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Analysis of catch rate of Estonian shrimp vessels in Div. 3M and Div. 3L in 2007 and 2008

by

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Abstract

Most common practice for Estonian fishing vessels in NAFO area is to conduct shrimp fishery both in Div. 3M and Div. 3L during the same fishing trip. Occasionally there are fishing trips when vessel conducts fishery only in Div. 3M. There hasn't been any fishing trips when vessel conducts fishery only in Div. 3L. 4 groups are defined. In order to analyze the observed catch rates of Div. 3M being higher two days before and after fishing in Div. 3L (group 3) compared to other days when fishing in 3M (groups 1 and 2) two reasons are studied: seasonality and use of single and double trawls. The first thought that comes into mind for group 3 having higher catch rates is misreporting. Whether this may have been due to misreporting this has to be further studied. But results show that seasonality may have had effect on group 3 having higher catch rate values. Including the single and double trawls combined and separately into the test did not change the test results. If there is solid proof of misreporting the calculated correction factors can be used to correct the data.

Since Estonian shrimp fishery in Div. 3M is one of the biggest fisheries in the area it is important that the data can be used in stock assessments.

Introduction

Usual situation in assessing stocks is that there is too few data available that can go into assessment analysis. All the time is in SC recommendations that catch rate data from all fleets be made available for the assessment but still even if the data is available then the catch rate data from commercial fishery is often considered erroneous and there are other data quality issues like misreporting etc (NIPAG, 2007).

In this paper we analyze Estonian shrimp vessels catch rates in Div. 3M and 3L in 2007 and 2008 in respect of what might be the reasons for catch rate of Div. 3M being higher two days before and after fishing in Div. 3L compared to other days when fishing in 3M. There are many reasons that might affect the catch rates starting from weather and ending with the experience of the skipper. Here are studied 2 possible reasons: seasonality and use of single and double trawls (Hvingel *et al*., 2007).

Material and methods

Data is from Estonian observer final reports from 2007 and 2008. CPUE is unstandardized shrimp catch (including shrimp discards) in trawl hours by haul. In 2008 reports contain data from fishery until August but data for June is also preliminary because all the reports were not available.

Assumptions to ANOVA were not met and Kruskal-Wallis ANOVA was used instead for analyzing the catch rate data.

If there has been any misreporting then it should be misreporting of the catches and not the haul duration, because the haul durations can be easily checked with VMS data. We decided that if someone wants to cheat then one probably thinks that 2 days before and 2 days after fishing in Div. 3L altering the Div. 3M catch figures in that period is enough to distribute the catch evenly between days so it would not be noticeable. 4 groups that we defined are:

Group 1 - Hauls in 3M when vessel was fishing only in Div. 3M during the fishing trip.

Group 2 - Hauls in Div. 3M when vessel was fishing both in Div. 3M and Div. 3L during the fishing trip except 2 days before and 2 days after the vessel has fished in Div. 3L.

Group 3 - Hauls in Div. 3M 2 days before and 2 days after the vessel has fished in Div. 3L.

Group 4 – Hauls in Div. 3L.

Since single and double trawls are known to affect the catch rates the tests were made with single and double trawls combined in analyses and then the same tests including only the hauls made using double trawls.

We divided months into two catch rate groups by catch rate values: group containing months which have higher than year's average catch rate value (catch rate group Higher) and group containing months which have lower than year's average catch rate value (catch rate group Lower). Number of hauls in each catch rate group is added together and the ratio of "catch rate group Higher" to "catch rate group Lower" is calculated.

ratio value =1 - same number of hauls

ratio value >1 - more hauls with higher than average catch rate

ratio value <1 - more hauls with lower than average catch rate

If ratio of group 3 is higher than ratio of group 2 then the seasonality may have favored the higher values of group 3 catch rate values and affected the test results.

The differences in medians of catch rates for groups 3 and 4 by vessel are calculated and presented in table 1. If there is proof of misreporting (the Div. 3L catch reported as Div. 3M catch) these equations can be used to calculate the percentages for correcting the data:

Equation for Group 3 $$\frac{100(\text{Group 2} - \text{Group 3})}{\text{Group 3}}$$

Equation for Group 4 $$\frac{100(\text{Group 2} - \text{Group 3})}{\text{Group 4}}$$, where

Group 2, 3 and 4 are medians of catch rates of group 2, 3 and 4.

Results and discussion

Most vessels had CPUE higher in group 3 compared to group 1 or 2 and that may mean that there has been misreporting of catches between Div. 3M and Div. 3L so that 3L catch has been reported as catch from Div. 3M. In

2007 three vessels (F, D and H) out of five had significant differences of CPUE between group 2 and 3 (differences were not significant for vessels C and B). In 2008 also three vessels had significant differences (H, D and C) and vessels F and B not having significant differences of catch rates between groups 2 and 3. Kruskal-Wallis ANOVA test results are in Annex 1.The fishermen are saying that because the Div. 3L is regulated by TAC they want to maximize the catch value and not the CPUE and that is why the CPUE in Div. 3L is lower than CPUE in Div. 3M. But may there have been other factors that may have affected the test results?

Simple significance test with all vessels combined in one test showed that group 3 has higher catch rate than group 2 in 2007 and 2008 (Kruskal-Wallis ANOVA)(Figure 1).

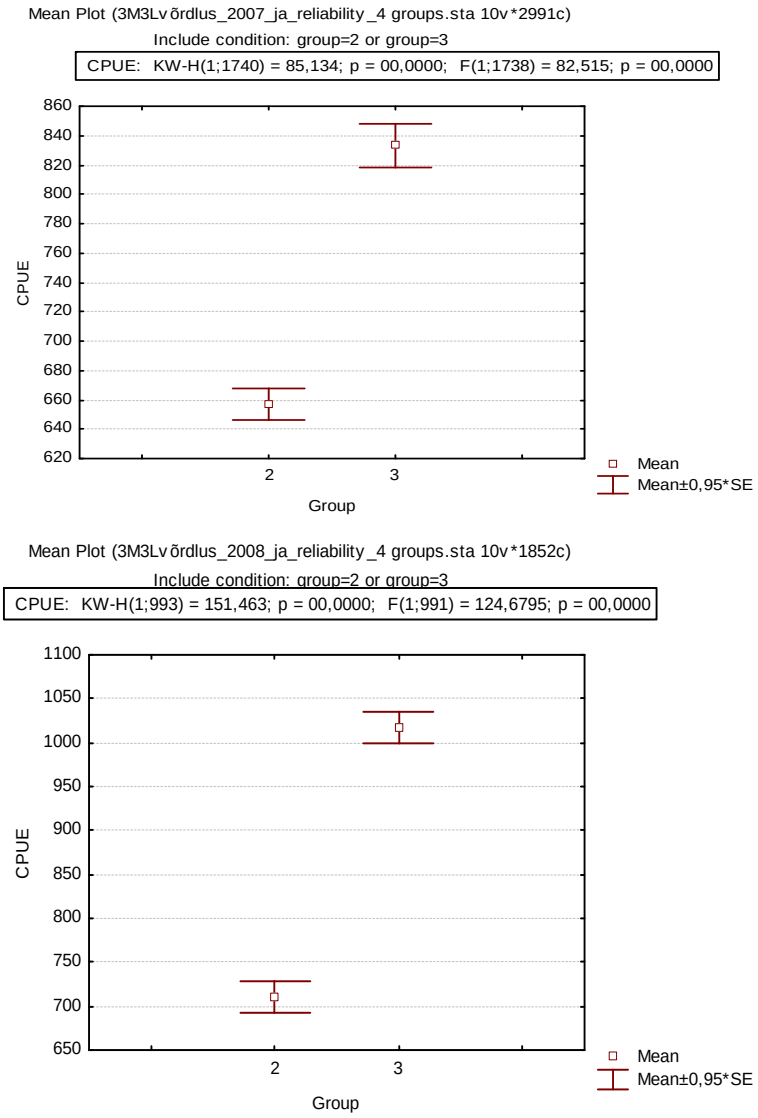


Figure 1. Group 3 has higher catch rate than group 2 in 2007 and 2008.

The seasonality is known to have effect on catch rate (Hvingel *et al*., 2007). The higher number of hauls in months when catch rates are higher raise the mean catch rate of the group. If in group 3 are more hauls from "catch rate group Higher" than from "catch rate group Lower", then group 3 has higher mean catch rate. If at the same time group 2 has more hauls from "catch rate group Lower" than from "catch rate group Higher", then group 2 has lower

mean catch rate. And this is due to seasonal differences in catch rates in different months and not due to misreporting or some other reasons.

In 2007 the catch rates were higher of the year's average in months 2, 3, 5, 6, 7 and 12 (December is in this group only with single and double trawls combined). In 2008 months 2, 3, 6 and 8 had catch rates higher than the year's average (Table 2, Fig. 2).

All vessels in 2008; hauls with double trawls only in 3M. The group 2 has ratio 0.46 and group 3 has ratio 2.28, so the seasonality may have affected the results because in group 3 are more hauls which have higher catch rate value and that may be the reason why group 3 has higher catch rate values than group 2 (Table 2, Fig. 3).

All vessels in 2008; hauls with single and double trawls in 3M. Group 2 ratio 0.45 and group 3 ratio 2.30. Seasonality may have favored the group 3 higher values (Table 2).

All vessels in 2007; hauls with double trawls only in 3M. Group 2 ratio 0.43 and group 3 ratio 0.51, so seasonality may have favored group 3 higher values but the affect should be small due to small difference of ratios (Table 2).

All vessels in 2007; hauls with single and double trawls in 3M. Group 2 ratio 0.48 and group 3 ratio 0.60, so seasonality may have favored group 3 higher values but the affect should be small due to small difference of ratios. But the difference is bigger compared to calculations when only hauls with double trawls were included (Table 2).

