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Fishermen and Forecasts: How Barometers Helped Make the Meteorological Department Safer in Victorian Britain

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Fishermen and Forecasts: How Barometers Helped Make the Meteorological Department Safer in Victorian Britain

Sarah Dry*

Abstract

In 1854, Admiral FitzRoy, acting as the first head of the Meteorological Department, initiated a project to distribute fishery barometers to poor fishing communities to help them predict poor weather. At roughly the same time, FitzRoy developed a controversial system of telegraphing weather forecasts to coastal towns to warn them of impending storms, the first of its kind in Britain. This episode serves as a case study in the role of tacit and formal knowledge in risk management and the construction of responsible users of scientific information. Rather than contributing to formal risk management in the new government office, the fishery barometers distributed by FitzRoy and the Meteorological Department were explicitly excluded from the wider project to map British and global weather. But by being excluded from the formal system, these barometers and their fishermen users were in fact able to contribute to the overall safety of the national system of meteorology. This study reveals that autonomous individuals can augment formalized risk management systems by remaining separate from them in key respects.

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Introduction

Most Victorian fishermen were illiterate. When writing to request a fishery barometer from the newly established Meteorological (hereafter Met) Department, the men of Britain's poorest communities relied on a local gentleman to draft and write the letter for them and many signed their names only with a simple mark. However, when these letters were received at the government office in Whitehall, they were submitted to an efficient system of review and annotation. In the standard manner, Admiral Robert FitzRoy, the newly appointed head of the office, noted on the back of the letter that the request should be acknowledged and, usually, an instrument supplied. Next to his notes the secretary duly recorded the date at which a barometer would be sent.

Petitions such as these represent a rare point of contact between a group of poor and uneducated fishermen, largely unable to write, and the new government office, which was obsessed with written records of its own business and of the weather. The fulcrum between these two worlds was the fishery barometer, an instrument that both FitzRoy and the fishermen believed could contribute to the safety of men at sea. Roughly two feet high, the barometer featured a large, easy-to-read display plate and a sturdy construction that would suit it to a life of public exposure on the roughest parts of Britain's coasts. By faithfully observing the rise and fall of the barometer, local fishermen would be able to predict storms that might have otherwise taken them by surprise, keeping them safe in harbour when the worst of the weather hit. In the mid-19th century, fishermen wrote to the central government office because they too believed that the government instruments could help keep them safe.

The relationship between safety and registration, which includes both the obsessive pursuit of registrations in the name of safety as well as their deliberate discouragement or mere absence, forms the core of this paper. This relationship is assessed through an investigation of both the cause and the surprising effect of the unlikely contact between a world of intense registration—that of mid-Victorian bureaucracy—and one of tacit or informal knowledge—that of mid-Victorian fishermen. The cause is the barometer itself, a product of the Meteorological Department, a specialized central scientific office. The surprising effect is that the subsequent contact between a system of bureaucratic control (not to say discipline) and a group of impoverished individuals who were quite literally the captains of their own ships did not result in the subordination of the latter to the former. Instead, as the remainder of this paper will demonstrate, the formal bureaucratic system came to rely on the informal one in important respects. Furthermore, this reliance was understood to further the safety of British fishermen and mariners and, perhaps even more significantly, the safety of the new government Meteorological Department itself.

Put another way, this paper seeks to address a basic question relevant to risk studies more generally: what is the relationship between tacit knowledge (which by definition cannot be communicated through writing) and formal risk management practices (which are by definition based on written rules)? It is clear that there is often a significant gap between how risks are identified and planned for in formal risk assessment and managements systems and what happens in practice when adverse events, be they accidents, disasters or financial crashes, actually occur. Both sides of this gap have been investigated in the extensive risk literature, and

there are rich studies of both risk management in action and formal risk management systems. What has proved more difficult to analyse are the ways in which formal and tacit (also known as informal or practical) approaches can actually be seen to interrelate and to connect with one another. Aside from offering the intuitively attractive possibility of a more holistic vision of risk, linking these as-yet-distinct genres may help eliminate the lingering deficit-model that still taints some studies of individual responses to risk while enabling a more realistic vision of how individuals, and organizations, actually respond to risk. Acknowledging that public knowledge can be, and is, constituted through the contributions of many kinds of knowers, which includes people such as fishermen, farmers, and local inhabitants as well as scientists, is one way to eliminate the implicit binary (and hierarchical) division between expert and lay knowledge that dogs so many public and scholarly debates over risk.

On the face of it, the government meteorological office and the fishermen were united in their interests. Both were committed to the same thing: the safety of sailors at sea. Indeed, the government office had been founded for the very purpose of keeping British mariners safe. In 1854, following an international meteorological congress held in Brussels, Parliament sanctioned a vote of £3200 to the Board of Trade and £1000 for the Admiralty to establish a "uniform system of meteorological observations at sea" in order to help determine the "very best tracks for ships to follow in order to make the quickest as well as safest passages." [1] The Met Department was established soon afterwards. But while the safety of sailors and fishermen (as well as the efficiency of sea voyages) was paramount, the official remit of the office was to gather meteorological statistics—registrations of the rise and fall of temperature, wind and current speed, and barometric pressure—which would eventually, but not immediately, lead to a better understanding of the laws of the weather. The bureaucratic and scientific habits of registration joined in the Met Department, whose founders believed that the safety of British sailors would be achieved only by combining the two in a slow and painstaking process of extensive data collection and eventual reduction to universal laws. This process included the construction, verification and distribution of standardized meteorological instruments as well as the collection of vast amounts of data from ships' log books. It did not include the distribution of expensive instruments to illiterate fishermen who were anyway more concerned with the immediate dangers posed by the sea than with the necessarily remote science of the weather.

While the Met Department lacked a formal founding directive, the advice of the Royal Society and several eminent foreign meteorologists was solicited in early 1855 and the subsequent correspondence from the Royal Society functioned as a *de facto* charter. [2] This correspondence clearly outlined the aims to which a respectable government science office should be directed. Edward Sabine, summarizing the conclusions in his capacity as President of the Royal Society, stipulated that the

[1]Parliament sanctioned a vote of £3200 to the Board of Trade and £1000 for the Admiralty to establish a 'uniform system of meteorological observations at sea' in order to help determine the 'very best tracks for ships to follow in order to make the quickest as well as safest passages.' Letter from James Booth, Committee of Privy Council for Trade, Sept 1854 'Report of the Met Department for 1857,' Parliamentary Paper (henceforth PP) 1857 XX, 283-372. These annual grants would remain unchanged for the first five years of the office.

[2] See Public Record Office, National Archives, Kew (henceforth PRO) BJ 7/4 iv for the letter from the Earl of Rosse and PRO BJ 7/4 v for replies from five foreign meteorologists: Adolphe Quetelet, Matthew Fontaine Maury, Erman (of Berlin), Kreil (of Durazzo, Albania), and Heis (of Munster, Westphalia).

new government department should be "an office for the discussion of the observations on Meteorology to be made at sea in all parts of the globe" which will constitute "an extension to the system of meteorological observations as may cause it to include, in addition to the information required for the purpose of navigation, such scientific desiderata as may be deemed best calculated for the investigation and establishment of great atmospheric and oceanic laws, and may be obtainable by observations either on land or on sea."[3] The office would "publish from time to time and to circulate such statistical results, obtained by means of the observations referred, as might be considered most desirable by men learned in the science of Meteorology, in addition to such other information as may be required for the purposes of navigation."[4]

The emphasis the Royal Society placed on the collection of statistics was consonant with their view that the government office would help constitute a new scientific discipline. Securing a proper foundation for this newly made discipline was urgent for those scientists who saw themselves as spokesmen, not simply for meteorology. but for a larger scientific project that would require consistent and generous endowment by the government.[5] William Whewell's three-stage model of scientific progress provided the template for their ambitions. According to Whewell's schema, preludes marked by patient and extensive data collection eventually gave way to inductive epochs in which great men such as Newton and Faraday discovered the (preferably mathematical) laws governing the once disordered mass of information, to be followed by periods of slower consolidation of the successes achieved.[6]

The fishery barometers, and the illiterate fishermen for whom they were intended, were not to be part of this inductive program. The instant judgement that the fishermen exercised when reading the barometer had no obvious place in such a project. Nevertheless, during the time that FitzRoy was managing the collection of data in the early years of the Met Department, he was also superintending a project to distribute barometers to poor fishing communities along British coasts. The project led to the installation of dozens of expensive barometers in small coastal villages, where many of them can still be seen today.

Asked in 1861 by the secretary of the Royal National Lifeboat Institution if he had considered the possibility of having fishermen register the rises and falls of the barometer on a special chart, FitzRoy replied that the matter:

> had due discussion here, before the first instrument reached its destination. Having weighed well the objects of registry, the construction of the 'Fishery Barometer,' and the qualifications of those persons entrusted with its care, it was decided to refrain from asking for any formal registration . . . . The register returned from an ordinary Fishery Station might not be required for official or scientific objects, because near other, and superior places of observation and record; while its character, for a certain time of inexperience, might not be so reliable as would be requisite. There must be a

[3] Royal Society letter from Earl of Rosse, June 19,1854, PRO BJ 7/4 iv.
[4] From a Royal Society letter of Feb 22, 1855, published as Appendix 2 in 'Report of a Committee Appointed to Consider Questions Relating to the Meteorological Department of the Board of Trade,' PP1866 XLV, vii.
[5] See G. L'E. Turner, ed., *The Patronage of Science in the Nineteenth Century*, Leyden, 1976; M. Boas Hall, *All Scientists Now: the Royal Society in the nineteenth century*, Cambridge, 1984.
[6] W. Whewell, History of the Inductive Sciences from the Earliest to the Present Time, 3rd edn, Vol 1, London, 1857.

