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ICES involvement in whaling and whale conservation, and implications of IWC actions

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From its foundation, ICES had a substantial concern for the conservation of the great whales and the management of commercial whaling. Early studies established the need for regulation. In the 1930s, ICES brought the issue to the attention of the League of Nations and so set in train a series of international negotiations and agreements among concerned governments, paralleled by negotiations among whaling companies. After the ratification of the International Convention for the Regulation of Whaling in 1946, which created the International Whaling Commission (IWC) and its Scientific Committee, the focus of scientific attention and responsibility shifted to the new body. Minimal science was involved in the first decade of IWC regulations, which were largely confined to commercial hunting of the four largest species of baleen whales in the Antarctic. In the 1960s, population models began to be used for calculating catch limits (total allowable catches – TACs – in modern fisheries terminology), which were similar to those used by ICES and other regional fisheries organizations for assessing the sustainable yields of fish stocks. However, continuing pressures for a moratorium on commercial whaling, which was eventually enacted in 1982, gave scientists a respite from the task of annually formulating advice on all catch limits. This respite was used to devise an entirely new approach to regulation, a catch-limit algorithm called the Revised Management Procedure (RMP). The RMP approach is proving to be of interest in a broader fisheries context, and it seems that a renewal of substantive scientific interaction between IWC and ICES might be timely and fruitful.

Keywords: Antarctic, catch limits, FAO, fisheries, history, international law, League of Nations, management, population dynamics, TACs, United Nations, whales, whaling.

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The early years: a potted history of "modern" whaling

"So remorseless a havoc..." was Herman Melville's famous description of the worldwide activities of Yankee hunters of sperm whales during the 19th century. But this was as nothing to the havoc wrought mainly by "modern" British and Norwegian whalers in the Antarctic during the 20th century. However, that living marine resources were finite, that they could possibly be exterminated in pursuit of profit, but might also be used and conserved, occurred first to those whalers – or rather to scientists from those same countries accompanying and studying them. The theory, if not the practice, of sustainable use was first applied to a few very large species of whalebone (baleen) whales – the rorquals – which feed in Antarctic waters and breed in the warmer waters of the Southern Hemisphere.

What was called "modern whaling" by Norwegian historians began with the invention, and deployment in 1864 from steam vessels, of an invention by Svend Foyn: a harpoon fired from a cannon and tipped with an explosive grenade (Tønnessen and Johnsen, 1982). This combination provided, for the first time, a means of hunting the fast-swimming rorquals: the four species of baleen whales – humpback, blue, fin, and sei – the catches of which were later lumped as Blue Whale Units (BWU), and also the minke whale and, later, the sei-like Bryde's whale. It also greatly facilitated hunting for sperm whales which, with the right whales, had been the prime target of "Yankee-style" pelagic whaling during the 19th century.

Modern whaling began off the northeast coast of Norway from shore stations. As the stocks of blue and humpback whales there were depleted, whalers moved further afield to Bear Island. Shore operations also moved westward to coastal areas important for cod fish-

ing. This aroused the opposition of fishermen and led, by 1903, to the prohibition by the Norwegian government of whaling in such areas. But before that, these whaling operations had extended to Iceland (1893), Korea (1889), Sakhalin (1897), Faroes (1894), Newfoundland (1898), Shetland (1903), Svalbard (also 1903), then the Hebrides and Ireland [see Tønnessen and Johnsen (1982), the classic study which is the main source of the historical information in this section, but see also Chatterton (1931) and Ellis (1992)]. The old whaling industry of Japan switched to the Norwegian method at the turn of the 20th century.

ICES was established in 1902, following the recommendation of the 1895 International Geological Congress for "a scheme of international cooperation in marine scientific research in which scientific investigation would be accompanied by a practical exposé of the steps to be taken in order to bring exploitation of the sea fishery more in accord with the natural conditions regulating the growth and increase of fish" (Hjort *et al.*, 1931). The following year, the expedition vessel "Antarctica", in the charge of a Norwegian whaler and sealer, C. A. Larsen, was crushed in the Antarctic ice. He and his crew were rescued by an Argentinian warship and taken to Buenos Aires. By December 1904, Larsen was in South Georgia, with a crew of Norwegians, heading an Argentine company, Cia Argentina de Pesca. Antarctic whaling had begun. By 1912, ICES was discussing the collection of statistics about catches of seals and whales in that region.

