The following supplement accompanies the article

Rethinking our approach to multiple stressor studies in marine environments

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Marine Ecology Progress Series 543: 273–281 (2016)

Table S1. Experimental studies that examined impacts of multiple stressor in marine systems. Each study was classified as mechanistic or phenomenological as defined in the main text. Studies highlighted in gray are those that used log-transformation of data prior to analysis. The number of experimental treatment levels for each stressor is given in parentheses.

1	Babarro and Zwaan 2002	Phenomenological	Tested the effects of salinity (3) and pH (3) on the disease resistance of the mussel *Mytilus edulis*. Used orthogonal experiment to look at combined effect.
2	Marubini and Atkinson 1999	Phenomenological	Tested the effects of pH (2) and nutrient enrichment (4) on the growth rate of the coral *Porites compressa*. Used orthogonal experiment to look at combined effect.
3	Marubini et al. 2001	Phenomenological	Tested the effects of light intensity (3) and pH (2) on the growth rate of the coral *Porites compressa*. Used orthogonal experiment to look at combined effect.

4	Van de Staaij et al. 1993	Phenomenological	Tested the effects of CO2 enrichment (2) and light intensity (2) on the biomass of the seagrass *Elymus athericus*. Used orthogonal experiment to look at combined effect.
5	Swanson and Fox 2007	Mechanistic	Tested the effects of CO_2 enrichment (2) and light intensity (2) on the biomass of the macroalgae *Saccharina latissima* and *Nereocystis luetkeana*. Examined photoprotective protein production and biomass decay rates as mechanisms for influencing biomass.
6	Baldwin et al. 1996	Mechanistic	Tested the effects of flooding (2) and vegetation disturbance (2) on the species richness of three oligohaline marshes. Examined seed germination and seed bank as mechanisms for influencing species richness.
7	Lenihan et al. 2001	Mechanistic	Tested the effects of hypoxia (2) and oyster reef harvesting (2) on the abundance of vertebrates and invertebrates in oyster reef communities. Examined behavior and the known mechanistic effect of oxygen deprivation on survival as mechanisms for influencing abundance.
8	Lenihan and Peterson 1998	Mechanistic	Tested the effects of hypoxia (2) and oyster reef harvesting (2) on the survival of the oyster *Crassostrea virginica*. Examined loss of reef height and

			immersion in oxygen minimum zones as mechanisms for influencing survival.
9	Renegar and Riegl 2005	Phenomenological	Tested the effects of nutrient (4) and CO_2 enrichment (2) on the growth rate of the coral *Acropora cervicornis*. Used orthogonal experiment to look at combined effect.
10	Bruno et al. 2003	Phenomenological	Tested the effects of nutrient enrichment (2) and disease presence (2) on the disease resistance of the coral *Monastrea sp*. Used orthogonal experiment to look at combined effect.
11	Voss and Richardson 2006	Phenomenological	Tested the effects of nutrient enrichment (3) and disease presence (2) on the disease resistance of the coral *Siderastrea siderea*. Used orthogonal experiment to look at combined effect.
12	Day et al. 2006	Mechanistic	Tested the effects of nutrient enrichment (2) and flooding (2) on the biomass of the trees *Salix nigra* and *Taxodium distichum*. Based study on known mechanistic effects of nutrient enrichment and flooding on plant growth rate.
13	Lovelock et al. 2007	Mechanistic	Tested the effects of sedimentation (2) and nutrient enrichment (3) on the growth rate of the mangrove *Avicennia marina*. Examined photosynthetic gas exchange and sediment respiration as mechanisms for influencing growth rate.
13	Lovelock et al. 2007	Phenomenological .	Tested the effects of sedimentation (2)

			and nutrient enrichment (3) on the productivity of a bacteria community. Used orthogonal experiment to look at combined effect.
14	Schloder and D'Croz 2004	Mechanistic	Tested the effects of nutrient enrichment (2) and temperature (3) on the biomass of the corals *Pocillopora damicornis* and *Porites lobata*. Examined zooxanthellae density and volume as well as chlorophyll and soluble protein concentrations as mechanisms for influencing biomass.
15	Nordemar et al. 2003	Mechanistic	Tested the effects of nutrient enrichment (2) and temperature (2) on the biomass of the coral *Porites cylindrica*. Examined photosynthesis and respiration rates, zooxanthellae density, and chlorophyll concentration as mechanisms for influencing survival.
16	Lotze and Worm 2002	Mechanistic	Tested the effects of temperature (3) and nutrient enrichment (2) on the abundance of the algae *Enteromorpha intestinalis.* Based study on known mechanistic effects of nutrients on algal growth.
17	Hagerthey et al. 2002	Phenomenological	Tested the effects of nutrient enrichment (2) and temperature (2) on the biomass of a phytoplankton community. Used orthogonal study to look at combined effect.
18	Lenihan et al. 2003	Mechanistic	Tested the effects of DOC enrichment (3) and heavy metals (3) on the abundance of

			arthropods, annelids, and echinoderms. Based study on the known mechanistic effect of life history strategies and detoxifying protein production on survival
19	Breitburg et al. 1999	Mechanistic	Tested the effects of nutrient enrichment (2) and heavy metals (2) on the productivity, abundance, and growth rate of species in an intertidal community. Examined predator/prey abundances and community composition as mechanisms for influencing productivity, abundance, and growth rates.
20	Sundback et al. 2007	Phenomenological	Tested the effects of nutrient enrichment (2) and an antifouling biocide (2) on the abundance of microalgae, zooplankton and bacteria communities. Used orthogonal experiment to look at combined effect.
21	Longhi et al. 2006	Phenomenological	Tested the effects of nutrient enrichment (2) and UV exposure (2) on the biomass of phytoplankton communities in different areas (3). Used orthogonal experiment to look at combined effect.
22	Wulff et al. 2000	Mechanistic	Tested the effects of light intensity (2) and nutrient enrichment (2) on the biomass of a macroalgae community. Examined primary production, carbon allocation, chlorophyll concentration, as well as composition of algae pigments

