10.1071/MF23064

Marine and Freshwater Research

Supplementary Material

Effects of spatial–temporal conditions and fishing-vessel capacity on the capture of swimming crabs by using different fishing gear around the waters of Taiwan

Muhamad Naimullah[A], *Kuo-Wei Lan*[A,B,*], *Cheng-Hsin Liao*[A], *Yu-Jhen Yang*[A], *Chao-Ching Chen*[C], *Hon Jung Liew*[D,E], *and Mhd Ikhwanuddin*[D,F,G]

[A]Department of Environmental Biology Fisheries Science, National Taiwan Ocean University, 2 Pei-Ning Road, Keelung20224, Taiwan, Republic of China.

[B]Center of Excellence for Oceans, National Taiwan Ocean University, 2 Pei-Ning Road, Keelung20224, Taiwan, Republic of China.

[C]Department of Fisheries Production and Management, National Kaohsiung University of Science and Technology, 142 Haijhuan Road, Nanzih District, Kaohsiung City81157, Taiwan, Republic of China.

[D]Higher Institution Center of Excellent, Institute of Tropical Aquaculture and Fisheries, Universiti Malaysia Terengganu, Kuala Nerus, Terengganu21030, Malaysia.

[E]Heilongjiang River Fisheries Research Institute, Chinese Academy of Fishery Sciences, Harbin, Heilongjiang, PR China.

[F]STU-UMT Joint Shellfish Research Laboratory, Shantou, Guangdong515063, PR China.

[G]Faculty of Fisheries and Marine, Campus C, Airlangga University, Mulyorejo, Surabaya60115, Indonesia.

[*]Correspondence to: Kuo-Wei Lan Department of Environmental Biology Fisheries Science, National Taiwan Ocean University, 2 Pei-Ning Road, Keelung 20224, Taiwan, Republic of China Email: kwlan@mail.ntou.edu.tw

Table S1 The description of data attributions used in the GLMMs.

	Group	Variables	Descriptions
Spatial-temporal	Fishing location	Outside north Taiwan Strait (ONTS)	>24.0°N, exclude NTS
		North Taiwan Strait (NTS)	24.0–26.0°N, 119.0–122.0°E
		South Taiwan Strait (STS)	22.0–24.0°N, 119.0–121.0°E
		Outside south Taiwan Strait (OSTS)	<24.0°N, exclude STS
	Climate events	Normal years	2012, 2013, 2019
		La Niña years	2011, 2016, 2017
		El Niño years	2014, 2015, 2018
	Seasons	Winter	December, January and February
		Spring	March, April and May
		Summer	June, July and August
		Autumn	September, October, and November
Vessels capacity	Work hours	Short work hour	<24 h
		Medium work hour	>24 h
		Long work hour	>48 h
	Vessel sizes	CT0	<5 Mg
		CT1	5–<10 Mg
		CT2	10–<20 Mg
		CT3	20–<50 Mg
		CT4	50–<100 Mg
		CT5	100 Mg

Table S2 Technical and total catch weight (kg) variables of VDRs and logbooks data from 2011 t o2019 for trawls, gill-nets and traps in the Taiwan Strait.

	Variables	Trawls	Gill-nets	Traps
Technical				
	Number of vessels	838	395	221
	Mean work hours (h trip^{-1})	3.04	2.90	5.54
	CT (number of vessels)	CT0 (111)	CT0 (160)	CT0 (21)
		CT1 (23)	CT1 (20)	CT1 (13)
		CT2 (83)	CT2 (94)	CT2 (31)
		CT3 (370)	CT3 (106)	CT3 (72)
		CT4 (204)	CT4 (15)	CT4 (73)
		CT5 (47)	CT5 (0)	CT5 (11)
Catch weight (tons)				
	Crustaceans (%)	23612.88 (29.68)	138.27 (1.07)	3763.72 (70.44)
	Demersal fish (%)	20203.51 (25.40)	3028.58 (23.48)	1198.89 (22.44)
	Miscellaneous fish (%)	20314.21 (25.54)	301.91 (2.34)	10.77 (0.20)
	Mollusk (%)	5674.46 (7.13)	232.58 (1.80)	349.28 (6.54)
	Pelagic fish (%)	9743.00 (12.25)	9197.74 (71.31)	20.43 (0.38)
	Total catch weight (kg)	**79548.07**	**12899.10**	**5343.12**

Table S3 Catch composition of crustacean species caught by trawls, gill-nets and traps from 2011 to 2019 in the Taiwan Strait.

