

Construction and interpretation of particle size distribution spectra from 19 Ecopath models of Chinese coastal ecosystems

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Supplementary materials

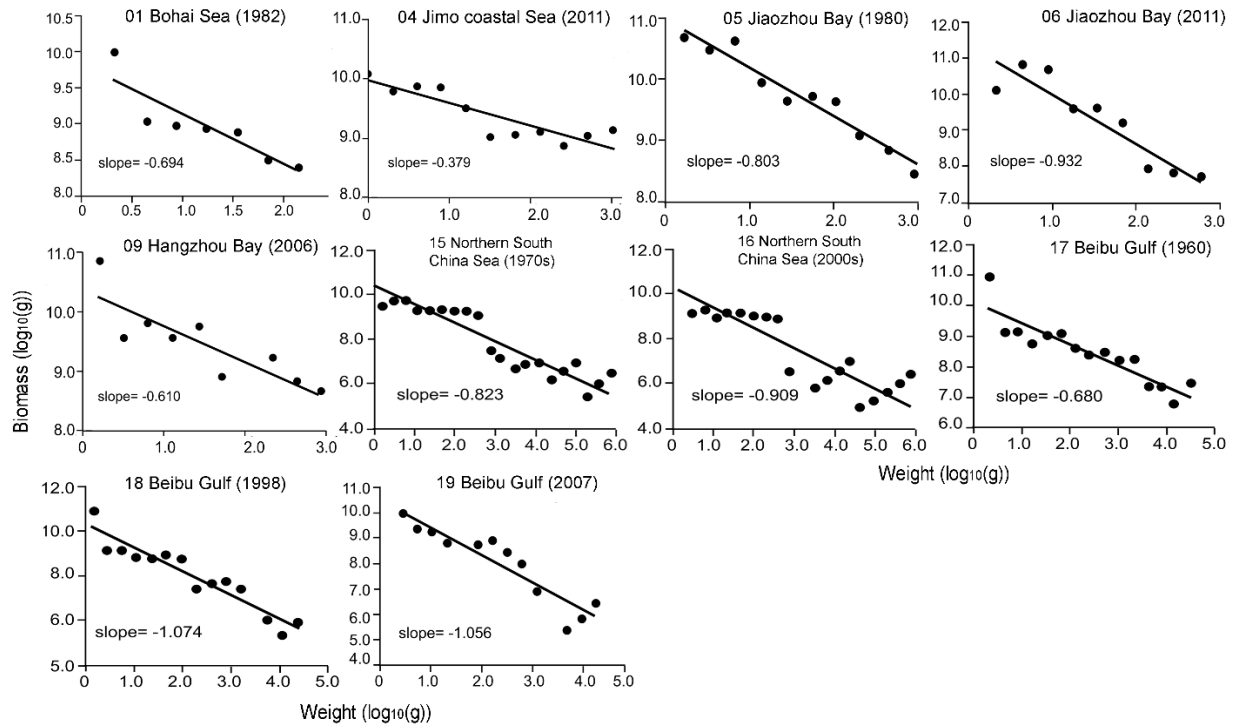


Figure SI. Particle size distributions (PSD) for the 10 Ecopath models of Chinese marine ecosystems for which either no adjustment for the biomass of jellyfish and/or farmed species was required or the small adjustment that were made had no effect of the slope of the PSD.

