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On the Relevance of a Combined Assessment of Greenland Halibut in NAFO Subareas 0, 1, 2 and Divisions 3KL

by

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Abstract.

At present, stock assessment of Greenland halibut is made separately for the Gulf of St. Lawrence (Div. 4RST), Labrador-Newfoundland (Subarea 2 and Div. 3KL) and the Davis Strait (Subarea 0+1). Based on an examination of the biological information on Greenland halibut in the Northwest Atlantic the relevance of combining the assesment for Subarea 0 + 1 and Subarea 2 and Div. 3KL is discussed. It is concluded that the assessment for the two areas should be combined, except for the populations in West Greenland fiords (inshore part of Subarea 1). These populations are probably recruited from the Davis Strait stock, but do not contribute to the spawning stock in the Davis Strait. Therefore, separate TAC's should be advised for these fiord populations. The separate assessment of the Gulf of St. Lawrence stock should be maintained.

1. Introduction.

Catches of Greenland halibut in Subarea 0 and 1 were rather stable throughout the eighties with an average catch of 9.000 tons. Most of the catch has been taken by Greenland in Div. 1A in a longline and gillnet fishery in the fiords (Anon., 1989).

In Subarea 2 and Div. 3KL catches have declined rather steadily since 1978 to reach an all time low of about 16.000 tons in 1986. The catches in 1987 and 1988 were 27.000 and 18.000 tons, respectively. The fishery has been taking place mainly in Div. 2J and 3KL. (Anon., 1989).

Stock assessments of Greenland halibut is at present made separately for Subarea 0 + 1, Subarea 2 + Div. 3KL, and Div. 4RST. The latter stock is assessed by CAFSAC. TAC in Subarea 0+1 has been 25,000 tons throughout the eighties. In Subarea 2 and Div. 3KL the TAC has been 100,000 tons between 1986 and 1989, but in 1990 TAC was advised to be 50,000 tons (for $F_{0.1}$ = 0.29 (Anon., 1989), due to a decrease in the estimated biomass in the area and a reduction in CPUE (Bowering and Brodie, 1989).

In recent years knowledge about stock delimitation of Greenland halibut in the Northwest Atlantic has been enhanced. Studies on parasites, genetics, meristics and tagging experiments suggest that Greenland halibut in the Northwest Atlantic belong to one common stock.

Based on a recommendation from STACFIS in 1989: "that consideration (should be) given to the biological and practical implications of combining Subareas 0, 1, 2 and division 3KL for stock assessment purposes when considering Greenland halibut" the aim of this paper is to give a short review of the present knowledge of the Greenland halibut populations in the Northwest Atlantic and their delimitation. This knowledge is the biological background for a possible combined assessment of the Greenland halibut resource in Subareas 0, 2, the offshore part of Subarea 1, and Divisions 3KL.

2. Biological information.

2.1. Reproduction and Recruitment.

Based on records of bottom temperatures and observations of the distribution of eggs and larvae, Smidt (1969) suggested that spawning takes place in the Davis Strait in relatively warm water, 3 - 4 ^{O}C, in late winter and early spring south of the ridge between Greenland and Baffin Island at about 67^{O}N. Investigations on sexual maturity in the Davis Strait by Yatsu et al. (1988) using gonad weight in relation to body weight as an index value, showed that the index value increases with increasing depth and Jørgensen and Akimoto (1990) show that the index value is increasing during the autumn and early winther. Further, Bowering (1983) found that size and age at maturity decreased significantly from south to north at eastern Canada and interpreted this as a northward migration towards the spawning area, which also supports Smidt's suggestion. Nevertheless, observations of fish with gonads in a condition close to spawning are very sparse in the Davis Strait.

The eggs and small larvae are found bathypelagic at 600-1000 m (Jensen, 1935). As the larvae grow they rise to the surface water and the main concentration of larvae off West Greenland is found between 62^{O}N and 66^{O}N (Smidt, 1969). The larvae are drifted along the West Greenland coast by the West Greenland current and toward Baffin Island by a branch of this current. From Baffin Island the larvae are distributed southward by the Labrador Current (Templeman, 1973). At a length of about 70 mm, the larvae metamorphose to the demersal stage (Jensen, 1935; Smidt, 1969) and settle at 200-300 m depth on the banks around Disko Island (Riget and Boje, 1989a) and off Baffin Island, Labrador and Eastern Newfoundland (Chumakov and Serebryakov, 1982; Bowering, 1978).