			and carbohydrates as mechanisms for influencing biomass.
23	Effler and Goyer 2006	Mechanistic	Tested the effects of nutrient enrichment (2) and flooding (3) on the biomass of the trees *Taxodium distichum* and *Nyssa aquatica*. Based study on known mechanistic effects of nutrient enrichment and flooding on plant growth rate.
24	Bouma et al. 2001	Mechanistic	Tested the effects of nutrient enrichment (2) and flooding (2) on the biomass of the salt grasses *Elmyus pycnanthus*, *Puccinellia maritima*, and *Spartina angelica*. Based study on known mechanistic effects of nutrient enrichment and flooding on plant growth rate.
25	Torquemada et al. 2005	Mechanistic	Tested the effects of salinity (2) and pH (3) on the productivity of the seagrass *Halophila johnsonii*. Based study on known mechanistic effects of salinity and pH on plant photosynthesis rate.
26	Lenssen et al. 1995	Mechanistic	Tested effects of salinity (4) and CO_2 (2) on biomass of seagrasses *Puccinellia maritime* and *Aster tripolium*. Examined stomatal conductance as mechanism for influencing seagrass growth.
27	Lenssen et al. 1993	Phenomenological	Tested effects of salinity (2), CO_2 (2), and sea level rise (2) on biomass (e.g. dry matter production and leaf development) of seagrasses *Elymus athericus* and *Spartina angelica*. Used orthogonal

			experiment to look at combined effect.
28	Kamer and Fong 2001	Mechanistic	Tested effects of salinity (3) and nutrients (e.g. nitrogen) (3) on the biomass of *Enteromorpha intestinalis*. Examined ability to remove nutrients from the water column and store nutrients in the tissues as mechanism for influencing biomass growth.
29	van Katwijk et al. 1999	Mechanistic	Tested effects of salinity (3) and nutrients (e.g. nitrate, ammonium, phosphate) (3) on abundances of seagrass *Zostera marina*. Examined chemical composition of the plant tissue as mechanism for vitality and abundance.
30	Rajmankova and Komarkova 2005	Mechanistic	Tested effects of salinity (3) and nutrients (e.g. phosphorus, nitrogen) (3) on cyanobacteria productivity. Examined primary production, N_2-fixation, APA activity, overshadowing, and grazing as mechanism for influencing productivity.
31	Sousa et al. 2007	Phenomenological	Tested effects of salinity (3) and nutrients (e.g. nitrogen and phosphorus) (3) on growth rate and chlorophyll *a* concentrations of *Enteromorpha* spp. Used orthogonal experiment to look at combined effect.
32	Baldwin and Mendelssohn 1998	Mechanistic	Tested effects of salinity (2) and sea level rise (2) on the biomass of seagrasses *Spartina alterniflora* and *Saggitaria lancifolia*. Examined soil Eh and sulfide

			concentration as mechanism for influencing aboveground biomass and species richness.
33	Howard and Mendelssohn 2000	Phenomenological	Tested effects of salinity (2) and sea level rise (2) on plant growth of seagrasses Used orthogonal experiment to look at combined effect.
34	Webb and Mendelssohn 1996	Mechanistic	Tested effects of salinity (2) and sea level rise (2) on the biomass of seagrass *Saggitaria lancifolia*. Examined soil Eh and sulfide concentration as mechanism for influencing aboveground biomass.
35	Howard and Rafferty 2006	Mechanistic	Tested effects of salinity (3) and sea level rise (2) on the biomass of seagrasses *Distichlis spicata* and *Schoenoplectus californicus*. Examined redox potential and sulfide concentration as mechanism for influencing aboveground biomass.
36	Carvalho et al. 2003	Phenomenological	Tested effects of salinity (3) and sea level rise (3) on biomass (e.g. dry matter production) and abundance of seagrass *Aster* spp. and fungi. Used orthogonal experiment to look at combined effect.
37	Charpenteir et al. 1998	Phenomenological	Tested effects of salinity (4) and sea level rise (5) on vegetative growth, germination, and seed development of seagrass *Juncus ferardi*. Used orthogonal experiment to look at combined effect.
38	Hellings and Gallagher 1992	Phenomenological	Tested effects of salinity (3) and sea level rise (3) on survivorship, above-ground

			production, and under-ground reserves of seagrass *Phragmites australis*. Used orthogonal experiment to look at combined effect.
39	Naidoo and Kift 2006	Mechanistic	Tested effects of salinity (8) and sea level rise (2) on biomass accumulation of seagrass *Juncus krausii*. Examined CO_2 exchange, stomatal conductance, Photosystem II (PSII) quantum yield and electron transport rate (ETR) through PSII as mechanism for influencing biomass.
40	Koch and Erskine 2001	Mechanistic	Tested effects of salinity (2) and temperature (2) on the biomass and mortality of seagrass *Thalassia testudinum*. Examined leaf O flux measurements and photosynthesis (in the form of carbohydrates) as mechanism for influencing biomass and mortality.
41	Gama-Flores et al. 2005	Phenomenological	Tested effects of salinity (2), temperature (2), and toxin (e.g. copper) (5) on population growth of planktonic rotifer *Brachionus rotundiformis*. Used orthogonal experiment to look at combined effect.
42	Prezslawski et al. 2005	Phenomenological	Tested effects of salinity (3), temperature (3), and UV (3) on mortality and retardation on developmental rates of rocky shore gastropods *Dolabrifera brazieri*, *Bembicium nanum*, and

			Siphonaria denticulata. Used orthogonal experiment to look at combined effect.
43	Ushakova 2003	Phenomenological	Tested effects of salinity (7) and temperature (3) on general survivorship of the larvae, secondary-attachment, and metamorphosis processes on tube-dwelling polychaetes *Spirorbis spirorbis* and *Circeus spirillum*. Used orthogonal experiment to look at combined effect.
44	Qiu and Qian 1998	Phenomenological	Tested effects of salinity (5) and temperature (4) on survival, growth, and subsequent reproduction of polychaete *Hydroides elegans*. Used orthogonal experiment to look at combined effect.
45	Nielsen and Tonseth 1991	Phenomenological	Tested effects of salinity (4) and temperature (5) on growth rate of cells and cellular content of carbon, nitrogen, and phosphorus of phytoplankton *Gyrodinium aureolum*. Used orthogonal experiment to look at combined effect.
46	Kwok and Leung 2005	Phenomenological	Tested effects of salinity (3), temperature (2), and toxin (e.g. copper and tributyltin) (4) on mortality of copepod *Tigripous japonicus*. Used orthogonal experiment to look at combined effect.
47	Brenchley and Probert 1998	Phenomenological	Tested effects of salinity (2) and temperature (2) on seed germination of seagrass *Zostera capricorni*. Used orthogonal experiment to look at combined effect.

