Supporting information for: Elliott Smith, E.A., and Fox, M.D. Characterizing energy flow in kelp forests: a review of the geochemical evidence and a call for additional research.

Appendix 1 – Citations and data for all reviewed manuscripts, additional analyses.

Table A1. List and description of manuscripts reviewed.

Marine Realm	Marine Province	Reference	Consumer Isotopic Data Provided?	Percent Kelp or Kelp+Macroalgae Quantified?
Arctic	1	Buchholz and Wiencke 2016	no	–
	1	Buchholz et al. 2019	no	–
	1	Dunton and Schell 1987	yes	yes
	1	Hobson and Welch 1992	yes	no
	1	Paar et al. 2019	yes	yes*
	1	Renaud et al. 2015	yes	no
	1	Schell 1983	yes	no
	1	Sokołowski et al. 2014	yes	no
Temperate Northern Atlantic	2	Adin and Riera 2003	yes	no
	2	Dauby et al. 1998	yes	no
	2	Fredriksen 2003	yes	yes
	2	Leclerc et al. 2013a	yes	yes
	2	Leclerc et al. 2013b	yes	yes
	2	Leclerc et al. 2015	yes	no
	2	Nilsen et al. 2008	yes	no
	2	Norderhaug et al. 2003	yes	no‡
	2	Queiros et al. 2019	yes	yes*
	2	Schaal et al. 2009	yes	yes
	2	Schaal et al. 2010a	yes	yes
	2	Schaal et al. 2010b	yes	no
	2	Schaal et al. 2012	yes	yes
	2	Steinarsdóttir et al. 2009	yes	no
	3	Freire et al. 2009	yes	yes
	5	Stephenson et al. 1984	no	no
	5	Kelly et al. 2012	yes	yes*
	5	Lesage et al. 2001	yes	no
	5	Nadon and Himmelman 2006	yes	no
	5	Nadon and Himmelman 2010	yes	no
	5	Stephenson et al. 1986	yes	no
Temperate Northern Pacific	8	Kang et al. 2008	yes	no
	8	Won et al. 2010	yes	no
	9	Takai et al. 2001	no	–
	9	Hayakawa et al. 2018	yes	no
	9	Shimoda et al. 2007	yes	no
	9	Takai et al. 2002	yes	no
	9	Won et al. 2007	yes	no
	10	Dethier et al. 2013	no	–
	10	Fox 2016	no	–
	10	Ramshaw et al. 2017	no	–
	10	Duggins et al. 1989	yes	yes
	10	Elliott Smith et al. 2018	yes	yes
	10	Galloway et al. 2013	yes	no
	10	Larsen et al. 2013	yes	yes
	10	Markel and Shurin 2015	yes	yes
	10	Olson et al. 2019	yes	yes

	10	Ramshaw 2012	yes	yes
	10	Simenstad and Wissmar 1985	yes	no
	10	Simenstad et al. 1993	yes	no
	10	Tallis 2009	yes	yes
	10	von Biela et al. 2016	yes	yes
	10, 11	Clementz and Koch 2001	yes	no
	10, 11	Vokhshoori et al. 2014	yes	no
	11	Miller et al. 2013	no	–
	11	Schimmelmann and Tegner 1991	no	–
	11	Gabara 2020	yes	yes
	11	Hamilton et al. 2011	yes	no
	11	Hamilton et al. 2014	yes	no
	11	Koenigs et al. 2015	yes	yes*
	11	Page et al. 2008	yes	no
	11	Foley 2009	yes	yes
	11	Pinon-Gimate et al. 2016	yes	yes
Temperate South America	45	Elliott Smith et al. 2020	yes	yes
	45	Reddin et al. 2015	yes	yes
	45	Rodriguez 2003	yes	no
	48	Andrade et al. 2016	yes	no
	48	Cari et al. 2020	yes	no
	48	Mayr et al. 2011	yes	no
	48	Riccialdelli et al. 2017	yes	yes
	48	Zapata-Hernández et al. 2014	yes	yes
	48	Zapata-Hernández et al. 2016	yes	no
Temperate Southern Africa	50	Dyer et al. 2019a	no	no
	50	Dyer et al. 2019b	no	no
	50	Bustamante and Branch 1996	yes	yes
	50, 51	Hill and McQuaid 2008	yes	no
Temperate Australasia	53	Salomon et al. 2008	yes	yes
	54	Wing et al. 2007	no	–
	54	Beer and Wing 2013	yes	yes
	54	Davis and Wing 2012	yes	yes
	54	Jack and Wing 2011	yes	no
	54	Lusseau and Wing 2006	yes	yes
	54	Udy et al. 2019a	yes	yes
	54	Udy et al. 2019b	yes	yes
	54	Wing and Jack 2012	yes	yes
	54	Wing et al. 2008	yes	yes
	56	Guest et al. 2008	yes	yes
	56	Guest et al. 2009	yes	no
	57	Hyndes and Lavery 2005	yes	yes
	57	Smit et al. 2005	yes	no
	57, 58	Crawley et al. 2009	yes	yes
	57, 58	Vanderklift and Wernberg 2010	yes	yes
Southern Ocean	59	Bushula et al. 2005	yes	yes
	59	Kaehler et al. 2000	yes	yes
	59	Kaehler et al. 2006	yes	yes
	59	Puccinelli et al. 2018	yes	–

* Percent of kelp (or kelp+macroalgae) quantified through non-stable isotope metrics, or via endmember 'indicator species' (*sensu* Post 2002).

‡ No percent kelp (or kelp+macroalgae) for wild fauna, only laboratory experiments.

Table A2. Kelp forest fauna with a quantified contribution of kelp (or kelp+macroalgae) determined through stable isotope analysis.

