Institution: University of Glasgow (UofG)		
Unit of Assessment: UoA 6 (Agriculture, Veterinary and Food Science)		
Title of case study: Development of EU legislation to protect vulnerable deep-sea species and ecosystems by defining a new depth limit for trawl fishing		
Period when the underpinning research was undertaken: 2008–2015		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Dr David Bailey	Senior Lecturer	March 2007–present
Period when the claimed impact occurred: 2016–2020		
Is this case study continued from a case study submitted in 2014? No		

1. Summary of the impact

UofG research on the environmental and economic implications of deep-sea bottom fishing established a depth below which trawl fishing has negative ecological and economic impacts. This finding provided an important contribution to the negotiation of the new Regulation (EU) 2016/2336 of the European Parliament, which applies to deep-sea fisheries in all EU member states. Effective as of 12 January 2017, bottom-trawling below 800 metres is prohibited in EU waters (~932,000 km^2) and by EU vessels in international waters around the central east Atlantic Ocean. As a result, 49 species of vulnerable deep-sea fishes will never be trawled again, and deep-sea coral and sponge ecosystems are now protected.

2. Underpinning research

Deep-sea bottom-trawling is an invasive fishing technique that uses weighted nets attached to steel plates and heavy rollers to drag the seabed in search of commercially desirable fish species. Sensitive ecosystems, such as coral and sponges and numerous 'unwanted' fish species, are destroyed by this fishing method. Limiting the depth to which trawling can occur has long been a priority for scientists, conservation groups and others. The Deep Sea Conservation Coalition of more than 70 environmental organisations, fishers' groups, and law and policy institutes reported that 'in 2004, more than one thousand scientists from 69 countries signed a statement calling on governments and the United Nations (UN) General Assembly to adopt a moratorium on high seas bottom trawling.' The UN General Assembly in turn called on countries to restrict deep-sea trawling. In European Union (EU) countries, any such change to regulations was robustly opposed by the fishing industries in several countries, and an initial legislative proposal in 2012 was narrowly defeated.

Economically and ecologically sustainable management of fisheries in areas of the deep-sea requires good quality data on the life history and populations of deep water fish species. Historically, however, such data have been scarce; there is very little long-term data available for non-target fish species affected by deep-sea fishing and for fish species that reside at sea depths deeper than that of typical fishing grounds.

Research undertaken between 2008–2009 at the University of Glasgow (UofG), led by Dr David Bailey, revealed — for the first time — the spatial extent and indiscriminate nature of deep water fishing in the north-east (NE) Atlantic. This research showed that fish abundance was reduced at depths much lower than the 1500 m maximum depth of commercial fishing, suggesting that the effects of fishing at this depth are transmitted to deeper areas of the ocean. Furthermore, these negative impacts extend to a horizontal distance of more than 70 km beyond the limits of fishing [1]. This work was highly cited and became immediately well-known in deep-sea research and the conservation community. Meanwhile, progress stalled in

international policy discussions on deep-sea conservation, particularly around setting a depth limit for deep-sea fishing.

In 2014, the UofG team initiated new research to address the following question: should there be a depth limit set for deep-sea fishing, and if so, at what depth should this limit be set? The UofG's Dr Bailey and Dr Francis Neat (of Marine Scotland) identified a way to address this question by looking at how trends in catch composition change with depth. They used data from trawl surveys collected between 240m and 1,500m in the NE Atlantic. These data derived from the use of different fishing gear used at various locations between 1978 and 2013. The resulting analysis revealed a clear transition in the composition and value of catches at depths of 600 to 800 metres, including a significant increase in biodiversity and in the ratio of discarded to commercial biomass, as well as in the ratio of sharks and rays to commercial biomass. As the ecological impacts increased, the commercial value per unit of effort decreased; trawling at greater depth requires more fuel and pulls up non-commercial fish species that are discarded [2].

The 2015 paper produced from this work [2] proposed limiting bottom trawling to a maximum depth of 600 m as an effective management strategy for deep-sea fishing that would meet the needs of European legislations, such as the Common Fisheries Policy (EC no. 1380/2013) and the Marine Strategy Framework Directive (2008/56/EC).