Shore-based whaling operations in the North Atlantic had virtually ceased by 1909, seven years after the formation of ICES, and so received little attention by the Council. But before the end of the 19th century, many expeditions had visited the western Antarctic looking for seals and right whales. Few right whales were found, and the seals near the sub-Antarctic islands were soon depleted (Ellis, 1992). However, during these expeditions, large numbers of fin whales were noticed. By 1905/1906, after Larsen had begun at South Georgia, similar activities were in full swing at South Shetland by Chilean and Newfoundland companies. In the following years, such whaling began elsewhere in the Southern Hemisphere at Durban (1908) and (in 1909) in Angola, Kerguelen, and on the coast of Chile. These stations required, however, spacious sites with assured access (i.e., not blocked by ice) and ample and continuous supplies of freshwater, both of which were rare in Antarctica.

The next move was, therefore, to the use of floating factories which could be moved from place to place according to the availability of whales and which could carry – and later produce – freshwater. At first, these were moored in sheltered harbours, the whales were tied alongside for flensing, and the flesh and blubber hauled aboard for processing. Then, in the early 1920s, factory ships with stern ramps began to be used; the whales could be hauled aboard the ship for processing, and so the factories could operate far from shore.

Throughout this development, although other countries sought involvement, the industry was firmly in the hands of Norway and the United Kingdom (UK), and the former, in particular, long had a virtual monopoly on skills (especially the all-important gunners). This monopoly was reinforced by its national laws. Experience in the North Atlantic and elsewhere had shown that whale stocks were not inexhaustible, and by the end of the 1920s, local depletions were evident in the Antarctic region (Holt, 2000a). Given the nationalities involved, and the Atlantic experience, as well as the fact that the pelagic expeditions were mainly based in Europe and were bringing products to European markets, it is understandable that ICES would be moved to take an initiative, despite the remoteness of the whaling operations.

Few people now closely associate ICES with research on whales and the regulation of whaling. Yet, the present arrangements for these activities, through the International Whaling Commission (IWC), were set in train by ICES in 1926, at its meeting that year, by the creation of a Comité International pour la Protection de la Baleine (CIPB), subsequently referred to in the *Rapports et Procès-Verbaux des Reunions* as the "Whaling Committee", with Johan Hjort (Norway) as Chair (ICES, 1927a).

Statistics

The ICES Whaling Committee met in Paris in April 1927 (ICES, 1927b). The lead was taken by the representatives there of the French Inter-Ministerial Committee for the Protection of Whales who argued that "whaling as carried out was proving disastrous to the stock" and called for international investigations and cooperation. At this meeting, the Committee laid out a comprehensive plan for research and collection of statistical materials from whaling stations. One of its main recommendations was that "the Council request the Norwegian Government to organise a central institution to collect statistics from the whaling industry throughout the world, on the understanding that a report be laid before the Committee yearly". These statistics should "be collected from every country, also from such as are not members of ICES". The Committee said that efforts should be made to compile statistics for previous years. A further specification was for the annual compilation of a list of all operating whaling companies and the number of catcher boats employed.

The Norwegian government acted promptly. It established a Committee for Whaling Statistics (CWS) comprising the Director of the Norwegian Statistical Central Bureau (Gunnar Jahn), the Secretary of the Norwegian Whalers' Association (NWA) (Sigurd Risting), and Professor Hjort (Hjort *et al.*, 1930; Risting, 1928). This Committee's original idea was to try to build an international statistical system on official returns from countries, but soon agreed it would be better to develop,

worldwide, the long-standing NWA system of soliciting data from the whaling industry. This led to the successful long period of annual publications by the CWS's instrument, the Bureau of International Whaling Statistics (BIWS), which continued until the IWC took over the task in the 1970s.

Data about whaling companies and ships were partially published in *Norsk Hvalfangertidende* (*Norwegian Whaling Gazette*) and partly in the BIWS reports *International Whaling Statistics*, which also contained some information about the production of baleen oil ("whale oil") and oil from sperm whales, as well as meal, blubber, and other "by-products". A severe limitation of these published data, however, was that information on operations and yields by individual expeditions and catchers was withheld from scientists and regulators as a commercial secret, even though it was available within BIWS. This was not corrected until the 1960s.

An unusual feature of the arrangement with BIWS was that, in later years, it was made responsible for administering some regulatory decisions. Thus, from 1949 through to the mid-1970s, pelagic expeditions telegraphed their catch results to the BIWS headquarters at Sandefjord where they were compiled in what we would now call "real time". From these reports, BIWS predicted when the agreed total allowable catch (TAC) would be reached and then sent back messages of closure of the Antarctic whaling season.

