Small Versus Large-Scale Fishing Operations In The North Atlantic

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Abstract: This paper compares small and large-scale fishing operations in the North Atlantic, by examining key policy relevant variables such as (i) the number of fishers they employ, (ii) the proportion of total annual catch that is landed by the two groups, (iii) the value of the catch they land, and (iv) annual catch that goes to the reduction industry relative to its use for direct human consumption. We gathered data from the literature to analyze the performance of the two sectors for the Canadian and Norwegian fishing fleets. We then used these country case studies to make inferences on how these two sectors perform at the level of the North Atlantic. Results from the analysis indicate, among other things that, small-scale fisheries employ more people for the same landed value, and that more of their catch is used for direct human consumption than large-scale fisheries. In some countries large-scale operations were more profitable (e.g., Norway) but there were countries in which small-scale operations did better (e.g., France). All in all, this study indicates that small-scale fisheries are better positioned to meet several of the policy goals set by both national governments and international organizations on the use of ocean resources.

Introduction

This paper compares small and large-scale fishing operations in the North Atlantic in similar fashion to Thompson (1980), who contrasted two classes of vessels for the developed and developing countries of the world. Thompson's work was later updated by FAO (see Maclean, 1988), leading to an iconic representation that was widely reproduced. In this paper, we develop a comparison of the two sectors in the North Atlantic, using Norway and Canada as case studies.

Table 1. Norwegian fishing fleets in 1998 divided into size categories.

Category	*Length (m)*
1	under 8
2	*8-12.9*
3	13-20.9
4	21-27.9
5	28-39.9
6	40 or over

Data on the following key fisheries variables were used to develop a similar comparison of the two fishing sectors:

- types and sizes of fishing vessels active in Norway and Canada;
- landings by small and large-scale fishing vessels;
- catch for direct human consumption by small and large-scale vessels;
- catch for industrial reduction to meal and oil by small and large-scale fishing vessels;
- landed values by small and large-scale vessels;
- number of fishers employed by the small and large-scale sectors;
- fishers employed for each $1 million invested in small and large-scale fishing vessels;
- total fuel consumed by small and large-scale vessels in Norway only; and
- mean fuel consumption per tonne of landings by small and large-scale vessels.

Other issues to be discussed are profitability of small and large-scale fishing vessels.

Materials and Methods

Definition of small and large-scale fisheries

In general there is no single definition of small and large-scale fisheries and/or commonly used definitions vary between countries. For many people, however, small-scale means artisanal and/or subsistence fisheries, both of these being made up of small vessels that operate in complex coastal areas. The first challenge for this paper is to find a reasonable definition of small and large-scale fishing operations that can be applied across countries in a given region. To do this, we follow the definition given in Ruttan *et al.* (2000). The cited paper categorizes fisheries as small or large on a relative rather than an absolute scale. The scale is based on vessel catch capacity, size or length, depending on the availability of data. The idea is that low catch capacity is a key attribute of 'smallness'.

To split the fisheries in Norway and Canada into large and small-scale, we prepare a list of vessel/gear types with their corresponding landed values. We then sort the data in ascending order of vessel/gear type, beginning with the smallest vessels. The cumulative landed value and corresponding cumulative percentage landed value are then computed. The cut off point between small and large vessels is taken to be the vessel size/type at which the cumulative percentage is 50. Note that this leads to cut off sizes that vary between countries.

Table 2. Landing and landed value data used to break down Norwegian fisheries into small-scale and large -scale, with the break at 50% of cumulative value of catch.