> limit to accumulations of paper, however well filled, if practical conclusions are to be drawn from them as, otherwise, they would overwhelm.[7]

Fishermen were not wanted to supply the registrations of barometers that were issued to them by the Met Department. Neither they nor their barometers were meant to contribute to the official project of meteorological statistics. Instead, the fishery barometer project relied on the absence of certain registrations. But rather than remaining simply irrelevant to the Met Department's central project of fostering a safe and respectable scientific discipline of meteorology, the fishery barometers actually helped it. By not registering the weather, I will argue, such instruments contributed to scientific administration by helping to create autonomous users of its weather forecasts. Designed, constructed, and calibrated in the capital, the barometers nonetheless became instruments of local autonomy. How and why this happened is the subject of this paper. The argument unfolds in four sections. Firstly, I discussed how the barometers were specially designed within the Meteorological Department; secondly, I review their distribution to small fishing communities where they were carefully sited according to local practices and geography. Next, I consider the relationship between FitzRoy's innovative project to provide national weather forecasts and the barometer distribution programme. Finally, I suggest some ways in which the advantages of local knowledge were further recognized.

Designing a government fishery barometer

The systematic ambitions of the Meteorological Department were part of a broader concern in this period with how order could be brought to unruly phenomena, both at home in Britain and in the farthest reaches of the British Empire. Colonial administrators were acutely concerned to know whether local habits could be extrapolated globally and whether any 'universal' (or British) order could ever be established. The vocabulary of storms was naturally that of governance. Did storms obey laws? Tropical colonies produced a simplified arena in which to study the matter; tropical storms were both more intense and simpler than those farther north.[8] Just as tropical territories required different modes of governance from those employed domestically, tropical weather laws did not necessarily apply in British latitudes. In a popular 1838 treatise titled *An Attempt to Develop the Laws of Storms by Means of Facts, Arranged According to Place and Time* (which was required reading in the Navy), William Reid demonstrated that hurricanes and depressions rotate in an anti-clockwise direction in the northern hemisphere.[9] "The winds are so complicated in the latitudes we inhabit," Reid explained, "that any explanation of the causes which lead to their variations, has hitherto been considered hopeless. Within the limits of the Equatorial regions, where the winds are nearly uniform, and storms seldom occur, the investigation is much simplified, for there a single storm may be studied."[10]

The continuity of natural laws was a matter of pressing concern to navigators and

[7] FitzRoy to John Street Adelphi, Secretary of National Lifeboat Institution, Jan 14, 1861, PRO BJ 9/8.
[8] On India as a laboratory for meteorology, see K. Anderson, *Predicting the Weather: Victorians and the science of meteorology*, Chicago, 2005, 250-264.
[9] W. Reid, *An Attempt to Develop the Law of Storms by Means of Facts, Arranged According to Place and Time*, London, 1838 ; Lieut.-Colonel Reid, 'An Attempt to Develope the Law Of Storms,' *Times*, Oct 4, 1838, 5.
[10] Reid op.cit. (9).

sailors. “If portions of the atmosphere within the Tropics, when set in motion by expansion, acquire a progressive and rotatory power, and in obedience to a fixed law of nature invariably rotate in the same direction, at what distance from the Equator do they cease to be subject to that law of nature?” wondered F. P. B Martin, in his treatise on equinoctial storms:

> If the diurnal motion of the globe causes the winds to rotate within the tropics, why not beyond the tropics? And if this rotatory property of great gales be limited to the surface of one portion only of the globe, but universal in its extent, to what precise description of gales is it to be considered applicable? If in a heavy gale the wind changes in accordance with a certain well established theory, why not in a gale less severe? or even in a very strong breeze? or even in one less strong? At what precise force in short does wind cease to be subject to this law of nature? If the seaman off Bermuda anticipates correctly the force, direction, and duration of the wind for hours to come, why not as well when he is off Madeira or the Azores? Why not off New York, the Coast of Portugal or Ireland? Why need he run into certain danger in one part of the world more than in another?[11]

Such matters bore directly on the well-being of British sailors and administrators. The seaman’s safety depended on the extent to which meteorological phenomena could be considered to follow universal laws. “Correct anticipations” of storms made off Bermuda might be incorrect off the coast of Ireland. Martin was left with the unsatisfactory conclusion that storms were subject to both universal laws and local influences. He wrote that “*subject to the varying modifications of local influences* THE LAW OF STORMS is Universal, Semper, ubique, et ab omnibus.”[12] Sorting out the relative importance of local and universal forms of governance was crucial to the safety of sailors at sea. The success of the Met Department similarly depended on the proper balance between the formal laws and government imposed from Whitehall and local self-government, or the “varying modifications of local influences.”

The design of Met Department barometers reflected their varying uses. FitzRoy’s first experience with barometers at the Met Department came from his work in designing and distributing standard meteorological instruments for Royal Navy and merchant marine ships. One of the first tasks to which he turned his attention was the design and testing of what would become the standard Kew Marine Barometer. Specialized meteorological instruments such as barometers and thermometers were supplied to voyages of exploration in the 1830s to take deep-sea measurements.[13] But supplying specialized instruments to customized ships for these one-off voyages differed widely from the challenge of transforming every naval ship into a piece of a meteorological network. Robust and universally calibrated instruments that could be easily incorporated into the normal routines of a merchant or Navy ship were needed. Ordinary ship’s barometers, useful to ship captains seeking to predict coming weather, were useless to a systematic project because their readings

[11] F.P.B. Martin, *Memoir on the Equinoctial Storms of March-April 1850; and inquiry into the extent to which the rotatory theory may be applied*, no publisher or location indicated, 1852, 3.

[12] Martin op.cit. (11), 5. Little biographical information is available on Francis Pitney Brouncker Martin. He appears to have been born in Madras in 1810 and to have returned to England with his wife Julia Augusta in 1845. They took up residence at Kingston House in Dorchester, Dorset, where Julia acted as a tutor to the young Thomas Hardy. See http://ace.kmc.ac.uk/virtual%20estate/history/TheMartins1845-1853.pdf.

[13] M. Deacon, *Scientists and the Sea, 1650-1900*, Aldershot, 1997, 276-305.

could not be meaningfully compared.[14]

In 1854, FitzRoy wrote to the Kew Committee of the Royal Society to ask for their help in devising standard meteorological instruments for use on board Navy ships. Mr Patrick Adie, a well-established London instrument-maker, was invited to design a barometer specially suited to marine use.[15] At the Kew Observatory, Superintendent John Welsh oversaw the testing of Adie's barometer.[16] By June the matter had been settled and J. P. Gassiot, head of the Kew Committee, was able to write to both the Board of Trade and the Admiralty, recommending the Adie barometer at 3 15*s*. 6*d*. These barometers consisted of a constricted glass tube protected by a tubular brass frame. An iron cistern at the base contained the bulk of the mercury and was sealed except for a small aperture open to the air. A small graduated scale provided for accurate readings to five-hundredths of an inch. Significantly, no weather indications, such as fair or rain, were marked on the scale, as FitzRoy hoped to encourage seamen to learn the subtleties of the barometer beyond the sometimes misleading rules of thumb. Finally, an air-trap prevented any air working its way through the column of mercury into the vacuum above and a thermometer affixed to the frame displayed the temperature within the brass case. The whole instrument was hung by a brass ring attached to another ring that allowed it to swivel freely and remain upright despite the rocking of a ship.[17]

Less than one year later, one hundred of such Kew marine barometers had been issued to Navy ships, and by 1856, 22 sets of Kew-verified instruments had been issued to the merchant marine.[18] Of the original Parliamentary grants (to the Admiralty and the Board of Trade) for the Met Department, the lion's share of each had gone in 1857 towards instrument costs, with the rest on salaries (FitzRoy was paid £300 out of each fund) and the payment of port agents (who received 2 10*s*. for each vessel they supplied with approved instruments).[19] The full set of instruments consisted of a marine barometer, six thermometers, one thermometer stand, four glass hydrometers (used for testing) and a compass. The total value of a set (which were to be given to Navy ships and could be lent or sold to merchant ships) was a not inconsiderable 12*l*. 6*s*.

Verifying the instruments took up a lot of John Welsh's time at Kew. In February,

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[14] On barometers, see G. L'E Turner, *Nineteenth-Century Scientific Instruments*, Chicago, 1983; B. Bolle, *Barometers*, Haarlem, 1978; and N. Goodison, *English Barometers, 1680-1860: a history of domestic barometers and their makers*, London, 1969. On barometers in the 18th century, see also J. Golinski, 'Barometers of Change: meteorological instruments as machines of Enlightenment' in *The Sciences in Enlightened Europe* (ed. W. Clark, J. Golinksi and S. Schaffer) Chicago, 1999, 69-93; J. Golinski, *British Weather and the Climate of Enlightenment*, Chicago, 2007; and V. Jankovic, *Reading the Skies: a cultural history of English weather, 1605-1820*, Manchester, 2000, 112.

[15] Patrick Adie was the son of Alexander Adie, an established Edinburgh scientific instrument maker with a special interest in meteorology. Patrick's brother John joined the father's business while his brother Richard started a business in Liverpool. Alexander and James Adie, Dictionary of National Biography.

[16] In this period, the British Association for the Advancement of Science managed Kew Observatory as a centre for electrical, magnetic and meteorological observations. For a history of the site, see R.H. Scott, 'The History of Kew Observatory,' *Proceedings of the Royal Society of London*, 39 (1885) 37-86.

[17] Bolle, op.cit. (14).

[18] Letters from Welsh to FitzRoy re: testing, supply and dispatch of instruments, Feb 27, 1855, PRO BJ 1/13 vii, f 2. By 1868, 212 barometers had been distributed to the Navy, and 488 to the mercantile marine. See also P. Skelton, 'The supply of marine barometers by the Met Office', *Marine Observer* (1949), **25**, 88-91.

[19] For agents fees, see 'Report of the Met Department for 1857,' PP1857 XX, 344.