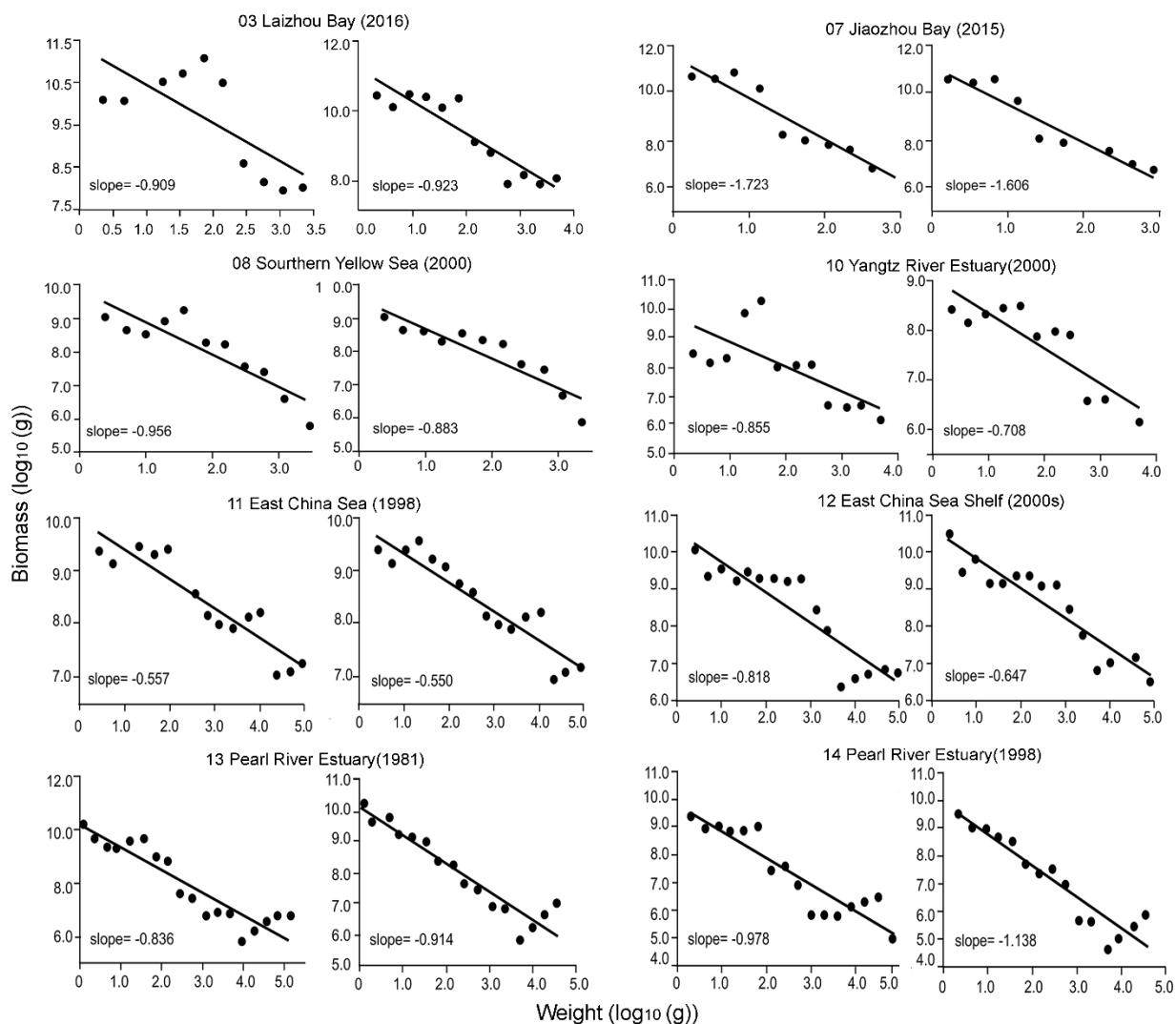


Figure SII. Particle size distributions (PSD) for the 8 Ecopath models of Chinese marine ecosystems for which either the biomass of jellyfish and/or farmed species was adjusted. For each ecosystem model, the PSD on the left show the original plot, and those on the right show the adjusted/corrected plots (see main text).

Table SI. Growth parameters of organisms in 19 Ecopath models of Chinese marine ecosystems, by increasing body weight; **a** and **b** refer to the corresponding length-weight relationships of the form $W=a \cdot L^b$.

Model	Functional group	Representative species	a	b	L _{inf} (cm)	W _{inf} (g)	K (year ⁻¹)	Source ^a
All	Phytoplankton	--	1.0	3.0	0.0050	$9.1 \cdot 10^{-8}$	40	Assumed value
All	Zooplankton	<i>Calanus sinicus</i>	0.21	2.7	0.010	$4.7 \cdot 10^{-7}$	40	Uye (1982); Jager et al. (2015)
10, 12-18	Benthic producer	--	1.0	3.0	0.0050	$9.1 \cdot 10^{-8}$	40	Assumed value
10, 11	Microbenthos	--	1.0	3.0	0.010	$1.0 \cdot 10^{-6}$	40	see Wikipedia on microbenthos, meiobenthos and macrobenthos.)
8, 10	Meiobenthos	--	1.0	3.0	0.045	$9.1 \cdot 10^{-5}$	40	
8, 10, 11	Macrobenthos	--	1.0	3.0	0.10	0.0010	40	
17, 18	Corals	<i>Balanophyllia europaea</i>	0.0020	2.5	2.10	0.012	0.11	Goffredo et al. (2004.
9	Zooplankton	<i>Moina salina</i>	0.010	2.6	0.13	0.013	33	Dumont et al. (1975); Gordon et al. (1994).
6, 12,-16, 19	Polychaetes; annelids	<i>Aglaophamus ornatus</i>	0.010	3.0	2.8	0.22	0.17	SeaLifeBase
1	Macrozooplankton	<i>Acetes chinensis</i>	0.090	2.9	1.4	0.23	1.8	Amani et al. (2011); Zafar et al. (1998).
5-8, 10	Shrimps	<i>Trachysalambria curvirostris</i>	0.80	2.5	2.2	5.8	2.8	SeaLifeBase; Yamada et al. (2007).
6	Crabs	<i>Charybdis bimaculata</i>	0.52	3.3	2.2	7.0	1.8	SeaLifeBase
19	<i>Secutor ruconius</i>	<i>Secutor ruconius</i>	0.060	2.6	6.3	7.6	1.6	FishBase
1, 4, 6, 12-14, 17, 18	Small mollusks; mollusks; demersal invertebrates; zoobenthos	<i>Arca submerata</i>	0.20	3.2	3.7	13	0.15	Puljas et al. (2015).

