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Minimizing undersized catches in deep water rose shrimp fisheries in the Strait of Sicily adopting Low Impact Fishing Techniques (LIFTs)

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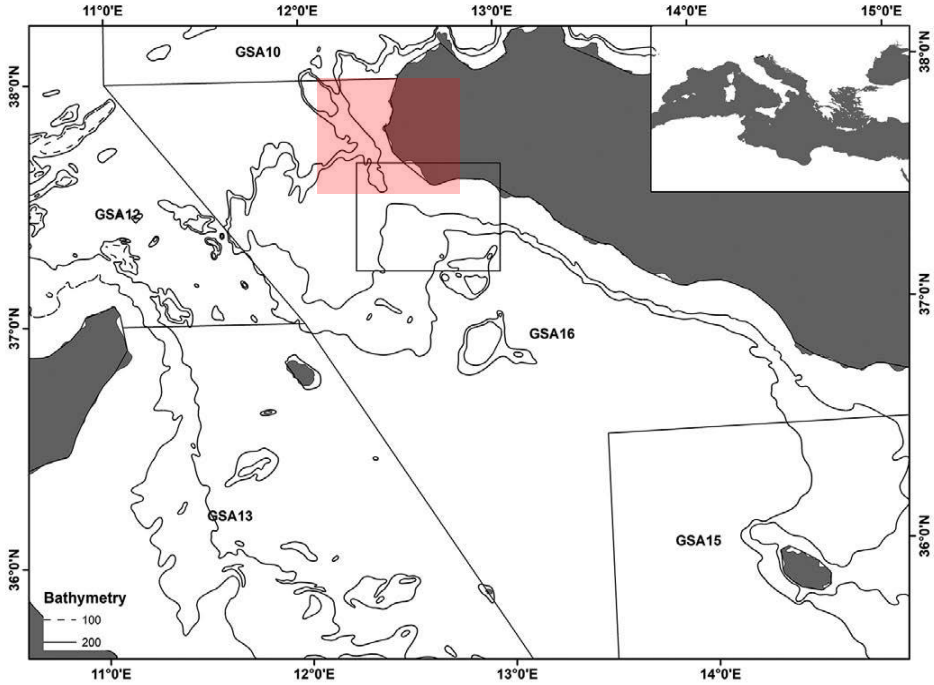
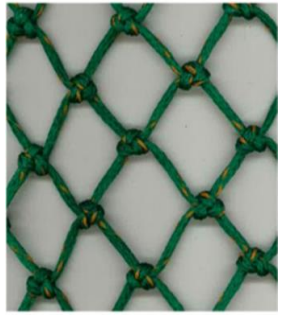
Project: Mediterranean Marine Initiative action plan to improve protection and environmental conservation of the Mediterranean area

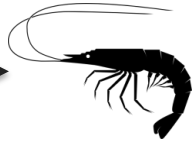
Goal: Testing innovative technology for selective (and less impacting) fishing gears to minimize the impacts of fisheries and unwanted catches, to promote a new generation of fishing practices.

2. Study area GSA16, South of Sicily



3. Study Design





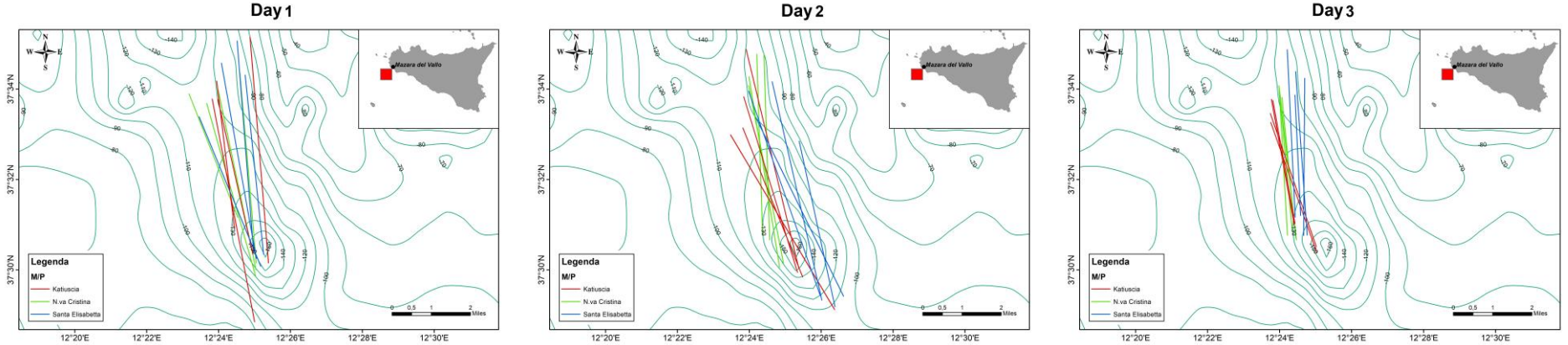
- Sars-CoV2 pandemic did not allow the embarking of scientific observers aboard the fishing vessels