The seasonality seems to have more effect in 2008 (higher differences in ratios) than in 2007.

This analysis can be done also for each vessel separately to analyze the seasonality effect by vessel but this was not done because we wanted to see if the seasonality may have had effect at all or not.

Table 2. Number of hauls by group and by year used in analysis; mean catch rates; number of hauls in "catch rate group Higher" and in "catch rate group Lower"; ratios of "catch rate group Higher" to "catch rate group Lower".
* month which had catch rates higher than year's average in 3M.

Number of hauls all vessels in 2008 only double trawls						
	Group					
Month	1	2	3	4	Grand Total	mean cpue, 3M
1	1	60	87	22	170	786.56
2*		42	117	49	208	959.78
3*		65	145	54	264	1079.93
4	50	198	13		261	510.92
5	227	6			233	602.63
6*	144	71			215	1008.60
7		119	16	7	142	845.30
8*			3	4	7	1440.15
Grand Total	422	561	381	136	1500	904.23
Total "catch rate group Higher"	144	**178**	**265**	107	694	
Total "catch rate group Lower"	278	**383**	**116**	29	806	
ratio of higher to lower	0.52	0.46	2.28	3.70	0.86	

Table 2 continued

Number of hauls all vessels in 2008 single and double trawls

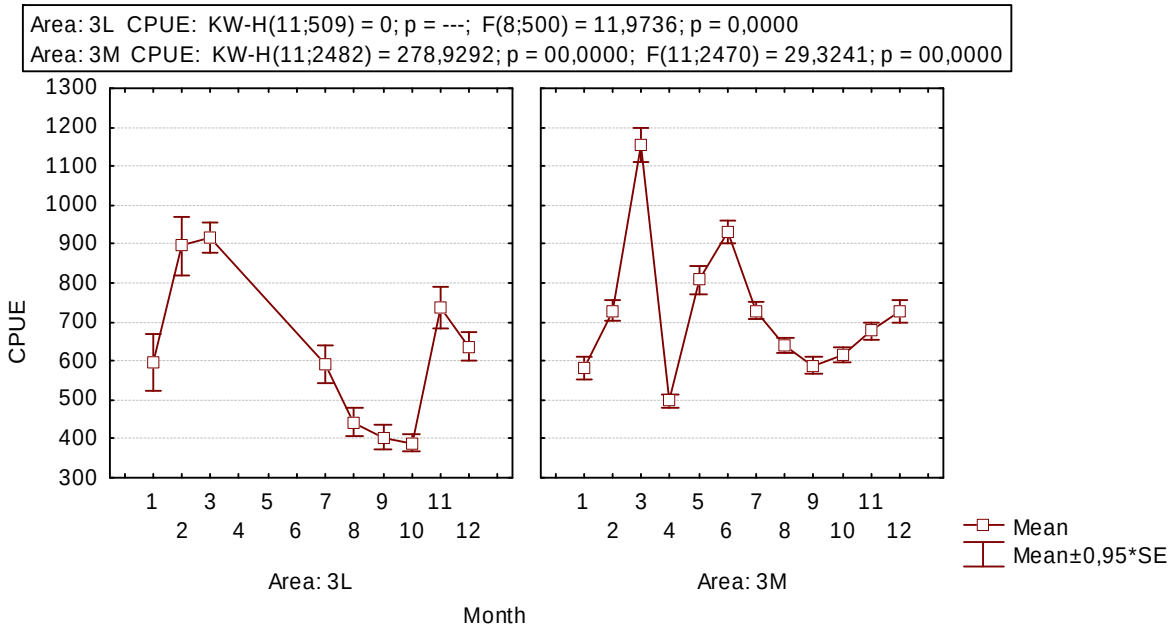
Month	Group 1	2	3	4	Grand Total	mean cpue, 3M
1	1	60	87	49	197	786.56
2*		42	117	79	238	959.78
3*		72	158	126	356	1044.07
4	78	224	18		320	470.86
5	303	6			309	532.24
6*	212	71			283	908.53
7		119	16	7	142	845.30
8*			3	4	7	1440.15
Grand Total	594	594	399	265	1852	873.44
Total “catch rate group Higher”	212	**185**	**278**	209	884	
Total “catch rate group Lower”	382	**409**	**121**	56	968	
ratio of higher to lower	0.55	0.45	2.30	3.73	0.91	

Number of hauls all vessels in 2007 double trawls

Month	Group 1	2	3	4	Grand Total	mean cpue, 3M
1	36	83	23	2	144	588.13
2*	26	27	59	4	116	774.32
3*		19	63	47	129	1154.67
4	125	52	10		187	496.92
5*	176				176	800.68
6*	114	78			192	931.12
7*	56	169	37	18	280	794.68
8	53	155	46	27	281	704.81
9		104	47	20	171	692.40
10	74	123	38	31	266	644.98
11		132	88	101	321	737.96
12	65	27	60	39	191	733.74
Grand Total	725	969	471	289	2454	754.53
Total “catch rate group Higher”	372	**293**	**159**	69	893	
Total “catch rate group Lower”	353	**676**	**312**	220	1561	
ratio of higher to lower	1.05	0.43	0.51	0.31	0.57	

Table 2 continued

Number of hauls all vessels in 2007 single and double trawls						
	Group					
Month	1	2	3	4	Grand Total	mean cpue, 3M
1	36	89	23	17	165	579.82
2*	36	27	59	65	187	728.96
3*		19	63	111	193	1154.67
4	125	52	10		187	496.92
5*	179				179	808.15
6*	114	78			192	931.12
7*	56	221	37	18	332	728.26
8	53	193	76	37	359	639.95
9		142	75	39	256	587.17
10	78	139	71	51	339	615.83
11		168	109	112	389	677.25
12*	65	29	60	59	213	726.88
Grand Total	742	1157	583	509	2991	722.91
Total “catch rate group Higher”	450	**374**	**219**	253	1296	
Total “catch rate group Lower”	292	**783**	**364**	256	1695	
ratio of higher to lower	1.54	0.48	0.60	0.99	0.76	



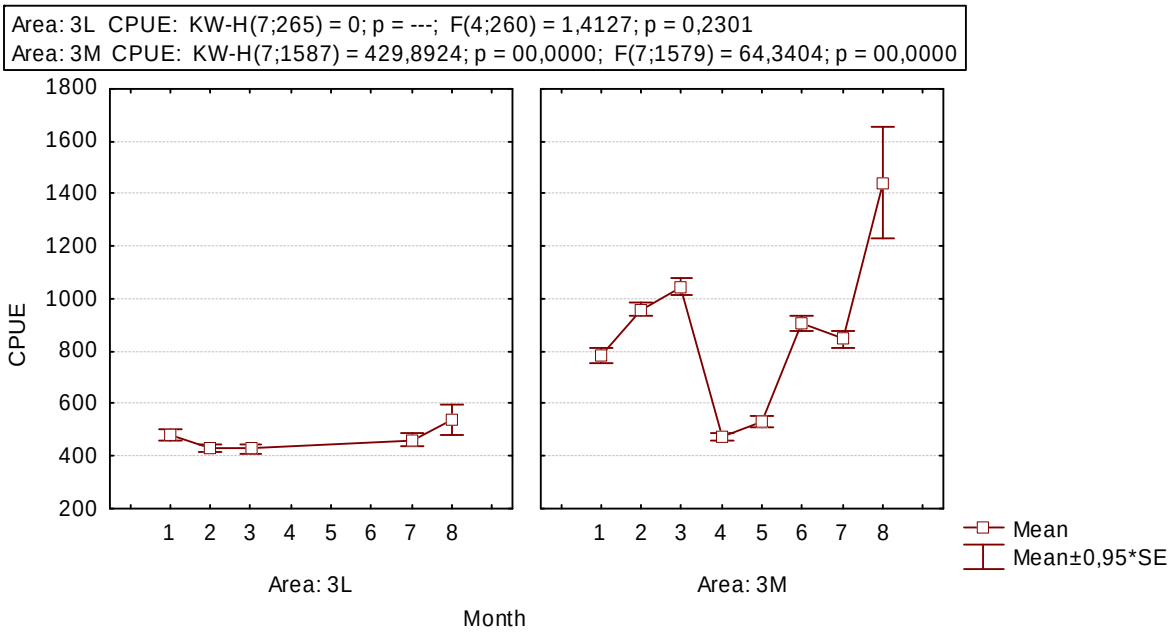


Figure 2. Catch rates in 2007 (upper panel) and 2008 (lower panel) by month by area. Single and double trawls combined.

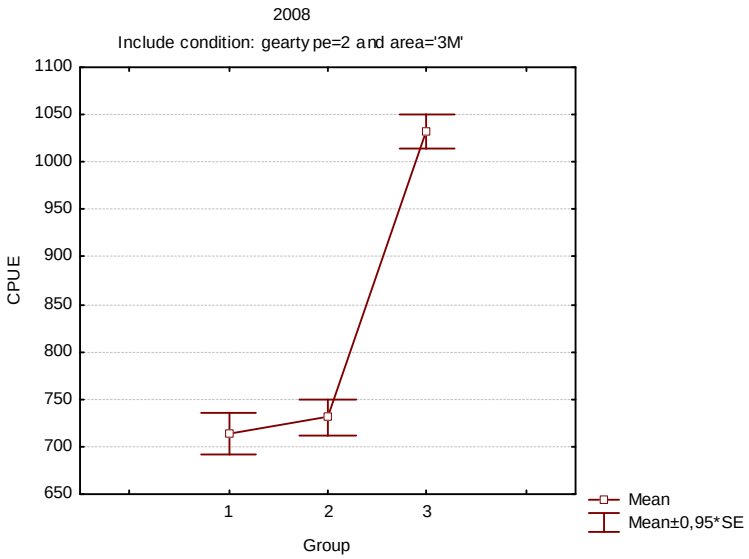


Figure 3. Mean catch rates in 2008 double trawls only in 3M.