1855 when the big push was on to get instruments onto ships as quickly as possible, he complained to FitzRoy that "It may be necessary however that the Kew Committee must give me more assistance as I find it rather too much to go through all the drudgery of comparison besides superintending all the other business of the Observatory. Between work for the B[oard of] T[rade] and the American Government I have since September verified 1500 therms and about 110 barometers—every reading having been taken by myself."[20]

Such careful calibration was needed to make barometers tools for long-term scientific research. But aside from the problem of whether the barometers themselves could be meaningfully compared, FitzRoy faced a more basic concern. As George Airy, the Astronomer Royal, had noted, the distribution of instruments to merchant marine ships had the potential to "to give more trouble than everything else relating to the observations." Giving "such fragile instruments" as barometers to merchant ship captains would lead to "perpetual heartburning on account of broken instruments." Airy's solution was to have the ship captains supply their own instruments, which would be duly registered and inspected *as if* they were government property: "If the ship-owners supply them, still the instruments must be treated as the property of Government: they must be marked with the Government-mark and with an ordinal number, and must be entered in the Government books, and must be examined by the Government officers."[21] The key to responsible stewardship, Airy understood, was ownership: thus the problem with expecting sailors to care for loaned equipment. On the other hand, for the meteorological project to work, privately owned instruments had to be integrated into the network of registration and inspection. Airy's plan was never taken up. John Washington, Hydrographer to the Navy, approved of the new Kew standard barometers and acknowledged the pitfalls of introducing delicate equipment owned by the new government office into naval culture. "We must endeavour to drill our rather <u>fast</u> captains into taking more care of them. I think you ought to write to each of those who return a broken bar.[ometer] a word of advice if you see no objection."[22]

As predicted, FitzRoy was soon fielding correspondence from ship captains reporting barometers broken in a variety of situations.[23] Captain Sulivan of HMS Merlin sparked a lengthy and detailed correspondence between FitzRoy, Adie, and Washington, when he wrote with the news that one of the first such barometers supplied by Adie had been broken by the "pitching of the ship." FitzRoy took such a report seriously, the more so since several of the early barometers had already turned up broken. "To me it appears that the glass tubes of his earlier lot were <u>not</u> well made—the glass was too brittle (In making the glass a certain alloy is used to give it toughness)—The Meandarks—Merlin's— Imperxxx [*illeg.*] –Eurydice's and Orion's—all of the first lot—were broken. 6 out of more than a hundred." Washington reminded Captain Sulivan that his claims would influence the whole meteorological programme: "As the further use of the Standard Barometer in this present form depends upon the reports of those already issued, Capt. Sulivan is requested to consider well and enquire whether it is possible that this Barometer received a blow or whether it really broke from pitching of the ship." Adie claimed

[20] Letters from Welsh to FitzRoy re: testing, supply and dispatch of instruments, Feb 27, 1855, PRO BJ 1/13 vii, f 2.
[21] Airy to Cardwell, Nov 11, 1853, PRO BJ 7/114.
[22] Washington to FitzRoy, Apr 15, 1858, PRO BJ 7/216.
[23] 'Notes of Admiralty and Board of Trade barometers sent out of and to places in London,' Jul 1,1857, PRO BJ 7/370.

that it was impossible for the pitching to break the tube unless very "quick and short strokes or heavings were given to it, such as I cannot conceive it could get on a wave."[24] One year later, FitzRoy noted that roughly 20% of all barometers sent from the Board of Trade and the Admiralty were broken in transit.[25]

When intact, these barometers were intended to furnish observations to be entered into the meteorological log carried on ship. Regular registrations of a calibrated marine barometer would contribute to the project to uncover universal laws of the weather, including laws of storms. Such barometers were undoubtedly also used by sailors to foretell the weather, but weather-watching practices were suppressed from the project of meteorological statistics and no official mention was made of the use of standard Board of Trade barometers as prognosticators. In contrast, when FitzRoy turned to the fishery barometer project, the prognostic value of barometers was foremost in his mind.

FitzRoy wrote to the instrument makers Negretti & Zambra on Dec 7, 1857 of his plan to "place ordinary land barometers as weather glasses solely, at some of the more exposed Fishing stations, and coasting harbours, in Great Britain and Ireland," requesting that they visit him with a selection of sturdy, easy to read barometers.[26] Tellingly, he referred interchangeably to barometers and weather-glasses in his initial correspondence on the project. By referring to the fishery barometer as a weather-glass, FitzRoy was recalling a much older tradition of prognostic weather-watching. The weather-glass, first mentioned by Francis Bacon in his *Sylva Sylvarum; or a naturall historie* of 1626, was an upright tube filled with water, terminating at the top in a bulb containing rarefied air. The water sank or rose in the tube as the air in the bulb expanded or contracted. The future that it foretold was not the utopian future in which a perfect science of the weather would be uncovered. It was the much more ordinary, daily future faced by thousands of British fishermen. Justifying the project to his boss, T. H. Farrer, the Assistant Secretary of the fast-growing Board of Trade, FitzRoy remarked that he had composed the "concise instructions" that would accompany the barometers "always remembering that the object of such instructions is, in the first place, the saving of valuable lives, on which, but too often, whole families depend . . . the more recent works as well as the earlier ones of the best scientific authorities have been consulted, in aid of the combined practical experience of those usually considered the most 'weather-wise'."[27] FitzRoy was happy to blend expensive London-made instrumentation with homespun weather-glasses, but his correspondents consistently demurred from labelling the Board of Trade instruments with the folk term and FitzRoy soon restricted himself likewise to talking of barometers.

It mattered to Negretti & Zambra that the barometers FitzRoy was requesting would not be required for scientific observation. The accuracy of their scales would be less

[24] Extensive correspondence of Capt Sulivan of HMS Merlin with Fitzroy, Washington, and Patrick Adie on broken barometer, Feb 20-26, 1856, PRO BJ 7/182. Barometers were broken in transit as well as onboard ship. Washington mentioned a breakage rate of 21% in a May 12, 1858 letter to FitzRoy in which he also reports taking Miss Herschell [sic] to see the curiosities the Royal Society, including Captain Toynbee's log and illustrations, PRO BJ 7/217.
[25] 'Notes of Admiralty and Board of Trade barometers sent out of and to places in London,' July 1, 1857, PRO BJ 7/370.
[26] FitzRoy's 'copy of specification' in form of a letter to Negretti & Zambra, re: supply of land barometers, Dec 9, 1857, PRO BJ 7/615.
[27] Notes on provision of barometers to poor local fishing towns that otherwise could not afford them, draft of a letter from FitzRoy to Farrer, undated, PRO BJ 7/19. On Farrer, see T.H. Farrer, DNB.

important, while their legibility and durability would be correspondingly more vital, were they to serve the rugged fishermen working the rough coasts of Britain. These were barometers made to be seen, rather than recorded. Negretti & Zambra's fishery barometers had clearly visible porcelain scales in a triangular shop window display and a few basic instructions for interpreting the rise and fall of the mercury. They were proud of their contribution and showed off the instrument in an 1864 treatise on meteorological instruments.[28] FitzRoy also wrote a simple manual of instructions intended to explain the basics of the instruments to fishermen.[29]

Crucial to FitzRoy's success in securing support for the scheme was limiting what might be construed as inappropriate government charity. FitzRoy assured Farrer that the programme was intended expressly to aid the poorest and smallest villages, which would be loaned the instruments, not given them outright. Even such loans would be strictly limited.

> It is understood that no such loan as that of a barometer, costing only four pounds (£4) should be made to towns, or large villages on the coast, however engaged in sea-faring pursuits their population may be: because such an instrument may be readily purchased by subscription if not provided by some generous benefactor (as in many places has been done).[30]

Towns large enough to raise the funds needed to buy a barometer would not be eligible for the loans and private benefactors would be sought whenever possible.

By January 1858, FitzRoy had obtained the permission of Board of Trade President, Lord Stanley, for the barometer experiment.[31] He turned his attention to Scotland first because severe weather conditions there were thought to affect the fishing (in particular the herring) industry more than in England.[32] Prior to sending barometers to coastal towns, FitzRoy elicited some statistical guidance from Bouverie Primrose, the Secretary to the Board of Fisheries of Scotland, as to the places that "have the largest amount of life and property risked afloat in their vicinity."[33] By April, FitzRoy had the Scottish returns from the singularly effective Primrose.[34] They indicated that while some villages already had a barometer (at Eyemouth the barometer was "daily noted, and esteemed as a faithful monitor by the Fishermen, its warnings having saved them many tempestuous gales"), others strongly desired one (in Coldingham the fact that "a number of the fishermen have the common weather glasses in their houses which they consider serviceable" was put forward "as a proof of the value they would attach to a Barometer were one erected").[35] FitzRoy anticipated that certain members of the local community might be antagonistic: in particular he mentioned "local feelings in respect of the Coast Guard, Ministers of Religion or private individuals which in some cases might operate inconveniently."[36] Such local figures, FitzRoy feared, might resent the

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[28] Negretti & Zambra, *A Treatise on Meteorological Instruments: explanatory of their scientific principles, method of construction, and practical utility*, London, 1864.
[29] R. FitzRoy, *Barometer and Weather Guide*, London, 1858.
[30] Notes on provision of barometers to poor local fishing towns that otherwise could not afford them, draft of a letter from FitzRoy to Farrer, undated, PRO BJ 7/19.
[31] For indirect evidence, see FitzRoy minute to Farrer, further to Lord Stanley's approval in principle of the proposal to aid fisheries with weather glasses, Jan 28-29, 1858, PRO BJ 7/616.
[32] T. Burton, 'Robert FitzRoy and the Early History of the Meteorological Office', *British Journal for the History of Science* (1986), **19**, 147-176.
[33] FitzRoy to Primrose, Feb 16, 1858, PRO BJ 7/617,
[34] Primrose to FitzRoy enclosing returns, Mar 29, 1858. PRO BJ 7/618.
[35] Barometer return from Eyemouth, PRO BJ 7/622.
[36] Notes on provision of barometers to poor local fishing towns that otherwise could not afford them, draft of a letter from FitzRoy to Farrer, undated, PRO BJ 7/19.