Crustacean species	Trawls		Gillnets		Traps	
	Catchweight (kg)	%	Catchweight (kg)	%	Catchweight (kg)	%
Acetes intermedius	**3874092**	**16.41**	0	0.00	0	0.00
Calappidae	2328	0.01	83	0.06	2473	0.07
Carcinoplax longimana	332	0.00	0	0.00	1	0.00
Charybdis acutifrons	0	0.00	3	0.00	0	0.00
Charybdis anisodon	7	0.00	0	0.00	609	0.02
Charybdis annulata	229	0.00	0	0.00	0	0.00
Charybdis feriatus	43164	0.18	4062	2.94	**995827**	**26.46**
Charybdis granulata	21	0.00	14	0.01	737	0.02
Charybdis japonica	1	0.00	0	0.00	0	0.00
Charybdis lucifera	61	0.00	166	0.12	758	0.02
Charybdis miles	61	0.00	4	0.00	0	0.00
Charybdis natator	2837	0.01	393	0.28	108623	2.89
Charybdis riversandersoni	281	0.00	0	0.00	0	0.00
Other Crustaceans	27440	0.12	131	0.09	0	0.00
Ibacus novemdentatus	41517	0.18	596	0.43	132	0.00
Litopenaeus vannamei	311480	1.32	2484	1.80	0	0.00
Mantis shrimp	9132	0.04	18	0.01	14	0.00
Metanephrops thomsoni	1270041	5.38	58	0.04	0	0.00
Metapenaeopsis barbata	730577	3.09	7861	5.69	0	0.00
Metapenaeopsis provocatoria longiroitris	495892	2.10	21	0.02	0	0.00
Metapenaeus ensis	218478	0.93	74	0.05	0	0.00
Other crabs	569779	2.41	**18797**	**13.59**	**427712**	**11.36**
Other shrimps	**9140360**	**38.71**	2935	2.12	53	0.00
Ovalipes punctatus	50867	0.22	26	0.02	492	0.01
Palinuridae	1943	0.01	8816	6.38	3826	0.10
Panulirus homarus	101703	0.43	1035	0.75	22	0.00
Panulirus ornatus	23353	0.10	240	0.17	27	0.00
Panulirus peniciliatus	0	0.00	216	0.16	0	0.00
Panulirus versicolor	1	0.00	5	0.00	0	0.00
Parapenaeus spp.	900526	3.81	1576	1.14	59	0.00
Penaeus japonicus	317388	1.34	3047	2.20	85	0.00
Penaeus marginatus	102285	0.43	20	0.01	15	0.00
Penaeus monodon	24431	0.10	498	0.36	4	0.00
Penaeus penicillatus	176749	0.75	**40004**	**28.93**	0	0.00
Penulirus japonicus	13	0.00	1660	1.20	2120	0.06
Portunus pelagicus	307206	1.30	15397	11.14	223019	5.93
Portunus sanguinolentus	292530	1.24	**19972**	**14.44**	**1813056**	**48.17**
Ranina ranina	29638	0.13	5890	4.26	182500	4.85

Scylla serrata	5793	0.02	1109	0.80	1561	0.04
Sergestes lucens	**4279079**	**18.12**	0	0.00	0	0.00
Solenocera alticarinata	261270	1.11	1061	0.77	0	0.00
Total catch weight (kg)	**23612883**		**138273**		**3763725**	

Bold formatting shows the top 3 species' catch percentages for each fishing gear.

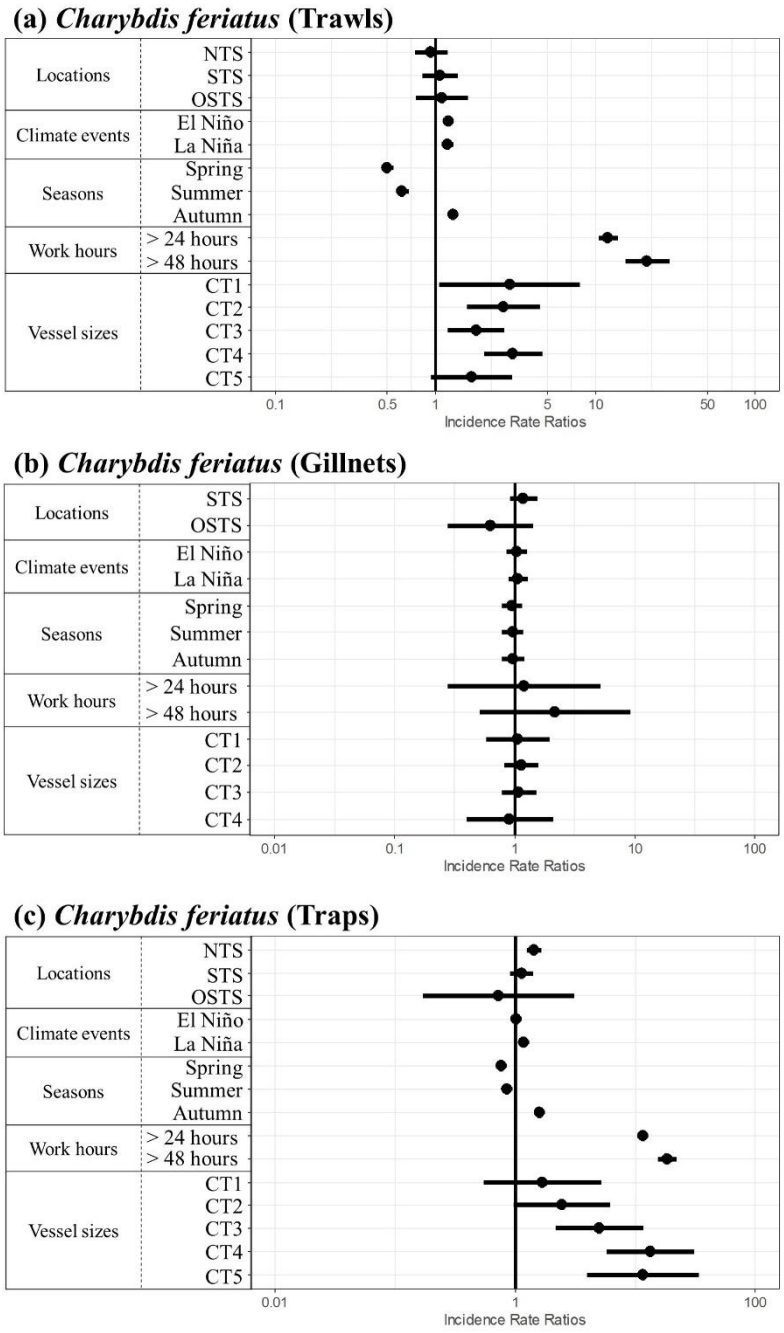

Figure S1. Visualisation of GLMM-derived estimates of catch weight for *Charybdis feriatus* caught using (a) trawls, (b) gill-nets and (c) traps *v.* fishing locations, climate events, seasons, work hours and vessel sizes. The comparisons are relative to the catch weight of *Charybdis feriatus* (the vertical solid black bar, which we treated as "control") with ONTS, normal years, winter, <24 h and CT0. The solid vertical bar indicates no statistically significant effect of the relevant covariate on the response variable.

