Non-trophic interactions amplify kelp harvest-induced biomass oscillations and biomass changes in a kelp forest ecological network model

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TABLES

Table S1. References for information about the list of species or groups (guilds) included in the Northeast Atlantic kelp forest ecological network model.

#	Species/group (guilds)	References
1	DOC	-
2	POC	-
3	*Laminaria hyperborea*	carbon content (Sjøtun et al. 1996)
4	Diatom small	carbon content (Leblanc et al. 2012)
5	Diatom medium	carbon content (Leblanc et al. 2012)
6	Diatom large	carbon content (Leblanc et al. 2012)
7	Dinoflagellate small	abundance (Hinder et al. 2012), carbon content (Olenina et al. 2006)
8	Dinoflagellate medium	abundance (Hinder et al. 2012), carbon content (Olenina et al. 2006)
9	Dinoflagellate large	abundance (Hinder et al. 2012), carbon content (Olenina et al. 2006)
10	Copepoda small	abundance (Kennington & Rowlands 2006), carbon content (Williams & Robins 1982, Conley & Turner 1985), diet (Kleppel 1993)
11	Copepoda medium	abundance (Kennington & Rowlands 2006), carbon content (Lindley et al. 1997, Swalethorp et al. 2011), diet (Kleppel 1993)
12	Copepoda large	abundance (Kennington & Rowlands 2006), carbon content (Lindley et al. 1997), diet (Kleppel 1993)
13	Decapoda larvae	carbon content (Anger 1988), diet (Harms & Seeger 1989)
14	Euphausiacea	carbon content (Lindley et al. 1997, 1999), diet (https://what-when-how.com/animal-life/order-euphausiacea/)
15	*Palaemon serratus*	abundance (Schoenrock et al. 2021), weight biomass (Kelly et al. 2008), diet (Haig et al. 2014, https://www.glaucus.org.uk/Beadlet.htm)
16	*Actinia equina*	chemical content (Yatkin et al. 2017), life cycle (Wirtz et al. 2003), abundance (Schoenrock et al. 2021)
17	Mollusca	Morphometrics (Demir 2003, Robinson et al. 2010), abundance (Schoenrock et al. 2021), life cycle (López-Jamar et al. 1987), diet (Perron & Turner 1978, Brady-Campbell et al. 1984, Ruus et al. 2005)
18	Asteroidea	diet (https://www.sealifebase.ca/TrophicEco/FoodItemsList.php?vstockcode=39550&genus=Asterias&species=rubens, https://www.marlin.ac.uk/species/detail/1194)
19	Echinoderms	growth (Nauen 1978), CaCO3 content (Lebrato et al. 2010), morphometrics (Robinson et al. 2010), abundance (Harms 1993, Schoenrock et al. 2021), diet (Scheibling et al. 1999, https://www.marlin.ac.uk/species/detail/1311)
20	*Cancer pagurus*	Biometrics (Fahy et al. 2004), abundance (Schoenrock et al. 2021), diet (https://www.marlin.ac.uk/species/detail/1179)
21	*Carcinus maenas*	abundance (Schoenrock et al. 2021), larval bioenergetics (Anger et al. 1998), biometry (Naczk et al. 2004), diet (Baeta et al. 2006, https://www.marlin.ac.uk/species/detail/1497)
22	*Pagurus bernhardus*	salinity tolerance (Davenport 1972), carbon content (Dawirs 1981), abundance (Schoenrock et al. 2021), diet (Ramsay et al. 1996, https://animaldiversity.org/accounts/Pagurus_bernhardus/)
23	*Homarus gammarus*	moulting (Lowndes & Panikkar 1941), abundance (Harms 1993, Schoenrock et al. 2021), diet (Cooper & Uzmann 1980, https://www.bioexplorer.net/what-do-lobsters-eat.html/)