3. References to the research

1. Bailey, D.M., Collins, M.A., Gordon, J.D.M., Zuur, A.F. and Priede, I.G. (2009) Long-term changes in deep-water fish populations in the northeast Atlantic: a deeper reaching effect of fisheries? *Proceedings of the Royal Society of London Series B: Biological Sciences*, 275(1664), pp. 1965–1969. (doi:10.1098/rspb.2009.0098) (Citations 2009–2015: 54, field-weighted citation impact: 3.7).
2. Clarke, J., Milligan, R. J., Bailey, D. M., and Neat, F. C. (2015) A scientific basis for regulating deep-sea fishing by depth. *Current Biology*, 25(18), pp. 2425–2429. (doi:10.1016/j.cub.2015.07.070)

4. Details of the impact

UofG research on the impacts of trawling at different depths on deep-sea fish species provided pertinent and timely evidence to support an EU policy in 2016 to ban trawling at depths of 800m or lower.

Lead-up to policy change

UofG research has played an important role in the long-running debate concerning deep-sea trawling and environmental damage. Bailey was a co-author on a 2011 report [A] that reviewed the implementation of previous UN General Assembly resolutions on deep-sea fisheries, which cited Bailey's previous deep-sea data [3.1]. This report found that the UN's resolutions were not being fully implemented, that precious ecosystems were not protected as intended and that the impact on non-commercial species, which were being caught and discarded as bycatch in significant numbers, was not being adequately measured. This and other work kept up the calls for the seabed's protection. Nevertheless, EU restrictions imposed in December 2013 were not implemented due to lack of approval from some member states.

In 2014, a debate was held at 'The Future of Scotland's Deep Sea Fisheries' (Edinburgh), in which Bailey participated as a panel member and discussed his research [3.1] on the long-term

changes to deep-sea fish populations. Speaking on this discussion, the co-founder of the Deep Sea Conservation Coalition highlighted the need for an evidence base to support change: '*We don't know the value of deep sea ecosystems so we don't know what we might lose*' [B]. As a result of his participation in this event, the Pew Charitable Trust invited Bailey to speak with EU officials in Brussels in late 2014 about this research. This meeting focussed on the need for changes to trawling depth limits, which had been proposed, to be guided by scientific evidence and led Bailey *et al*. to commence research (ultimately published in 3.2) to address this requirement. Bailey was also invited to present to UK policymakers at Westminster (20 January 2015) about deep-sea fisheries and the conservation of deep water ecosystems. He again discussed his earlier work [3.1] on the impact of deep-sea fishing, and his preliminary findings on conservation impact trends as a result of fishing depth [B]. In January 2015, Bailey also co-authored a letter, alongside other UK and international marine scientists, to the UK Fisheries Minister, which advocated for the UK to play a pro-active role in upcoming EU negotiations on the management of deep-sea fishing [C]. As correspondence between Bailey and the European Commission noted at the time, '*We at the European Commission are very much convinced about the benefits of restricting deep sea fishing to shallower depths like 600m. It is mostly some particular Member States in the EU that criticize your paper and of course parts of the fishing industry, but that is not surprising as they do not want to see any depths limitation in the new legislation on deep sea fishing*' [D].

In August 2015, Bailey's research [3.2] was published, providing evidence of the environmental consequences of seabed trawling, in addition to decreased economic returns for fishermen trawling at then-current depths. This work was extensively covered in the media across Europe [E], given the commercial and political sensitivities of the European fishing industry (the sector is dominated by France, Spain, the UK and Denmark, but all EU members engage to some extent). There was significant pushback on the suggested depth limit, and UofG researchers responded accordingly, citing their findings that the dangers to certain bycatch species' populations, endangered by trawling practice, increased significantly at depths of 600m and greater [F]. In October 2015, Bailey spoke at a public event at the Zoological Society of London on the conservation value of European deep-sea habitats and met with UK government policymakers in attendance [G]. These public engagements coincided with the European Parliament reopening discussions on fishing limits. The Deep Sea Conservation Coalition co-founder, speaking about the UofG research, stated that not only did '*[we make] extensive use of their research in our work with policy-makers in Brussels and in EU Member States advocating for a new and more rigorous regulation for the management of deep-sea fisheries in EU waters*', but also that the '*work has…been recognised in numerous discussions amongst Members of European Parliament and their staff, the European Commission and Member States involved in the negotiation of the new legislation*' [H].