48	Alutoin et al. 2001	Phenomenological	Tested effects of salinity (2) and toxin (e.g. copper) (2) on primary production rate per chlorophyll *a* and respiration per surface area of coral *Porites lutea*. Used orthogonal experiment to look at combined effect.
49	Elfwing and Tedengren 2002	Mechanistic	Tested effects of salinity (2) and toxin (e.g. copper) (2) on production and mollusc grazing activity of marine gastropod mollusk *Trochus maculatus* and macroalga *Enteromorpha intestinalis* and *Gracilaria tenuistipitata*. Examined respiration, excretion, and absorption efficiency as mechanism for influencing production and grazing.
50	DeLisle and Roberts 1994	Mechanistic	Tested effects of salinity (6) and toxin (e.g. cadmium) (6) mortality and molting rate of shrimp *Mysidopsis bahia*. Examined osmoregulatory capacity as mechanism for influencing survival and molting rate.
51	Karsten et al. 2003	Mechanistic	Tested the effects of UV exposure (2) and salinity (3) on the productivity of the two algae species *Devaleraea ramentacea* and *Palmaria palmata*. Examined photoprotective protein production and variable chlorophyll fluorescence of photosystem II as mechanisms for influencing production.
52	Kahn and Durako 2006	Phenomenological	Tested the effects of salinity (8) and

			ammonium (3) on the survival, respiration, chlorophyll fluorescence, and osmolality of the macrophyte *Thalassia testudinum.* Used orthogonal experiment to look at combined effects.
53	Porter et al. 1999	Phenomenological	Tested the effects of salinity (2) and temperature (2) on the productivity of the coral *Montastrea annularis*. Used orthogonal experiment to look at combined effects.
54	Piazzi et al. 2005	Phenomenological	Tested the effects of sedimentation (2) and the presence of an invader (2) on the abundance and percent cover of a native algal assemblage. Used orthogonal experiment to look at combined effects.
55	Gorgula and Connell 2004	Phenomenological	Tested the effects of sedimentation (2) and nutrients in the water (2) and in the sediments (2) on the percent cover of turf algae. Used orthogonal experiment to look at combined effects
56	Gray and Mogg 2001	Mechanistic	Based study on known mechanistic effect of CO_2 on the production of C4 and C3 plants as well as the known temperature preferences of the macrophyte species *Spartina angelica* and *Puccinellia maritima* to examine the effects of CO_2 (2) and temperature (2) on the competition between and biomass of each species.
57	Reynaud et al. 2003	Mechanistic	Tested the effects of CO_2 (2) and

			temperature (2) on the productivity of the coral species *Stylophora pistillata*. Examined content of chlorophyll *a* and c2, as well as protein production, as mechanisms for influencing production.
57	Reynaud et al. 2003	Phenomenological	Tested the effects of CO_2 (2) and temperature (2) on the calcification of the coral *Stylophora pistillata*. Used orthogonal experiment to look at combined effects.
58	Fu et al. 2007	Mechanistic	Tested the effects of CO_2 (2) and temperature (2) on the phytoplankton *Prochlorococcus* sp. and *Synechoccocus* sp. Examined chlorophyll fluorescence, phycobilliopigment, and chlorophyll concentrations as mechanisms influencing photosynthetic efficiency and growth rate.
59	Cervino et al. 2004	Mechanistic	Tested the effects of yellow band disease (2) and temperature (3) on the coral *Monastrea* spp. Examined zooxanthellae densities as the mechanism influencing mortality.
60	Ward et al. 2007	Mechanistic	Tested the effects of temperature (3) and disease (2) on the coral *Gorgonia ventalina.* Examined anti-fungal chemical production as the mechanism influencing disease inhibition.
60	Ward et al. 2007	Phenomenological	Tested the effects of temperature (3) and disease (2) on the abundance of zooxanthellae of the coral *Gorgonia*

			ventalina. Used orthogonal experiment to look at combined effects.
61	Braid et al. 2005	Phenomenological	Tested the effects of temperature (2), food availability (2), and presence of disease (2) on the mortality in the red abalone *Haliotis rufescens*. Used orthogonal experiment to look at the combined effects.
62	Aeby and Santavy 2006	Phenomenological	Tested the effects of temperature (2) and injury (2) on the disease severity in the coral *Montastraea faveolata*. Used orthogonal experiment to look at the combined effects.
63	Mora et al. 2007	Phenomenological	Tested the effects of temperature (constant warming) (3), exploitation (removal) (5), and habitat fragmentation (5) on the abundance of the rotifer *Brachionus plicatilis*. Used orthogonal experiment to look at the combined effects.
64	Cancino et al. 2003	Mechanistic	Based study on known mechanistic effect of oxygen and temperature on embryonic mollusk development to examine the combined effects of temperature (3) and oxygen (2) deprivation on the development of the snail *Chorus giganteus.*
65	Hicks and McMahon 2005	Phenomenological	Tested the effects of temperature (3) and dissolved oxygen (5) on the mortality of the mussel *Perna perna.* Used orthogonal

			experiment to look at the combined effects.
66	Vilchis et al. 2005	Phenomenological	Tested the effects of temperature (3) and food quality (3) and quantity (3) on the growth, reproductive output, and susceptibility to disease of the abalone *Haliotis bermudense.* Used orthoganal experiments to look at the combined effects.
67	Anthony et al. 2007	Mechanistic	Tested the effects of temperature (2), light intensity (2), and sedimentation (2) on the coral *Acropora intermedia*. Examined lipid stores and chlorophyll content as the mechanisms influencing mortality.
68	Nyström et al. 2001	Phenomenological	Tested the effects of temperature (2) and toxin levels in the form of copper (2) on the productivity of the coral *Porites cylindrica.* Used orthogonal study to look at the combined effects.
69	Drohan et al. 2005	Mechanistic	Based study on the known mechanistic effect of temperature an UV intensity on zooxanthellae through damage and production of toxins to examine the combined effects of temperature (4) and UV intensity (3) on the abundance of zooxanthellae in the coral *Eunicea tourneforti.*
70	Rautenberger and Bischof 2006	Mechanistic	Tested the effects of temperature (2) and UV intensity (3) on the macroalgal species *Ulva bulbosa*and *Ulva clathrata.*