The use of single and double trawls also influences the catch rate. In 2007 total of 112 hauls with single trawls and 471 hauls with double trawls in group 3 were made. In 2008 18 and 381 hauls correspondingly. This may mean that the higher catch rate that we noted in group 3 earlier may be due to greater number of hauls with double trawls in group 3 which must be totally coincidental because there can't be any reasonable explanation to using the double trawls in group 3 on purpose. Vessel F is always using single trawls. So the test with vessel F was not influenced by use of single or double trawls. When we repeated the tests with only hauls with double trawls included all the tests had the same result as earlier when both single and double trawls were included (Annex 2).

The use of single and double trawls has effect on catch rate (Figure 4). But it probably didn't affect test results due to small number of hauls with single trawls. In 2007 537 hauls with single trawls against 2454 with double trawls were made and 352 against 1500 in 2008 (Table 3).

Table 3. Number of hauls with single and double trawls by month by year. Trawl 1 for single trawl and 2 for double trawl.

Year	Month	Trawl	Group 1	Group 2	Group 3	Group 4	Grand Total
2007	1	1		6		15	21
		2	36	83	23	2	144
	2	1	10			61	71
		2	26	27	59	4	116
	3	1				64	64
		2		19	63	47	129
	4	1			0		
		2	125	52	10		187
	5	1	3				3
		2	176				176
	6	1					
		2	114	78			192
	7	1		52			52
		2	56	169	37	18	280
	8	1		38	30	10	78
		2	53	155	46	27	281
	9	1		38	28	19	85
		2		104	47	20	171
	10	1	4	16	33	20	73
		2	74	123	38	31	266
	11	1		36	21	11	68
		2		132	88	101	321
	12	1		2		20	22
		2	65	27	60	39	191
	Grand Total	1	17	**188**	**112**	220	537
	Grand Total	2	725	**969**	**471**	289	2454
	Grand Total	1,2	742	1157	583	509	2991
2008	1	1				27	27
		2	1	60	87	22	170
	2	1				30	30
		2		42	117	49	208
	3	1		7	13	72	92
		2		65	145	54	264
	4	1	28	26	5		59
		2	50	198	13		261
	5	1	76				76
		2	227	6			233
	6	1	68				68
		2	144	71			215
	7	1					
		2		119	16	7	142
	8	1					
		2			3	4	7
	Grand Total	1	172	**33**	**18**	129	352
	Grand Total	2	422	**561**	**381**	136	1500
	Grand Total	1,2	594	594	399	265	1852

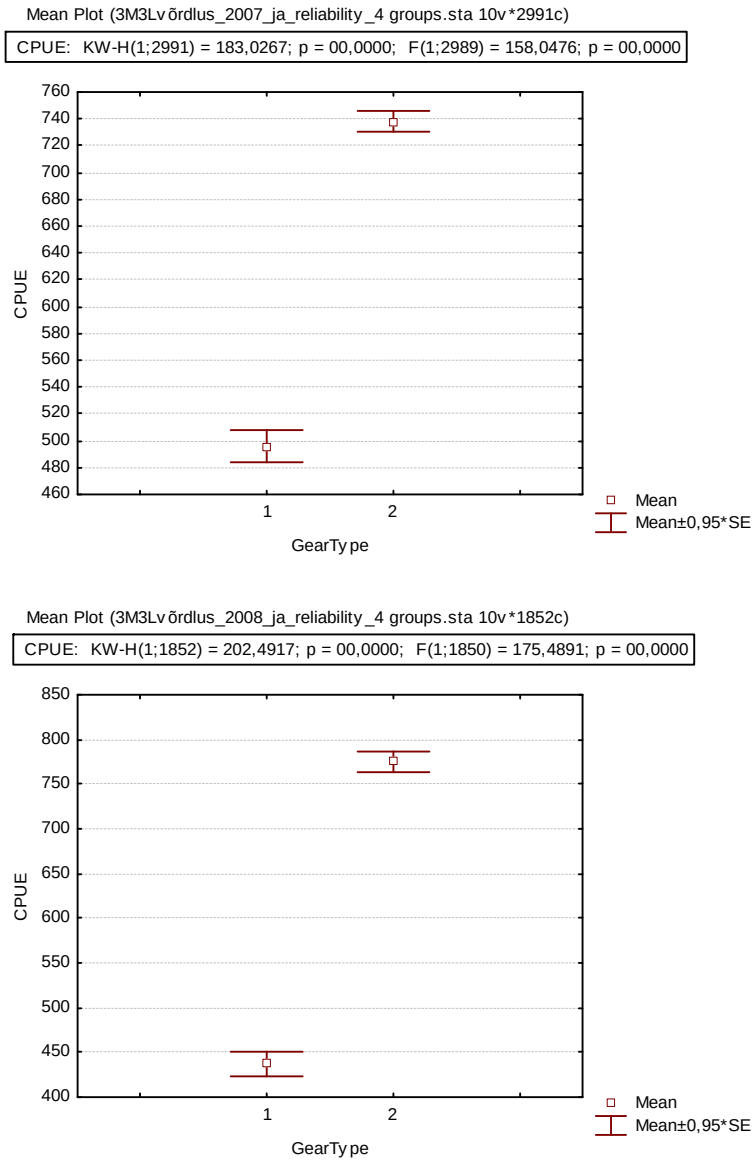


Figure 4. Compared to single trawls double trawls have higher catch rate in 2007 (upper panel) and 2008 (lower panel). All vessels.

When the catch rate of groups 2 and 3 is significantly different whereas catch rate of group 3 being higher than catch rate of group 2 then the catch rate of corresponding group 4 is usually higher or lower? Calculating the misreporting aspect. If there aren't any other reasons that we didn't cover here then if the catch rate of corresponding group 4 is lower then it may be suggested that it's lower because some catch is reported to group 3. The data shows that in 5 cases out of 10 the catch rate of group 4 was lower when the difference of group 2 and 3 was significantly different (Table 4). So this is the most frequent case. But is this enough to say that the lower catch rate in group 4 is due to misreporting? That has to be studied further.

Table 4. y sign (5 cases) – the catch rate of group 4 was lower and the catch rates of group 2 and 3 was significantly different; y not sign (1 cases) – the catch rate of group 4 was lower and the catch rates of group 2 and 3 was not significantly different; n not sign (3 cases) – the catch rate of group 4 was not lower and the catch rates of group 2 and 3 was significantly different; n sign (1 case) – the catch rate of group 4 was not lower and the catch rates of group 2 and 3 was significantly different;

Vessel	2007	2008
H	Y sign	Y sign
F	N not sign	Y sign
D	Y sign	Y sign
C	N sign	N not sign
B	N not sign	Y not sign

Conclusions

Seasonality may have had affected the test results in a way that group 3 got higher catch rate values due to seasonal differences in catch rates.

Use of single and double trawls combined or not in tests did not change the test results. The use of single and double trawls could not have affected the group 3 catch rate in a way that it got higher values.

This analysis did not find out if the group 3 higher catch rates are due to misreporting. This has to be studied further. If it is decided that the only reason for catch rate of group 3 being higher is due to misreporting then the corresponding correction factor can be used in order to get the corrected data.

Acknowledgements

I thank the Estonian observers for collecting data onboard vessels.

References

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Skúladóttir, U. & Pétursson, G. 2006. Assessment of the International Fishery for Shrimp (Pandalus borealis) in Division 3M (Flemish Cap), 1993-2006. NAFO SCR Doc. 06/76.

Table 1. Medians and calculated correction factors by vessels and groups.

Vessel ID	Group	Area	Year	No. Of Hauls	Mean	Median	Minimum	Maximum	% that should be added to catch rate of group 3	% that should be added to catch rate of group 4
F	2	3M	2007	179	374.61	353.00	8.44	958.33		
F	3	3M	2007	112	467.20	478.98	13.82	1005.00	-26.3	
F	4	3L	2007	38	216.62	214.14	78.16	484.67		58.8
D	1	3M	2007	57	424.45	482.50	20.52	962.69		
D	2	3M	2007	353	760.48	737.43	76.29	1865.26		
D	3	3M	2007	180	997.96	922.22	356.00	2890.00	-20.0	
D	4	3L	2007	194	796.95	677.44	213.85	5088.00		27.3
C	1	3M	2007	77	925.52	910.11	31.91	2066.67		
C	2	3M	2007	163	585.80	511.47	73.64	1762.86		
C	3	3M	2007	82	643.35	592.66	179.63	1409.43	-13.7	
C	4	3L	2007	82	853.85	634.54	158.68	3735.33		12.8
H	1	3M	2007	206	743.53	694.61	0.00	2295.74		
H	2	3M	2007	305	754.38	726.47	37.26	3800.00		
H	3	3M	2007	175	1016.33	997.00	224.00	2225.18	-27.1	
H	4	3L	2007	179	618.44	570.59	9.16	2088.00		47.4
B	1	3M	2007	402	573.53	521.40	0.00	2032.00		
B	2	3M	2007	157	629.44	604.85	95.69	1941.71		
B	3	3M	2007	34	681.80	646.82	178.29	1356.40	-6.5	
B	4	3L	2007	16	588.05	574.29	310.16	1021.80		7.3
H	1	3M	2008	0						
H	2	3M	2008	99	658.23	528.30	0.00	4123.50		
H	3	3M	2008	116	1080.41	1023.18	78.75	2377.33	-48.4	
H	4	3L	2008	91	485.88	461.56	165.45	1294.58		107.2
F	1	3M	2008	172	408.47	313.68	7.10	1807.00		
F	2	3M	2008	32	361.94	377.78	93.10	642.80		
F	3	3M	2008	17	665.16	609.00	191.70	1417.75	-38.0	
F	4	3L	2008	13	481.63	560.50	155.77	767.50		41.3
D	1	3M	2008	159	823.30	773.88	16.00	3331.63		
D	2	3M	2008	201	872.25	823.36	169.80	1996.33		
D	3	3M	2008	153	1157.20	1095.61	431.57	2134.00	-24.8	
D	4	3L	2008	77	459.33	424.40	244.14	1193.11		64.2
C	1	3M	2008	99	507.79	462.43	10.35	1523.15		
C	2	3M	2008	114	479.96	423.54	26.43	1353.11		
C	3	3M	2008	49	785.08	816.43	268.16	1237.08	-48.1	
C	4	3L	2008	43	368.07	380.00	147.86	532.28		103.4
B	1	3M	2008	164	733.07	653.49	0.00	3016.25		
B	2	3M	2008	148	780.12	696.81	0.00	2727.74		
B	3	3M	2008	64	840.41	799.65	379.86	1558.07	-12.9	
B	4	3L	2008	41	375.72	348.80	250.40	674.71		29.5

Annex 1. Kruskal-Wallis ANOVA test results by vessel by year.

