economics as if people and the planet mattered

Value Slipping Through the Net

Managing fish stocks for public benefit

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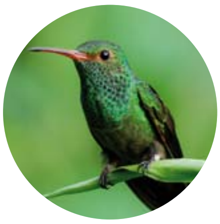

Natural Economies

Social Policy

Valuing What Matters

Well-being

nef (the new economics foundation) is a registered charity founded in 1986 by the leaders of The Other Economic Summit (TOES), which forced issues such as international debt onto the agenda of the G8 summit meetings. It has taken a lead in helping establish new coalitions and organisations such as the Jubilee 2000 debt campaign; the Ethical Trading Initiative; the UK Social Investment Forum; and new ways to measure social and economic well-being.

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Executive summary

Fish stocks are public resources which need to be managed in the best interests of society. Yet, from the majestic bluefin tuna to the tiny anchovies of the Bay of Biscay, fish stocks around the world are in poor shape. In the EU, 72 per cent are overfished, small and large, from sea to sea. This doesn't just have economic costs, but social and environmental ones too. Reforms in fisheries are desperately needed to reverse this rip-off of society.Who is allowed to fish, how much, where, and when should all be conditional on how much society benefits now and in the future. The public deserves to benefit from the management and use of the resources it owns.

Fish are a public good, owned by everybody. They are also valuable to the country, to its economy, society and environment. Ensuring that society actually benefits and continue to benefit from fishing should duly be at the heart of management.

But, at the moment, neither the European Union (EU) nor its member states place any conditions on fishermen to deliver social and environmental benefits to society, in spite of the public ownership of the resource.[1] Without these, the process of allocating quotas – essentially giving permission to exploit a commonly owned resource – is blind to virtually all of the impacts of fisheries and risks the future health of marine resources and the fishing industry.

Fish stocks are a resource that can be exploited by many different types of fishing. Each type of fishing has different impacts, ranging from how many people have jobs and whether benefits support resilient coastal communities to how severe environmental damage is, how many fish are discarded, and the level of greenhouse gas (GHG) emissions. We use this logic to propose the implementation of access criteria, or conditions on fishing, so that fishing delivers the best of these, while being conducive to rebuilding the perilous state of fish resources.

Currently, the EU allocates fish resources on the basis of relative stability, a means to maintain fishing 'rights' within its member states. Each member state then allocates these resources to different sectors of the fleet *based on historical records.* While this has failed on its own terms, it has no way to prioritise those fishing activities or communities that deliver the most benefit to the public. As a result, the current situation of EU fisheries is characterised by overfishing,[2] discarding,[3,4,5] habitat destruction,[6,7,8,9,10] unemployment,[11] and subsidy-dependence.[12,13,14,15,16,17,18] Indeed, where different types of fishing techniques could be used, it is possible that, just as we find in this report, destructive fishing occurs at the expense of more sustainable alternatives.

In this report, we argue that societal, value-based criteria are necessary components of EU fisheries management. We discuss the need to align fishermen's interests with society's objectives. We demonstrate that in the UK North Sea cod fishery, the fleet that has greatest access to the resource is *not* the one that delivers the most value to society; in fact it is more destructive than it is 'value-adding'. The one that performs best is actually given the *smallest* quota. We compare two types of fishing – gillnets and trawlers – in terms of value created for society by looking at net revenues, employment, subsidies, discards, and GHG emissions. We find that over the 2006–2008 period:

- For every tonne of cod landed, trawlers delivered negative value ranging from -£116 for the smallest trawlers to almost -£2,000 for the largest.
- Gillnets, on the other hand, generated a net +£865 of value.
- Trawlers landed almost 6,000 tonnes of cod, while gillnets landed less than 3 per cent of this – just 163 tonnes.
- The largest trawlers received direct subsidies of £219/tonne of cod landed while gillnets received £38.

The implications are clear: the current quota-allocation system in the UK is privileging a sector of the UK fleet that is costing the British public real value. While the results themselves cannot be generalised – which type of fishing is best for society depends on the location, fish stocks, gear used and so on – the principle itself can be, both nationwide and EU-wide. A re-allocation of fishing privileges and subsidies across the fleet from low-value to high-value sectors, where such alternatives exist, would deliver tangible returns to the public. This report shows one widely applicable approach to measuring such value.

The EU has a legal commitment, which it helped write, to restore its fish stocks by 2015. Under current trends, however, it will miss this deadline by more than 30 years. The current reform of the EU Common Fisheries Policy (CFP) is a unique opportunity for a radical change of direction, one that rewards sustainable, constructive fishing for the benefit of all society. Successful implementation of such access criteria will require several steps, such as good data, transparent and evidence-based decision-making, accountability, enforcement, and penalties. But most of all it requires bold action by EU governments.

Introduction

Man talks of a battle with nature, forgetting that if he won the battle, he would find himself on the losing side.

E. F. Schumacher, economist[19]

Valuable fisheries

Well-managed fisheries benefit society in a variety of ways: sustaining food supply, livelihoods, and coastal communities while also permitting a healthy environment. Fisheries directly support 44.9 million people, and indirectly sustain a further 540 million people's livelihoods, equivalent to 8 per cent of the world's population.[20] They also provide around 3 billion people with 15 per cent of their animal protein intake.[21] In the UK, average annual landings (2007–2009) are just under 600,000 tonnes,[22] supporting around 12,200 fishermen,[23] and a further 14,600 jobs in the processing and retailing sector.[24]

But, beyond their value as providers of food, jobs, and revenue, fish stocks have real, albeit economically 'softer', value to the social and cultural fabric of many coastal communities. Also, as an integral piece of marine ecosystems, they are key to the provision of other ecosystem services, such as nutrient recycling and climate regulation.[25,26,27,28]

Catching fish yet losing value

As a renewable resource, fish stocks have the capacity to provide these wide-ranging benefits in perpetuity. Unfortunately, we are far from capturing their full potential. For too many years we have been taking more fish from the oceans than can be replaced, diminishing the capacity of fish stocks to provide these benefits. In the EU, 72 per cent of fish stocks are now overexploited[29]; globally this figure is 32 per cent.[30] Large predatory fish biomass has fallen enormously over the past half-century, many to less than 10 per cent of their pre-industrial fishing levels.[31] In addition, pollution, ocean acidification, and climate change are exacerbating the effects of overfishing, meaning that the state of our oceans continues to worsen, with diminished long-term viability of fish stocks. For example, sea warming caused by climate change makes it unlikely that North Sea cod stocks will ever rebuild to their previous levels.[32,33,34,35]

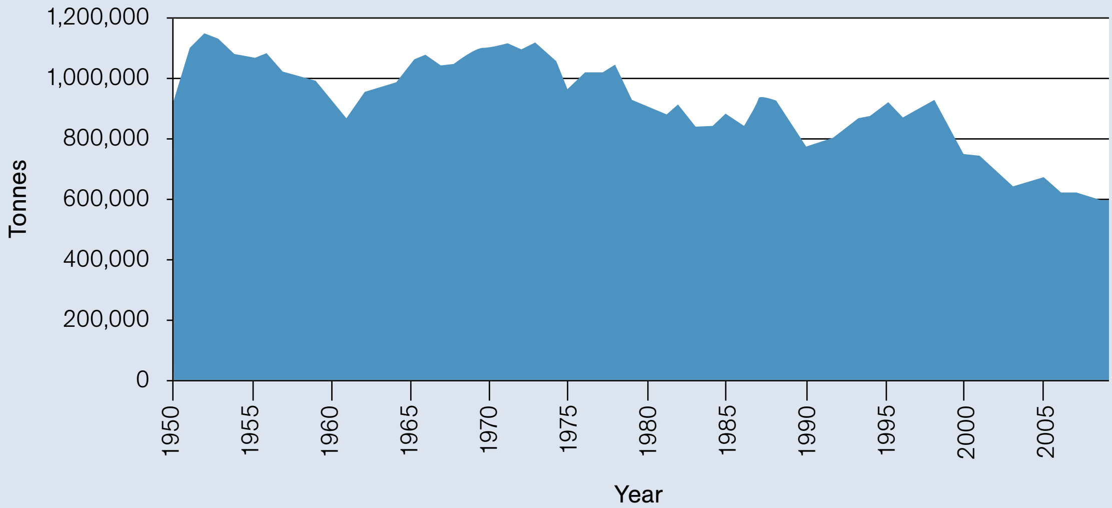
Overfishing is enormously costly to society. The United Nations (UN) and the World Bank have estimated global losses because of such inefficient use of resources to come to $50 billion per year, and $2 trillion over the past 30 years.[36] The true figure could be much higher when environmental and social damages are included. Fishing beyond sustainable levels reduces total catches, puts jobs at risk, and makes the industry more vulnerable.

Declining catches, rising unemployment

Catches have been falling as a result of declining populations and policies designed to mitigate their poor health. Total landings in the EU have declined 2 per cent on average every year since 1993 (on a weight basis), leading to an increasingly vulnerable fishing industry.[37,38] Almost all demersal (near the seabed) stocks have declined, and total EU landings from the northeast Atlantic Ocean and Mediterranean Sea have fallen by 30 per cent over the past decade.[39,40]

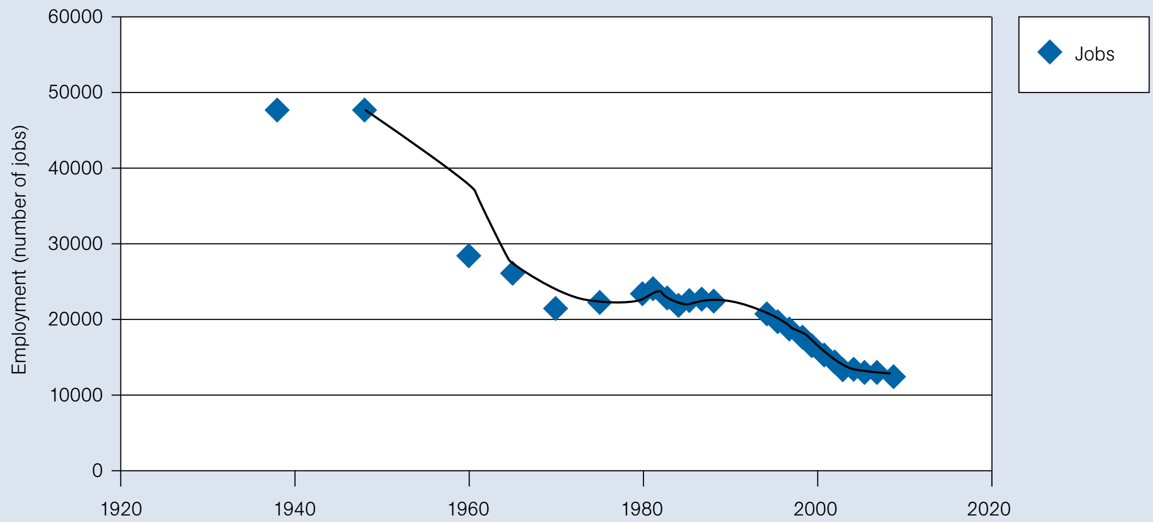
In 2009, the UK fishing fleet landed 580,000 tonnes of fish worth £674 million,[42] the lowest since at least 1950 when records began at the Maritime Management Organisation (MMO). North Sea cod stock populations declined 70 per cent during the 1985–2002 period.[43,44]

Figure 1. UK landings of all species from all fishing areas, 1950-2009 (excludes aquaculture).[41].



Source: *Eurostat*

Figure 2. Time series of number of UK fishermen 1938–2009, with some data values missing. Trendline is a two-period moving average.[46]



Source: *Eurostat*

With a decline in the fishing industry's fundamental resource, jobs have become insecure. Employment has been falling almost constantly in the UK since 1938 – the earliest records held by the MMO – from just under 50,000 fishermen to the current 12,200 fishermen.[45]

Falling productivity

In spite of technological advances, fishing productivity has been declining because of the fall in fish abundance. This decline in fisheries productivity has made it increasingly difficult to maintain catch levels from smaller populations and has increased the risk of driving some stocks towards collapse.