Gear/vessel type	Catch (t)	Value (1,000$)	Vessel	Crew	Energy Intensity (litres/tonne)	Cum. value (1000$)	Cum. % value
Others/1	295,273	172,986	10,903	13,084	-	172,986	12
Shrimp trawl/2	982	2,271	34	48	-	175,257	13
Shrimp trawl/com./2	1,111	2,175	35	49	-	177,432	13
Shrimp trawl/3	5,185	12,666	97	310	-	190,098	14
Bottom trawl/2	19,870	20,773	341	477	-	210,871	15
Gillnet/handline/2	36,744	35,758	530	742	-	246,628	18
Longline/2	16,032	17,519	187	262	-	264,148	19
Danish Seine/2	815	907	7	10	-	265,055	19
Shrimp trawl/com./3	7,906	9,028	55	176	1,500	274,083	20
Bottom trawl/3	22,095	18,678	100	320	589	292,761	21
Longline/3	20,699	22,752	80	256	572	315,513	23
Gillnet/handline/3	57,177	48,347	186	595	430	363,860	26
Seining/2	4,957	2,357	15	21	-	366,216	26
Danish Seine/3	46,990	38,610	113	362	478	404,826	29
Shrimp trawl/4	18,135	13,989	31	198	377	418,815	30
Bottom trawl/5	10,100	13,291	11	107	407	432,106	31
Danish Seine/4	41,232	24,885	39	250	298	456,991	33
Bottom trawl/4	49,127	34,581	45	288	248	491,572	36
Seining/3	80,310	29,983	66	211	159	521,555	38
Shrimp trawl/5	22,117	30,978	15	146	625	552,533	40
Shrimp trawl/6	13,450	27,452	9	119	1,309	579,985	42
Longline/5	87,819	130,866	58	563	382	710,851	51
Trawlers/5	80,842	80,604	47	456	434	791,455	57
Trawlers/6	84,173	96,274	39	515	495	887,729	64
Seining/4	95,637	34,625	42	269	133	922,354	67
Trawlers/6	86,270	124,662	21	277	640	1,047,016	76
Purse seining/6	231,792	67,509	34	449	96	1,114,525	80
Trawlers/5	423,429	62,749	54	524	95	1,177,274	85
Purse seining/6	126,155	38,693	16	211	126	1,215,967	88
Purse seining/6	864,361	168,736	41	541	85	1,384,704	100
Total	**2,850,785**	**1,384,704**	**13,251**	**21,834**	**-**	**16,425,165**	**-**

COUNTRY ANALYSIS: NORWAY

Fishing Fleet Structure

The Norwegian fishing fleet is reported to consist of 13,251 vessels in 1998, of which 10,870 were less than 8 meter in length. Thus, vessels of this size constituted about 82 percent of the total number of vessels active in Norway. About 2,348 vessels 8 meter length and over were fishing year-round, 1,199 of these were of 13 meter length and over. This group accounted for 9 percent of the total number of vessels (Anon., 1999 and Anon., 2000a).

The fleet could be divided into the following categories: (i) large purse seines fishing for pelagic species, for instance, herring, mackerel and capelin; (ii) large factory trawlers fishing either for shrimp or demersal species, such as cod and haddock; (iii) small steel trawlers, purse seines and shrimp trawlers fishing for small quantities of a number of different fish species; and (iv) a large number of highly diversified boats, known collectively as 'coastal' vessels that fish along the Norwegian coast (FAO, 1998).

Total number of crew fully employed in the Norwegian fishing industry was reported to be 15,141 in 1998. In addition, 6,157 fishers worked part time in the fishery, according to Norwegian Fisheries Statistics (Anon., 2000a).

Landing, landed values and profitability

The total catch by Norwegian fishing vessels in 1998, including crustacean and molluscs, was estimated at 2,850 thousand tonnes, with a landed value of about US$1,385 million. The demersal and pelagic fisheries accounted for 25 percent and 73 percent of total landings, respectively. These landings produced about 60 percent and 30 percent of the total landed values. The top four species fished in 1998 (in terms of landings) were herring (831,700 t); blue whiting (570,700 t); sandeel (343,400 t) and Northeast Atlantic cod (321,600 t). In terms of landed values, the top species are Northeast Atlantic cod (US$ 446 million); herring (US$ 194 million), saithe (US$ 139 million) and deep water prawn (US$ 107 million) (Anon., 2000b).