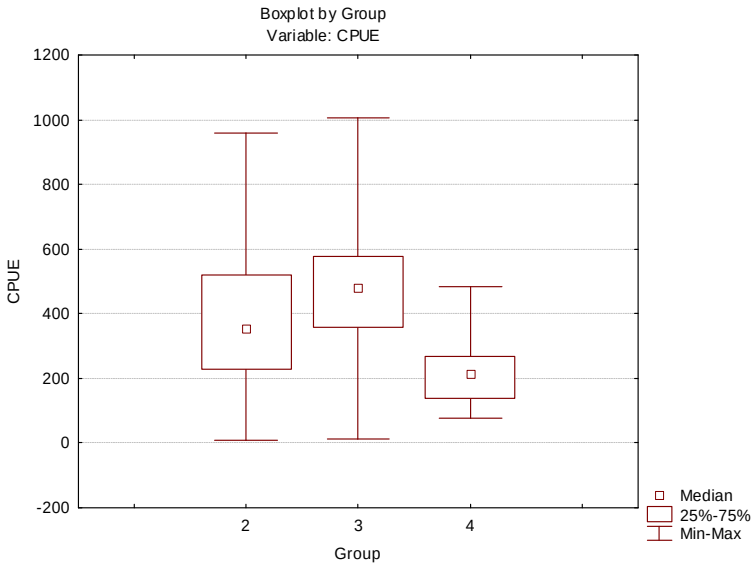
Tests with VESSEL F in 2007:

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (2, N= 329) =54,48488 p =,0000
Include condition: Vessel='F'

Depend.: CPUE	2 R:158,70	3 R:205,38	4 R:75,671
2		4,073486	4,887029
3	4,073486		7,263719
4	4,887029	7,263719	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (2, N= 329) =54,48488 p =,0000
Include condition: Vessel='F'

Depend.: CPUE	2 R:158,70	3 R:205,38	4 R:75,671
2		0,000139	0,000003
3	0,000139		0,000000
4	0,000003	0,000000	



CPUE in group 3 is significantly higher than in group 2.

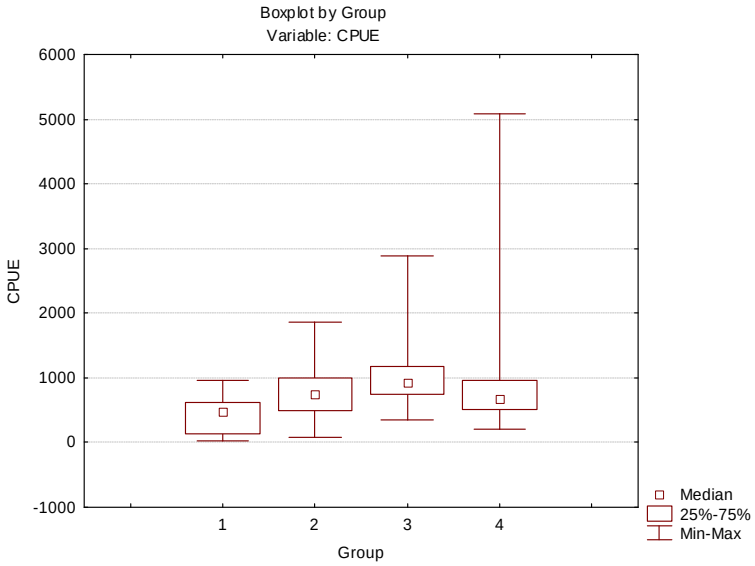
Tests with VESSEL D in 2007:

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 784) =106,4487 p =0,000
Include condition: Vessel='D'

Depend.: CPUE	1 R:178,86	2 R:377,88	3 R:514,37	4 R:368,81
1		6,156274	9,747707	5,567135
2	6,156274		6,580693	0,448059
3	9,747707	6,580693		6,210825
4	5,567135	0,448059	6,210825	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 784) =106,4487 p =0,000
Include condition: Vessel='D'

Depend.: CPUE	1 R:178,86	2 R:377,88	3 R:514,37	4 R:368,81
1		0,000000	0,000000	0,000000
2	0,000000		0,000000	1,000000
3	0,000000	0,000000		0,000000
4	0,000000	1,000000	0,000000	



CPUE of group 3 is significantly higher than CPUE of group 2.

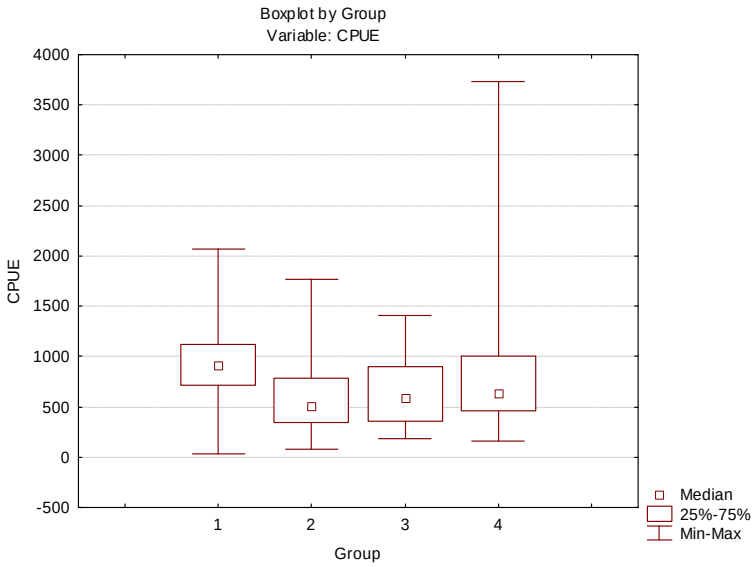
Tests with VESSEL C in 2007:

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (3, N= 404) =49,27891 p =,0000
Include condition: Vessel='C'

Depend.: CPUE	1 R:277,24	2 R:166,73	3 R:188,74	4 R:217,18
1		6,844164	4,775860	3,241098
2	6,844164		1,392664	3,191555
3	4,775860	1,392664		1,559477
4	3,241098	3,191555	1,559477	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (3, N= 404) =49,27891 p =,0000
Include condition: Vessel='C'

Depend.: CPUE	1 R:277,24	2 R:166,73	3 R:188,74	4 R:217,18
1		0,000000	0,000011	0,007144
2	0,000000		0,982328	0,008491
3	0,000011	0,982328		0,713301
4	0,007144	0,008491	0,713301	



CPUE in groups 2 and 3 is not significantly different. But CPUE in group 1 is significantly higher than CPUE in groups 2. 3 and 4.

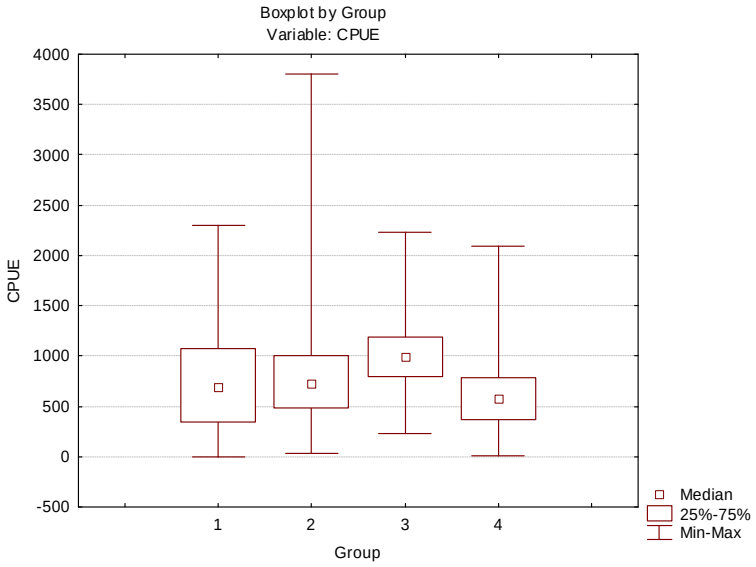
Tests with VESSEL H in 2007:

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (3, N= 865) =107,7973 p =0,000
Include condition: Vessel='H'

Depend.: CPUE	1 R:408,75	2 R:420,20	3 R:593,43	4 R:325,88
1		0,508197	7,19012	3,24593
2	0,508197		7,31132	4,00935
3	7,190117	7,311316		10,07327
4	3,245926	4,009352	10,07327	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (3, N= 865) =107,7973 p =0,000
Include condition: Vessel='H'

Depend.: CPUE	1 R:408,75	2 R:420,20	3 R:593,43	4 R:325,88
1		1,000000	0,00	0,007024
2	1,000000		0,00	0,000365
3	0,000000	0,000000		0,000000
4	0,007024	0,000365	0,00	



CPUE in groups 2 and 3 was significantly different. whereas CPUE in group 3 being significantly higher than in groups 1 and 2.

