**Institution:** Imperial College London

**Unit of Assessment:** 5 Biological Sciences

**Title of case study:** 8 – Twenty-five years of Falkland Islands Fisheries assessment and management resulting in one of the best managed fisheries in the world and license revenue of tens of millions of pounds

**1. Summary of the impact** (indicative maximum 100 words)

Between 1987 and 2011, the Fish group at Imperial College London assisted the Falkland Islands Government by providing fisheries management advice as well as delivering seasonal licencing and fee analyses which determined the number and type of fishing licences allocated to commercial vessels operating in Falkland waters. The work of the Fish group had unprecedented economic, commercial and environmental impacts on the Falkland Islands, where between 50% and 75% of the annual revenue required to fund all infrastructure, research and development in the Islands is generated by the £20M income from the sale of commercial fishing licences. In 2006, the Falkland Islands changed from a seasonal fishing licensing system to a rights-based management system of Individual Transferrable Quotas (ITQs) for fishing companies. The move to ITQs, which was recommended by the Fish Group, generated revenue of £9.5 million in 2010 and the system will remain in place until 2031. During a transition period between 2008 and 2011, the Fish Group supported the planned hand-over of licencing and fee responsibilities to the Falkland Island Fisheries Department which continues to use the bio-economic and stock assessment models developed by the Fish Group at Imperial for the sustainable management of marine resources.

**2. Underpinning research** (indicative maximum 500 words)

In 1987, the Foreign and Commonwealth Office (FCO) commissioned the Fish Group at Imperial College (until 2005 known as the Renewable Resources Assessment Group or RRAG) to provide scientific advice to the Falkland Islands Government (FIG). Over a 25 year period between 1987 and 2011, the Fish Group developed and maintained a comprehensive fisheries database for the Falkland Islands Fisheries Department (FIFD), assisted with data collection and used scientific observer data, logbook statistics and survey information (collected by FIFD, Imperial researchers and commercial vessels) to formulate fisheries management advice for submission to FIG. Between 1987 and 2008, the Fish Group was led by Prof Sir John Beddington, FRS (awarded the Companion of St. Michael and St. George for services to fisheries science and management in 2003) and subsequently by Imperial academic staff members Dr D. Agnew (2008), Dr K. Lorenzen (2009-2010) and Prof. E.J. Milner-Gulland (2010-2011). The work was funded through a series of grants to the Fish Group from the scientific budget of the Falkland Islands Government, totalling £5,242,094 of funding between January 1993 and June 2011 [G1, G2].

Very little was known concerning the status of the marine resources of the Falkland Islands prior to an initial investigation in 1986, commissioned by the Falkland Islands Development Corporation and led by Prof. Sir John Beddington of Imperial College, which highlighted the huge economic potential of fisheries in the Falklands region and urged for the introduction of a fisheries management regime to secure fishing rights for the Falkland Islands. In the following year, the Fish Group at Imperial College embarked on a series of pioneering studies into all major aspects of the age, growth, fecundity and migration of commercial fish and squid species in Falkland waters in order to formulate strategic management advice and ensure the conservation of stocks and sustainability of fisheries. The Fish Group created a licensing classification system for each fishery and developed bio-economic models to calculate appropriate fees for each licence type in each fishery i.e. Illex squid, Loligo squid, hake southern blue whiting, skates & rays, toothfish and rock-cod. Particularly relevant findings for impact are:

Agnew et al. (1998, [1]) demonstrated that variations in annual spawning and recruitment patterns of the Loligo squid required the management of this species as separate summer and winter stocks with seasonal vessel allocations and licence fee structures. Agnew et al. (2000, [2]) presented a management model for skates and rays and showed that changes in species composition and rapid decline in numbers of skates and rays, had been partially halted by the closure of the southern fishery, as recommended by the Fish Group and adopted by FIG in 1996.