Vessels that operate year-round took nearly 90

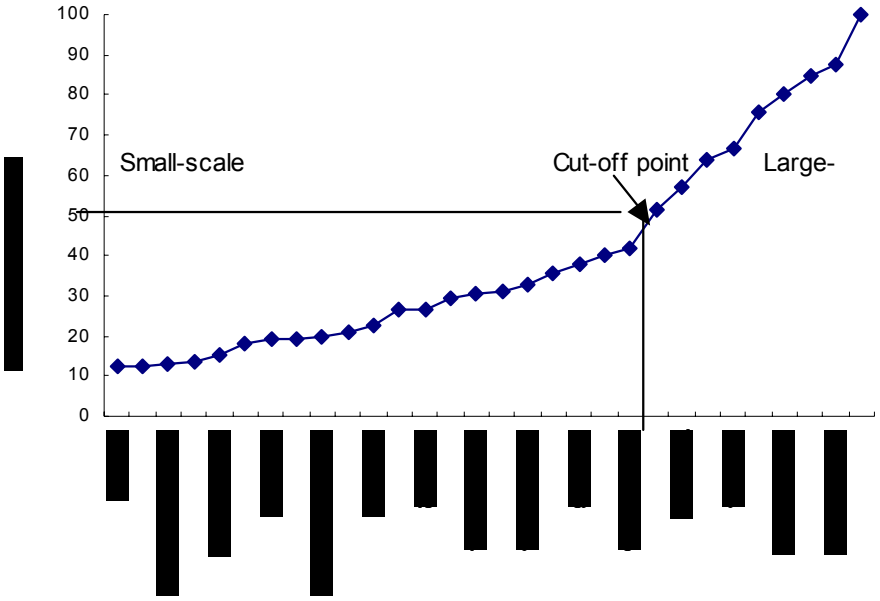

Figure 1. Gear/vessel type against cumulative percentage landed value. The 50 percent cumulative landed shown as cut-off point for small and large-scale fisheries

percent of the total landings and captured about 88 percent of landed values from Norwegian fisheries in 1998. Of these amounts, the vessels 13 meter length and over contributed 87 percent and 82 percent in total landings and landed values, respectively (Anon., 1999).

It is reported that in 1998, fishing vessels 8-meter length and over that operated year-round in Norway earned a total operating profit of (US$ 200 million). The average operating margin for vessels 8-12.9 meters was estimated to be 9.2 percent; the equivalent margin for vessels 13 meter and over was about 16.1 percent (Anon., 1999). It therefore appears that larger Norwegian vessels are more profitable than smaller ones.

Splitting fisheries into small-scale and large-scale

Data were mainly extracted from Anon. (1999), which gives a detailed survey of profitability for vessels 8 meters and over, operated year-round. As mentioned earlier, this group of vessels accounted for 90 percent and 88 percent of total landings and landed values from Norwegian fisheries. The rest of the landings and landed values were assumed to come from vessels less than 8 meter length, that is, coastal boats with diverse gears. To obtain landings, landed values, number of vessels and crew size for this group of vessels, we deduct from the totals of these values for vessels that are 8-meter length and over.

The vessel/gear categories employed in Norwegian fisheries are gill-net/handline, Danish seines, longline, purse seine, bottom (or factory) trawl, shrimp trawl, and other trawls. It should be noted that boats less than 8 meter in length are classified as 'others' because most of them are not operated year-round, and they use highly diverse gears. We divide the different vessels operating in Norway into six groups in terms of vessel length as shown in Table 1 below. Landings and landed values are sorted in ascending order of average vessel size.

Finally, average crew sizes of each vessel group are applied to compute total crew members for each vessel group. This gives total crew size of 21,834, very close to the 21,298 reported in Norwegian Fisheries Statistics for the 1998.

Table 2 presents landing and landed value data used to split Norwegian fisheries into small and large-scale following Ruttan et al. (2000). Other data reported in this table are number of vessels of the different groups employed and their crew sizes.

Reduction and human consumption

According to Anon. (2000a), 46 percent (that is, 1,308 thousand tonnes) of total Norwegian landings (excluding seaweed) go to reduction fisheries for fishmeal, oil and other similar uses. The key species destined for reduction are Atlantic herring, Atlantic mackerel, blue whiting, capelin, Norway pout, sprat and sandeel. Of these species, blue whiting, capelin, sprat, sandeel,

Table 3. Canadian fishing fleets in 1998 divided into size categories

Class	Tonnes
0	Not known
1	0-24.9
2	0-49.9
3	50-149.9
4	150-499.9
5	500-999.9
6	1000-1999.9
7	2000 or greater

FISHERY BENEFITS	SMALL-SCALE	LARGE-SCALE
Number of fishers	18,592	3,242
Number of vessels	12,957	294
Annual Catch (1,000 tonnes)	858	1,993
Annual catch (1,000 tonnes) of marine fish for human consumption	724	816
Annual catch (1,000 tonnes) of marine fish for industrial reduction to meal and oil, etc.	134	1176
Landed value (million US$)	$$$$ 711	$$$$ 674
Total fuel consumed (million litres)	350	300
Energy intensity (litres/tonne)	410	150
Fishers employed for each $1 million landed value	26	5

Figure 2: Comparison of small-scale and large scale fisheries for Norway in 1998.

Atlantic horse mackerel and Norway pout go in total for reduction. For the remaining species, 27 percent of total landings go to reduction, while 17 percent of landed values are derived from industrial use (Åse Mobråten, pers. comm.). We apply this information to calculate and report in Figure 2 the quantity of Norwegian fish landings used for industrial purposes.