			Examined numerous physiological mechanisms including damage to proteins in and fluorescence of photosystem II as the mechanisms influencing productivity.
71	Lesser 1996	Mechanistic	Tested the effects of temperature (5) and UV (2) intensity on the zooxanthellae species *Symbodium bermudense*. Examined numerous physiological mechanisms including Rubisco activity and production of superoxide radicals as the mechanisms influencing productivity.
72	Hoffman et al. 2003	Phenomenological	Tested the effects of temperature (3) and UV (4) exposure on the germination and cell number of the macroalgal species *Alaria marginata* and *Fucus gardneri*. Used orthogonal study to look at the combined effects.
73	Altamirano et al. 2003	Phenomenological	Tested the effects of temperature (2) and UV intensity (3) on the growth and survival of the macroalgal species *Fucus spiralis, Fucus vesiculosus,*and *Fucus serratus*. Used orthogonal study to look at the combined effects.
74	Ferrier-Pagés et al. 2007	Mechanistic	Based study on the known mechanistic effects of temperature and UV exposure on zooxanthellae productivity to examine and compare the combined effects of temperature (4) and UV (2) exposure on the photosythetic efficiency of the coral species *Stylophora pistillata, Pavona*

			cactus, Acropora sp., and *Pavona cactus*.
75	Lesser et al. 1990	Mechanistic	Tested the effects of temperature (2), light level (2), and UV intensity (2) on the zooxanthellae in the coral *Palythoa caribaeorum*. Examined production of detoxifying enzymes as the mechanism which influences zooxanthellae expulsion.
76	Anderson et al. 1998	Mechanistic	Tested effects of tributyltin (2) and hypoxia (2) on the mortality of *Crassostrea virginica*. Examined lysozymes as mechanism for influencing mortality from *P. marinus* infections.
77	Koch et al. 2007	Mechanistic	Tested effects of high temperatures (4) and sulfide accumulation (2) on the growth and mortality of *Halodule wrightii* and *Thalassia testdinium*. Examined biogeochemical response to labile C as mechanism for influencing growth and mortality
78	Liess et al. 2001	Phenomenological	Tested effects of UVB radiation (2) and food shortage (2) on the copper sensitivity of *Paramoera walkeri*. Used orthogonal experiment to look at combined effect.
79	Sargian et al. 2005a	Phenomenological	Tested effects of water-soluble fraction of crude oil (2) and UVB radiation (2) on the growth and assemblage of phytoplankton and bacteria. Used orthogonal experiment to look at

			combined effect.
80	Sargian et al. 2005b	Mechanistic	Tested effects of tributyltin (2) and UVB radiation (2) on the growth rate of phytoplankton and bacteria. Examined photosynthetic efficiency as mechanism for influencing growth rate.
81	Duquesne and Liess 2003	Phenomenological	Tested effects of heavy metals (2) and UVB radiation (2) on the heavy metal sensitivity of *Paramorea walkeri*. Used orthogonal experiment to look at combined effect.
82	Peachey 2005	Phenomenological	Tested effects of hydrocarbon pollutants (4) and UV radiation (2) on the larval mortality of several species of crabs. Used orthogonal experiment to look at combined effect.
83	Martinez et al. 2007	Phenomenological	Tested effects of UV radiation (2) and polycyclic aromatic hydrocarbons (3) on the mortality and bleaching of *Porites divaricata*. Used orthogonal experiment to look at combined effect.
84	Cleveland et al. 2000	Phenomenological	Tested effects of UV radiation (3) and oil contaminants (6) on the survival and growth of *Mysidopsis bahia*. Used orthogonal experiment to look at combined effect.
85	Pelletier et al. 2006	Mechanistic	Tested effects of UVB radiation (2) and organic contaminants (2) on the growth and mortality of select organisms within coastal ecosystems. Examined

			photochemical efficiency as mechanism for influencing growth and mortality.
86	Little et al. 2000	Phenomenological	Tested effects of UV radiation (4) and water-soluble fraction of crude oil (6) on the survival and growth of *Menidia beryllina*. Used orthogonal experiment to look at combined effect.
87	Sargian et al. 2007	Mechanistic	Tested effects of water-soluble fraction of crude oil (2) and UVB radiation (2) on the assemblage and survival of microplankton. Examined pigment production, destruction, and recovery as mechanism for influencing survival.
88	Southerland and Lewitus 2004	Mechanistic	Tested effects of UV radiation (3) and fluoranthene toxicity (3) on the abundance and mortality of *Ankistrodesmus*. Examined photopigment responses as mechanism for influencing abundance and mortality.
89	Steevens et al. 1999	Phenomenological	Tested effects of UVB radiation (2) and polyaromatic hydrocarbon exposure (5) on the bioluminescence and growth rates *Vibrio fischeri* and *Lytechinus variegatus*. Used orthogonal experiment to look at combined effect.
90	Miller and Hay 1996	Phenomenological	Tested effects of nutrient levels (2), depth (2), and presence of seaweed (2) on the abundance of *Oculina arbuscula* colonies. Used orthogonal experiment to look at combined effect.

91	McClanahan et al. 2003	Phenomenological	Tested effects of nutrient availability (2) and herbivory (2) on the abundance of algae and corals. Used orthogonal experiment to look at combined effect.
92	Thacker et al. 2001	Phenomenological	Tested effects of nutrient levels (2) and herbivory (3) on the growth rates of cyanobacteria and macroalgae. Used orthogonal experiment to look at combined effect.
93	Humphrey et al. 2008	Phenomenological	Tested effects of nutrients (3) and sediment (3) on the coral *Acropora millepora* fertilization rate. Used orthogonal experiment to look at combined effect.
94	Canning-Clode et al. 2008	Phenomenological	Tested effects of nutrients (4) and physical disturbance (3) on fouling community diversity. Used orthogonal experiment to look at combined effect.
95	Sundback et al. 2010	Both	Tested effects of nutrients (2) and toxicants (2) on meiofauna biomass and grazing rates and on microalgal abundance. Did not measure reason for impacts on meiofauna (phenomenological). Examined changes in meiofauna grazing as mechanism for influencing microalgal abundance (mechanistic)
96	Fukunaga et al. 2010	Phenomenological	Tested effects of contamination by different heavy metals (2) on estuarine infaunal community assemblage. Used

			orthogonal experiment to look at combined effects.
97	Byrne et al. 2010	Phenomenological	Tested effects of temperature (3) and acidity (4) on fertilization of echinoid species. Hypothesized mechanism, but did not measure sperm swimming speed to allow test of hypothesis.
98	Atalah and Crowe 2010	Phenomenological	Tested effects of nutrients (3) and sediment (3) on percent cover of rock pool assemblage. Used orthogonal experiment to look at combined effect.
99	Fukunaga et al. 2011	Phenomenological	Tested effects of zinc (3) and copper (2) on infaunal invertebrate richness. Used orthogonal experiment to look at combined effect.
100	Fitch and Crowe 2012	Phenomenological	Tested effects of nutrients (3) and organic matter enrichment (2) on benthic infaunal richness and diversity. Used orthogonal experiment to look at combined effect.
101	Jochum et al. 2012	Mechanistic	Tested effects of temperature (3) and nutrients (2) on intertidal abundance of macroalgae and invertebrates. Reasoned that temperature would influence invertebrate body size. So experimentally manipulated body size to mechanistically simulate temperature effect and combined with nutrient additions to see overall effect.
102	Roger et al. 2012	Phenomenological	Tested effects of temperature (2) and salinity (2) on the abundance of different

