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Use of Seasonal Spawning Area Closures in the Management of Haddock Fisheries in the Northwest Atlantic

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Abstract

Seasonal closures of haddock spawning areas in Div. 4X and Subarea 5 of the Northwest Atlantic were instituted by the International Commission for the Northwest Atlantic Fisheries (ICNAF) for 1970 and subsequent years, and these have been retained by both Canada and USA after extensions of jurisdiction. The ostensible reason for initiating these closures was because they encompassed the spawning area and season, spawning area closures being one of a limited set of regulatory measures available under the ICNAF Convention in 1969. The objectives were to reduce catches during this period and supplement total catch limitations by spreading catches throughout the year; this was a reasonable expectation as the closures corresponded to areas and times of peak commercial catch rates. There is no basis upon which to judge whether or not spawning closures have intrinsic biological value, e.g. through improving recruitment. Nonetheless, this appears to be the basis for fishermen's support of these measures. Despite numerous changes made to the closures, those in effect now are not greatly different than those first instituted. Areas off Cape Cod and on Browns Bank are slightly smaller, but closed seasons are one or two months longer than in 1970. Attempts to institute a spawning closure for Div. 4W haddock failed.

Introduction

In the history of international fishery management in the Northwest Atlantic, the use of spawning area fishery closures as a conservation measure is unique to the management of haddock stocks. Fishery closures for other purposes, such as to reduce catches of small fish or to reduce by-catch problems, have been implemented also, but only in the case of the haddock closures were these implemented because the areas and seasons of closure encompassed the spawning areas and seasons of the stocks to be conserved.

The International Commission for the Northwest Atlantic Fisheries (ICNAF) first adopted closed area and season regulations for haddock stocks in Div. 4X and in Subarea 5 for 1970. These regulations survived the transition to coastal state management subsequent to Canadian and USA extensions of fisheries jurisdiction in 1977 and continue in effect. A similar closure for the haddock stock in Div. 4VW was considered by ICNAF but was not implemented. The recent (1984) resolution of the maritime boundary dispute between Canada and USA in the Gulf of Maine Area presented both of these countries with new circumstances within which they must discharge their responsibilities for fishery management. The haddock spawning area closures are important aspects of the groundfish management regimes in the Gulf of Maine Area, and the closure area on Georges Bank is transected by the USA-Canada boundary. These closures inevitably will be subject to review in any revision of management practices which might result from boundary settlement. Consequently, this is an opportune time to review the history of the haddock closures, thus providing a basis on which their future can be considered.

This paper explains the circumstances under which the haddock spawning closure regulations were introduced and the rationales which have been given for them at various times. It then describes precisely the nature of the regulations, in terms of which areas were closed for which seasons to which gears, in a chronology of changes.

Introduction of Spawning Area Closures and the Reasons for Them

The International Convention for the Northwest Atlantic Fisheries, which created ICNAF, entered into force in 1950. The Convention gave the Commission authority to make certain kinds of proposals to Contracting Governments to keep fish stocks "at a level permitting the maximum sustained catch" (ICNAF, 1951). The measures allowed under Article VIII of the Convention were: (a) establishing open and closed seasons; (b) closing to fishing such portions of a subarea as the Panel concerned finds to be a spawning area or to be populated by small or immature fish; (c) establishing size limits for any species; (d) prescribing the fishing gear and appliances the use of which is prohibited; and (e) prescribing an overall catch limit for any species of fish. Thus, in the late 1960's, when prospects for declining yields from haddock stocks were causing grave concern, these were the regulatory measures available for use.

In the mid-to-late 1960's, ICNAF became increasingly concerned about the buildup of fishing effort in the area and indications of resource declines (e.g. ICNAF, 1968). Georges Bank haddock was the first clearly documented case of depletion due to fishing (Hennemuth, MS 1968) and the situation was made worse by several years of recruitment failure. Browns Bank haddock were fully-exploited (Shultz and Halliday, MS 1969) and prospective recruitment failure was documented (Grosslein, MS 1969), but this stock was still considered to be capable of giving close to long-term average yields. In contrast, the status of haddock in Div. 4VW was likened to that in Subarea 5 (ICNAF, 1969a). The USA fishery depended most heavily on Georges Bank haddock, and the USA took the initiative by proposing regulatory measures to reduce the exploitation level (USA, MS 1969). The USA was motivated by the clear prospect of severe economic dislocation of its groundfish fishery. The Standing Committee on Research and Statistics (STACRES) of ICNAF had indicated that Subarea 5 haddock stocks, which had yielded close to 50,000 (metric) tons on average in 1935-60, would yield only 13,000 tons in 1970 at the same exploitation rate, and that a 4-5 year period of no or very little fishing was required to effect recovery (ICNAF, 1969a). Canada made a complementary proposal for regulation of Div. 4X haddock, citing the prognosis for poor recruitment and stock decline in its rationale (ICNAF, MS 1969). The Div. 4X haddock stock had come to support the most important Canadian haddock fishery by the late 1960's, and its decline was foreseen to have serious adverse economic repercussions. As Div 4X haddock were still faily abundant, concern about possible diversion of fishing effort from Subarea 5 to this stock, as STACRES had predicted (ICNAF, 1969a), was likely also a motivating factor. Another important motivation, however, stemmed from the close interrelationships between the haddock fisheries in these two areas. The same USA and Canadian fleet components fished both areas, often on the same trip, and the geographic proximity of the major banks (Georges Bank and Browns Bank) would have made it difficult to control fishing on one if fishing on the other was unregulated. ICNAF accepted the Canadian and USA regulatory proposals for Div. 4X and Subarea 5 stocks, including spawning area closure provisions, effective for 1970 (ICNAF, MS 1969). Quantification of Div. 4VW haddock stock status (Halliday, 1970) led to regulation of exploitation in 1972 (ICNAF, MS 1971), but this did not include spawning area closure although such closure had been proposed by Canada (ICNAF, 1970).