From the first years of Antarctic whaling, Norwegian domestic law provided for the presence of national inspectors on each factory ship, and the other big whaling country at the time – UK – did likewise, voluntarily. With the formation of the IWC in 1946, this became mandatory for all IWC Member States. In theory, this ensured that statistics were provided honestly and that regulations (such as prohibition of the catching of calves, nursing mothers, and certain protected whale species, and those on species size limits) were honoured. In practice, although this was better than nothing, scientists concluded from circumstantial evidence (such as discontinuous length distributions) that many "infractions" were not reported.

Another weakness in the BIWS operations was a failure to move with the times. Norwegian-style industrial whaling was almost entirely concentrated on oil production. Japanese whaling was always primarily for production of meat for human consumption, but these statistics were entirely lacking from BIWS publications.

The ICES Whaling Committee

Throughout the pre-World War II years, the ICES Whaling Committee (WC) was very active in coordinating and evaluating research, monitoring the industry, and intervening in diplomatic and political issues. In 1928, it advised on the draft whaling bill proposed by the Norwegian government (ICES, 1928). The same year, it assisted ICES in establishing relations with the League of Nations and pointed out the important differences between the whaling issues – which were global – and other fisheries issues which could and should be dealt with regionally. But ICES did add that "it was not at present disposed to advance any concrete proposals for the regulation of whaling for embodiment in an international convention of general application".

In 1929, the WC issued a very significant statement (ICES, 1929):

> While fully admitting that it is not likely that any definitive results can be derived from the scientific researches now in progress until a considerable time has elapsed, the Committee feels strongly that the enormous expansion of the whaling industry in recent years constitutes a real menace to the maintenance of the stocks of whales, and that if the expansion continues at the present rate there is a real risk of those stocks being so reduced as to cause serious detriment to the industry.
>
> While admitting that until the scientific researches have reached a definite conclusion it will be impossible to devise any measures of protection of a permanent nature, the Committee is of opinion that the Governments of the countries interested in whaling should, as a matter of urgency, give serious consideration to the question of taking immediately temporary measures for dealing with the situation.

The statement went on to detail such possible measures. There could hardly have been a clearer enunciation of what we would now call "the precautionary principle".

The 1930 and 1931 WC meetings found that the Norwegian and French laws were in harmony, but did nothing more because of the crisis in the industry, connected with the world economic situation, involving huge unsold stockpiles of oil. In 1930, they were waiting for the results of the recently held conference in Berlin under the Economic Committee of the League (ICES, 1930), and in 1931 gave their endorsement to the draft Geneva Convention for the Protection of Whales and the Regulation of Whaling (ICES, 1931), which followed closely the ICES proposals of 1927. By the 1933 meeting (ICES, 1933), the WC members were becoming pessimistic "since the industry was concerned more with finding markets than with the whale stock". Then, and in the succeeding years, the WC followed the ratification process of the Convention and noted the failure of the hoped-for collaboration between Norway and the UK. Warnings were given each year, both to industry and to governments, that trouble lay ahead, but to no avail. By 1938, the British scientists were suggesting, quaintly, "a year's holiday" for the humpback whale. The problem that most preoccupied the WC by 1937 was the difficulty of involving Germany and Japan in regulatory and conservation measures. Pessimism ruled through to 1939, there having been little progress in inter-governmental negotiations, but scientific results at least were beginning to be significant, particularly from

marking experiments. It was now apparent that the fin whale, as well as the blue whale, was in decline (ICES, 1939).

The WC met next in October 1945 (ICES, 1946), but did little business, in expectation of a conference to be convened by the United States government the following year. At the August 1946 ICES meeting (ICES, 1947), the eminent Norwegian scientist, J. T. Ruud, announced success in determining the ages of blue and fin whales from ridges on their baleen plates. By 1946, the International Convention for the Regulation of Whaling (which created the IWC) had been signed. WC members were concerned that the current working limit of 16 000 BWU for pelagic catches of baleen whales in the Antarctic was too high, and they agreed to pursue scientific work that would be pertinent to the new IWC when it came into being. This continued until the WC's 1949 meeting (ICES, 1950) when – the IWC having met earlier that year – the question arose as to whether the WC should continue to exist. Meanwhile, it was agreed to send scientific results such as Ruud's age distributions to the IWC Secretary. In 1950 (ICES, 1951), there was a majority against abolition of the WC, but it was agreed to suspend the hitherto regular meetings, the then Chair, N. A. Mackintosh, being asked to convene future meetings as and when he thought necessary. An interesting point at this meeting was the recognition that the small minke whale had now acquired economic importance.

