Northwest Atlantic Fisheries Organization

Serial No. N2322 NAFO SCR Doc. 93/127

SCIENTIFIC COUNCIL MEETING - SEPTEMBER 1993

A Canadian Northern Shrimp Selectivity Program 1993

by

D. Balfour

Fish Industry Services Branch, Department of Fisheries and Oceans
Canada

Introduction

Following a number of successful exploratory cruises conducted by the Department of Fisheries and Oceans in the early 70's, it was clear that Atlantic Canada's northern shrimp stocks had the potential for development. The first commercial fishery was conducted off the coast of Labrador in 1978, however, it was not until a decade later that the industry began to mature. With the decline of the northern cod stocks, the northern shrimp fishery has assumed greater economic importance and Canada now has a fleet of high tech factory trawlers. Since 1988, landings have been above 14,500t each year, with the largest catch landed in 1992 (24,199t). This industry now offers direct employment to over 600 people and is estimated to produce 250 additional related full-time equivalent positions. The fleet represents a capital investment of around $200 million. Figure 1 illustrates the shrimp fishing areas of the Northwest Atlantic.

The Department focused on three main objectives for the Northern Shrimp Fishery: optimum sustainable exploitation of the northern shrimp resource; development of a modern offshore fleet and the highest level of Canadian participation, including an increase in Canadian benefits from the fishery with special attention to the needs of native groups. The growth and expansion witnessed in this fishery attests to the success of this fishing sector.

Unfortunately, worldwide revenues in the fishery fell last year in response to the global recession and other market conditions. As a result, the total value of the fishery fell to around $85 million a year from over $100 million a few years ago. Northern shrimp fishermen are feeling the squeeze, and operators are under intense pressure to maximize the value of each tonne of shrimp landed. This has led to increased reports of "high-grading", dumping and non-reporting of catches of small, low-value shrimp, and a predictable move by the Department to eliminate such practices. In 1990 and onwards a number of initiatives by the Government of Canada, e.g. a five year Atlantic Fisheries Adjustment Program (AFAP) have been introduced to assist rebuilding fish stocks and ensure sustainable development of marine resources. The Fishing Industry Services Branch has undertaken a specific joint industry-government approach to the Northern Shrimp Fishery consistent with these initiatives and proactive in terms of conducting experiments and organizing open discussions with operators on responsible harvesting activity.

Gear Selectivity/Technical Interactions Symposium

For the shrimp industry, improved selectivity offers the possibility of the further reduction of unwanted by-catch and increased revenues by increasing the ratio of higher-value larger shrimp in the catch. Although overall by-catch levels of non-target species are relatively low in the northern shrimp fishery, further reductions can mean reduced labour in sorting the catch and improved overall quality. Equally important is the potential to reduce conflict with competing user groups and mitigation of the regulatory burden associated with finfish conservation.

In 1993, the partnership built up between industry and the government in the management of the northern shrimp stock resulted in the completion of three selectivity experiments. These experiments were conducted jointly by the Fishing Industry Services Branch and the industry and the objectives, methods and preliminary results are provided in this progress report. It should be emphasized that the trials were purposely conducted under commercial conditions (i.e. vessels, gear, grounds and time of year) so as to ensure their relevance to commercial fishing and credibility with the industry. This research culminated in the presentation of the preliminary findings at a Northern Shrimp Workshop in July of this year. The open discussion of results and some interpretations in formulating policy put forward there are summarized in this report.

This workshop also provided an opportunity to examine similar work being carried out internationally, specifically in Norway, Russia and the United States. Discussion of these findings and their applicability to current commercial northern shrimp operations were discussed with a focus placed on the alternatives to be investigated in the future to further improve the northern shrimp industry. Such a workshop is of paramount importance since it served, not only to inform, but to consult and actively advance the process of technical innovation and change in the industry.

Northern Shrimp Selectivity Experiments, 1993

The goals of all of three projects was to investigate various ways of increasing the ratio of higher-value large shrimp in the catch and to reduce the unwanted by-catch of juveniles and of other species. The Fish By-Catch Selectivity Experiment was made to test the effectiveness of Nordmore grates with various bar spacings and of codend mesh of various sizes. In the Industrial Shrimp By-Catch Selectivity Experiment, the primary objective was to assess the performance of such selectivity devices as lastridge ropes; shrimp sorting grates; shrimp sorting grates combined with lastridge ropes and shrimp sorting grates and a guiding panel, in the reduction of industrial grade shrimp by-catch. The Mesh Size Selectivity Experiment investigated the effects of increasing the minimum codend mesh size from the currently regulated 40mm. Codends of 3 mesh sizes were each compared with a control codend.