24	*Ctenolabrus rupestris*	abundance (Schoenrock et al. 2021), morphology (Bauchot 1987), diet (Sayer et al. 1995)
25	*Centrolabrus exoletus*	abundance (Schoenrock et al. 2021), morphology (Quignard & Pras 1986), diet (Sayer et al. 1996)
26	*Symphodus melops*	abundance (Schoenrock et al. 2021), morphology (Quignard & Pras 1986), diet (Deady & Fives 1995)
27	*Labrus mixtus*	abundance (Schoenrock et al. 2021), morphology (Quignard & Pras 1986), diet (https://www.fishbase.se/summary/1375)
28	*Labrus bergylta*	abundance (Schoenrock et al. 2021), morphology (Quignard & Pras 1986), diet (Deady & Fives 1995)
29	*Pholis gunnellus*	abundance (Schoenrock et al. 2021), diet and distribution (Picton & Morrow 2016), diet (https://www.fishbase.se/TrophicEco/FoodItemsList.php?vstockcode=4000&genus=Pholis&species=gunnellus)
30	*Platichthys flesus*	abundance (Schoenrock et al. 2021), distribution and taxonomy (Vinnikov et al. 2018), diet (Pihl 1982)
31	*Taurulus bubalis*	abundance (Schoenrock et al. 2021), life cycle (Fedorov 1986), diet (King & Fives 1983)
32	*Gobiusculus flavescense*	abundance (Schoenrock et al. 2021), biology (Miller & Loates 1997), diet (Fosså 1991)
33	*Pomatoschistus spp.*	abundance (Schoenrock et al. 2021), biology (Miller 1986), diet (https://www.fishbase.se/TrophicEco/FoodItemsList.php?vstockcode=1362&genus=Pomatoschistus&species=microps)
34	*Thorogobius ephippiatus*	abundance (Schoenrock et al. 2021), biology (Miller 1986), diet (https://www.fishbase.de/summary/Thorogobius-ephippiatus.html)
35	*Gobius niger*	abundance (Schoenrock et al. 2021), biology (Miller 1986), diet (https://www.fishbase.de/TrophicEco/FoodItemsList.php?vstockcode=81&genus=Gobius&species=niger)
36	*Gobius paganellus*	abundance (Schoenrock et al. 2021), distribution (Maugé 1986), diet (https://www.fishbase.de/summary/Gobius-paganellus.html)
37	*Lipophrys pholis*	abundance (Schoenrock et al. 2021), biology (Miller 1986), diet (Monteiro et al. 2005)
38	*Callionymus lyra*	abundance (Schoenrock et al. 2021), distribution and biology (Davis & Fricke 1990), diet (King et al. 1994, Griffin et al. 2012)
39	*Ammodytes tobianus*	abundance (Schoenrock et al. 2021), morphology (Bauchot 1987), diet (Reay 1970)
40	*Ciliata mustela*	abundance (Schoenrock et al. 2021), distribution and biology (Cohen et al. 1990), diet (http://52.32.33.191/TrophicEco/DietCompoSummary.php?dietcode=5656&genusname=Ciliata&speciesname=mustela, https://www.globalbioticinteractions.org/browse/?interactionType=interactsWith&resultType=json&sourceTaxon=Ciliata%20mustela&targetTaxon)
41	*Pollachius pollachius*	abundance (Schoenrock et al. 2021), diet (https://www.marlin.ac.uk/species/detail/9)
42	*Gadus morhua*	abundance (Schoenrock et al. 2021), distribution and biology (Cohen et al. 1990), diet (Heath & Lough 2007, Link et al. 2009)
43	*Scyliorhinus canicular*	abundance (Schoenrock et al. 2021), biology (Soares & Carvalho 2019), diet (Henderson & Dunne 1999, Wieczorek et al. 2018, https://www.globalbioticinteractions.org/browse/?interactionType=interactsWith&resultType=json&sourceTaxon=Scyliorhinus%20canicula&targetTaxon)

Table S2. Fish species information for the ecosystem model. Constants a and b are for equation $W = a \times L^b$, where W = fresh weight in grams and L = length in cm.