Up to 1969, ICNAF had utilized only regulatory measures under section (d) of Convention Article VIII, to control mesh size and gear construction of otter trawls used in groundfish fisheries. The haddock problem presented a new situation, one which proved to be the harbinger of a new era of fishery regulation in the Northwest Atlantic. In addressing it, Canada and the USA decided to use all of the other relevant measures provided by the Convention. The measures agreed to at the 1969 Annual Meeting of ICNAF, to apply from the beginning of 1970, included the first total allowable catch (TAC) regulations introduced by the Commission (section (e) of Article VIII) and closure of the spawning grounds (section (b)) for the spawning season (section (a)).

The detailed rationale for the choice of measures is not recorded but some of the reasons can be deduced from analysis of prevailing circumstances. The fundamental intent of the regulations was to reduce exploitation rate to a low level, i.e. to reduce the proportion of the haddock stock which was killed each year as a result of fishing. On the other hand, major sectors of the USA fleet and of the Canadian fleet based in southwestern Nova Scotia depended heavily on these areas for their livelihood, and needed freedom to fully exploit the other resources in the area such as cod and pollock. At least initially, it was also considered necessary that these fleets be allowed to continue to direct some effort towards haddock, as TACs were set above the minimum estimated to be required to account for by-catches in other fisheries.

Control by TAC had a serious limitation at that time as ICNAF had no provision for national allocation. Any country could enter the fishery and catch the TAC early in the year and then the fishery would be closed to everybody. Similarly, countries were faced with serious difficulties in managing their domestic fisheries so that all sectors shared equitably in a limited resource, when the total available was uncertain and depended on the actions of foreign fleets. Problems resulting from this last factor were alleviated by a "gentleman's agreement" among ICNAF members to restrict non-coastal state fishermen to by-catches only of haddock.

Closed area and season regulations were looked upon as catch limitation measures and thus as alternatives to TAC regulation. When it considered Georges Bank haddock at its 1969 meeting, STACRES stated (ICNAF, 1969a): "The application of closed season and/or closed area regulations as alternatives to catch limitation was considered. It was indicated that closure during March and April when catch rates are highest on adult fish would alone reduce landings by about 20%, and in conjunction with a catch quota would tend to spread the catch more evenly through the remaining part of the year. It is noted that unless trawling for all other species on Georges Bank were banned, some incidental by-catch of haddock would be inevitable."

Thus, an important additional concept, introduced in the STACRES report, was that of using closed seasons and areas as adjuncts to TAC regulation which would spread catches throughout the year. Both Can-

ada and USA were anxious to minimize disruption to the activities of their fleets. The fleets affected had limited mobility; and rapid utilization of the TAC implied prolonged periods of fishing under strict by-catch allowances or even fleet tie-ups.

As STACRES pointed out, haddock are most concentrated when in prespawning and spawning aggregations. The fishery had taken advantage of this, concentrating its fishing effort in this season of peak catch rates and, of course, around the spawning grounds where these aggregations occurred. By preventing the fleet from capitalizing on this opportunity, catch rates would be reduced and this was expected to reduce total annual haddock catches. Thus, the rationale for spawning season and area closure, was not only because they were the spawning season and area *per se*, but also because they were the season and area of peak catch rates, and hence this closure could be expected to have a large impact in reducing catches, or at least in spreading them more evenly throughout the year.

Inclusion of a spawning season closure in the 1969 USA regulatory proposals for Subarea 5 haddock can be credited to the insistence of USA fishermen (R. C. Hennemuth, Nat. Mar. Fish. Serv., Northeast Fisheries Center, Woods Hole, Mass., pers. comm.). Closure proposals met with the approval of Canadian fishermen also. This reflected a strong element of belief among fishermen that protection of fish while they are in the act of spawning will have some direct biological benefits. Definition of the specific areas and season proposed for closure was based on analysis of the distribution of ripe, spawning, and spent fish in commercial and research vessel catches (Hennemuth, pers. comm.), planktonic egg distributions (Grosslein and Hennemuth, 1973), and seasonal egg production curves (Marak and Livingstone, 1970). Thus, the closures were based on data on spawning, not on commercial catch rates. Nonetheless, biologists advised from the beginning that they could not demonstrate benefits from protection of spawning fish, and at no point in the deliberations of the Commission of ICNAF or STACRES, in 1969 or later, was it ever proposed that the closures would have a direct effect on spawning success.