Province	Taxa	Functional Group	References
1: Arctic	Annelida spp.	Deposit Feeder	Dunton and Schell 1987
	Cerebratulus sp.	Carnivore	Dunton and Schell 1987
	Chitonida spp.	Herbivore	Dunton and Schell 1987
	Choanites lutkenii	Suspension Feeder	Dunton and Schell 1987
	Gersemia rubiformis	Suspension Feeder	Dunton and Schell 1987
	Haliclona gracilis	Suspension Feeder	Dunton and Schell 1987
	Margarites vorticifera	Herbivore	Dunton and Schell 1987
	Mogula griffithsii	Suspension Feeder	Dunton and Schell 1987
	Mysis litoralis	Suspension Feeder	Dunton and Schell 1987
	Neptunea borealis	Omnivore	Dunton and Schell 1987
	Nicolea zostericola	Detritivore/Scavenger	Dunton and Schell 1987
	Polinices pallidus	Carnivore	Dunton and Schell 1987
	Scoloplos armiger	Deposit Feeder	Dunton and Schell 1987
2, 3: Northern European Seas & Lusitanian	*Achelia echinata*	Deposit Feeder	Leclerc et al. 2013a
	Alcyonidium gelatinosum	Suspension Feeder	Leclerc et al. 2013a
	Amphiglena mediterranea	Suspension Feeder	Schaal et al. 2012
	Amphipholis squamata	Deposit Feeder	Leclerc et al. 2013a
	Aplidium pallidum	Suspension Feeder	Schaal et al. 2009, Schaal et al. 2010a, Schaal et al. 2012
	Balanus perforatus	Suspension Feeder	Schaal et al. 2010a
	Botryllus schlosseri	Suspension Feeder	Fredriksen 2003, Schaal et al. 2010a, Schaal et al. 2012
	Branchiomma bombyx	Suspension Feeder	Leclerc et al. 2013a
	Bugula sp.	Suspension Feeder	Fredriksen 2003
	Calliostoma zizyphinum	Carnivore	Fredriksen 2003
	Cancer pagurus	Carnivore	Fredriksen 2003
	Centrolabrus exoletus	Carnivore	Fredriksen 2003
	Chthamalus montagui	Suspension Feeder	Schaal et al. 2010a
	Ctenolabrus rupestris	Carnivore	Fredriksen 2003
	Dendrodoa grossularia	Suspension Feeder	Schaal et al. 2010a
	Didemnum candidum	Suspension Feeder	Schaal et al. 2012
	Didemnum maculosum	Suspension Feeder	Schaal et al. 2012
	Didemnum spp.	Suspension Feeder	Schaal et al. 2010a, Schaal et al. 2012
	Echinus esculentus	Grazer	Fredriksen 2003
	Electra pilosa	Suspension Feeder	Fredriksen 2003, Schaal et al. 2009, Schaal et al. 2010a, Leclerc et al. 2013a
	Elminius modestus	Suspension Feeder	Schaal et al. 2010a
	Eupolymnia nesidensis	Deposit Feeder	Leclerc et al. 2013a
	Flustrellidra hispida	Suspension Feeder	Schaal et al. 2009, Schaal et al. 2010a
	Gadus morhua	Carnivore	Fredriksen 2003
	Gibbula cineraria	Grazer	Leclerc et al. 2013a
	Gibbula sp.	Grazer	Fredriksen 2003
	Granita compressa	Suspension Feeder	Schaal et al. 2009
	Halichondria panicea	Suspension Feeder	Schaal et al. 2009, Schaal et al. 2010a
	Haliotis tuberculata	Grazer	Leclerc et al. 2013a
	Helicon pellucidum	Grazer	Fredriksen 2003
	Hiatella arctica	Suspension Feeder	Fredriksen 2003
	Hymeniacidon sanguinea	Suspension Feeder	Schaal et al. 2009, Schaal et al. 2010a
	Jassa falcata	Suspension Feeder	Schaal et al. 2012,

			Leclerc et al. 2013a
	Labrus bergylta	Carnivore	Fredriksen 2003
	Lacuna vincta	Grazer	Fredriksen 2003
	Liparis montagui	Carnivore	Fredriksen 2003
	Maera inaequipes	Deposit Feeder	Leclerc et al. 2013a
	Microstomus kitt	Carnivore	Fredriksen 2003
	Mytilus edulis	Suspension Feeder	Schaal et al. 2010a
	Nereis sp.	Carnivore	Fredriksen 2003
	Nicolea venustula	Suspension Feeder	Schaal et al. 2009, Schaal et al. 2012
	Nicolea zostericola	Deposit Feeder	Leclerc et al. 2013a
	Ophiothrix fragilis	Suspension Feeder	Schaal et al. 2010a, Schaal et al. 2012
	Ophiurae spp.	Suspension Feeder	Fredriksen 2003
	Ophlitaspongia papilla	Suspension Feeder	Leclerc et al. 2013a
	Pachimatisma johnstonia	Suspension Feeder	Schaal et al. 2010a
	Patella pellucida	Grazer	Leclerc et al. 2013a
	Phalacrocorax carbo	Carnivore	Fredriksen 2003
	Pisidia longicornis	Suspension Feeder	Schaal et al. 2010a, Leclerc et al. 2013a
	Platynereis dumerilii	Grazer	Leclerc et al. 2013a
	Pollachius pollachius	Carnivore	Fredriksen 2003
	Pollachius virens	Carnivore	Fredriksen 2003
	Porcellana platycheles	Suspension Feeder	Schaal et al. 2009, Schaal et al. 2010a
	Sabella pavonina	Suspension Feeder	Schaal et al. 2010a, Schaal et al. 2012
	Schizoporella sp.	Suspension Feeder	Schaal et al. 2010a
	Scypha compressa	Suspension Feeder	Fredriksen 2003
	Somateria mollissima	Carnivore	Fredriksen 2003
	Stylostichon plumosum	Suspension Feeder	Schaal et al. 2009
	Tricolia pullus	Grazer	Leclerc et al. 2013a
	Tubularia larynx	Suspension Feeder	Fredriksen 2003
	Tunicata spp.	Suspension Feeder	Fredriksen 2003
	Benthic meoifauna†‡	Varied	Queiros et al. 2019
	Maja brachydactyla	Omnivore	Freire et al. 2009
10: Cold Temperate Northeast Pacific	Alcyonaria sp.	Suspension Feeder	Duggins et al. 1989
	Amphipoda sp.	Uncategorized	Markel and Shurin 2015
	Anomura	Detritivore/Scavenger	Ramshaw 2012
	Anonyx sp.	Detritivore/Scavenger	Duggins et al. 1989
	Astraea gibberosa	Grazer	Ramshaw 2012
	Balanus glandula	Suspension Feeder	Tallis 2009
	Balanus nubilus	Suspension Feeder	Duggins et al. 1989
	Calliostoma sp.	Omnivore	Ramshaw 2012
	Chlamys sp.	Suspension Feeder	Ramshaw 2012
	Clupea pallasii	Suspension Feeder	Markel and Shurin 2015
	Cottidae sp.	Uncategorized	Ramshaw 2012
	Decapoda sp.	Uncategorized	Markel and Shurin 2015
	Dermaturus mandtii	Detritivore/Scavenger	Duggins et al. 1989
	Hexagrammos decagrammus	Carnivore	Duggins et al. 1989, von Biela et al. 2016
	Isopoda sp.	Uncategorized	Markel and Shurin 2015
	Leptasterias spp.	Carnivore	Duggins et al. 1989
	Metridium senile	Suspension Feeder	Duggins et al. 1989
	Mytilus californianus	Suspension Feeder	Tallis 2009, Larsen et al. 2013, Markel and Shurin 2015
	Mytilus edulis	Suspension Feeder	Duggins et al. 1989
	Mytilus sp.	Suspension Feeder	Elliott Smith et al. 2018
	Nucella sp.	Carnivore	Elliott Smith et al. 2018
	Phalacrocorax pelagicus	Carnivore	Duggins et al. 1989
	Pleuronectoidea spp.	Uncategorized	Ramshaw 2012

