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Preliminary evaluation of trawls used for research vessel surveys by Canada, USA and USSR on the Nova Scotia Shelf, and some observations on the resulting biomass estimates.

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Introduction

In 1970 and 1971, Canada, USA and USSR carried out coordinated groundfish surveys on the Nova Scotian Shelf. Canadian and USSR surveys were in July and August respectively, and USA surveys were in November. All three countries used the same stratified random sampling scheme in both years. Thus it is possible to make approximate comparisons of relative fishing power of the trawls, and to obtain a preliminary notion of the accuracy of abundance indices for various species. Comparisons of catch per haul data, and mimimum biomass estimates are presented here for selected species, to help evaluate the relative efficiency of the different trawls.

Methods

A 27.1m Soviet "herring" trawl was used by the USSR vessels, and a #36 Yankee trawl was used by Canada and USA. Specifications of construction and rigging of trawls, are described in Research Documents 68/87, 71/117, 71/35 and 72/112. The horizontal and vertical openings of the Yankee trawl are about 11.5 and 2.6 meters respectively, and corresponding values for the 27.1 in trawl are approximately 20 percent greater. The Yankee trawls are rigged with rollers but the Soviet trawl has been fished without rollers. There were differences in rigging of the Yankee trawls used by Canada and USA, the most important of which are that Canada uses longer bridles (60 feet as compared with 30 feet), and 120-foot ground cables, an extension piece and greater scope in shoal waters. The 27.1 trawl used in 1971 was constructed of lighter twine, and a new model trawl door was used; opening of the trawl was slightly less than that for the previous model but on the average fishing power was substantially greater for the new model (Res. Doc. 72/112). Canadian and USSR vessels are side trawlers and the USA vessel is a stern trawler. Average towing speed was 3.5 knots for all surveys and the stratification scheme developed by Halliday was used (figure 1). Weight and length frequency of all species was recorded for each trawl on all surveys, and therefore relative efficiency of trawls can be measured in terms of the whole complex of

Catch per haul comparisons

Stratified mean catch per haul figures were calculated for the following three strata sets:

1) Strata 70-78, 80, 81 (Offshore Div. 4X)

2) Strata 53-66 (Div. 4W)

3) Strata 47-52 (Banquereau area)

The first set was surveyed by all three countries, and the second and third sets were surveyed by Canada and USSR. Canada also surveyed the remainder of Divisions 4X and 4V. On each survey some trawling was done in each stratum in each area, except that USSR did not make hauls in stratum 59 (figure 1).

In spite of the larger size of the Soviet trawl, average catch per haul generally was less than that for the Yankee trawls for all species except on Banquereau (Tables 1-3). Comparisons between the Canadian and USSR catches provide perhaps that best comparison between the two trawl types on the Scotian Shelf because the surveys occurred within one month of each other and presumably changes in fish distribution were relatively small. In Division 4X the average catch per haul of all species by the 27.1 trawl was less than half that of the Canadian Yankee trawl in both 1970 and 1971, even after removing the effect of an unusually large dogfish catch in the Canadian survey in 1971 (Table 1). In Division 4W the mean catch of all species by the Yankee trawl was about twice that of the 27.1 trawl in 1970 but only slightly greater in 1971 (Table 2). Finally the comparisons for Banquereau showed about the same catch for the two trawls in 1970 but a reversal in 1971 with the Soviet trawl catching nearly three times that of the Yankee trawl (Table 3).

These comparisons are difficult to interpret because:

1) the new model 27.1 used in 1971 is believed to have at least 50 percent greater fishing power than the standard 27.1 used in 1970, as indicated by trawl comparison experiments in Subarea 5 (Res. Doc. 72/112).

2) the increase in fishing power of the new 27.1 trawl in 1971 on the Scotian shelf appeared to be relatively very much greater in the Banquereau area than in Divisions 4X and 4W.