Whether or not seasonal spawning area closures directly affect spawning success is an important issue in evaluation of their usefulness as a conservation tool. Unfortunately, it would be very difficult if not impossible to resolve this issue. Reproductive behavior of haddock is complex (Hawkins *et al.*, 1967), involving aggressive behavior, sound production and coloration changes by males, and courtship prior to mating between individual males and females. Courting may occur on or near the bottom, but spawning occurs while a mated pair swims vertically upwards. A female will spawn batches of eggs at 1 to 2 day intervals over a period of 2 to 3 weeks. Given this complex breeding behavior, it is conceivable that persistent disturbance by fishing gear could disrupt mating and result in fewer eggs being fertilized per spawning female. (As the eggs and larvae are pelagic, they will not be killed by commercial fishing gear.) To establish the benefits of closure, however, it would be necessary to prove not only that disturbance reduced the number of fertilized eggs, but also that this reduction translated into a reduction in the numbers of recruits to the fishable stock. Nonetheless, it is generally accepted that at low stock sizes it is possible that insufficient eggs are produced to take full advantage of the opportunities offered by the environment. Thus, it is conceivable that, at low stock sizes, disruption of mating could directly reduce recruitment.

Although the hypothesis that fishing during the spawning act reduces production of fertilized eggs per spawning female cannot be disproved, it has been looked upon by biologists as, at most, a secondary issue. They have consistently emphasized the overriding importance of the number of haddock available to spawn, i.e. spawning stock size. It is intuitively obvious that, if there are relatively few mature fish available to spawn, there can be relatively few eggs produced, whether or not there is some disruption of the spawning act by fishing. In other words, biologists have seen the main issue to be one of reducing exploitation rate and allowing more fish to survive and participate in the reproduction process. Biologists have supported spawning area closures only to the extent that they have contributed to reduction of exploitation rate. Indeed, STACRES went as far as to state, in considering the Div. 4W haddock closed area proposal, that "closure of spawning areas would not be expected to result in any direct significant biological benefits" (ICNAF, 1971).

The seasonal closed area regulations were under constant review within ICNAF and subject to frequent revision as their advantages and disadvantages became clearer with experience. Through changing their fishing patterns, fishermen were able to compensate for exclusion from the spawning area, and reduction in catch of Subarea 5 haddock during closure was only half of that predicted (ICNAF, 1971). Nonetheless, Canada found that controlling haddock catch through various trip limits and by-catch exemptions was not particularly effective, because these measures encouraged misreporting and dumping at sea of excess catches, and concluded that the closed area regulations were having the greater effect in reducing haddock mortality (Canada, MS 1974). These observations encouraged Canada to persist in proposing extension of closures both in time and area to increase protection of haddock stocks.

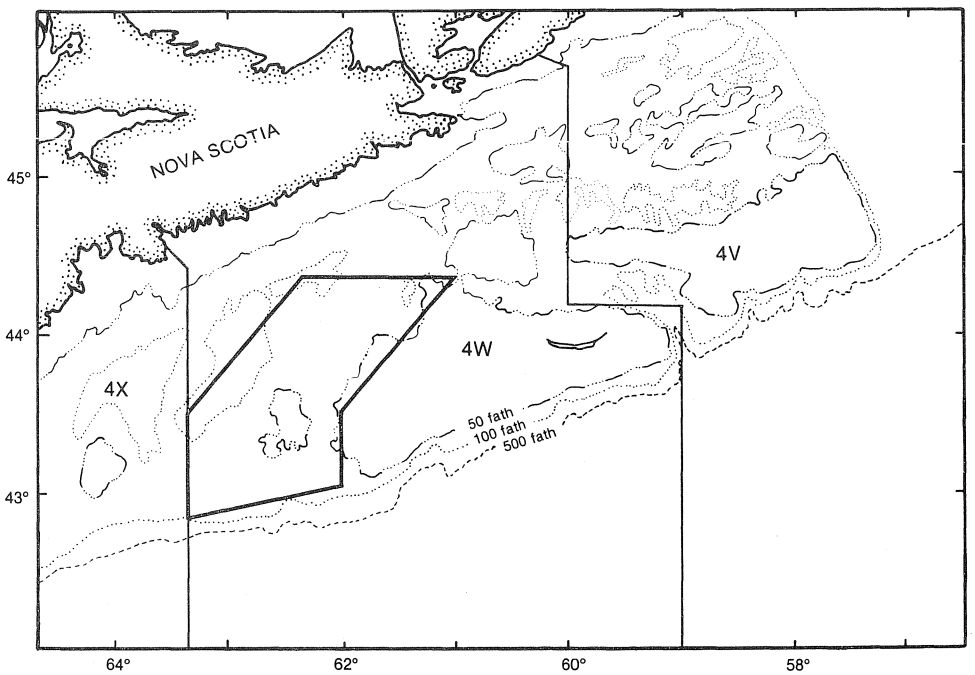

Fig. 1. One example of haddock closed area proposed for Div. 4W by Canada in the 1970–72 period to illustrate general area under consideration.