Index	Species/group	L	a	b	Prey items (links)
24	*Ctenolabrus rupestris 0*	4.5	0.0123	3.000	10–13
25	*Ctenolabrus rupestris 1*	7.9	0.0123	3.000	10–13
26	*Ctenolabrus rupestris 2*	9.5	0.0123	3.000	14, 15, 17, 20–22
27	*Ctenolabrus rupestris 3*	11.3	0.0123	3.000	14, 15, 17, 20–22
28	*Ctenolabrus rupestris 4+*	12.9	0.0123	3.000	14, 15, 17, 20–22
29	*Centrolabrus exoletus 0*	5.3	0.0047	3.230	10–13
30	*Centrolabrus exoletus 1*	9.5	0.0047	3.230	10–13
31	*Centrolabrus exoletus 2*	11.5	0.0047	3.230	14,15, 17, 20–23
32	*Centrolabrus exoletus 3*	12.3	0.0047	3.230	14, 15, 17, 20–23
33	*Centrolabrus exoletus 4+*	13.3	0.0047	3.230	14, 15, 17, 20–23
34	*Symphodus melops 0*	5.1	0.0056	3.180	10–13
35	*Symphodus melops 1*	9.1	0.0056	3.180	10–13
36	*Symphodus melops 2*	12.9	0.0056	3.180	15, 17, 20–22
37	*Symphodus melops 3*	14.9	0.0056	3.180	15, 17, 20–22
38	*Symphodus melops 4+*	18.6	0.0056	3.180	15, 17, 20–22
39	*Labrus mixtus 0*	4.7	0.0048	3.318	10–13
40	*Labrus mixtus 1*	8.4	0.0048	3.318	10–15, 17, 20–22
41	*Labrus mixtus 2*	11.9	0.0048	3.318	14, 15, 17, 18, 20–23
42	*Labrus mixtus 3*	14.3	0.0048	3.318	14, 15, 17, 18, 20–23
43	*Labrus mixtus 4+*	17.8	0.0048	3.318	14, 15, 17, 18, 20–23
44	*Labrus bergylta 0*	4.7	0.0119	3.115	10–13
45	*Labrus bergylta 1*	8.4	0.0119	3.115	10–13
46	*Labrus bergylta 2*	13	0.0119	3.115	13–15, 17, 20–23
47	*Labrus bergylta 3*	16.1	0.0119	3.115	15, 17, 20–23
48	*Labrus bergylta 4+*	21.9	0.0119	3.115	15, 17, 20–23
49	*Pholis gunnellus 0*	4.3	0.0043	3.018	10–13
50	*Pholis gunnellus 1*	7.6	0.0043	3.018	10–13
51	*Pholis gunnellus 2*	9.7	0.0043	3.018	13–15, 17, 20–22, 24, 29, 34, 39, 44, 49, 54, 59, 64, 69, 74, 79, 84, 89, 94, 99, 104, 109, 114
52	*Pholis gunnellus 3*	12.2	0.0043	3.018	13–15, 17, 20–22, 24, 29, 34, 39, 44, 49, 54, 59, 64, 69, 74, 79, 84, 89, 94, 99, 104, 109, 114