Agnew et al. (2000, [3]) identified critical spawning and nursery areas for fish and squid species on the Southern Patagonian Shelf and the potential effect of oil pollution on the commercial fishery. Agnew et al. (2002, [4]) demonstrated a strong correlation between sea surface temperature and recruitment for Loligo squid and incorporated this relationship to use in a predictive model used to forecast the biomass of new recruits in the Loligo fishery. Payne et al. (2005, [5]) conducted the first formal assessment of the toothfish stock in Falkland waters and described the impact of illegal fishing on population numbers.

Members of the Fish Group represented the interests of the Falkland Islands at the 23 meetings of the scientific sub-committee (SSC) of the South Atlantic Fisheries Commission (SAFC) in all years between the inception of the SAFC in 1990 and its suspension due to the withdrawal by Argentina in 2005. The primary aim of the SSC was to improve the conservation of migratory and straddling stocks in Argentine and Falkland waters. The Fish Group collaborated with researchers at the National Institute of Fisheries Research and Development of Argentina (INIDEP) through the routine exchange of fisheries data for the joint assessment of shared stocks. Members of the Fish Group participated in joint survey cruises in both Argentine and Falkland fishing zones with scientific teams that included researchers from the Fish Group. The results of this research were used by the Fish Group to determine population parameters and assess the status of shared stocks of Illex squid, Loligo squid, hake southern blue whiting, skates and rays. These assessments were presented to the Argentinian delegation at meetings of the SSC and provided the basis for agreement by the Argentine and Falkland Islands on sustainable catch quotas for shared stocks (Barton 2007, [6]).

**3. References to the research** (* References that best indicate quality of underpinning research)


[1] *Agnew, D.J., Baranowski, R., Beddington, J.R., des Clers, S. & Nolan, C.P., '*Approaches to assessing stocks of Loligo gahi around the Falkland Islands*', Fisheries Research, Vol:35, Pages:155-169 (1998). DOI, **30 citations (as at 3/6/13)**

[2] *Agnew, D. J., Nolan, C. P., Beddington, J. R., and Baranowski, R., 'Approaches to the assessment and management of multispecies skate and ray fisheries using the Falkland Islands fishery as an example', Can. J. Fish. Aquat. Sci., 57: 429–440 (2000). DOI, **21 citations (as at 3/6/13)**

[3] Agnew, D.J., '*Critical aspects of the Falkland Islands pelagic ecosystem: distribution, spawning and migration of pelagic animals in relation to oil exploration*' Aquatic Conserv. Mar. Freshw Ecosyst., 12 (1), 39-50 (2002). DOI, **10 citations (as at 3/6/13)**

[4] *Agnew, D.J., Beddington J.R., Hill, S.L., '*The potential use of environmental information to manage squid stocks*', Can. J. Fish. Aquat. Sci., 59, 1851-1857 (2002). DOI, **22 citations (as at 3/6/13)**

[5] Payne, A.G., Agnew, D.J., Brandao, A., '*Preliminary assessment of the Falklands Patagonian toothfish (Dissostichus eleginoides) population: Use of recruitment indices and the estimation of unreported catches*', Fisheries Research (76) pp. 344-358 (2005). DOI, **3 citations (as at 3/6/13)**

[6] Barton, A. J., Agnew, D. J. and Purchase, L. V., '*The Southwest Atlantic; Achievements of Bilateral Management and the Case for a Multilateral Arrangement'*, in Management of Shared Fish Stocks (eds A.I.L. Payne, C.M. O'Brien and S.I. Rogers), Blackwell Publishing Ltd, Oxford, UK (2007). DOI.



Grants to Imperial College London for this research:

[G1] *Falkland Islands Government - Fisheries Department "*Falkland Island Fish Stock Assessment". PI Prof. Sir John Beddington. (£5,068,809, Jan 1993- Dec 2008)

[G2] *Falkland Islands Government - Fisheries Department "*Falkland Island Fish Stock Assessment". PI Dr D. Agnew (2008/9), Dr K. Lorenzen (2009/10), Prof E.J. Milner-Gulland (2010/11). (£173,285.98, Jan 2008- Jun 2011).