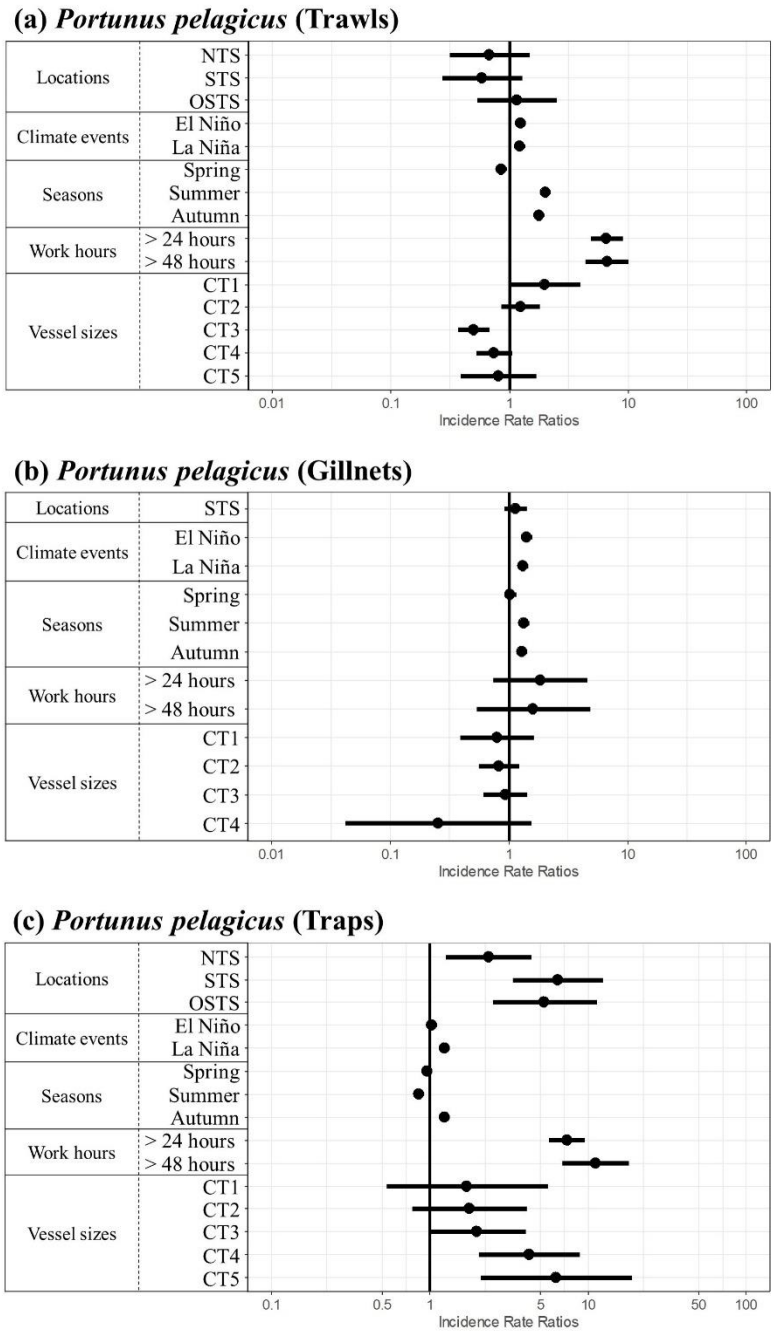

Figure S2. Visualisation of GLMM-derived estimates of catch weight for *Portunus pelagicus* caught using (a) trawls, (b) gill-nets and (c) traps versus fishing locations, climate events, seasons, work hours and vessel sizes. The comparisons are relative to the catch weight of *Portunus pelagicus* (the vertical solid black bar, which we treated as "control") with ONTS, normal years, winter, <24 h and CT0. The solid vertical bar indicates no statistically significant effect of the relevant covariate on the response variable.

