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The rise and fall of the Irish orange roughy fishery: An economic analysis

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ABSTRACT

An Irish commercial fishery for orange roughy began in the Northeast Atlantic in 2001 with the assistance of government grants. The fishery began as an open access, non-quota fishery. The rapid boom and bust of many deep water fisheries was experienced. Landings peaked in 2002 and then dropped significantly the following year. Many vessels were forced out of the fishery due to high costs and rapidly declining stocks. By 2005 the fishery was largely closed. Applying a bioeconomic analysis, this paper shows why the fishery no longer exists and discusses both the external and opportunity costs of the fishery. A bioeconomic model is applied to the available data to assess the open access effort and harvest with and without government grant aid. The results suggest that in the absence of subsidies, deep water trawling would not have been viable. In addition to the financial costs such as high fuel consumption, there are also externalities associated with deep water trawling. Orange roughy is closely associated with deep water ecosystems such as seamounts and cold water corals. This paper examines the costs of damage to cold water corals. These costs include the loss of fish habitats and lost future use and preservation values.

1. Introduction

Increasing pressure on traditional fisheries in readily accessible inshore waters on the continental shelf has forced fishermen to explore deeper waters [1,2]. These new fisheries are facilitated by the development of new fishing gear and sonar technologies. The move to deep water fisheries is encouraged further by governments offering grants and subsidies in an effort to alleviate the pressures on inshore stocks [3].

Perhaps the best known example of the large-scale commercial exploitation of an underutilized deep water fishery is the case of the orange roughy (*Hoplostethus atlanticus*). Fishing for orange roughy began in Australia and New Zealand in the 1970s [4,5] and subsequently in Namibia and Ireland in the 1990s [6,7].

However, the orange roughy fishery is frequently cited as an example of poor fisheries management where the stock has declined significantly and is not rebuilding [8,9]. Orange roughy fisheries are also considered to be heavily subsidised [10], and involve excessive monitoring and compliance costs to the state [11]. Concerns have also been voiced that the orange roughy fishery and its habitats are not resilient enough to withstand the destructive fishing practices on vulnerable deep sea ecosystems and the resulting environmental costs too large and uncertain to allow the fishery to continue [12].

On the other hand a number of other studies have argued that "the jury is still out" on the question of whether orange roughy fisheries are sustainable over the long term [5,13] and some suggest that the orange roughy fishery should continue and is both sustainable and economically viable [14], provides employment and supports coastal communities. Hilborn et al. [14] report that the New Zealand orange roughy fishery was in fact sustainable and close to being economically optimal.

This inconsistent picture presents a number of difficulties for policy makers concerned about the management of the deep sea fishery.

It is worth noting, however, that the paper by Hilborn et al. [14] focuses on the fish stock and ignores the effects of fishing on the ecosystem and thus provides a financial perspective rather than an economic one since externalities are not given consideration. Concerns by academics and the public at large about the destructive effects of deep sea fishing are not confined solely to the collapse of fish stocks as suggested by Hilborn et al. [14] but have also focused on the negative external effects of trawling on deep sea habitats. Recently, attention has been drawn to the fact that deep sea habitats such as cold water corals and seamounts play an important role in the provision of ecosystem goods and services. By damaging cold water coral, destructive fishing practices thus impose user costs[1] not only on the fishermen themselves but also other stakeholders. Glenn et al. [16] report that the Irish public show strong preferences for a ban on trawling in

[1] Intertemporal scarcity imposes an opportunity cost that we refer to as the marginal user cost. When resources are scarce, greater current use reduces future opportunities. The marginal user cost is the present value of these forgone opportunities at the margin [15].

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order to conserve cold water corals in the Atlantic and Foley et al. [17] suggest that fishing practices that damage cold water coral may reduce the yield of another deep sea fish species, redfish. Armstrong and van den Hove [18] also suggest that deep sea trawling can damage cold water coral and impose external effects on coastal fishermen.

An Irish fishery targeting orange roughy began in 2001 and ended shortly after, resulting in the boom and bust cycle of many orange roughy fisheries. Shephard et al. [19] discuss the stakeholder aspects of the fishery and Minto and Nolan [20] have looked at the biological background of the fishery, while Shephard and Rogan have considered the seasonal distribution of the fishery [7]. There have been no discussions on the economics of the Irish orange roughy fishery.

In this paper Irish orange roughy data is applied to a bioeconomic model and the results of the fishery with grant aid and without are compared. Studies of orange roughy are limited, two studies that have applied bioeconomic models to orange roughy fisheries are Hilborn et al. [14] and Campbell et al. [21]. Hilborn et al. [14] use a simple model to evaluate alternative management histories for New Zealand orange roughy stocks. Campbell et al. [21] use a cohort model to analyse the orange roughy fishery off the east coast of Tasmania, while this paper applies a biomass model. The short duration of the Irish orange roughy venture, and the limitations in available Irish data make the application of a biomass model both acceptable and unavoidable. For the purpose of studying the economic consequences of this fishery, a biomass model is also sufficient. This paper provides an additional discussion compared to Campbell et al. [21], namely on the externalities of fishing on deep water habitats associated with the orange roughy fishery and whether the precautionary approach has a role to play in the fishery. The aims of this paper are:

1. To describe the orange roughy fishery in the NE Atlantic.
2. To establish the influence of grant aid on the orange roughy fishery in the NE Atlantic.
3. To demonstrate why the NE Atlantic orange roughy fishery no longer exists.
4. To discuss the costs to the NE Atlantic orange roughy fishery including the external costs.

