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Linear programming simulations of the effects of by-catch on national catches in ICNAF Subarea 5 and Statistical Area 6

by

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Abstract

Linear programming simulations of 1976 expected national catches were made using 1974 by-catch ratios in directed fisheries and 1976 national species quotas. The expected total catch derived from each set of by-catch ratios is about 81% of the sum of the species quotas and 94% of the 1976 Total Allowable Catch for all species combined.

Introduction

The control of fishing mortality by means of individual species catch quotas is very difficult to accomplish whenever a significant proportion of the fishing mortality on any given species is generated as a result of the incidental catch or by-catch of that species in fisheries directed toward other species. Since 1973 the catch of all major species in ICNAF Subarea 5 and Statistical Area 6 has been regulated by national quotas, and the estimated by-catch in the major directed fisheries has been large. Under these circumstances, attempting to catch the entire quota of a given species by means of a directed fishery for that species may cause the total catch to exceed the allowable catch because of the by-catch of that species in the other fisheries.

The present paper simulates 1976 catches with 1974 by-catch ratios. Linear programming techniques are used to determine a country's directed catch for each species, such that its total catch for each species does not exceed its national species quotas. A comparison between the total of estimated species' catches with the total quota for all species combined reflects the expected performance of 1976 controls in regulating catch.

Methods and Materials

Data base

Nominal landings and effort for designated main species (or species group) sought categories are submitted annually by almost all countries fishing in Subarea 5 and Statistical Area 6. These data are published in Table 5 of the ICNAF Statistical Bulletin; 1974 data were the bases from which the proportions of by-catch and directed catch were estimated. The nominal catches do not include fish caught and discarded at sea.

The nominal catch and effort (days fished) for finfish only were summarized over months for each of the "main species sought" categories reported in Tables 4 and 5 of the 1974 ICNAF Statistical Bulletin. Catches made with fixed gears as well as catches of menhaden, halibut, and large pelagic fishes, i.e., tuna, billfish, and sharks (other than dogfish), were excluded. In instances where no "main species sought" category was indicated or where landings were attributed to a mixed fishery, the monthly landings were assigned to "species sought" categories according to the species which formed a simple plurality of the catch. The term "fishery" as used in this paper refers to the vessels and associated catch on these "main species sought" categories. The term "species" refers to both individual species and species groups. All reported landings were thus identified by two factors: species and fisheries. Such tabulations were prepared for all nations except Cuba for which data were not available.

The national restraints (TACs) needed for each species and country to simulate the 1976 fishery were derived from several different sources. The proposed 1976 national quota allocations for Member Countries in Subarea 5 and Statistical Area 6 (ICNAF Meeting Proceedings 1975) was the main basis. For some species and countries,there was not allocated a specific quota. In these cases individual country quotas were proportioned from the "Others" allocation category for each individual species. This proportion was the ratio of the 1974 nominal catch of the species by each country to the total catch of that species by all countries in the "Others" group. The procedure for countries for which there was a quota for a particular species but no directed fishery for that species is outlined in Analytical Methods. The quota for "other groundfish" and "other pelagic" was proportioned from the "other fish" TAC for each country. The quotas for "American plaice and witch" were proportioned from the "other flounder" TAC for each individual country. Each country's national quota allocation for "pollock" was set by ICNAF for Div. 4VWX plus Subarea 5. This simulation is based on setting each country's pollock quota for Subarea 5 and Statistical Area 6 as a percentage of the 1976 national quota allocations for pollock. The percentage for Subarea 5 was determined by the percent of the nominal "pollock" catches in Div. 4VWX and Subarea 5 taken in Subarea 5 in 1974 (33%).

In this paper, the catch limitations described above will all be referred to as "quotas."

Analytical methods

Within each fishery the 1974 catch of each species was expressed as a proportion, r, of the catch of the main species sought (Appendix Tables 2-14). This computation showed the by-catch as a proportion of the main species sought catch in a given fishery. For purposes of comparison, by-catch ratios for 1972 and 1973 are also given. For countries for which there was a quota for a particular species but no directed fishery for that species the by-catch ratios were taken from 1973 data if there was no data available in 1973 the by-catch ratios were taken from calculations made on all countries' data combined for 1974 (Appendix Table 1). Exceptions to this procedure were made in assigning Canada the by-catch ratios of a directed USSR mackerel fishery to cover Canada's mackerel quota and in assigning Cuba the 1974 by-catch ratios of USSR. The 1974 CH ratios (r) and the quota restraints were then used to simulate the 1976 fishery of each country using linear programming techniques outlined in Brown *et al*. (1975) and Brown *et al*. (1973).

Results and Discussion

The results of each country's simulation are given in Appendix Tables 15-28. Table 1 provides a summary of these results. As would be expected, in each case the sum of the species quota allocations exceeded a country's 1976 predicted total catch as determined by the linear programming model. Table 1 lists the percentage that the predicted 1976 total catch was of the sum of species 1976 quotas for each country. For every country except FRG and Canada there was an increase in this percentage over the analogous percentage calculated using 1973 by-catch ratios and 1975 quota constraints. For FRG, the percent dropped from .98 to .77 and for Canada, from .45 to .43. For the totals of all countries, the percent calculated for 1974 by-catch ratios was .81, while that from the analysis using 1973 by-catch data was .60. Table 2 lists the species for which the quota was a limiting factor to a country's catching its 1976 quota rather than by-catch.

The 1976 quota allocations of herring seem to be the most limiting factors, with mackerel and haddock next.