With fewer fish to catch, the fishing industry has embarked on a technological race to increase its profitability faster than catches fall. Despite this, overall productivity has been declining. To land the same quantity of fish as they did in 1889, UK trawlers must now exert 17 times more effort – equivalent to a 94 per cent fall in productivity.[47] Unfortunately, such investments come at a cost, not just to the private operators for their technology, but to the whole of society due to foregone fish resources and revenues, and mis-directed effort.

EU Common Fisheries Policy (CFP) unfit for purpose

The overarching objective of the CFP is to ensure that EU fisheries' resources are managed in an ecologically, socially, and environmentally viable manner.[48] But, with 72 per cent of assessed fish stocks overfished, (such that *catches could actually be increased by fishing less*); decreasing catches, profits, and jobs; and a fleet dependent on public subsidies to remain viable, the EU has failed on both social and environmental fronts. Much has been written about the multiple failures of the CFP, including quotas set above scientific recommended levels, misuse of subsidies, poor governance, and more.

Yet, one crucial piece of the puzzle seems to be missing. Management has completely failed to meet its explicit objective of ensuring the publicly owned resource is sustainably exploited. The CFP has also failed to incorporate 'best value to society' criteria in its allocation of fish resources and public funds.

Social and environmental impacts are unaccounted for, and a history of compliance (or not) with legislation is ignored. Instead, EU member states are allocated a fixed proportion of the total allowable catch as their national quota, under the premises of relative stability.[49] The same can be said for how member states distribute the quota across their national fleets, which is often based on historical records rather than on any measure of social and environmental performance.

The CFP reform: an opportunity for change

By placing 'value to society' at the heart of fisheries policy-making, the reform of the CFP is a unique opportunity to ensure that EU fish stocks are managed in the best interests of society.

Making a transition towards a new EU fisheries model that delivers positive economic, social, and environmental outcomes will require policymakers to favour those sectors of the fishing industry that create most value; to reward the techniques and fishing vessels that deliver the most benefit. Equally, disincentives are needed for those that create the least value, and, more importantly, for those that actually destroy value.

It is time to unveil the real value that different fishing fleets and sectors deliver to society. The implementation of value-based guiding principles in fisheries policy will be a significant first step towards improving decision-making in fisheries management with particular relevance to the following policy processes:

- Allocating fishing access to those vessels that create the most value for society.
- Diverting public funds towards those fleets and fisheries that deliver the most benefit to society.
- Setting criteria for a reduction in fishing capacity, with the burden on those sectors that provide little or even negative value for society.

Allocating resources to those that fish best

Implementing a value-based approach to fisheries requires an understanding of the impacts – both positive and negative – that different fishing activities have in economic, social, and environmental terms. While these impacts are not always visible or easy to measure, they need to be at the heart of fisheries management. Different types of fisheries or fishing activities vary in terms of impacts and will thus contribute differently to societal goals (e.g. sustainable use of resources, employment, and reduction of GHG emissions).

Implementing a value-based approach to fisheries also requires designing a set of transparent, publicly available criteria that point towards the direction we want to go, the type of outcomes we want to see, and how we want the actors to behave when it comes to exploiting our resources.

For example, the allocation of resources (fish or funds) amongst operators of a particular fleet could be prioritised based on:

- Higher selectivity to avoid catches of juvenile fish, cut discards and by-catch (i.e. accidental catch of other species), and minimised seabed damage.
- The number of jobs and quality of employment created per tonne of fish caught.
- The GHG emissions per tonne of fish caught.
- Compliance with EU and member state regulations, such as catch reporting etc.

The implementation of these criteria EU-wide would help create more sustainable EU fisheries to the benefit of both the marine environment and the communities that depend on it. Such criteria can further help create an economic context in which fishermen compete for access and public funds but whose fishing is effectively a cooperative act to benefit society.

There is no one-size-fits-all answer. There will be different sets of criteria and various ways to operationalise them depending on the situation and the context. But, ultimately, whichever solutions and mechanisms are used to respond to the challenges faced by EU fisheries, they need to incorporate 'best value to society' as a guiding principle.

The North Sea cod fishery

To provide an illustration of how different fishing techniques perform in terms of value created for society, we compare two different fishing techniques: trawlers (mobile gear) and gillnets (static gear) targeting cod in the North Sea.

Using a cost-benefit approach, each of these gear types is studied according to a number of environmental, social, and economic variables:

- private fishing revenues and costs
- employment
- GHG emissions
- discard rates
- subsidies.

While these factors together constitute a large part of the picture, in terms of fisheries impacts, there are some notable exceptions. For example, we do not include impacts on the sustainability of the stock, seabed damage or by-catch. In these terms, the sustainability impacts of removing one tonne of cod by either gear are assumed to be the same. In fact, trawlers are less sustainable because of their non-selectivity, with an equal weight made up by more, smaller, fish that are important for the stock's future productivity. Because of resource constraints, we also omit any community or cultural value, as might be captured by economic techniques such as contingent valuation.

Cod in the North Sea

Cod (*Gadus morhua)*, has particular cultural significance in the UK, but also in other countries such as Portugal and Spain. There are cod populations ('stocks') across the North Atlantic, ranging from the northeast coast of North America, across the coasts of Greenland and Iceland to Europe, where cod is distributed from the Bay of Biscay, the English Channel, the North Sea, the Baltic Sea, and the Barents Sea.

The North Sea is an extremely productive area for fisheries, with 17 major commercial species, including cod, haddock, whiting, capelin, plaice, and herring (Figure 3).

The North Sea cod biomass has declined substantially from between 440,000 and 1,250,000 tonnes in the 1960s and 1970s to current levels of around 200,000 tonnes.[51] The decline in catches becomes more dramatic when we consider the stock's historical productivity.

The data presented in Figure 4 has a relatively short time frame of around half a century, and shows how the total biomass has fallen following periods of high catches. Over this period, spawning stock biomass has fluctuated between 250,000 tonnes in the 1966–1975 period and current levels of 50,000 tonnes. Yet, before the advent of industrial fishing, the pristine stock may have been much larger. Now, even with no fishing pressure, its recovery is likely to be hampered by other anthropogenic factors, such as rising water temperature.[52,53,54] Higher catches could be sustained, but instead this iconic stock has now been classified as vulnerable to extinction.[55]

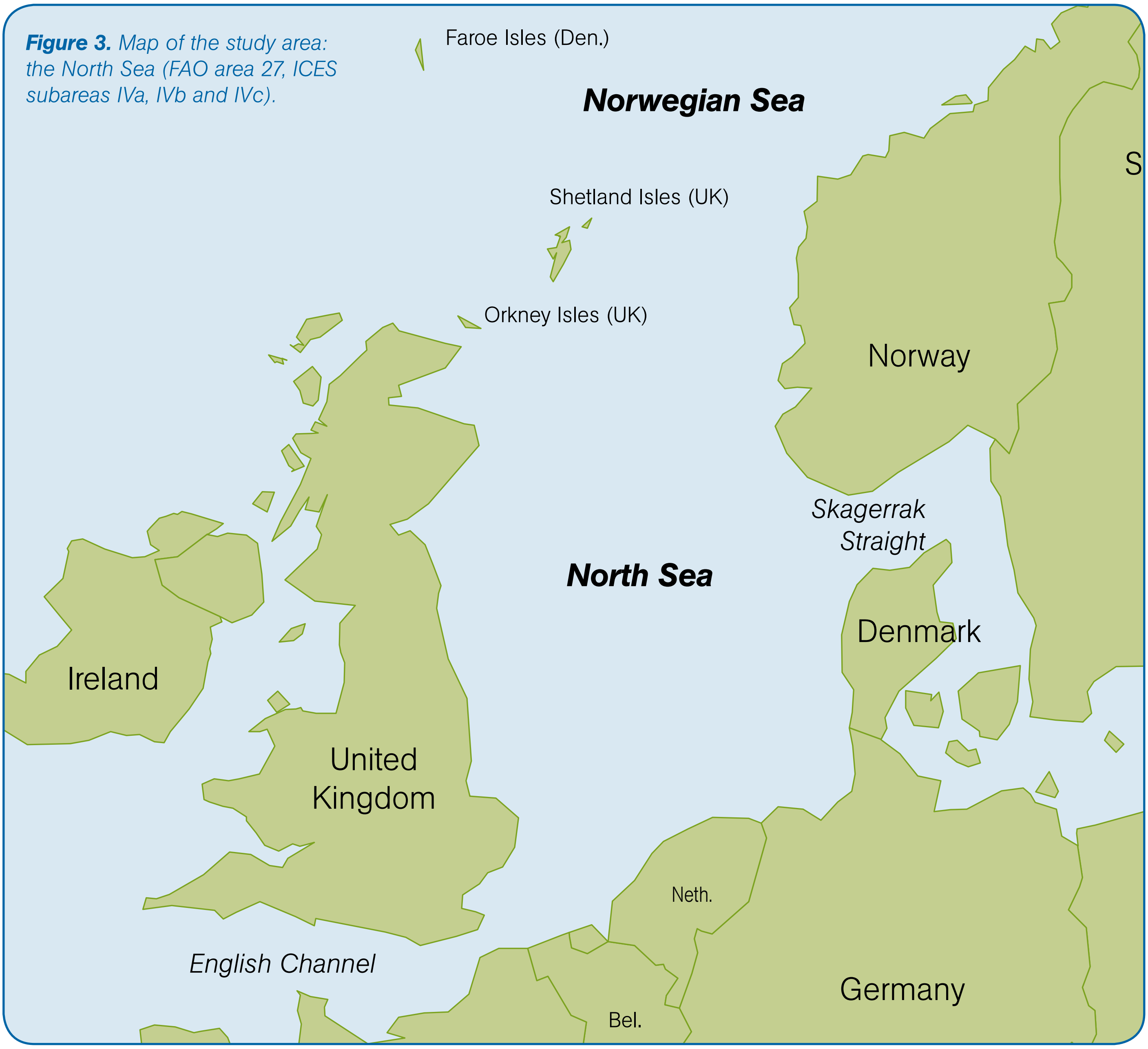


Figure 3. *Map of the study area: the North Sea (FAO area 27, ICES subareas IVa, IVb and IVc).*

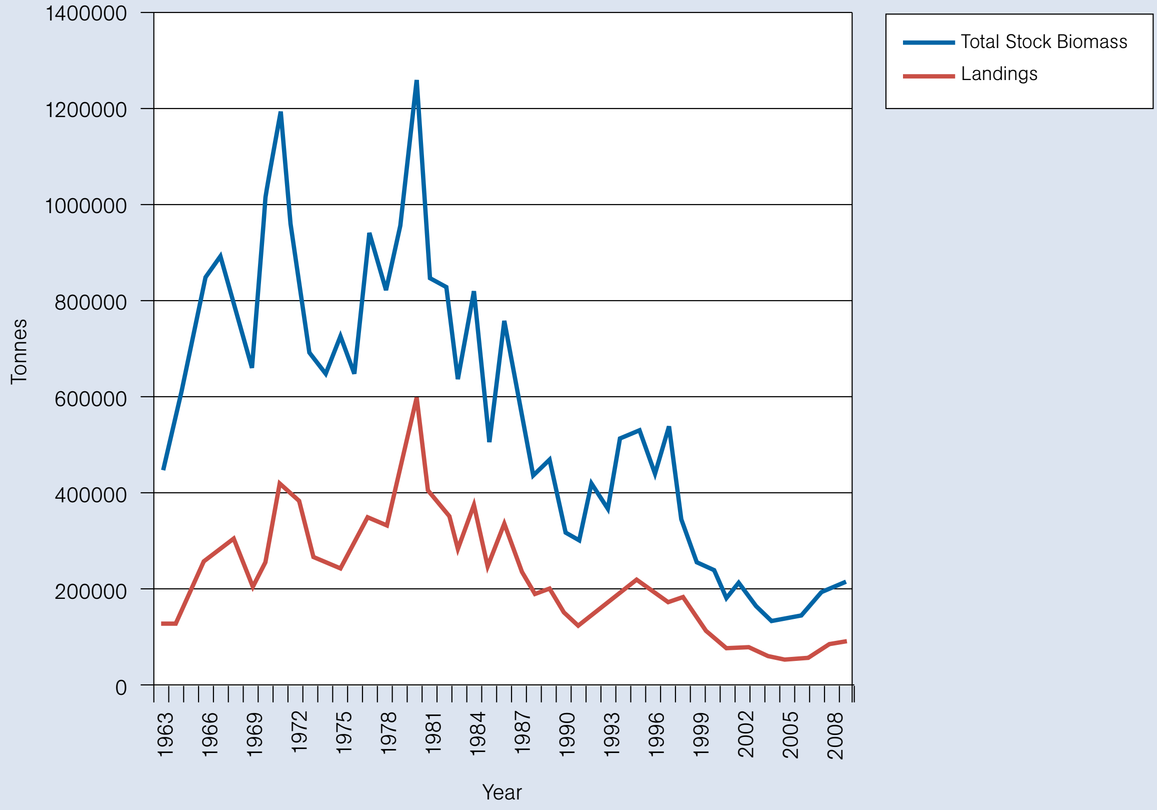
The UK has been responsible for around one-third (38 per cent) of annual North Sea cod catches for at least the past decade.[57] The UK fleet is, therefore, the singularly most important one in the North Sea cod fishery and provides a powerful case study. The next largest fishery is that of Denmark (approximately 27 per cent), with the other major European countries (the Netherlands, Germany, France, Belgium, Norway, and Sweden) together making up 33 per cent.