intrusion of new technologies for managing the uncertainty of sea-going, methods that might possibly curtail their own authority. The Coast Guard might resent the intrusion of the Met Department in their management of coastal traffic, while ministers might fear that the prognostic qualities of the barometers would undermine religious faith. There is no evidence, however, to suggest that either the Coast Guard or ministers felt this way.[37]

Distributing barometers to fishermen

By June 1858, the specially designed barometers were ready and the surveys adequately completed. It was time to distribute the barometers. FitzRoy expressed his intention to commence "the experiment of lending a barometer, belonging to the Board of Trade, to poor men, (Fishermen and other seafaring persons) whose lives are more or less dependent on weather, but who are unable to buy weatherglasses by which to be forewarned of impending storms."[38] He sent out the first batch of ten Negretti & Zambra fishery barometers to Primrose to be distributed to poor fishing villages in Scotland and St. Ives. Favourable weather permitted Primrose to deliver the barometers by boat. The response was immediate and positive. At Secretary's Hole, the "fishermen and others mustered on the beach and headed by Mr Macintosh, Boat Builder, as Spokesman, warmly expressed their thanks for the barometer as it was being landed." At Rosehearty, the Chief Magistrate expressed thanks for the instrument and promised to find a suitable place for it. In Leith, twenty-six of the town's chief fishermen "entered very cordially" into the subject of where the barometer should be placed and who should take responsibility for it.[39]

Stewardship of the instruments was inseparable from their worth. Captain Walker reported to Mr Farrer, Secretary of the Board of Trade:

> Within the last few years many lives and much property have been lost on the northern and Eastern coasts of Scotland owing to the fishermen proceeding to sea when a gale of wind was brewing which they were not aware of, but its proximity would have been indicated by a Barometer. These valuable instruments lose much of their worth if not placed under the management of some person who has some knowledge of their properties and who should attend to the range of the mercury and set the index, before sending them away we should know who is to have charge of them.[40]

Primrose complained to FitzRoy that despite the good weather, "it has been no easy matter to get them fitted up and it was impossible to do so at some of the places in more than a temporary manner." Stone houses were erected to protect the barometers at some locations. All were arranged so that they were easily visible for public examination. Primrose concluded his report by stating that "the people are

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[37] For debates over religious and scientific authority onboard ships, see W. Winter, '"Compasses all awry": the iron ship and the ambiguities of cultural authority in Victorian Britain', *Victorian Studies* (1994), **38**, 69-98; and C. Smith, I. Higginson, and P. Wolstenholme. ' "Imitations of God's Own Works": making trustworthy the ocean steamship', *History of Science* (2003), **41**, 379-426. For a book-length study of how authority and trust for steam and telegraph technologies was established, see B. Marsden and C. Smith, *Engineering Empires: a cultural history of technology in nineteenth-century Britain*, Basingstoke, 2005.

[38] Notes on provision of barometers to poor local fishing towns that otherwise could not afford them, draft of a letter from FitzRoy to Farrer, undated, PRO BJ 7/19.

[39] Extracts from Fraserburgh Fishery Officer's letter to Primrose, Jul 1, 1858, and extract from Leith fisheries officer's letter, 'Primrose report on the distribution and location of first eight barometers and manuals, including letters of thanks from fisheries,' Jun 28, 1858, PRO BJ 7/647.

[40] Walker to Farrer, Jun 2, 1858, PRO BJ 7/644.

much pleased and very grateful."[41]

Fishermen considered the Met Department instruments to be highly desirable additions to their weather-wisdom tool-kit, in addition to reading the skies, weather-glasses and almanacks.[42] The news of the Scottish 'barometers for fisheries' programme prompted an influx of requests for barometers from many fishing villages in England and Scotland. The fishermen of Beadnell, on the rough coast of Northumberland, sent a typical petition via their spokesman, Mr Walker. Understanding that public barometers are being placed in the fishing villages in the North of Scotland, and that Mr. Stebbing [the optician employed by the Met Department] is superintending the setting of and adjustment of these instruments, the Fishermen of this village have applied to me to address you on the subject. This Coast (the neighbourhood of the Farne Islands), is particularly liable to violent gales, which frequently come without any warning + I need hardly remark how great a boon such an instrument would be to the Fishermen engaged in the white and Herring Fishery here.[43]

Matters of geography, circulation and responsibility were paramount. The inhabitants of Burghead, at the edge of the Moray Firth in Scotland, reminded the Met Office that their village was frequented by vessels connected with the foreign export trade and that "any improvement that tends to augment its safety, is calculated to be a benefit extending to interests beyond those of the mere locality."[44] At Bridlington Quay on the Yorkshire coast, a Mr Brambles referred to the "exceedingly useful donation of Barometers recently made by your Admirable Board" and requested an instrument to protect the "large number of Boatmen daily exposing themselves on the sea guided alone, as to the weather, by their own uncertain judgment."[45]

The petitioners recognized the importance of finding an appropriate location for the requested barometers. In their letter requesting a barometer, the fishermen and seamen of Burnham characteristically promised to "undertake to place it in a good public situation and have every care taken of it."[46] In the east Devon coastal town of Budleigh Salterton, 17 men signed a petition (some with a mark rather than a signature), requesting "a public Barometer" and suggesting the centrally located Coast Guard station as a good place for it.[47] And in Berwick, Henry Gates wrote that the watch house recently built on the Quay could safely protect and display a weather-glass.[48] On Plymouth Sound, William Walker eagerly assured FitzRoy that he would:

> go over to Cawsand Bay at once and look out for a suitable house where Pilots, Fishermen, and Coasters may view the Barometer and take note thereof . . . If you can get free access for fishermen to view the Barometers at Coast Guard Station houses where such stations houses may be situated on the same side of the water as the residence of the Fishermen and others interested in the weather. Such station houses would be a better place than in

[41] Primrose to FitzRoy, Jul 19, 1858, PRO BJ 7/645.
[42] Anderson, op.cit. (8), 41-82.
[43] Walker to FitzRoy, Jul 7, 1858, PRO BJ 7/659.
[44] Petition from Burghead, Dec 2, 1862, PRO BJ 7/651.
[45] Brambles to Secretary, Marine Department Board of Trade, Jan 5, 1859, PRO BJ 7/662.
[46] Petition signed by 12 men sent to FitzRoy, Nov 29, 1861, PRO BJ 7/664.
[47] Request for barometers from Budleigh Salterton, undated, PRO BJ 7/663.
[48] Gates to FitzRoy, Oct 20, 1863, PRO BJ 7/660.

either private or "Public Houses"!![49]

Though the dangers of drink in the pub threatened the authority of the barometer, it was nonetheless still important to ensure that the barometers were publicly accessible, both their purpose and provenance requiring it. As FitzRoy soon discovered, even seemingly likely spots had hidden pitfalls. In a letter justifying the project to HR Williams, Accountant for the Board of Trade, he explained:

> I once thought the Coast Guard a good means of forwarding this work—so did Mr Farrer—but I found, on close inquiry, that the Coast Guard and the Fisherman (for whose use the barometers are especially intended)—do not associate (for obvious reasons) and that for a fisherman to be seen near a Coast-guard house exposes him to the suspicion of being an informer (respecting some smuggling affair)—Beside which the Coast Guard premises are kept so very clean that Fishermen with dirty boots are not welcome—<u>at any time</u>.[50]

Five days later, Walker had solved the problem, reporting that the fishery barometer had been:

> received and put up in the front parlour window of the house of Mr Isaac Pearse, a first class branch Pilot, and moreover a well-informed man of high character with a scientific turn of mind who <u>volunteered</u> to take charge of the instrument leaving it open for consultation by everybody. It is a Capital instrument for the purpose, easily read off and understood: the Cawsand people are much pleased with the Bd of Trade's liberality.[51]

This privately controlled, but publicly visible space, superintended by a sailor with scientific and voluntaristic leanings, is precisely the sort of space in which a 'liberally'-supplied barometer sent from a government office in central London could serve as a weather-glass to local fishermen. The physical situation of the barometer captured the sense of carefully calibrated control and mediated responsibility that the Met Department strove to achieve. The spirit of voluntarism evidenced by Isaac Pearse and underlined by Walker testifies to a moral responsibility more trustworthy than a mere salary could secure. This was precisely the kind of trust that full-time government administrators and scientists struggled to establish for themselves.

Mr. Walker gave a vivid account of how such matters were time- as well as space-sensitive. In a letter written on 12 July 1858, he reported having received FitzRoy's letter on the subject of barometers on 8 July:

> I called a meeting of the men the same evening who at once said they would subscribe among them the necessary funds £4 which you say is the price of a good barometer. The next day I went by sea with a deputation of the Fishermen to procure the cooperation and assistance of their landlord TN Craster Esq of Craster Tower in this neighbourhood who agreed to be at the expense of making a place of security for it in the wall of one of the houses equidistant from the Northern and Southern extremities of the village. Mr Craster agrees with me in selecting an old respectable Fisherman of the name of Ralph Dixon to be in charge of the instrument, and this selection meets also with the approval of the men, who are anxious to have it set up as

[49] Barometers for Cawsand Bay, William Walker to FitzRoy, Aug 12, 1858, PRO BJ 7/665.
[50] FitzRoy to H. R. Williams, Esq., Accountant, Aug 6, 1858, PRO BJ 7/17.
[51] Barometers for Cawsand Bay, Walker to FitzRoy, Aug 17, 1858, PRO BJ 7/665.