**4. Details of the impact** (indicative maximum 750 words)

In 1987, the Falkland Islands Government (FIG) assumed control of fishing in national waters through the introduction of a licensing system for all commercial vessels fishing in the new Falkland Inner Conservation Zone (FICZ). At that time, the Falkland Islands Fisheries Department (FIFD) was in an early stage of development and had neither the resources nor the expertise necessary to conduct the scientific research or develop the fisheries policy necessary for

management of a rapidly expanding commercial fishery. The Fish Group (then known as RRAG) at Imperial College was already carrying out world-class research on marine resources and was appointed by the UK Foreign and Commonwealth Office to provide the scientific support essential for the development and management of the commercial fishery in the Islands. The Fish Group provided scientific advice to FIG continuously for the next 25 years, until 2011. By 2011, FIFD had expanded to become a multi-national team of trained fisheries professionals and, with assistance, training and mentoring by the Fish Group, responsibility for the determination of fisheries licencing and vessel fees was eventually transferred to the FIFD, which continues to use the bio-economic and stock assessment models developed by the Fish Group at Imperial.

The Fish Group developed assessment models for all major commercial fish and squid stocks in Falkland waters. These assessments afforded the first information of the stock status of many of these species in the south-western Atlantic and provided under-pinning evidence for determining appropriate levels of sustainable exploitation. Research by the Fish Group highlighted the need for further protection of fishing areas and, in 1990, FIG acted on this advice by declaring the Falklands Outer Conservation Zone (FOCZ), extending jurisdiction to the 200 nautical mile Economic Exclusion Zone.

Until 2011, the Fish Group was responsible for determining the seasonal licence fees and vessel effort for all commercial fishing vessels in Falkland waters. The Fish Group regularly produced bi-annual reports for FIFD which were submitted by the Director of Natural Resources to the Executive Council for approval before passing into legislation [e.g. A, B]. The fisheries licensing regime provides the bedrock of the Falklands economy and, during the period 1987-2011, which included 4 years in the 2008-2013 REF period, the annual revenue of the Falkland Islands was directly impacted by the scientific advice afforded to FIG by the Fish Group. The main economic driver in the Falklands is the commercial fishery and the average annual revenue to FIG of £20 Million generated from fishing licences funds 50-75% of all capital and operational expenditure [C, D].

During this time the Fish Group was responsible for supplying seasonal real-time management information to FIFD for the Illex and Loligo fisheries. This involved conducting stock assessments, often on a daily basis, in order to prevent over-fishing and protect the spawning stock. When squid numbers approached predetermined cut-off thresholds, the Fish Group was able to alert FIFD of the need for early closure of the fishery.

In 1996, FIG was swift to act on the advice of the Fish Group to protect the skate and ray fishery; first introducing separate licences for the skate and ray fishery and then closing the southern area to all fishing in the face of continuing declines in catches. These protective measures were so effective that the impact is still being felt: catches of skates and rays have doubled, increasing from 3,475 tonnes in 1996 to 6,954 tonnes in 2011 [E].

In 2006, the Falkland Islands changed from a seasonal licensing system to a rights-based management system of Individual Transferrable Quotas (ITQs). The Fish Group recommended the company quotas for the Loligo fishery that were accepted by the Executive Council and passed into legislation. The move to a system based on ITQs received widespread support and allowed fishing companies to secure their long-term interests in the industry, resulting in a marked increase in local investment [F]. The company ITQs recommended by the Fish Group will remain in place for 25 years (until 30$^{th}$ June 2031) [G]. They generated revenue of £9.5 million for the FIG in 2010 [E, table B.16, all licenses except A & G].

In 2009, the fisheries management in the Falkland Islands was rated as having the highest level of effectiveness in the world [H]. This achievement is testament to the role played by the Fish Group in establishing a foundation for sound fisheries management through provision of robust long-term scientific advice and policy recommendations to FIG.