Fuel consumption

From the analysis by Tyedmers (2001), estimates of the total fuel consumed and fuel consumption per tonne of landings (i.e., energy intensity) by all Norwegian fleet sub-sets comprised of vessels greater than 13m in length were available. As a result, while data were available regarding the fuel consumed by the entire Norwegian large-scale sector, fuel use data were only available for just over 55% of the small-scale sector's total landings (Table 2). However, by assuming that the rate of fuel consumption by Norwegian vessels smaller than 13m approximates that of the rest of the small-scale sector's fleet sub-sets, we were able to estimate the total fuel consumed by this sector.

Results

The results illustrated in Figure 2 show that (i) small-scale fisheries in Norway employ about five times more people than large-scale fisheries, while they land only 43 percent of the landings of the large-scale fishers, (ii) small-scale fisheries send only 15 percent of their landings to the reduction industry, the equivalent number for the large-scale sector is about 60%; (iii) small scale fisheries achieve nearly 150 percent more landed value per tonne than their large scale counterparts; (iv) in terms of total fuel consumed, the small and large-scale sectors consume roughly equal amounts, about 350 and 300 million litres respectively; (v) small-scale fisheries create 26 jobs for each US$1 million they generate, while the large-scale fisheries generate only 5 for the same amount of landed value; and (vi) small-scale fisheries consume, on average, almost three times more energy per tonne of fish or shellfish landed as do large scale fisheries. This is most probably because large-scale vessels in Norway target quite a lot of pelagic (schooling) species.

Table 4. Landing and landed value data used to break down Canadian fisheries into small-scale and large-scale, with the break (horizontal line) at 50% of cumulative value of catch.

Gear/vessel	Catch (t)	Value (1,000$)	Vessels	Crew	Cum. value (1,000$)	Cum. % value
Grappling /0	78	123	4	8	123	0.01
Mobile Seine/0	225	177	10	22	301	0.03
Other Gear/0	2,704	3,288	125	265	3,588	0.33
Hooks and Lines/0	7,870	9,920	363	772	13,508	1.25
Surrounding Nets/0	21,752	22,915	1,003	2,134	36,423	3.38
Gillnets /0	25,120	38,032	1,159	2,465	74,455	6.91
Traps and Lift Nets/0	88,143	133,624	4,065	8,649	208,079	19
Traps and Lift Nets/1a	70,993	307,859	3,274	6,966	515,938	48
Dredges/0	3,264	2,241	151	320	518,178	48
Other Gear/1	44,524	33,173	2,053	4,369	551,351	51
Bottom Trawls/0	41,229	53,910	1,901	4,046	605,261	56
Hooks and Lines/1	13,519	30,593	623	1,327	635,853	59
Bottom Trawls/1	10,930	15,421	504	1,073	651,274	60
Dredges/1	8,360	7,989	386	820	659,263	61
Surrounding Nets/1	3,991	4,062	184	392	663,326	62
Gillnets /1	72,204	69,155	3,330	7,085	732,481	68
Midwater Trawls/0	2,153	824	99	211	733,305	68
Grappling /1	390	1,827	18	38	735,132	68
Mobile Seine/1	1,590	1,346	73	156	736,478	68
Bottom Trawls/2	20,559	20,712	615	1,755	757,189	70
Midwater Trawls/2	10	5	0	1	757,195	70
Mobile Seine/2	2,810	2,277	84	240	759,472	70
Surrounding Nets/2	3,653	4,799	109	312	764,271	71
Gillnets /2	6,386	9,401	191	545	773,672	72
Hooks and Lines/2	6,614	11,415	198	564	785,087	73
Traps and Lift Nets/2	12,360	36,577	370	1,055	821,664	76
Dredges/2	3,646	3,255	109	311	824,919	77
Grappling /2	129	1,002	4	11	825,921	77
Other Gear/2	408	646	12	35	826,567	77
Bottom Trawls/3	56,296	68,097	472	1,638	894,664	83
Mobile Seine/3	629	533	5	18	895,197	83
Surrounding Nets/3	37,431	14,280	314	1,089	909,476	84
Gillnets /3	1,882	4,803	16	55	914,279	85
Hooks and Lines/3	2,287	5,764	19	67	920,044	85
Traps and Lift Nets/3	11,074	18,011	93	322	938,054	87
Dredges/3	5,293	4,635	44	154	942,689	87
Grappling/3	111	262	1	3	942,951	88
Other Gear/3	129	203	1	4	943,154	88
Bottom Trawls/4	6,338	4,924	11	85	948,078	88
Midwater Trawls/4	260	105	0	3	948,183	88
Surrounding Nets/4	57,726	22,936	99	775	971,119	90
Gillnets /4	65	104	0	1	971,223	90
Hooks and Lines/4	1,455	3,461	3	20	974,684	90
Traps and Lift Nets/4	1,404	4,326	2	19	979,010	91
Dredges/4	40,845	41,639	70	548	1,020,650	95
Bottom Trawls/5	10,613	8,838	14	197	1,029,487	96
Midwater Trawls/5	2,827	1,101	4	53	1,030,588	96
Dredges/5	3,092	3,142	4	58	1,033,730	96
Bottom Trawls/6	8,431	13,094	5	77	1,046,824	97
Dredges/6	9,471	6,377	5	87	1,053,201	98
Bottom Trawls/7	18,624	24,192	10	243	1,077,393	100
Total	**751,897**	**1,077,393**	**22,210**	**51,462**	**2,154,785**	**-**