> soon as possible, as they are all preparing for the herring fishing—They are also anxious to have instructions in the adjustment of the instrument and in the use of the scale.[52]

The instant meeting, the next-day journey to see the local landlord, the identification of a central location and respectable caretaker for the instrument demonstrate both how urgently the men desired a barometer and their understanding of how narrow were the conditions under which such a tool could successfully operate. FitzRoy forwarded the Beadnell petition to Mr Bowring, registrar at the Board of Trade, noting in a memo that the letter "may be considered more or less a type of others likely to follow on the same subject" and asking him to "submit to the President my humble opinion that such a barometer (as understood to be available) might be sent to Beadnell, in Northumberland, when opportunity offers—provided that £4 be paid (to the Accountant of the Board of Trade) on its establishment at Beadnell."[53]

FitzRoy's internal memo received grudging approval that did not conceal the bureaucratic resistance to what was, in FitzRoy's own terms, an experiment, an uncertain projection of government monies and authority into private, semi-private or even public spaces with loyalties to different authorities. Bowring reminded FitzRoy that the

> [b]arometers that have been sanctioned are, I understand, in the way of experiment only and it is not intended to carry the experiment any further until some experience has been had of the advantage expected to result from its. In the present case, the parties propose to pay for the Barometer and to put it up at their own expense. We might properly I think point out the kind of Barometer that Admiral FitzRoy would recommend and inform the parties where it is to be got at the price that it is suggested we should charge—But I think it would be undesirable that we should furnish the Barometer at a price to be paid for to us.[54]

Bowring's desire to distance the Board of Trade from the sale of barometers to fisheries is an indication of the general distaste for government intervention. His awkward grammar is the marker of his complex reasoning: not only should the Board of Trade definitely avoid *granting* barometers to fishermen, but it should also avoid the risk to government disinterestedness posed by simply *facilitating* the supply of cut-price barometers. The 'barometers for fisheries' programme shows how important it was, even in the relatively simple matter of loaning out barometers, to draw the line between suggesting an appropriate price for a barometer and facilitating the sale of one at that price. Such fine distinctions were required to protect the government from the dangers of excessive intervention.

Despite this internally generated difficulty, FitzRoy was successful in supplying dozens of coastal villages with barometers. His office responded very quickly to requests for barometers (many requests were annotated on the day of receipt with

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[52] Barometers for Beadnell, July 12, 1858, PRO BJ 7/659 f3.

[53] Barometers for Beadnell, Board of Trade Marine Department Minute Paper, undated [July 1858], PRO BJ 7/659 f5. Edgar Alfred Bowring (1826-1911), the son of Sir John Bowring (Jeremy Bentham's literary executor and later governor of Hong Kong) served as librarian and registrar at the Board of Trade from 1848-1863 and was secretary to the Royal Commissioner of Exhibition of 1851. He kept a journal in which he recorded daily weather observations. See Edgar Bowring journal (1841-1857, 14 vols.), William Perkins Library, Duke University.

[54] Barometers for Beadnell, Board of Trade Marine Department Minute Paper, undated [July 1858], PRO BJ 7/659 f5.

FitzRoy's efficient "Ack[knowledge]. Barometer to be sent."), and extant correspondence suggests very few instances where requests for barometers were rejected. Annual reports from the Met Department listed a steady rise in the number of fishery barometers supplied to small fishing communities. Even the encomium to loan barometers only to the smallest and poorest towns and to require larger towns to raise a subscription themselves seems to have been loosened. In 1858, a request for a barometer from the people of Filey in Yorkshire was annotated (by a hand other than FitzRoy's) with a note suggesting that given the size of the village (95 married and 79 unmarried fishermen) "those interested fishermen should get one at their own expense. It would not be more than 1/6 a boat and if the Fishermen would not subscribe such a small sum for such a purpose I cannot think they have a claim of the Gov't."[55] (A barometer—it is unclear whether it was loaned or sold—was eventually shipped to Filey.) By 1863, in contrast, good-sized towns such as Berwick on the Northumberland coast and Devoran in Cornwall were regularly loaned the instruments. In his 1863 Met Department report, FitzRoy published a list of 89 fishery stations in Britain supplied with barometers, of which 25 were private gifts and the rest Board of Trade instruments.[56] A steady stream of requests from fishing communities continued to arrive at the Department, but from 1861 the programme seemed to take care of itself. FitzRoy's impulse to extend the borders of a new office whose remit was somewhat ambiguous (if its central objective of meteorological statistics was not) soon settled on what would prove a rather more turbulent object.

Weather forecasts as dangerous knowledge

FitzRoy's forecasting project was informed by several decades worth of storm studies that preceded it, but he was emboldened by the *Royal Charter* storms of late October and early November, (named after one of the 343 ships wrecked on British coasts by its high winds and seas), to begin his programme of weather forecasting based on the rotatory theory of storms.[57] FitzRoy used the occasion to test the current idea that storms displayed characteristic counter-clockwise rotation in the northern hemisphere (and clockwise rotation in the southern). "I was turning round two half crowns on a piece of paper (for cyclones) when your packet arrived," FitzRoy wrote to John Washington, Hydrographer to the Navy, "Tomorrow I will send a draft for a Circular—(letter not storm)."[58] Observations of the *Royal Charter* storm sent to his office from all over Britain had convinced FitzRoy that the cyclonic (or rotatory) theory of storms could be used to predict their movements up to two days ahead of time.[59]

FitzRoy soon established a telegraphic system of coastal observers to enable him to gather real-time observations and, more radically, to turn the system inside out and transmit information back out of London to the coastal stations where it was needed most. Begun in February 1861, his initial project to issue storm warnings was authorized by the Council of the British Association for the Advancement of Science (based on a suggestion first made in Section A (Mathematical and Physical

[55] Request for barometer for Filey, Yorks, Feb, 1858, PRO BJ 7/670.
[56] 'Report of the Meteorological Office of the Board of Trade for 1863,' PP1863 LXIII, 27.
[57] For number of wrecks caused by *Royal Charter* gale, see 'Returns of Number of Wrecks, Casualties, and Collisions reported to Board of Trade on Coasts of United Kingdom, 1861-1870,' PP1871 LXI, 669.
[58] FitzRoy to Washington, Dec 15, 1859, Hydrographic Office Archives, Taunton (henceforth HO) MLP 29 f14.
[59] FitzRoy to Washington, Dec 23, 1859, HO Misc 29 f15.

Science) at the 1859 meeting of the BAAS in Aberdeen).[60] FitzRoy's impatience may have been related to the system of weather telegraphy recently established by Urbain Le Verrier, director of the Imperial Observatory in Paris, by which current weather (including any storms) at various points in France and elsewhere in Europe were telegraphed to Paris. Such warnings were significantly limited to communications of the "actual state of the weather", not predictions of future storms. Le Verrier himself had warned FitzRoy "not to reject what we [the French] offer on the pretence that we could do more."[61] But FitzRoy was not content to wait. In May 1861, he took the significant step of predicting rather than simply reporting poor weather in what he called a weather *forecast.* He telegraphed his coastal observers with forecasts based on their previously telegraphed observations; coastal stations with poor forecasts were also sent cautionary notices, advising them to raise a series of flags or night lanterns signalling the direction of any dangerous winds or gales to nearby ships.[62] This innovation was entirely FitzRoy's, unsanctioned by the Board of Trade or the Council of the British Association.

FitzRoy's daily forecasts were based on a collection of rules and maxims relating to the law of rotatory storms that had been confirmed by the *Royal Charter* storm. Telegraphs from coastal observers were received in the Whitehall office daily at 10 am. FitzRoy drew up the forecasts from west to east, in the order in which the weather tended to move. Irish regional forecasts were drawn up first, followed by forecasts for the western, central, south-western and south-eastern coasts of Britain. Writing these short abstracts took just 30 minutes. FitzRoy also quickly selected, from over 200 stations, a list of those places to be immediately telegraphed cautionary notices in addition to forecasts. These notices were displayed by raised flags in harbours throughout Britain within 30 minutes of receipt. By 11 a.m., forecasts had been sent to the *Times* (for its second edition of the day), Lloyd's, the Shipping Gazette, the Board of Trade, the Admiralty and the Horse Guards, and then to other afternoon papers. Later in the day, reports modified by additional observations sent in by telegraph in the afternoon were sent out for the next morning's early papers.[63] FitzRoy and one other assistant (probably Mr Babington) were alone responsible for the forecasts. Fitzroy was proud that few written rules were consulted or recorded: "An outline chart, with wind-markers, is useful; likewise a transparent horn, or a glass, with circles; but a certain amount of practice enables one to dispense with such assistance, and work out the questions mentally (like a chess-player who need not look at the board.)"[64]

Almost as soon as he had begun the forecasts in 1861, FitzRoy came under a great deal of pressure. His incorporation of the tools of local weather-watching—rules of thumb and individual judgement—with the synoptic technology of telegraphy and a central office was highly controversial. Some saw evidence that meteorology had finally matured. When the Met Department issued warnings about the gale in which

[60] 'Report of a Committee Appointed to Consider Questions Relating to the Meteorological Department of the Board of Trade,' PP1866 LXV, 18. And correspondence between Airy and FitzRoy, June 6-9, 1860, Royal Greenwich Observatory Archives, Cambridge University Library, 6/702/19/230.
[61] 'Report of a Committee Appointed to Consider Questions Relating to the Meteorological Department of the Board of Trade,' PP1866 LXV, 18-19. On Le Verrier's weather forecasting system, see Fabier Locher, 'Le Nombr et le temps: la meteorologie en France, 1830-1888' EHESS PhD dissertation, 2004..
[62] On forecasting, see Burton, op.cit. (32), 161-164; and Anderson op.cit. (8), 110-115.
[63] R. FitzRoy, *The Weather-book: a manual of practical meteorology*, London, 1863, 194.
[64] FitzRoy, op.cit. (64), 218.

the Whitby lifeboat crew was lost, the *Times* considered that "the event was predicted with as much certainty as an eclipse . . . Meteorology now rests upon evidence as palpable as that which confirms our theories of astronomy."[65] Others were far less sanguine. Criticism of the forecasts came from a diverse lot: astro-meteorologists and lunarists who viewed them as competition; Royal Society fellows who thought the shaky forecasts were far less accurate than eclipse predictions and brought Science in general into disrepute; and Parliament, which responded to a suggestion that the weather might be predicted 24 hours in advance with laughter.[66] By their nature the forecasts were imprecise.[67] The Royal Society Committee headed by Galton noted disapprovingly what FitzRoy had boasted of: that, like a chess-player, he worked out his forecasts mentally. Their report concluded that "it is the custom of the Department to perform the whole of the foregoing operations, and to determine the forecast, after a simple inspection of the list of weather returns [received from coastal observers]. No notes or calculations upon paper are made. The operation occupies about half an hour, and is conducted mentally."[68] In addition to possibly damaging the scientific status of meteorology, they threatened to burden the government with too much responsibility. What if fair weather was forecast and ships went to sea only to be beset with an unforeseen storm? Equally unacceptable for the commercial vessels was the possibility that they might heed a warning of poor weather and stay in harbour, only to find sunny skies and money wasted through needless inactivity. Would the government repay unearned income?