- Fishermen were trained by the CNR staff on:

i. Aims of the project
ii. Recording geographical coordinates and depth of each haul
iii. Recording the overall catch including DPS and HKE (in kilograms)
iv. Sampling both catch and discard
v. Subsampled DPS and HKE catch as well as discard both in terms of commercial and discarded fraction

- Scientific observer were replaced by one camera installed in each fishing vessel.

- Fishing trips were remotely monitored by AIS tracking system



Red line: G1-SM40, **Green line: T-90**, **Blue line: Control**

- Mean depth of paired hauls per net setup and days

Net setup	Day	Mean depth (m) ± sd
T-90	1	132±20
	2	129±19
	3	127±17
G1-SM40	1	130±23
	2	119±18
	3	127±19
Control	1	120±11
	2	130±15
	3	120±9

Main descriptive statistics of DPS and HKE samples per net setup

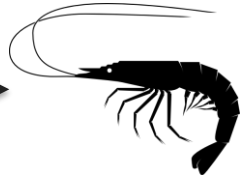
Net setup	Species	*N*	Min. length (mm)	Max. length (mm)	Mean ± sd (mm)	Undersized (*N*)	Undersized (%)
T-90	DPS	8936	6	31	20 ± 3	4254	48
	HKE	250	75	635	307 ± 93	9	4
G1-SM40	DPS	59308	10	34	20 ± 4	28911	49
	HKE	617	55	570	195 ± 78	431	70
Control	DPS	66888	5	31	19 ± 3	41999	63
	HKE	921	55	700	187 ± 84	676	73

- Control showed a very low selectivity towards undersized individuals (i.e. DPS: 63%, HKE: 73%)
- LIFTs showed similar proportion of undersized DPS individuals (i.e. T-90: 48%, G1-SM40: 49%)
- T-90 showed catches of undersized DPS of about 10 times lower than Control and G1-SM40, respectively
- T-90 showed catches of undersized HKE of about 75 and 48 times lower than Control and G1-SM40, respectively

N.B.: Undersized refers to specimens below to the Minimum Conservation Reference Size (MCRS): DPS: 20 mm CL, HKE: 200 mm TL (Reg. EU 1967/2006)

7. Data analysis #2 – Size structure - Length Frequency Distribution

Length Frequency Distribution (LFD)