The sum of the linear programming estimates for species using 1974 data are presented in Table 3. For 69% of the species the ratio of the sum of the 1976 catches predicted by the linear programming to the species TAC was greater than 0.8, but less than 1.0, with an overall average of 82%. This latter figure represents a substantial improvement over the 55% figure using 1973 data and simulating 1975 catches. For pollock and other fish ratio was less than .50. Table 3 also shows the simulated directed catches as percentage of the total catch for the species. The overall percent is 78%, the same ratio calculated on the predicted 1975 catches (Brown _et al_., 1975).

From Table 1 it is obvious that the overall TAC of 648,500 MT for 1976 cannot be attained without exceeding certain species TACs unless by-catch is reduced from 1974 to 1976. The expected catches of 661,684 MT is 81% of the 1976 sum of the species TACs. On a country basis, and using the results derived from the 1974 by-catches, it can be seen that the country total TACs were set for 1976 at approximately appropriate levels for USSR, Spain, Romania, Bulgaria, and the USA; too low for Poland, GDR, Japan; and too high for the other countries. In fact, summing the national total TACs rather than the linear program estimates of country catch, when the former are limiting, to obtain an overall estimated catch, results in an expected total catch of 608,800 MT, 94% of the overall TAC, a considerable improvement over the analogous 66% figure on predicted 1975 catches (Brown _et al_., 1975).

Table 1. 1974 Nominal catches, sum of 1976 species TACs, 1976 total TAC, 1976 catch predicted from simulation, ratio of predicted 1976 catch/sum of 1976 species TACs and ratio of predicted 1975 catch/sum of 1975 species TACs by country.

Country	1974 catch (000's tons)	Sum of 1976 species TACs	1976 total TAC	Predicted 1976 catch	(Predicted 1976 catch)/(Sum of 1976 species TACs)	(Predicted 1975 catch/(Sum of 1975 species TACs)[1]
Bulgaria	29.5	30.7	14.4	15.8	.51	.19
Canada	10.9	27.7	18.0	11.8	.43	.45
Cuba		15.3	21.0	2.6	.17	-
France	3.8	1.3	3.0	1.3	.98	.89
FRG	26.8	12.4	14.9	9.6	.77	.98
GDR	95.5	63.3	48.6	61.1	.97	.40
Italy	4.7	6.0	6.8	4.7	.79	-
Japan	25.8	28.4	18.0	26.8	.94	.65
Poland	152.9	106.2	76.5	103.1	.97	.95
Romania	9.9	10.9	3.9	4.8	.44	.07
Spain	24.2	21.9	16.0	17.0	.78	.71
UK	.7	.3	-	<.1	.15	-
USSR	351.4	257.8	171.4	171.4	.66	.27
USA	252.5	231.6	230.0	231.7	1.00	.86
Total	988.6	813.9	648.4	661.7	.81	.60

[1]From Brown et al. (1975), Table 1A.

Table 2. Species for which country could catch entire quota - i.e. no by-catch restrictions.

Country	Species
Bulgaria	Silver hake
Canada	Silver hake, witch, yellowtail flounder, other flounders, herring, mackerel, other fish
FRG	Herring
Italy	Squid
Romania	Herring, mackerel
Spain	Haddock, squid
UK	Haddock
USSR	Haddock, witch, other flounders, other groundfish, herring, mackerel, other pelagic.

Table 3. Sum of individual country's linear programming simulation of 1976 catches, maximizing total catch ('000 tons).

Species sought	Total allowable catch constraint (TAC)	Directed catch	Predicted total catch in 1976	Predicted total catch/TAC in 1976	Directed catch/ Total catch
Cod	43.0	25.0	33.3	.77	.75
Haddock	6.0	2.4	5.2	.87	.46
Redfish	17.0	12.4	13.8	.81	.90
Silver hake	103.0	37.8	56.4	.55	.67
Red hake	42.0	23.0	29.0	.69	.79
*Pollock	18.3	1.4	4.7	.26	.30
American plaice	1.8	0.4	1.8	1.00	.22
Witch	1.7	0.5	1.7	1.00	.29
Yellowtail	20.0	14.6	20.0	1.00	.73
Other flounder	16.5	7.8	16.4	.99	.48
Other groundfish	23.9	8.0	23.6	.99	.34
Herring	67.0	50.3	65.4	.98	.77
Mackerel	254.0	231.7	242.4	.95	.96
Other pelagic	57.1	41.4	54.5	.95	.76
Other fish	69.0	14.3	30.4	.44	.47
Squid	74.0	47.6	63.2	.85	.75
Total	814.3	518.6	661.8	.81	.78

*Pollock 1/3 of 4VWX + 5 quota.

Appendix Table 1. By-catch ratios by "main species sought" category for catches of all countries, 1972-1974.