3, 9, 13, 14, 15, 16	Zoobenthos; infauna; non-ceph, mollusks	<i>Tegillarca granosa</i>	0.44	2.7	3.5	14	1.1	SeaLifeBase
11	<i>Champsodon capensis</i>	<i>Champsodon capensis</i>	0.010	3.0	12	15	0.60	FishBase
5, 7, 11	Benthic fishes; Sparidae; small demersal fishes	<i>Jaydia lineata</i>	0.030	3.2	7.3	15	0.50	FishBase
12	Invertebrates	<i>Tegillarca granosa</i>	0.37	2.9	3.6	16	2.3	SeaLifeBase
19	Crustaceans	<i>Solenocera crassicornis</i>	0.010	3.0	11	19	1.2	SeaLifeBase
2, 11, 12, 15, 16	Shrimps	<i>Metapenaeus joyneri</i>	0.76	2.7	3.5	21	1.2	SeaLifeBase
2, 6	Gobies	<i>Amblychaeturichthys hexanema</i>	0.010	3.0	15	25	0.46	FishBase
2, 15, 16, 17, 18	Demersal fishes	<i>Jaydia lineata</i>	0.030	3.2	8.7	26	1.1	Kume et al. (1998)
9	Shrimps	<i>Metapenaeus monoceros</i>	0.010	2.8	19	27	1.5	SeaLifeBase
1, 2, 4, 5, 7, 8, 11, 17, 18	Small pelagic fishes; <i>Engraulis japonicus</i> ; pelagic fishes; Engraulinae	<i>Engraulis japonicus</i>	0.0040	3.2	16	28	0.80	Zhu (2007)
9	Mollusks	<i>Crassostrea gigas</i>	0.15	2.2	10	28	2.4	SeaLifeBase
12	Small benthopelagic fishes	<i>Centracanthus cirrus</i>	0.010	3.0	14	29	0.50	FishBase
2, 5-7	Perciformes; gunnel	<i>Pholis fangi</i>	0.0017	3.4	19	36	0.49	Huang (2010).
2, 6, 8, 15, 16	Pelagic fishes; <i>Thryssa mystax</i>	<i>Thryssa mystax</i>	0.0027	3.3	19	39	0.76	FishBase

5-7, 19	Cultured shellfishes; mollusks; <i>Ruditapes philippinarum</i>	<i>Ruditapes philippinarum</i>	0.26	3.1	5.2	41	0.91	SeaLifeBase
10, 11	Pe.pf.fish ^b ; small pelagic fishes; <i>Coilia mystus</i>	<i>Coilia mystus</i>	0.0020	3.3	22	46	0.53	FishBase
17, 18	Penaeid prawns	<i>Fenneropenaeus chinensis</i>	0.0040	3.4	17	47	0.90	SeaLifeBase
2, 5, 7, 11	Pelagic fishes; sardine	<i>Sardinella zunasi</i>	0.020	2.9	13	49	0.50	FishBase
3	<i>Cittarium pica</i>	<i>Cittarium pica</i>	0.31	2.2	9.7	50	0.40	SeaLifeBase
2, 8, 11, 12	Small pelagic fishes; <i>Setipinna tenuifilis</i>	<i>Setipinna tenuifilis</i>	0.050	2.7	20	90	0.60	Zhang et al. (2004)
2, 5, 7, 8, 10-19	Jellyfishes	<i>Aurelia aurita</i>	0.060	2.8	31	104	1.5	Palomares and Pauly (2009)
11	Thamnaconus	<i>Thamnaconus hypargyreus</i>	0.060	2.6	18	105	0.47	FishBase
1, 5, 7	Gobiidae; <i>Chaeturichthys stigmatias</i>	<i>Chaeturichthys stigmatias</i>	0.020	2.6	30	107	0.29	FishBase
13, 14	<i>Upeneus bensasi</i>	<i>Upeneus bensasi</i>	0.010	3.1	19	110	0.90	FishBase
1	Demersal fishes	<i>Collichthys lucidus</i>	0.010	3.1	18	114	0.42	Liu et al. (2014)
6, 12	Small benthic fishes; small reef-associated fishes	<i>Sillago sihama</i>	0.010	3.1	25	119	0.80	FishBase
1-4, 6, 12- 18	Small crustaceans; benthic crustaceans; <i>Oratosquilla oratoria</i>	<i>Oratosquilla oratoria</i>	0.030	2.9	19	120	0.72	Kim et al. (2017)
3	Oysters	<i>Crassostrea gigas</i>	0.19	2.9	9.9	134	2.7	SeaLifeBase