COUNTRY ANALYSIS: CANADA

Fishing fleet structure

Data reported by Canada's Department of Fisheries and Oceans (DFO) shows that a total of about 22,100 vessels were used to exploit fish in Eastern Canada in 1998. Using the average crew sizes of the different vessel types active in the Scotia-Fundy and Gulf regions of Canada (W.J. MacEachern, pers. comm.), we determined that there were about 51,462 active crew-members on the east cost of Canada in 1998.

Most of the active fishing fleets on the east coast, that is, Atlantic Canada, are less than 65ft in length. In fact, this group makes up 99 percent of total Canadian fishing vessels in 1998 (Anon., 2000c). Most of these vessels operate 'inshore' (P. Fanning and S. Guénette, pers. comm.). The inshore fleet is usually split into three groups, those under 35ft length, those between 35 and 45 ft, and those between 45 and 65 ft. Amongst these groups, vessels under 35ft number around 15,000, representing 85 percent of licensed vessels operating in Canada in 1998. The vessels range from motorized, open-decked boats to small trawlers, Danish seiners and longliners with sophisticated equipment. Most inshore vessels are versatile, participating in the groundfish fishery as well as other fisheries such as those for lobsters, herring, mackerel and squid. Only 1 percent or 171 of the total number of fishing vessels are over 65ft in length, they operate offshore. These vessels are highly specialized, mobile, capital-intensive units, normally running year-round, depending on resource availability (FAO, 2000).

Landings and landed values

According to official Canadian statistics, a total of about 785 thousand tonnes of marine fishes were landed on the Atlantic coast of Canada in 1998, valued at about US$ 869 million. In terms of landings, the top four species were herring (191,144t), shrimp (107,909t), queen crab (75,219t) and scallop (63,035t). With respect to landed values, shellfish dominated, with lobster contributing US$ 299 million, followed by shrimp with a contribution of US$ 168 million, queen crab generated US$ 118 million, and scallop was forth with US$ 65 million landed value (Anon., 2000c).

Splitting into small-scale and large-scale fisheries

The catch data and tonnage/gear size definition we used for Canadian fisheries analysis are derived from Watson et al. (this volume), which is to a great extent based on official Canadian Fisheries Statistics and FAO Statistics.

The price per unit weight of each species is obtained by dividing their total landed values with the total landings for each species as reported in Canadian Fisheries Statistics for 1998. These prices are then applied to the catches, leading to the landed values reported in Table 4.

FISHERY BENEFITS	SMALL-SCALE	LARGE-SCALE
Number of fishers employed	25,972	25,491
Number of vessel	12,207	10,003
Annual Catch (1,000 tonnes)	265	487
Annual catch (1,000 tonnes) of marine fish for human consumption	265	487
Landed value (million US$)	551	526
Fishers employed for each $1 million invested in fishing vessels	47	48

Figure 4. Comparison of small and large-scale for Atlantic Canada fisheries in 1998.

