Supplementary Material

Estimating ecological carrying capacity for stock enhancement in marine ranching ecosystems of Northern China

Table S1 Relative diet composition (proportion) for the functional groups in the Ecopath model of the Laizhou Bay marine ranching ecosystem, Shandong Peninsula, China. Numbers of functional groups are: 1: *Sebastes schlegelii* 2: *Hexagrammos otakii* 3: *Lateolabrax japonicus* 4: *Sparus macrocephalus* 5: Gobiidae 6: Other demersal fishes 7: Pelagic fishes 8: Octopodidae 9: *Charybdis japonica* 10: *Oratosquilla oratoria* 11: *Rapana venosa* 12: *Apostichopus japonicus* 13: *Crassostrea gigas* 14: *Aurelia aurita* 15: Spatangoida 16: Other shrimps and crabs 17: Annelida 18: Other Mollusca 19: Other macro-zoobenthos 20: Small zoobenthos 21: Zooplankton 22: Bacterioplankton 23: Sediment bacteria

Prey/ Predator	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Fish																							
Sebastes schlegelii	0.0452	0.0131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hexagrammos otakii	0.0267	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lateolabrax japonicus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sparus macrocephalus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gobiidae	0.0268	0.015	0.012	0	0.1026	0	0	0.1	0	0.029	0	0	0	0	0	0	0	0	0	0	0	0	0
Other demersal fishes	0	0.03	0.02	0.02	0	0.016	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pelagic fishes	0.01	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Invertebrates																							

Octopodidae	0	0	0.029	0	0	0.269	0	0.0375	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charybdis japonica	0.7333	0.153	0.752	0.26	0	0	0	0.275	0.01	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0
Oratosquilla oratoria	0.01	0	0.021	0.278	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rapana venosa	0	0	0	0	0	0	0	0.13	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0
Apostichopus japonicus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crassostrea gigas	0	0	0	0	0	0	0	0.2	0.595	0	0.4	0	0.1	0	0	0.1	0.01	0	0	0	0	0	0
Aurelia aurita	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spatangoida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other shrimps and crabs	0.035	0.1932	0.041	0.048	0.2265	0.314	0.056	0	0.02	0.065	0	0	0	0	0	0	0	0	0	0	0	0	0
Annelida	0	0.08	0	0.058	0.1436	0.028	0	0	0	0	0	0	0	0	0	0	0.12	0	0	0	0	0	0
Other Mollusca	0.113	0.516	0.105	0.2619	0.5273	0.349	0	0.238	0.315	0.686	0.045	0	0	0	0	0.05	0	0	0	0	0	0	0
Other macro-zoobenthos	0	0	0	0	0	0.024	0	0	0.04	0.06	0	0	0	0	0	0.05	0	0	0	0	0	0	0
Small zoobenthos	0	0	0	0	0	0	0	0	0	0	0	0.026	0	0	0	0.09	0.04	0	0	0	0	0	0
Zooplankton	0	0	0	0	0	0	0.702	0	0.02	0.16	0	0	0.1257	0.05	0	0	0	0.126	0.05	0	0	0	0
Bacterioplankton	0	0	0	0	0	0	0	0	0	0	0	0	0.0737	0	0	0	0	0.074	0	0	0	0	0
Sediment bacteria	0	0	0	0	0	0	0	0	0	0	0.03	0.24	0	0	0	0	0.1	0	0	0.25	0	0	0
Phytoplankton	0	0	0	0	0	0	0.242	0	0	0	0.3	0	0.45	0.5	0	0	0	0.4	0.95	0	0	0	0
Microphytobenthos	0	0	0	0	0	0	0	0	0	0	0.175	0.64	0.051	0	0.2	0.08	0.21	0.25	0	0.45	0	0	0
Detritus in water	0	0	0	0.034	0	0	0	0	0	0	0	0	0.2	0.45	0	0.02	0.27	0.15	0	0	0	1	0
Detritus in sediment	0	0	0	0	0	0	0	0	0	0	0.05	0.094	0	0	0.8	0.5	0.25	0	0	0.3	1	0	1
Import	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table S2 Sources of data for the input parameters for the Ecopath model of Laizhou Bay marine ranching ecosystem, Shandong Peninsula, China. BOTCL = Blue Ocean Technology Co., Ltd.