2, 4, 15, 16	Benthos sessile/invertebrates	<i>Anadara broughtonii</i>	0.22	2.6	12	138	0.27	Selin (1999); Yoo and Yoo (1974)
1, 2, 5-8, 11-18	Large mollusks; cephalopods	<i>Sepiella inermis</i>	0.57	2.3	11	143	0.52	SeaLifeBase
2	<i>Cynoglossus lighti</i>	<i>Cynoglossus lighti</i>	0.0013	3.5	29	143	0.57	Liu et al. (2014); Wang et al. (2015)
11	<i>Harpadon nehereus</i>	<i>Harpadon nehereus</i>	0.0019	3.3	31	145	0.50	FishBase
6	<i>Konosirus punctatus</i>	<i>Konosirus punctatus</i>	0.010	3.0	24	148	0.30	FishBase
2, 19	Gizzardshad; omnivorous fishes	<i>Konosirus punctatus</i>	0.020	2.9	24	175	0.50	Lu and Chen (2009)
2, 3	<i>Chaeturichthys stigmatias</i> ; Gobiidae	<i>Chaeturichthys stigmatias</i>	0.030	2.6	30	184	0.29	FishBase
11, 13, 14, 17, 18	Medium demersal fishes; <i>Decapterus maruadsi</i>	<i>Decapterus maruadsi</i>	0.010	3.0	24	202	1.0	FishBase
11	Argentinidae	<i>Glossanodon semifasciatus</i>	0.020	3.3	16	203	1.2	FishBase
15, 16	<i>Nemipterus bathybius</i>	<i>Nemipterus bathybius</i>	0.030	2.8	25	216	0.40	FishBase
2, 6-8, 10, 15, 16, 19	Sciaenidae; de.mf.fish ^c ; croakers; benthopelagics; <i>Larimichthys polyactis</i>	<i>Larimichthys polyactis</i>	0.010	3.0	26	220	0.47	Liu et al. (2018)
11, 12	<i>Larimichthys polyactis</i>	<i>Larimichthys polyactis</i>	0.030	2.8	26	227	0.50	Guo et al. (2006)
12	Demersal fishes	<i>Doederleinia berycoides</i>	0.020	3.0	25	230	0.35	FishBase
8, 10, 11, 12, 15-18	Seabirds	<i>Larus ridibundus</i>	1.0	3.0	6.2	237	33	SeaLifeBase
12	<i>Nemipterus peronii</i>	<i>Nemipterus peronii</i>	0.010	2.9	31	243	0.55	FishBase

13, 14	<i>Priacanthus tayenus</i>	<i>Priacanthus tayenus</i>	0.040	2.8	25	265	0.80	FishBase
6	Demersal mollusks	<i>Atrina pectinata</i>	0.010	3.0	28	298	0.53	SeaLifeBase
13, 14	<i>Psenopsis anomala</i>	<i>Psenopsis anomala</i>	0.020	3.1	21	302	0.30	FishBase
13, 14	<i>Nemipterus virgatus</i>	<i>Nemipterus virgatus</i>	0.030	2.9	28	332	0.20	FishBase
1, 2, 11, 17, 18	Top pelagic feeders; Sphyracnidae; medium pelagic fishes	<i>Sphyracna pinguis</i>	0.030	2.7	31	346	0.42	FishBase
3, 4, 10	Large crustaceans; crustaceans	<i>Scylla serrata</i>	0.34	2.8	12	354	0.50	SeaLifeBase
3	<i>Charybdis feriatus</i>	<i>Charybdis feriatus</i>	0.090	2.9	17	370	0.97	SeaLifeBase
11-16	Bigeyes; <i>Priacanthus macracanthus</i>	<i>Priacanthus macracanthus</i>	0.020	2.9	31	397	1.4	FishBase
15, 16	Echinoderms	<i>Tripneustes gratilla</i>	1.2	2.4	11	407	1.1	SeaLifeBase
15, 16	<i>Psenopsis anomala</i>	<i>Psenopsis anomala</i>	0.020	3.1	24	442	0.30	FishBase
13, 14	<i>Trachurus japonicus</i>	<i>Trachurus japonicus</i>	0.010	3.0	34	471	0.32	FishBase
6, 8	Demersal fishes	<i>Johnius belangerii</i>	0.010	3.1	32	473	0.57	FishBase
1, 2, 4-7, 8, 9, 11, 12, 15, 16	Large crustaceans; crabs; <i>Portunus trituberculatus</i>	<i>Portunus trituberculatus</i>	0.13	2.7	22	507	0.84	Sugilar et al. (2012)
8, 10-12, 15, 16	Bp.pf.fish ^d ; Tromateoidae; <i>Pampus argenteus</i>	<i>Pampus argenteus</i>	0.020	3.1	27	583	0.44	Cui et al. (2008)
11	<i>Scomber japonicus</i>	<i>Scomber japonicus</i>	0.0042	3.3	38	593	0.50	FishBase
4, 15, 16	Demersal fishes; benthopelagic fishes	<i>Pennahia argentata</i>	0.020	2.9	34	618	0.60	FishBase
11, 19	<i>Trachurus japonicus</i>	<i>Trachurus japonicus</i>	0.010	3.0	40	721	0.30	FishBase