Cod biology

It is important to understand some cod biology to appreciate how poorly managed the stock has been, what impacts fishing currently has, and how the stock can be rebuilt.

Cod is an omnivorous species that lives in the ocean water column (pelagic zone) and near the bottom of the ocean (demersal). It is, as such, a target for trawlers and gillnets. The rate at which cod grow individually (their ‘intrinsic’ growth rate), and the rate at which they grow as a stock (‘recruitment’) both depend on multiple factors. Their intrinsic growth rate depends on water temperature, food availability, and even fishing pressure (which is altering their genetic makeup by continually catching the faster growing fish).[58,59,60] The size of the stock and the rate of recruitment depend on the number of mature fish in the stock (itself largely dependent on fishing activity), their spawning activity, natural predation (including cannibalism), food availability and climate variability.[61,62]

Figure 4. *North Sea cod biomass and landings by all countries 1963–2009.*[56]



Source: *International Council for the Exploration of the Sea (ICES)*

Evidently, the more fish there are, the more catches can be sustained, bringing in higher revenue and jobs to fishermen and their communities, and more fish supply to the public. But, catching too much will in turn negatively impact fishermen and their communities by diminishing the resource.

Individually, their growth rate is also highly important because given the limited number of fish in the sea, the largest quantity (by weight) of fish can be accrued by catching fish when they are older and weigh more. The modal weight of cod caught is around 1 kilogram for trawlers and 2 kilograms for gillnets. To put this in perspective, cod can live up to 20 years, with some recorded at 25 years of age, and with an average mass of 5–7 kilograms, though some have reached a mass of 100 kilograms.[63] On an individual basis, cod typically grow in a slight sigmoid fashion (Figure 5).

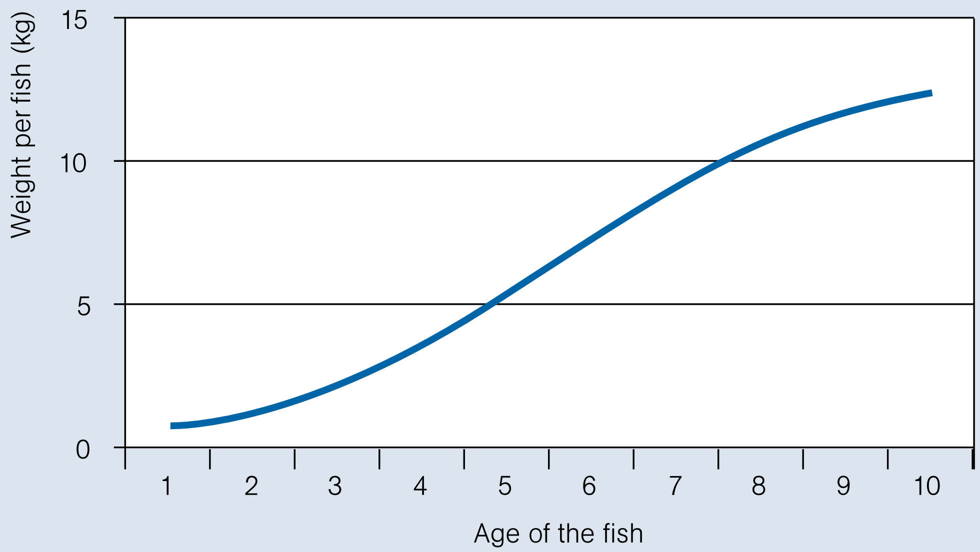
It seems clear that fishing should selectively catch the older fish, reducing the number of fish needing to be caught in order to maintain catch weights. However, there is another dynamic at play, which works against this: natural mortality. Each age of fish is exposed to different levels of predation, with the result that the maximum weights from fishing can be achieved by selectively catching the middle ages (6–7). The calculations behind this are illustrated in the **nef** report *Money Overboard*.[65]

Fishing for cod in the North Sea

North Sea cod are predominantly targeted by trawlers and gillnets because of their living range. The size of gillnet vessels goes up to 12 metres whereas trawlers can be 40 metres long or more.

In the UK North Sea cod fishery, trawlers are the major fishing gear used, with approximately 40 vessels in the 0–12 metres length category, 115 of length 12–24 metres, and 75 of length 24–40 metres. They are responsible for the vast majority of the cod catches, around 6,000 tonnes per year, or almost 40 times that of gillnets which is around 160 tonnes per year.[67]

***Figure 5**. North Sea cod weight-at-age per fish (kg), using data averaged 2000-2008.[64] Over time fishing pressure tends to lower the average weight of fish at each age. Data shown is only for landed fish; discarded fish tend to weigh less.*



Source: *International Council for the Exploration of the Sea (ICES)*

***Table 1.** Subfleet characteristics: number of vessels, capacity and power.[68]*

			Trawlers		
Average 2006-2008	***under 12m***	***12-24m***	***24-40m***	***over 40m***	***Sum***
Number of vessels	40.7	115.3	74.0	6.0	236.0
Subfleet tonnage (GT)	242.8	10,986.6	14,839.1	2,913.0	28,981.6
Subfleet power (kW)	2,563.6	31,414.2	35,283.5	7,779.7	77,041.0
Weight of landings (tonnes)	34.9	2,332.0	3,475.0	138.0	5,979.9
Value of landings (£)	48,399.0	4,521,931.7	7,131,930.8	289,977.2	11,992,238.7
Direct subsidies (£)	509.0	6,058.1	24,861.1	29,265.4	60,693.6
			Gillnets		
Average 2006-2008	***under 12m***	***12-24m***	***24-40m***	***over 40m***	***Sum***
Number of vessels	104.3	3.3	0.0	0.0	110.3
Subfleet tonnage (GT)	84.8	13.2	0.0	0.0	98.1
Subfleet power (kW)	970.7	44.2	0.0	0.0	1014.9
Weight of landings (tonnes)	60.9	N/A	N/A	N/A	N/A
Value of landings (£)	99,121.1	N/A	N/A	N/A	N/A
Direct subsidies (£)	2,204.8	0.0	0.0	0.0	2204.8

Overall there are 236 trawlers operating in the North Sea cod fishery versus 110 gillnets. Trawlers also have considerably more tonnage and power than gillnets. In terms of length, the median subfleets are 12–24 metres for trawlers and under 12 metres for gillnets. The number of vessels in each subfleet, along with the subfleets total capacity and power, are presented in Table 1.

Box 1. Gillnets and trawlers

Gillnets and entangling nets are nets constructed as a vertical wall in the water, suspended at specific depths by floats on the upper line and weights on the ground line. These are either anchored to the bottom (particularly in coastal waters) or freely drifting ('driftnets' are favoured on the high seas), or connected to the vessel. The mesh size is such that, in cod fishing, they are highly selective for target species and for the middle age range. The modal age of fish caught by gillnets is three years, weighing an average of 2 kilograms per fish.[69,70]

Because of a small mesh size, discard rates are extremely low, and so is the incidental catch of other fish species. However, by-catch of marine mammals, turtles, sharks, and seabirds is a serious worry worldwide.[71,72] High seas gillnet fisheries have, at their peak, led to 500,000 seabird deaths every year in the North Pacific.[73] In Europe, 90,000 birds are killed annually by gillnets, though the researchers suggest this figure could be 200,000.[74]

Gillnets can be modified to reduce the by-catch.[75] In one study, seabird by-catch was reduced by 75 per cent without affecting the fishery's efficiency.[76] Therefore, even if gillnets prove more sustainable than other gear types for the target stocks, perhaps certain areas should be closed to them.[77] Energy use is low because the gear is passive and is not actively pulled by vessels.[78]

Trawlers

Trawlers are vessels that tow cone-shaped trawl nets on the bottom or in mid-water. There are many variations of this kind of fishing gear, adapted to be towed with beams in muddy seabeds, or rollers ('rockhoppers') over rocks, and with mesh sizes intended for particular species and environments.[79]

Trawlers are one of the least selective gear types, catching all ages of target fish and bringing in considerable by-catch that are frequently discarded. The modal age of capture by trawlers is two years, when fish weigh around 1 kilogram per fish and are often immature (and even less likely to have reproduced).[80]

Additionally, trawlers have often been criticised for destroying marine ecosystems, and hampering the recovery of their ecology and the potential replenishment of the target species. They also require more fuel to actively pull the nets and attachments through the water (due to their typically larger size), resulting in higher emissions of GHGs.[81]

Methodology

We divided the fleet into gear type and vessel length categories. The impacts of each subfleet were assessed based on social, economic, and environmental factors. The net value of different subfleets was then calculated by putting these impacts together on a comparative basis

We divided the fleet into two gear types (trawlers and gillnets) and four vessel lengths (0 metres to under 12 metres, 12 metres to under 24 metres, 24 metres to under 40 metres, and 40 and over metres). This created eight subfleets, although we excluded the three gillnet subfleets over 12 metres in length because there were so few vessels as to make their data commercially sensitive. By dividing the subfleets this way we could elicit gear *and* length-specific impacts. The fleet is highly heterogeneous in terms of size, power, and fishing activity.

We present the activity across these fleets, subfleets, and average vessels of each subfleet. To make the fleets comparable, and to negate the effects of different catches due to quota allocation, all figures were converted to per-tonne units, with the exception of Catch Per Unit Effort (CPUE) and Revenue Per Unit Effort (RPUE) (both indicators of productivity).

Whilst the results are presented in subfleet categories, all calculations were made at the highest specification, starting with a per-trip basis in a given year, then finding average vessel values, and then subfleets. These were then scaled to a per-tonne-of-cod-landed basis to make fleets comparable.