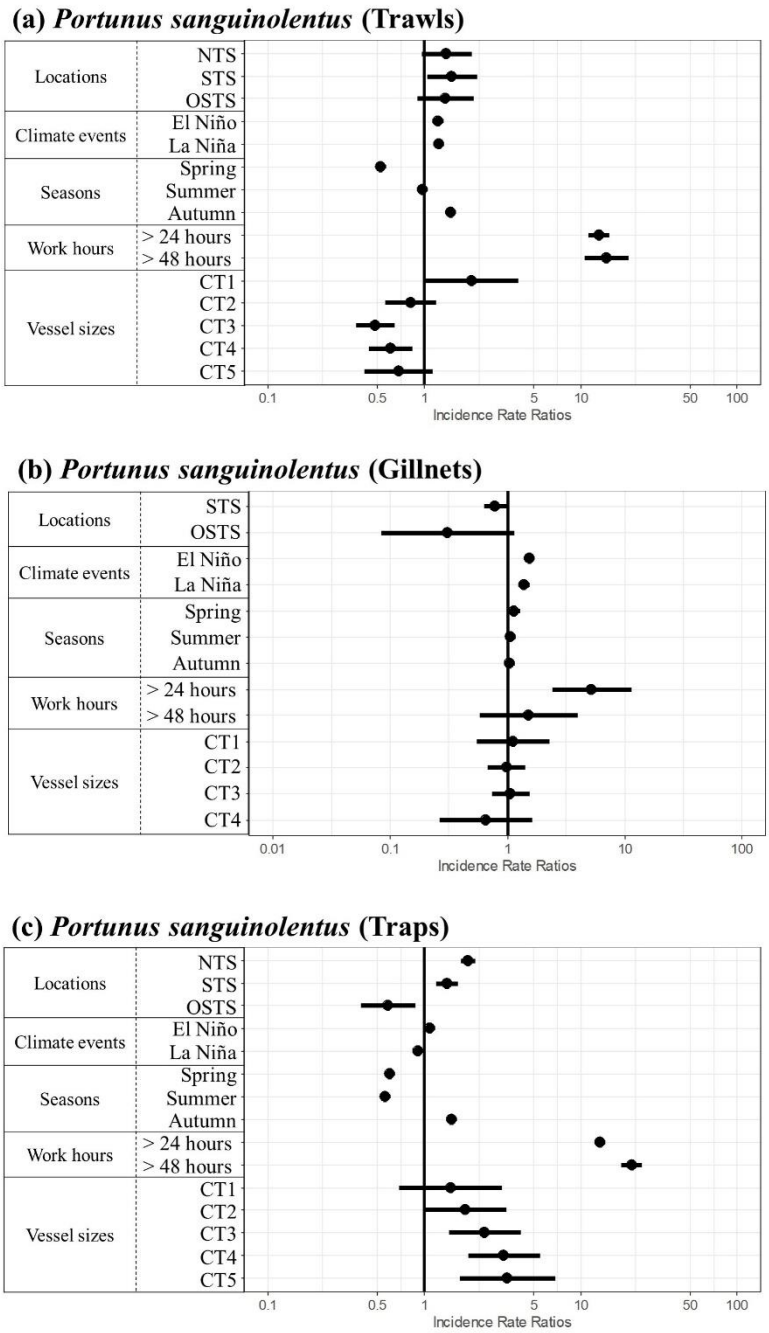

Figure S3. Visualisation of GLMM-derived estimates of catch weight for *Portunus sanguinolentus* caught using (a) trawls, (b) gill-nets and (c) traps versus fishing locations, climate events, seasons, work hours and vessel sizes. The comparisons are relative to the catch weight of *Portunus sanguinolentus* (the vertical solid black bar, which we treated as "control") with ONTS, normal years, winter, <24 h and CT0. The solid vertical bar indicates no statistically significant effect of the relevant covariate on the response variable.

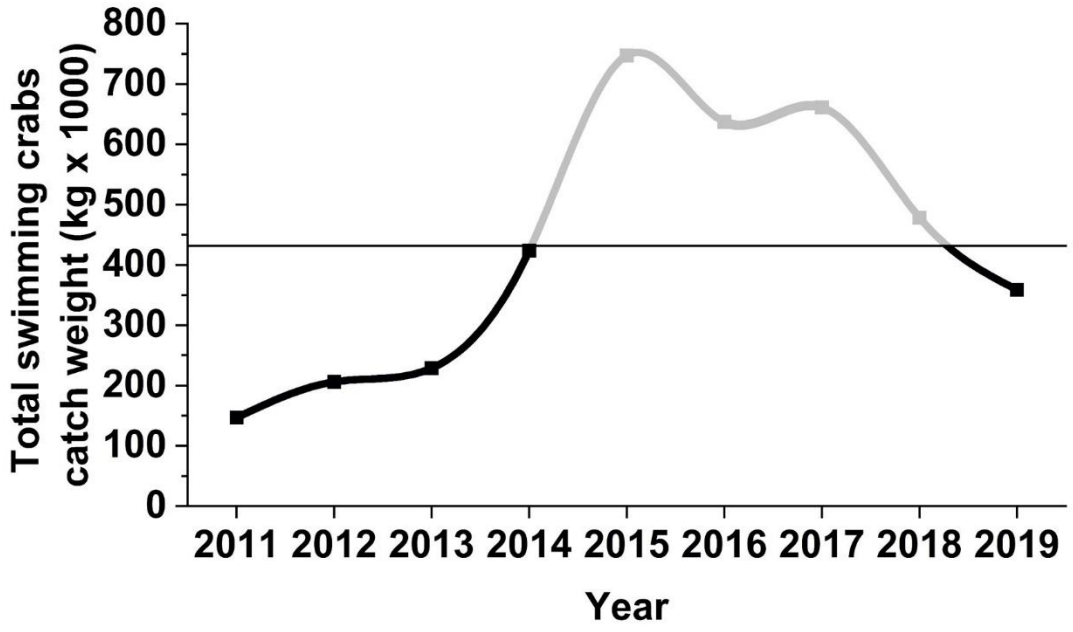

Figure S4. The annual swimming crab's total catch weight (kg) from 2011 to 2019 VDRs and logbook data in the Taiwan Strait. The horizontal line indicated the mean catch weight of swimming crabs from 2011 to 2019. The grey line is the catch weight higher than the mean catch weight; the black line is the catch weight lower than the mean catch weight.