	Pododesmus cepio	Suspension Feeder	Duggins et al. 1989
	Pollicipes polymerus	Suspension Feeder	Tallis 2009
	Proneomysis sp.	Suspension Feeder	Duggins et al. 1989
	Pycnopodia helianthoides	Carnivore	Elliott Smith et al. 2018
	Sebastes caurinus	Carnivore	Markel and Shurin 2015
	Sebastes caurinus/maliger	Carnivore	Olson et al. 2019
	Sebastes melanops	Carnivore	Markel and Shurin 2015, von Biela et al. 2016
	Semibalanus cariosus	Suspension Feeder	Tallis 2009
	Strongylocentrotus droebachiensis	Grazer	Elliott Smith et al. 2018
	Tegula pulligo	Grazer	Markel and Shurin 2015
	Shrimp†	Uncategorized	Markel and Shurin 2015
11: Warm Temperate Northeast Pacific*	*Americardia biangulata*	Suspension Feeder	Gabara 2020
	Conus californicus	Carnivore	Gabara 2020
	Dendraster excentricus	Detritivore/Scavenger	Gabara 2020
	Eurystomella spp.	Suspension Feeder	Gabara 2020
	Limaria hemphilli	Suspension Feeder	Gabara 2020
	Lirularia spp.	Herbivore	Pinon-Gimate 2016, Gabara 2020
	Megastraea undosa	Detritivore/Scavenger	Gabara 2020
	Megathura crenulata	Omnivore	Pinon-Gimate 2016
	Membranipora membranacea	Suspension Feeder	Foley 2009
	Mytilus californianus	Suspension Feeder	Foley 2009
	Tethya aurantia	Suspension Feeder	Foley 2009
	Hydrozoa *sp.*	Suspension Feeder	Foley 2009
	Norrisia norrisii	Herbivore	Gabara 2020
	Parastichopus parvimensis	Detritivore/Scavenger	Gabara 2020
	Podochela hemphilli	Carnivore	Gabara 2020
	Unknown†	Carnivore	Gabara 2020
	Unknown†	Herbivore	Gabara 2020
	Unknown†	Detritivore/Scavenger	Gabara 2020
45: Warm Temperate Southeastern Pacific	*Aplodactylus punctatus*	Herbivore	Elliott Smith et al. 2020
	Cheilodactylus variegatus	Carnivore	Elliott Smith et al. 2020
	Concholepas concholepas	Carnivore	Elliott Smith et al. 2020
	Echinolittorina peruviana	Grazer	Reddin et al. 2015
	Engraulis ringens	Suspension Feeder	Elliott Smith et al. 2020
	Isacia conceptionis	Omnivore	Elliott Smith et al. 2020
	Paralabrax humeralis	Carnivore	Elliott Smith et al. 2020
	Perumytilus purpuratus	Suspension Feeder	Reddin et al. 2015, Elliott Smith et al. 2020
	Scurria viridula	Grazer	Reddin et al. 2015
	Taliepus sp.	Herbivore	Elliott Smith et al. 2020
	Tegula atra	Grazer	Reddin et al. 2015, Elliott Smith et al. 2020
	Tetrapygus niger	Grazer	Elliott Smith et al. 2020
	Zooplankton†	Suspension Feeder	Elliott Smith et al. 2020
48: Magellanic	*Ampelisca* sp.	Suspension Feeder	Zapata-Hernandez et al. 2016
	Desmophyllum dianthus	Suspension Feeder	Zapata-Hernandez et al. 2016
	Eurypodius latreillii	Detritivore/Scavenger	Zapata-Hernandez et al. 2016
	Halicarcinus planatus	Detritivore/Scavenger	Ricciadelli et al. 2017
	Isopoda sp.	Deposit Feeder	Ricciadelli et al. 2017
	Munida gregaria	Detritivore/Scavenger	Ricciadelli et al. 2017
	Nacella deaureata	Grazer	Ricciadelli et al. 2017
	Orbiniidae sp.	Deposit Feeder	Zapata-Hernandez et al. 2016
	Pachyciphonaria lessoni	Grazer	Ricciadelli et al. 2017
	Polyplacophora sp.	Grazer	Ricciadelli et al. 2017
	Tripylaster philippii	Detritivore/Scavenger	Zapata-Hernandez et al. 2016
50: Benguela	*Aulacomya ater*	Suspension Feeder	Bustamente and Branch 1996
	Gunnarea capensis	Suspension Feeder	Bustamente and Branch 1996
	Mytilus galloprovincialis	Suspension Feeder	Bustamente and Branch 1996