Eventually, a meeting of what was then called the ICES Whaling Sub-Committee was held in 1953 (ICES, 1954). Apparently this remained inactive until 1963 when its status was again reviewed by the Council. No changes were made at that time. The WC did meet again – now with J. T. Ruud as the acting Chair – in October 1966 to consider the transition agreed by an extraordinary meeting of ICES Delegates in May of that year to transform it into a Marine Mammals Committee (MMC). From then on, the MMC met annually through 1997, after which the Committee became part of a new Living Resources Committee. An examination of the MMC's proceedings through to 1978 indicates that, although there was some reference in these meetings to research on the large whales, and especially to marking with Discovery tags, there is, remarkably, no trace of the fact that the IWC and the whaling industry had been passing through one crisis after another, that all the earlier concerns about the future of whales and whaling had been more than justified, and that there had been a renaissance of science within the IWC beginning in the 1960s. Even in October 1972, there is no reference to the fact that the United Nations (UN) Conference on the Human Environment, held in Stockholm in June of that year, had discussed the whaling issue as one of its most important topics, just as had the League of Nations 40 years previously.

Similarly, in 1974, 1975, and 1976, there is no reference to the fact that, in 1974, the IWC had embarked on a new, science-based approach to regulating whaling, seeking a balance between sustainable use and protection. While IWC and ICES were exchanging observers (usually not scientists) at their annual meetings, there was no apparent substantive flow of scientific information between them. ICES responded negatively to a request by the Food and Agriculture Organization (FAO) of the UN that it collaborate in an FAO/UNEP (UN Environment Programme) project to review the status of all marine mammals. (This project led to a landmark international conference in Bergen, Norway, in 1976 attended by 400 scientists and whose proceedings were published by FAO in four volumes entitled "Mammals in the Seas" in the following years.)

Law

Apart from arranging for statistical collection, compilation, and publication, the most important action by the ICES Whaling Committee was to bring the need for regulation of Antarctic whaling to the attention of the League of Nations. With the support of ICES, the League convened a meeting of experts in April 1930 attended by representatives from France, Germany, Japan, Norway, Portugal, the UK, and the USA. They proposed an international regulatory agreement following the principles of the Norwegian law of 1929. The draft proposed by ICES was re-examined by another committee – the Committee of Experts for the Progressive Codification of International Law (CEPCIL) – in Geneva in September 1931, the report of which was adopted the same month by delegates from 26 governments (Birnie, 1985).

This "Geneva Convention" was the basis for all future international agreements, both among governments and among whaling companies. The Rapporteur of CEPCIL was an Argentine lawyer, José Leon Suárez, a man far ahead of his time insofar as the legal principles of managing industries based on marine mammals were concerned. In particular, Suárez proposed the designation of a substantial part of the Southern Ocean as a "sanctuary" for whales (Holt, 2000a), an idea that was partially implemented by the IWC from 1946 to 1955, and then fully from 1994.

The Geneva Convention included a ban on the catching of right whales, calves, lactating females, and sexually immature animals. It required full utilization of carcasses, that whaling could only be undertaken on the basis of governmental licenses, that statistics be submitted to BIWS, and that accurate logbooks be maintained. Most importantly for the future of all whaling management, the Geneva Convention provided that bonuses to gunners would be based on size, species, and oil yield of the whale, and not merely on the numbers of whales. The latter, favoured by the British companies, was in practice, of course, very wasteful of whales. Because of this disagreement, the UK did not ratify the Convention until the end of 1934. This was perhaps the first of many

occasions when such prolonged delays impeded actions promoting the conservation of whales and the sustainability of the industry. In the longer run, the complex BWU formula, based roughly on the relative oil yields from blue, fin, humpback, and sei whales, came to dominate regulatory considerations for 40 years.

During the 1930s, ICES involvement was essentially a "watching brief". Scientific advances were being made, but scientific input to the diplomatic negotiations was negligible. These negotiations, and related activities, are described in detail by Holt (2001).