Control vs T-90 — *KS test: D = 0.17145, p-value < 2.2^{e-16}*

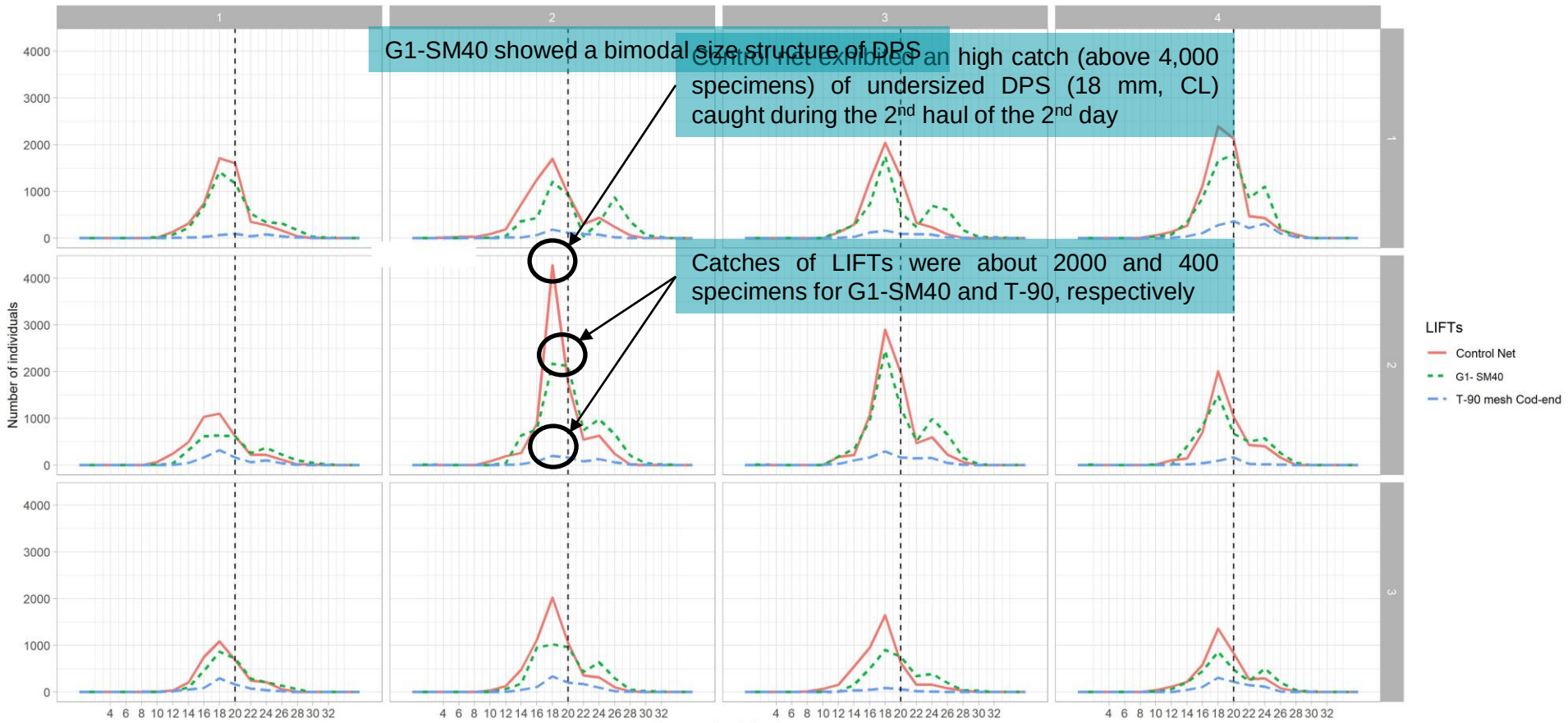
Control vs G1-SM40 — *KS test: D = 0.15684, p-value < 2.2^{e-16}*

Control vs T-90 — *KS test: D = 0.70084, p-value < 2.2^{e-16}*

Control vs G1-SM40 — *KS test: D = 0.13625, p-value = 2.204^{e-06}*

- Non parametric two-sample Kolmogorov Smirnov test (KS test) ***showed significant differences of size structure of both DPS and HKE samples***