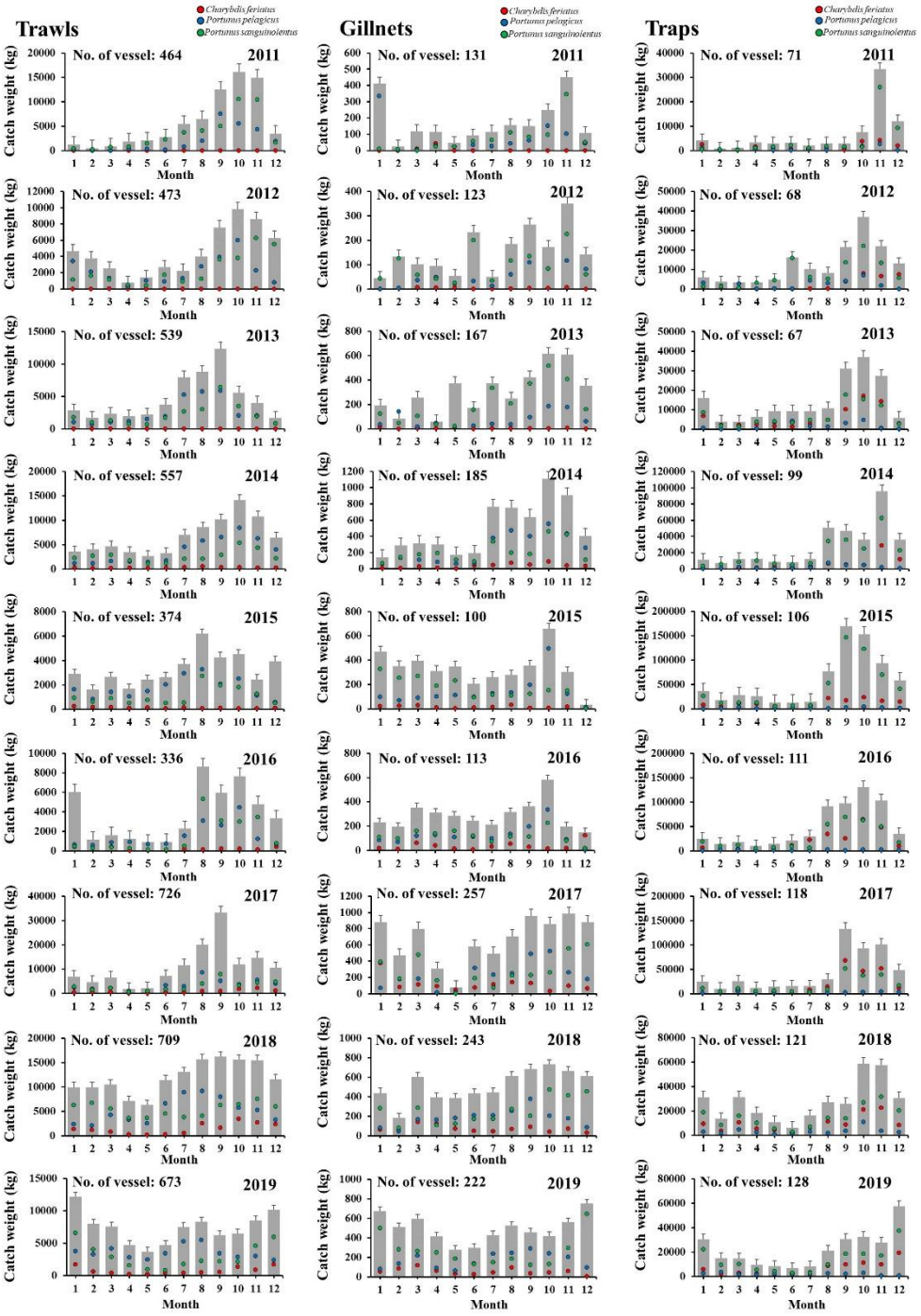

Figure S5. The monthly total swimming crabs (all swimming crab species) for each year from 2011 to 2019 using trawls, gill-nets and traps in the Taiwan Strait. The circle in the grey bar is the monthly total catch weight of *Charybdis feriatus* (red), *Portunus pelagicus* (blue) and *Portunus sanguinolentus* (green) for each year from 2011 to 2019 using trawls, gill-nets and traps.