This research focused on the search for practical solutions and the expertise and experience of the shrimp fishers were utilized in the planning and completion of these experiments which were conducted from commercial vessels that participate in the northern shrimp fishery.

Fish By-Catch Selectivity Experiment

This experiment in January to March 1993, conducted aboard the M/V "Newfoundland Otter"

in NAFO subdivisions 2J and 3K tested the effectiveness of (a) The Nordmore Gate, using three different bar spacings (22 mm, 25 mm and 28 mm) in reducing fish by-catch and (b) a 43 mm square mesh codend in reducing the catch of small shrimp.

A total of 216 sets of various tow durations (18 minutes to 5 hours) in water depths varying between 286 to 507 meters were made. The experimental arrangements added into an Angmagssalik 3,600 x 40 mm trawl were fished on an alternating basis, i.e. over a 24 hour period followed by a 24 hour period of fishing with a similar trawl without experimental additions. The results are summarized as follows:

Table 1 **SUMMARY OF EXPERIMENTAL CATCH COMPARISONS**
Between Shrimp Trawl Codend with a Nordmore Grate and a Shrimp Trawl without a Nordmore Grate

	22 mm Nordmore Grate			25 mm Nordmore Grate			28 mm Nordmore Grate		
Catch	With Grate	With out Grate	% C/R	With Grate	With out Grate	% C/R	With Grate	With out Grate	% C/R
Number of Sets	16	16		15	15		9	8	
Duration (Hours)	41.5	33		43.6	34		31.1	25.5	
Shrimp (kg)	43,975	46,289		35,511	49,045		33,087	27,942	
Shrimp (C.P.H.)	1,060	1,403	24.4	814	1,443	43.6	1,064	1,096	2.9
Shrimp size #/kg (average)	120.7	128.6		126.5	116.5		129.9	122.3	
Turbot	409	1,078		310	667		89	266	
Turbot (C.P.H.)	9.9	32.7	69.7	7.1	19.6	63.8	2.9	10.4	72.1
American Plaice (kg)	28	198		45	256		11	62	
American Plaice (C.P.H.)	0.7	6	88.3	1	7.5	86.7	0.4	2.4	83.3
Cod (kg)	27	486		16	785		6	317	
Cod (C.P.H)	0.7	14.7	95.2	0.1	23.1	99.6	0.2	12.4	
Redfish (kg)	291	574		243	1,085		114	511	
Redfish (C.P.H.)	7	17.4	95.2	5.6	31.9	82.4	3.7	20	81.5
Other By-Catch (kg)	250	1,142		246	865		128	572	
Other By-Catch (C.P.H.)	6	34.6	82.7	5.6	25.4	78	4.1	22.4	81.7
Total By-Catch (kg)	1,005	3,478		860	3,658		348	1,728	
% By-Catch is of Total Catch	2.2	7		2.1	6.9		1	5.8	

C/R = Catch Reduction C.P.H. = Catch Per Hour

SUMMARY OF EXPERIMENTAL CATCH COMPARISONS (Continued)

Catch	Between Shrimp Trawl with a 43 mm Square Mesh Codend and a Shrimp Trawl with a 43 mm Diamond Mesh Codend		Between Shrimp Trawl with Retainer Over the 22 mm Nordmore Grate and a Shrimp Trawl		
	Square Mesh Codend	Diamond Mesh Codend	Retainer Over Grate	Diamond Mesh Codend	% C/R
Number of Sets	11	19	12	12	
Duration (Hours)	43.2	54.7	30.8	30.8	
Shrimp (kg)	31,066	77,803	7,182	29,804	
Shrimp (C.P.H.)	719	1,422	233	968	19.4
Shrimp Size #/kg (average)	120.9	129.8	154.9	136.3	
Turbot (kg)	388	1,542	194	71	
Turbot (C.P.H)	9	28.2	6.3	2.3	73.3
American Plaice (kg)	192	347	97	21	
American Plaice (C.P.H.)	4.4	6.3	3.1	0.7	82.2
Cod (kg)	1,058	2,119	970	25	
Cod (C.P.H.)	24.5	38.7	31.5	0.8	97.5
Redfish (kg)	764	1,021	129	55	
Redfish (C.P.H.)	17.7	18.7	4.2	1.8	70
Other By-Catch (kg)	473	697	-	-	
Other By-Catch (C.P.H.)	10.9	12.7	-	-	
Total By-Catch (kg)	2,875	5,726	1,390	172	89
% By-Catch is of Total Catch	8.5	6.9	16	0.5	

C/R = Catch Reduction C.P.H. = Catch Per Hour

Preliminary conclusions can be drawn from these results including:

The Nordmore Grate greatly reduces by-catches of all species especially roundfish.