Quite clearly the change in relative efficiency on Banquereau in 1971 occurred with the Soviet gear since catch per haul increased markedly for virtually all species, and this is not consistent with knowledge of the general status of groundfish stocks in the area. It is possible that the change may be due to changes in handling of the 27.1 trawl on Banquereau or to use of different criteria in that area for selecting alternate trawl stations in rough-bottom areas. With the information at hand we cannot adequately explain the discrepancy. However there seems to be a clear implication here that roller gear is important not only for reducing gear damage but it also may be important from the standpoint of maintaining consistency in the selection of stations and handling of gear.

Comparisons between the 27.1 trawls and the USA version of the Yankee trawl in Division 4X showed the two trawls to have about the same fishing power (Table 1). Also the comparisons are consistent with the pattern noted above, in that the relative fishing power of the Soviet gear was greater in 1971 than in 1970, but the change was small in Division 4X in comparison with that observed in the Banquereau area. The Canadian Yankee trawl clearly had greater fishing power than the USA trawl particularly for cod and haddock (Table 1). The difference undoubtedly represents the effect of ground cables and perhaps scope as well. However, changes in fish distribution from summer to fall may also be involved.

Biomass Estimates

Minimum estimates of biomass for selected species were calculated for each area by simple expansion of mean catch per square mile of bottom swept per standard haul using estimates of horizontal spread between forward parts of wings and making no allowance for vertical distribution of fish on the herding

the three trawls are shown in tables 4 and 5, and the Canadian estimates for the remaining parts of 4X and 4V are shown in table 6. Although we do not yet have accurate estimates of catchability coefficients for any species, preliminary analysis suggest that the coefficients may be fairly high for some species. Furthermore we have been encouraged by the year-to-year consistency of catches particularly for gadids and flounders which suggests that the surveys will provide meaningful measures of stock size when availability coefficients are evaluated.

In the case of cod and haddock we can compare the direct estimates of biomass with independent estimates of stock size based on assessment studies. For example current size of the Division 4VW haddock stock appears to be on the order of 18,000 tons and the estimated population size from Canadian surveys was 25,000 tons in 1970 and 16,000 tons in 1971 (Tables 4-6). Thus the 1970 and 1971 survey estimates bracket very closely the population estimate derived from the estimated fishing mortality in relation to landings.

For Division 4X haddock, estimates of F and Z are .6 and.8 respectively, and with current landings at 18,000 tons, the estimated stock size is 43,000 tons. The corresponding direct biomass estimates based on the Canadian surveys in the whole of Division 4X were 38,000 tons in 1970 and 50,000 tons in 1971 (Tables 4-6). The offshore Division 4X cod stock presently is estimated at approximately 22,000 tons (F=.7, Z=.9, current landings at 10,000 tons), and the survey estimates were 38,000 tons in 1970 and 16,000 tons in 1971 (Tables 4,5).

Thus for cod and haddock the survey biomass estimates appear to provide reasonably good approximations to actual stock sizes in Subarea 4. Since it is unlikely that catchability coefficients are equal to 1 especially for cod, this implies that there is some herding effect by the ground cables; that is, the effective sweep of the trawl is greater than the actual wingspread. In any case, it is most encouraging to get such good correspondence between the survey and assessment estimates. It is still too early of course to rule out the possibility that this may be partly coincidence because sampling errors are fairly large. Also a few more years in the time series will be necessary to be sure that availability does not show wide variations.

Biomass estimates of cod and haddock in the late autumn based on USA surveys show considerably smaller values, and this is believed to be attributable chiefly to the lower fishing power of the USA rigging of the Yankee trawl, although distribution may also be involved. In any case biomass estimates were quite consistent between the two years, and this is encouraging also.

It is of some interest to compare the minimum biomass estimate for all species combined based on the Canadian surveys in Divisions 4V-X, with the recorded total landings of groundfish, flounders and skates. Survey estimates were 712,000 and 737,000 tons in 1970 and 1971 respectively, while landings of groundfish and flounders (plus skates) were about 390,000 and 400,000 tons in the two years. Assuming that no more than 1/3 of the total standing crop of groundfish is removed each year by fishing (and this may be conservative under the present heavy fishing), then the survey estimate would be roughly 1/2 the correct value. In view of the results with cod and haddock, an average "availability coefficient" of .5 for all groundfish does not seem to be unreasonable. Here again the consistency of the estimates for both years is encouraging.