Riget and Boje (1989a) found that spawning in the inshore areas of West Greenland only occurs sporadically and they further hypothesize that the fiord populations in West Greenland do not participate in spawning in the Davis Strait. However, eggs and pelagic larvae have never been found in the fiords of West Greenland and according to Riget and Boje (1989a) Greenland halibut in the fiords are recruited mainly from the spawning area in the Davis Strait.

The general current pattern, indicates that pelagic larvae from the Davis Strait area have difficulty in reaching the coast in the southernmost part of West Greenland because the current here is dominated by the East Greenland/Irminger Current deriving from the East Greenland area. It therefore seems quite possible that young Greenland halibut are carried by the East Greenland/Irminger Current to the southern West Greenland from spawning areas at West Iceland (Riget and Boje, 1989a).

Templeman (1970) concluded that a separate breeding population of Greenland halibut occurs in the Gulf of St. Lawrence. However, there is no clear evidence that this stock is isolated from the Davis Strait stock and young fish from the latter stock might immigrate to the Gulf through the Strait of Bell Isle (Bowering, 1981).

2.2 Migrations.

Shrimp trawl surveys, bottom trawl surveys and longline catches at West Greenland, all show that size of fish increases with increasing depth (Riget and Boje, 1989). The bottom topography in the West Greenland area implies that mean size increases from the banks in an inshore direction as well as an offshore direction. In the offshore areas the mean size increases in a southward direction as well (Yatsu & Jørgensen, 1989). This has lead to the conclusion that Greenland halibut when growing up on the banks of West Greenland, migrate both in an inshore and an offshore direction.

These conclusions are supported by tagging experiments in West Greenland fiords (Smidt, 1969, Riget & Boje, 1987, Riget & Boje, 1989a, Boje, 1990) carried out since 1935. Except for 5 specimens recaptured northwest of Iceland, all recaptures were recorded at or nearby the tagging sites, indicating strong stationarity among the fiord populations. The 5 recaptures from Icelandic waters where all tagged in the southern fiords of West Greenland, indicating that part of the populations in the southern fiords of West Greenland migrate to Icelandic waters. However, a lack of recaptures in the Davis Strait is likely due to the low fishing intensity in the area, and does not mean that migration from the West Greenland fiords to the Davis Strait can be rejected. Information on size distributions in the fiords makes it difficult to explain a migration pattern similar to the migration pattern along the east Canadian coast.

Canadian and USSR bottom trawl surveys carried out in NAFO Subarea 0, 2 and Div. 3K from 1977 to 1987, show that mean size increases with increasing depth in all these areas (Bowering & Chumakov, 1989). However, the bottom topography in Canadian waters is different from that in the Greenland waters and an increase in size by depth means only increase in an offshore as well as a in northward direction in the Canadian area. This has been interpreted as northward migration when growing up, towards the deeper areas of the Davis Strait.

Tagging experiments carried out in the Labrador-Newfoundland region 1969-1980 (Bowering, 1984) support the interpretations of the size distributions, generally indicating a movement of Greenland halibut in a northeastern direction towards the deeper parts of the Davis Strait, although some experiments in bays of Newfoundland indicate little movements from the tagging sites.

No recaptures in West Greenland waters have ever been recorded from tagging experiments at Iceland as well as from tagging experiments in Canada.

2.3 Studies on stock identification.

2.3.1 Genetic differentiation.

Recently, Boje et *al.*(1989), presented the results of a study of genetic differentiation of Greenland halibut in the Northwest Atlantic. The area included the Denmark Strait, West Greenland, inshore as well as offshore, and Newfoundland. Although there were found minor differences in allele frequencies between the samples, Greenland halibut seems to form a single stock throughout the area studied. The investigation indicated mixed populations and the occurence of at least two spawning populations. This study supported a study by Fairbairn (1981), who investigated an area from the Davis Strait to the northern Grand bank including Gulf of St. Lawrence. She also found that Greenland halibut in the area studied form a single homogenous stock, although Gulf of St. Lawrence seem to be partly isolated from the eastern Newfoundland area.