Extensions of closures met increased resistance, however, as they interfered with the conduct of other fisheries. Distant water fleets which conducted small-mesh fisheries for argentine and silver hake in deep water wanted these areas left open and preferred strict incidental catch limits to control haddock mortality. Canadian and USA fisheries for cod and pollock were also restricted by haddock closures. Canadian abandonment of proposals for a Div. 4W spawning closure resulted from opposition based on the anticipated interference to silver hake and cod fisheries (ICNAF, 1972a). Surprisingly, the only documentation of the area of Div. 4W involved is provided by a map in Kohler's (MS 1971) analysis of the disruption to historical fishing patterns likely to be caused by the proposed closure (Fig. 1). Several variations to boundaries were proposed by Canada to minimize interference with other fisheries, but to no avail. Canada eventually also refrained from further efforts to extend the Div. 4X closure, because the cost in disruption of other fisheries caused serious opposition (ICNAF, 1975a).

Biologists did not encourage greater use of closures, suggesting that more direct means of reducing exploitation rate and of spreading catches throughout the year (e.g. lower TACs, seasonal quotas, low by-catch limits) would be more effective (ICNAF, 1971). They pointed out that, in the southern part of the ICNAF Area where many species occur, closures must inevitably cause interference with fisheries for other species. This made the key issue one of whether the costs, in terms of interference, were justifiable in relation to the benefits expected, or whether alternative methods of regulating haddock mortality would be more cost-effective, i.e. it was an economic and administrative matter and not a biological one (ICNAF, 1975b).

Areas and Seasons Closed and A Chronology of Changes

There are three aspects of the haddock closures which can be varied; the area, the season, and the type of fishing to which the closure applies. When introduced in 1970 (ICNAF, 1969b), three areas which encompassed haddock spawning grounds were closed, one in Div. 4X and two in Subarea 5 (Fig. 2). The closures were for the two months of March and April and applied to "fishing with gear capable of catching demersal species." (Coordinates defining these areas and their subsequent modifications are given in Table 1.)

No changes were introduced for 1971 but several took place for 1972 (Fig. 3; ICNAF, MS 1971). The Div. 4X closed area (area C) was reduced by cutting off an approximately triangular part of the previously closed area southeast of Browns Bank and a 28′ longitudinal section at the western end, to allow the prosecution of spring fisheries for argentine and silver hake in these deep-water areas. The closed area off Cape Cod (area A) was also reduced in size to minimize disruption of USA redfish and shrimp fisheries. The closed season was extended through May, i.e. to 3 months, thus including more of the spawning season in the closure. This applied to all three areas. The closures applied to "... using fishing gear in a manner capable of catching

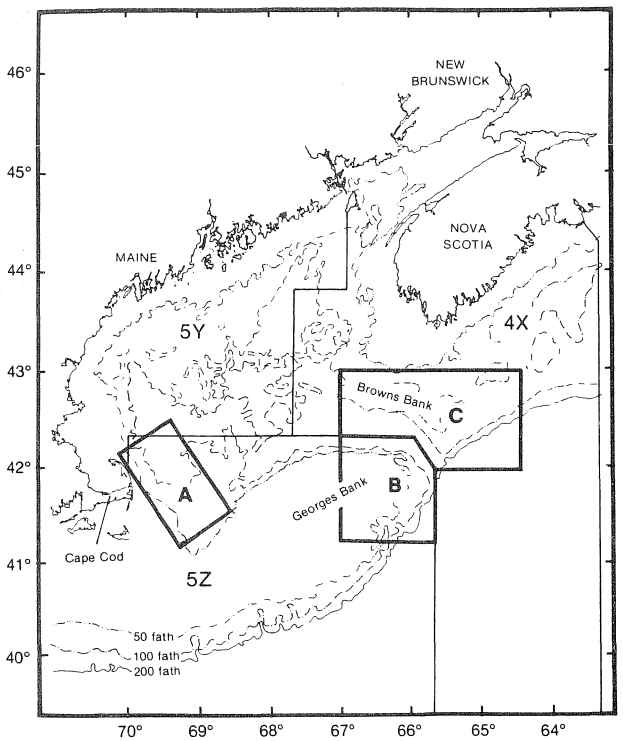

Fig. 2. Haddock closed areas for 1970-71; closure period March and April. (NAFO (ICNAF) divisions and localities mentioned in text are also shown.)

demersal species ...". The reason for this change in wording is not documented but presumably it was intended to allow fishing for pelagic species with off-bottom gear. An exemption to Subarea 5 closed areas was also introduced for "... vessels that fish with hooks having a gape of not less than 3 cm". The USA intention was to allow their small vessels to fish area A for species other than haddock. A 3 cm hook gape was claimed to be too big to catch haddock. To reach agreement, ICNAF accepted an exemption for all vessels in both areas A and B.