8. Data analysis #3 – Length Frequency Distribution

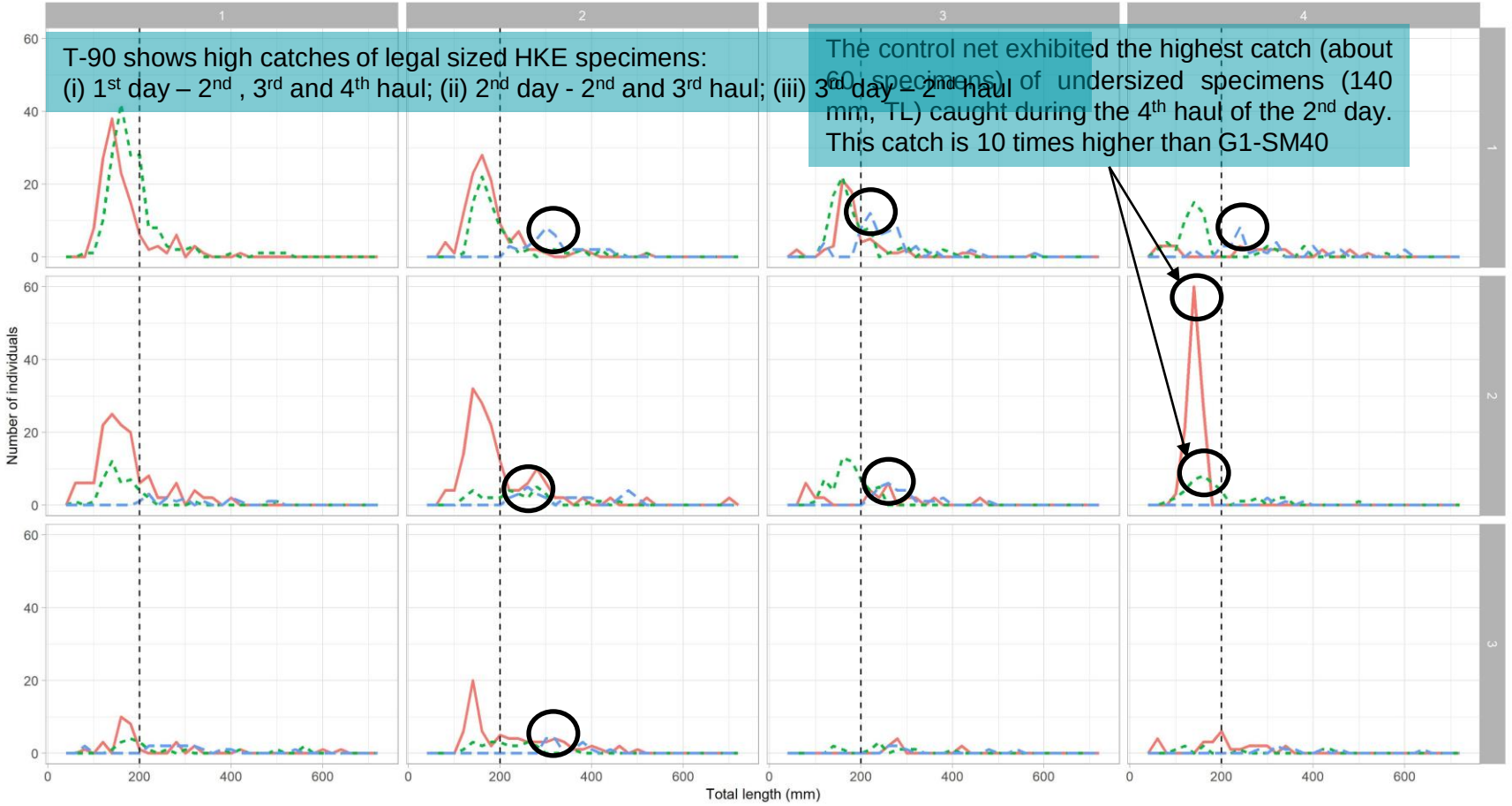


- G1-SM40 showed an overall reduction of undersized and an increase of legal sized DPS catches compared to the control
- T-90 showed much lower number of DPS than control

9. Data analysis #4 – Length Frequency Distribution

T-90 shows high catches of legal sized HKE specimens:
(i) 1st day – 2nd , 3rd and 4th haul; (ii) 2nd day - 2nd and 3rd haul; (iii) 3rd day – 2nd haul

The control net exhibited the highest catch (about 60 specimens) of undersized specimens (140 mm, TL) caught during the 4th haul of the 2nd day. This catch is 10 times higher than G1-SM40