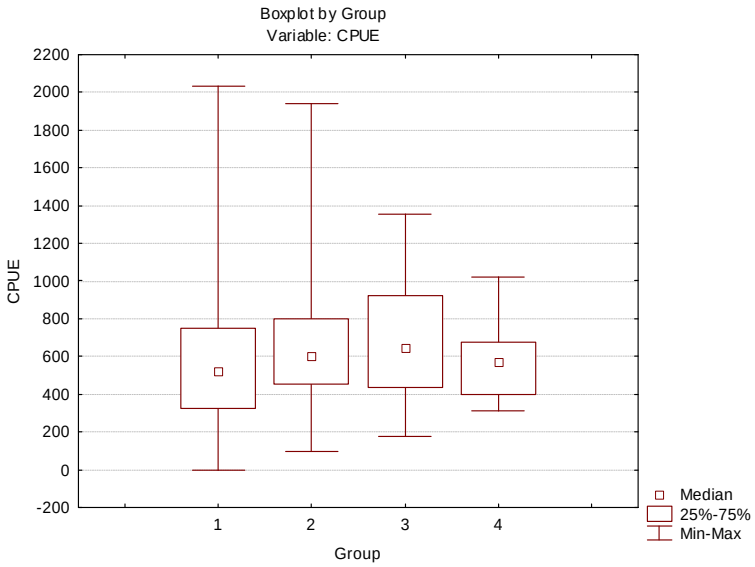
Tests with VESSEL B in 2007:

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 609) =10,72613 p =,0133
Include condition: Vessel='B'

Depend.: CPUE	1 R:288,73	2 R:334,60	3 R:355,26	4 R:316,66
1		2,770097	2,117377	0,622689
2	2,770097		0,621030	0,388516
3	2,117377	0,621030		0,723792
4	0,622689	0,388516	0,723792	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 609) =10,72613 p =,0133
Include condition: Vessel='B'

Depend.: CPUE	1 R:288,73	2 R:334,60	3 R:355,26	4 R:316,66
1		0,033624	0,205367	1,000000
2	0,033624		1,000000	1,000000
3	0,205367	1,000000		1,000000
4	1,000000	1,000000	1,000000	



CPUE was significantly different only between groups 1 and 2. whereas CPUE in group 1 being lower than in group 2.

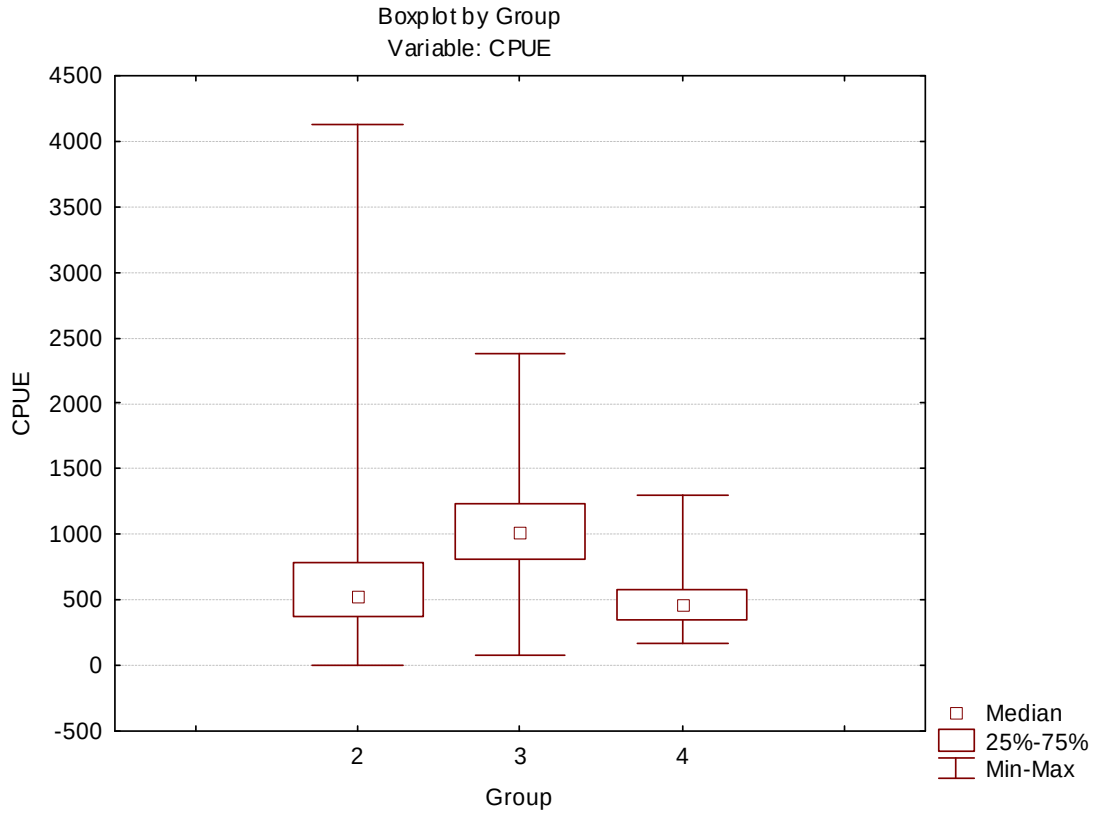
Tests with vessel H in 2008:

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (2, N= 306) =125,8119 p =0,000
Include condition: v2='H'

Depend.: CPUE	2 R:122,67	3 R:224,86	4 R:96,077
2		8,44150	2,06936
3	8,441496		10,39420
4	2,069361	10,39420	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (2, N= 306) =125,8119 p =0,000
Include condition: v2='H'

Depend.: CPUE	2 R:122,67	3 R:224,86	4 R:96,077
2		0,00	0,115537
3	0,000000		0,000000
4	0,115537	0,00	



CPUE of group 3 was significantly higher compared to CPUE of group 2.

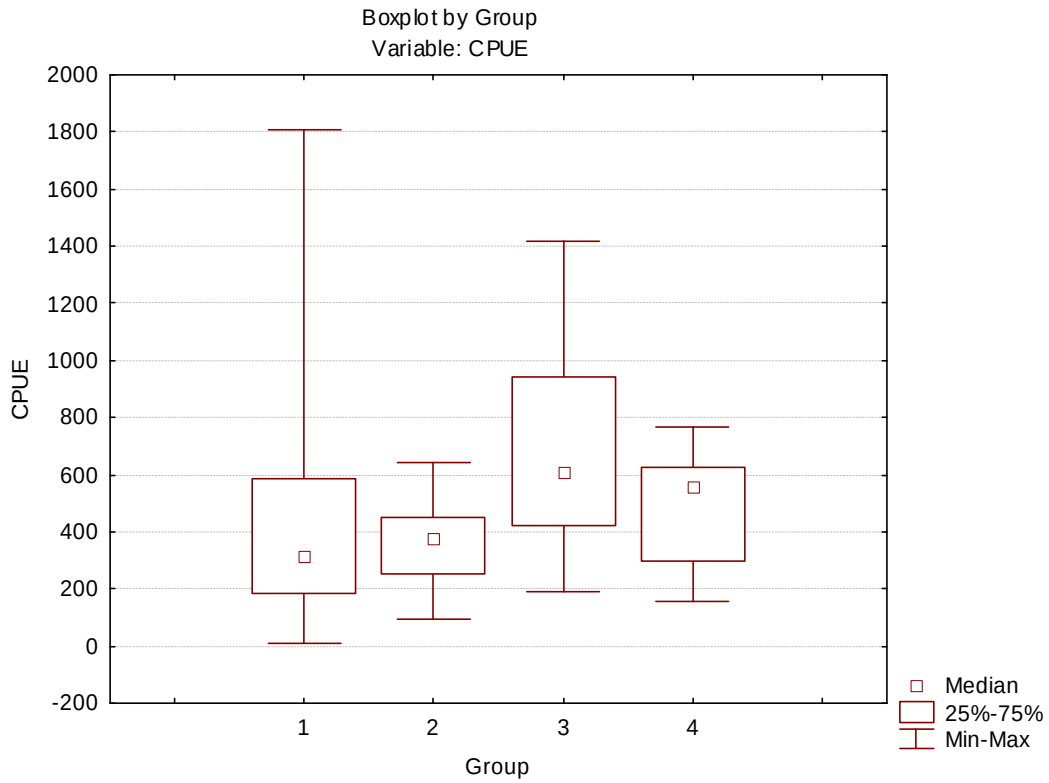
Tests with vessel F in 2008:

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (3, N= 234) =11,48516 p =,0094
Include condition: v2='F'

Depend.: CPUE	1 R:111,58	2 R:114,22	3 R:165,24	4 R:141,54
1		0,202814	3,117848	1,538801
2	0,202814		2,511084	1,227059
3	3,117848	2,511084		0,950111
4	1,538801	1,227059	0,950111	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (3, N= 234) =11,48516 p =,0094
Include condition: v2='F'

Depend.: CPUE	1 R:111,58	2 R:114,22	3 R:165,24	4 R:141,54
1		1,000000	0,010931	0,743118
2	1,000000		0,072217	1,000000
3	0,010931	0,072217		1,000000
4	0,743118	1,000000	1,000000	



CPUE of groups 2 and 3 were not significantly different.