13, 14	<i>Saurida</i>	<i>Saurida tumbil</i>	0.0040	3.2	43	730	0.70	FishBase
12	Flatfishes	<i>Pleuronichthys cornutus</i>	0.020	3.0	36	747	0.20	FishBase
12	Large reef-associated fishes; pelagic	<i>Platycephalus indicus</i>	0.010	3.1	48	763	0.50	FishBase
8, 13, 14	Benthic fishes; demersal fishes	<i>Pseudopleuronectes yokohamae</i>	0.17	3.4	33	773	0.29	Chen et al. (1992)
11	<i>Branchiostegus</i>	<i>Branchiostegus japonicus</i>	0.010	3.1	36	773	0.30	FishBase
3, 6, 10, 19	Cephalopods	<i>Uroteuthis chinensis</i>	0.21	2.2	41	791	0.49	SeaLifeBase
19	<i>Parargyrops edita</i>	<i>Parargyrops edita</i>	0.040	3.0	28	836	0.28	FishBase
6	Squids	<i>Illex illecebrosus</i>	0.21	2.2	42	839	1.7	SeaLifeBase
3, 5-7, 13, 14, 19	Zoobenthos; echinoderms; <i>Actinopyga echinites</i>	<i>Actinopyga echinites</i>	0.14	2.6	30	928	0.090	SeaLifeBase
10	Pe.mf.fish ^e	<i>Chelidonichthys kumu</i>	0.010	3.0	45	946	0.49	FishBase
4, 6, 10, 13-16, 19	Bp.mf.fish ^f ; pelagic fishes; plankton feeding fishes; <i>Scomber japonicus</i>	<i>Scomber japonicus</i>	0.020	3.0	41	1192	0.22	Zhang (2018); Lin et al., (2001)
12	Echinoderms	<i>Acanthaster planci</i>	0.11	2.6	34	1197	0.53	SeaLifeBase
3, 5, 7	Hexagrammidae; <i>Hexagrammos otakii</i>	<i>Hexagrammos otakii</i>	0.020	3.1	40	1338	0.35	FishBase
11	Pleuronectiform	<i>Pseudopleuronectes yokohamae</i>	0.0020	3.0	42	1490	0.20	Chen et al. (1992)
5, 7	Skates and rays	<i>Okamejei kenojei</i>	0.0030	3.3	59	1542	0.23	Wang et al. (2016) and FishBase

6, 8, 10-16, 19	Large benthic fishes; bp.nf.fishg; Trichiuridae; <i>Trichiurus lepturus</i>	<i>Trichiurus lepturus</i>	0.010	3.0	50	1592	0.44	Hong (1980); FishBase
6	Large demersal fishes	<i>Conger myriaster</i>	0.0020	3.0	93	1600	0.60	Zhang (2018); FishBase
4, 8, 11	<i>Nibea albiflora</i>	<i>Nibea albiflora</i>	0.020	3.0	45	1633	0.30	FishBase
2, 15, 16	Demersal fishes	<i>Cynoglossus semilaevis</i>	0.0032	3.2	63	1712	0.24	FishBase
3, 5, 7	Sebastidae; <i>Sebastes schlegelii</i>	<i>Sebastes schlegelii</i>	0.020	3.0	41	1734	0.21	Yin et al. (2016)
9	Benthic-feeding fishes	<i>Acanthopagrus schlegelii</i>	0.020	3.0	43	1935	0.20	FishBase
11, 12, 15, 16	<i>Saurida</i> ; <i>Saurida elongata</i>	<i>Saurida elongata</i>	0.010	3.1	57	2172	0.19	Du et al. (2011)
9	Herbivorous fishes	<i>Mugil cephalus</i>	0.010	3.0	59	2612	0.20	FishBase
9, 11, 12, 15, 16	Piscivorous fishes; croakers; <i>Larimichthys crocea</i>	<i>Larimichthys crocea</i>	0.020	3.0	55	2925	0.29	FishBase
4	<i>Muraenesox cinereus</i>	<i>Muraenesox cinereus</i>	0.0002 0	3.4	126	3065	0.20	FishBase
3, 9, 11, 12	Mesopelagic fishes; large pelagic fishes	<i>Scomberomorus niphonius</i> ;	0.020	2.8	71	3741	0.53	Liu et al. (1982)
10	Pe.nf.fish ^h	<i>Scomberomorus niphonius</i>	0.010	3.0	76	4217	0.52	Zhang, 2018; Lin et al., 2001
8	Marine mammals	<i>Lagenodelphis hosei</i>	0.0040	3.0	114	5180	0.45	SeaLifeBase
1, 3, 5, 7, 10, 17, 18	Herbivorous feeders; Mugiliformes;	<i>Planiliza haematocheila</i>	0.010	3.0	86	5208	0.12	FishBase