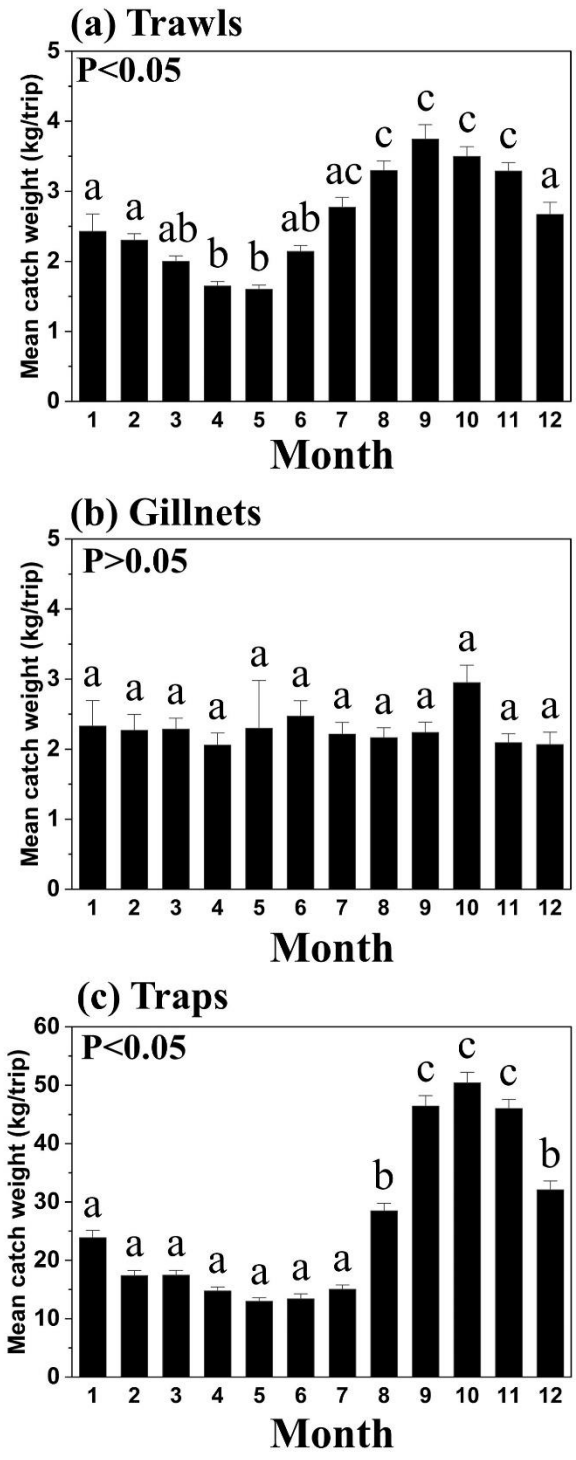

Figure S6. Mean monthly catch (kg month^{-1}) of swimming crabs (all species) from 2011 to 2019 using (a) trawls, (b) gill-nets and (c) traps in the Taiwan Strait. Differences in alpha characters above bars (0.95% CI) denote significant differences ($P < 0.05$).

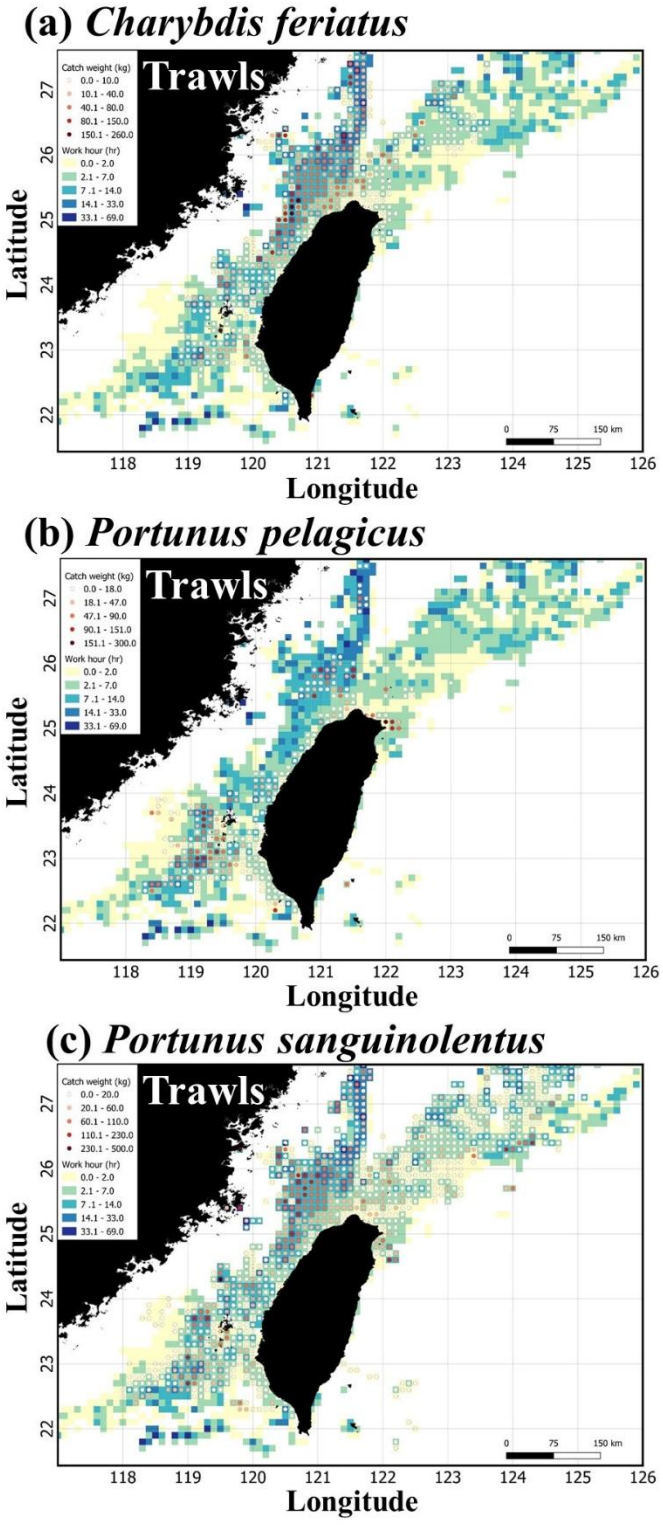

Figure S7. The mean of work hours (h trip^{-1}) overlaid with the mean of catch weight (kg trip^{-1}) using trawls from 2011 to 2019 in the Taiwan Strait for (a) *Charybdis feriatus*, (b) *Portunus pelagicus* and (c) *Portunus sanguinolentus*.