All Countries Combined		Species Caught															
		COD	HAD	RED	SH	RH	POL	AP	WIT	YEL	OFLA	OGR	HER	MAC	OPEL	OF	INV
Main Species Sought																	
Cod	1972	1.000	.128	.004	.001	0	.043	.006	.003	.014	.044	.059	0	0	0	.012	0
	1973	1.000	.088	.009	.001	0	.081	.006	.002	.021	.051	.049	0	0	0	0	0
	1974	1.000	.079	.008	.001	.003	.080	.007	.002	.027	.072	.044	.002	.001	0	.005	0
Haddock	1972	.371	1.000	.013	.002	0	.106	.011	.003	.050	.050	.065	0	.002	0	0	0
	1973	.486	1.000	.003	0	0	.114	.010	.004	.018	.016	.046	0	0	0	0	.001
	1974	.135	1.000	.006	.006	0	.090	.007	.001	.009	.012	.017	0	0	0	0	0
Redfish	1972	.029	.008	1.000	.004	.009	.027	.003	.004	0	.001	.026	0	.050	0	.066	0
	1973	.039	.006	1.000	.001	0	.066	.005	.007	0	0	.046	0	0	0	0	.001
	1974	.041	.011	1.000	.002	0	.060	.004	.005	0	.001	.047	0	0	0	0	0
Silver hake	1972	.010	.001	.003	1.000	.380	.014	.005	.020	.036	.029	.075	.098	.326	.001	.242	.077
	1973	.012	.001	.031	1.000	.207	.004	.001	.002	.002	.006	.062	.062	.262	.006	.164	.067
	1974	.007	.001	.011	1.000	.085	.001	.001	.002	.006	.007	.021	.022	.237	.007	.121	.033
Red hake	1972	.029	0	.001	.577	1.000	.002	.004	.029	.062	.034	.128	.224	.124	.004	.298	.016
	1973	.020	0	.018	.399	1.000	.009	.003	.004	.016	.018	.131	.111	.222	.008	.113	.035
	1974	.007	0	.029	.187	1.000	0	.001	.002	.007	.009	.026	.092	.030	.032	.063	.090
Pollock	1972	.046	.019	.016	.005	0	1.000	0	0	0	0	.003	0	0	0	0	0
	1973	.087	.027	.024	.022	.004	1.000	.003	.011	.004	.002	.084	.010	.002	0	.001	.002
	1974	.161	.067	.022	.005	.011	1.000	.005	.003	.002	.004	.051	0	0	.002	.010	.044
American Plaice	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	.281	.024	0	.005	.005	.014	1.000	.162	.072	.005	.048	0	0	0	0	0
Witch	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	.146	.014	.005	.005	0	.014	.099	1.000	.080	.005	.090	0	0	0	0	.005
Yellowtail	1972	.063	.016	0	.001	0	.001	.017	.026	1.000	.054	.003	0	0	.001	0	.004
	1973	.091	.014	.001	.001	0	.001	.010	.020	1.000	.053	.004	0	0	.001	0	.003
	1974	.101	.015	0	.001	0	.003	.014	.022	1.000	.058	.004	0	0	0	0	.004
Other flatfishes	1972	.451	.113	.003	.013	.002	.013	.130	.266	.468	1.000	.066	0	0	.001	.004	.012
	1973	.493	.074	.003	.013	.003	.014	.125	.231	.423	1.000	.072	0	0	.003	.005	.019
	1974	.266	.036	0	.054	.005	.007	.060	.051	.296	1.000	.170	.001	.002	.059	.089	.112
Other groundfish	1972	.368	.179	.068	.100	.081	.318	.021	.034	.105	.087	1.000	.014	.093	.032	.240	.068
	1973	.381	.116	.055	.226	.086	.276	.016	.029	.064	.134	1.000	.036	.017	.018	.063	.037
	1974	.307	.076	.056	.143	.046	.143	.033	.024	.066	.117	1.000	.028	.017	.017	.152	.045
Herring	1972	.001	0	.001	.007	.002	.001	0	0	0	0	.002	1.000	.084	.003	.018	.002
	1973	.002	0	.001	.011	.008	0	0	0	0	0	.008	1.000	.077	.010	.080	.007
	1974	.002	0	0	.004	.021	0	0	0	0	0	.001	1.000	.043	.007	.018	.011
Mackerel	1972	.001	0	.006	.061	.025	.001	0	.001	.003	.001	.012	.102	1.000	.005	.126	.010
	1973	.004	.002	.006	.055	.033	.006	.001	.001	0	.002	.023	.137	1.000	.006	.048	.016
	1974	.001	0	0	.042	.005	0	0	0	0	0	.009	.051	1.000	.021	.033	.020
Other pelagic	1972	.002	0	0	.002	.003	0	0	0	.013	.009	.028	0	.001	1.000	.047	.603
	1973	0	0	0	.031	.039	0	0	0	0	.003	.004	.007	.031	1.000	.060	.282
	1974	.001	0	0	.003	.001	0	0	0	.002	.012	.052	.405	.007	1.000	.046	.049
Other fish	1972	.006	0	.001	.029	.019	0	0	0	.080	.084	.076	.030	.090	.043	1.000	.196
	1973	.011	0	.001	.123	.038	.009	.002	.002	.082	.171	.173	.015	.039	.021	1.000	.229
	1974	.004	.001	.003	.037	.064	0	0	0	.003	.079	.070	.031	.020	.125	1.000	.173
Squid	1972	0	0	0	0	0	0	0	0	0	0	.001	0	.052	0	.004	1.000
	1973	0	0	0	0	0	0	0	0	0	.002	.040	0	.031	.007	.018	1.000
	1974	0	0	0	.002	0	0	0	0	0	.003	.020	0	.016	.043	.003	1.000
Invertebrates	1972	.001	0	0	.005	.016	0	0	0	0	0	.016	.006	.094	.076	.068	1.000
	1973	0	0	0	.013	0	0	0	0	0	.012	.012	.013	.043	.096	.055	1.000
	1974	0	0	0	.001	.001	0	0	0	0	.001	.003	.001	.004	.285	.013	1.000

Appendix Table 2. By-catch ratios by "main species sought" category for 1972-1974 catches of Canada.