	de.if.fish ⁱ ; large pelagic fishes							
10	Turtles	<i>Eretmochelys imbricata</i>	0.010	3.0	81	5314	0.30	SeaLifeBase
2, 5, 7, 8, 10-12	Carnivorous fishes; de.nf.fishj; demersal fishes; <i>Lophius litulon</i>	<i>Lophius litulon</i>	0.030	3.0	58	5344	0.28	Yin et al. (2015)
12	Demersal fishes	<i>Netuma thalassina</i>	0.030	2.8	85	7122	0.20	FishBase
3, 4	Octopodidae	<i>Octopus vulgaris</i>	0.44	2.9	29	7364	0.70	SeaLifeBase
5, 7	Paralichthyidae	<i>Paralichthys olivaceus</i>	0.020	3.0	80	8109	0.21	Zhu et al. (1991); FishBase
13, 14	Sharks	<i>Carcharhinus porosus</i>	0.0010	3.3	109	8445	0.10	FishBase
11, 12, 15-18	Snappers; large demersal fishes; <i>Lutjanus argentimaculatus</i>	<i>Lutjanus argentimaculatus</i>	0.030	2.9	85	9902	0.19	FishBase
12, 15, 16	Groupers; <i>Epinephelus coioides</i>	<i>Epinephelus coioides</i>	0.010	3.1	98	18236	0.14	FishBase
10, 15, 16	Sharks; pelagic sharks and rays	<i>Carcharhinus limbatus</i>	0.010	2.9	142	18793	0.20	FishBase
11	<i>Acipenser gueldenstaedtii</i>	<i>Acipenser gueldenstaedtii</i>	0.010	4.0	253	24942	0.045	FishBase
11	<i>Seriola lalandi</i>	<i>Seriola lalandi</i>	0.040	2.8	129	26375	0.10	FishBase
4, 9	<i>Planiliza haematocheila</i>	<i>Planiliza haematocheila</i>	0.030	2.9	121	28125	0.11	Geng (2001)
8	Demersal sharks and rays	<i>Carcharhinus plumbeus</i>	0.0018	3.3	171	34173	0.040	FishBase

16-19	Marine mammals	<i>Stenella attenuata</i>	0.010	2.9	160	35486	0.20	SeaLifeBase
12	Large benthopelagic fishes	<i>Coryphaenoides rupestris</i>	0.66	2.5	73	35665	0.10	FishBase
19	Chondrichthyes	<i>Carcharhinus signatus</i>	0.0050	3.1	213	68452	0.10	FishBase
13, 14	<i>Lagenodelphis hosei</i>	<i>Lagenodelphis hosei</i>	0.010	3.0	236	68690	0.14	SeaLifeBase
12, 15-18	Demersal sharks; elasmobranchs	<i>Carcharhinus plumbeus</i>	0.0018	3.3	246	112130	0.040	FishBase
11, 12, 15, 16	Sea turtles	<i>Chelonia mydas</i>	0.11	3.0	99	124007	0.10	SeaLifeBase
17, 18	Rays and skates	<i>Dipturus oxyrinchus</i>	0.0010	3.5	256	136378	0.040	FishBase
15, 11, 12	Marine mammals	<i>Sousa chinensis</i>	0.010	3.2	227	158611	0.14	SeaLifeBase
12	Pelagic sharks	<i>Carcharhinus longimanus</i>	0.030	2.8	285	310161	0.10	FishBase
11	Sharks and rays	<i>Carcharhinus falciformis</i>	0.010	3.1	315	446000	0.090	FishBase
15, 16	Pinnipeds	<i>Odobenus rosmarus</i>	0.020	3.0	432	1410877	0.10	SeaLifeBase

^a FishBase (www.fishbase.org); SeaLifeBase (www.sealifebase.org);

^b pe.pf.fish: pelagic phytoplankton feeding fishes;

^c de.mf.fish: demersal omnivorous fishes;

^d bp.pf.fish: benthopelagic phytoplankton feeding fishes;

^e pe.mf.fish: pelagic omnivorous fishes;

^f bp.mf.fish: benthopelagic omnivorous fishes;

^g bp.nf.fish: benthopelagic carnivorous fishes;

^h pe.nf.fish: pelagic carnivorous fishes;

ⁱ de.if.fish: demersal invertebrates feeding fishes;