Functional group	Biomass	Production/Biomass	Consumption/Biomass	Diet composition	Landing
Sebastes schlegelii	*in situ* estimation by gillnet and long fishing trap survey (2020-2021)	empirical relationship (Palomares and Pauly, 1989)	empirical relationship (Palomares and Pauly, 1989)	*in situ* stomach content analysis	BOTCL
Hexagrammos otakii	*in situ* estimation by gillnet and long fishing trap survey (2020-2021)	empirical relationship (Palomares and Pauly, 1989)	empirical relationship (Palomares and Pauly, 1989)	*in situ* stomach content analysis	
Lateolabrax japonicus	*in situ* estimation from trawler and gill net survey (2020-2021)	empirical relationship (Pauly and Bartz, 1993)	empirical relationship (Pauly and Bartz, 1993)	Yang (2001b)	BOTCL
Sparus macrocephalus	*in situ* estimation from trawler and gill net survey (2020-2021)	empirical relationship (Palomares and Pauly, 1989)	empirical relationship (Palomares and Pauly, 1989)	Yang (2001b)	BOTCL
Gobiidae	*in situ* estimation from trawler and gill net survey (2020-2021)	empirical relationship (Palomares and Pauly, 1989)	empirical relationship (Palomares and Pauly, 1989)	Xu et al. (2019)	
Other demersal fishes	*in situ* estimation trawler and gill net survey (2020-2021)	empirical relationship (Pauly and Bartz, 1993)	empirical relationship (Pauly and Bartz, 1993)	Feng et al. (2018)	
Pelagic fishes	*in situ* estimation from trawler and gill net survey (2020-2021)	empirical relationship (Pauly and Bartz, 1993)	empirical relationship (Pauly and Bartz, 1993)	Yang (2001b)	

Octopodidae	*in situ* estimation by trawler and long fishing trap (2020-2021)	Lin et al. (2009)	Lin et al. (2009)	Xu et al. (2019)	
Charybdis japonica	*in situ* estimation by gillnet and long fishing trap (2020-2021)	Lin et al. (2009)	Lin et al. (2009)	*in situ* stomach content analysis	BOTCL
Oratosquilla oratoria	*in situ* estimation by gillnet and long fishing trap (2020-2021)	Lin et al. (2009)	Lin et al. (2009)	Xu et al. (2019)	BOTCL
Rapana venosa	*in situ* measurements by SUCBA quadrat (2020-2021)	Xu et al. (2019)	Lin et al. (2009)	Xu et al. (2019)	BOTCL
Apostichopus japonicus	*in situ* measurements by SUCBA quadrat (2020-2021)	Xu et al. (2019)	Xu et al. (2019)	Wu et al. (2013)	BOTCL
Crassostrea gigas	*in situ* measurements by SUCBA quadrat (2020-2021)	Xu et al. (2019)	Yang et al. (2016)	Xu et al. (2019)	
Aurelia aurita	in situ measurements (2020-2021)	Cheng et al. (2009)	Cheng et al. (2009)	Cheng et al. (2009)	
Spatangoida	*in situ* estimation by bottom sampler (2020-2021)	Zhang (2004)	Zhang (2004)	Zhang (2004)	
Other shrimps and crabs	*in situ* estimation by bottom sampler (2020-2021)	Yang et al. (2016)	Yang et al. (2016)	Xu et al. (2019)	
Annelida	*in situ* estimation by bottom sampler (2020-2021)	Lin et al. (2009)	Lin et al. (2009)	Yang (2001a)	
Other Mollusca	*in situ* estimation by bottom sampler (2020-2021)	Xu et al. (2019)	Xu et al. (2019)	Yang (2001a)	