Canada		SPECIES CAUGHT															
		COD	HAD	RED	SH	RH	POL	AP	WIT	YEL	OFLA	OGR	HER	MAC	OPEL	OF	INV
Main Species Sought																	
Cod	1972	1.000	.130	.000	.000	.000	.067	.008	.000	.001	.020	.208	.000	.000	.000	.000	.000
	1973	1.000	.214	.009	.000	.000	.081	.003	.002	.004	.011	.125	.000	.000	.000	.000	.000
	1974	1.000	.124	.003	.000	.000	.083	.003	.000	.000	.025	.248	.000	.000	.000	.000	.000
Haddock	1972	.599	1.000	.020	.000	.000	.289	.007	.000	.000	.007	.099	.000	.007	.000	.000	.000
	1973	.549	1.000	.002	.000	.000	.126	.015	.004	.001	.004	.059	.000	.000	.000	.000	.000
	1974	.275	1.000	.007	.000	.000	.203	.007	.000	.007	.014	.065	.000	.000	.000	.000	.000
Redfish	1972	.081	.054	1.000	.000	.000	.189	.000	.000	.000	.000	.081	.000	.000	.000	.000	.000
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	.259	.111	1.000	.000	.000	.370	.000	.037	.000	.000	.259	.000	.000	.000	.000	.000
Pollock	1972	.185	.100	.068	.000	.000	1.000	.003	.001	.001	.001	.018	.000	.000	.000	.000	.000
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	.103	.105	.007	.000	.000	1.000	.002	.002	.001	.004	.027	.000	.000	.000	.000	.000
Witch	1972	.250	.000	.333	.000	.000	.000	.000	1.000	.000	.167	.000	.000	.000	.000	.000	.667
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other groundfish	1972	.512	.225	.000	.000	.000	.000	.000	.000	.000	.007	1.000	.000	.000	.000	.000	.000
	1973	1.087	.700	.027	.000	.000	3.472	.012	.005	.000	.019	1.000	.000	.000	.000	.000	.000
	1974	.466	.100	.000	.000	.000	.000	.000	.000	.000	.018	1.000	.000	.000	.000	.000	.000
Herring	1972	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.000	.000	.000	.000
	1973	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.006	.000	.000	.000
	1974	.000	.000	.001	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.000	.000	.000	.000
Other pelagic	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.000	.000
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Squid	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.000

Appendix Table 3. By-catch ratios by "main species sought" category for 1972-1974 catches of France.

France		SPECIES CAUGHT														
		COD	HAD	RED	SH	RH	POL	AP	YEL	OFLA	OGR	HER	MAC	OPEL	OF	INV
Main Species Sought																
Cod	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	1.000	0	0	0	0	0	0	0	0	0	0	0	0	.045	0
Herring	1972	0	0	0	0	0	0	0	0	0	0	1.000	0	0	0	0
	1973	0	0	0	0	0	0	0	0	0	0	1.000	0	0	0	0
	1974	0	0	0	0	0	.002	0	0	0	0	1.000	0	0	.003	0
Squid	1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.000
	1973	0	0	0	0	0	0	0	0	0	.023	0	0	0	0	1.000
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix Table 4. By-catch ratios by "main species sought" category for 1972-1974 catches of Bulgaria.

Bulgaria		SPECIES CAUGHT															
		COD	HAD	RED	SH	RH	POL	AP	WIT	YEL	OFLA	OGR	HER	MAC	OPEL	OF	INV
Main Species Sought																	
Silver hake	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	.000	.000	.000	1.000	.091	.000	.000	.000	.000	.000	.000	.280	.039	.077	.031	.037
Herring	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	.006	.000	.064	.060	.050	.000	.000	.000	.010	.000	.000	1.000	.243	.049	.000	.000
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mackerel	1972	.003	.000	.001	.150	.064	.000	.000	.000	.024	.000	.004	.100	1.000	.008	.313	.021
	1973	.001	.000	.000	.048	.011	.000	.000	.000	.003	.000	.007	.039	1.000	.007	.026	.013
	1974	.000	.000	.000	.050	.016	.000	.000	.000	.000	.000	.018	.065	1.000	.106	.035	.026

Appendix Table 5. By-catch ratios by "main species sought" category for 1972-1974 catches of FRG.

Federal Republic of Germany		SPECIES CAUGHT															
		COD	HAD	RED	SH	RH	POL	AP	WIT	YEL	OFLA	OGR	HER	MAC	OPEL	OF	INV
Main Species Sought																	
Pollock	1972	.024	0	0	.079	0	1.000	0	0	0	0	0	0	0	0	0	0
	1973	.005	0	0	.027	0	1.000	0	0	0	0	.065	0	0	0	0	0
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other groundfish	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	0	0	0	0	0	0	0	0	0	0	1.000	0	.083	0	0	0
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Herring	1972	0	0	0	.011	0	.003	0	0	0	0	0	1.000	.016	.001	.002	0
	1973	0	0	0	0	0	0	0	0	0	0	0	1.000	.010	.008	.010	0
	1974	0	0	0	.002	0	.001	0	0	0	0	0	1.000	.018	.001	.001	0
Mackerel	1972	0	0	0	0	0	0	0	0	0	0	0	.117	1.000	0	.238	0
	1973	0	0	0	0	0	0	0	0	0	0	0	0	1.000	.094	0	.080
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Squid	1972	0	0	0	0	0	0	0	0	0	0	0	0	.028	0	.056	1.000
	1973	0	0	0	.001	0	0	0	.001	0	0	.463	0	.178	.084	.005	1.000
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix Table 6. By-catch ratios by "main species sought" category for 1972-1974 catches of Italy.

Italy		SPECIES CAUGHT															
		COD	HAD	RED	SH	RH	POL	AP	WIT	YEL	OFLA	OGR	HER	MAC	OPEL	OF	INV
Main Species Sought																	
Squid	1972	0	0	0	0	0	0	0	0	0	0	0	0	.250	0	0	0
	1973	0	0	0	0	0	0	0	0	0	0	0	0	.118	0	.118	0
	1974	0	0	0	0	0	0	0	0	0	0	0	0	.099	0	0	0

Appendix Table 7. By-catch ratios by "main species sought" category for 1972-1974 catches of GDR.