	Patella argenvillei	Grazer	Bustamente and Branch 1996
	Patella granatina	Grazer	Bustamente and Branch 1996
53, 54: Northern & Southern New Zealand	*Crassostrea gigas*	Suspension Feeder	Salomon et al. 2008
	Perna canaliculus	Suspension Feeder	Salomon et al. 2008
	Antipathes fiordensis	Suspension Feeder	Wing and Jack 2012
	Aplodactylus arctidens	Herbivore	Udy et al. 2019b
	Aulacomya maoriana	Suspension Feeder	Wing and Jack 2012
	Caesioperca lepidoptera	Carnivore	Udy et al. 2019b
	Cnemido bicornuata	Suspension Feeder	Wing and Jack 2012
	Evechinus chloroticus	Grazer	Wing et al. 2008
	Latridopsis ciliaris	Omnivore	Udy et al. 2019b
	Liothyrella neozelandea	Suspension Feeder	Wing and Jack 2012
	Mytilus galloprovincialis	Suspension Feeder	Wing and Jack 2012
	Nemadactylus macropterus	Omnivore	Udy et al. 2019b
	Neovermilia sphaeroomatus	Suspension Feeder	Wing and Jack 2012
	Notolabrus celidotus	Carnivore	Davis and Wing 2012, Udy et al. 2019b
	Notolabrus fucicola	Carnivore	Davis and Wing 2012, Udy et al. 2019b
	Odax pullus	Herbivore	Udy et al. 2019b
	Parapercis colias	Carnivore	Beer and Wing 2013, Udy et al. 2019b
	Parika scaber	Carnivore	Udy et al. 2019b
	Perna canaliculus	Suspension Feeder	Wing and Jack 2012
	Pseudolabrus miles	Carnivore	Davis and Wing 2012, Udy et al. 2019b
	Stichopus mollis	Detritivore/Scavenger	Wing et al. 2008
	Terebratella sanguinea	Suspension Feeder	Wing and Jack 2012
	Tursiops sp.	Carnivore	Lusseau and Wing 2006
	Fish community‡	Uncategorized	Udy et al. 2019a
56, 57, 58: Southern Australian Shelf	*Haliotis rubra*	Herbivore	Guest et al. 2008
	Amphipoda sp.	Herbivore	Hyndes and Lavery 2005
	Calanoida sp.	Herbivore	Hyndes and Lavery 2005
	Harpacticoida sp.	Herbivore	Hyndes and Lavery 2005
	Polychaeta	Omnivore	Hyndes and Lavery 2005
	Allochestes compressa	Grazer	Crawley et al. 2009
	Heliocidaris erythogramma	Herbivore	Vanderklift and Wernberg 2010
59: Subantarctic Islands	*Gobionotothen marionensis*	Carnivore	Bushla et al. 2005
	Magellania kerguelenensis	Suspension Feeder	Kaehler et al. 2006
	Grazing guild‡	Grazer	Kaehler et al. 2000
	Suspension feeding guild‡	Suspension Feeder	Kaehler et al. 2000

† Consumer groups unidentified.

‡ Percent kelp (or kelp+macroalgae) provided for a grouping of multiple unrelated species.

* For this Province we have excluded six fish species from Koenings et al. (2015) as this manuscript used benthic and pelagic invertebrate 'indicator species' (*sensu* Post 2002).