The remainder of this paper is as follows: the next section gives a background to the orange roughy fishery in Ireland and elsewhere. A brief description of the bioeconomic model and the orange roughy data set is then provided. The data for the orange roughy fishery is applied to the bioeconomic model and the open access harvest and effort with and without government grant aid are evaluated. This is followed by a discussion on the additional costs to deep water fisheries including user costs, preservation values and the precautionary approach.

2. Background

2.1. Orange roughy

Orange roughy (*H. atlanticus*) is a deep-water species, with an almost global distribution [13]. Orange roughy is associated with continental slopes and generally occurs at 200–1800 m, but is most commonly found between 700 and 1400 m where it is known to form spawning and feeding aggregations [13]. The species has a slow growth rate, is long lived (> 100 years), has a low natural mortality, a high age-at-sexual maturity (25–30 years) and low fecundity [20,22–25]. Orange roughy feeds on luminescent prawns, squid and fish [26].

Orange roughy was first fished commercially in 1978–79 from the Chatham Rise off New Zealand. Subsequently orange roughy fisheries have developed off south-eastern Australia in 1989 [27], in the northwest off the UK in the Rockall Trench off Northwest Europe and Ireland in 1990 [28], off Namibia in 1995 [29], in the Pacific off Chile in 1998 [30], and most recently in the South Western Indian Ocean in 1999 [31]. Exploitation rapidly expanded to the East Indian Ocean when Australia became a major producer at the end of the 1980s, and to the Southeast Atlantic when Namibia joined the top producers in 1995. Orange roughy has become a popular export, with nearly half the catch going to the United States in 2001. All fishing for orange roughy is by bottom trawling.

New Zealand's orange roughy fisheries contribute over half of the global catch to date and approximately half of the annual catch in recent years [13]. In New Zealand, the orange roughy catch from seamounts grew from about 30% of the annual catch of orange roughy in 1985 to 80% of the annual catch by 1995, subsequently stabilizing at 60–70% [32]. Initially landings were maintained through the discovery of these new aggregation areas [5]. Reduced catches by the 1990s led to a search for new sites, and by 2000 approximately 80% of known seamounts had been fished [32].

Total global production of orange roughy peaked at 91,500 tonnes in 1990 but has sharply declined since, falling to some 25,000 tonnes in 2001, in part because New Zealand has set catch quotas. Namibia's catch reached 18,000 tonnes in 1997 and dropped by over 90% to 1600 tonnes in 2000. Catches of newly discovered stocks often decline within a few years of their discovery, in some cases resulting in the closing of the fishing grounds.

The exact status of orange roughy stocks is difficult to determine due to a lack of accurate assessments for most stocks, the long lifespan of the species and the lack of information about pre-recruits [13]. Stocks often experience a rapid boom and bust cycle. Most orange roughy fisheries have been fished down within as little as 5–10 years to less than 20% of their original stock size. One recent analysis found that nearly half of 30 orange roughy stocks assessed had been fished below 30% of the original biomass of the stock [33]. In Namibia, orange roughy quotas fell from 12,000 to 1875 tonnes as the stock was fished to less than 30% of its original biomass in 6 years [34,35]. Koslow et al. [36] and Clark [37] suggest that, even the Chatham rise, which is still actively fished has depleted a number of sub-populations and caution that the apparent longevity of the fishery, based on overall landings may be misleading.

In New Zealand the fishery of larger stocks has been successfully maintained; however, for smaller stock sizes the fisheries are often unsustainable and unregulated fisheries may be especially vulnerable. For example, Hilborn et al. [14] suggest that most New Zealand orange roughy (*H. atlanticus*) stocks are sustainably managed and can be cited as an example of successful, rather than failed, management. Hilborn et al. [14] suggest that one could view the rapid decline in abundance of the orange roughy fishery as the fishery developed as a catastrophic collapse or, alternatively, as the planned development of a new fishery leading to near legislated outcomes. One of the reasons for this difference of interpretation is that, for many orange roughy populations, what we have witnessed over the last decade or two is "the fishdown phase" [35,36]. Hilborn et al. [14] suggest that part of the conflict in perceptions of the status of the orange roughy fishery comes from a focus on abundance as opposed to sustainable yield. After the "fishdown phase" fish stocks might be at relatively low abundance, indicating failed management to some, while still producing at or near maximum sustainable yield (MSY), indicating success to others. Hilborn et al. [14] suggest that the case of orange roughy in New Zealand illustrates this distinction. Koslow et al. [36] also suggest that large catches were taken