53	*Pholis gunnellus 4+*	17.7	0.0043	3.018	13–15, 17, 20–22, 24, 29, 34, 39, 44, 49, 54, 59, 64, 69, 74, 79, 84, 89, 94, 99, 104, 109, 114
54	*Platichthys flesus 0*	4.2	0.0098	3.024	10–13
55	*Platichthys flesus 1*	7.4	0.0098	3.024	10–13, 17, 54
56	*Platichthys flesus 2*	15	0.0098	3.024	10–13, 15, 17, 54, 55, 69–73, 79, 80, 84, 85
57	*Platichthys flesus 3*	21.9	0.0098	3.024	15, 17, 20–22, 49–52, 54–56, 69–73, 79–82, 84–87, 99–102
58	*Platichthys flesus 4+*	30.1	0.0098	3.024	15, 17, 20–22, 51–53, 56, 57, 71–73, 81–83, 86–88, 101–103
59	*Taurulus bubalis 0*	1.5	0.0154	3.000	10–13
60	*Taurulus bubalis 1*	1.9	0.0154	3.000	10–14
61	*Taurulus bubalis 2*	7	0.0154	3.000	10–15, 17, 64, 65, 69, 79, 74–75
62	*Taurulus bubalis 3*	12	0.0154	3.000	14, 15, 17, 20–22, 64–67, 69–77, 79–82, 84–87, 94–97
63	*Taurulus bubalis 4+*	16.7	0.0154	3.000	14, 15, 17, 20–22, 66–68, 71–73, 76–78, 81–83, 86–88, 96–98
64	*Gobiusculus flavescense 0*	2	0.00603	3.090	10–12
65	*Gobiusculus flavescense 1*	3	0.00603	3.090	10–13
66	*Gobiusculus flavescense 2*	5.5	0.00603	3.090	10–13
67	*Gobiusculus flavescense 3*	5.5	0.00603	3.090	10–13
68	*Gobiusculus flavescense 4*	5.5	0.00603	3.090	10–13
69	*Pomatoschistus spp. 0*	1.8	0.0075	3.180	10–12
70	*Pomatoschistus spp. 1*	2.5	0.0075	3.180	10–13
71	*Pomatoschistus spp. 2*	4	0.0075	3.180	10–13
72	*Pomatoschistus spp. 3*	4	0.0075	3.180	10–13
73	*Pomatoschistus spp. 4*	4	0.0075	3.180	10–13
74	*Thorogobius ephippiatus 0*	2	0.0075	3.180	10–12
75	*Thorogobius ephippiatus 1*	3	0.0075	3.180	10–13
76	*Thorogobius ephippiatus 2*	4.5	0.0075	3.180	10–13, 15, 17
77	*Thorogobius ephippiatus 3*	6	0.0075	3.180	10–13, 15, 17
78	*Thorogobius ephippiatus 4+*	8	0.0075	3.180	10–13, 15, 17