The Met Department worked hard to make its interventions seem restrained rather than forceful so that the fishermen's judgements could come to the fore. This had the dual advantage of curbing the office's liability for the lives and incomes of fishermen and limiting its exposure to ridicule for going too far in prophesying the weather. The forecasting controversy was an extremely public demonstration of the limits (what some would call the failures) of scientific expertise at a moment when the fight for cultural authority was fiercely contested.[69] The taint of the fairground and the fortune-teller clung to the would-be weather prophet and provided a vocabulary for mockery of FitzRoy's programme. Prediction was a slippery thing; it could mark the highest science (astronomy) and the tawdriest sham (palm-reading).

Kept safely in the appropriate domains, prophesying was not just acceptable but desirable. FitzRoy's forecasting system was not that different from what he expected the fishermen to do with their fishery barometers: to make individual

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[65] *Times*, Feb 13, 1861, 8-9.

[66] On the response of astro-meteorologists and the Royal Society to FitzRoy's weather forecasts, see Anderson op.cit. (8), 83-131. On laughter in Parliament, see Burton op.cit. (32), 151.

[67] FitzRoy correlated changes in pressure indicated by barometrical observations with the movements of two postulated contrary currents of air, one warm and moist from the south or southwest, the other cold and dry from the north or northeast, based on Heinrich Dove's theory of rotatory storms. FitzRoy's internal verification of the forecasts consisted of a list of warnings used, observations made at coastal stations and an informal collection of extracts on weather from local newspapers. An external committee set up to monitor the forecasts reported to Parliament in 1864. See 'Tables of observations by Board of Trade for recording Actual Weather Corresponding to Admiral FitzRoy's Daily Forecasts and Warning Signals,' PP1864 LV, 341.

[68] 'Report of a Committee Appointed to Consider Questions Relating to the Meteorological Department of the Board of Trade,' PP1866 LXV, 20.

[69] On the claims made by scientific naturalists for authority, see F. Turner, *Contesting Cultural Authority: essays in Victorian intellectual life*, Cambridge, 1993. On meteorology in particular as a feature of the contest for cultural authority, see Anderson op.cit. (8), 285.

judgements based on instrumental readings. The difference, of course, was that FitzRoy represented and broadcast the authority of the government along with his forecasts, while fishermen were accountable only to themselves. Their methods, based on simple rules of thumb and not requiring data-intensive reduction but day-to-day comparison, were largely similar. Both FitzRoy's forecasts, and the forecasting he was encouraging the fishermen to do on a daily basis, contrasted with the slow, long-term and largely unpractical official programme of government meteorology. While FitzRoy could have enlisted weather-watchers as contributors to the great project in meteorological registration alongside the vast workforce of the Royal Navy, he did not. Despite their expense and the high standard of their construction, the fishery barometers were not conceived as constituting part of the Met Office's formal programme of gathering comparable meteorological observations from sea and coastal observers: they were just weather-glasses. Fishermen were not, and should not be made, subject to the same discipline that existed in the Royal Navy.

Though the barometers for fisheries programme predated his forecasts, the former soon became an important counterbalance to the latter. While fishermen lacked certain qualifications, their practice of making daily judgements about going to sea and their responsibility for themselves made them ideal participants in FitzRoy's forecasting programme. Their role as voluntary observers operating at a local level offered a corrective to the risks of the universal project.

FitzRoy's barometer project was supplemented by parallel programmes in the period situated firmly (and more comfortably) within the British tradition of philanthropic and voluntary organizations. In 1859, the Duke of Northumberland supplied 14 barometers to poor fishing villages along the Northumberland coast between the Tweed and the Tyne.[70] In 1860, the National Life-Boat Institution announced that it would endeavour to supplement the barometrical philanthropy of FitzRoy and the Duke of Northumberland by attempting to supply "every life-boat house in the system with a barometer and to train the coxswain how to use it."[71] In June 1874, the Marquis of Tweeddale, President of the Scottish Meteorological Society, presented twenty sea-thermometers to the society for the use of the fishermen for observations of the temperature of the sea, to be taken by them on the fishing grounds.[72]

These projects underlined the links between self-help and safety in the matter of weather forecasting. In an article published in *The Lifeboat*, the journal of the National Lifeboat Institution, FitzRoy suggested that the independent judgement of the fishermen could act as a corrective to the shortcomings of the forecasts:

> Objection has been taken to such forecasts, because they cannot be always correct, for all places in one district. It is, however, considered by most persons that general, comprehensive expressions, in aid of local observers, who can form independent judgments from the tables and their own

[70] 'Report of the Meteorological Department of the Board of Trade,' PP1864 LV, 125; 'Report of the Meteorological Office of the Board of Trade for 1863,' PP1863 LXIII, appendix 2.
[71] 'Barometers for Life-Boat Stations,' *Lifeboat*, Oct 1, 1860, 336.
[72] A. Buchan, 'Third report on the relations of the herring fishery to meteorology', *Journal of the Scottish Meteorological Society* (1879), **5**, 240-251; M. Deacon, 'Some 19th century research on weather and fisheries: the work of the Scottish meteorological society' in *British Marine Science and Meteorology: the history of their development and application to marine fishing problems* Buckland occasional Papers No. 2, Buckland Foundation, 1996, 117-132; and 'Report of the Meteorological Department of the Board of Trade' PP1864 LV, 125.

> instruments, respecting their immediate vicinity, though not so well for distant places, may be very useful, as well as interesting; while to an unprovided or otherwise uninformed person, an idea of the kind of weather thought probable cannot be otherwise than acceptable, provided that he is in no way bound to act in accordance with such views, against his own judgment. Like the storm signals, such notices should be merely cautionary, to denote anticipated disturbance somewhere over these islands, without being in the least degree compulsory, or interfering arbitrarily with the movements of vessels or individuals.[73]

Forecasts would not impair the judgement of those who used them, argued FitzRoy; they would improve it when used alongside tools such as barometers and weather-wisdom. British sailors would be free to pursue their livelihoods free from excessive government interference. "But, say some, and justly, are ships to remain waiting to avoid a gale that, after all, may not happen? Are fisherman and coasters to wait idle and miss their opportunities? By no means. All that the cautionary signals imply is, 'Look out.' 'Be on your guard.' 'Notice your glasses and the signs of the weather.' 'The atmosphere is much disturbed.'"[74]

Extending this reasoning, in another *Lifeboat* article James Glaisher, meteorologist at the Royal Observatory in Greenwich, pointed out that both coastal and marine barometers could be considered part of the heroic technologies of life-saving:

> I am sure that every assistance will be cheerfully rendered by the National Life-Boat Institution to save life—whether by life-boats, ships' life-boats, seamen's life-belts, fishing life-boats; or, lastly but not least, in its great and good work, by helping the sailor on board ship to possess a truthful and cheap barometer—a scheme which is indeed only an extension to the sea, of the coast barometer system of the Institution; and thus prevent, as far as possible, by timely warnings on board ship, the necessity of calling into use the last but most glorious assistance—the services of the life-boat itself.[75]

Only by combining the barometric readings with their own, individual judgments of the weather could lifeboat men successfully forecast the weather. Though it would be "folly" to neglect the "cautions given by the barometer," Glaisher noted the "absolute necessity which exists for combining instrumental indications with their own local weather estimates, drawn from natural and familiar sources."[76]

A questionnaire circulated by the Met Department in 1863 evaluating the utility of the fishery barometers confirmed that the instruments sharpened rather than dulled the faculties of local fishermen. In Kingsdown, Thomas Sydenham Clarke noted that the barometer there was consulted over 500 times a day ("I believe no boat goes to sea without the glass being consulted in the first place") and "forms quite a topic of conversation amongst the men, which naturally engenders thought, and reflection, and renders barometers and their use more familiar to the men and boys." He added that "the men are very fond of comparing the appearance of the clouds, sea, atmosphere, &c., with the glass, and seeing how far their natural observation harmonizes with the variations of the glass, and this sharpens their

[73] Rear-Admiral Fitz-Roy, 'Weather reports and forecasts in the daily newspapers,' *Lifeboat*, Oct 1, 1862, 147.
[74] Ibid 148.
[75] James Glaisher, 'On the Variations of the Reading of the Barometer and the Weather in the Months of September, October, and November, 1865,' *Lifeboat*, Oct 1, 1862, 10.
[76] James Glaisher 'On the connection between the recent gales of wind and the readings of the barometer,' *Lifeboat*, Jan 1, 1864, 355.

observation and corrects many an idle myth and vulgar notion."[77]

The advantage from this increased observational expertise accrued to the local fishermen, but FitzRoy benefited indirectly. He was freer to make forecasts because he would be less liable for incorrect prognostications if the fishermen were seen to be more responsible for themselves. By rendering fishermen more self-reliant, FitzRoy could be seen to be making them safer. FitzRoy attempted to make the Met Department look like a project characterized by restraint on the part of the government and calculated to increase self-reliance on the citizen's part. In the context of Victorian governance, there's nothing new here. But histories of science in Britain in the period (notably histories of electro-technical metrology and standardization), have emphasized how the success of such systems depended on their ability to reproduce centrally delimited conditions which by definition erased or over-wrote local conditions.[78] The story of FitzRoy and the barometers provides an interesting counterpoint to George Airy's attempt to introduce sophisticated metropolitan instrumentation on board naval and merchant marine ships and to establish robust methods for adjusting the compasses on iron-clad ships.[79] In contrast to what Alison Winter has argued was Airy's attempt to subdue the authority of ship captains, FitzRoy (a retired sea captain himself, after all,) sought a way to make the self-sufficiency of the mariner congruent with a successfully disciplined scientific network. While Airy was opposed by William Scoresby, who waged a popular campaign to limit the intrusions of distant and elite natural philosophers into matters that were to remain under local control, FitzRoy faced no significant opposition to his project to bring metropolitan instruments to local fishermen (though he wondered at one point if he would). The barometer story is an example of how enhancing the individual authority of local actors could help sustain centralized liberal governance and generate safety at both the local and the government level.