Data requirements and sources

Data was obtained from the following sources:

- Fishing activity from the UK Marine Management Organisation (MMO)
- Cod biological data from the International Council for the Exploration of the Sea (ICES)
- Economic, employment, and subsidies data from the Annual Economic Report, European Commission[82]
- Taxes, GHG emissions and environmental costs from the UK Government

***Table 2.** Factors used to assess the impacts (and corresponding value) of the subfleets.*

Variable	*Unit of measurement*
Private costs and revenues	GBP £ per tonne of cod landed
Employment	Part-time and full-time equivalent (FTE) jobs per tonne of cod landed
Discards	GBP £ per tonne of cod landed
GHG emissions	GBP £ per tonne of cod landed
Subsidies	GBP £ per tonne of cod landed
Productivity (CPUE & RPUE)	Grams per fishing day & £ per fishing day

Note: CPUE: catch per unit effort. RPUE: revenue per unit effort

Vessel activity: Marine Management Organisation

Vessel activity data was obtained from vessel logbook data held by the MMO, a government body associated with the Department for Environment, Food and Rural Affairs (Defra). This extensive dataset covers vessel characteristics and trip information for all vessels fishing in the North Sea for the period 2006–2008. We used averages of these three years, and all monetary figures are nominal (we do not adjust for inflation).

The parameters in this database used in the study can be divided into vessel-specific data and trip-specific data. Vessel data consisted of nationality, home port activity years, vessel identification number (rss), and vessel tonnage, power, and length. Trip data for each vessel consisted of date of departure from and return to port, port of landings, size of the catch by species, and corresponding revenue.

Biological data: ICES stock parameters

Data on cod stock parameters were collected from ICES, an authoritative network of international scientists that promotes marine research on the North Atlantic Ocean and adjacent seas. We collected data on a number of stock-specific parameters: weight-at-age, and catch and discard rates by gear type operating in the North Sea. We used these to estimate the number of fish caught (including discards) by each gear type per tonne landed. Assuming the same per tonne value of landed cod by each subfleet,[83] we estimated the potential value of these discards.[84]

The MMO dataset contained data on the landings per vessel and per trip. However, this did not tell us the level of discarding, which we estimated using gear selectivity characteristics and cod biological parameters sourced from ICES working groups[85]. Data included landing and discard rates-at-age for each gear type in each fishing area, and landing and discard weights-at-age.[86] Given each tonne of cod landed by each gear type, we could calculate the number, age, and weight composition of the catch, including gear-specific average discard estimates.

Economic data and employment: Annual Economic Report on European Fishing Fleet

Most economic data were taken from the Annual Economic Report (AER) on EU fishing fleet;[87] the flagship economic report produced by the Joint Research Council (JRC) of the Scientific, Technical, and Economic Committee for Fisheries (STECF) for the European Commission (EC).

While the AER data covers every UK subfleet, it is based on multiple fishing grounds and species, with few figures based on the North Sea specifically, and none on cod fishing alone. An important consideration, therefore, is the attribution of impacts to North Sea cod fishing specifically. We calculate average (nominal) values, per subfleet-specific vessel, and over the 2002–2007 period. We then assumed that each economic parameter made up a constant share of fishing revenues, and that this relationship held equally for the general AER data as for North Sea cod fishing itself. Without better data on attribution, we tested other methods, such as fishing effort-related costs, but found these estimates less realistic when compared to other estimates of economic data of fisheries.[88] Furthermore, fixing parameters as shares of revenue is a behavioural assumption that fishing is done according to expected profits (and, therefore, revenues).

For example, the AER may show that a 12–24 metre trawler has fuel costs making up 30 per cent of its revenues. If the logbook data indicates that a 15-metre-long trawler catches £5,000 of cod in the North Sea in one trip and £5,000 of other fish species, we attributed 30 per cent of revenues to fuel costs, of which 15 per cent is attributed to cod fishing specifically. This is a slight simplification, in that the economic data is annualised, so we had to annualise the trip and vessel activity data from the logbooks. Also, crucially, to make the fleets comparable, as the final stage, all parameters (revenues and costs, GHG emissions, subsidies and discard rates) were converted to a per tonne of landed cod basis.

Private fishing costs
Using this approach we estimated the following parameters of the private economic costs of fishing: crew, fuel, repair, capital, variable, fixed, and total costs. Also covered was fuel use (litres per subfleet vessel) which was in turn used to calculate vessel GHG emissions, as well as indirect fuel subsidies (tax rebates on fuel used for commercial fishing).

GHG emissions
Fuel costs for catching (strictly, landing) cod, as estimated above, were divided by the fuel cost per litre (itself based on the AER, calculated as total fuel costs divided by fuel consumption in litres). This gave an estimate of fuel consumed in catching cod. GHG emission costs are estimated by multiplying fuel use in litres by the carbon equivalent (CO_2e) emissions per litre (0.0026694 t/CO_2e) and then by the short-term non-traded price of £60 per tonne of CO_2e in 2020[89,90].

Employment
Crew cost per FTE employee was calculated from the AER and was then multiplied by the cod-specific crew costs. This told us the number of employees that could be supported (in total and in FTE) by cod revenues.

Subsidies
Direct subsidies were calculated by cross matching each vessel in the study sample (by vessel-specific rss identification codes) with an EC-derived database of direct transfer subsidies for the years 2006–2008.[91] As with other parameters, averages per year were calculated, and then estimates of subfleet-specific subsidies (rather than vessel-specific). These were then scaled similarly to the cost estimates above (scaling to cod-specific revenues). This was done on the assumption that subsidies are either awarded based on financial performance or that it is reasonable to apportion subsidies proportional to the revenues they supplement.

Marine diesel consumption by commercial fishing vessels is exempt of fuel duty, which we considered an indirect subsidy. We valued this subsidy by assuming a duty for marine diesel equal to diesel for recreational marine vessels, and normal diesel used by land vehicles, both of which are taxed by the UK Government at £0.5895 per litre[92], and then multiplying this by the estimated fuel use per vessel (and specific to cod fishing).

Discards
To value the discarded fish, we used a previously published method.[93] We used the catch and discard (for each age) rates for each gear type, and combined these with their weights (at each age) to calculate the relative weights that make up one tonne of catch. This provided us with estimates of the quantity of discards per tonne of landed cod, and we applied the same subfleet-specific price per tonne of landed cod to these discarded fish. We did not compensate for price or displaced landings since we assumed that landings by individual vessels would not affect market prices.

Productivity
Species effort was calculated by multiplying the days at sea by the weight-proportion of the catch of each species, multiplied by the power of the vessel. Catch per unit effort (CPUE) was then calculated by dividing the catch of each species (in grams) by the effort required per species, while revenue per unit effort (RPUE) was calculated by dividing cod revenues per species by effort.

Converting variables into net social value
Crew cost is considered a private and a social cost, while employment is a social benefit. While this is paradoxical, and also ignores the community and well being value of employment, we took this approach for simplicity and to reflect the fact that public funds used to support employment are simultaneously an investment cost and benefit. Other costs are fuel, repair, variable, fixed, and capital costs. Other costs, specifically on society, are GHG costs, all subsidies, and the costs of discard fish.

All of these costs were then subtracted from fishing revenue (the landing value of a tonne of cod) by each subfleet to give net societal impact. While crew costs form part of this calculation, employment levels are shown separately to reflect the fact that they are themselves a societal goal.

Controls, caveats and exclusions

Controlling for sources of error

Differences may have arisen between the impacts of fleets due to environmental factors rather than the fleet behaviour itself. To control for this, we studied the two fleets targeting the same cod stock (North Sea in ICES area 27.4a-c). However, differences remain. For example, gillnets fish mostly in the southern North Sea, while trawlers fish mostly in the northern parts.

Quota allocation can affect the results in that those fleets with the largest quota will inevitably have results skewed by the size of the quota, which in turn is more of a policy decision than fleet behaviour. To control for this, comparisons between fleets were done on a per-tonne-of-cod-landed basis, where appropriate.

Static vs dynamic

Our analysis is a static one; we looked only at the temporal snapshot of the fleets. We did not incorporate any dynamic feedbacks (except where they implicitly affected fleet behaviour).

Relevance of parameters

We consider the parameters included in this study to be the major ones capturing the impacts of fishing on society of the two different fleets. Some are far more significant than others – for example, fuel subsidies compared to repair costs – in determining their societal value, and whether the activity is overall a net benefit. Other parameters that have been excluded from this study – mostly due to resource constraints, lack of quality data, or significance – may individually or altogether lead to some changes in the fully accounted impact of fisheries. For example, we could not find any data on tax revenues from either gillnets or trawlers operating in the North Sea. In this regard, we depend on future research to revise and improve our own figures.

Geographical scope

As discussed in the previous section, there are different distributions of trawlers and gillnets in the North Sea. This may be due to a number of factors, some of which would make the results less potent. For example, the northern areas of the North Sea may be more appropriate for trawlers, perhaps because they are further from the coast and require larger vessels. In these instances, gillnets may also prove destructive to society if they were used to travel further than they normally do. However, it remains a valid point that even in areas of exclusive fleets, where only one gear type operates, fleets should still be contributing positively to society.

Sustainability

We did not measure the sustainability of the fishing, probably the single most important factor that has not been included here. The costs of unsustainable fishing may well be enough to negate any positive returns from fishing activity. While it may seem that there is little to differentiate the impacts on the sustainability of a stock from the removal of one tonne of fish by a trawler compared to a gillnet, this is not true. Trawlers tend to catch younger fish and discard far more for every tonne of fish landed. Their resource costs are, therefore, much higher, due to the waste of fish (discarded) and young fish now no longer able to reproduce. Consequently, the inclusion of sustainability in this analysis is likely to weigh more against the impact of trawlers than against gillnets. The answer to the question of which gear type should be allowed to fish is unlikely to change, but it may be found that for stocks at low levels such as cod in the North Sea, less or zero fishing effort for a few years would contribute positively to society in terms of speed of stock recovery.

Nominal values

All economic values are nominal, without adjusting for sectoral inflation. We did not collect data on underlying inflation of prices in the fishing sector. Adjusting the figures is unlikely to alter the results, particularly comparisons, significantly.

Cultural value

We didn't look into this in detail so our assumption is that the cultural value is equivalent across the gear types and does not differentiate their impacts significantly.

Exclusion criteria

A number of exclusion criteria were used. First, trips were only included if cod was landed. Therefore, while a vessel may spend many days at sea fishing many species, we only included them on a trip-by-trip basis. First, only trips where cod was landed were included. Estimates of fleet characteristics represent only cod-related activity, not all activity. Second, trips are only in ICES areas 27.4.a, 27.4.b and 27.4.c, where the North Sea cod stock is located. Third, there must be more than six vessels per category in order to be counted, due to confidentiality issues.

Photos: © OCEAN2012 and Corey Arnold

Results

Values are presented in tables and figures on a subfleet, vessel or per tonne basis. Per-tonne-of-cod-landed values are important given the issues of quota being allocated largely to trawlers, which land just under 6,000 tonnes versus the 163 tonnes landed by gillnets.[94]

Catches

While the trawler fleet is much larger than the gillnet fleet, it also lands the largest quantity of cod, as can be seen in Table 3 and Figure 7. These serve to illustrate the imbalance between the gear types, with larger trawlers given far greater access to cod resources.

These figures are shown graphically in Figure 7. Clearly, catches by medium to large-sized trawlers dominate the cod fishery in the North Sea.

The cod catch per vessel in each subfleet shows similar results, but with the largest trawlers also catching substantial quantities on a per vessel basis (Table 4 and Figure 8). Therefore, not only do the larger trawlers land the greatest quantity, but there are also many more of these vessel types.