79	*Gobius niger 0*	1	0.011	3.030	10–12
80	*Gobius niger 1*	5.6	0.011	3.030	10–13, 79, 84
81	*Gobius niger 2*	9	0.011	3.030	10–13, 15, 17, 69, 70, 79, 80, 84, 85, 89, 90
82	*Gobius niger 3*	10.9	0.011	3.030	10–13, 15, 17, 21, 69–73, 79–81, 84–86, 89–91
83	*Gobius niger 4*	10.9	0.011	3.030	10–13, 15, 17, 21, 69–73, 79–81, 84–86, 89–91
84	*Gobius paganellus 0*	2	0.0112	3.100	10–12
85	*Gobius paganellus 1*	3	0.0112	3.100	10–13
86	*Gobius paganellus 2*	6	0.0112	3.100	10–13, 15, 34
87	*Gobius paganellus 3*	7.5	0.0112	3.100	10–13, 15, 21, 22, 34
88	*Gobius paganellus 4+*	10.5	0.0112	3.100	10–13, 15, 21, 22, 34
89	*Lipophrys pholis 0*	4.5	0.0093	3.000	10–12
90	*Lipophrys pholis 1*	7.9	0.0093	3.000	10–13, 15, 79
91	*Lipophrys pholis 2*	10.9	0.0093	3.000	15, 17, 79, 80
92	*Lipophrys pholis 3*	12.3	0.0093	3.000	15, 17, 79–81
93	*Lipophrys pholis 4+*	14.7	0.0093	3.000	15, 17, 79–83
94	*Callionymus lyra 0*	6	0.0204	2.578	10–13
95	*Callionymus lyra 1*	11	0.0204	2.578	10–13
96	*Callionymus lyra 2*	17	0.0204	2.578	13, 15, 21, 22
97	*Callionymus lyra 3*	19	0.0204	2.578	13, 15, 20–22
98	*Callionymus lyra 4*	21	0.0204	2.578	13, 15, 20–22
99	*Ammodytes tobianus 0*	3	0.0063	2.693	4–12
100	*Ammodytes tobianus 1*	4.9	0.0063	2.693	4–12, 14, 99
101	*Ammodytes tobianus 2*	13	0.0063	2.693	10–15, 17, 99, 100
102	*Ammodytes tobianus 3*	17	0.0063	2.693	10–15, 17, 100, 101
103	*Ammodytes tobianus 4*	19.5	0.0063	2.693	10–15, 17, 101, 102
104	*Ciliata mustela 0*	6.8	0.0052	3.169	10–13
105	*Ciliata mustela 1*	12.5	0.0052	3.169	13–15, 17, 18, 21
106	*Ciliata mustela 2*	18.5	0.0052	3.169	13–15, 17, 18, 21, 64–88
107	*Ciliata mustela 3*	25	0.0052	3.169	13–15, 17, 18, 21, 64–88
108	*Ciliata mustela 4*	25	0.0052	3.169	13–15, 17, 18, 21, 64–88
109	*Pollachius pollachius 0*	11.5	0.0107	2.966	10–15
110	*Pollachius pollachius 1*	22	0.0107	2.966	14, 15, 17, 20–22, 39–42, 44–47, 64–73, 79–88, 94–98, 109, 114
111	*Pollachius pollachius 2*	35	0.0107	2.966	14, 15, 17, 20–22, 39–48, 64–73, 79–88, 94–98, 109, 110, 114, 115
112	*Pollachius pollachius 3*	40	0.0107	2.966	14, 15, 17, 20–22, 40–43, 45–48, 65–68, 70–73, 80–83, 85–88, 95–98, 100–103, 109–111, 114, 115
113	*Pollachius pollachius 4+*	50.5	0.0107	2.966	14, 15, 17, 20–22, 40–43, 45–48, 65–68, 70–73, 80–83, 85–88, 95–98, 100–103, 110–112, 114–116
114	*Gadus morhua 0*	11.9	0.0065	3.098	10–15
115	*Gadus morhua 1*	22.7	0.0065	3.098	10–15, 17, 18, 20, 22, 23, 70–73, 79–83, 89–93, 94–98, 104–106, 109, 110, 114
116	*Gadus morhua 2*	44.6	0.0065	3.098	10–15, 17, 18, 20, 22, 23, 49–58, 69–73, 79–110, 119, 120
117	*Gadus morhua 3*	64.9	0.0065	3.098	10–15, 17, 18, 20, 22, 23, 50–53, 55–58, 80–83, 85–88, 90–93, 95–98, 100–103, 105–111, 119–121
118	*Gadus morhua 4+*	87.05	0.0065	3.098	10–15, 17, 18, 20, 22, 23, 51–53, 56–58, 81–83, 91–93, 96–103, 106–108, 110–112, 120, 121
119	*Scyliorhinus canicular 0*	10	0.0021	3.128	10–15, 17
120	*Scyliorhinus canicular 1*	15	0.0021	3.128	13–15, 17, 20–23
121	*Scyliorhinus canicular 2*	22.5	0.0021	3.128	13–15, 17, 20–23, 50–58, 64–88, 94–97, 99–102, 119, 120
122	*Scyliorhinus canicular 3*	32.5	0.0021	3.128	13–15, 17, 20–23, 50–53, 55–58, 64–88, 95–98, 100–103, 119–121
123	*Scyliorhinus canicular 4+*	62.5	0.0021	3.128	13–15, 17, 20–23, 50–53, 55–58, 65–68, 70–73, 75–78, 80–83, 85–88, 95–98, 100–103, 120–122