Sustainability and catch limits

The American demographer R. Pearl hypothesized that population growth rates would slow as a linear function of population size or, rather, of population density (numbers per unit area) (Pearl and Reed, 1923; Lewontin, 1969; Lotka, 1925), which leads to the well-known symmetrical *sigmoid* growth curve, or *logistic*. The party of *continuity*, insofar as it was interested in wild animals, was perhaps best exemplified in the works of the Italian scientist, V. Volterra, published in the 1920s by ICES (Volterra, 1928; see also Volterra, 1938; Holt, 2000b). The first application of Volterra's ideas in the field of fisheries was to whales, by Hjort, Jahn, and Ottestad, in 1933. These authors at first considered that the catch per catcher boat would give an index of the abundance of whales. However, because the length of the whaling season was regulated by governments and/or the industry, they later switched to the "catch per catcher's day's work" as the fundamental index. Noticing that this catch per unit effort (cpue) for blue whales had declined rather quickly in the Antarctic, they fitted the logistic curve in the opposite direction to the usual one of population growth, and pointed out that if a whale population could be held near the inflexion of that sigmoid, or allowed to increase to it, a *maximum* (*optimal*) catch could be obtained in perpetuity.

Hjort and his collaborators had additional information about whales which was pertinent to their conclusions (Hjort *et al.*, 1931). Studies of dead animals on factory ships and land stations had revealed the relationship between size and sexual maturity. They had noted declines in the average sizes of caught whales and had the results of tagging experiments that had been launched (unsuccessfully) by Hjort and (successfully) by the British Discovery Committee in 1932.

A major obstacle was lack of an ability to determine the ages of whales. In 1929, Mackintosh and Wheeler concluded that the number of years elapsed after sexual maturity of females could be estimated by counting the corpora lutea in their ovaries. To those numbers had to be added, of course, the average age at maturity. A rough idea of this had come from studies of growth over short periods of time, including from tagging experiments. Then in 1940, as already mentioned, Johan Ruud published a method based on counting baleen ridges (Ruud, 1942). Subsequently, a more reliable method of age determination, from laminations in the earplugs of fin and other baleen whales, was developed by P. E. Purves and M. O. Mountford and published in 1959. These techniques came too late, however, to be of much practical use before the Antarctic whaling industry effectively collapsed as a result of overfishing.

The logistic curve approach to management was applied by M. Graham (1939) (see also Russell, 1931, and Ricker, 1946) to cod and other groundfishes and received much attention in ICES circles. In the post-World War II years, it was replaced in most European fisheries applications, and hence in ICES publications, by age-structured models which had been pioneered by the Russian mathematician T. I. Baranov as early as 1918, but largely forgotten, and developed some decades later, especially by R. J. H. Beverton and the present author (Beverton and Holt, 1957). In the United States, however, the logistic curve methodology was applied especially to the Pacific tuna fisheries (there being no means then of determining the ages of tunas), and its development is associated especially with M. B. Schaefer (1954).

For essentially the same reason, the same approach, in only slightly modified form, persisted until the late 1970s in the IWC's efforts to regulate whaling on a scientific basis. The modification was little more than the use of a non-linear (power or polynomial) function, as proposed by J. J. Pella and P. K. Tomlinson (1969), who also studied tuna. This produced an asymmetrical sigmoid population growth curve which was applied by the IWC's Scientific Committee with improved methods of using historical data to estimate some of the parameters of the model (de la Mare, 1987). Thus, the approach pioneered by ICES in the 1930s persisted for nearly half a century. The application of age-structured models to whales was also impeded by the interest of the IWC only in "optimizing" the numbers of whales caught rather than the total weight of the catches (and hence their value). This was, in some sense, a degrading of the approach during the 1930s when the management focus was primarily on the quantity of the main product.

Main developments in the IWC

Details of the following account may be found in the annual Reports of the IWC (London and Cambridge, UK) and summarized and analysed from different perspectives in Birnie (1985) and Holt (2000a).

When it began work in 1949, the IWC took over the overall catch limit of 16 000 BWU for Antarctic pelagic whaling south of 40°S. This limit – about half of the high catch of 1937/1938 – had no scientific foundation, but was agreed on the basis of three considerations:

1) the assumption/hope that it would be sustainable;

2) a presumption that the whales had increased substantially in number as a result of the reduction in whaling during the war years;
3) the expectation that exploitation pressure would thereby be removed from the blue whale.

The decision was wrong on all counts.

As catch rates declined through the 1950s, some countries (particularly the UK and Norway, and also the USA) made strenuous efforts to obtain agreement on minor reductions in this catch limit and to give more protection to the most depleted species (humpback and blue) by adjusting seasonal opening and closing dates by species and, eventually, by designating as "protected" those species the very existence of which was perceived to be endangered. However, by the 1957/1958 season, the only agreement was to bring the limit down to 14 500 BWU, and it was put up again to 15 000 for 1958/1959. For the next three seasons, no limit was adopted by the IWC, and the five pelagic whaling countries – the UK, Norway, the Netherlands, Japan, and the USSR – agreed among themselves to keep catches no higher than 17 500 BWU.