A final point of interest here is a comparison of the total groundfish landings per unit area in Divisions 4V, W, X, with the estimated maximum sustainable yield per unit area of groundfish in 5Z. The 4V-X groundfish landings in 1970 and 1971 amounted to approximately 8 tons per square mile, whereas the MSY of groundfish in 5Z is estimated to be roughly 14 tons per square mile. Assuming the two areas have equal productive capacity, this would imply that MSY of the total groundfish resource in 4V-X was little more that 50 percent greater than represented by current harvest levels. There is some evidence however that overall productivity is greater on Georges Bank and therefore current harvests in 4V-X may be much closer to the MSY than implied by the above comparison. The similarities in the pattern of decline for some of the principal groundfish stocks such as cod and haddock, on parts of both Georges and the Scotian Shelf suggest that we may already be near or even past the level of MSY for most groundfish species in 4V-X.

The biomass estimates and analyses presented in this report must be considered preliminary. While some results are encouraging, a longer time series of survey data will be required to confirm their true accuracy. It is hoped however, that this paper will stimulate other countries to summarize their survey data in similar fashion, and thus strengthen the data base for evaluating the potential of groundfish surveys.

Table 1 -- Mean catch per haul (kg) for selected species and all species combined, in Division 4X, based on trawl surveys in 1970 and 1971. 1/

Species	1970 CAN	1970 USA	1970 USSR	1971 CAN	1971 USA	1971 USSR
Cod	41.62	6.37	3.12	17.61	6.49	4.27
Haddock	22.66	8.87	7.58	39.37	9.06	8.46
Silver hake	5.19	2.73	2.40	3.57	1.71	3.42
White hake	5.13	2.18	0.31	2.17	1.21	1.20
Redfish	13.92	33.76	33.04	67.64	11.94	33.56
Plaice	5.79	1.52	0.22	1.58	1.14	0.47
Witch	1.65	0.88	0.39	0.11	0.55	0.46
Yellowtail flounder	0.29	0.89	0.16	0.31	0.54	0.15
Thorny skate	1.16	3.37	0.30	1.52	4.02	1.24
Squid	0.48	0.41	0.49	4.16	0.66	0.56
Other species	20.72	6.90	7.55	136.12 2/	10.81	10.95
All species combined	118.61	67.88	55.56	274.16	48.13	64.74

1/ [illegible] strata 70-7[illegible] 80 8[illegible]

2/ [illegible] fish ([illegible])

Table 2 -- Mean catch per haul (kg) for selected species and all species combined in Division 4W, for trawl surveys in 1970 and 1971. 1/

Species	1970 CAN	1970 USSR	1971 CAN	1971 USSR
Cod	13.88	4.15	15.74	14.76
Haddock	10.59	6.48	9.01	7.78
Silver hake	10.14	5.00	1.99	6.75
White hake	6.92	0.69	1.50	0.24
Redfish	58.10	9.80	26.64	8.94
Plaice	5.86	8.11	5.72	2.77
Witch	0.96	6.12	0.83	1.14
Yellowtail flounder	7.21	4.34	5.72	5.04
Thorny skate	4.38	6.15	4.58	2.10
Squid	0.63	3.95	4.66	0.68
Other species	24.02	12.52	10.86	21.89
All species combined	142.69	67.31	87.25	72.09

1/ Includes only strata 53-66

Table 3. -- Mean catch per haul (kg) for selected species and all species combined in Division 4V (Banquereau) for trawl surveys in 1970 and 1971. 1/