Table 3. *Weight of landings and discards (in tonnes) for each subfleet category on a subfleet basis.*

Whole subfleet	Trawl				Gillnet
Average 2006–2008	<12m	12–24m	24–40m	+40m	<12m
Number of vessels	40.7	115.3	74.0	6.0	104.3
Weight of landings (tonnes)	34.9	2332.0	3475.0	138.0	60.9
Weight of discards (tonnes)	9.3	624.7	930.8	37.0	0.0004053

Table 4. *Weight of landings and discards (in tonnes) for each subfleet category on a per vessel basis.*

Per vessel	*Trawl*				*Gillnet*
Average 2006-2008	<12m	12–24m	24–40m	+40m	<12m
Fleet (number)	40.7	115.3	74.0	6.0	104.3
Weight of landings (tonnes)	0.973	20.194	46.929	23.957	0.589
Weight of discards (tonnes)	0.261	5.409	12.571	6.417	0.000004

Figure 7. *Total catches, composed of landings and estimated discards, per subfleet. The major subfleets targeting cod are the trawlers of length 12–40m.*

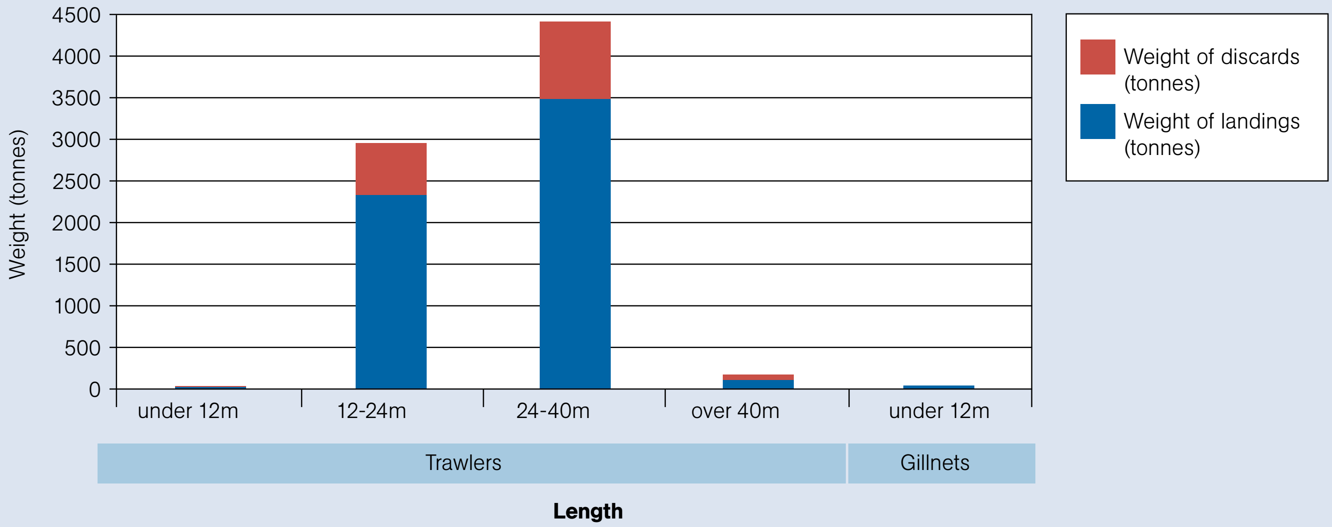
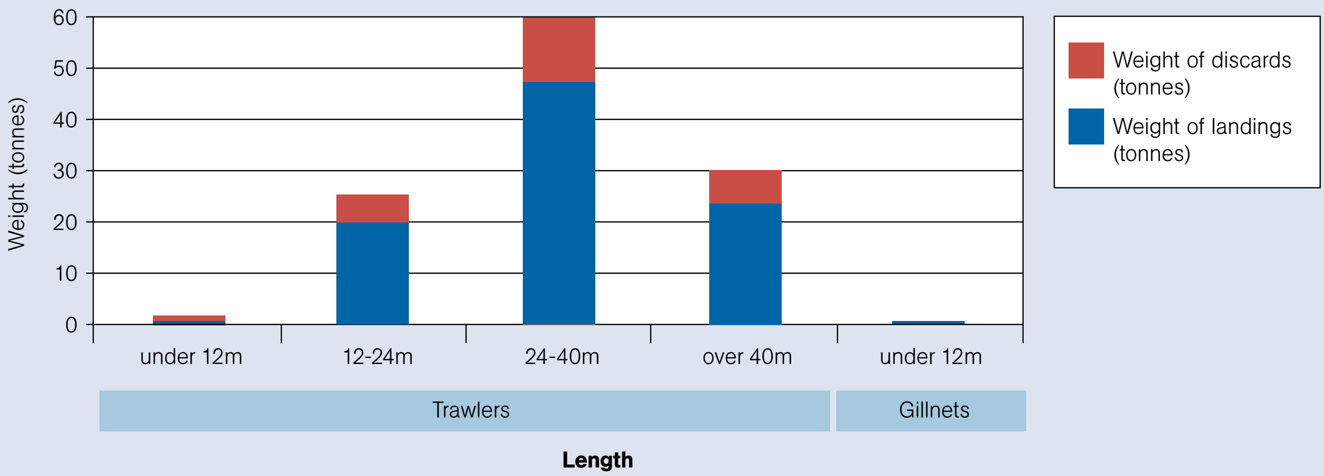
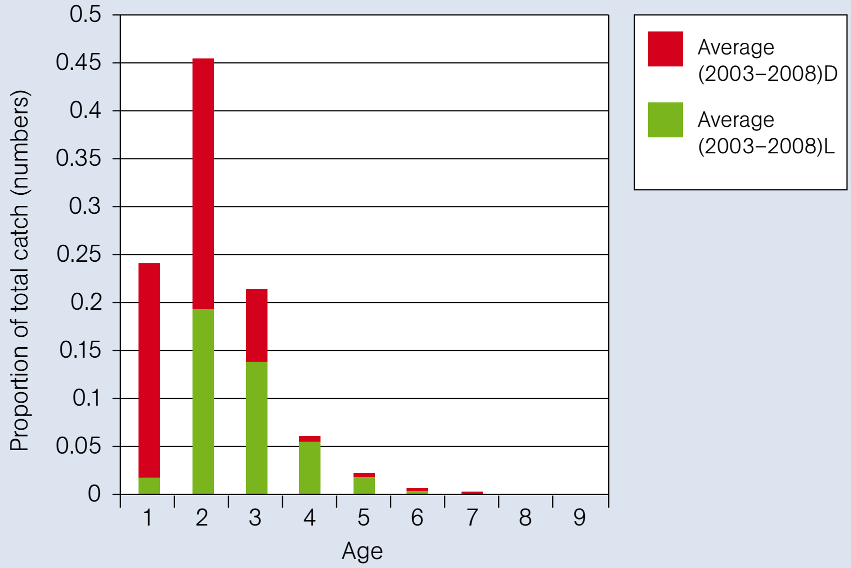


Figure 8. *Landings and estimated discards per vessel of each subfleet. Large trawlers, particularly 24–40m trawlers, catch more per vessel than under 12m vessels. Own calculations based on source data.*



Figures 9a and 9b. *Landings and estimated discards per vessel of each subfleet. Large trawlers, particularly 24–40m trawlers, catch more per vessel than under 12m vessels. Own calculations based on source data.*



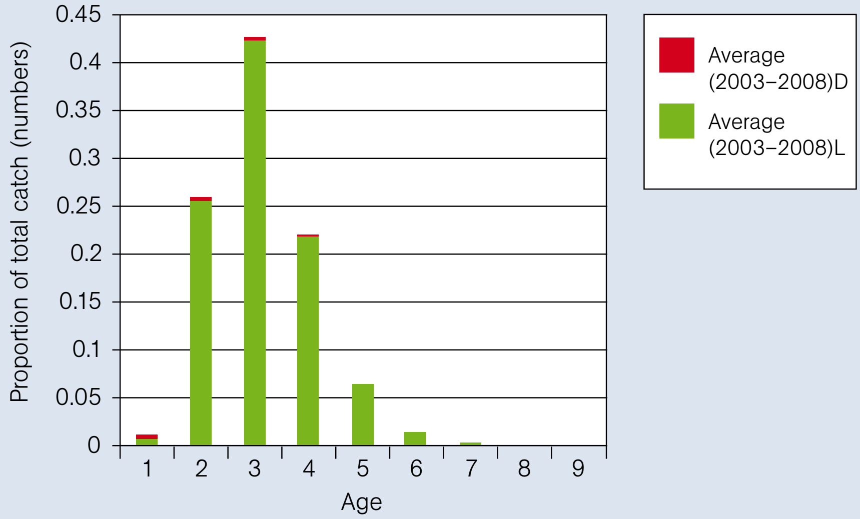


Figure 10. *Value of landings and estimated discards per tonne landed by each subfleet. Discards tend to weigh less than landed fish, so that large numbers of young discards may have relatively little value on a per tonne basis (but may have considerably higher value in a sustainable value to the stock, which is not measured here). Source: Own calculations based on source data*[96,97].

Figures 9a and 9b illustrate the proportion of landings and discards in numbers of fish, stacked to 100 per cent of any particular catch. For example, if 100 fish are caught by trawlers, just over 20 fish aged 1 will be discarded, and just one to two fish aged 1 will be landed. This is important because the discarded fish, even if they weigh less than those kept for landings, could have been left alive to reproduce, contributing to the future health of the stock. There are no vessel lengths shown because selectivity depends on the mesh size of the nets used (TR1 and GN1) and not the length of the vessel.

The figures are different on a per-tonne basis, rather than per individual fish. Discarded fish tend to weigh less than those landed, so on a per-tonne basis, the difference in selectivity between the gear types is less severe in value terms (Figure 10).

Productivity

CPUE (in grams/kW days) and revenue-per-unit-effort (RPUE, in £/kw days) are shown in Table 5 and Figure 11. Gillnets have the lowest RPUE and the second lowest CPUE, after trawlers larger than 40 metres. This may in part reflect the well-known difficulties of estimating gillnet effort based on kW, where the static gear's effectiveness is mostly independent of the power of the vessel (since the nets are not pulled by the vessel, as with trawlers). The most productive vessels are small trawlers under 12 metres, though the 12–24 metres category earns the highest RPUE.

***Table 5**. Productivity of each subfleet in weight and revenue per unit effort terms. CPUE = Catch-per-unit-effort, where catch units are grams (by convention) and effort units are in kW x days. RPUE = Revenue-per-unit-effort, where revenue units are sterling (£) and effort units are in kW x days. Days spent fishing calculated as total trip length (in days) multiplied by the catch in weight of cod, divided by the catch in weight of all species (i.e. time attributed by size of the cod catch). Data from MMO and ICES.*[98]

Average 2006–2008	***Trawl***				***Gillnet***
Average 2006-2008	<12m	12–24m	24–40m	+40m	<12m
CPUE (g/effort)	7257.9	6272.7	4319.7	1339.2	1892.9
RPUE (£/effort)	8.1	10.8	8.7	3.5	3.2

***Figures 11a and 11b:** Catch-per-unit-effort (CPUE) and revenue-per-unit-effort (RPUE) of each subfleet. The most productive vessels in catch terms (highest CPUE) are 0–12m trawlers, with gillnets (0–12m) being one of the least productive. In terms of revenue, trawlers of 12–40m are more productive, in large part due to their higher value per tonne. Own calculations based on source data.*[99,100]

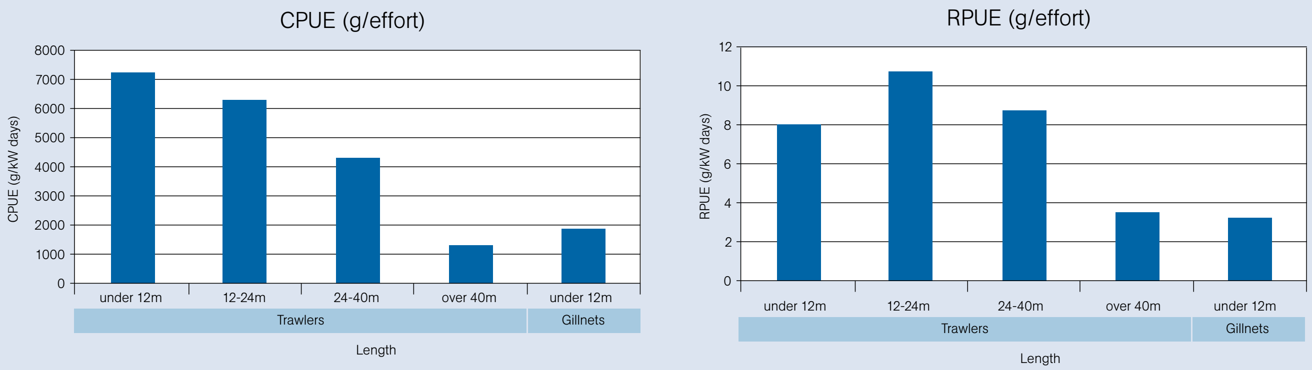


Figure 12. Employment per tonne of cod landed by each subfleet. See Appendix for supporting table.[102]