A further change in the boundaries of area A was adopted for 1973 (Fig. 4; ICNAF, 1972b), presumably to further ease conflicts with fisheries for other species. For 1974, the exemption for vessels fishing with large hooks was restricted to area A, the original USA intent (ICNAF, 1973).

Although there were no changes affecting the Div. 4X closure for 1973 or 1974, Canada was active in trying to bring about changes. Canada wished to return to the pre-1972 boundaries, as there was information that substantial amounts of small haddock were being caught in areas contiguous with the then current closed area (ICNAF, 1974a). (Although arguments concerning catches of small fish were not consistent with the intent of spawning closures, a constitutional amendment of December 1971 had given the Commission freedom to make "appropriate" proposals for optimum utilization.) Strong resistence from the USSR, in particular, based on preservation of its interests in silver hake and argentine fisheries, resulted in intense

TABLE 1. Spawning closure area coordinates and seasons of closure for haddock in Subareas 4 and 5, 1970-87. (Boundaries are defined by coordinates in the order of listing.)

Area	Years	Months	Long.	Lat.
A.	1970-71	Mar-Apr	70° 00'W	42° 10'N
			69° 10'W	41° 10'N
			68° 30'W	41° 35'N
			69° 20'W	42° 30'N
	1972	Mar-May	69° 55'W	42° 10'N
			69° 10'W	41° 10'N
			68° 30'W	41° 35'N
			69° 00'W	42° 10'N
	1973 to Mar 1982	Mar-May	69° 55'W	42° 10'N
			69° 10'W	41° 10'N
			68° 30'W	41° 35'N
			68° 45'W	41° 50'N
			69° 00'W	41° 50'N
	Apr 1982 to 1986	Mar-May	69° 45'W	41° 50'N
			68° 55'W	40° 55'N
			68° 30'W	41° 35'N
			68° 45'W	41° 50'N
	1987	Feb-May	69° 40'W	41° 50'N
			68° 53'W	40° 53'N
			68° 30'W	41° 35'N
			68° 45'W	41° 50'N
B.	1970-71	Mar-Apr	67° 00'W	42° 20'N
			67° 00'W	41° 15'N
			65° 40'W	41° 15'N
			65° 40'W	42° 00'N
			66° 00'W	42° 20'N
	1972-86	Mar-May	(As above)	
	1987	Mar-May (Can) Feb-May (USA)	(As above)[a]	
C.	1970-71	Mar-Apr	67° 00'W	43° 00'N
			67° 00'W	42° 20'N
			66° 00'W	42° 20'N
			65° 40'W	42° 00'N
			64° 30'W	42° 00'N
			64° 30'W	43° 00'N
	1972-74	Mar-May	66° 32'W	43° 00'N
			66° 32'W	42° 20'N
			66° 00'W	42° 20'N
			65° 44'W	42° 04'N
			64° 30'W	42° 40'N
			64° 30'W	43° 00'N
	1975	Feb-May	67° 00'W	43° 00'N
			66° 32'W	42° 42'N
			66° 32'W	42° 20'N
			66° 00'W	42° 20'N
			65° 44'W	42° 04'N
			64° 00'W	42° 49'N
			64° 00'W	43° 30'N
			65° 40'W	43° 00'N
	1976-87	Mar-May	(as for 1972-74)	

[a] USA Northeast Multispecies Management Plan recognizes international maritime boundary by giving coordinates for part of original closed area which is in US waters only, as follows: 67° 00'W 41° 59.1'N, 67° 00'W 41° 15'N, 66° 22.4'W 41° 15'N.

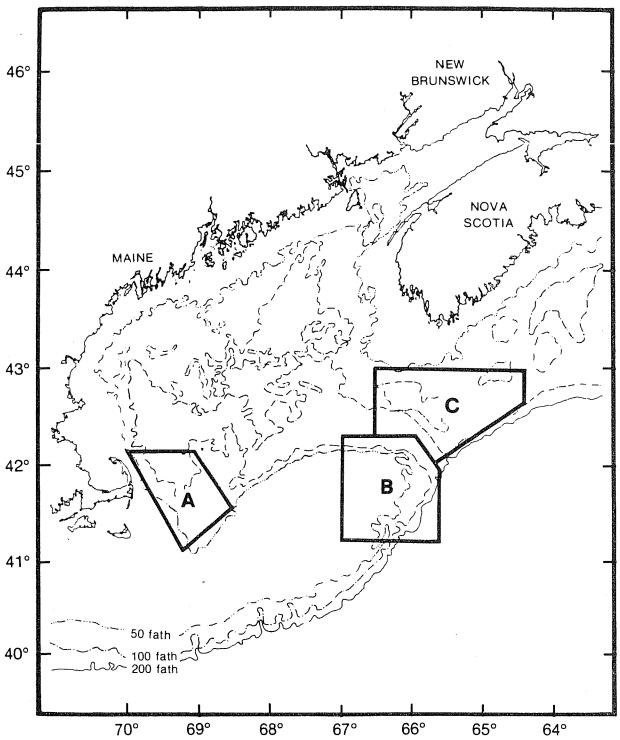

Fig. 3. Haddock closed areas for 1972; closure period March–May.