^j de.nf.fish: demersal carnivorous fishes

Reference

- Amani, A. A., Amin, S. N., Arshad, A., and Rahman, M. A. (2011). Population dynamics of sergestid shrimps *Acetes japonicus* in the estuary of Tanjung Dawai, Kedah, Malaysia. *Journal of Fisheries and Aquatic Science*, 6(7), 751.
- Chen, D. G., Liu, C. G., and Dou, S. Z. (1992). The biology of flatfish (Pleuronectinae) in the coastal waters of China. *Netherlands journal of sea research*, 29(1-3), 25-33. Doi: [https://doi.org/10.1016/0077-7579\(92\)90005-Y](https://doi.org/10.1016/0077-7579(92)90005-Y).
- Cui, Q. M., Yuan, C. Y., Dong, J. G., and Zhang, Q. T. (2008). Age and Growth of the Silver Pomfret *Pampus argenteus* in the Bohai Bay. *Journal of Tianjin University of Science & Technology*, 23(3), 30-32. Doi: 10.3923/ijomes.2012.36.49.
- Du, J., Lu, Z., Yang, S., and Chen, M. (2011). Studies on ecological characteristics variation and population dynamics of four lizardfishes in the southern Taiwan Straits. *Acta Oceanologica Sinica*, 30(6), 72-81. Doi: <https://doi.org/10.1007/s13131-011-0163-y>.
- Dumont, H. J., Van de Velde, I., and Dumont, S. (1975). The dry weight estimate of biomass in a selection of Cladocera, Copepoda and Rotifera from the plankton, periphyton and benthos of continental waters. *Oecologia*, 19(1), 75-97. Doi: 10.1007/BF00377592.
- Geng, X. Y., Li, X. P., Ma, W. L., Liu, M. L., Fang, E. J., Wang, Z. Q., and Xing, L. J. (2001). The relationship between age and growth of *Planiliza haematocheila* in Bohai Sea. *Tianjin Fisheries*, (4), 30-32.
- Goffredo, S., Mattioli, G., and Zaccanti, F. (2004). Growth and population dynamics model of the Mediterranean solitary coral *Balanophyllia europaea* (Scleractinia, Dendrophylliidae). *Coral Reefs*, 23(3), 433-443. Doi: <https://doi.org/10.1007/s00338-004-0395-9>.
- Gordo, T., Lubian, L. M., and Canavate, J. P. (1994). Influence of temperature on growth, reproduction and longevity of *Moina salina* Daday, 1888 (Cladocera, Moinidae). *Journal of Plankton Research*, 16(11), 1513-1523. Doi: <https://doi.org/10.1093/plankt/16.11.1513>.
- Guo, X. P., Jin, X. S., and Dai, F. Q. (2006). Growth variations of small yellow croaker (*Pseudosciaena polyactis* Bleeker) in the Bohai Sea. *Journal of Fishery Sciences of China*, 13(2), 243-249.
- Hong, X. Y. (1980). A study on the age and growth of the hairtail in the Po Hai and Huang Hai. *Journal of fisheries of China*, 4(4), 361-870.
- Huang, X. X. (2010). Study on the fishery biology of *Enedrias fangi* et Wang in the inshore waters of Qingdao. [Master's thesis]. Ocean University of China, Qingdao, 25-57.
- Jager, T., Salaberria, I., and Hansen, B. H. (2015). Capturing the life history of the marine copepod *Calanus sinicus* into a generic bioenergetics framework. *Ecological Modelling*, 299, 114-120. Doi: <https://doi.org/10.1016/j.ecolmodel.2014.12.011>.
- Kim, S., Kim, H., Bae, H., Kim, H. G., and Oh, C. W. (2017). Growth and reproduction of the Japanese mantis shrimp, *Oratosquilla oratoria* (De Haan 1844) in the coastal area of Tongyeong, Korea. *Ocean Science Journal*, 52(2), 257-265. Doi: <https://doi.org/10.1007/s12601-017-0027-2>.
- Kume, G., Yamaguchi, A., and Taniuchi, T. (1998). Age and growth of the cardinalfish *Apogon lineatus* in Tokyo Bay, Japan. *Fisheries science*, 64(6), 921-923. Doi: <https://doi.org/10.2331/fishsci.64.921>.
- Lin, C., Su, J., Xu, B., and Tang, Q. (2001). Long-term variations of temperature and salinity of the Bohai Sea and their influence on its ecosystem. *Progress in Oceanography*, 49(1-4), 7-19. Doi: [https://doi.org/10.1016/S0079-6611\(01\)00013-1](https://doi.org/10.1016/S0079-6611(01)00013-1).