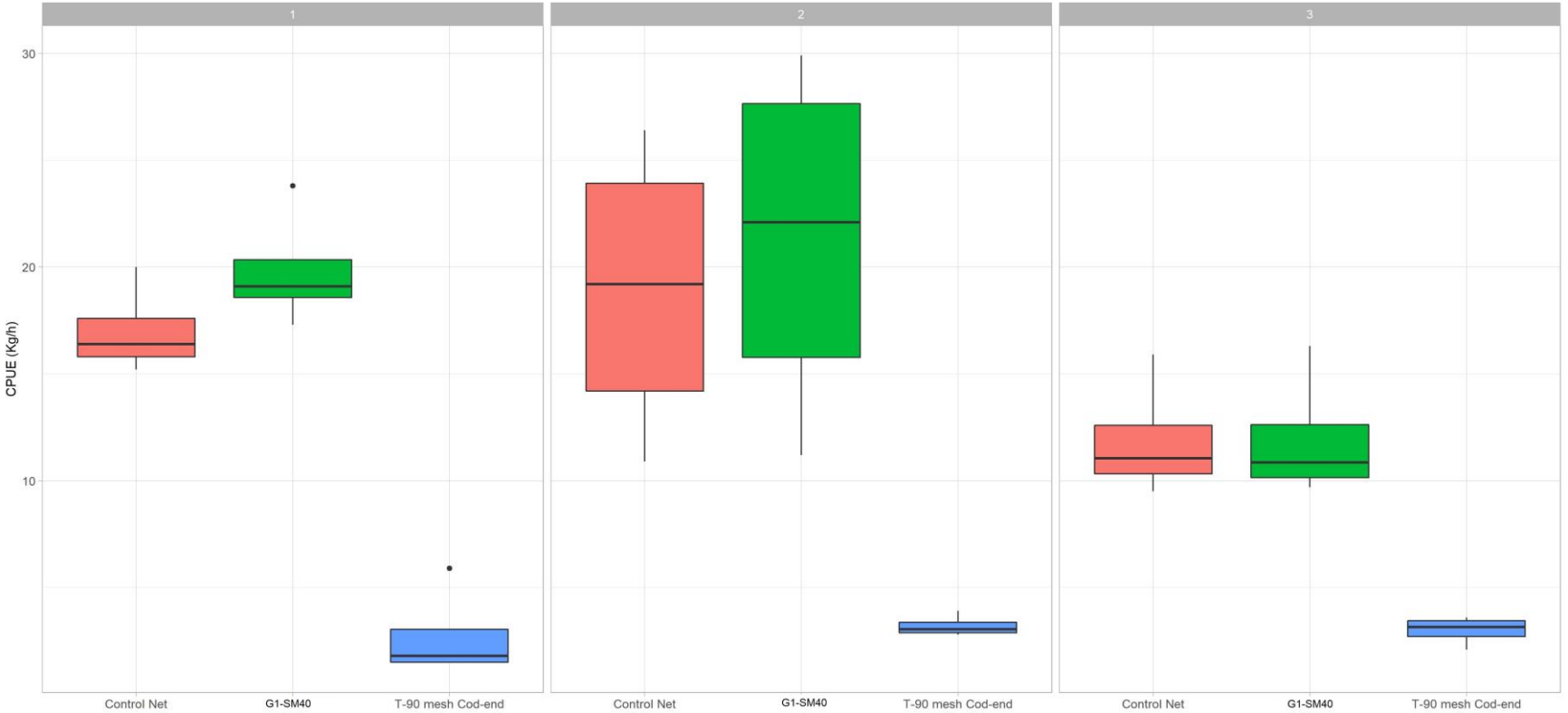
- G1-SM40 showed an overall reduction of both undersized and legal sized HKE
- T-90 net showed much lower catches of HKE than control but mainly composed by legal sized HKE

Total and individual weight of DPS and HKE samples per net setup

Nets setup	Species	Tot. weight (Kg)	Min. weight (g)	Max. weight (g)	Mean ± sd (g)
T-90	DPS	48	1	15	5 ± 3
	HKE	75	3	2269	302± 280
G1-SM40	DPS	320	1	18	5 ± 3
	HKE	57	1	1600	93± 84
Control	DPS	287	1	14	4 ± 2
	HKE	84	1	2974	91±86