References

Anger K (1988) Growth and elemental composition (C, N, H) in *Inachus dorsettensis* (Decapoda: Majidae) larvae reared in the laboratory. Mar Biol 99:255–260.

Anger K, Spivak E, Luppi T (1998) Effects of reduced salinities on development and bioenergetics of early larval shore crab, *Carcinus maenas*. J Exp Mar Biol Ecol 220:287–304.

Baeta A, Cabral HN, Marques JC, Pardal MA (2006) Feeding Ecology of the Green Crab, *Carcinus maenas* (L., 1758) in a Temperate Estuary, Portugal. Crustaceana 79:1181–1193.

Bauchot ML (1987) Poissons osseux. Fiches FAO Identif Pour Besoins Pêch 1 Méditerranée Mer Noire Zone Pêche 37:891–1421.

Brady-Campbell MM, Campbell DB, Harlin MM (1984) Productivity of kelp (*Laminaria* spp.) near the southern limit in the Northwestern Atlantic Ocean. Mar Ecol Prog Ser 18:79–88.

Cohen DM, Inada T, Iwamoto T, Scialabba N (1990) Gadiform fishes of the world. FAO Fish Synop 10.

Conley WJ, Turner JT (1985) Omnivory by the coastal marine copepods *Centropages hamatus* and *Labidocera aestiva*. Mar Ecol Prog Ser 21:113–120.

Cooper RA, Uzmann JR (1980) Ecology of Juvenile and Adult *Homarus*. In: *The Biology and Management of Lobsters: Ecology and Management*. Elsevier

Davenport J (1972) Effects of size upon salinity tolerance and volume regulation in the hermit crab *Pagurus bernhardus*. Mar Biol 17:222–227.

Davis WP, Fricke R (1990) Callionymidae. In: *Check-list of the fishes of the eastern tropical Atlantic (CLOFETA)*. p 921–924

Dawirs RR (1981) Elemental composition (C, N, H) and energy in the development of *Pagurus bernhardus* (Decapoda: Pagurida) megalopa. Mar Biol 64:117–123.

Deady S, Fives JM (1995) Diet of ballan wrasse, *Labrus bergylta*, and some comparisons with the diet of corkwing wrasse, *Crenilabrus melops*. J Mar Biol Assoc U K 75:651–665.

Demir M (2003) Shells of Mollusca Collected from the Seas of Turkey. Turk J Zool 27.

Fahy E, Hickey J, Perella N, Hervas A, Carroll J, Andray C (2004) Bionomics of brown crab *Cancer pagurus* in the south east Ireland inshore fishery. Ir Fish Investig No 12 Mar Inst.

Fedorov VV (1986) Cottidae. In: *Fishes of the north-eastern Atlantic and the Mediterranean*. p 1243–1260

Fosså JH (1991) The ecology of the two-spot goby (*Gobiusculus flavescens* Fabricius): the potential for cod enhancement. ICES Mar Sci Symp 192:147–155.

Griffin R, Pearce B, Handy RD (2012) Dietary preference and feeding selectivity of common dragonet *Callionymus lyra* in U.K. J Fish Biol 81:1019–1031.

Haig J, Ryan NM, Williams KF, Kaiser MJ (2014) A review of the *Palaemon serratus* fishery: biology, ecology & management. Bang Univ Fish Conserv Rep.

Harms J (1993) Check list of species (algae, invertebrates and vertebrates) found in the vicinity of the island of helgoland (North Sea, German Bight) — a review of recent records. Helgoländer Meeresunters 47:1–34.

Harms J, Seeger B (1989) Larval development and survival in seven decapod species (Crustacea) in relation to laboratory diet. J Exp Mar Biol Ecol 133:129–139.

Heath MR, Lough RG (2007) A synthesis of large-scale patterns in the planktonic prey of larval and juvenile cod (*Gadus morhua*). Fish Oceanogr 16:169–185.

Henderson AC, Dunne JJ (1999) Food of the Lesser-Spotted Dogfish *Scyliorhinus canicula* (L.), in Galway Bay. Ir Nat J 26:191–194.

Hinder SL, Hays GC, Edwards M, Roberts EC, Walne AW, Gravenor MB (2012) Changes in marine dinoflagellate and diatom abundance under climate change. Nat Clim Change 2:271–275.

Kelly E, Tully O, Lehane B, Breathnach S (2008) The Shrimp (*Palaemon serratus* P.) Fishery: Analysis of the Resource in 2003-2007. BIM Fish Resour Ser 8.

Kennington K, Rowlands WL (2006) SEA area 6 Technical report – Plankton ecology of the Irish Sea.

King PA, Fives JM (1983) Littoral and Benthic Investigations on the West Coast of Ireland: XVI. The Biology of the Long-Spined Sea Scorpion *Taurulus bubalis* (Euphrasen, 1786) in the Galway Bay Area. Proc R Ir Acad [B] 83B:215–239.

King PA, Fives JM, McGrath D (1994) Reproduction, growth and feeding of the dragonet, *Callionymus lyra* (Teleostei: Callionymidae), in Galway Bay, Ireland. J Mar Biol Assoc U K 74:513–526.