- Liu, X. C., Zhang, X., and Yang, K. W. (1982). Studies on the growth of Spanish mackerel, *Scomberomorus niphonius* in the Huanghai Sea and Bohai Sea. *Oceanologia et Limnologia Sinica*, 13(2), 170-178.
- Liu, X. Z., Guo, D., Wang, A. Y., Dong, J., Wang, X. L., Duan, Y., and Chai, Y. (2018). *Marine Fisheries*, 40(2), 139-146.
- Liu, Y. W., Xue, Y., Wei, B. F., and Ren, Y. P. (2014). An estimation of population parameters for five major fish species in the Haizhou Bay, Yellow Sea. *Journal of Fishery Science of China*, 21(1): 125-133. Doi: 10.3724/SP.J.1118.2014.00125.
- Lu, Z. B., and Chen, X. (2008). The parameters and their changes of the growth and mortality of Angraulidae and Clupeidae in Fujian coastal waters. *Journal of Xiamen University (Natural Science)*, 47(2), 279-285.
- Palomares, M. L. D., and Pauly, D. (2008). The growth of jellyfishes. (In *Jellyfish Blooms: Causes, Consequences, and Recent Advances*, Springer, Dordrecht, 11-21.)
- Puljas, S., Peharda, M., Župan, I., and Bukša, F. (2015). Maximum recorded life span of *Arca noae* Linnaeus, 1758 in the marine protected area Telaščica, Adriatic Sea. *Cah Biol Mar*, 56,163-168.
- Selin, N. I. (2000). Shell form and growth of the bivalve *Scapharca broughtoni*. *Russian Journal of Marine Biology*, 26(3), 204-208. Doi: <https://doi.org/10.1007/BF02759540>.
- Sugilar, H., Park, Y. C., Lee, N. H., Han, D. W., and Han, K. N. (2012). Population dynamics of the swimming crab *Portunus trituberculatus* (Miers, 1876) (Brachyura, Portunidae) from the West Sea of Korea. *International Journal of Oceanography and Marine Ecological System*, 1(2), 36-49. Doi: 10.3923/ijomes.2012.36.49.
- Uye, S. I. (1982). Length-weight relationships of important zooplankton from the Inland Sea of Japan. *Journal of the Oceanographical Society of Japan*, 38(3), 149-158. Doi: 10.1007/BF02110286.
- Wang, L. J., Wu, Z. H., Nie, M. M., Liu, M. X., Liu, W., and You, F. (2016). Length–weight relationships and length–length relationships of 13 fish species in Rongcheng Bay, China. *Journal of Applied Ichthyology*, 32(4), 737-739. Doi: <https://doi.org/10.1111/jai.13058>.
- Yamada, R., Kodama, K., Yamakawa, T., Horiguchi, T., and Aoki, I. (2007). Growth and reproductive biology of the small penaeid shrimp *Trachysalambria curvirostris* in Tokyo Bay. *Marine Biology*, 151(3), 961-971. Doi: 10.1007/s00227-006-0536-5.
- Yasuda, T. (1971). Ecological studies on the jellyfish *Aurelia aurita* in Urazoko Bay, Fukui Prefecture-IV. Monthly change in the bell-length composition and breeding season. *Bull. Japan. Soc. sci. Fish.*, 37, 364-370.
- Yin, Z. Q, Xu, C. C., and Chen, Y. (2015). Growth and rational utilization of *Lophius litulon* in Dalian Sea. *Journal of Anhui Agri. Sci.*, 43(28): 125-127.
- Yin, Z. Q., Lu, W. Q., Chen, Y., Liu, Y. H., Zhou, S. L., Meng, W. D., Yang, J., and Tian, T. (2016). Growth characteristics and resource evaluation of *Sebastes schlegelii* in Zhangzidao artificial reef area. *Animal Husbandry and Feed Science*, 8(3), 186-188.
- YOO, M. S., and YOO, S. K. (1974). Spat collection and the growth of *Anadara broughtoni* Schrenck. *Korean Journal of Fisheries and Aquatic Sciences*, 7(2), 79-86.
- Zafar, M., Mustafa, M. G., and Amin, S. N. (1998). Population dynamics of *Acetes chinensis* in the Kutubdia channel of Bangladesh coastal waters. *Indian Journal of Fisheries*, 45(2), 121-127.

- Zhang, M. H, Wang, Y., and Zhang, J. (2004). Studies on the growth and death character of *Setipinna taty* in the south of Bohai Sea. *Journal of Zhejiang Ocean University (Natural Science)*, 23(1), 31-36.
- Zhang, Y.Q. (2018). The analysis on the current situation of the main fishery resources in the coastal waters of Shandong during 2015-2016. [Master's thesis]. Yantai University, Yantai, China, 1-73.
- Zhu, J. C. (2007). Age determination and growth characteristics of the anchovy in the Yellow Sea. [Master's thesis]. Ocean University of China, Qingdao, 38-50.
- Zhu, X. H., Wu, H. Z., Cheng, Gui, S. C., and Wang, X. C. (1991). Study on age and growth of the bastard halibuts, *Paralichthys olivaceus* of the northern China Sea. *Oceanologia et limnologia sinica*, 22(5), 402-611.