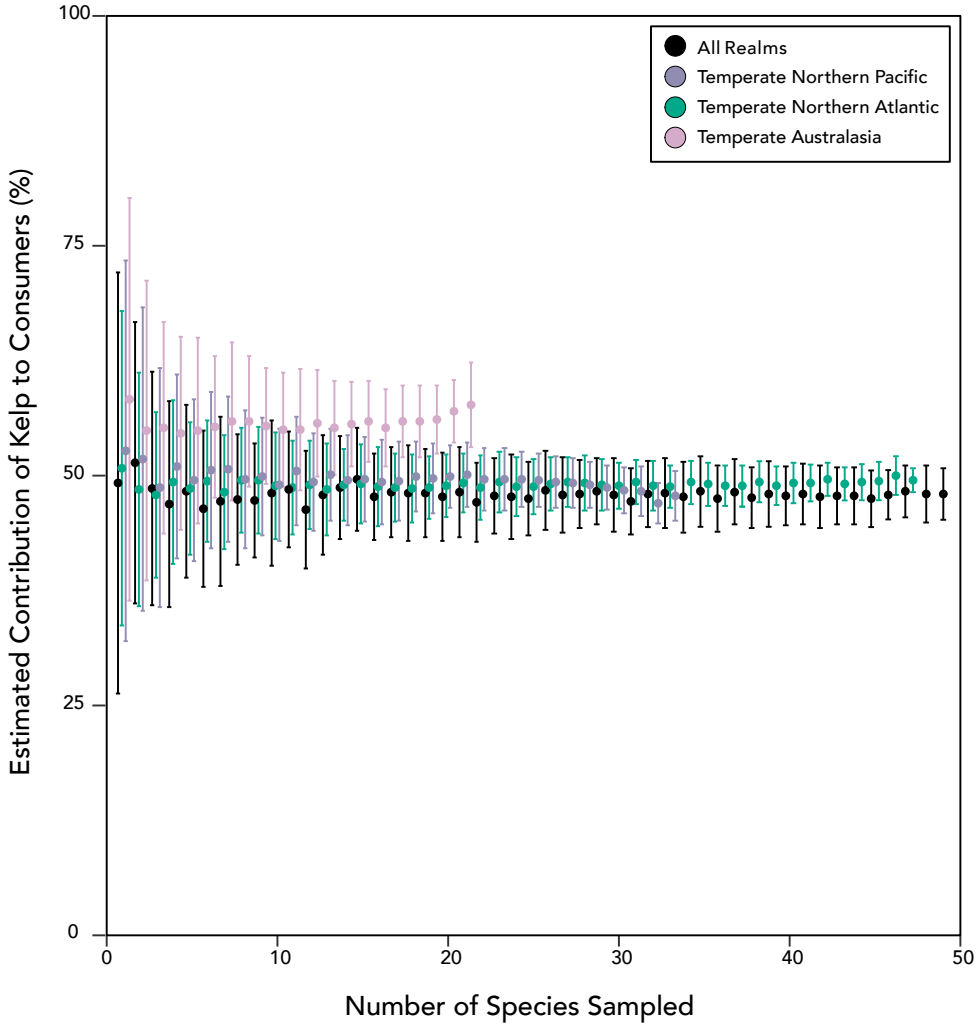

Figure A1. Influence of sample size on isotopic estimates of kelp contribution to consumer tissues. For this analysis, we randomly selected (with replacement) 1 to 100 samples from our dataset of the best represented consumer functional groups across the globe. These data included kelp contribution estimates for suspension feeders (n = 118 measurements, 77 taxa), carnivores (n = 59 measurements, 37 taxa), and grazer/herbivores (n = 48 measurements, 40 taxa). We repeated this random sampling process 100 times. For each iteration we calculated (1) the mean estimated contribution of kelp (or a kelp + macroalgae endmember) with associated standard deviation, and (2) the number of species randomly sampled within each iteration. We conducted these tests at the global level ("All Realms"), and also separately for the Temperate Northern Pacific (n=73 measurements, 36 taxa), Temperate Northern Atlantic (n=75 measurements, 58 taxa), and Temperate Australasia (n=35 measurements, 25 taxa). In all cases, our saturation curves suggest that as sample size decreases below 15-20 species, we have reduced confidence in the characterization of kelp-derived energy to local fauna. For random samples of 5 taxa, for example, the variance in our estimate across All Realms was ~40% greater than at 10 taxa and 94% greater than at 15 taxa. This same pattern held within the three realms we examined independently.

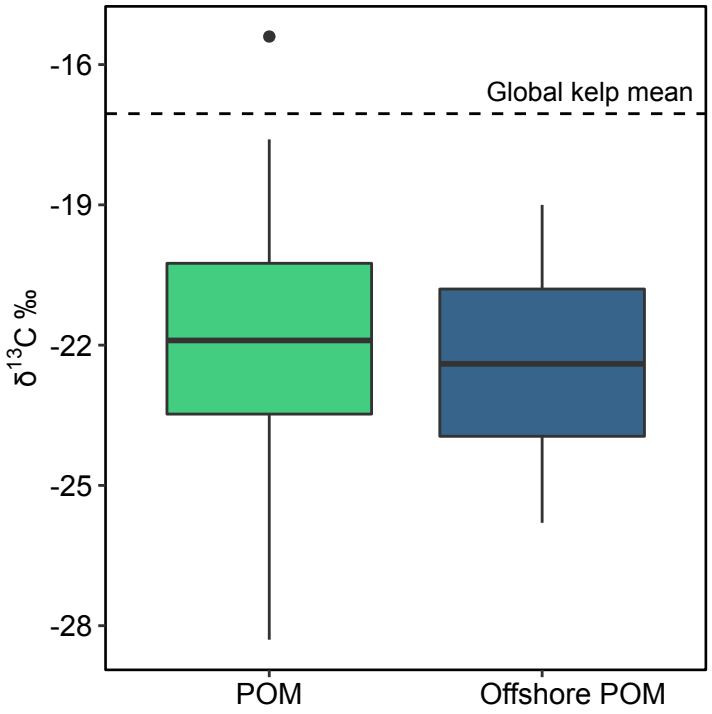

Figure A2. A comparison of reported particulate organic matter (POM) values and offshore POM values reported in studies of kelp forest ecosystems. Box plots illustrate the spread of data around the median value POM values that are pooled across all reviewed studies. We assume POM values not designated as "offshore" in the literature reflect nearshore water samples (n=98) while samples defined as offshore reflect pelagic water samples (n=35). Given the similarity in the global means for each group we pool all POM samples for comparison to global kelp $\delta^{13}C$ values.