			genotypes of the diatom *Skeletonema marinoi*. Found that differed across genotypes, but did not explore why.
103	Thiyagarajan and Ko 2012	Phenomenological	Tested effects of pH (2), temperature (2), and salinity (2) on the oyster *Crassostrea angulate* shells. Used orthogonal experiment to look at combined effect.
104	Alsterberg and Sundback 2013	Phenomenological	Tested effects of temperature (2) and heavy metal exposure (2) across different levels of benthic sediment community. Used orthogonal experiment to look at combined effect on multiple community components (bacteria, microalgae, meiofauna).
105	Chan et al. 2013	Mechanistic	Tested effects of temperature (2), salinity (2), and pH (2) on shell of tubeworm *Hydroides elegans*. Measured structural aspects of shell in response to individual and multiple stressors as mechanism for influencing shell hardness and elasticity.
106	Ekvall et al. 2013	Phenomenological	Tested effects of temperature (2) and humification (2) of water on abundance and toxicity of the cyanobacteria *Microcystis botrys*. Used orthogonal experiment to look at combined effect.
107	Byrne et al. 2013	Phenomenological	Tested effects of temperature (3) and acidification (3) on several larval stages of the sea star *Patiriella regularis*. Used orthogonal experiment to look at combined effects.

108	Cabrerizo et al. 2014	Mechanistic	Tested effects of UV radiation (2), temperature (3), and nutrients (2) on photosynthesis and respiration in several phytoplankton groups. Measured changes in PSII yield as a mechanism for differences in photosynthesis between groups.
109	Dangre et al. 2010	Mechanistic	Tested effects of cadmium (2) and anoxic conditions (2) on the development of the fish *Cyprinodon variegatus*. Examined gene expression under stressor conditions as mechanisms for differential development.
110	Davis et al. 2013	Phenomenological	Tested effects of temperature (2), pH (2), and UV radiation (3) on mortality and development rate of the snail *Bembicium nanum.* Used orthogonal experiment to look at combined effects.
111	Delorme and Sewell 2014	Phenomenological	Tested effects of temperature (2) and salinity (5) on development in the urchin *Evechinus chloroticus*. Used orthogonal experiment to look at combined effects on development times.
112	Enzor and Place 2014	Mechanistic	Tested effects of temperature (2) and pCO_2 (2) on the antioxidant capacity of three species of Antarctic fish. Measured enzyme activity and protein damage as mechanisms that influenced antioxidant capacity under different stress conditions.
113	Ericson et al. 2012	Phenomenological	Tested effects of temperature (2) and

			acidity (2) on fertilization and development of the urchin *Sterechinus neumayeri*. Used orthogonal experiment to look at combined effect.
114	Fleming and Di Giulio 2014	Mechanistic	Tested effects of hypoxia (2) and PAHs (2) on the development of the fish *Danio rerio*. Experimental knockout of gene known to be influenced by toxins to show mechanism of changes in development.
115	Foo et al. 2012	Phenomenological	Tested effects of temperature (3) and acidity (3) on survival and development of the urchin *Centrostephanus rodgersii*. Used orthogonal experiment with different genetic lines to show combined effects.
116	Foo et al. 2014	Phenomenological	Tested effects of temperature (2) and acidity (3) on survival and development of the urchin *Pseudoboletia indiana*. Used orthogonal experiment with different genetic lines to show combined effects.
117	Gaitan-Espitia et al. 2014	Phenomenological	Tested effects of temperature (2) and pCO_2 (2) on germination, development, and mortality of the kelp *Macrocystic pyrifera*. Used orthogonal experiment to look at combined effect.
118	Godbold and Solan 2013	Mechanistic	Tested effects of temperature (2) and acidity (3) on the nutrient release of the worm *Alitta virens*. Used differences in behavior as mechanism to understand

			nutrient release under different stressor conditions.
119	Hoher et al. 2013	Mechanistic	Tested effects of salinity (2) and heavy metal (3) on the immune response of the mussel *Mytilus edulis*. Measured changes in abundance of different cell types as mechanism for observed immune response.
120	Holiday et al. 2009	Phenomenological	Tested effects of salinity (4) and PCBs (2) on the growth and metabolic rate of the turtle *Malaclemys terrapin*. Used orthogonal experiment to look at combined effects.
121	Ivanina et al. 2009	Phenomenological	Tested effects of temperature (6) and heavy metals (2) on the response of heat shock proteins in the oyster *Crassostrea virginica*. Used experiment to examine impacts of stressors, but did not use this mechanistically to explain higher level phenomena.
122	Ivanina et al. 2014	Phenomenological	Tested effects of pCO_2 (3) and heavy metals (2) on the immune response of two bivalves. Used experiment to examine impacts of stressors, but did not use this mechanistically to explain higher level phenomena.
123	Ko et al. 2014	Mechanistic	Tested effects of acidity (2), temperature (2), and salinity (2) on early life stages of the oyster *Crassostrea gigas*. Measured lipid reserves and body size as

			(unsuccessful) mechanisms to understand metamorphosis.
124	Martinez-Crego et al. 2014	Mechanistic	Tested effects of CO_2 (2) and nutrients (2) on entire invertebrate community. By examining entire community with stressor was able to use effect on macroalgae C:N ratio as mechanism to understand cascading effects on entire food web.
125	Matoo et al. 2013	Phenomenological	Tested effect of temperature (2) and acidity (2) on metabolism and oxidative stress in two bivalves. Used experiment to examine impacts of stressor, but did not use this mechanistically to explain higher level phenomena.
126	Miller et al. 2014	Phenomenological	Tested effect of salinity (3) and pCO_2 (2) on metabolic rate of the crab *Petrolithses cinctipes*. Used experiment where stressors were presented in series rather than simultaneously and measured response.
127	Muthukrishnan and Fong 2014	Phenomenological	Tested effects of nutrients (2), sediment (2), and consumers on coral reefs in field experiment. Measured impacts on coral cover, algal cover, species assemblage, and biomass.
128	Neale et al. 2014	Phenomenological	Tested effects of CO_2 (2), nutrients (2), and light (2) on plankton biomass. Measured different levels of planktonic food web and inferred, but did not measure, trophic cascades.