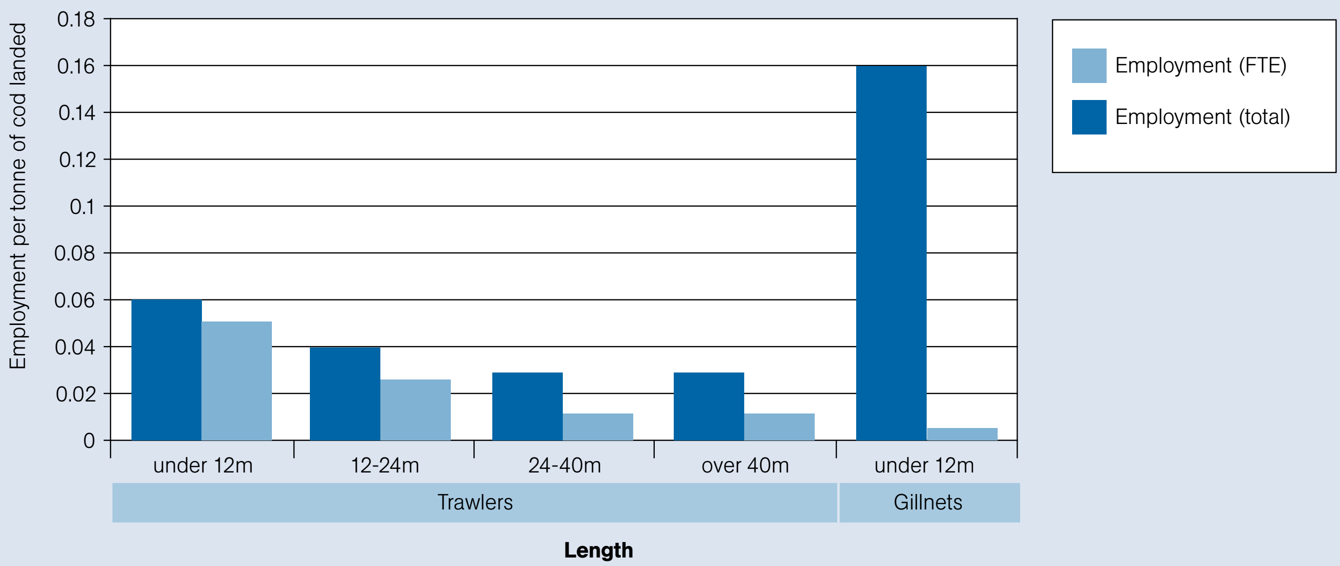
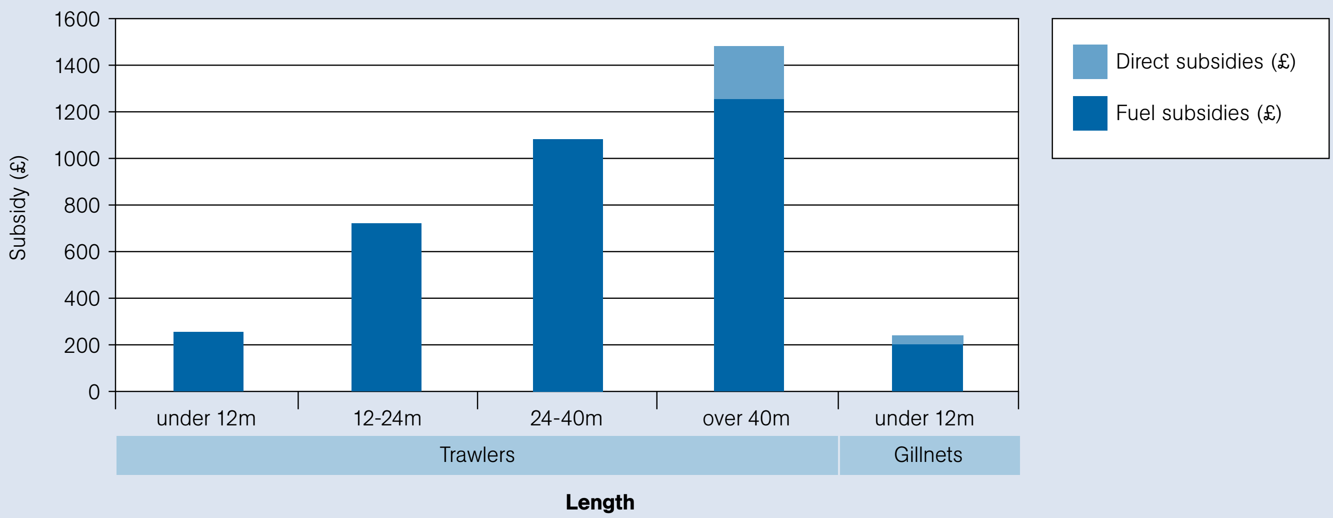


Figure 13. Subsidies received by vessels of each subfleet per tonne of cod landed. Calculations based on source data[103,104,105].



Employment

We assume that crew costs are the same as those reported in the AER[101] and, therefore, the results presented are for the numbers of employees supported by the revenues derived from landing one tonne of cod alone (i.e. employment per landed tonne of cod). These results are shown graphically in Figure 12.

Subsidies

Subsidies are split into direct and indirect fuel subsidies, with totals also shown in Table 6. Evidently, fuel subsidies scale with fuel consumption, with larger vessels with more power requiring more fuel. More surprising, however, are the direct subsidies which the 40 metres and over trawl fleet enjoys.

Figure 14. *Cost of GHG emissions*

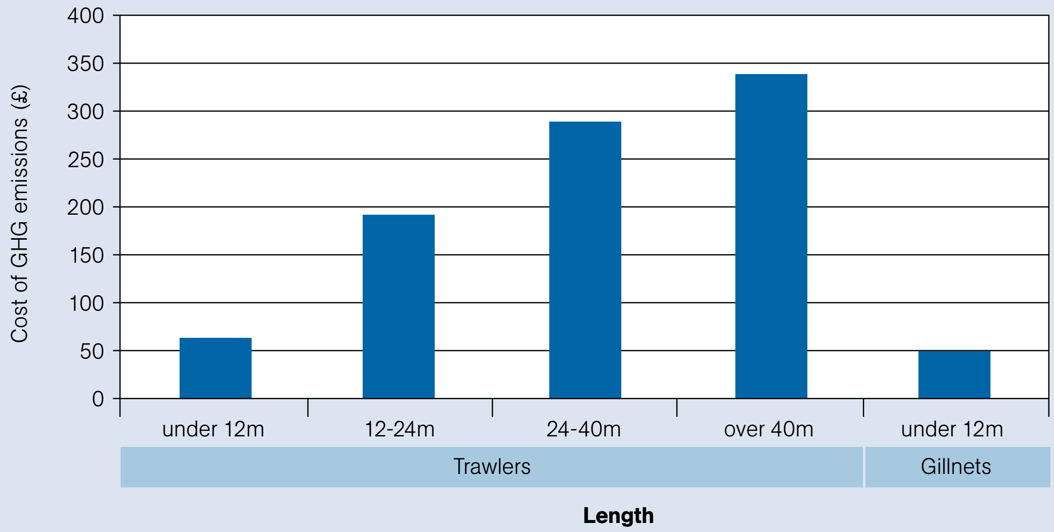
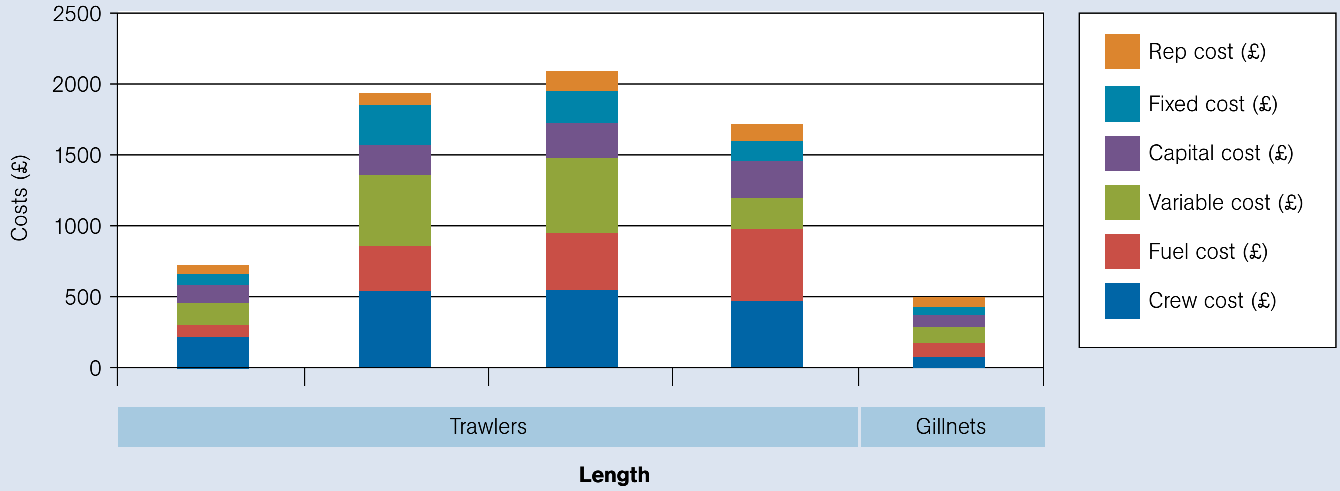


Figure 15. *Private costs per tonne landed by each subfleet. Own calculations based on source data[106].*



Value of greenhouse gas emissions

Similar to indirect fuel subsidies, GHG costs scale with fuel use and, therefore, are mostly caused by trawlers, increasing with the size of the vessel.

Total costs

Figures 15 and 16 pull together these results to show total private costs and total societal costs in a decomposed fashion.

Table 6. *GHG costs for each subfleet, calculated on a per tonne basis. Results clearly scale with fuel use, in turn dependent on the size (length, capacity and power) of the vessel.*

		Trawl			Gillnet
Average 2006–2008	<12m	12–24m	24–40m	+40m	<12m
GHG cost (£)	65.0	192.8	289.3	340.0	53.2

Figure 16. Private and societal costs per tonne landed by each subfleet. Own calculations based on source data.