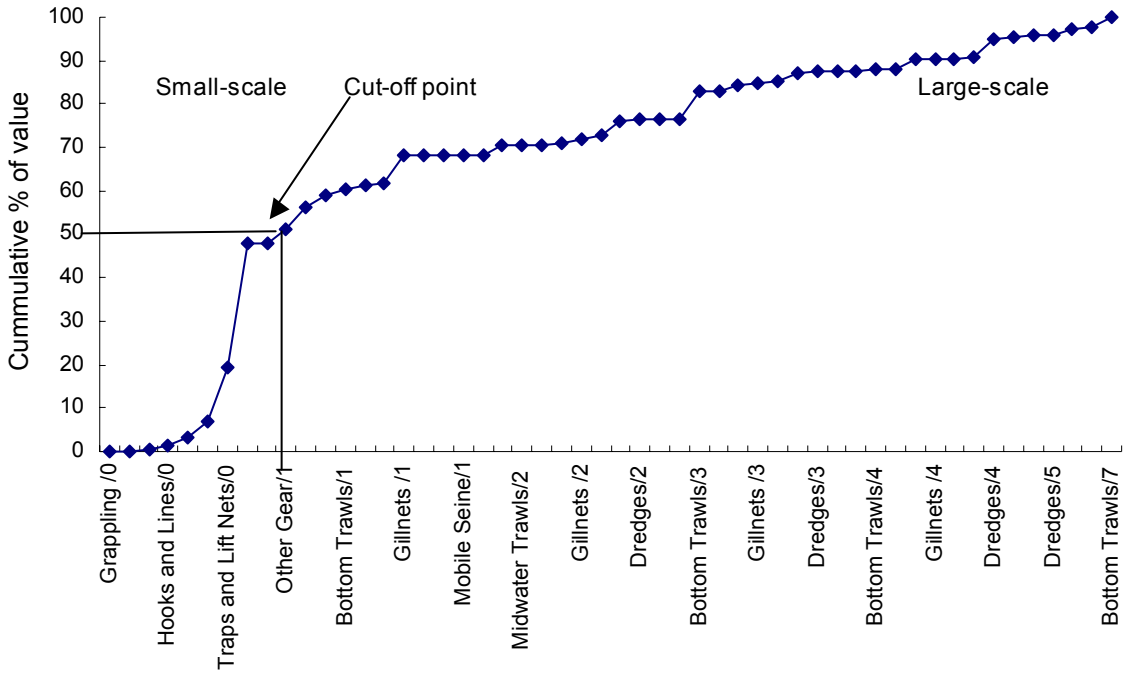

Figure 3: Gear/vessel type against cumulative percentage landed value. The 50 percent cumulative landed shown as cut-off point for small and large-scale fisheries

Reduction Fisheries

Currently, by law, there are no directed reduction fisheries in Canada,. The only reduction activities still taking place in Canada use fish wastes, such as offals and bones, and carcasses from some roe fisheries (SW Nova Scotia spring herring). There used to be foreign vessels operating reduction plants in Canada: vessels from the then USSR produced fishmeal from wastes, undersized or low quality silver hake. They also had a capelin fishery which was specifically for reduction, but that was terminated in the 1970's (P. Fanning, pers. comm.). Thus, both landings and landed values for reduction fisheries in Canada are zero, and hence the entire landings by Canadian fisheries are for direct human consumption.

Results

The results reported in Figure 4 below show that (i) small-scale fisheries in Canada employ slightly less people than the large-scale sector; (ii) large-scale fisheries land about 80 percent more tonnes of fish than small-scale fisheries; and (iii) small-scale fisheries achieve double the landed values obtained by the large scale sector per tonne of landings.

Discussion

A comparison of the results obtained for Norway and Canada show that Norwegian small-scale fisheries employ more people per dollar of landed value than Canadian small-scale fisheries. Also, the difference in employment between small and large-scale fisheries is smaller in Canada than in the case of Norway. This may be explained by the fact that Norway has a lot more small vessels, and that the difference between large and small among the Norwegian fleets is much greater than among Canadian vessels. Our study reveals that in both countries (taken together), and presumably in the North Atlantic as a whole, small-scale fisheries employ on average more people for a given amount of landed value they generate. In addition, more of their catches are used for direct human consumption than catches by large-scale vessels.

With respect to profitability, large-scale vessels in Norway appear to do better than the small-scale fisheries (Anon., 2000). On the other hand, small-scale fishers appear to be more profitable in other countries of the North Atlantic. For instance, Lery et al. (1999) reports that Spanish and French deep-sea trawlers achieved a return on investment of 7.3 and 3.1 percent, respectively. On the other hand Spanish coastal seiners (small-scale) and French handliners (small-scale) achieved returns on investment of 13.1 and 29.9 percent, respectively. In conclusion, this study shows that relative to large-scale fisheries, small-scale fisheries are more capable of meeting several of the policy goals formulated by various countries, for example, catching fish for direct

human consumption, providing jobs to the population, and deriving a higher economic value from each tonne of fish caught.

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