129	O'Gorman et al. 2012	Phenomenological	Tested effects of nutrients (3) and organic enrichment (2) on infaunal diversity, evenness, and food chain length. Presented stresses and measured impacts through time.
130	Paul-Pont et al. 2010	Mechanistic	Tested how parasites (2) influenced the response to heavy metal exposure (2) in the clam *Ruditapes philippinarum*. Measured hemocyte concentration and metallothionein as mechanisms that influenced cadmium accumulation.
131	Petersen et al. 2009	Phenomenological	Tested effects of nutrients (2) and toxicants (2) on benthic invertebrates. Experimentally applied stresses and then measured community structure and nutrient fluxes.
132	Queiros et al. 2015	Mechanistic	Tested effects of temperature (2) and acidity (3) on the whelk *Nucella lapillus*. Measured behavioral, physiological, and dispersal response to stressors and then used these mechanistically within a dynamic bioclimatic envelope model to predict future distribution of the whelk.
133	Renick et al. 2015	Phenomenological	Tested effects of pesticides (4) and habitat destruction (5) on predation risk on larval fish *Atherinops affinis*. Exposed larval fish to pesticides and then put into different types of habitat and measured predation by sticklebacks.
134	Rivest and Hofmann 2014	Mechanistic	Tested effects of temperature (2) and

			acidity (2) on metabolic response of the coral *Pocillopora damicornis.* Presented with stressors and measured metabolism, but also mechanistically measured citrate synthase as the rate-limiting enzyme in aerobic metabolism.
135	Schneider et al. 2010	Phenomenological	Tested effects of temperature (2) and food availability (2) on survival of two mussel species. Used orthogonal experiment to vary food level and temperature and measured survival.
136	Schram et al. 2014	Phenomenological	Tested effects of temperature (2) and acidity (2) on righting time of snail and limpet. Experimentally exposed over long time to stressors and them measured response.
137	Tait 2014	Phenomenological	Tested effects of temperature (2), acidity (3), and light (2) on photosynthesis in coralline algae and kelp. Experimentally exposed to stressors and then measured the increase in oxygen production.
138	Vaz-Pinto et al. 2013	Mechanistic	Tested effects of temperature (2) and pCO_2 (2) on the invasion success of the macroalgae *Sargassum muticum*. Measured effects of stressors on functional diversity of macroalgal assemblage as bioinhibition mechanism for success of spores.
139	Vieira and Guilhermino 2012	Phenomenological	Tested effects of temperature (2) and PAHs (7) on growth of the plankton

			Tetraselmis chuii. Presented with stressors and then measured culture growth.
140	Zervoudaki et al. 2013	Phenomenological	Tested effects of temperature (2) and acidity (2) on the copepod *Acartia clause*. Experimentally exposed to stresses and then measured egg production, hatching success, excretion, and metabolic rates.
141	Ferrari et al. 2015	Phenomenological	Tested effects of temperature (2) and acidity (2) on predation of two species of damselfish. Presented prey with stressors and then measured predation rate and selectivity by predatory fish.
142	Coelho et al. 2015	Mechanistic	Tested effects of acidity (2), UVB (2), and oil contamination (2) on the bacterial community and invertebrates. Presented with stressors in factorial experiment and compared bacterial community. Also examined oxidative stress on invertebrates as mechanism for impacts on these indicator species.
143	Suckling et al. 2015	Phenomenological	Tested effects of acidity (3) and temperature (1 – no temperature control because the effect of temperature increase was already well established) on the urchin *Sterechinus neumayeri*. Presented adults with long-term stress (2 years) and examined acclimation via changes in physiology and reproductive success.

LITERATURE CITED

1. Babarro JMF, de Zwaan A (2002) Influence of abiotic factors on bacterial proliferation and anoxic survival of the sea mussel *Mytilus edulis* L. J Exp Mar Biol Ecol 273:33-49

2. Marubini F, Atkinson MJ (1999) Effects of lowered pH and elevated nitrate on coral calcification. Mar Ecol Prog Ser 188:117-121

3. Marubini F, Barnett H, Langdon C, Atkinson MJ (2001) Dependence of calcification on light and carbonate ion concentration for the hermatypic coral Porites compressa. Mar Ecol Prog Ser 220:153-162

4. Van de Staaij JWM, Lenssen GM, Stroetenga M, Rozema J (1993) The Combined Effects of Elevated Co2 Levels and Uv-B Radiation on Growth-Characteristics of *Elymus athericus* (= *E. pycnanathus*). Vegetation 104:433-439

5. Swanson AK, Fox CH (2007) Altered kelp (Laminariales) phlorotannins and growth under elevated carbon dioxide and ultraviolet-B treatments can influence associated intertidal food webs. Global Change Biol 13:1696-1709

6. Baldwin AH, McKee KL, Mendelssohn IA (1996) The influence of vegetation, salinity, and inundation on seed banks of oligohaline coastal marshes. Am J Bot 83:470-479

7. Lenihan HS, Peterson CH, Byers JE, Grabowski JH, Thayer GW, Colby DR (2001) Cascading of habitat degradation: Oyster reefs invaded by refugee fishes escaping stress. Ecol Appl 11:764-782

8. Lenihan HS, Peterson CH (1998) How habitat degradation through fishery disturbance enhances impacts of hypoxia on oyster reefs. Ecol Appl 8:128-140

9. Renegar DA, Riegl BM (2005) Effect of nutrient enrichment and elevated CO2 partial pressure on growth rate of Atlantic scleractinian coral Acropora cervicornis. Mar Ecol Prog Ser 293:69-76

10. Bruno JF, Petes LE, Harvell CD, Hettinger A (2003) Nutrient enrichment can increase the severity of coral diseases. Ecol Lett 6:1056-1061

11. Voss JD, Richardson LL (2006) Nutrient enrichment enhances black band disease progression in corals. Coral Reefs 25:569-576

12. Day RH, Doyle TW, Draugelis-Dale RO (2006) Interactive effects of substrate, hydroperiod, and nutrients on seedling growth of Salix nigra and Taxodium distichum. Environ Exp Bot 55:163-174

13. Lovelock C, Feller I, Ellis J, Schwarz A, Hancock N, Sorrell B (2007) Mangrove growth in New Zealand estuaries: the role of nutrient enrichment at sites with contrasting rates of sedimentation. Oecologia 153:633-641

14. Schloder C, D'Croz L (2004) Responses of massive and branching coral species to the combined effects of water temperature and nitrate enrichment. J Exp Mar Biol Ecol 313:255-268

15. Nordemar I, Nystrom M, Dizon R (2003) Effects of elevated seawater temperature and nitrate enrichment on the branching coral *Porites cylindrica* in the absence of particulate food. Mar Biol 142:669-677