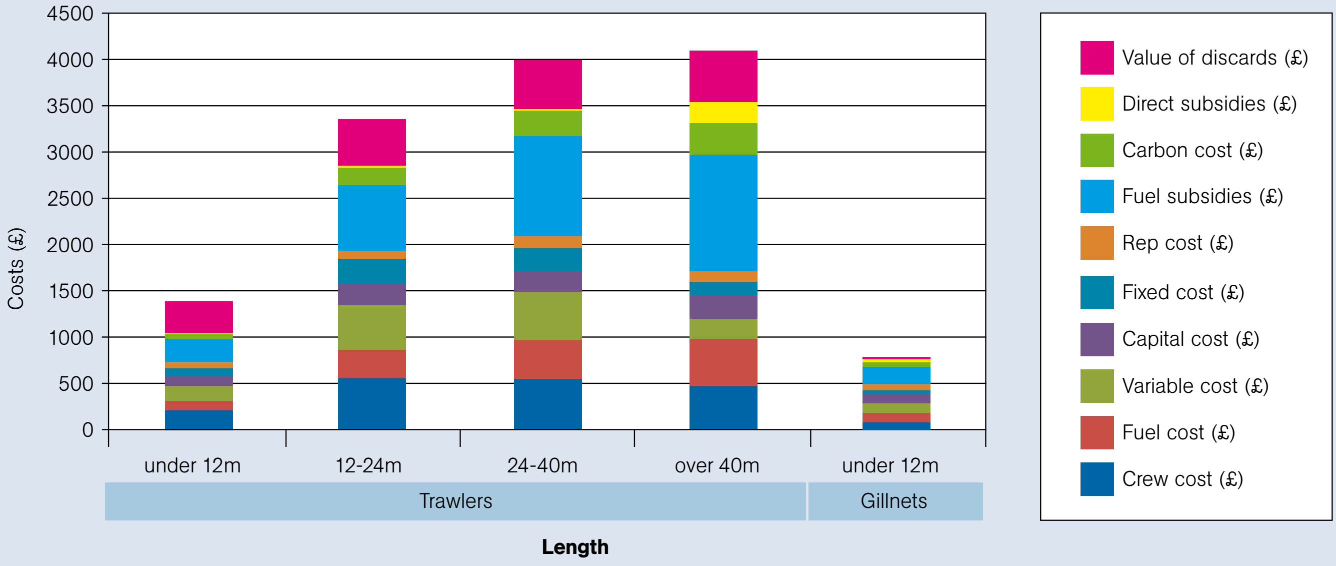
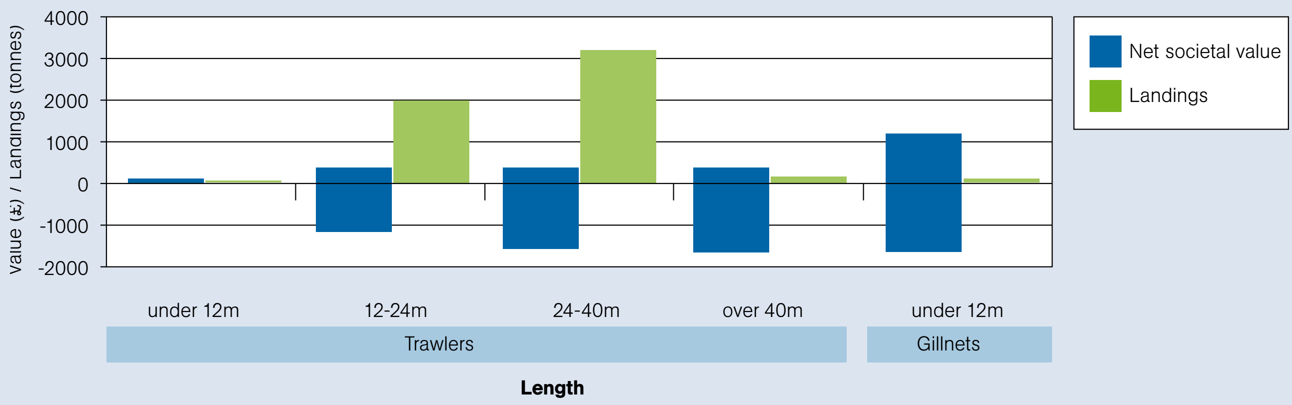


Figure 17. Societal profit per tonne of landed cod, and total landings of cod, by each subfleet type. Gillnets show the largest benefit per tonne of landed cod, with all other subfleets being destructive to society in their cod fishing, particularly the larger trawlers. Landings are in tonnes, and value is in GBP£, both on the vertical axis. Source: Own calculations based on source data.



Societal costs

Calculating social costs of fishing supplemented all of these plus three further factors: discard market value, GHG emissions, and subsidies, shown in Figure 16.

Societal benefits

The net benefits ('social profit') of fishing are derived by subtracting the above costs from the total revenue of landed fish, plus the value of job creation (a loss to private operators and an investment by society, but which is negated by an equal social benefit of employment, though this only partially captures the wider societal benefits of employment). These values are contrasted with the landings of each subfleet to show the disparity between who is allowed to fish and who generates the most value to society.

Discussion

The fishing industry is less important to Europe's economy than its sewing-machine manufacturers. Yet it consistently gets to overrule scientific advice and drive fish stocks to the brink of collapse. Without massive subsidies, European fisheries would be bankrupt: the cost of hunting the few remaining fish would exceed the income from selling the catch.

Dr Rainer Froese, Fisheries Scientist[107]

The results presented in this report demonstrate the differences between two major fleets in the North Sea targeting cod, an iconic stock of enormous economic value both for the UK and the EU generally. The figures speak for themselves: for every tonne landed, gillnets deliver £865 of net value, while trawlers destroy value of between £116/tonne for the smallest vessels (0–12 metres) and £1,992/tonne for the largest vessels (over 40 metres).

The results are stark when environmental and social variables are calculated in net terms: all trawlers, regardless of size, have a deleterious net societal impact, while gillnetters have a positive impact. The policy implications of this are simple: where fish resources can be exploited by either, access should be granted to gillnet-equipped vessels at the expense of trawlers. It is shocking that there are no access criteria, or even comparative socio-environmental assessments, used by the EU in allocating resources. This is a costly mistake: for each tonne of North Sea cod landed by a trawler, the UK is losing value.

There are surprisingly few assessments comparing fishing practices, and fewer still that incorporate the social and environmental factors. But, this is only more surprising considering that the objective of fisheries management is to maximise society's gains.

While we have not looked at other stocks in UK or EU waters, the principles applied here can easily be extended to measure the impacts of fishing activities on society in general. Other impacts could also be considered. For example, we did not include the cultural value of fisheries, which may be more prominent for certain fishery types such as small-scale fisheries. Also significant is that we did not measure the sustainability of the fishing: we did not look at the opportunity cost of catching fish (whether landed or discarded), i.e. the benefit accrued were the fish left in the sea to potentially reproduce and replenish the fish stock. Considering existing low stock levels, and their potential for re-growth, it is highly possible that the opportunity cost of fishing is so great that it makes current gillnet fishing destructive.

Sustainability is largely determined by the scale of fishing, and in this respect there is little to differentiate the two gear types analysed. Both can be used to catch an unsustainable or sustainable amount of fish, i.e. the opportunity cost of fishing will equally impact the value of gillnets and the value of trawlers. Yet, there are other factors that *would* differentiate the gear types. For example, trawlers tend to catch younger, more immature fish than gillnets (Figures 9a and 9b), which means lower weight per fish and also lower spawning in the next generation. Trawlers also have larger ecosystem impacts, reducing biodiversity, altering the physical basis of the ecosystem, and changing the balance of the trophic levels, which can all reduce the replenishment of target species in the trawled area.[108,109]

Therefore, while this analysis does not capture every impact, we believe that many of the factors excluded from the analysis would actually work more against trawlers than against gillnets. It is also worth noting that this is a static analysis. We did not optimise the allocation of resources across the fleet. It may be the case that some factors become more or less important depending on the abundance of the stock. As also mentioned in the caveats section, these results are most pertinent to areas in the North Sea where gillnets and trawlers are equally capable of fishing cod.

We urge caution in the application of the results. For instance, the results should not be interpreted such that gillnets are always better for society than trawlers, or that smaller vessels are better than larger ones. In this particular case, that of the North Sea cod stock, we found that this is true, and indeed only in areas where gear types overlap. There are many factors that would favour performance of one type of vessel/gear versus another: whether it is a mixed or single species fishery; whether the fish are near to the coast or in the deep ocean; whether the stock is healthy or overfished, and so forth.

Should North Sea cod resources be allocated entirely to gillnets?
The short answer to this is 'no', for two reasons. First, gillnets can outcompete trawlers in terms of societal value only where they overlap trawlers in their fishing grounds. Where they do not, the questions instead become: Should these resources be exploited at a significant cost to society? What technologies can be better used in these fishing grounds? Secondly, as they currently operate, gillnets may be inflicting a high cost on biodiversity through their by-catch levels, which has not been measured here.[110]

Priority access therefore becomes a reward to the most sustainable fishing available. The use of quotas in this way requires the fleet to constantly evolve such that the application of criteria to an entirely gillnet fishery would in turn spur the innovation of more environmental and social approaches. For example, there are multiple ways to improve gillnets so as to reduce their by-catch levels.[111,112,113]

Implementation of access criteria – is it possible?
What we argue here is that it is possible to implement access criteria, and indeed it is necessary to do so. The implementation of access criteria requires strong regulation and commitment from policymakers. Fisheries science is rapidly progressing towards an ecosystem approach, where all interactions in complex marine ecosystems are considered, along with the impact of fishing activity.[114,115] While this is an advance on single-stock assessments, it is still in its infancy. In developing countries, where even single-stock assessments can be unfeasible, ecosystem-based assessments can prove impossible. Here, ecological indicators can prove particularly useful. The same developments are needed for social and economic impacts, where the broader implications of fishing need to be considered.

There are a number of ways that fisheries policy can assess the social and environmental impacts of fisheries, and allocate resources appropriately. Some major ones are:

1. Employing evidence, data and analysis using broader cost-benefit analysis.

2. Using indicators of better management approaches.

3. Making comparative (i.e. ordinal rather than cardinal) allocations that favour more constructive/less destructive methods over others.

Developed and developing countries face different challenges in the valuation and subsequent allocation in fisheries.

Developed countries tend to be data-rich, facilitating the assessment of different fisheries impacts. The skills to perform such an analysis also exist. What is lacking, however, is the institutional framework to ensure resources are allocated based on these impacts. A number of features need to be in place for this to happen. In the political arena, there needs to be transparency, accountability, industry-independence, and legal recognition of the need for evidence-based policy that extends beyond political short-termism. Policy implementation then needs to be supported by effective enforcement, penalties for infractions, monitoring, observing, and so on. In terms of the evidence required to support access criteria for fishing, much of this has already been collected and researched. Despite this, neither the EU, nor its member states, allocates fish resources on any social or environmental criteria.

Data-poor countries, particularly in the global south, are rarely able to perform such an analysis, and have a set of more pressing problems. Tropical fisheries contribute around half of the world's supply of fish,[116] making their management equally important to the global north – if not more so because of the higher regional biodiversity and their economic dependence on natural resources. Some of the additional challenges facing fisheries science in developing countries are cost-effectiveness, credibility amongst stakeholders, and being of practical use to management.[117] In these cases, indicators can prove helpful substitutes for full data collection and analysis. Degnbol and Jarre provide a lengthy list of candidate indicators that can be used, with scope to balance cost-efficiency and robustness of information; some of these are already in use.[118] One indicator, for example, could be the size and maturity of fish in catches, sampled across different gear types in a fleet.

It is clear that the range of data informing fisheries management is not only useful for stock assessments and understanding fleet-wide impacts, but is also useful for allocating resources so as to maximise societal gains. Fishing activity can be 'ordered' according to its collateral impacts as studied elsewhere (but with as similar characteristics as possible to the area of implementation). Where fish stocks can be exploited by multiple different gear types, for example, then access should be granted to the more sustainable types of fishing (i.e. with the lowest collateral damage).[119,120] Studies of gear types are fairly extensive, with the difficulty lying in the parallels that can be drawn between the impacts in different areas.

These three assessment approaches must incorporate interdisciplinary information from the natural and social sciences. Some types of information are inevitably easier to obtain, and this can skew the weighting of the three pillars of sustainability: social, environmental, and economic. However, it is worth bearing in mind that the environmental side determines the boundary conditions of natural resource exploitation, and must be considered foremost. The lack of information about environmental sustainability is not substitutable by other factors, such as economic profits, since it is well established that such profits can be entirely destructive to society's welfare.[121,122] Instead, a precautionary approach must be adopted, with the resources allocated in a highly conservative fashion but still in a criteria-based fashion, using broader social and economic impacts.