Catch sorting time was reduced with grate use, but fishing time was also reduced in heavy ice conditions.

The 43 mm square mesh codend catches of shrimp were of a lower count/kg than those of the 43 mm diamond mesh.

Industrial Shrimp By-Catch Selectivity Experiment

This experiment in May 1993, conducted aboard the M/V AQVIC in NAFO subdivision 3K tested the effectiveness of the following devices/arrangements in reducing catches of industrial grade (carapace size $\leq$ 21mm) shrimp by-catches: **a)** lastridge ropes, (2 x 16 mm diameter corkline lastridge ropes attached to the lacing and two extra ropes on both top and lower sections, each with hanging ratio 80% of the overall length of experimental sections) and **b)** shrimp sorting grates (734 mm wide x 1,253 high and bar spacing 11 mm and a guiding funnel) **c)** as (b) without guiding funnel **d)** combination of (a) and (c) together

A total of 51 sets of various tow durations with twin, 45 mm diameter mesh codends, one for the selectivity device and other for control, were made. The results can be summarized as follows:

Table 2: Summary of Experiment Results

Experiment	# of tows	Type	Total Shrimp Catches (kg)	Avg. catch rate kg/hr	% of shrimp weight ≤ 21 mm	% of shrimp weight > 21 mm	# of shrimp/kg
Lastridge ropes only	16	Experimental gear Control gear	9,302 8,923	164 148	20% 26%	80% 74%	126 129
Shrimp sorting grate only	13	Experimental gear Control gear	9,564 12,143	161 202	20% 26%	80% 74%	126 131
Shrimp sorting grate and lastridge rope	15	Experimental gear Control gear	10,950 13,859	208 258	21% 25%	79% 75%	128 133
Shrimp sorting grates and guiding panel	8	Experimental gear Control gear	3,753 4,714	117 148	11% 14%	89% 86%	119 122

Table 3: Distribution of Shrimp Catches as Allocated at the Factory Deck

Experiment	Type	90-110/kg	90-120/kg	120-150/kg	Mixed	Industrial
Lastridge ropes only	Control gear Experimental	4.02 3.87	21.61 22.86	33.15 32.39	3.93 4.7	37.29 36.18
Shrimp sorting grate only	Control gear Experimental gear	4.27 4.5	23.86 26.3	31.32 32.99	5.44 5.12	35.1 31.18
Shrimp sorting grate and lastridge rope	Control gear Experimental gear	5.29 6.66	25.78 26.78	27.32 28.11	4.61 4.29	36.99 34.17
Shrimp sorting grates and guiding panel	Control Experimental gear	5.98 5.44	30.66 31.44	34.58 34.64	6.05 5.86	22.76 22.62

Very preliminary analysis of the data has been completed and the following tentative observations are provided:

Lastridge ropes show some promise in excluding small shrimp. While an inexpensive approach, further tests are needed to examine the effect of rope length and performance in heavy shrimp concentrations.

The sorting grate reduces the percentage of small shrimp (<21 mm) caught about the same amount as the lastridge ropes. However, the total shrimp catch rates were considerably reduced. Fine tuning and research is indicated.

The combination of ropes with grates and also grates with a guiding panel were not very promising solutions during these trials.

Codend Mesh Size Selectivity Experiment

This experiment in May 1993, conducted aboard the M/V "Northern Osprey" in NAFO subdivisions 2J and 3K, tested the shrimp catch implications of codends constructed with nominal mesh sizes of 45, 50 and 55 mm.

A total of 93 tows (including 12 for gear symmetry and checking) were made using twin codends with a 22 mm mesh codend as control and one of each of the experimental codends. Of these, 47 were considered valid comparisons. The experimental fishing plan included rotation of the position of the control codend between port and starboard and the order of use of each experimental codend. A "Nordsea Labrador" 2,036 x 6cm trawl was used together with underwater instrumentation and cameras used for monitoring throughout the trials.

The results and some preliminary analysis obtained can be summarized as follows:

Table 4: Total Catches, Catch Rates and Corresponding Retention Probability/Frequency Analysis

Experiment	# of tows	Total Shrimp Catch (kg)	Average Catch Rate (kg per/hr)	L25	L50	L75	SF	SR
45 mm codend (Experimental)	13	16,230	417	9.9	12.98	16.1	0.289	6.23
22 mm codend (Control)	13	16,467	423					
50 mm codend (Experimental)	14	14,633	350	10.4	12.83	15.3	0.257	4.95
22 mm codend (Control)	14	15,316	366					
55 mm codend (Experimental)	20	20,022	331	12.0	14.4	16.9	0.262	4.91
22 mm codend (Control)	20	20,896	345					