16. Lotze HK, Worm B (2002) Complex interactions of climatic and ecological controls on macroalgal recruitment. Limnol Oceanogr 47:1734-1741

17. Hagerthey SE, Defew EC, Paterson DM (2002) Influence of *Corophium volutator* and Hydrobia ulvae on intertidal benthic diatom assemblages under different nutrient and temperature regimes. Mar Ecol Prog Ser 245:47-59

18. Lenihan HS, Peterson CH, Kim SL, Conlan KE, Fairey R, McDonald C, Grabowski JH, Oliver JS (2003) Variation in marine benthic community composition allows discrimination of multiple stressors. Mar Ecol Prog Ser 261:63-73

19. Breitburg DL, Sanders JG, Gilmour CC, Hatfield CA, Osman RW, Riedel GF, Seitzinger SB, Sellner KG (1999) Variability in responses to nutrients and trace elements, and transmission of stressor effects through an estuarine food web. Limnol Oceanogr 44:837-863

20. Sundback K, Petersen DG, Dahllof I, Larson F (2007) Combined nutrient-toxicant effects on a shallow-water marine sediment system: sensitivity and resilience of ecosystem functions. Mar Ecol Prog Ser 330:13-30

21. Longhi ML, Ferreyra G, Schloss I, Roy S (2006) Variable phytoplankton response to enhanced UV-B and nitrate addition in mesocosm experiments at three latitudes (Canada, Brazil and Argentina). Mar Ecol Prog Ser 313:57-72

22. Wulff A, Wangberg SA, Sundback K, Nilsson C, Underwood GJC (2000) Effects of UVB radiation on a marine microphytobenthic community growing on a sand-substratum under different nutrient conditions. Limnol Oceanogr 45:1144-1152

23. Effler RS, Goyer RA (2006) Baldcypress and water tupelo sapling response to multiple stress agents and reforestation implications for Louisiana swamps. For Ecol Manage 226:330-340

24. Bouma TJ, Koutstaal BP, van Dongen M, Nielsen KL (2001) Coping with low nutrient availability and inundation: root growth responses of three halophytic grass species from different elevations along a flooding gradient. Oecologia 126:472-481

25. Torquemada YF, Durako MJ, Lizaso JLS (2005) Effects of salinity and possible interactions with temperature and pH on growth and photosynthesis of *Halophila johnsonii* Eiseman. Mar Biol 148:251-260

26. Lenssen GM, Vanduin WE, Jak P, Rozema J (1995) The Response of *Aster tripolium* and *Puccinellia maritima* to Atmospheric Carbon-Dioxide Enrichment and Their Interactions with Flooding and Salinity. Aquat Bot 50:181-192

27. Lenssen GM, Lamers J, Stroetenga M, Rozema J (1993) Interactive Effects of Atmospheric CO2 Enrichment, Salinity and Flooding on Growth of C-3 (*Elymus athericus*) and C-4 (*Spartina anglica*) Salt-Marsh Species. Vegetatino 104:379-388

28. Kamer K, Fong P (2001) Nitrogen enrichment ameliorates the negative effects of reduced salinity on the green macroalga *Enteromorpha intestinalis*. Mar Ecol Prog Ser 218:87-93

29. van Katwijk, MM, Schmitz GHW, Gasseling AP, van Avesaath PH (1999) Effects of salinity and nutrient load and their interaction on *Zostera marina*. Mar Ecol Prog Ser 190:155-165

30. Rejmankova E, Komarkova J (2005) Response of cyanobacterial mats to nutrient and salinity changes. Aquat Bot 83:87-107

31. Sousa AI, Martins I, Lillebo AI, Flindt MR, Pardal MA (2007) Influence of salinity, nutrients and light on the germination and growth of *Enteromorpha* sp. spores. J Exp Mar Biol Ecol 341:142-150

32. Baldwin AH, Mendelssohn IA (1998) Effects of salinity and water level on coastal marshes: an experimental test of disturbance as a catalyst for vegetation change. Aquat Bot 61:255-268

33. Howard RJ, Mendelssohn IA (2000) Structure and composition of oligohaline marsh plant communities exposed to salinity pulses. Aquat Bot 68:143-164

34. Webb EC, Mendelssohn IA (1996) Factors affecting vegetation dieback of an oligohaline marsh in coastal Louisiana: Field manipulation of salinity and submergence. Am J Bot 83:1429-1434

35. Howard RJ, Rafferty PS (2006) Clonal variation in response to salinity and flooding stress in four marsh macrophytes of the northern Gulf of Mexico, USA. Environ Exp Bot 56:301-313

36. Carvalho LM, Correia PM, Cacador I, Martins-Loucao MA (2003) Effects of salinity and flooding on the infectivity of salt marsh arbuscular mycorrhizal fungi in *Aster tripolium* L. Biol Fertility Soils 38:137-143

37. Charpentier A, Mesleard F, Grillas P (1998) The role of water level and salinity in the regulation of *Juncus gerardi* populations in former ricefields in southern France. J Veg Sci 9:361-370

38. Hellings SE, Gallagher JL (1992) The Effects of Salinity and Flooding on *Phragmites australis*. J Appl Ecol 29:41-49

39. Naidoo G, Kift J (2006) Responses of the saltmarsh rush *Juncus kraussii* to salinity and waterlogging. Aquat Bot 84:217-225.

40. Koch MS, Erskine JM (2001) Sulfide as a phytotoxin to the tropical seagrass *Thalassia testudinum:* interactions with light, salinity and temperature. J Exp Mar Biol Ecol 266:81-95

41. Gama-Flores JL, Sarma SSS, Nandini S (2005) Interaction among copper toxicity, temperature and salinity on the population dynamics of *Brachionus rotundiformis* (Rotifera). Hydrobiologia 546:559-568

42. Przeslawski R, Davis AR, Benkendorff K (2005) Synergistic effects associated with climate change and the development of rocky shore molluscs. Global Change Biol 11:515-522

43. Ushakova OO (2003) Combined effect of salinity and temperature on *Spirorbis spirorbis* L. and *Circeus spirillum* L. larvae from the White Sea. J Exp Mar Biol Ecol 296:23-33

44. Qiu JW, Qian PY (1998) Combined effects of salinity and temperature on juvenile survival, growth and maturation in the polychaete *Hydroides elegans*. Mar Ecol Prog Ser 168:127-134

45. Nielsen MV, Tonseth, CP (1991) Temperature and Salinity Effect on Growth and Chemical-Composition of *Gyrodinium aureolum* Hulburt in Culture. J Plankton Res 13:389-398

