will greatly strengthen value work on marine ecosystems.

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Dr Daniel Pauly is Project Leader and Dr Reg Watson is a Senior Research Associate for the Sea Around Us Project.

The SAUP Methodology Report

The Fisheries Centre is pleased to announce that a new report in the Fisheries Centre Research Report series has been published. Edited by Daniel Pauly and Tony Pitcher, *Methods for Evaluating the Impacts of Fisheries on North Atlantic Ecosystems* presents the methodology in use in the Sea Around Us Project.

To order, contact the Fisheries Centre's Events Officer, phone (604) 822-0618, fax (604) 822-8934, or email events@fisheries.ubc.ca. The full citation is: Methods for Evaluating the Impacts of Fisheries on North Atlantic Ecosystems. Fisheries Centre Research Report 2000, Vol. 8 (2), 195 pp, $20.

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Appendices

An Overview of Spatial Mapping of Fishing Grounds of Marine Fisheries

By Ahmed A. Gelchu

My career as fisheries biologist started back in 1992 in Ethiopia. I worked in inland fisheries on Ethiopian rift valley lakes as well as on man made lakes. After serving there for four years I went to Norway for further studies and did a masters degree in Fisheries Biology and Fisheries Management at the University of Bergen. Finally, I immigrated to Canada in 1999 and joined the Fisheries Centre soon afterwards, with the hope of eventually beginning doctoral studies.

Having explained how I came to join the Centre, let me take you directly to the topic of my work here: Spatial Mapping of the Fishing Grounds of Marine Fisheries.

The rationale behind mapping fishing grounds comes from the very fact that all marine species have geographic limits to their distributions. The distributions can be relatively wide in geographic range or restricted as dictated by combinations of factors such as the biology of the fish, and oceanographic, ecological, and climatic barriers. The knowledge of these distributions, and the geographic locations of the fishing areas within the distribution ranges, are of a paramount importance. It helps to relate any changes in fisheries to the peculiar characteristics of each geographic locality, and hence helps to define the ecosystems. Defining the ecosystems in turn enables scientists to see changes in fisheries in light of ecosystem context that would help to bring about effective stock status assessment and make suitable management policies that would maintain the health of the entire ecosystem.

To this end, a primary focus of the *Sea Around Us Project* is to find where the main marine fisheries of the world are taking place. The geographic information is then stored using standard GIS (Geographic Information Systems) techniques, providing an excellent tool to analyse and display spatially-distributed data. The aim is to develop a comprehensive database that will include, among others, the exact address of each economically important fishery in oceans of the world within the systematic hierarchies of various oceanic classification schemes (Domains, LMEs, EEZs, and FAO areas) previously designed. Dr Reg Watson, a scientist in charge of the mapping unit of the project, is developing suitable software for this purpose.

So far, on a global scale, we have identified 61 top species, important in that they account for a significant portion of total world marine catches. Geographic information regarding the fishing grounds (distribution map) has been digitized and registered to common co-ordinate system.

In the coming weeks and months, the task of identifying fishing grounds of the remaining important species will be finished, and eventually most marine species for which there is an important fishery will be included in the database. After this phase is completed, the catches of the world marine fisheries will be allocated to their respective places of origin in the oceans.

We will then be in a better position to address questions of a spatial nature; questions in which the location of one fishery in relation to another, or its specific environment, is the centre of focus.

Hopefully, in the near future, I will be continuing in these areas with emphasis on re-mapping the total catches and effort of global marine fisheries by applying a GIS-based analysis using historical time series of catch and effort statistics for my doctoral thesis. I will work to trace back in time the catches and effort of marine fisheries as far as the availability of data will allow, to visualize how fisheries have been responding to exploitation schemes over space and time, and come up with explanations as to what possible factors were involved in generating the observed trends in each geographical area.

Ahmed Gelchu is a Research Assistant with the Sea Around Us Project.