Species	1970		1971	
	CAN	USSR	CAN	USSR
Cod	7.73	2.15	2.29	33.12
Haddock	15.13	14.15	1.50	2.59
Silver hake	0.84	0.71	+	12.00
White hake	0.94	0.54	1.68	0.21
Redfish	8.04	18.95	25.34	0.90
Plaice	28.57	19.38	18.41	51.73
Witch	2.82	4.09	1.47	4.15
Yellowtail flounder	23.26	22.55	19.18	75.14
Thorny skate	30.60	52.91	19.60	53.20
Squid	0.16	1.12	0.50	1.05
Other Species	23.45	7.80	7.87	63.55
All species combined	141.54	144.35	97.84	297.64

1/ Includes only strata 47-52

Table 4. -- Minimum estimates of biomass (metric tons) of selected species, and all species combined, based on coordinated trawl surveys on Nova Scotian shelf in 1970.

Species	Division 4X			Division 4W		Banquereau	
	CAN	USA	USSR	CAN	USSR	CAN	USSR
Cod	38,000	5,900	2,400	23,800	4,900	3,100	700
Haddock	21,000	8,200	5,700	18,200	7,600	6,100	4,800
Silver hake	4,800	2,500	1,800	17,400	5,900	300	200
White hake	4,700	2,000	200	11,900	800	400	200
Redfish	12,800	31,200	25,000	99,600	11,500	3,300	6,400
Plaice	5,300	1,400	200	10,000	9,500	11,600	6,600
Witch	1,500	800	300	1,600	7 200	1,100	1,400
Yellowtail flounder	300	800	100	12,400	5,100	9,400	7,700
Thorny skate	1,100	3,100	200	7,500	7,200	12,400	18,000
Squid	400	400	400	1,100	4,600	100	400
Other species	18,700	6,400	5,700	41,200	14,700	9,600	2,600
All species combined	108,600	62,600	42,000	244,700	79,200	57,400	49,100

Table 5. -- Minimum estimates of biomass (metric tons) of selected species, and all species combined, based on coordinated trawl surveys on Nova Scotian Shelf in 1971.

Species	Division 4X			Division 4W		Banquereau	
	CAN	USA	USSR	CAN	USSR	CAN	USSR
Cod	16,100	6,000	3,200	27,000	17,400	900	11,300
Haddock	36,100	8,400	6,400	15,500	9,200	600	900
Silver hake	3,300	1,600	2,600	3,400	7,900	+	4,100
White hake	2,000	1,100	900	2,600	300	700	100
Redfish	62,000	11,000	25,400	45,700	10,500	10,300	300
Plaice	1,400	1,000	400	9,800	3,300	7,500	17,600
Witch	100	500	400	1,400	1,300	600	1,400
Yellowtail flounder	300	500	100	9,800	5,900	7,800	25,500
Thorny skate	1,400	3,700	900	7,800	2,500	8,000	18,100
Squid	3,800	600	400	8,000	800	200	400
Other species	124,200 1/	10,000	8,300	18,600	25,800	3,000	21,600
All species combined	250,700	44,400	49,000	149,600	84,800	39,600	101,200

1/ includes estimate of 110,000 tons of spiny dogfish

Table 6 Minimum estimates of biomass (metric tons) of selected species and all species combined, for remainder of 4X and 4V not given in tables 4 and 5. Canadian travel surveys only.

Species	Trawl 4X		4V	
	1970	1971	1970	1971
Cod	12,000	7,600	36,000	90,700
Haddock	17,400	13,600	800	100
Silver hake	1,000	1,200	-	-
White hake	48,600	5,400	2,100	1,800
Redfish	6,400	6,900	50,300	61,500
Plaice	1,600	2,000	17,200	30,600
Witch	1,200	900	4,200	5,800
Yellowtail	-	-	300	200
Thorny skate	5,200	1,800	5,800	8,500
Squid	100	1,600	200	1,100
Other species	77,700	46,800	12,800	9,200
All species combined	171,200	87,800	129,700	209,500

1/ Includes strata 82-95 (see figure 1)

2/ Includes strata 40-46 (see figure 1)