On 14 December 2016, the European Parliament passed Regulation (EU) 2016/2336 'establishing specific conditions for fishing for deep-sea stocks', which stated that '*In order to mitigate the potential damaging impacts of bottom trawling, it is appropriate to permit fishing with bottom trawls only at, or above, a depth of 800 metres*' [I]. Adopting an 800m limit was seen as '*a compromise between those rejecting any limit and scientific evidence supporting a shallower 600m limit*' [J]. Reflecting the significance of the research, the Marine Scotland collaborator Dr Francis Neat joined an EU delegation to a UN workshop on sea-floor bottom fishing (held in New York, USA); he stated that, "…*our study was highlighted by the EU as being an important piece of evidence in their decision to prohibit bottom trawling at depths > 800m. So, it was rewarding to see our efforts being acknowledged at that level*" [K]. The EU

legislation was also welcomed in the UK by the The Scottish White Fish Producers' Association, UK's largest fishing association [L].

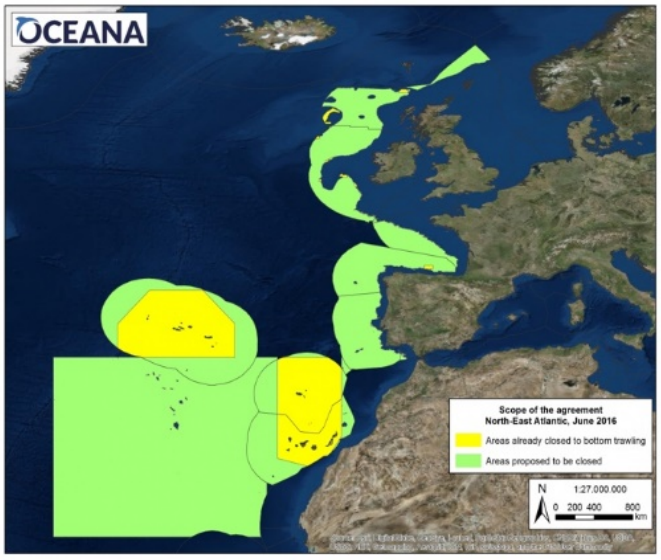

Figure 1: 932,000 km2 now protected (green)

The new legislation came into force on 1st January 2017 and applies across an area of 932,000km^2 (Fig. 1 green zones, now protected). It has particular impact across the 15% (143,000km^2) of EU waters (primarily continental slope) that has traditionally been fished to 1500m depth. The new legislation will benefit ~49 species of deep-sea fish, including roundnose grenadier (*Coryphaenoides rupestris*), black scabbardfish (*Aphanopus carbo*), birdbeak dogfish (*Deania calceus*), orange roughy (*Hoplostethus atlanticus*), rabbit fish (*Chimaeridae*), blue ling (*Molva dypterygia*) and anglerfish (*Lophius piscatorius*) [3.1]. In Scottish ports in 2012, 3,737 tonnes of three deep-sea fish species (black scabbardfish, blue ling and Greenland halibut) were landed by all vessels combined. Of this, 94% were landed by foreign vessels, mostly French and Spanish. Since 2016, International Council for the Exploration of the Sea (ICES) data indicate a large drop in landings of ecologically important deep-sea target species, notably of the endangered roundnose grenadier. Catches of this species decreased from 38 to 30 tonnes in 'Division 5.b.' (area north of UK); from 725 to 202 tonnes in 'Division 6' (area north-west of UK); and from 4 to 0.8 tonnes in 'Division 7' (area west of UK) [M]—some fish are still caught as they can move to shallower waters, which aren't protected. Furthermore, within the ICES report an observation from the French observers at sea programme, which monitor landings and discards, reported that discards as % weight of total catch had decreased from 5% weight in 2016 to an almost negligible 0.7% weight in 2019, and that this was related to, a) a change in the depth of the French fleet towards shallower depths; and 2) attempts to avoid areas where discards are high [M].