2.3.2 Meristic studies.

Studies on stock identification using meristic characters of Greenland halibut in the Northwest Atlantic were carried out by Templeman (1970), Misra & Bowering (1984) and Riget & Boje (1989b). The areas investigated include the Denmark Strait, the fiords of West Greenland, the Davis Strait, the banks along the Canadian eastcoast southward to the Grand Bank and the Gulf of St. Lawrence.

The studies by Templeman (1970) and Misra & Bowering (1984) in Canadian waters, suggest the existence of at least two separate populations of Greenland halibut in the Northwest Atlantic, viz. a population from the Davis Strait to the Grand Bank and a population in the Gulf of St. Lawrence. Riget & Boje (1989b) found that populations in the offshore areas, i.e. Newfoundland, Davis Strait and Denmark Strait showed small differences, while those of the inshore areas at West Greenland differed substantially from those in the offshore areas, indicating that the populations have been under different temperature conditions during their egg and larval stages. Bowering (1988) found differences in morphometric characters between Greenland halibut sampled in the Davis Strait and those sampled along the coast of Labrador and Newfoundland, but he concluded that the differences could be caused by factors other than existence of discrete spawning populations.

2.3.3 Parasitological investigations.

On the basis of prevalences of blood protozoa from Greenland halibut, Khan *et al.* (1982) suggested that Greenland halibut in the area from the Davis Strait to the northern Grand Bank form one stock complex, while Greenland halibut from the Gulf of St. Lawrence and Fortune Bay, appear to represent distinct stocks. Reimer and Ernst (1989) studied parasitic infestation of Greenland halibut from Labrador and Newfoundland and concluded that the populations studied belong to the same stock. Boje *et al.*(1990) analysed infestation of parasites in Greenland halibut from the Denmark Strait, the fiords of West Greenland, the Davis Strait and off Newfoundland. They found that the southernmost fiords seems to be partly isolated from the offshore populations and associated with Denmark Strait. Greenland halibut from the Davis Strait and Newfoundland seem to belong to the same population, as clines in parasite prevalences

often were found from Newfoundland to the Davis Strait and further on to the other locations.

3. Conclusions

3.1 Stock relationship.

Several studies indicate that the populations of Greenland halibut exposed to fishery in Subarea 0,1 and 2 and Div. 3KL originate from the same spawning stock in the Davis Strait. The distribution patterns of pelagic larvae and young demersal stages at West Greenland and at the Canadian eastcoast, indicates that the main recruitment occurs from a spawning area in the deeper part of the Davis Strait. Investigations on stock relationship, including studies on genetics, meristics, parasitology and tagging experiments as well as size distribution, all indicate a common stock in the Davis Strait. However, in view of the ocean current patterns, it seems likely that the stocks in the southernmost fiords of West Greenland can be recruited from the spawning grounds west of Iceland.

In some way the populations of Greenland halibut in the West Greenland fiords seem to be isolated. Investiagtions on eggs and larvae indicate that the populations are recruited from the Davis Strait stock complex. But mature fish from these populations do not seem to participate in spawning in the Davis Strait. Tagging studies as well as studies on parasites and meristics indicate an isolation of the fiord populations from the Davis Strait stock complex. The fiords populations at West Greenland should therefore be treated as 'dead ends' of the overall stock complex.

Studies on genetics, meristics, morphometric characters and taking the currents into consideration, seem to point to the same status for Gulf of St. Lawrence as the West Greenland fiords.

3.2 Practical implications for the assessment.

The present biomass estimates available for Subareas 0 and 1 (Jørgensen & Akimoto, 1990; Chumakov, 1989; Atkinson & Bowering, 1987), all represent estimates for the offshore areas only. These estimates should be included in a combined assessment for Subarea 0,1 and 2 and Div. 3KL.

However, as nearly all catches of Greenland halibut in Subareas 0+1 derive from an inshore fishery in Subarea 1, such catches of Greenland halibut in Subareas 0+1 should not be included in a combined assessment.

A TAC for Subarea 0,1 and 2 and Div. 3KL should apply only for the offshore areas. As Greenland halibut in the fiords of West Greenland seem to be isolated and do not mix between the fiords, an overall TAC for the total inshore area of West Greenland is meaningless. If possible, assessment should be carried out for each fiordsystem in Subarea 1. This will involve assessments for the following fiords: the Godthaabsfiord (Div. 1D), Disko Bay (Div. 1A), Umanak fiord (Div. 1A) and Upernavik fiord (Div. 1A).

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