German Democratic Republic		SPECIES CAUGHT															
Main Species Sought		COD	HAD	RED	SH	RH	POL	AP	WIT	YEL	OFLA	OGR	HER	MAC	OPEL	OF	INV
Cod	1972	1.000	0	0	0	0	0	0	0	0	0	0	.400	.200	0	.200	0
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	1.000	0	0	0	0	0	0	0	0	0	0	0	.500	0	.125	0
Pollock	1972	.014	0	.002	0	0	1.000	0	0	0	0	0	0	0	0	.001	0
	1973	.004	0	.005	0	0	1.000	0	0	0	0	0	.420	.009	0	0	0
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Herring	1972	.001	0	.002	.004	0	0	0	0	0	0	0	1.000	.056	0	.018	0
	1973	.001	0	.001	.003	0	.001	0	0	0	0	0	1.000	.008	0	.211	.005
	1974	0	0	.001	0	0	0	0	0	0	0	0	1.000	.002	0	.008	0
Mackerel	1972	0	0	0	0	.001	0	0	0	0	0	.004	.037	1.000	0	.018	0
	1973	0	0	0	.001	0	0	0	0	0	0	0	.031	1.000	.003	.010	0
	1974	0	0	0	.001	0	0	0	0	0	0	0	.040	1.000	.001	.012	0
Other pelagic	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	0	0	0	0	0	0	0	0	0	0	0	.444	0	1.000	0	0
Other fish	1972	.008	0	0	.013	0	0	0	0	0	0	0	.308	.422	.007	1.000	0
	1973	.011	0	0	.006	0	.006	0	0	0	0	.001	.204	.225	.006	1.000	0
	1974	.015	0	0	0	0	0	0	0	0	0	0	.236	.051	0	1.000	0

Appendix Table 8. By-catch ratios by "main species sought" category for 1972-1974 catches of Japan.

Japan		SPECIES CAUGHT															
Main Species Sought		COD	HAD	RED	SH	RH	POL	AP	WIT	YEL	OFLA	OGR	HER	MAC	OPEL	OF	INV
Red hake	1972	0	0	0	0	1.000	0	0	0	0	0	.037	0	0	.222	0	.074
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other groundfish	1972	0	0	0	.015	.027	0	0	0	0	.002	1.000	.002	.345	.034	.439	.488
	1973	0	0	0	0	0	0	0	0	0	.044	1.000	0	0	0	0	.007
	1974	0	0	0	0	0	0	0	0	0	0	1.000	0	0	1.000	0	.091
Herring	1972	.080	0	.013	.001	.118	0	0	0	.002	0	.054	1.000	.028	.075	.105	.022
	1973	0	0	.015	.011	0	0	0	0	0	.001	0	1.000	0	.057	.038	.012
	1974	0	0	0	0	0	0	0	0	0	0	.005	1.000	0	0	0	.005
Mackerel	1972	0	0	0	.070	0	0	0	0	0	0	.130	0	1.000	.151	.022	.827
	1973	0	0	0	0	0	.813	0	0	0	0	0	0	1.000	.813	.062	.875
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other pelagic	1972	0	0	0	0	0	0	0	0	0	0	0	0	0	1.000	.003	.831
	1973	0	0	.015	.020	0	0	0	0	0	.003	.003	.007	.017	1.000	.055	.334
	1974	0	0	0	.001	0	0	0	0	0	0	.015	0	.002	1.000	0	.188
Other fish	1972	.023	0	0	.008	.047	0	0	0	0	0	.203	0	.133	.407	1.000	.250
	1973	.005	0	0	.012	0	0	0	0	0	0	.002	.025	0	.062	1.000	.447
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Squid	1972	0	0	0	.010	.032	0	0	0	0	.001	.029	0	.034	.157	.049	1.000
	1973	0	0	0	.020	0	0	0	0	0	.002	.008	.001	.023	.215	.071	1.000
	1974	0	0	0	.004	0	0	0	0	0	.003	.040	0	0	.116	0	1.000
Inv	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	0	0	0	.013	0	0	0	0	0	.010	.069	0	.015	.183	0	1.000

Appendix Table 9. By-catch ratios by "main species sought" category for 1972-1974 catches of Poland.

Poland		SPECIES CAUGHT															
		COD	HAD	RED	SH	RH	POL	AP	WIT	YEL	OFLA	OGR	HER	MAC	OPEL	OF	INV
Main Species Sought																	
Cod	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	1.000	.000	.021	.000	.000	.000	.000	.000	.000	.000	.000	.333	.073	.000	.042	.000
Red hake	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	0	0	0	0	1.000	.031	0	0	0	0	0	.047	0	.172	.031	0
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pollock	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	0	0	0	0	0	1.000	0	0	0	0	0	0	0	0	.250	0
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Herring	1972	.004	0	0	0	0	0	0	0	0	0	0	1.000	.241	0	.048	.009
	1973	.004	0	0	0	0	0	0	0	0	0	.012	1.000	.258	.034	.039	.024
	1974	.007	0	0	0	0	0	0	0	0	0	0	1.000	.145	.028	.051	.020
Mackerel	1972	.001	0	0	0	0	0	0	0	0	0	.005	.149	1.000	0	.051	.011
	1973	.003	0	0	.001	0	0	0	0	0	0	.012	.075	1.000	.006	.056	.027
	1974	.003	0	0	.002	0	0	0	0	0	0	.008	.072	1.000	.030	.043	.044
Other pelagic	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	0	0	0	0	.142	.025	0	0	0	0	.039	.025	.352	1.000	.167	0
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other fish	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	0	0	0	.092	.167	0	0	0	0	0	.017	.033	.317	.125	1.000	0
	1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.000	0
Invertebrates	1972	.005	0	0	0	.003	0	0	0	0	0	.004	.058	.754	.001	.155	1.000
	1973	0	0	0	.034	0	0	0	0	0	0	.057	.080	.231	.144	.197	1.000
	1974	0	0	0	0	0	0	0	0	0	0	0	.120	.816	0	.001	1.000

Appendix Table 10. By-catch ratios by "main species sought" category for 1972-1974 catches of Spain.