Other macro-zoobenthos	*in situ* estimation by bottom sampler (2020-2021)	Lin et al. (2009)	Lin et al. (2009)	Yang (2001a)
Small zoobenthos	*in situ* estimation by bottom sampler (2020-2021)	empirical relationship (Pauly and Bartz, 1993)	empirical relationship (Pauly and Bartz, 1993)	Yang (2001a)
Zooplankton	*in situ* measurements (2020-2021)	Yang et al. (2016)	Yang et al. (2016)	Lin et al. (2013)
Bacterioplankton	*in situ* measurements (2020-2021)	Yang et al. (2016)	Yang et al. (2016)	Lin et al. (2013)
Sediment bacteria	*in situ* measurements (2020-2021)	Yang et al. (2016)	Yang et al. (2016)	Lin et al. (2013)
Phytoplankton	*in situ* Chl a concentration	Xu et al. (2019)		
Microphytobenthos	*in situ* Chl a concentration	Yang et al. (2016)		
Detritus in water	*in situ* estimation by empirical relationship (Pauly and Bartz, 1993)			
Detritus in sediment	*in situ* estimation by empirical relationship (Pauly and Bartz, 1993)			

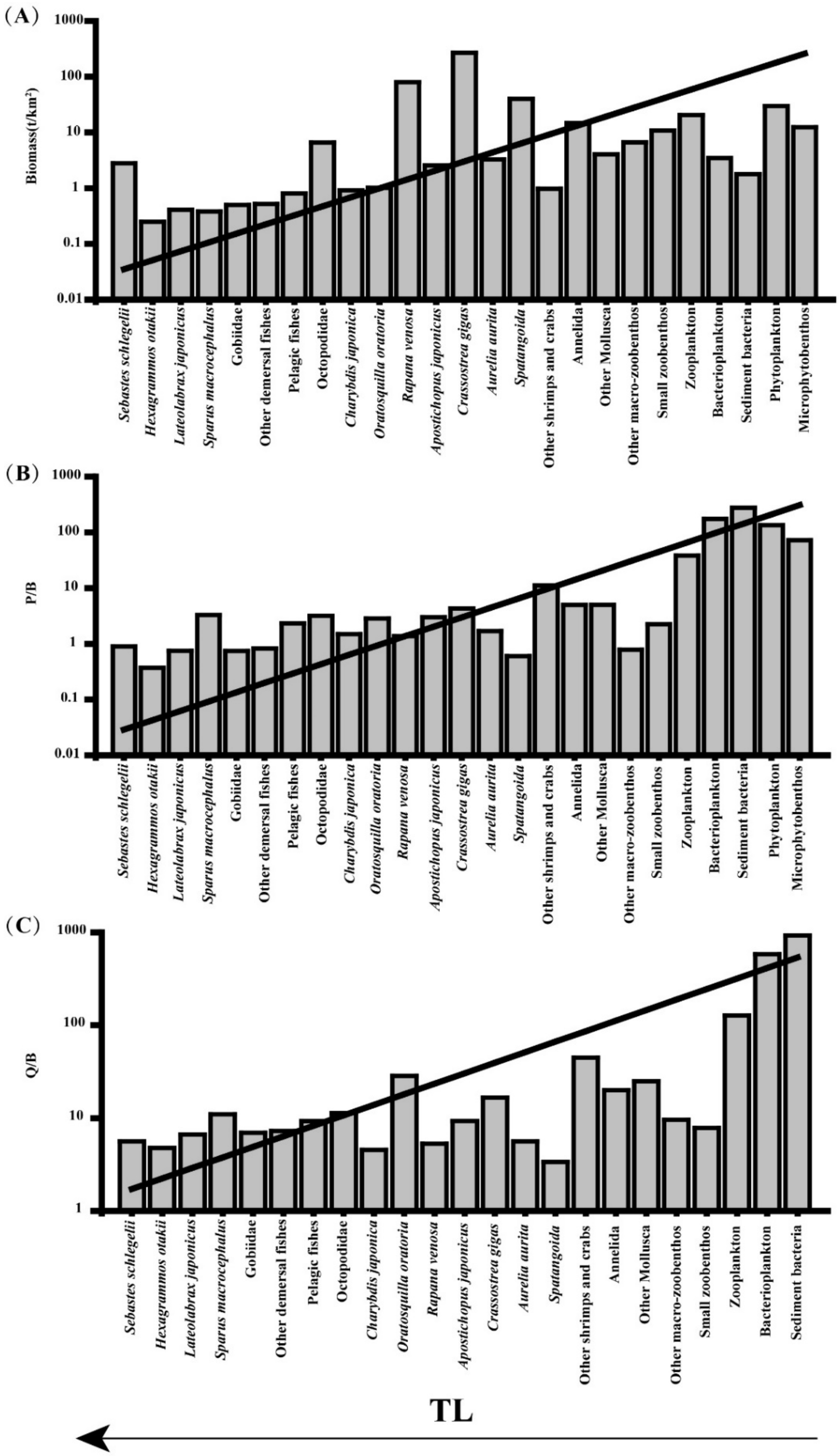

Figure S1 Pre-balance diagnostics of the Laizhou Bay marine ranching Ecopath model in (A) Biomass estimates (t/km^2) (B) P/B estimates (C) Q/B estimates on a logarithmic scale. Three solid regression lines represented the increasing levels of biomass, P/B and Q/B with decreasing trophic levels respectively. TL: trophic level. TL increased from right to left.