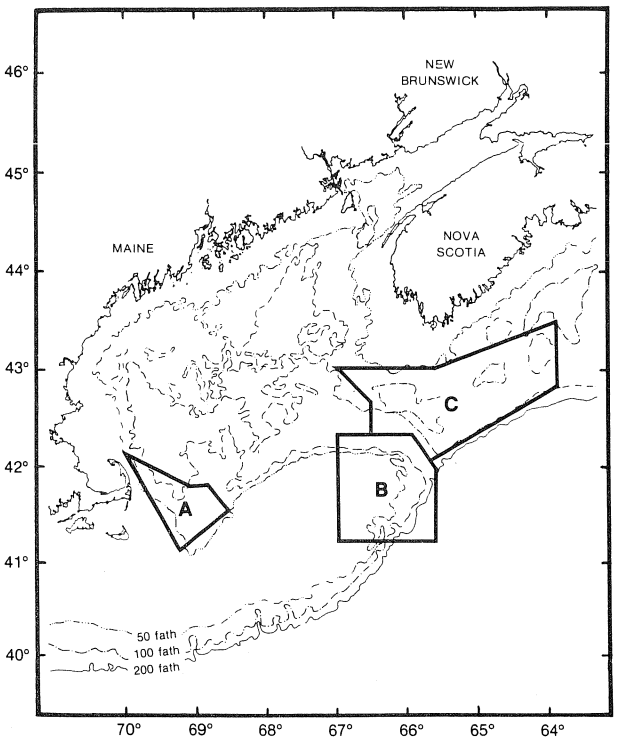

Fig. 5. Haddock closed areas for 1975; closure periods March–May for areas A and B, February–May for area C.

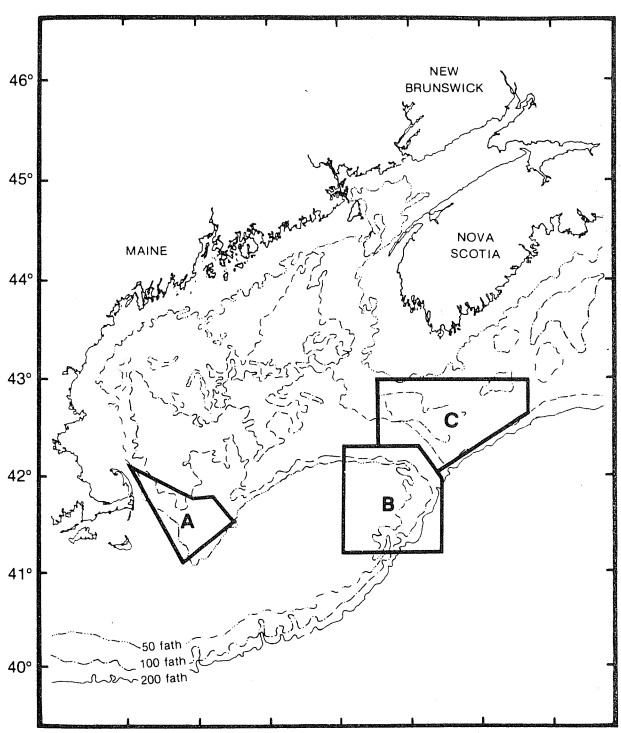

Fig. 4. Haddock closed areas for 1973–74 and for 1976 to March 1982; closure period March–May.

debate and a compromise solution for 1975 (ICNAF, 1975a, 1975c) which involved extension of the closed area (Fig. 5) and extension of the closed season to include February (i.e. for a total of 4 months).

The USA also made proposals for substantial changes in Subarea 5 closures for 1975, which included closure of almost all of Georges Bank for the entire year to bottom fishing by vessels over 130 ft (in addition to the seasonal spawning area closure), and changes to by-catch allowances for haddock (USA, MS 1974a). This met strong resistence and the closure regulations remained unchanged (ICNAF, 1975c), but by-catch provisions were changed in the Subarea 5 haddock regulations for 1975 from 10% by weight to 1% by weight. The USA introduced a similar proposal in 1975 for a year-round closure of most of Georges Bank to bottom fishing by vessels greater than 155 ft in length. This was raised as an amendment to the haddock regulations but addressed by-catch problems for other species as well (USA, MS 1975), and, by the time a revised proposal was adopted by ICNAF, it had become an amendment to a different regulation; a general one designed to regulate fishing gear employed in Subarea 5 and Stat. Area 6 (ICNAF, 1976). Further USA regulatory initiatives within ICNAF did not address the haddock seasonal spawning closed area regulations *per*

se, but addressed by-catch problems in general. This approach evolved, by the end of 1976, into the "window" system (ICNAF, 1977) which paved the way for the USA approach to foreign fishing subsequent to their extension of jurisdiction.