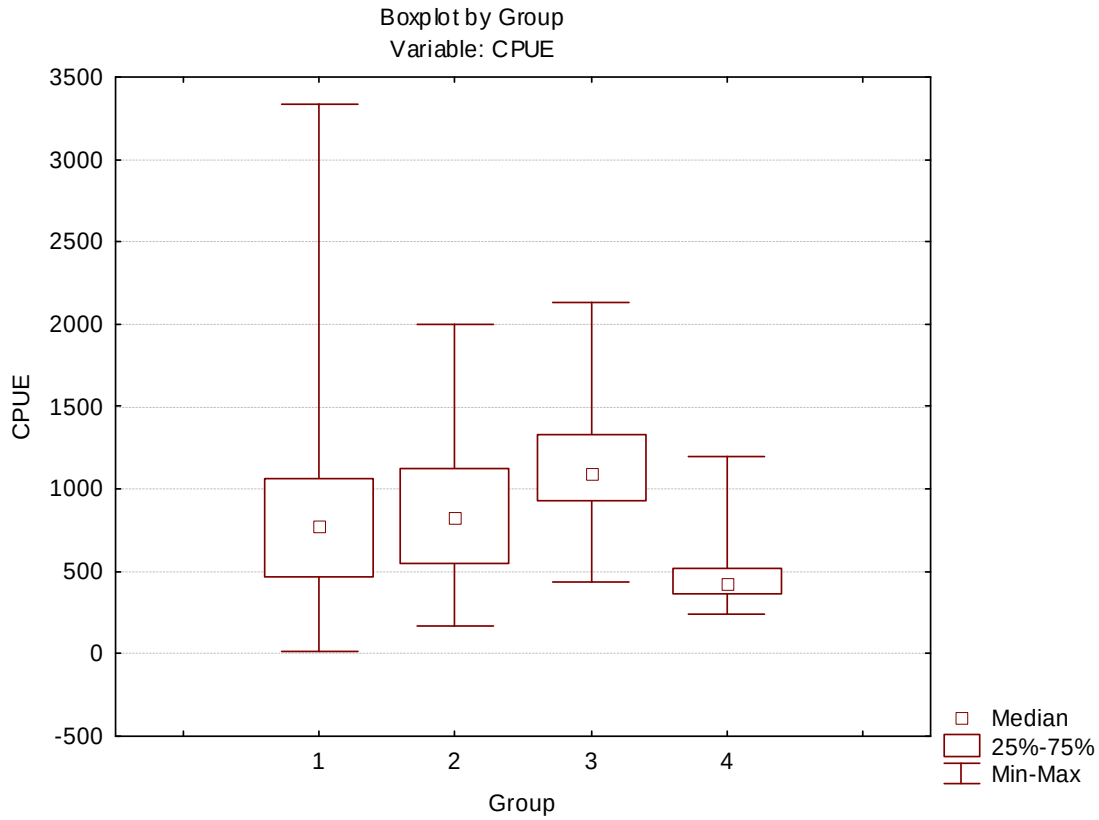
Tests with vessel D in 2008:

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (3, N= 590) =162,3048 p =0,000
Include condition: v2='D'

Depend.: CPUE	1 R:267,25	2 R:295,72	3 R:414,10	4 R:117,60
1		1,573660	7,60729	6,32322
2	1,573660		6,47310	7,79665
3	7,607290	6,473097		12,44896
4	6,323223	7,796653	12,44896	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (3, N= 590) =162,3048 p =0,000
Include condition: v2='D'

Depend.: CPUE	1 R:267,25	2 R:295,72	3 R:414,10	4 R:117,60
1		0,693396	0,000000	0,000000
2	0,693396		0,000000	0,000000
3	0,000000	0,000000		0,000000
4	0,000000	0,000000	0,000000	



CPUE of group 3 was significantly higher compared to CPUE of group 2.

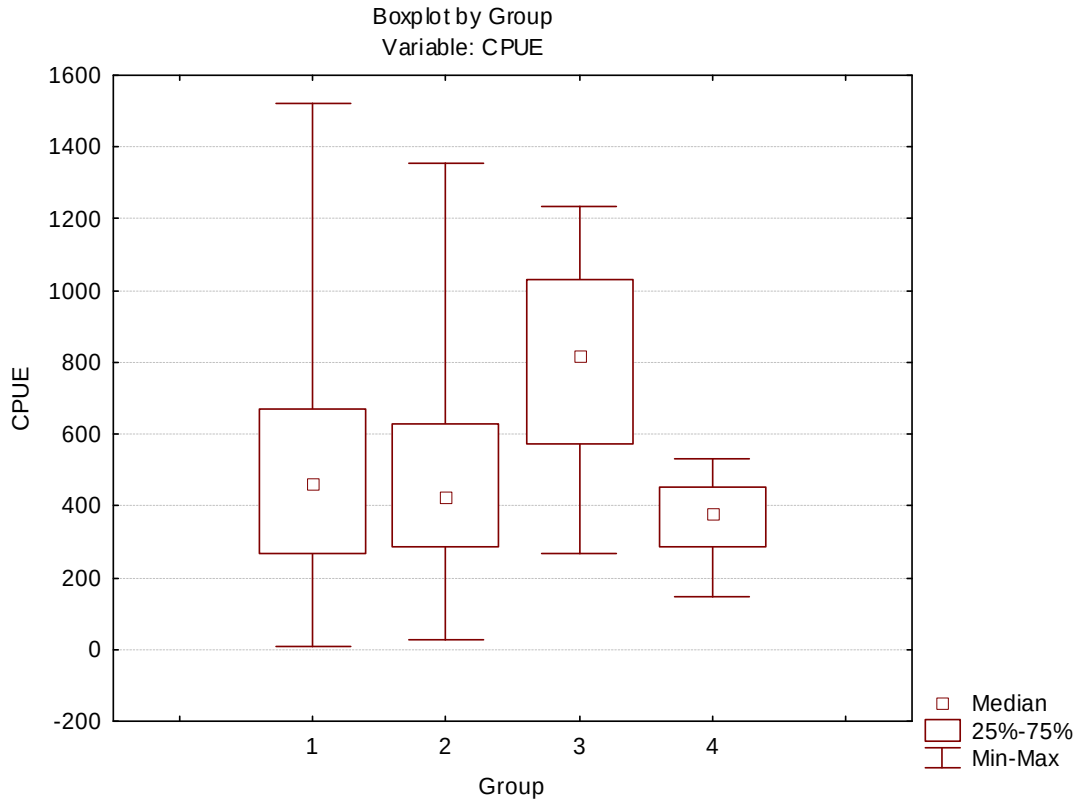
Tests with vessel C in 2008:

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (3, N= 305) =54,21367 p =,0000
Include condition: v2='C'

Depend.: CPUE	1 R:147,91	2 R:139,75	3 R:233,08	4 R:108,58
1		0,673083	5,529226	2,441665
2	0,673083		6,195054	1,975128
3	5,529226	6,195054		6,755983
4	2,441665	1,975128	6,755983	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (3, N= 305) =54,21367 p =,0000
Include condition: v2='C'

Depend.: CPUE	1 R:147,91	2 R:139,75	3 R:233,08	4 R:108,58
1		1,000000	0,000000	0,087718
2	1,000000		0,000000	0,289522
3	0,000000	0,000000		0,000000
4	0,087718	0,289522	0,000000	



CPUE of group 3 was significantly higher compared to CPUE of group 2.

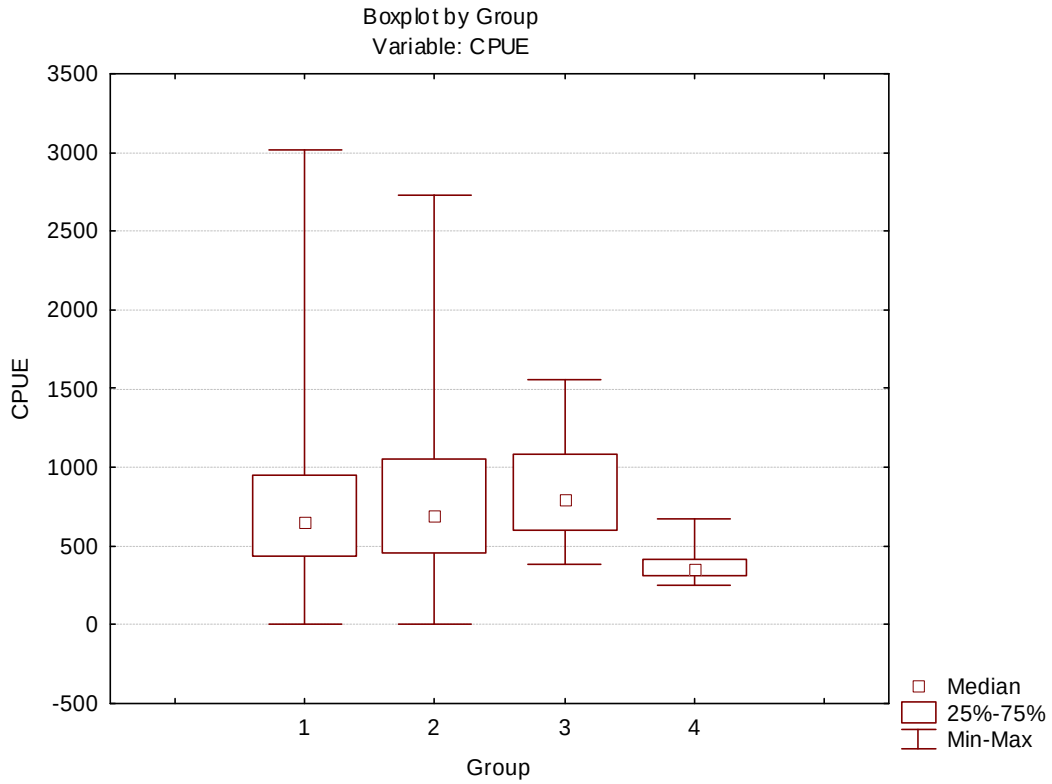
Tests with vessel B in 2008:

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (3, N= 417) =60,72073 p =,0000
Include condition: v2='B'

Depend.: CPUE	1 R:204,03	2 R:226,78	3 R:261,55	4 R:82,659
1		1,664683	3,237781	5,767673
2	1,664683		1,928182	6,775732
3	3,237781	1,928182		7,419997
4	5,767673	6,775732	7,419997	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable:Group
Kruskal-Wallis test: H (3, N= 417) =60,72073 p =,0000
Include condition: v2='B'

Depend.: CPUE	1 R:204,03	2 R:226,78	3 R:261,55	4 R:82,659
1		0,575856	0,007228	0,000000
2	0,575856		0,322995	0,000000
3	0,007228	0,322995		0,000000
4	0,000000	0,000000	0,000000	



CPUE of groups 2 and 3 was not significantly different.