One problem was that, in their efforts to maintain or increase their shares of an overall total, countries steadily increased the sizes of factory ships, the tonnages and horsepower of catcher boats, and the numbers of catchers attached to each expedition. The consequence was called "the whaling Olympics". There were other problems connected with the efforts by other countries – especially non-members of IWC – to get into this profitable business. In 1958, the UK government suggested that the five countries should get together to negotiate equitable shares of the overall catch limit. Such negotiations continued right through the 1960s and were inextricably linked with negotiations to establish an international observer scheme so that the five could keep their eyes on each other (Holt, 2001).

By 1960, the situation was so bad that the IWC decided to invite three "independent" fisheries scientists not specialized in whale assessment and from countries not engaged in Antarctic whaling to provide advice on the current sustainable yields from the stocks being exploited in the Antarctic. They were D. G. Chapman (USA, spokesman for the so-called "three wise men"), K. R. Allen (Canada/New Zealand), and the present author (British, but working for FAO and, therefore, acceptably neutral). There was a vague commitment by countries eventually to act on the recommendations of this Committee of Three, and unprecedented arrangements were made for their access to data. Their analysis provided the first instance of electronic computers being used in the sphere of whaling management.

By that time, the Antarctic catches consisted primarily of fin whales. During the Committee of Three's work, the catching of the smaller sei whale was greatly increased, but no data were available for making meaningful assessments. The blue whale was not yet protected, but its catches were small and rapidly declining. Whaling for the smallest rorqual, the minke, had not yet begun; since 1972/1973, it has dominated the residual Antarctic whaling.

The appointment of the Committee of Three effectively brought the IWC back into the arena of scientific fisheries management from which numerically competent scientists had been effectively disengaged since ICES stepped back. The Committee was required to report back by June 1964, but was so worried by its interim findings that it reported early in an effort to get the global catch limit drastically reduced for the 1963/1964 whaling season. It recommended that catching be immediately reduced from 15 000 to about 4500 BWU and that limits be set by species, applied also to Antarctic land station catches, and eventually to the entire Southern Hemisphere. Further, it was considered that eventually for catches to be sustainable and for stocks to be allowed to recover towards optimal levels, catches could be no more that 4000 fin whales (2000 BWU) and 5000 sei (<1000 BWU), with the blue whale being completely protected.

Through the next 5–6 years, the IWC haggled over these numbers, but the limit was brought down to 2300 by 1971/1972. The work of the Committee of Three was not based strongly on any particular population model, but rather an empirical approach was taken, resting heavily on cpue data, but using as far as practicable the gathering results of tagging programmes and age determinations. For the first time, corrections were made to catch-per-catcher-day data (following methods used by ICES in its studies of bottom trawling) in an attempt to calibrate for increases in efficiency with sizes and powers of catchers, to look separately at the performances of the various national fleets, and to allow for disparities in the balance of factory handling capacity and numbers of catchers per factory.

When the Committee of Three had finished its work, by 1965, continuation of increasingly routine assessments was made the responsibility, for a few years, of a small group of scientists within FAO, who happened to have been closely associated with ICES: Luit Boerema and John Gulland.

Although progress was being made in the 1960s in terms of reducing the pressure of whaling, the reluctance of the IWC to act responsibly in accordance with its mandate and to effect adequate controls, while some species, especially the blue whale, seemed to be driven towards extinction, led to a demand at the 1972 UN Conference on the Human Environment held in Stockholm that the IWC enact a 10-year moratorium on all commercial whaling. The USSR was not represented at Stockholm, but the other four Antarctic whaling countries did not oppose the idea. This was evidently a tactical decision because when the debate moved to the IWC in that and following years, Norway, Japan, and the USSR strongly opposed the proposal. Since a binding decision by IWC requires a three-fourths majority vote (not counting abstentions) and any such decision could,

in any case, be the subject of an "objection" by any country, there was clearly no prospect of enacting a moratorium. Following the Stockholm meeting, the IWC did, however, agree to set catch limits by species for each and every whale "stock". It also appointed a full-time Secretariat for the first time (taking it a step towards the demonstrably successful ICES structure) and launched a greatly expanded programme of research.