Local knowledge resurgent

Following FitzRoy's death in 1865, it became clear that the Met Department had become dangerously synonymous with FitzRoy himself. The lack of written rules made the forecasting system almost unrecoverable without him, despite his assistant Babington's extensive experience. Under a heading titled "This practice not carried on according to any definite rules," the Royal Society Committee reported that Babington "does not think that the grounds on which the Department acts in foretelling weather are capable of being stated in the form of Rules or Laws." All of the knowledge of government forecasting existed solely in the heads of a few government employees. "Were the gentlemen now in the Department to leave it, no rules would be found in the Office for continuing the duties on their present basis."[80] The Committee recommended that the storm warnings continue but that forecasts be suspended from May 28, 1866. The barometer programme

[77] 'Kingsdown House, near Dover, March 23rd, 1863,' *Report of the Meteorological Office of the Board of Trade, 1863*, PP1863 LXIII, 27-92.
[78] S. Schaffer, 'Late Victorian metrology and its instrumentation: "a manufactory of Ohms"' in *Invisible Connexions: instruments, institutions and science* (ed. R. Bud and S. Cozzens) Bellingham, Wash. 1992, 23-56; S. Schaffer 'Accurate measurement is an English science' in *The Values of Precision* (ed. N. Wise) Princeton, 1995, 135-172.
[79] Alison Winter, ' "Compasses all awry": the iron ship and the ambiguities of cultural authority in Victorian Britain'. *Victorian Studies* 1994(38) 69-98.
[80] 'Report of a Committee Appointed to Consider Questions Relating to the Meteorological Department of the Board of Trade,' PP1866 LXV, 20.

continued. Management of the newly renamed Met Office succeeded to a meteorological committee of the Royal Society (largely made up of members of its Kew Committee).[81]

R. H. Scott, translator of Dove's *The Law of Storms* in 1862, was appointed head of the reorganized Office, a post he held for thirty-three years under the watchful eyes and increased authority of a Meteorological Committee of the Royal Society. Scott immediately began reformulating the Office's purpose along lines more acceptable to the Committee. In a letter to Farrer, Scott assured him that "though they [the Met Office] distinctly decline to prognosticate weather, or to transmit what have been called 'storm warnings', they are collecting information which they confidently anticipate will enable them, sooner or later, to frame rules by which such prognostications can be made; and that one of the main objects which they propose to themselves is the advancement of meteorological science in this important practical direction."[82]

The debate over the utility of barometers in relation to weather forecasts continued. In 1876, the Meteorological Committee was charged by the Treasury with reviewing the "results obtained" from the by then considerable annual grant from Parliament of £10,000. The committee pondered whether the signals and forecasts should be reinstated. They heard evidence collected by W. F. Pilter, Superintendent of the Mercantile Marine in Shields, from local men involved in the fishing trade on the question of whether the still-suspended forecasts had been considered helpful or dangerous. Herring, a deep-sea fish that lurks in deep waters, drew the fishermen in its pursuit out to sea in perilous open boats. As a consequence, the herring fishermen of Shields "never disregard [storm] signals," reported Pilter. Salmon, on the other hand, stayed closer to shore and correspondingly so did its fishermen: "the distances they go is so short they can always run into harbour." Salmon-fishermen, it seemed, paid consequently little attention to the forecasts. Because sailing-ship masters could not count on out-running an impending gale, they "generally speaking, detain their vessels and put confidence in the signals." But steamboat masters could count on getting "clear of the district in which the gale is expected before it breaks." Despite "believing a gale will almost certainly follow the hoisting of a signal, [they] do not as a rule detain their vessels, if it is fair weather at the time." For steam tug owners, any delay caused by storm warnings was money lost: "It is to their advantage to tow a vessel to sea as soon as she is ready. Detention keeps them idle … Their interest in the vessel ceases as soon as they have taken her safely over the bar. Witnesses, to prove the utter uselessness of the signals, can be easily obtained from this class of men." They "heartily wish they [storm signals] were abolished." Pilter's letter concluded with the assertion that, despite the variety of attitudes towards storm signals, "the general feeling amongst the maritime community is in favour of a continuation of the signals."[83]

Henry Lindsay, collector of the Custom House in Shields, also shared his views on storm signals. He began by noting that the warnings were not as useful on the east

[81] Burton op.cit. (31), 173 and 'Return of Establishment and Cost of Meteorological Department of Board of Trade, 1862-66,' PP1867 LXIII, 497-512. The Met Office was run by the meteorological committee of the Royal Society until 1877 when it was renamed a meteorological council, with similar responsibilities. See Anderson op.cit. (8), 144.
[82] Letter from R. H. Scott to T. H. Farrer, 'Report of the Meteorological Committee of the Royal Society for 1867,' PP1867-68 LXIII, Appendix, 63.
[83] Minutes of Evidence 'Report of the Meteorological Committee of the Royal Society, 1876-77,' PP1877 XXXIII, 631.

coast as they were on the west, since the falling barometer on which they were based usually indicated a strong off-shore wind that became fair for most boats leaving Tyne. He did acknowledge, however that "when first hoisted in the Tyne, their novelty, and the new science they evidenced caused them to be carefully observed, and I am aware that they did, in many instances, deter masters from putting to sea." But simple deterrence was not in itself proof of the utility of storm signals. Fishermen, sailing-ship masters and steam tug owners alike made their living from the sea and staying in port in fine weather was bad business. If working sailors simply took the forecasts at face value, they would quickly find themselves overly dependent on a dangerous form of universalized knowledge that did not, for example, take into account the different meanings of falling barometric pressure on the east and west coasts of England. Such forecasts could easily let them down.[84]

Rather than rendering the ship captains more reliant on information from without, however, Lindsay suggested the forecasts made them more self-reliant. "Masters of vessels," he wrote, "who had in this temperate zone paid little attention to the indications of the barometer, content to be weather-wise from their observations of atmospheric or other natural phenomena, began first to study their instruments for evidence of the forecasts as signified by the signals, and then to rely greatly on their own capacity to judge of the coming weather. They practically, therefore, depend very much on themselves." Rather than robbing autocratic captains of their personal authority, according to Lindsay, the introduction of storm signals spurred them into a reappraisal of their own skills, a kind of continuing education in which the captains tested their capacity to "judge of the coming weather" against that of the government meteorologists responsible for storm warnings. The implication was two-fold: ship captains who relied on themselves were better off than either those captains who took storm signals literally or those who disregarded them completely; and storm signals would have the effect of stimulating the captains into fuller self-reliance.[85]

Pilter and Lindsay's emphasis on locally differentiated responses to storm warnings was largely ignored by a Committee concerned with the bigger question of whether meteorology should be pursued by a government body at all, and, if so, in what form. Storm signals were central to the on-going identity crisis suffered by the government meteorological office in the twenty years since its founding. The debate over forecasting and prediction in which they figured tended to be polarized in the following terms: practical, local and empirical weather-wisdom was contrasted with scientific, universal and theoretical meteorology. Scott worked hard to distinguish warnings about existing weather from forecasts relating to future storms. Warnings could be safely incorporated with local readings and tools:

> It seems to me . . . that this office may without attempting to forecast weather, place outstations in possession of such meteorological information as it may have received on any day. It must be clearly understood that any telegraphic message of a warning nature is merely meant to imply that there is a storm existing along a certain region of coast, say the S.W., and consequently that there is or *may be* danger impending at other districts. Accordingly vessels bound southwards will know what they have to expect, but the crews of local craft, such as fishermen, must be guided as to the immediate risk which they incur by their own observations of the look of the sky, etc, and also by the behaviour of the local instruments, such as fishery

[84] Ibid, 68-70.
[85] Ibid, 68-70.