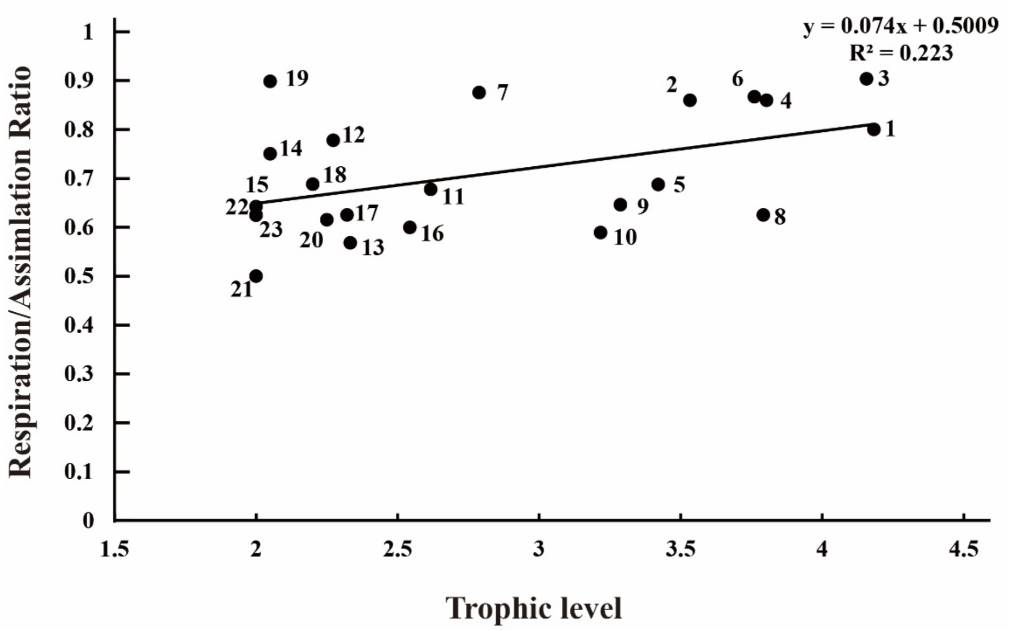

Figure S2 Relationship between the respiration to assimilation ratio and the trophic levels predicted by the Laizhou Bay marine ranching Ecopath model. Numbers of functional groups are: 1: *Sebastes schlegelii* 2: *Hexagrammos otakii* 3: *Lateolabrax japonicus* 4: *Sparus macrocephalus* 5: Gobiidae 6: Other demersal fishes 7: Pelagic fishes 8: Octopodidae 9: *Charybdis japonica* 10: *Oratosquilla oratoria* 11: *Rapana venosa* 12: *Apostichopus japonicus* 13: *Crassostrea gigas* 14: *Aurelia aurita* 15: *Spatangoida* 16: Other shrimps and crabs 17: Annelida 18: Other Mollusca 19: Other macro-zoobenthos 20: Small zoobenthos 21: Zooplankton 22: Bacterioplankton 23: Sediment bacteria