In these circumstances, Australia – then still a shore-based whaling country – proposed in 1974 what it saw as a compromise between the proponents of a moratorium (notably the USA, the UK, and France) and the "business-as-before" countries. In this proposal, which was adopted in 1975, implemented for the 1975/1976 and 1976 seasons, and called the New Management Procedure (NMP), stocks deemed by the Scientific Committee to have been reduced to less than 54% of their "virgin" number were to be protected, while the rest would be subject to catch limits at 90% of their estimated maximum sustainable yields (MSY). This led quickly to the closure of whaling in the Southern Hemisphere for the four "BWU" species, but it was not useful – because of lack of data – in regulating the new industry for minke whales or the continuing hunt for sperm whales. Furthermore, operations recently set up in the Northern Hemisphere in Canada, Spain, Iceland, and Korea to provide meat to the Japanese market were difficult to assess. Naturally, the burden of proof of over-exploitation remained with those seeking more conservative regulation. The small "safety factors", such as the provision for taking "only" 90% of the estimated MSY, were wholly inadequate.

The assessments made for applying the NMP were based on a modified logistic, employing the Pella-Tomlinson model, with parameters adjusted so that the MSY would be available when the stock was at 60% of its carrying capacity. There was a limited age structure in that the model was applied to the "recruited" (essentially the mature) stock and all density dependence (of natural mortality and reproduction combined) was assigned to the pre-recruit phase. The application relied heavily on very questionable estimates of natural mortality rates, on long historical series of catch data, and on one or more estimates of the absolute number of whales (from, for example, tagging experiments and, later, direct visual surveys). What constituted a "stock" was arbitrary – as it still largely is – since very little was known about the identity and degree of mixing/separation of biologically distinct populations. A computer simulation submitted to the IWC in 1985 (de la Mare, 1986) finally brought an end to attempts to implement the NMP. De la Mare demonstrated that the NMP must lead to the continued depletion of stocks even if parameters of the model used were well estimated and if the model accurately reflected the real dynamics of a whale population. But in 1982, the Commission had at last adopted a proposal for an indefinite moratorium on all commercial whaling, which would come into effect in 1986.

This decision was essentially for a sufficiently prolonged pause in commercial whaling. However, some of those governments supporting the idea, and many non-governmental organizations, came to regard the moratorium as a step towards a permanent closure of commercial operations (there were already moratoria in place on all catching of sperm whales and on pelagic whaling except for minke whales), some on ethical grounds and others in consideration of pessimism – in the harsh light of history – that high seas whaling, especially pelagic whaling, could ever in practice be rigorously regulated.

De la Mare's simulations and subsequent studies by J. G. Cooke (Cooke, 1995) pointed to a radically different way of providing scientific advice for management. The same approach that had demonstrated the inevitable inadequacy of the NMP could be used to test the consequences of applying any other algorithms for the calculation of catch limits. In 1992, the IWC adopted the algorithm devised by Cooke under the name of Revised Management Procedure (RMP). This has, however, not yet been implemented, pending completion of negotiations for effective international inspection and other elements of a proposed Revised Management Scheme (RMS).

Here I briefly review the essential features of the RMP, in case this approach might be useful in situations of direct concern to ICES:

1) The IWC Scientific Committee presided over a competition among five groups of scientists to create the most effective algorithm, having established precise performance criteria.
2) The Committee induced the Commission itself to clarify the specific objectives of regulation and to establish its priorities among these. The top priority objective was to avoid the unintentional depletion of a stock and to provide for its potential recovery to high, but not predetermined, levels. It would thus embody the "precautionary principle" in a formally quantified manner. The second priority was to assure high cumulative catches in the long term (simulations were undertaken to the then maximum feasibly computable period of 100 years). The third objective was to ensure that there would be few unnecessarily wild changes in annual catch limits which could destabilize the industry.
3) The catch-limit algorithm had to be robust to the consequences of poor estimation of variables and to failure of any population model to reflect the real-world dynamics in order to allow adequately for known and unexpected uncertainties in these, and to abrupt or any long-term environmental (carrying capacity) changes which could include the consequences of interspecific interactions.
4) The procedure would not depend critically on knowledge of population trajectories, such as from abundance indices like cpue. In fact, the adopted procedure depends only on reasonably adequate knowledge of catch histories and on single esti-

mates of whale abundance from periodic, scientifically planned, conducted, and analysed surveys together with robust estimates of sampling errors in those surveys.