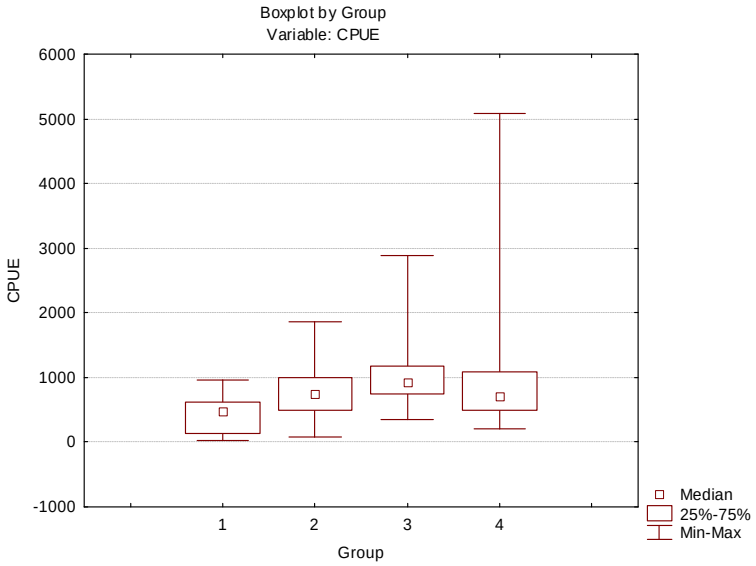
Annex 2. Tests with only double trawls included:

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 720) =99,62595 p =0,000
Include condition: Vessel='D' AND GEARTYPE=2

Depend.: CPUE	1 R:162,04	2 R:342,89	3 R:464,44	4 R:351,23
1		6,087765	9,566377	5,745808
2	6,087765		6,371697	0,393684
3	9,566377	6,371697		4,760367
4	5,745808	0,393684	4,760367	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 720) =99,62595 p =0,000
Include condition: Vessel='D' AND GEARTYPE=2

Depend.: CPUE	1 R:162,04	2 R:342,89	3 R:464,44	4 R:351,23
1		0,000000	0,000000	0,000000
2	0,000000		0,000000	1,000000
3	0,000000	0,000000		0,000012
4	0,000000	1,000000	0,000012	



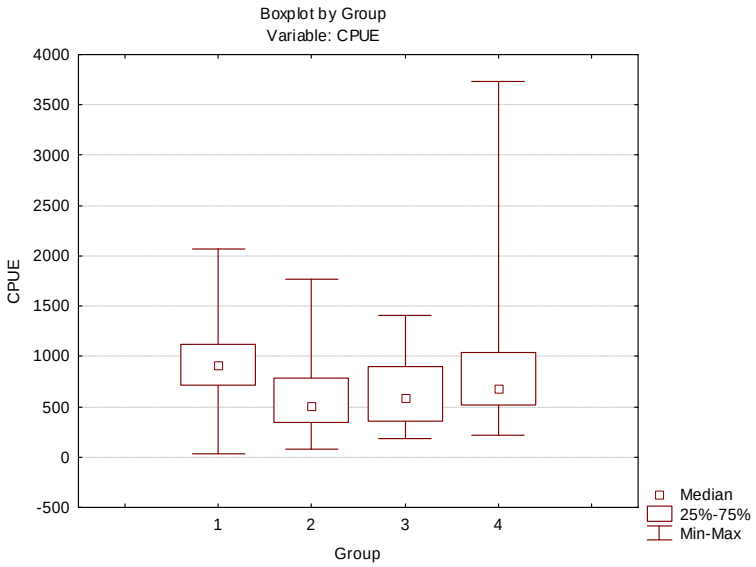
CPUE of groups 2 and 3 was significantly different. Prewious test had the same result. Yes the catch rate of group 4 is lower than catch rate of 3.

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 394) =52,61080 p =,0000
Include condition: Vessel='C' and geartype=2

Depend.: CPUE	1 R:268,03	2 R:160,22	3 R:181,72	4 R:224,44
1		6,846292	4,776103	2,334692
2	6,846292		1,394552	3,985524
3	4,776103	1,394552		2,322941
4	2,334692	3,985524	2,322941	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 394) =52,61080 p =,0000
Include condition: Vessel='C' and geartype=2

Depend.: CPUE	1 R:268,03	2 R:160,22	3 R:181,72	4 R:224,44
1		0,000000	0,000011	0,117357
2	0,000000		0,978905	0,000404
3	0,000011	0,978905		0,121094
4	0,117357	0,000404	0,121094	



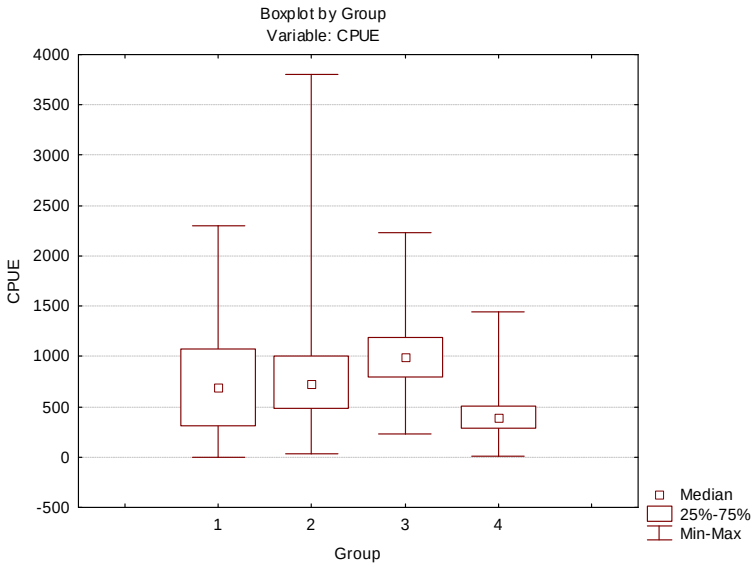
CPUE of groups 2 and 3 was not significantly different. Prewious test had the same result. No the catch rate of group 4 was not lower than catch rate of 2 and 3.

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 748) =133,6166 p =0,000
Include condition: Vessel='H' AND GEARTYPE=2

Depend.: CPUE	1 R:346,50	2 R:364,15	3 R:507,10	4 R:168,52
1		0,898940	7,20554	5,94276
2	0,898940		6,95520	6,82105
3	7,205542	6,955197		11,08019
4	5,942762	6,821048	11,08019	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 748) =133,6166 p =0,000
Include condition: Vessel='H' AND GEARTYPE=2

Depend.: CPUE	1 R:346,50	2 R:364,15	3 R:507,10	4 R:168,52
1		1,000000	0,000000	0,000000
2	1,000000		0,000000	0,000000
3	0,000000	0,000000		0,000000
4	0,000000	0,000000	0,000000	



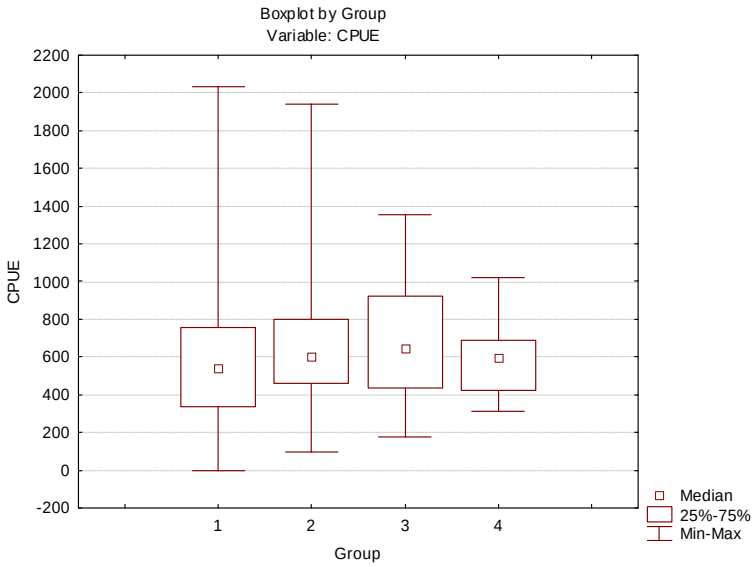
CPUE of groups 2 and 3 was significantly different. Prewious test had the same result. Yes the catch rate of group 4 is lower than catch rate of 2 and 3 and 1.