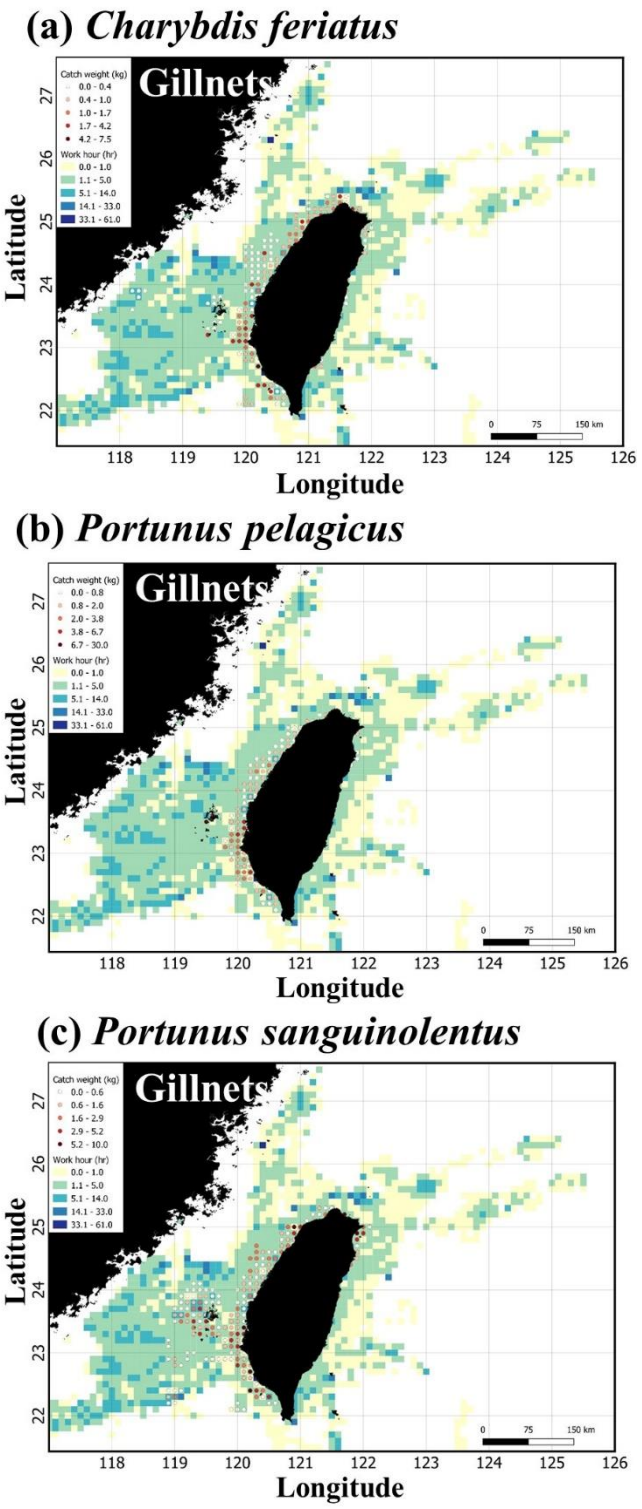

Figure S8. The mean of work hours (h trip^{-1}) overlaid with the mean of catch weight (kg trip^{-1}) using gill-nets from 2011 to 2019 in the Taiwan Strait for (a) *Charybdis feriatus*, (b) *Portunus pelagicus* and (c) *Portunus sanguinolentus*.