Spain		SPECIES CAUGHT															
		COD	HAD	RED	SH	RH	POL	AP	WIT	YEL	OFLA	OGR	HER	MAC	OPEL	OF	INV
Main Species Sought																	
Cod	1972	1.000	.164	0	0	0	.012	0	0	0	0	.003	0	0	0	.029	0
	1973	1.000	.065	0	0	.001	.134	0	0	0	0	0	0	0	0	0	0
	1974	1.000	.120	0	0	.009	.104	0	0	0	0	0	0	0	0	.013	0
Squid	1972	0	0	0	0	0	0	0	0	0	0	.001	0	.001	0	.003	1.000
	1973	0	0	0	0	0	0	0	0	0	0	.003	0	0	0	0	1.000
	1974	0	0	0	0	0	0	0	0	0	.002	.002	0	0	0	.006	1.000

Appendix Table 11. By-catch ratios by "main species sought" category for 1972-1974 catches of Romania.

Romania		SPECIES CAUGHT															
		COD	HAD	RED	SH	RH	POL	AP	WIT	YEL	OFLA	OGR	HER	MAC	OPEL	OF	INV
Main Species Sought																	
Herring	1972	0	.007	.007	.020	0	0	0	0	.016	0	0	1.000	.223	.035	0	0
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	.001	0	0	.146	.115	0	0	0	0	0	0	1.000	.387	0	.008	.002
Mackerel	1972	0	0	0	.062	.021	0	0	0	.020	0	.033	.049	1.000	.054	.017	.032
	1973	0	0	0	.008	0	0	0	0	0	0	.064	.051	1.000	.058	.010	.026
	1974	0	0	0	.027	.012	0	0	0	0	0	.001	.146	1.000	0	.053	.001

Appendix Table 12. By-catch ratios by "main species sought" category for 1972-1974 catches of United Kingdom.

United Kingdom		SPECIES CAUGHT															
		COD	HAD	RED	SH	RH	POL	AP	WIT	YEL	OFLA	OGR	HER	MAC	OPEL	OF	INV
Main Species Sought																	
Haddock	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	.076	1.000	0	0	0	.083	.004	0	0	0	.011	0	0	0	0	0

Appendix Table 13. By-catch ratios by "main species sought" category for 1972-1974 catches of USSR.

Union Soviet Socialist Republics		SPECIES CAUGHT															
		COD	HAD	RED	SH	RH	POL	AP	WIT	YEL	OFLA	OGR	HER	MAC	OPEL	OF	INV
Main Species Sought																	
Redfish	1972	.016	0	1.000	.016	.039	.002	0	0	0	0	0	.001	.211	0	.279	0
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver hake	1972	.006	.001	.002	1.000	.418	.013	.004	.021	.039	.026	.077	.108	.364	.001	.260	.081
	1973	.005	.001	.034	1.000	.236	.003	.001	.001	.002	.004	.062	.069	.303	.006	.188	.073
	1974	.003	0	.012	1.000	.085	0	0	.002	.001	.001	.013	.019	.262	.005	.132	.032
Red hake	1972	.029	0	.001	.581	1.000	.002	.004	.029	.057	.030	.120	.227	.126	.003	.296	.016
	1973	.020	0	.019	.410	1.000	.009	.003	.004	.007	.011	.117	.118	.237	.002	.107	.032
	1974	.006	0	.030	.168	1.000	0	.001	.002	.004	.005	.007	.096	.032	.012	.062	.090
Other groundfish	1972	0	0	0	.005	0	0	0	0	.006	0	1.000	.007	.223	.068	.538	.038
	1973	.494	0	0	.571	.101	0	.002	.012	.035	.058	1.000	.164	.148	.036	.031	0
	1974	0	0	.014	.034	.049	0	0	0	0	0	1.000	.174	0	0	.201	.040
Herring	1972	0	0	0	.029	.008	0	0	0	0	0	.004	1.000	.195	0	.041	.004
	1973	.011	0	0	.187	.140	0	.003	.002	.004	.007	.100	1.000	.227	.001	.110	0
	1974	0	0	0	.009	.109	0	0	.001	0	0	.003	1.000	.022	.004	.029	.025
Mackerel	1972	.003	0	.019	.170	.069	.001	0	.002	.003	.002	.029	.090	1.000	.014	.270	.011
	1973	.010	.005	.017	.147	.094	.017	.002	.003	.001	.005	.051	.301	1.000	.003	.082	.017
	1974	0	0	0	.116	.011	0	0	.001	0	0	.014	.026	1.000	.007	.036	.010
Other pelagic	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1973	0	0	0	.092	.299	0	0	0	0	0	0	0	.055	1.000	.061	.001
	1974	0	0	0	0	0	0	0	0	0	0	0	0	0	1.000	0	0
Other fish	1972	.003	0	.001	.047	.011	0	0	.001	0	0	.011	.012	.083	0	1.000	.006
	1973	.068	.003	.010	.147	.245	.126	.024	.026	.006	.056	.675	.099	.250	.020	1.000	.059
	1974	.005	.003	.007	.067	.126	0	0	.002	.003	.002	.062	.038	.035	.001	1.000	.039
Invertebrates	1972	0	0	0	.111	0	0	0	0	0	0	0	0	.074	.111	0	1.000
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1974	.009	.003	0	.225	.205	0	0	0	.002	.001	0	.066	.010	.022	.139	1.000

Appendix Table 14. By-catch ratios by "main species sought" category for 1972-1974 catches of USA.