Kleppel GS (1993) On the diets of calanoid copepods. Mar Ecol Prog Ser 99:183–195.

Leblanc K, Arístegui J, Armand L, Assmy P, Beker B, Bode A, Breton E, Cornet V, Gibson J, Gosselin M-P, Kopczynska E, Marshall H, Peloquin J, Piontkovski S, Poulton AJ, Quéguiner B, Schiebel R, Shipe R, Stefels

J, van Leeuwe MA, Varela M, Widdicombe C, Yallop M (2012) A global diatom database – abundance, biovolume and biomass in the world ocean. Earth Syst Sci Data 4:149–165.

Lebrato M, Iglesias-Rodríguez D, Feely RA, Greeley D, Jones DOB, Suarez-Bosche N, Lampitt RS, Cartes JE, Green DRH, Alker B (2010) Global contribution of echinoderms to the marine carbon cycle: CaCO3 budget and benthic compartments. Ecol Monogr 80:441–467.

Lindley JA, John AWG, Robins DB (1997) Dry Weight, Carbon and Nitrogen Content of Some Calanoid Copepods from the Seas Around Southern Britain in Winter. J Mar Biol Assoc U K 77:249–252.

Lindley JA, Robins DB, Williams R (1999) Dry weight carbon and nitrogen content of some euphausiids from the north Atlantic Ocean and the Celtic Sea. J Plankton Res 21:2053–2066.

Link JS, Bogstad B, Sparholt H, Lilly GR (2009) Trophic role of Atlantic cod in the ecosystem. Fish Fish 10:58–87.

López-Jamar E, González G, Mejuto J (1987) Temporal changes of community structure and biomass in two subtidal macroinfaunal assemblages in La Coruña bay, NW Spain. In: *Long-Term Changes in Coastal Benthic Communities*. Developments in Hydrobiology, Heip C, Keegan BF, Lewis JR (eds) Springer Netherlands, Dordrecht, p 137–150

Lowndes AG, Panikkar NK (1941) A Note on the Changes in Water Content of the Lobster (*Homarus vulgaris* M.-EDW.) During Moult. J Mar Biol Assoc U K 25:111–112.

Maugé AL (1986) Gobiidae. In: *Check-list of the freshwater fishes of Africa*. Royal Museum for Central Africa, p 358–388

Miller P, Loates M (1997) Pocket guide to fish of Britain and Europe. Harper Collins.

Miller PJ (1986) Gobiidae. In: *Fishes of the North-eastern Atlantic and Mediterranean*. p 1019–1085

Monteiro NM, Quinteira SM, Silva K, Vieira MN, Almada VC (2005) Diet preference reflects the ontogenetic shift in microhabitat use in *Lipophrys pholis*. J Fish Biol 67:102–113.

Naczk M, Williams J, Brennan K, Liyanapathirana C, Shahidi F (2004) Compositional characteristics of green crab (*Carcinus maenas*). Food Chem 88:429–434.

Nauen CE (1978) The growth of the sea star, *Asterias rubens*, and its role as benthic predator in Kiel Bay. Kiel Meeresforsch - Sonderh 4:68–81.

Olenina I, Hajdu S, Edler L, Andersson A, Wasmund N, Busch S, Göbel J, Gromisz S, Huseby S, Huttunen M, Jaanus A, Kokkonen P, Ledaine I, Niemkiewicz E (2006) Biovolumes and size-classes of phytoplankton in the Baltic Sea. In: *HELCOM Baltic Sea Environment Proceedings*. No. 106,

Perron FE, Turner RD (1978) The feeding behaviour and diet of *Calliostoma occidentale*, a coelenterate-associated prosobranch gastropod. J Molluscan Stud 44:100–103.

Picton BE, Morrow CC (2016) *Pholis gunnellus* (Linnaeus, 1758). Encycl Mar Life Br Irel.

Pihl L (1982) Food intake of young cod and flounder in a shallow bay on the Swedish west coast. Neth J Sea Res 15:419–432.