Following the United Kingdom's exit from the EU, the adopted EU regulation 2016/2336 has been converted and preserved in the UK as *retained EU law,* thus binding UK fisheries to this legislation. Furthermore, in September 2020 the Scottish Government designated a 100,000km^2 area of national waters in the North-East Atlantic as the West of Scotland Marine Protected Area (MPA). This deep-sea marine reserve provides additional protections to some of the deepest parts of Scotland's seas. The region falls outwith the area protected in the EU regulation, but the EU regulation was used as the basis for the area, extending protections against trawling at depths below 800m within the MPA, the boundary of which follows the 800m depth contour of the seabed [N].

Additional impacts of the legislation include protection to sea floor cold-water coral reef and sponge ecosystems. Work at Plymouth University has shown that prohibiting trawl fishing below 800m will substantially increase the area of protection for vulnerable cold-water corals (Ireland: from 15% to 43%; UK: from 41% to 53%), sponges (Ireland: from 2% to 100%; UK: from 11% to 100%) and xenophyophore communities (Ireland: from 7% to 99%; UK: from 13% to 99%) [O].

5. Sources to corroborate the impact [PDFs uploaded for all listed items]

A. The impact of deep-sea fisheries and implementation of the UNGA Resolutions 61/105 and 64/72: Report of an international scientific workshop, accessed 15/10/2018 [Ref 3.1 cited on p.4 (para 6), p.20 (para 3)]
B. Newsletter, Centre for Marine Biodiversity and Biotechnology: Scientists and Fishermen take part in exciting debate on the future of Scotland's deep-sea fisheries
C. (1) Co-authored letter to the UK Fisheries Minister, and was outlined in (2) The Guardian: UK should take a lead role in the EU drive to overhaul deep-sea trawling (21 January 2015)
D. Correspondence with Head of the Fisheries Management Atlantic, North Sea and Baltic Sea at European Commission
E. Media selection: (1) news feature in *Nature:* Evidence supports trawling depth limit; (2) news feature in *NewScientist*: Europe to discuss deep-sea trawling ban to protect biodiversity; (3) BBC World Service *Science in Action*: Trawling Depth Restrictions in EU Waters (radio broadcast); (4) piece in *The Economist*: Drawing the line—when regulating fishing, it always helps to have data
F. The Conversation, 'Evidence says it's time for a depth limit on trawling', 12 Oct 2015, accessed 15/10/2018
G. ZSL agenda and abstracts, 13 October 2015
H. Letter from Co-founder, Deep Sea Conservation Coalition, dated 20 February 2017. (pdf uploaded)
I. Regulation (EU) 2016/2336 of the European Parliament and of the Council of 14 December 2016 [See para (8), accessed 16/10/2018.
J. Conservationists urge full implementation of new EU regulation on deep-sea fishing formally adopted today, 13 December 2016, Deep Sea Conservation Coalition.
K. Correspondence from Dr Francis Neat, Marine Scotland
L. SWFPA Welcomes New Deep Water Trawling Regulation, The Fish Site (13 January 2017)
M. Roundnose grenadier (*Coryphaenoides rupestris*) *In*: Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP) 2020 report, ICES SCIENTIFIC REPORTS 2:38, ICES (for landings data, see: Tables 8.2.0a to 8.2.0c, p.394–399; French observers at sea programme data, p.390, para 2). [Note: the specific table data are highlighted the uploaded PDFs]
N. UK legal updates: (1) UK law: note changes to be implemented are technical operability changes, for example replacing EU-specific terms with a UK equivalent term; (2) Scottish Government announcement (September 2020); (3) Marine Scotland Business & Regulatory Impact Assessment of the West of Scotland MPA (October 2020) [see p.3, para 2 of PDF]
O. Deep-sea habitats: (1) Ross, R. E. and Howell, K. L. (2013), Use of predictive habitat modelling to assess the distribution and extent of the current protection of 'listed' deep-sea habitats. *Diversity Distrib.*, 19: 433−445. doi:10.1111/ddi.12010; (2) Infographic: 'Protecting deep sea corals in UK and Irish waters', Deep Sea Conservation Coalition