United States of America		SPECIES CAUGHT															
		COD	HAD	RED	SH	RH	POL	AP	WIT	YEL	OFLA	OGR	HER	MAC	OPEL	OF	
Main Species Sought																	
Cod	1972	1.000	.103	.008	.002	0	.060	.009	.006	.026	.079	.066	0	0	0	.003	
	1973	1.000	.075	.013	.002	0	.052	.009	.004	.035	.088	.056	0	0	0	.001	
	1974	1.000	.059	.012	.002	0	.070	.011	.003	.041	.108	.052	0	0	0	.001	
Haddock	1972	.297	1.000	.011	.002	0	.047	.013	.004	.066	.064	.053	0	0	0	0	
	1973	.343	1.000	.006	0	0	.087	0	.006	.056	.045	.017	0	0	0	0	
	1974	.214	1.000	.022	.027	0	.027	.016	.005	.038	.049	0	0	0	0	0	
Redfish	1972	.033	.010	1.000	.001	0	.034	.004	.006	0	.001	.034	0	0	0	0	
	1973	.039	.006	1.000	.001	0	.066	.005	.007	0	0	.046	0	0	0	0	
	1974	.040	.011	1.000	.002	0	.059	.004	.005	0	.001	.046	0	0	0	0	
Silver hake	1972	.049	.002	.010	1.000	.061	.023	.008	.011	.009	.037	.069	.012	.003	.003	.009	
	1973	.054	.003	.010	1.000	.022	.010	.007	.006	.004	.016	.058	.014	.002	.008	.009	
	1974	.051	.003	.004	1.000	.081	.005	.009	.004	.061	.073	.106	.005	.009	.018	.017	
Red hake	1972	.035	0	0	.355	1.000	.002	0	0	.374	.269	.659	.037	.011	.066	.449	
	1973	.023	0	0	.241	1.000	0	0	0	.148	.132	.357	.011	.001	.096	.216	
	1974	.021	0	0	.496	1.000	0	0	.001	.054	.082	.360	.010	.001	.377	.081	
Pollock	1972	-	-	-	-	-	-	-	-	-							
	1973	.168	.054	.045	.028	.008	1.000	.007	.021	.007	.004	.130	.001	0	0	.001	
	1974	.213	.032	.035	.009	.022	1.000	.008	.005	.003	.003	.073	0	.001	.004	.020	
American plaice	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	1974	.281	.024	0	.005	.005	.014	1.000	.162	.076	.005	.048	0	0	0	0	
Witch	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	1974	.146	.014	.005	.005	0	.014	.099	1.000	.080	.005	.090	0	0	0	0	
Yellowtail	1972	.063	.016	0	.001	0	.001	.017	.026	1.000	.054	.003	0	0	.001	0	
	1973	.091	.014	.001	.001	0	.001	.010	.020	1.000	.053	.004	0	0	.001	0	
	1974	.101	.015	0	.001	0	.003	.014	.022	1.000	.058	.004	0	0	0	0	
Other flatfishes	1972	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	1973	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	1974	.266	.036	0	.054	.005	.007	.060	.051	.296	1.000	.170	.001	.002	.059	.089	
Other groundfish	1972	.585	.285	.113	.162	.181	.531	.035	.056	.173	.145	1.000	.020	.006	.016	.082	
	1973	.344	.108	.063	.197	.088	.188	.019	.033	.070	.148	1.000	.023	.003	.017	.069	
	1974	.313	.078	.060	.152	.048	.153	.036	.026	.070	.124	1.000	.024	.019	.017	.156	
Herring	1972	.002	0	0	.003	0	.001	0	0	0	0	.004	1.000	.004	.009	0	
	1973	.001	0	0	0	0	0	0	0	0	0	0	1.000	.002	.006	0	
	1974	.001	0	0	0	0	0	0	0	0	0	0	1.000	0	0	0	
Mackerel	1972	0	0	0	0	0	0	0	0	0	0	.023	.071	1.000	.136	.025	
	1973	0	0	0	.018	.014	.018	0	0	.004	.016	.148	.059	1.000	.087	.024	
	1974	.009	0	0	.024	0	.012	0	0	0	0	.042	.072	1.000	.096	.090	
Other pelagic	1972	.010	0	0	.010	.013	0	0	0	.045	.033	.103	0	.003	1.000	.161	
	1973	.003	0	0	.125	.003	0	0	0	.003	.006	.030	0	.064	1.000	.107	
	1974	.001	0	0	.003	.001	0	0	0	.002	.013	.056	0	.002	1.000	.044	
Other fish	1972	0	0	0	0	0	0	0	0	0	0	0	0	0	.009	1.000	0
	1973	.010	0	0	0	0	0	0	.010	0	0	0	0	0	.160	1.000	0
	1974	.003	0	0	.007	0	0	0	0	.002	.177	.087	.002	.001	.281	1.000	.347
Squid	1972	0	0	0	0	.001	0	0	0	.001	0	.005	0	.003	.003	.068	1.000
	1973	0	0	0	.001	.001	0	0	0	.006	.012	.009	0	.001	.006	.062	1.000
	1974	0	0	0	0	0	0	0	0	0	.001	.002	0	0	.287	.013	1.000

Appendix Table 15. Linear programming simulation of 1976 Bulgaria catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Silver hake	.6	.0	.6
Red hake	3.0	-	.2
Other groundfish	.4	-	.2
Herring	1.1	-	.8
Mackerel	16.3	12.0	12.0
Other pelagic	2.7	-	1.3
Other fish	.9	-	.4
Squid	5.6	-	.3
Total	30.7		15.8