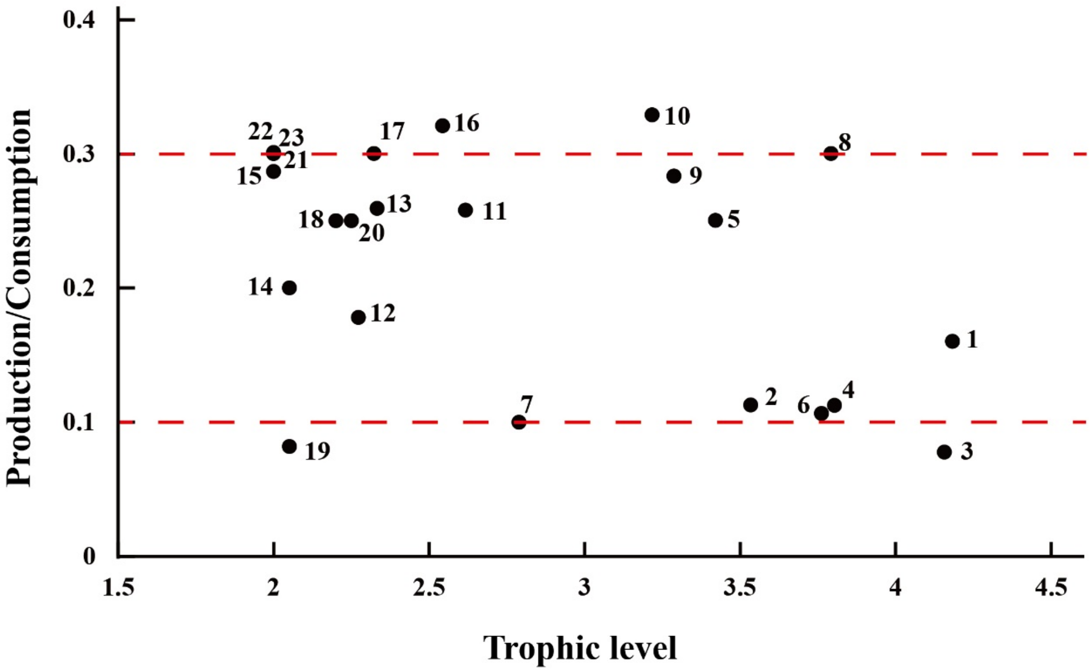

Figure S3 Distribution of the ratios of production to consumption(P/Q) values predicted by the model. Numbers of functional groups are: 1: *Sebastes schlegelii* 2: *Hexagrammos otakii* 3: *Lateolabrax japonicus* 4: *Sparus macrocephalus* 5: Gobiidae 6: Other demersal fishes 7: Pelagic fishes 8: Octopodidae 9: *Charybdis japonica* 10: *Oratosquilla oratoria* 11: *Rapana venosa* 12: *Apostichopus japonicus* 13: *Crassostrea gigas* 14: *Aurelia aurita* 15: Spatangoida 16: Other shrimps and crabs 17: Annelida 18: Other Mollusca 19: Other macro-zoobenthos 20: Small zoobenthos 21: Zooplankton 22: Bacterioplankton 23: Sediment bacteria

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