SF = Selection Factor
SR = Selection Range, analysis method Millar and Walsh, 1992

In view of the potential variations in effects arising from diurnal variation in shrimp behaviour and geographic location, the catch results taken from area 6A during daylight hours only have been extracted and presented below:

Table 5: Total Catches, Catch Rates and Corresponding Retention Probability/Frequency Analysis

Experiment	# of tows	Total Shrimp Catch (kg)	Average Catch Rate (kg/hr)	L25	L50	L75	SF	SR
45 mm codend (Experimental)	10	13,663	422	10.3	13.08	15.6	0.289	5.31
22 mm codend (Control)	10	14,197	438					
50 mm codend (Experimental)	3	4,345	470	9.8	13.19	16.6	0.264	6.72
22 mm codend (Control	3	4,380	474					
55 mm codend (Experimental)	6	10,609	595	12.5	14.23	16.0	0.259	3.46
22 mm codend (Control)	6	11,175	627					

Table 6: Percentage Distribution of Catch From Factory Deck Records

Grade Count Range	Japanese (60-100/kg)	Cooked (70-180/kg)	Industrial (150-200/kg)	Discards (200 + /kg)
45 mm codend (Experimental)	24.1	33.0	33.5	9.4
22 mm codend (Control)	22.5	33.6	34.0	9.9
50 mm codend (Experimental)	22.7	40.2	28.9	8.1
22 mm codend (Control)	21.5	34.9	35.0	8.6
55 mm codend (Experimental)	22.8	34.5	35.9	6.8
22 mm codend (Control)	22.9	32.5	36.7	7.8

Preliminary conclusions include:

The main feature of the test results is the lack of observed differences in the catch rates and quite small degree of differences in selectivity between the three mesh sizes tested.

The factory deck distributions of shrimp to each of Japanese, Cooked and Industrial Shrimp classifications, resulting from the use of the 45 mm, 50 mm and 55 mm codends when compared to the control codends were similar. This tends to confirm the results obtained by sampling the catch.

With codends producing very similar results, as was the case here, the economic implications are obvious. Calculated catch value differences for each of the three mesh sizes are insignificant.

Northern Shrimp Selectivity Workshop, St. John's, Nfld., 1993

There was a consensus that the industry should expand its role in selectivity research and development, including sharing the financial burden with government. It was also agreed that selectivity initiatives by all fishing nations should be carefully monitored through existing mechanisms of international cooperation and that there was a related need for data sharing.

Concerning the gear selectivity work described above and recently completed in Canada, and immediate term methods of reducing by-catch of small shrimp and non-target species, particular recommendations arising from the preliminary reports were put forward and include:

Use of the Nordmore grate whenever conditions warrant. It was suggested that the grates should not be regulated for use under all circumstances, but only in areas where the by-catch exceeds acceptable levels (5% for example). It was also suggested that vessels be given the options of installing the grate or moving to a new fishing area whenever by-catch becomes a problem. Although the Nordmore Grate was recognized to be the best technology available for the reduction of by-catches, it is believed that this device can be further improved perhaps through new selection of bar spacings, size and type.

Further research on other selectivity devices (e.g other grates, lastridge ropes, "fish eyes", etc.) should be actively pursued.

On the question of possible use of mesh size/shape changes for selectivity, it is noted that while square mesh holds some potential, any major improvement in selectivity is likely to arise from alternative selectivity devices, rather than from changes to standard (diamond) mesh size.

There was a general consensus that while equipment technology may help in improving selectivity, there was also a need to re-zone the shrimp fishing areas allowing skippers to have freedom to operate in the most appropriate areas. Such a re-zoning process

would add operational flexibility and result in lower catches of less valuable juvenile shrimp and minimize, the already mainly low, by-catches of other commercially valuable species.

Plans for Continuation of Shrimp Selectivity Program

The 1993 Shrimp *Selectivity* Program has provided a full opportunity for cooperation between government and industry and has been successfully used to examine options and potentially valuable mechanisms for selectivity improvement. The open discussion of preliminary results of the Canadian experiments and the approaches of other countries has contributed to the education and commitment of stakeholders.

It is therefore intended, funds permitting, to follow up these initiatives as follows:

a) completion of full and detailed analysis and reporting of the three experiments conducted in 1993,

b) continue the experiments on devices as recommended at the St. John's workshop using the collaborative approaches agreed and

c) focus on the tracking and reporting of successful selectivity performance i.e. as the implementation of new device use and other approaches lowers and ultimately eliminates the by-catch of shrimp trawl operation.

Figure 1: Shrimp fishing areas of the Northwest Atlantic