Canada's arguments in relation to Div. 4X haddock also increasingly emphasized by-catch problems, but attempts to address these through further extensions of the closed area and closed season were strongly resisted, particularly by the USSR. Canada finally de-emphasized the seasonal closed area approach, and, for 1976, a Canadian proposal was accepted which returned the area and season of closure to that in force in 1972–74 (Fig. 4). To compensate, by-catch allowances were reduced to 1% for both haddock and cod in Div. 4X. This brought the Div. 4X regulations for haddock into line with those adopted for Subarea 5 in the previous year (ICNAF, 1975d).

There were changes to the type of fishing to which all three closures applied in 1975 and 1976. The USA proposed that the regulation for 1975 should be changed to prohibit "all types of trawls or trawl lines" being fished in the closed area except for those used in fishing crustaceans and scallops, i.e. to exclude pelagic gear (USA, MS 1974b). However, the regulation for 1975 was revised to read as a prohibition of "... fishing gear other than pelagic fishing gear (purse seines or true midwater trawls, using midwater trawl doors incapable of being fished on the bottom) and from attaching any protective device to pelagic fishing gear or employing any means which would in effect make it possible to fish for demersal species ..." (ICNAF, 1974b). While this strengthened the regulation against use of pelagic gears to catch demersal species, it inadvertently prohibited fishing for crustaceans and scallops. (This prohibition was ignored in the conduct of lobster pot and scallop drag fisheries in 1975.) This oversight was corrected for 1976 by an amendment which stated that these provisions would not apply to fishing "... with gear designed to fish for crustaceans and scallops" (ICNAF, 1975e).

The haddock seasonal closed area regulations in effect under ICNAF in 1976 have survived to the present with relatively little change. In the USA, haddock were managed by the New England Fishery Management Council (NEFMC) under their Fisheries Management Plan for Atlantic Groundfish from 15 March 1977 to 30 March 1982 (USA, 1978). This plan contained the same spawning area seasonal closure regulations as in the ICNAF regulations. The NEFMC Interim Groundfish Fishery Management Plan implemented on 31 March 1982 (USA, 1982) contained a modification to the boundaries of area A, but those of area B and the seasons of closure remained the same. The exemption for fishing area A with large hooks (greater than 3 cm) was also retained. The new coordinates of area A (Fig. 6) moved

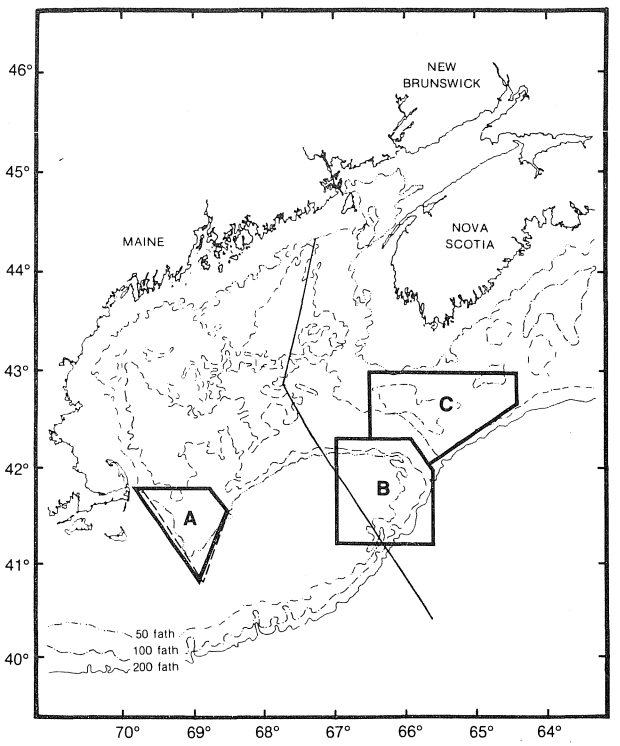

Fig. 6. Haddock closed areas after March 1982. For area A, solid lines indicate closed area boundaries through 1986, dashed lines indicate changes for 1987. Canada-USA maritime boundary effective 12 October 1984 also shown. Closure periods March–May except for area A and USA portion of B in 1987 which were set as February–May with provision to re-open prior to the end of May if spawning judged complete.

it southeast into shallower waters. There had been a reported shoalward shift in haddock spawning activity and redefinition of the area "refocussed" the closure on concentrations on spawning haddock while coincidentally lessening interference with fisheries for other species. The Northeast Multispecies Fishery Management Plan which took effect on 19 September 1986 (USA, 1986) extended the closed season to include February but contained provision for reopening of either or both of areas A and B if it was determined that "concentrations of spawning fish are no longer in the area(s)." The large hook exemption for area A (called Closed Area I in the USA plan) was retained and the coordinates of this area were modified slightly (Table 1, Fig. 6). Area B (USA Closed Area II) remained unchanged except that it was defined by coordinates describing only that part on the USA side of the maritime boundary.