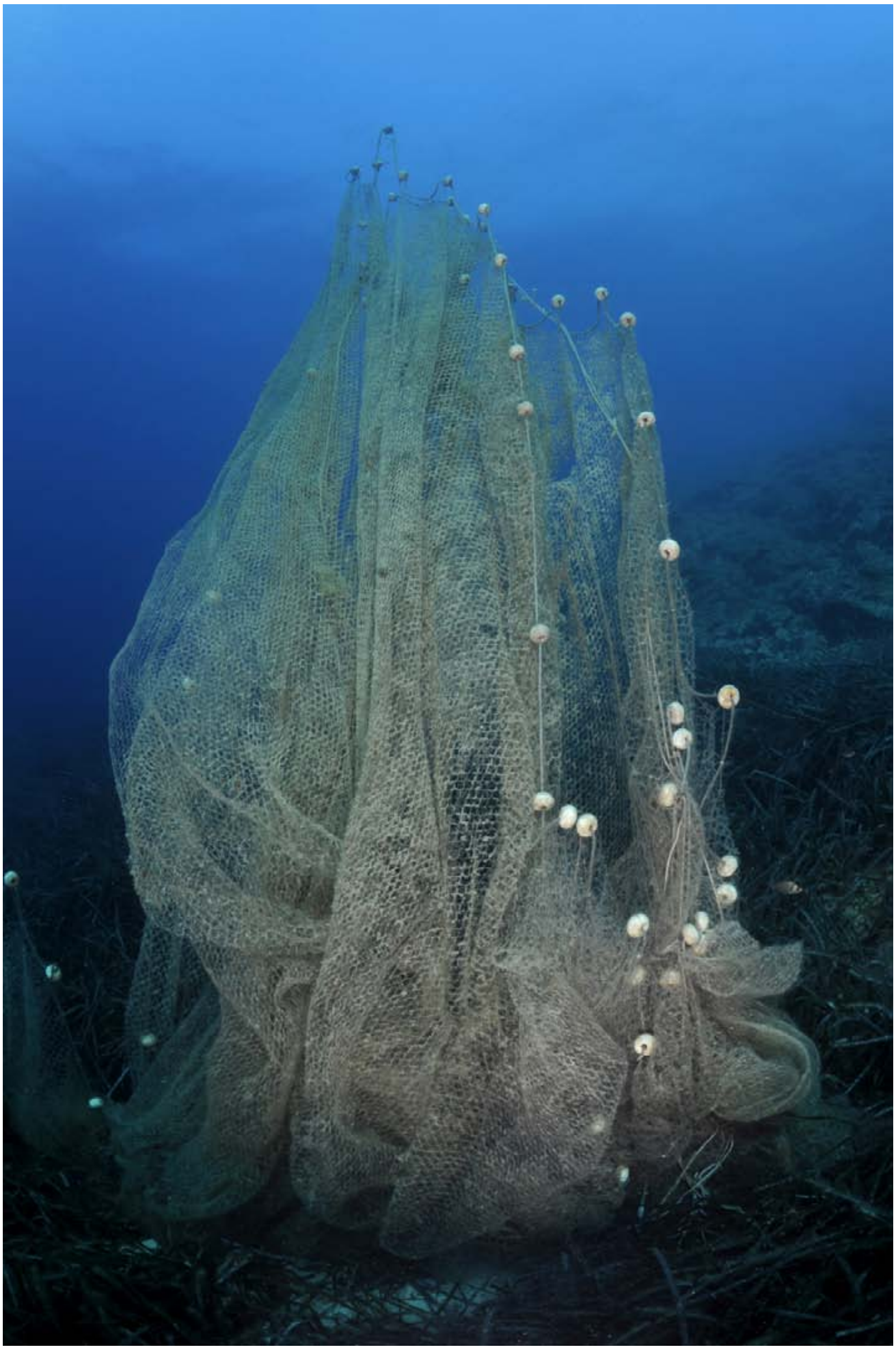
Those with more sustainable characteristics, across a range of indicators, should be prioritised for access to the resource at the expense of others. Allied with good observation of practices (to tackle high-grading and other nefarious fishing activities), such approaches can actually foster more competition between fishermen to be more conservationist since their fishing access – and their profits – depend on it. A good example of such a case is the spot prawn (*Pandalus platyceros*) fishery in California, where bottom trawling was replaced by traps, with the result that by-catch fell and the habitat improved, both of which convey economic benefits to fishers.[123]

The role of markets and regulation

Fisheries around the world have a dizzying array of management structures. Generally, these fall into private, public, or community cooperatives. In some cases this has led to sustainable use of resources, allocated by public (or government by proxy), rather than market-based mechanisms. In others, such as the EU, public management has failed to reverse the declines in fish stocks.

Private ownership, or 'catch shares', is an emergent market-based management approach at the other extreme. Individual transferable quotas (ITQs) are such an example and have been implemented in many countries, including Australia, Canada, Iceland, Namibia and New Zealand.[124] Judged in terms of stock sustainability, a number of these have been highly successful.[125,126,127] In these cases, their success owes largely to the elimination of perverse economic incentives, such as the 'race to fish'.[128] On the other hand, they come with their share of criticism, particularly around equity issues of transferring valuable public assets to the private sector, typically for free and in perpetuity (as well as intra-industry inequity due to concentration of fishing rights). [129,130,131,132]

The need for access criteria, however, remains just as pertinent in either case. Fishermen operating under an ITQ or under public management do not take account of their activity's 'externalities', such as biodiversity loss and climate change, or indeed the sentimental (or 'existence') value that fish and a healthy marine environment have for people, which could increase exponentially as the stocks become more scarce.[133,134] It remains a theoretical possibility that private owners could even drive the stock to extinction.[135] Public owners, on the other hand, must consider the wider impacts because they are not external to the public's welfare.[136] Given that true ownership must remain with the public, access criteria must be implemented in both public and private management schemes. The use of the market to allocate quota does not mean other regulations cannot be enforced, such as a 'social and environmental licence' to ensure best practice.



Conclusion and recommendations

Fisheries are a valuable public resource that should be managed in a way that delivers the highest net positive outcomes to society, where the environment and society are fully taken into account. The case of the North Sea cod fishery demonstrates the contrasting impacts that different activities can have: gillnets create significant value to society (£865/tonne of cod landed), while trawlers destroy value, with the larger trawlers destroying more value (£1,992/tonne landed) than the smaller ones (£115/tonne landed). We have also illustrated the perverse structure of fisheries such that the most destructive gear types are allocated the largest public resources in terms of fish quota and subsidies.

While we make no claim that these results hold for different species in different areas, the results strongly illustrate that some types of fishing are fully capable of harming society while others can benefit it. Such differences must be incorporated into the decision-making process in order to reward sustainable behaviour and move fisheries towards a positive economic model instead of one dependent on subsidies and facing an uncertain future.

Fleet implications

At present, the EU fleet is structured in such a way that the public owners of the fisheries resource do not receive the maximum benefit from its exploitation. To provide a positive return to the public fisheries must move towards environmentally and socially responsible practices. For example, trawlers must improve their fuel efficiency and selectivity characteristics and gillnets must reduce their by-catch levels.

Policy implications

Our results have significant implications for fisheries policy, particularly in terms of the quota allocations, the allocation of funds, and fleet reduction measures.

The reform of the CFP offers a unique and timely opportunity to reduce the environmental burden of fishing while building a stable future for coastal communities. A reformed CFP must place environmental objectives at its core. A first step needs to be a commitment to reward best practices with preferential access to fish resources, and to target a reduction in fishing capacity that works towards eliminating fishing methods that cause the greatest damage to the marine environment and provide the lowest overall value to society.

The current proposal of mandatory Transferable Fishing Concessions (TFCs) put forward by the European Commission as an answer to fleet overcapacity does not take into account social and environmental criteria. Small-scale artisanal fishers, many of whom fish in a non-intensive manner, using seasonally diverse fishing methods and who are intrinsically linked to their coastal communities, are likely to be disadvantaged by this proposal, which will favour the most economically powerful sections of the fleet. As such, a reformed CFP must:

- clearly outline priority access criteria to fish resources to those that fish in ways that provide the greatest benefit to society and have the lowest adverse impact on the marine environment

- revoke the mandatory nature of the proposed TFCs scheme, and provide an alternative range of management tools which can be adapted on a fishery by fishery basis, enabling social and sustainability criteria to be incorporated into fishery management strategies
- make a commitment to ending financial subsidies for fishing practices that provide the lowest return to society.

While the CFP reform process offers an important opportunity to radically change fisheries management, this does not preclude individual Member State governments from taking immediate steps. Such steps should include:

- identifying and assessing the values to society of the different types of fisheries within their jurisdiction
- re-assessing their current methods of quota allocation, moving towards use of environmental and social criteria, as opposed to historical catch records, when allocating quota among its fleet
- establishing and applying clear conditions and obligations on different users targeting shared stocks and common fishing grounds.

Current European fisheries management practices have led to deterioration in the productivity of its waters and a decline in the employment within the industry which, in turn, have led to a profligate waste of a public resource. It is time to reverse these trends.

Appendix

Table A1: *Results for private and societal costs and revenues of all subfleets, including economic, social and environmental factors. All scaled to the landing of one tonne of cod, to make comparisons possible.*

	Trawl				Gillnet
	under 12m	*12-24m*	*24-40m*	*over 40m*	*under 12m*
Value of landings (£)	1271.872	1939.122	2054.090	2112.912	1635.155
Value of discards (£)	340.688	519.419	550.215	565.971	0.011
Direct subsidies (£)	10.900	2.574	7.159	219.300	37.519
Fuel subsidies (£)	241.069	714.958	1073.041	1261.142	197.419
Fuel consumption (litres)	408.938	1212.821	1820.255	2139.341	334.892
GHG emission costs (£)	64.995	192.760	289.302	340.016	53.226
Fuel cost per litre (£/litre)	0.258	0.013	0.005	0.010	0.516
Fuel costs (£)	102.737	322.550	420.342	512.541	101.761
Crew Costs (£)	206.632	545.204	548.080	468.839	77.345
Employment (total)	0.069	0.035	0.020	0.018	0.179
Employment (FTE)	0.057	0.035	0.020	0.017	0.008
Variable Cost (£)	139.452	479.502	508.498	215.084	97.492
Fixed Cost (£)	88.080	283.264	232.822	141.993	52.076
Capital Cost (£)	133.197	226.175	244.558	269.164	98.175
Repair Cost (£)	60.076	78.467	141.873	111.328	54.807
Total Cost (£)	730.174	1935.162	2096.172	1718.949	481.657
Private profit (£)	541.698	3.960	-42.083	393.963	1153.498
Societal value (£)	-115.953	-1425.751	-1961.800	-1992.467	865.324

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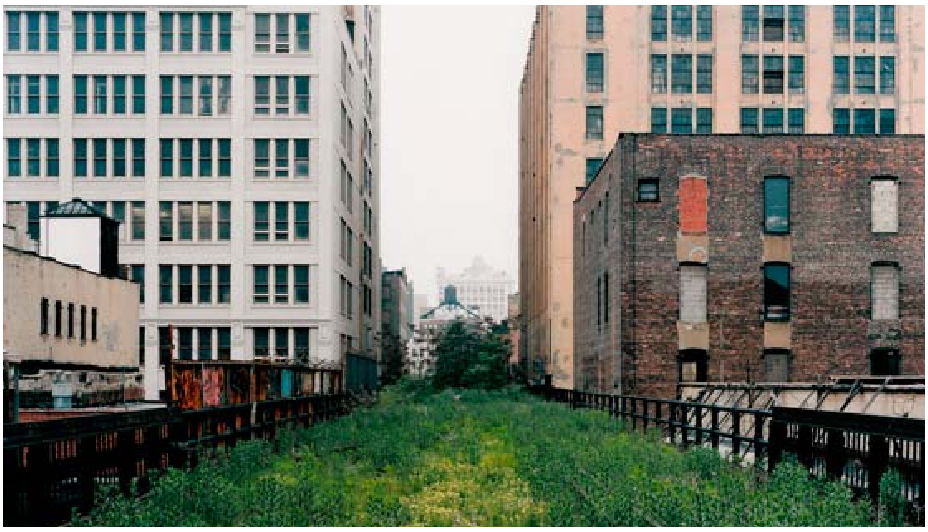
The Great Transition

Photo: Joel Sternfeld



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