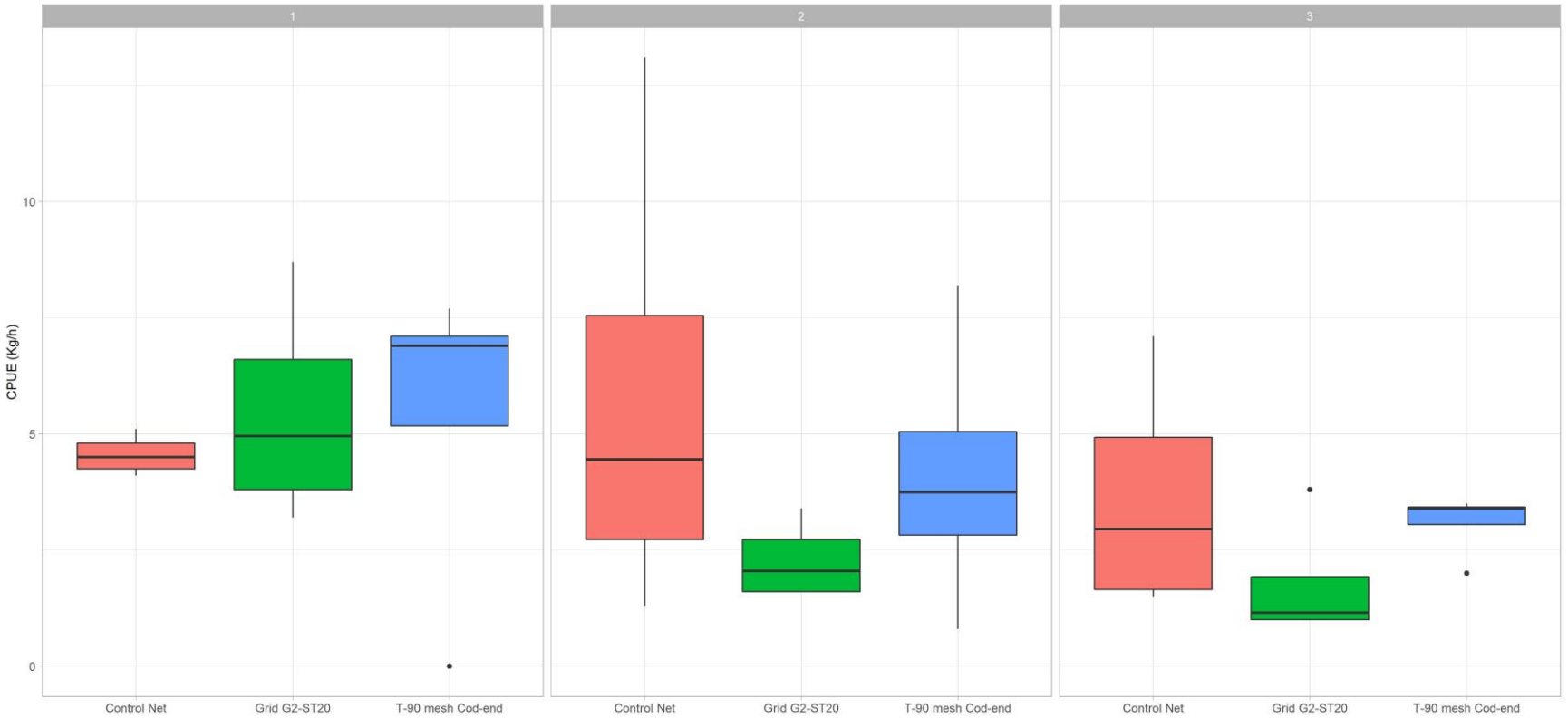
- G1-SM40 showed the most abundant catch of DPS followed by Control (i.e. G1-SM40: 320 kg, Control: 287 kg)
- Control showed the highest catch of HKE followed by T-90 (i.e. Control: 84 kg, T-90: 75 kg)
- Mean weight of DPS samples was 4 (Control), 5 (G1-SM40) and 5 g (T-90)
- Mean weight of HKE samples ranged from 91 (Control), 93 (G1-SM40), 302 g (T-90)

11. Data analysis #6 – Catch rates - CPUE



- G1-SM40 showed the higher CPUE whereas T-90 showed the lower one
- CPUEs of DPS showed significant difference between gears *(Kruskal-Wallis test: chi-squared = 23.701, df = 2, p-value = 7.134^{e-06})*
- Dunn *post-hoc* test showed significant difference between T90 and Control as well as between T-90 vs G1-SM40, (*p<0,05)*

12. Data analysis #7 – Catch rates - CPUE



- T-90 showed the most abundant CPUEs of HKE during the first and third day whereas Control showed an high CPUE during the second day
- CPUEs of the HKE showed no significant difference between gears *(Kruskal-Wallis chi-squared = 2.5603, df = 2, p-value = 0.278*)

- T-90 mesh cod-end resulted the most selective gear within LIFTs about catches of undersized HKEs
- T-90 mesh cod-end recorded the higher CPUEs within LIFTs due to weight of legal sized HKEs

- G1-SM40 reduced the catch of undersized DPSs of about 14% compared to Control
- G1-SM40 recorded the higher CPUEs while the percentage of undersized specimens was quite similar by T-90 (i.e. T-90: 48%, G1-SM40: 49%)

Conclusion

- Low selectivity of Control was confirmed by the high catches of both DPS and HKE undersized specimens (DPS 63%; HKE 73%)
- T-90 was more selective towards undersized DPS and HKE, however, considering the very low DPS catch rates obtained with T-90, only G1-SM40 seems a technological improvement that might be capitalized on deep water crustacean fishery although further modification of the gear should be tested with the aim to reduce the catches of undersized HKE

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