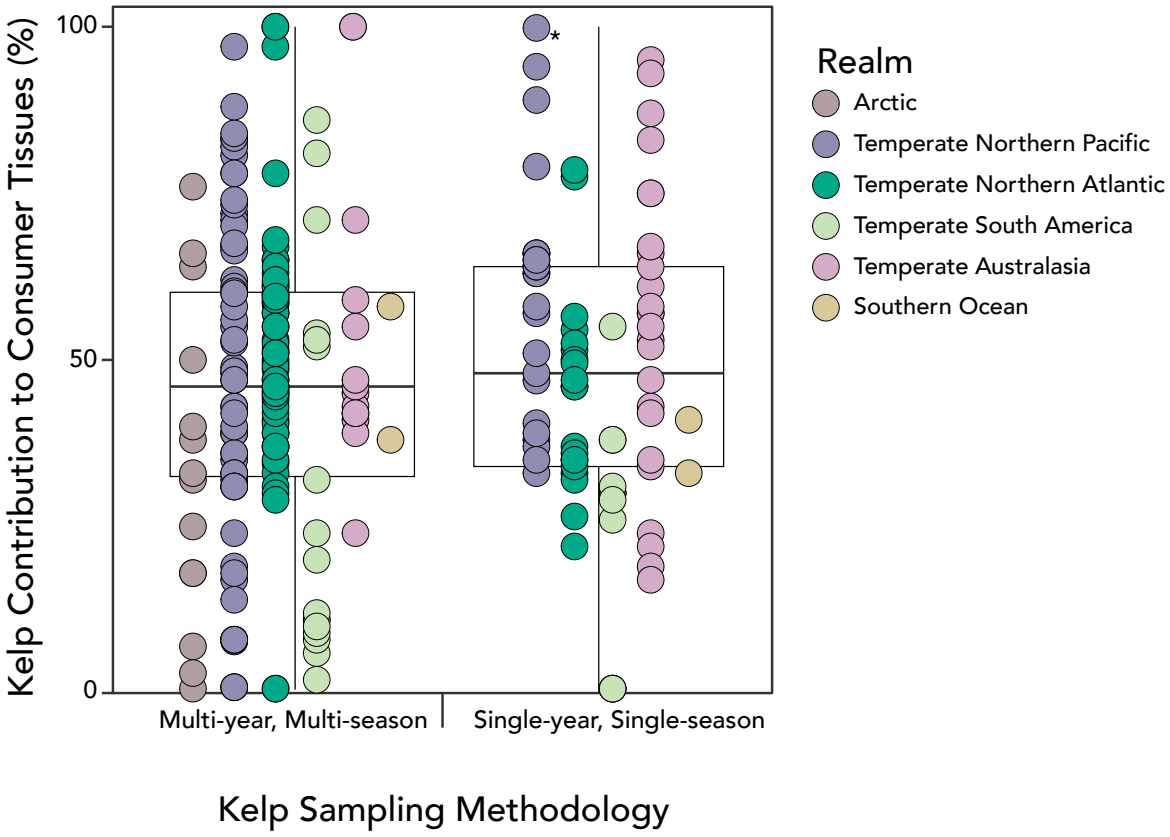

Figure A3. Effects of kelp sampling time frame on the estimated contribution of kelp carbon to consumers. Box plots illustrate the spread of data around the median % kelp contribution pooled across all reviewed studies which provided quantitative estimates for this metric (Supplementary material Appendix 1 Table A2) and also provided sufficient methodological information to characterize the sampling time frame of the kelp endmember. Circles represent the average % contributions of kelp (n=212) or a combined kelp + macroalgae endmember (n=44) to a given consumer species and locality; colors indicate biogeographic 'Realms' (as per Spalding et al. 2007). We excluded data from 'Uncategorized' functional groups (n=16). Asterisk (*) indicates a single estimate of 109% kelp for *Tegula pulligo* from Markel and Shurin (2015) which we have assumed here to be simply 100%. Studies were binned according to the time frame of kelp sampling – either samples were collected over just a single season and year, or a broader time frame. No statistically significant differences in the reported % kelp estimates are evident among these groupings. This was true at the broader factor scale comparing 'Multi-year, Multi-season', vs. 'Single-year, Single-season' globally (ANOVA: $F_{(1, 254)} = 1.037$, p-value = 0.31), as well as within Realms (post hoc Tukey's HSD showed no significant differences of methodology within Realms). All relevant data/metadata can be found in Supplementary material Appendix 2 Data A2.