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 592) =8,213823 p =,0418
Include condition: Vessel='B' and geartype=2

Depend.: CPUE	1 R:282,25	2 R:320,88	3 R:340,09	4 R:313,82
1		2,382280	1,890589	0,678466
2	2,382280		0,593312	0,147948
3	1,890589	0,593312		0,483607
4	0,678466	0,147948	0,483607	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2007_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 592) =8,213823 p =,0418
Include condition: Vessel='B' and geartype=2

Depend.: CPUE	1 R:282,25	2 R:320,88	3 R:340,09	4 R:313,82
1		0,103235	0,352075	1,000000
2	0,103235		1,000000	1,000000
3	0,352075	1,000000		1,000000
4	1,000000	1,000000	1,000000	



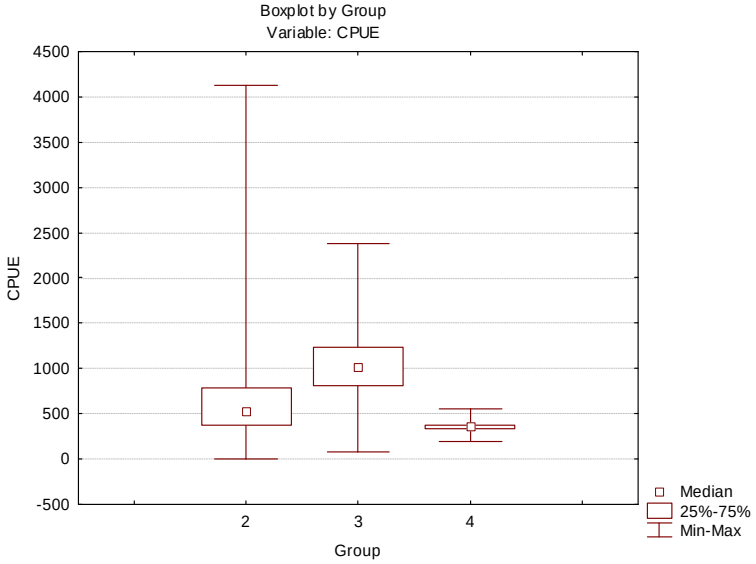
CPUE of groups 2 and 3 was not significantly different. Prewious test had the same result. No the catch rate of group 4 is not lower than catch rate of 2 and 3.

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (2, N= 219) =75,06683 p =,0000
Include condition: vessel='H' and geartype=2

Depend.: CPUE	2 R:73,394	3 R:144,83	4 R:33,600
2		8,223627	1,370125
3	8,223627		3,842741
4	1,370125	3,842741	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (2, N= 219) =75,06683 p =,0000
Include condition: vessel='H' and geartype=2

Depend.: CPUE	2 R:73,394	3 R:144,83	4 R:33,600
2		0,000000	0,511944
3	0,000000		0,000365
4	0,511944	0,000365	



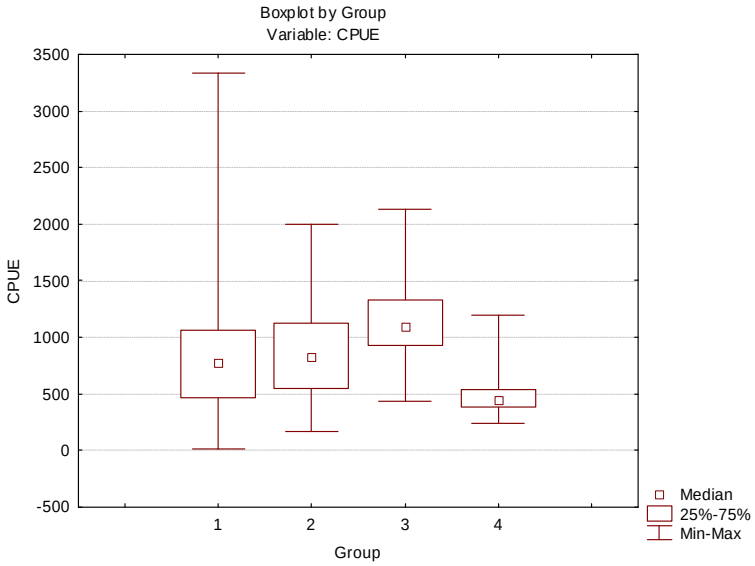
CPUE of groups 2 and 3 was significantly different. Prewious test had the same result. Yes the catch rate of group 4 is lower than catch rate of 3.

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 579) =146,5901 p =0,000
Include condition: vessel='D' and geartype=2

Depend.: CPUE	1 R:258,33	2 R:285,85	3 R:403,11	4 R:116,71
1		1,550169	7,64215	5,78143
2	1,550169		6,53313	7,12690
3	7,642152	6,533133		11,62531
4	5,781430	7,126904	11,62531	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 579) =146,5901 p =0,000
Include condition: vessel='D' and geartype=2

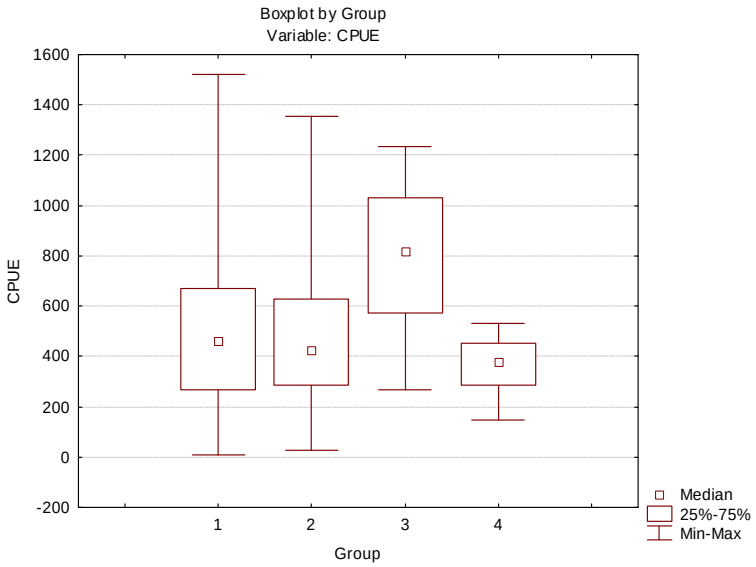
Depend.: CPUE	1 R:258,33	2 R:285,85	3 R:403,11	4 R:116,71
1		0,726605	0,000000	0,000000
2	0,726605		0,000000	0,000000
3	0,000000	0,000000		0,000000
4	0,000000	0,000000	0,000000	



CPUE of groups 2 and 3 was significantly different. Prewious test had the same result. Yes the catch rate of group 4 is lower than catch rate of 2. 3 and 4.

	Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta) Independent (grouping) variable: Group Kruskal-Wallis test: H (3, N= 305) =54,21367 p =,0000 Include condition: vessel='C' and geartype=2			
Depend.: CPUE	1 R:147,91	2 R:139,75	3 R:233,08	4 R:108,58
1		0,673083	5,529226	2,441665
2	0,673083		6,195054	1,975128
3	5,529226	6,195054		6,755983
4	2,441665	1,975128	6,755983	

	Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta) Independent (grouping) variable: Group Kruskal-Wallis test: H (3, N= 305) =54,21367 p =,0000 Include condition: vessel='C' and geartype=2			
Depend.: CPUE	1 R:147,91	2 R:139,75	3 R:233,08	4 R:108,58
1		1,000000	0,000000	0,087718
2	1,000000		0,000000	0,289522
3	0,000000	0,000000		0,000000
4	0,087718	0,289522	0,000000	



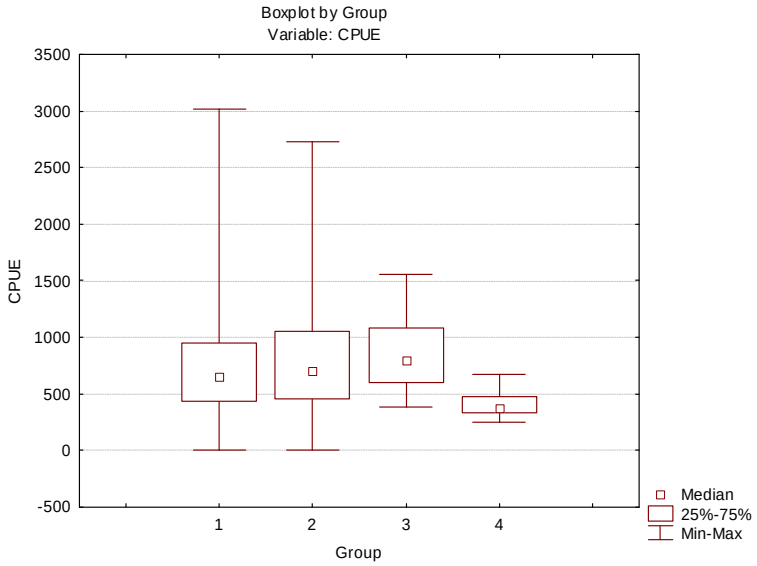
CPUE of groups 2 and 3 was significantly different. Prewious test had the same result. In 2008 vessel used only double trawls. Yes the catch rate of group 4 is lower than catch rate of 3 but the same as 1 and 2.

Multiple Comparisons z' values; CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 397) =33,84406 p =,0000
Include condition: vessel='B' and geartype=2

Depend.: CPUE	1 R:188,39	2 R:209,43	3 R:241,92	4 R:83,545
1		1,614725	3,165436	4,024064
2	1,614725		1,890644	4,799099
3	3,165436	1,890644		5,584656
4	4,024064	4,799099	5,584656	

Multiple Comparisons p values (2-tailed); CPUE (3M3Lvõrdlus_2008_ja_reliability_4 groups.sta)
Independent (grouping) variable: Group
Kruskal-Wallis test: H (3, N= 397) =33,84406 p =,0000
Include condition: vessel='B' and geartype=2

Depend.: CPUE	1 R:188,39	2 R:209,43	3 R:241,92	4 R:83,545
1		0,638222	0,009291	0,000343
2	0,638222		0,352032	0,000010
3	0,009291	0,352032		0,000000
4	0,000343	0,000010	0,000000	



Catch rate of groups 2 and 3 was not significantly different. Prewious test had the same result. Yes the catch rate of group 4 is lower than catch rate of 1. 2 and 3.