> barometers with which the coast has been so liberally supplied by the Government.[86]

Initially thought to be reducible to instrumental traces, local knowledge proved to be both more intractable and more valuable. The Met Committee included a section on "local signs" in their ten-year report on the progress of the Office since FitzRoy's death:

> These are really among the most important indications of coming change; but practically they can scarcely be utilized by us. They cannot be reduced to rule, and they depend almost entirely on personal experience. It is impossible in a telegram to convey the entire line of reasoning which leads one, in the absence of instruments, to know that a storm is impending. The character, elevation, and motion of clouds, the colour of the sky, the clearness or the contrary of the air, the appearance of the aurora, and numerous other signs are well known to every one who studies the weather; and from these helps the cabinet meteorologist is entirely debarred. He is like a physician dealing with a case by correspondence, without the chance of a personal interview with his patient; for what can a resident in an inland town like London, on any given day, know of the look of the weather on the sea-coast on the same day.[87]

This appreciation of local signs grew, by the 1870s and 1880s, to include an interest in indigenous customs and traditions. While Victorian fishermen left few traces of their own (in contrast to the hundreds of thousands of ships' logbooks that remain from the period), their habits were increasingly considered worthy of registration by a growing English folklore movement.[88] While inspecting coastal barometer stations in 1883 for the Scottish Meteorological Society, H. N. Dickson met with fishermen to teach them the law of storms and how to use the barometers. "The method followed in conducting these meetings was to suggest generalizations on facts already known to the men; and it thus became necessary to ascertain, in each case, what facts were to them most important in forming opinions about probable weather."[89] Registering this kind of information was not easy. Dickson struggled to elicit "definite information" that he could include in his report. "The cloud observations made by fishermen are of great interest, but there is considerable difficulty in getting accurate descriptions of them—the men know the weather by the 'look of the heavens,' but it is not easy to get them to explain *how*."[90] A tantalizing doggerel verse on tides was incomplete:

> When the loon begins to cry
> Anchors and cables you stand by,
> . . . . . .
> Never trust the second flood.
> (Third line had been forgotten and could not be recovered.)[91]

Some things completely defied the will to record them. Of a prognostic believed to

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[86] 'Report of the Meteorological Committee of the Royal Society for 1867,' PP1867-68 LXIII, 297.
[87] 'Report of the Meteorological Committee to the President and Council of the Royal Society on the work done in the Meteorological Office since their appointment in 1866 to December 31, 1875' PP877 XXXIII, 139.
[88] R. Dorson, 'The great team of English folklorists', *The Journal of American Folklore* (1951), **64**, 1-10; W. Gregor, 'Some folk-lore of the sea', *Folk-lore Journal* (1885), **3**, 52-56..
[89] H. Dickson, 'Weather folk-lore of Scottish fishermen', *Journal of the Scottish Meteorological Society* 3rd series (1889), **8,** 349-355.
349-350.
[90] Dickson, op.cit. (89), 351.
[91] Dickson, op.cit. (89), 353.

have been common in the villages between Aberdeen and Stonehaven—by which the severity of the early months of the year could be foretold by the state of the upper clouds during the previous November and December—Dickson was "unfortunately unable to find any trace."[92]

Conclusion

Two distinct but related historiographies relate to this early episode in government meteorology, both of which bear on the question of how safety was generated in the period. One is the literature that treats the broad question of the 'revolution in government' from the perspective of self-evident 'social evils' such as accidents and epidemics. The other is that on the growth of science in the period, which includes a small but significant sub-literature on government science and government funding for science.[93] From different angles, both attempt to explain the increase in certain kinds of government intervention (or funding) into public health and safety in this period but they produce strikingly different descriptions of the actions of government, to say nothing of their different explanations for such actions. In the literature on the revolution in government, spearheaded by Oliver MacDonagh, government is described as responding in an *ad hoc* manner to an outraged public.[94] Government response is seen as *ad hoc* because of the contingent nature of the provocations: a combination of appalling disasters, the cumulative horror of poor living and working conditions, and a number of highly effective reformers. In the sub-literature on government science and government funding for science literature, the arrow generally points outward from government to projects such as the Parliamentary Committees (of which the Devonshire Commission is a prime example) and the *Challenger* expedition of 1872-1876. Within this historiography, the rise of the expert has often been plotted as a teleological phenomenon in which the scientist fights for and eventually gains his due authority. The flip side of the growing power of the expert in this literature is the decreasing importance of inexpert, local, or artisanal knowledge. When and where scientists in the period are seen to fail (as they are quite frequently), such histories identify a lack of system or control rather than a successful negotiation between alternate forms of authority. The power of the expert in this historiography is understood to directly relate to his ability to quell alternate forms of knowledge while simultaneously training those who would participate in a network of communication or apprenticeship.

There is a subtle but important irony to these criss-crossing historiographic vectors. According to the literature on government science, endowments for science—provisional, piecemeal and self-consciously 'exceptional' though they may have been in this period—originated within government, and were enacted by a cadre of government experts with increasing authority.[95] Within the historiography of a

[92] Dickson, op.cit. (89), 355.
[93] Turner, op.cit. (5); and R. MacLeod, ed. *Government and Expertise: specialists, administrators and professionals 1860-1919*, Cambridge, 1988.
[94] O. MacDonagh, 'The nineteenth-century revolution in government: a reappraisal', The Historical Journal (1958), 2, 52-67. For a review of the extensive literature this article spawned, see P. Mandler, 'Introduction: state and society in Victorian Britain', in *Liberty and Authority in Victorian Britain* (ed. idem) Cambridge, 2006, 1-21**,** 6-13; and MacLeod, op.cit. (92), 1-26.
[95] MacLeod, op.cit. (93), 10-15; R. MacLeod, 'Science and government in Victorian England: lighthouse illumination and the Board of Trade: 1866-1886', *Isis* (1969), **60**, 4-38; and R. MacLeod, 'The Alkali Acts Administration, 1863-84: the emergence of the civil scientist', *Victorian Studies* (1965), **9**, 85-112.

‘revolution in government’, on the other hand, the enduring emblems of social control such as the Factory and Railway Inspectorates are considered to be subject to a fluctuating tide of public opinion and outrage. Combining these historiographies produces an odd beast: a steady but relatively passive response by the government to social evils and an erratic but more active government approach to science.

In the historiography of the ‘revolution in government’, the distribution of barometers to fishermen would therefore be interpreted as a result of public angst over a rising tide of shipwrecks involving poor fishermen. In the literature on government science, on the other hand, it would be understood as a move to increase the authority of a science by establishing a system of disciplined users of scientific instruments. This divergence only disappears when the distinction between applications to address public health (broadly conceived to include shipwreck and railway accident alongside cholera and overcrowding) and scientific projects is made to disappear. At the early Met Department, government meteorologists attempted to impose centralized control on something that only existed as a collection of data points: a kind of weather that could never be experienced anywhere but in FitzRoy’s office. Yet the justification for this type of science as government science was always based at least partially on its practical utility to British fishermen, sailors and farmers who expressly did not contribute to centralized registration systems.

FitzRoy’s ability to gather support for the unauthorized project underscores the ambiguity of purpose that characterized the early Met Department. Funded by both the Board of Trade and the Admiralty, administered by a naval man but counselled by the Royal Society, the office expressed the ambivalent desire both to link the scientific to the practical (for funding purposes) and to distinguish them (lest science become too tainted by the practical). In giving barometers to fisheries, FitzRoy was attending to the practical matter of their immediate safety. The fishermen responded with alacrity, eager for any tool that might protect them from the dangers of the sea. FitzRoy’s background as a naval captain helps explain his desire to materially improve the lives of fishermen while the statistical project ran its course. But his other big unofficial practical project—his establishment first of telegraphed storm warnings indicating the movements of already observed storms, and eventually, of weather forecasts predicting future storms not yet observed—soon brought the new Department under heavy scrutiny.

Weather forecasts could be dangerous to the government because they might lead to an erosion of individual responsibility and a misplaced assumption of government control. This potentially dangerous loss of local control as a result of increasing government regulation and intervention only made it clearer how essential common judgements remained. Such judgements inoculated the centralized administration from responsibility for a range of local decisions and, potentially, accidents. The barometer project served to promote the autonomy and responsibility of individual fishermen who might also be users of FitzRoy’s forecasts. In providing instruments to fishermen, the government office elicited a specific kind of resistance to its own authority that rendered it more, rather than less viable, and more, rather than less safe. These different forms of authority were in fact symbiotic. The synoptic vision of government meteorology depended on the autonomous judgement of various citizens. By protecting the government scientists from their worst possible mistakes, the judgement of the individual fishermen allowed the government

science project to continue.

By revealing the potential for an instrument to be useful when not generating inscriptions, this episode also suggests a broader role for elite instrumentation than has previously been recognized. This mechanically-aided form of individual judgment was necessary and possible only within the framework of a new government office, which sought to govern something that had previously been ungovernable—the weather—while allowing British individuals to continue to govern themselves. The new government Met Office proposed simultaneously to reorganize existing materials and budgets while generating a new kind of knowledge and, by extension, a new kind of British safety. This new safety was born of knowledge of the weather that could only be generated in the central office where FitzRoy gathered telegraphic dispatches from coastal observers but that could only be put to use in a responsible fashion at the edges of the telegraphic network, and, beyond, at the edges of the British nation. The barometers for fisheries project therefore discloses a substantial and mutually beneficial entanglement between a scientific government office and a set of mostly illiterate and impoverished fishermen. It provides a different view of government science from the usual historiographic tropes of professionalisation and administrative excrescence. Here instead is a story about a project that was more or less without cost to the government, and that was driven not by the increasing authority of scientific experts but by a desire to harness the personal authority of the British mariner.

Meteorology at the moment of its institutional origins and that of the larger 'revolution in government' should be understood in terms of a dialectic between loss of control and self-reliance that characterized the period more generally. Like other new government interventions into public health, the Met Department was perceived with high scepticism by many who believed that, at best, any extension of government set an undesirable precedent of ill-founded charity and, at worst, dangerous intrusion. At risk was the self-sufficiency upon which the nation's commercial and imperial advances were based. By keeping fishermen outside the registration regime, FitzRoy saved them as icons of British independence and self-help. By making them better watchers of the weather, the Met Department barometers in fact helped to make them safer users of the uncertain forecasts. A well-informed fisherman accustomed to using a complete set of weather watching tools, which included reading the skies and consulting a public barometer as well as taking note of Met Department forecasts, would be less likely to hold the government liable for the repercussions of any incorrect forecasts. But while the tacit knowledge and individualized judgements of fishermen helped make the barometer programme a success, FitzRoy's attempt to keep his forecasting methods largely in his own head was deeply suspicious to the Meteorological Committee of the Royal Society.

This paper has demonstrated one set of relations between formal and tacit knowledge in the context of a new government department. Rather than finding opposition between the two forms of knowledge, it recounts a history in which a useful symbiosis between the two was knowingly constructed by contemporary actors even as a explicit commitment to formal knowledge was maintained. The Met Department would only achieve its full goal of contributing to the safety of sailors at sea (via an increased understanding of the laws of the weather) by careful measurement and registration of the weather. In the meantime, however, it was just

as important the fishermen be encouraged to develop their own ability to read that weather. This story of balancing local knowledge against centralized knowledge demonstrates that both instruments and institutions can promote autonomy as well as discipline in the name of public safety.

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