Quignard JP, Pras A (1986) Labridae. In: *Fishes of the North-eastern Atlantic and the Mediterranean 2*. p 919–942

Ramsay K, Kaiser MJ, Hughes RN (1996) Changes in hermit crab feeding patterns in response to trawling disturbance. Mar Ecol Prog Ser 144:63–72.

Reay PJ (1970) Synopsis of biological data on North Atlantic sandeels of the genus Ammodytes (*A. tobianus*, *A. dubius*, *A. americanus* and *A. marinus*). Food and Agriculture Organization of the United Nations.

Robinson LA, Greenstreet SPR, Reiss H, Callaway R, Craeymeersch J, Boois I de, Degraer S, Ehrich S, Fraser HM, Goffin A, Kröncke I, Jorgenson LL, Robertson MR, Lancaster J (2010) Length–weight relationships of 216 North Sea benthic invertebrates and fish. J Mar Biol Assoc U K 90:95–104.

Ruus A, Schaanning M, Øxnevad S, Hylland K (2005) Experimental results on bioaccumulation of metals and organic contaminants from marine sediments. Aquat Toxicol 72:273–292.

Sayer MDJ, Gibson RN, Atkinson RJA (1996) Growth, diet and condition of corkwing wrasse and rock cook on the west coast of Scotland. J Fish Biol 49:76–94.

Sayer MDJ, Gibson RN, Atkinson RJA (1995) Growth, diet and condition of goldsinny on the west coast of Scotland. J Fish Biol 46:317–340.

Scheibling RE, Hennigar AW, Balch T (1999) Destructive grazing, epiphytism, and disease: the dynamics of sea urchin - kelp interactions in Nova Scotia. Can J Fish Aquat Sci 56:2300–2314.

Schoenrock KM, O'Callaghan R, O'Callaghan T, O'Connor A, Stengel DB (2021) An ecological baseline for *Laminaria hyperborea* forests in western Ireland. Limnol Oceanogr 66:3439–3454.

Sjøtun K, Fredriksen S, Rueness J (1996) Seasonal growth and carbon and nitrogen content in canopy and first-year plants of *Laminaria hyperborea* (Laminariales, Phaeophyceae). Phycologia 35:1–8.

Soares KDA, Carvalho MRD (2019) The catshark genus *Scyliorhinus* (Chondrichthyes: Carcharhiniformes: Scyliorhinidae): taxonomy, morphology and distribution. Zootaxa 4601:1–147.

Swalethorp R, Kjellerup S, Dünweber M, Nielsen TG, Møller EF, Rysgaard S, Winding Hansen B (2011) Grazing, egg production, and biochemical evidence of differences in the life strategies of *Calanus finmarchicus*, *C. glacialis* and *C. hyperboreus* in Disko Bay, western Greenland. Mar Ecol Prog Ser 429:125–144.

Vinnikov KA, Thomson RC, Munroe TA (2018) Revised classification of the righteye flounders (Teleostei: Pleuronectidae) based on multilocus phylogeny with complete taxon sampling. Mol Phylogenet Evol 125:147–162.

Wieczorek AM, Power AM, Browne P, Graham CT (2018) Stable-isotope analysis reveals the importance of soft-bodied prey in the diet of lesser spotted dogfish *Scyliorhinus canicula*. J Fish Biol 93:685–693.

Williams R, Robins DB (1982) Effects of preservation on wet weight, dry weight, nitrogen and carbon contents of *Calanus helgolandicus* (Crustacea: Copepoda). Mar Biol 71:271–281.

Wirtz P, Ocaña O, Molodtsova T (2003) Actiniaria and Ceriantharia of the Azores (Cnidaria Anthozoa). Helgol Mar Res 57:114–117.

Yatkin K, Ayas D, Köşker AR, Durmuş M, Uçar Y (2017) Seasonal Changes in the Chemical Composition of the Beadlet Anemones (*Actinia equina*) from Mersin Bay, Northeastern Mediterranean coast of Turkey. Nat Eng Sci 2:11–20.

Data and software used in the article

The data and software are published in Dryad and Zenodo and can be accessed by the link provided in the citation below.

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