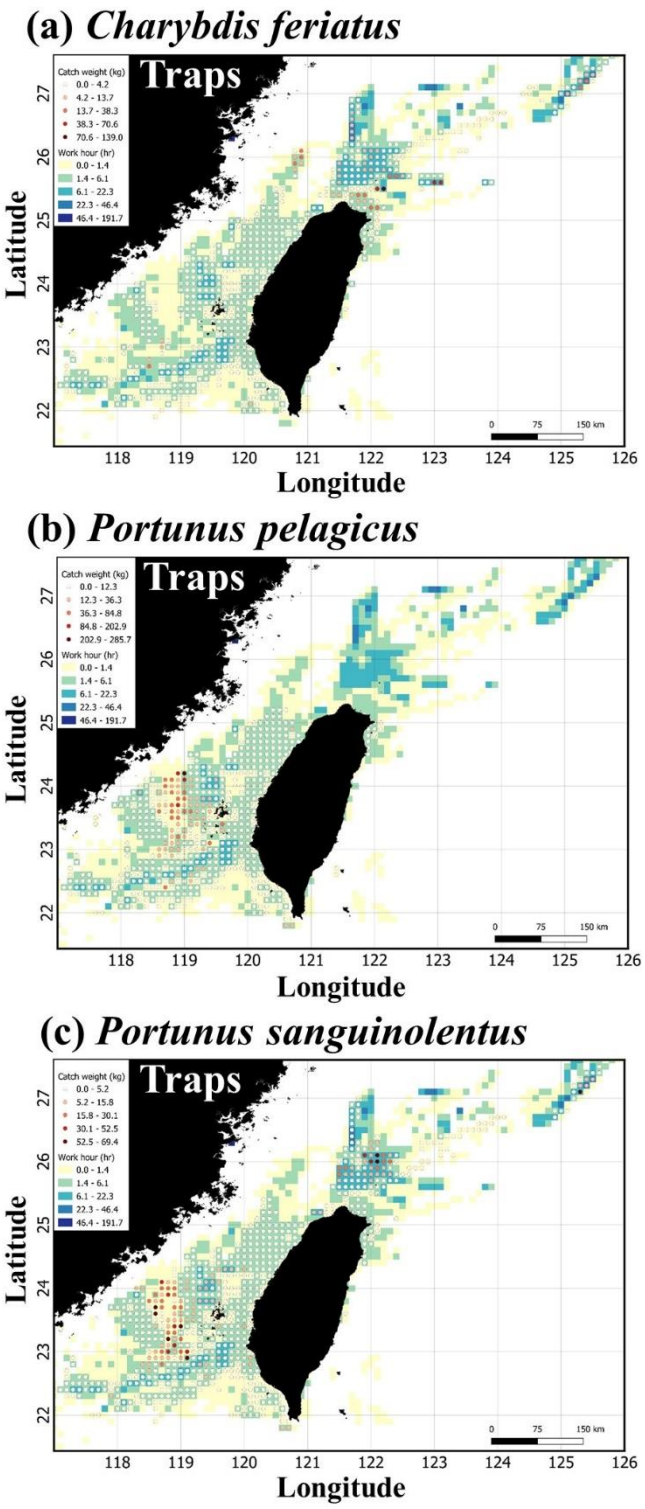

Figure S9. The mean of work hours (h trip^{-1}) overlaid with the mean of catch weight (kg trip^{-1}) using traps from 2011 to 2019 in the Taiwan Strait for (a) *Charybdis feriatus*, (b) *Portunus pelagicus* and (c) *Portunus sanguinolentus*.

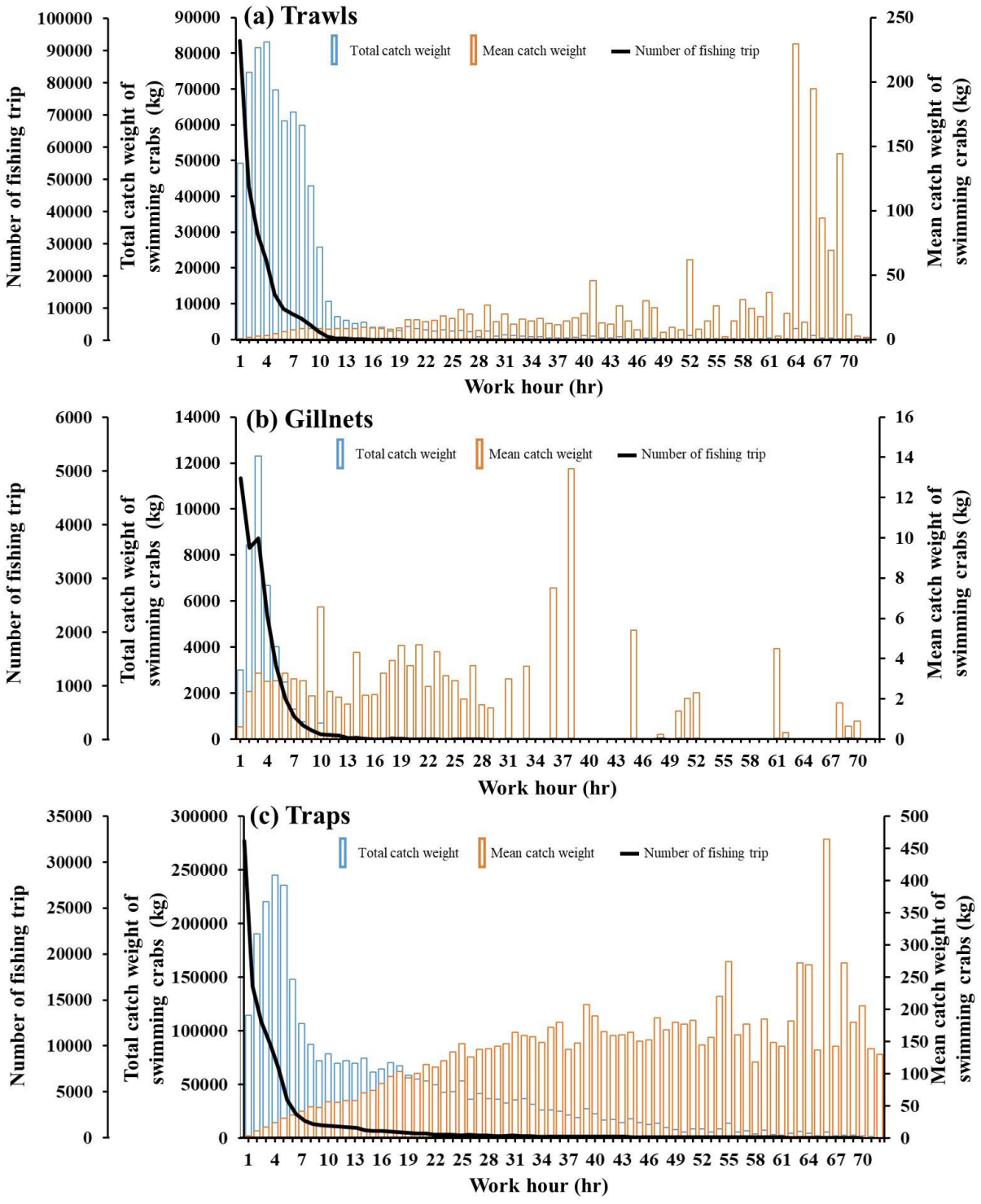

Figure S10. Total and mean catch weight of swimming crabs and the number of fishing trips when using (a) trawls, (b) gill-nets and (c) traps with different work hour in the Taiwan Strait.