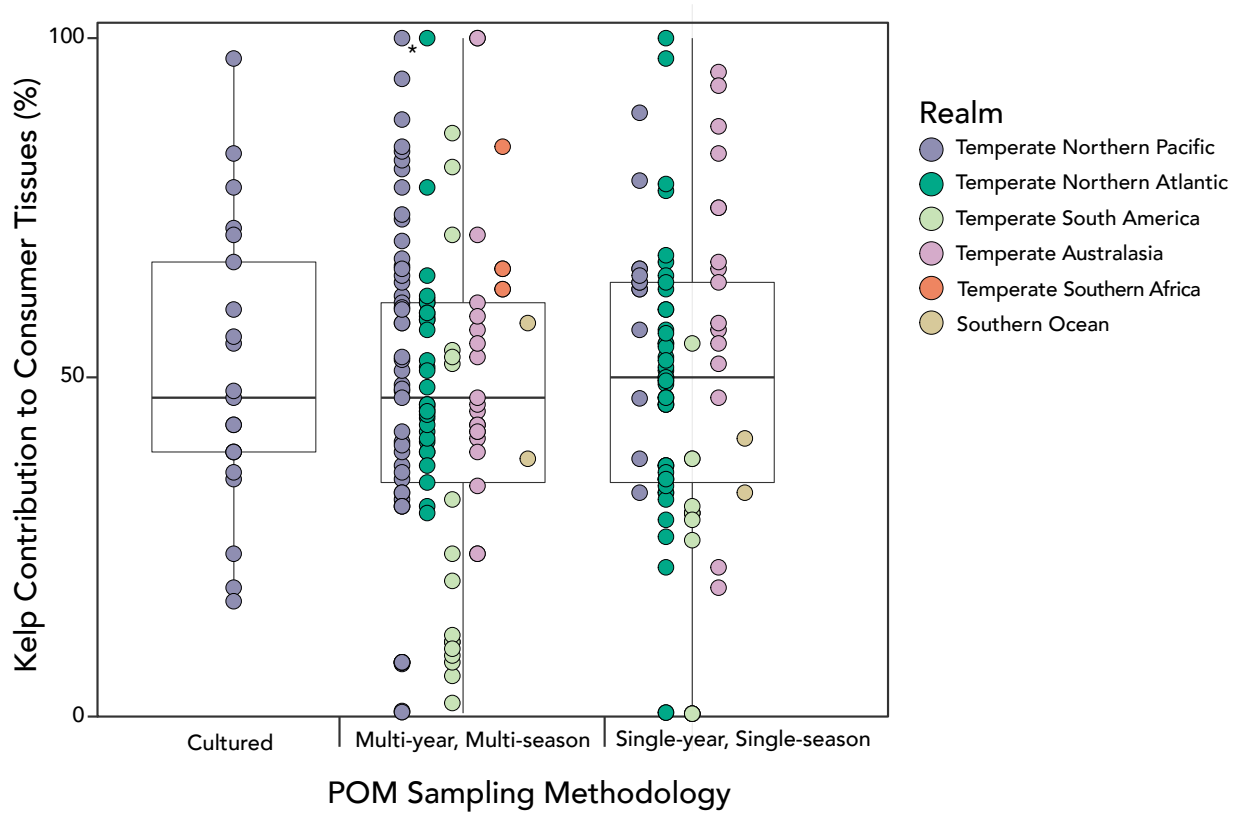

Figure A4. Effects of particulate organic matter (POM) sampling time frame on kelp contribution estimates to consumers. Box plots illustrate the spread of data around the median % kelp pooled across all reviewed studies which provided quantitative estimates for this metric (Supplementary material Appendix 1 Table A2) and also provided sufficient methodological information to characterize the sampling time frame of a POM endmember. Circles represent % contribution of kelp (n=201) or a combined kelp + macroalgae endmember (n=41) to a given consumer species and locality; colors indicate biogeographic 'Realms' (as per Spalding et al. 2007). We excluded data from 'Uncategorized' functional groups (n=16). Asterisk (*) indicates a single estimate of 109% kelp for *Tegula pulligo* from Markel and Shurin (2015) which we have assumed here to be simply 100%. Studies were binned according to the time frame of POM sampling – either samples were cultured (Duggins et al. 1989), collected over just a single season and year, or a broader time frame. No statistically significant differences in the reported % kelp estimates are evident among these groupings. This was true at the broader factor scale comparing 'Cultured', 'Multi-year, Multi-season', vs. 'Single-year, Single-season' globally (ANOVA: $F_{(2, 239)} = 0.198$, p-value = 0.821), as well as within Realms (post hoc Tukey's HSD showed no significant differences of methodology within Realms). All relevant data/metadata can be found in Supplementary material Appendix 2 Data A2.