Canada continued to apply the ICNAF haddock closure regulations through domestic regulation after extension of jurisdiction and has introduced no changes in areas or seasons closed. Consideration was given to elimination of the Div. 4X closure during formulation of the 1982 Canadian Atlantic Coast Groundfish Management Plan as an enforcement cost-saving measure. The proposal was based on the observation that the Div. 4X stock had fully recovered from the

recruitment failure which greatly reduced spawning stock size in the early 1970's and appeared to be sustaining production at historical levels. Thus, the protection provided by the closed area perhaps was no longer necessary. The Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) pointed out that the regulation had aided in spreading catches throughout the year and, if the closure was dispensed with, alternative measures would be required (Canada, 1982). There was also opposition to removal by various sectors of the Canadian fishing industry and no change was implemented.

Canada did change regulations concerning the large hook exemption, however. Initially imposed for both areas A and B in Subarea 5 for 1972, the exemption was restricted to area A after 1973 in ICNAF regulations. In a revision and consolidation of Canadian regulations in 1978, area A was dropped as it lay in undisputed USA waters. The clause exempting fishing with large hooks in this area was inadvertently retained, however (Canada, 1978). An amendment in 1981 caused the exemption to apply to area B on Georges Bank (Canada, 1981). As a result, Canadian longline fishermen currently benefit from a large hook exemption in the Georges Bank closed area, and apparently did so as far back as 1982-84 (Halliday and Sinclair, 1987). It has not been possible to determine the process through which an oversight in the regulatory revision of 1978 translated into a widely used exemption to the area B closure.

Discussion

The seasonal closures of haddock spawning areas in Div. 4X and Subarea 5 were part of the first ICNAF regulations devised to control overall mortality rate of any of the fish stocks in the Northwest Atlantic. Although the intentions of the USA and Canadian governments were to reduce haddock mortality to as low a level as was practical, while spreading catches through the year and minimizing disruption to fisheries for other species, they had limited tools with which to work. In particular, the only basis for enacting closure of an area under Article VIII of the ICNAF Convention was if it was found to be a spawning area (or to be populated by small or immature fish). Thus, the ostensible reason for closure of the particular areas and seasons was indeed because these were the haddock spawning areas and seasons. The underlying motivation, however, was because the areas and periods of highest commercial catch rates coincided with these. Spawning area closures were expected to decrease fleet efficiency and, if not result in an overall reduction in annual catch, at least to spread these catches which were allowed under restrictive TAC regulation throughout the year.

Acceptance of the haddock spawning closures by fishermen, and indeed their active defence of these regulations on occasion, has stemmed in substantial part from their belief that these would have direct effects on spawning success, i.e. that recruitment would be enhanced by allowing spawning to proceed undisturbed by fishing. Fishermen's acceptance reached its limits as larger areas were proposed for closure for longer periods, thus increasing interference with the conduct of fisheries for other species, and also further reducing the quantities of haddock they could catch.

Spawning area closures would be highly efficient regulations if they had intrinsic biological benefits. Depleted stocks could be rehabilitated through temporary abstention from fishing in a limited area, while catches could be largely maintained by fishing harder at other times of the year. Biologists have not encouraged belief in such intrinsic benefits and have tended to discount their possibility, while admitting that their absence cannot be scientifically established. The propensity of fishermen to espouse such a belief is easy to understand, however.

Biologists consistently adopted the view that maximization of the probability of haddock recovery required minimization of fishing mortality. They also discouraged the extension of closed areas as a means of achieving this, suggesting that more direct means, such as lower TACs and low by-catch limits, would be more effective and perhaps more economically efficient (ICNAF, 1971). These were largely theoretical arguments, however, and the practical Canadian experience, at least in the early years of closure regulations, was that the Div. 4X closure was having a greater effect in reducing haddock mortality than various catch quotas and by-catch limits (Canada, MS 1974).

The 1971 views of STACRES on the relative merits of seasonal area closures were formulated at the beginning of ICNAF attempts to control exploitation rate through regulation of fishing activities. Experience in the intervening period has more clearly demonstrated the practical difficulties of effective implementation of many types of regulatory controls. In particular, TAC and by-catch limits have been found difficult to enforce. It has also proved difficult to calculate TAC levels which control fishing mortality close to desired levels. Although area closures may be blunt instruments for control of exploitation rate, they may lend themselves to more effective enforcement than TACs. Costs to the enforcement agency of enforcing area closures can be readily calculated as activities largely involve surveillance by vessels and aircraft, and costs of operating these vehicles are usually known. It is more difficult to calculate the costs of, say, catch quota enforcement; there is usually a less clear perception of

what these costs are, and as a result they tend to be discounted when considering the relative merits of alternative regulatory measures. With the experience now available, it should be possible to base future reconsiderations of the seasonal haddock spawning closures not only on the relative expected benefits from alternative regulatory measures, but also taking into account the practicalities of effective enforcement and associated costs.

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