5) The procedure must be tested to have been robust to systematic errors in reporting of catch statistics.
6) Most importantly, the procedure must be applicable to groups of notionally separate but insufficiently specified and identified "stocks". This is potentially the greatest weakness in the revised system.

The Scientific Committee of the IWC is fundamentally composed of scientists nominated by Member Governments, although representatives of FAO, IUCN (International Union for the Conservation of Nature), and, more recently, UNEP, have full but non-voting status in it. The IWC has been plagued throughout its existence with suspicion that members of the Committee are frequently less than objective in the provision of scientific advice on management questions. There is much circumstantial and some direct evidence for this in terms of the known support by some individuals for policies of their governments. The IWC has, however, for many years, made provision for the appointment, on a year-to-year basis, of "Invited Participants" taking part in their individual capacities, though barred from comment on the formulation of specific management advice. This arrangement has, I think, ensured a higher quality of scientific scrutiny than would otherwise have pertained. Despite this, it has often proven impossible for the IWC's scientific advisers to reach consensus on advice which has, from time to time, led to external proposals that reference should be made to supposedly "independent" advisers. This did work once, in 1960–1964; the task given was a strictly defined and limited one, and the membership of the IWC's own Committee at the time was manifestly not technically competent to conduct the kinds of analyses that the Committee of Three undertook. Subsequent informal efforts to make alternative analyses other than those conducted by the Scientific Committee have rarely been fruitful; the reality is that the scientific methodology has become so technical and specialized that it is increasingly difficult for "outsiders" to contribute convincingly.

Since the IWC completed this part of developing a Revised Management System, the approach devised by its Scientific Committee has begun to be looked at by groups concerned with the management of fisheries for tunas, cod, and some other species. Those who are accustomed to the procedures followed in fisheries research and management for the past 50 or so years find some difficulty in understanding a "theory of fishing" which does not rely on the calculation of parameter values in a population model used for assessment. I believe that a new paradigm has been created by the IWC in the special circumstances provided by a moratorium, and the lessons from that exercise may influence the future work of ICES and other fisheries scientific and management organizations.

Summary and conclusions

Beginning in 1927, ICES engaged actively and successfully in matters of whaling regulation – especially in the new Antarctic industry – and of research on whales. It initiated the first international treaty, through the League of Nations, and followed closely, through the 1930s and in the immediate post-war years, the succession of follow-up agreements and the development of the relevant science.

As early as 1929, the Council recognized that current science was inadequate for providing reliable advice about managing whaling, and that it would be many years before it might be in a much better position. At that time, the ICES Whaling Committee enunciated what we would now call a "precautionary principle".

During the 1930s, ICES led the way in providing a theoretical framework for considering sustainability. The original studies by Volterra were applied by Hjort and his collaborators to the blue whale. In those years, and in the post-war period, ICES was advanced in developing and trying to apply a "theory of fishing". Scientists – particularly the Norwegians and the British – working through ICES made important original scientific contributions. The Whaling Committee closely followed the whaling story through to the first meeting of the IWC in 1949.

Thereafter, however, the contacts between the two intergovernmental organizations became largely symbolic. ICES observers followed the work of the IWC from its second meeting in 1950 until 1996 (except 1984, 1989, and 1994), while the IWC frequently nominated observers to ICES meetings. ICES observers at IWC meetings have nearly always been from Nordic countries, particularly Norway, but are not invited to attend IWC Scientific Committee meetings, unlike representatives from FAO, UNEP, and IUCN.

The lack of substantive contact between ICES and the IWC was unfortunate because the IWC, which had been operating in its first decade virtually without relevant scientific advice, entered a crisis in 1960, to the resolution of which ICES scientific input might have contributed. The new surge of advice had instead to come from fisheries scientists from the USA, Canada, and FAO. Thereafter, ICES remained disengaged from the renewed attempts at scientific management begun in 1974 after the UN had pressed the IWC to enact a 10-year moratorium on all commercial whaling. When a moratorium was, in fact, declared in 1982, a new wave of scientific studies related to management, within the IWC's Scientific Committee, led to the construction of a fundamentally new advisory paradigm (Cooke, 1995; de la Mare, 1986). Three decades ago, an opportunity was lost for the ICES scientific expertise to continue to assist in the conservation of whales and the regulation of whaling. Now, ICES might, in its fisheries role, itself benefit from consideration of the new approaches pioneered by the IWC. The IWC probably suffered scien-

tifically over the years from being rather isolated from other major international fisheries bodies, especially ICES. Now, following many years of intensive original studies by the IWC Scientific Committee, the reverse might be true.

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