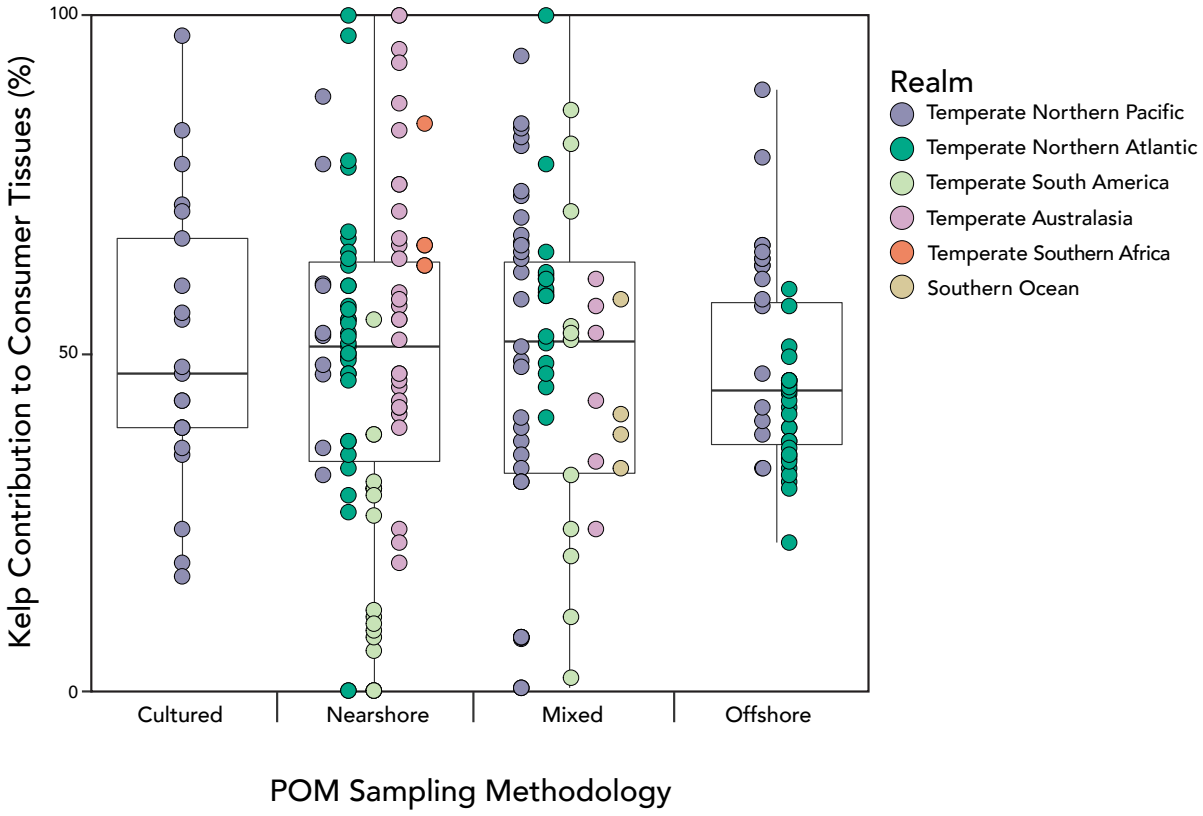

Figure A5. Effects of particulate organic matter (POM) sampling type on kelp contribution estimates to consumers. Box plots illustrate the spread of data around the median % kelp estimates pooled across all reviewed studies which provided quantitative estimates for this metric (Supplementary material Appendix 1 Table A2) and also provided sufficient methodological information to characterize the sampling strategy for a POM endmember. Circles represent % contribution of kelp (n=201) or a combined kelp + macroalgae endmember (n=41) to a given consumer species and locality; colors indicate biogeographic 'Realms' (as per Spalding et al. 2007). We excluded data from 'Uncategorized' functional groups (n=16). Asterisk (*) indicates a single estimate of 109% kelp for *Tegula pulligo* from Markel and Shurin (2015) which we have assumed here to be simply 100%. Studies were binned according to the type of POM sampled – either samples were cultured (Duggins et al. 1989), collected from the nearshore only, collected from offshore locations only, or collected from both offshore and nearshore locations ('Mixed'). No statistically significant differences are evident among these groupings. This was true at the broader factor scale comparing 'Cultured', 'Nearshore', 'Nearshore & Offshore', and 'Offshore' globally (ANOVA: $F_{(3, 238)} = 0.16$, p-value = 0.923), as well as within Realms (post-hoc Tukey's HSD showed no significant differences of methodology within Realms). All relevant data/metadata can be found in Supplementary material Appendix 2 Data A2.

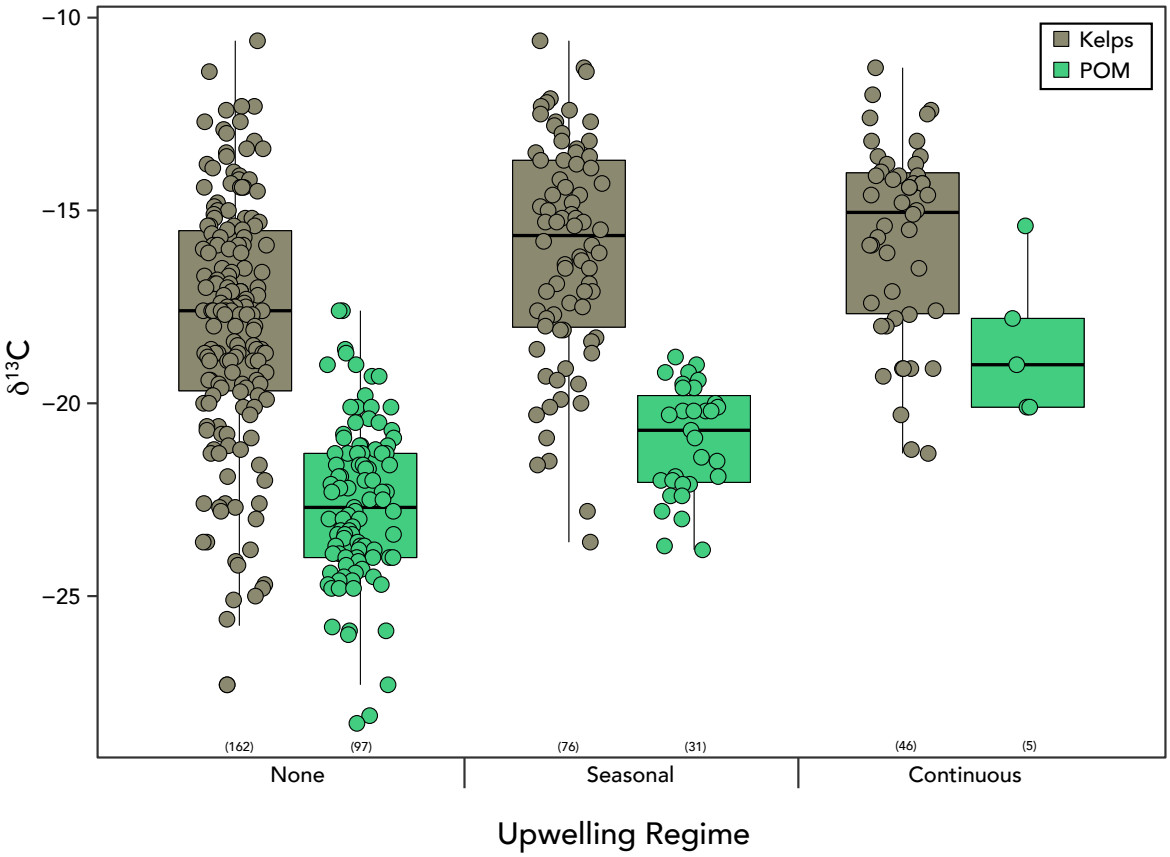

Figure A6. Carbon isotope values of kelp forest endmembers as a function of local oceanography. Box plots illustrate the spread of data around the median $\delta^{13}C$ values of kelps and particulate organic matter (POM) pooled from all reviewed studies (Supplementary material Appendix 1 Table A2). Sample sizes are provided parenthetically. ANOVA results indicate significant differences in the $\delta^{13}C$ values of each endmember between areas with no upwelling ("None') as compared to areas with either "Seasonal" or "Consistent" upwelling; kelps and POM sampled from upwelling regions had higher values than areas with no upwelling [ANOVA for kelps: $F_{(2,281)}=15.02$, $p<0.001$; ANOVA for POM: $F_{(2,130)}=16.53$, $p<0.001$]. We found no difference between Seasonal and Consistent upwelling areas for kelps (Tukey's HSD: $p_{adjusted}=0.8212$). We did find a significant difference between Seasonal and Consistent upwelling areas for POM (Tukey's HSD: $p_{adjusted}=0.0253$); however, we consider this result to be inconclusive due to the low sample size from the Consistent region (n=5). We also found significant differences within oceanographic regions between endmembers. Kelps and POMs differed by 4.7‰ in areas without upwelling (Tukey's HSD: $p_{adjusted}<0.001$), and by 4.9‰ in areas with Seasonal upwelling (Tukey's HSD: $p_{adjusted}<0.001$). We found no differences between these sources in areas with Consistent upwelling (Tukey's HSD: $p_{adjusted}=0.2593$); however as above the low sample size for POM in this category makes this finding inconclusive. All isotopic endmember data can be found in Supplementary material Appendix 2 Data A1.

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