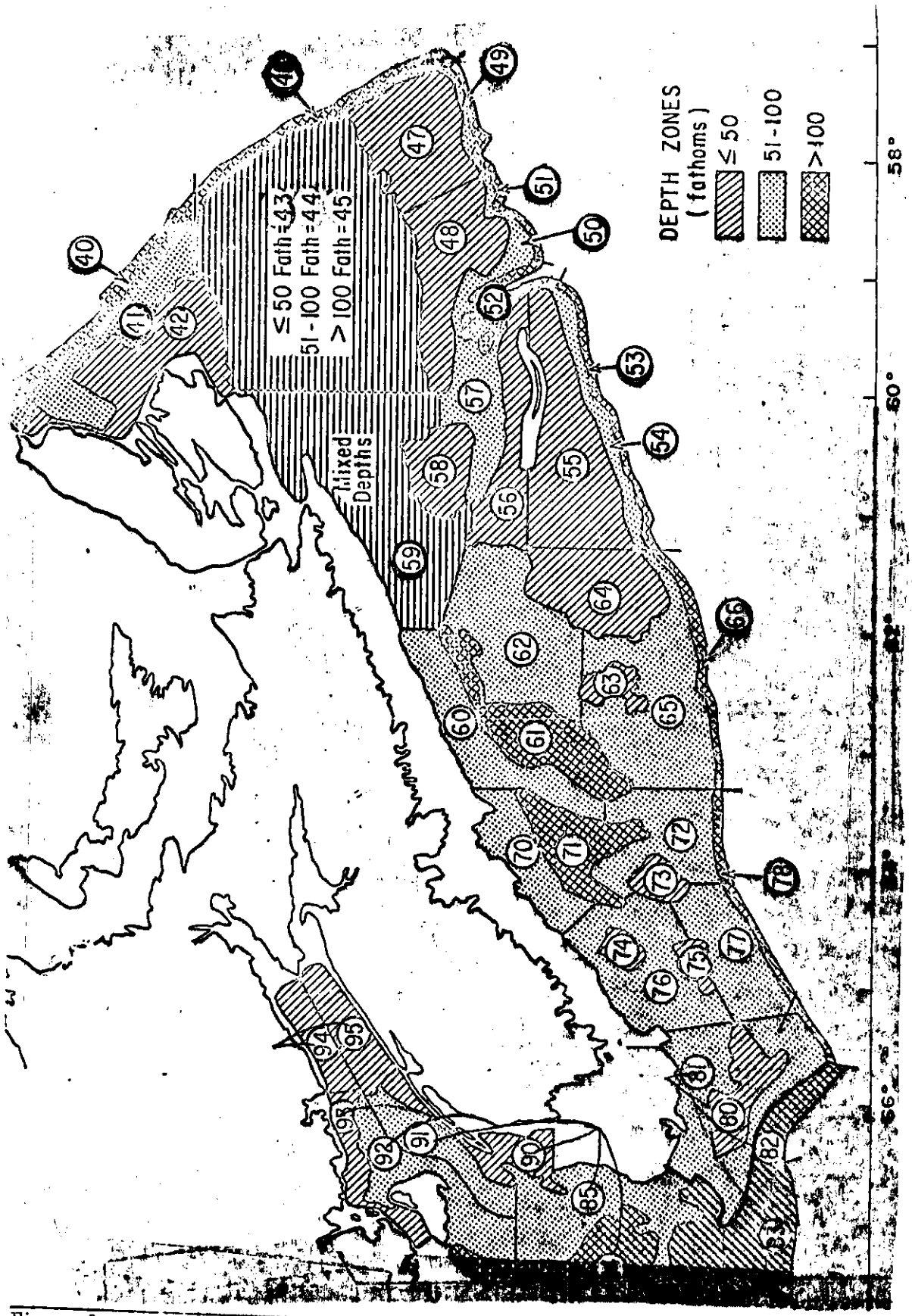

Figure 1. Sampling strata developed for Canadian groundfish surveys in Subarea 4. Strata 47-81 used in USSR surveys, and strata 70-81 used in USA surveys.