Appendix Table 16. Linear programming simulation of 1976 Canada catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Cod	4.7	1.4	1.9
Haddock	1.2	.1	.4
Redfish	1.5	.0	.0
Silver hake	.0	-	.0
Pollock	11.2	.5	.6
American plaice	.0	-	.0
Witch	.0	-	.0
Yellowtail	.0	-	.0
Other flounder	.0	-	.0
Other groundfish	1.3	.9	1.3
Herring	3.2	3.2	3.2
Mackerel	4.4	4.4	4.4
Other fish	.0	-	.0
Squid	.2	.0	.0
Total	27.7		11.8

Appendix Table 17. Linear programming simulation of 1976 Cuba catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Cod	.4	-	.0
Silver hake	.3	.0	.3
Red hake	2.7	-	.0
Pollock	.4	-	.0
Herring	.5	-	.1
Mackerel	7.0	2.1	2.1
Other fish	3.0	-	.1
Squid	1.0	.0	.0
Total	15.3		2.6

Appendix Table 18. Linear programming simulation of 1976 France catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Cod	.2	.2	.2
Pollock	.0	-	.0
Herring	1.1	1.1	1.1
Other fish	.0	-	.0
Total	1.3		1.3

Appendix Table 19. Linear programming simulation of 1976 FRG catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Cod	.0	-	.0
Redfish	.1	-	.0
Silver hake	.6	-	.0
Pollock	.5	-	.0
Herring	8.9	8.9	8.9
Mackerel	1.2	-	.2
Other pelagic	.1	-	.0
Squid	1.0	.4	.4
Total	12.4		9.5

Appendix Table 20. Linear programming simulation of 1976 GDR catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Cod	.3	.2	.3
Redfish	.6	-	.0
Silver hake	.5	-	.0
Pollock	1.2	-	.0
Other groundfish	.0	-	.0
Herring	8.8	6.4	8.8
Mackerel	48.9	48.6	48.9
Other pelagic	.1	.0	.1
Other fish	2.9	2.3	2.9
Total	63.3		61.0

Appendix Table 21. Linear programming simulation of 1976 Italy catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Mackerel	1.7	-	.4
Squid	4.3	4.3	4.3
Total	6.0		4.7

Appendix Table 22. Linear programming simulation of 1976 Japan catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Redfish	.0	-	.0
Silver hake	1.4	-	.1
Other flounder	.1	-	.0
Other groundfish	1.3	.5	1.3
Herring	1.1	1.1	1.1
Mackerel	.3	-	.1
Other pelagic	8.5	6.0	8.5
Squid	15.7	14.5	15.7
Total	28.4		26.8

Appendix Table 23. Linear programming simulation of 1976 Poland catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Cod	.5	.2	.5
Redfish	.0	-	.0
Silver hake	1.9	-	.2
Pollock	.0	-	.0
Other groundfish	.7	-	.6
Herring	8.8	3.0	8.8
Mackerel	78.3	75.1	78.3
Other pelagic	3.6	-	2.3
Other fish	5.7	2.3	5.7
Squid	6.7	3.3	6.7
Total	106.2		103.1

Appendix Table 24. Linear programming simulation of 1976 Romania catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Cod	.0	-	.0
Redfish	.3	-	.0
Silver hake	4.3	-	.2
Red hake	1.3	-	.1
Other groundfish	.0	-	.0
Herring	1.1	.7	1.1
Mackerel	3.2	2.9	3.2
Other fish	.6	-	.2
Squid	.1	-	.0
Total	10.9		4.8

Appendix Table 25. Linear programming simulation of 1976 Spain catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Cod	6.6	2.5	2.5
Haddock	.3	-	.3
Red hake	.4	-	.0
Pollock	.4	-	.3
Other flounder	.1	-	.0
Other groundfish	.0	-	.0
Other fish	.3	-	.1
Squid	13.8	13.8	13.8
Total	21.9		17.0

Appendix Table 26. Linear programming simulation of 1976 UK catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Cod	.2	-	.0
Haddock	.0	.0	.0
Pollock	.1	-	.0
Other groundfish	.0	-	.0
Total	.3		<.1

Appendix Table 27. Linear programming simulation of 1976 USSR catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Cod	2.3	-	.2
Haddock	.0	-	.0
Red fish	1.4	-	.8
Silver hake	66.4	14.6	28.1
Red hake	28.0	18.2	21.7
Pollock	.7	-	.0
American Plaice	.0	-	.0
Witch	.2	-	.2
Yellowtail	.1	-	.1
Other flounder	.1	-	.1
Other groundfish	4.9	3.4	4.9
Herring	11.1	6.1	11.1
Mackerel	88.0	83.4	88.0
Other pelagic	3.2	2.2	3.2
Other fish	41.9	.0	7.3
Squid	9.5	2.7	5.9
Total	257.8		171.6

Appendix Table 28. Linear programming simulation of 1976 USA catches maximizing total catch ('000 tons).

Species	Total allowable catch constraint	Directed catch	Total catch
Cod	27.8	20.5	27.8
Haddock'	4.4	2.2	4.4
Redfish	13.0	12.4	13.0
Silver hake	27.0	23.2	27.0
Red hake	7.0	4.9	7.0
Pollock	3.8	.9	3.8
American Plaice	1.8	.4	1.8
Witch	1.6	.5	1.6
Yellowtail	19.9	14.6	19.9
Other flounder	16.2	7.8	16.2
Other groundfish	15.2	3.2	15.2
Herring	20.4	19.9	20.4
Mackerel	4.7	3.0	4.7
Other pelagic	39.1	33.1	39.1
Other fish	13.7	9.7	13.7
Squid	16.0	8.5	16.0
Total	231.6		231.6