In summary, the impacts of research by the Fish Group at Imperial has therefore contributed to:

a) The conservation of commercial fish stocks in Falkland waters and the long-term sustainability of the fishery. Fishing effort has been deliberately controlled in order to prevent over-fishing, for example, catches of the extremely vulnerable Patagonian toothfish have been capped at less than 1,600 tonnes since 2006 [A].

b) Improving the knowledge of the population dynamics and stock status of commercially exploited species of fish and squid in the south-western Atlantic, as evidenced by the development of new assessments models documented in peer-reviewed journals.

c) The economic security of the Falkland Islands through the provision of sound scientific advice that has maximised licence fee revenue and provided the majority of funds used by FIG for research, development and infrastructure. With the introduction of a management regime, in 1987, the sale of licence fees generated £19.7 million of revenue to FIG and the total revenue generated from licence fees during the 4 year period 2008-2011 was £57,596,298 [A].

d) The development and expansion of FIFD into an organisation with a world-wide reputation for excellence in fisheries management.

The following statement by Mr. John Barton, Director of Natural Resources for FIG describes the impact of the Fish Group (aka RRAG)–

"*The Renewable Resources Assessment Group (RRAG), Imperial College provided fisheries management advice to the Falkland Islands Government (FIG) from 1987 to 2010. RRAG undertook stock assessment of the main offshore fish and squid resources and provided advice to FIG. The successful and innovative management of short lived squid species and the flexibility of effort controlled fisheries were major achievements of the period. RRAG also played a significant role in the bilateral South Atlantic Fisheries Commission (UK & Argentina) during 1991 – 2005. The fishery has been the mainstay of the Falkland Island's economy since the introduction of the fisheries zone in 1986. FIG's main fishery objective has been the sustainable management of marine resources and the scientific and advisory role undertaken by RRAG, working with FIG's Fisheries Department, made a major contribution to achieving that*."

**5. Sources to corroborate the impact** (indicative maximum of 10 references)

[A] Executive Council paper, DoF-205/08, 'Fisheries Access or Quota Fees 2009, 13/11/08 (available here). Contains fee advice prepared by the Fish Group for the 2009 fishing season.
[B] Executive Council paper, 264/09, 'Fisheries Access Fees 2010', 17/12/09 (available here). Contains fee advice prepared by the Fish Group for the 2010 fishing season.
[C] FIG website detailing the importance of the commercial fishery to the economy of the Falkland Islands, http://www.transformingthefalklands.co.uk/Facts-and-Figures (archived here on 3/7/13)
[D] Mercopress article highlighting the impact of fisheries revenue on the Falklands economy, http://en.mercopress.com/2012/04/22/falklands-fisheries-25-years-of-success-and-one-of-the-two-best-managed-in-the-world (archived here on 3/7/13)
[E] FIFD Fishery Statistics, Vol 15 (2001-2010), including tables of annual revenue generated by license fees, ITQs as determined by the Fish Group and a description of the contract with the Imperial Fish Group http://www.fis.com/falklandfish/FisheriesBulletin15.pdf (archived here).
[F] Falklands: Legislative Council: 26 August 2005 (Part 1: The Fisheries Conservation and Management Bill 2005 and Explanation), (archived here)
[G] Falkland Islands Economic Development Strategy, Part A: Setting the Scene, Section D, item 1.2, (available here).
[H] Assessment of the Falkland Islands fishery as one of the two best-managed fisheries in the world: Mora, C., Myers, R.A., Coll, M., Libralato S., Pitcher, T.J., Sumaila, R.U., Zeller, D., Warson, R., Gaston, K.J. & Worm, B.,'Management Effectiveness of the World's Marine Fisheries', *PLoS Biol* 7(6): e1000131 (2009), DOI (archived here), pages 3-4.

Individuals who can corroborate impact:

[I] Sustainable Fisheries Manager – Foreign and Commonwealth Office
[J] Director of Natural Resources, Falkland Islands Fisheries Department-FIG