46. Kwok KWH, Leung KMY (2005) Toxicity of antifouling biocides to the intertidal harpacticoid copepod *Tigriopus japonicus* (Crustacea, Copepoda): Effects of temperature and salinity. Mar Pollut Bull 51:830-837

47. Brenchley JL, Probert RJ (1998) Seed germination responses to some environmental factors in the seagrass *Zostera capricorni* from eastern Australia. Aquat Bot 62:177-188

48. Alutoin S, Boberg J, Nystrom M, Tedengren M (2001) Effects of the multiple stressors copper and reduced salinity on the metabolism of the hermatypic coral *Porites lutea*. Mar Environ Res 52:289-299

49. Elfwing T, Tedengren M (2002) Effects of copper and reduced salinity on grazing activity and macroalgae production: a short-term study on a mollusc grazer, *Trochus maculatus* and two species of macroalgae in the inner Gulf of Thailand. Mar Biol 140:913-919

50. De Lisle PF, Roberzt MH (1994) The Effect of Salinity on Cadmium Toxicity in the Estuarine Mysid *Mysidopsis bahia* - Roles of Osmoregulation and Calcium. Mar Environ Res 37:47-62

51. Karsten U, Dummermuth A, Hoyer K, Wiencke C (2003) Interactive effects of ultraviolet radiation and salinity on the ecophysiology of two Arctic red algae from shallow waters. Polar Biol 26:249-258

52. Kahn AE, Durako MJ (2006) *Thalassia testudinum* seedling responses to changes in salinity and nitrogen levels. J Exp Mar Biol Ecol 335:1-12

53. Porter JW, Lewis SK, Porter KG (1999) The effect of multiple stressors on the Florida Keys coral reef ecosystem: A landscape hypothesis and a physiological test. Limnol Oceanogr 44:941-949

54. Piazzi L, Balata D, Ceccherelli G, Cinelli F (2005) Interactive effect of sedimentation and *Caulerpa racemosa* var. *cylindracea* invasion on macroalgal assemblages in the Mediterranean Sea. Estuarine Coastal and Shelf Science 64:467-474

55. Gorgula SK, Connell SD (2004) Expansive covers of turf-forming algae on human-dominated coast: the relative effects of increasing nutrient and sediment loads. Mar Biol 145:613-619

56. Gray AJ, Mogg RJ (2001) Climate impacts on pioneer saltmarsh plants. Clim Res 18:105-112

57. Reynaud S, Leclercq N, Romaine-Lioud S, Ferrier-Pages C, Jaubert J, Gattuso JP (2003) Interacting effects of CO2 partial pressure and temperature on photosynthesis and calcification in a scleractinian coral. Global Change Biol 9:1660-1668

58. Fu FX, Warner ME, Zhang YH, Feng YY, Hutchin, DA (2007) Effects of increased temperature and CO2 on photosynthesis, growth, and elemental ratios in marine Synechococcus and Prochlorococcus (Cyanobacteria). J Phycol 43:485-496

59. Cervino JM, Hayes RL, Polson SW, Polson SC, Goreau TJ, Martinez RJ, Smith GW (2004) Relationship of Vibrio species infection and elevated temperatures to yellow blotch/band disease in Caribbean corals. Appl Environ Microbiol 70:6855-6864

60. Ward JR, Kim K, Harvell CD (2006) Temperature affects coral disease resistance and pathogen growth. Mar Ecol Prog Ser 329:115-121

61. Braid BA, Moore JD, Robbins TT, Hedrick RP, Tjeerdema RS, Friedman CS (2005) Health and survival of red abalone, *Haliotis rufescens*, under varying temperature, food supply, and exposure to the agent of withering syndrome. J Invertebr Pathol 89:219-231

62. Aeby GS, Santavy DL (2006) Factors affecting susceptibility of the coral *Montastraea faveolata* to black-band disease. Mar Ecol Prog Ser 318:103-110

63. Mora C, Metzger R, Rollo A, Myers R (2007) Experimental simulations about the effects of overexploitation and habitat fragmentation on populations facing environmental warming. Proc R Soc Lond, Ser B: Biol Sci 274 1023 - 1028

64. Cancino JM, Gallardo JA, Torres FA (2003) Combined effects of dissolved oxygen concentration and water temperature on embryonic development and larval shell secretion in the marine snail *Chorus giganteus* (Gastropoda : Muricidae). Mar Biol 142:133-139

65. Hicks DW, McMahon RF (2005) Effects of temperature on chronic hypoxia tolerance in the non-indigenous brown mussel, *Perna perna* (Bivalvia : Mytilidae) from the Texas Gulf of Mexico. J Molluscan Stud 71:401-408

66. Vilchis LI, Tegner MJ, Moore JD, Friedman CS, Riser KL, Robbins TT, Dayton PK (2005) Ocean warming effects on growth, reproduction, and survivorship of Southern California abalone. Ecol Appl 15:469-480

67. Anthony KRN, Connolly SR, Hoegh-Guldberg O (2007) Bleaching, energetics, and coral mortality risk: Effects of temperature, light, and sediment regime. Limnol Oceanogr 52:716-726

68. Nystrom M, Nordemar I, Tedengren M (2001) Simultaneous and sequential stress from increased temperature and copper on the metabolism of the hermatypic coral *Porites cylindrica*. Mar Biol 138:1225-1231

69. Drohan AF, Thoney DA, Baker AC (2005) Synergistic effect of high temperature and ultraviolet-B radiation on the gorgonian *Eunicea tourneforti* (Octocorallia : Alcyonacea : Plexauridae). Bull Mar Sci 77:257-266

70. Rautenberger R, Bischof K (2006) Impact of temperature on UV-susceptibility of two Ulva (Chlorophyta) species from Antarctic and Subantarctic regions. Polar Biol 29:988-996

71. Lesser MP (1996) Elevated temperatures and ultraviolet radiation cause oxidative stress and inhibit photosynthesis in symbiotic dinoflagellates. Limnol Oceanogr 41:271-283

72. Hoffman JR, Hansen LJ, Klinger T (2003) Interactions between UV radiation and temperature limit inferences from single-factor experiments. J Phycol 39:268-272

73. Altamirano M, Flores-Moya A, Figueroa FL (2003) Effects of UV radiation and temperature on growth of germlings of three species of *Fucus* (Phaeophyceae). Aquat Bot 75:9-20

74. Ferrier-Pages C, Richard C, Forcioli D, Allemand D, Pichon M, Shick JM (2007) Effects of temperature and UV radiation increases on the photosynthetic efficiency in four scleractinian coral species. Biological Bulletin 213:76-87

75. Lesser MP, Stochaj WR, Tapley DW, Shick JM (1990) Bleaching in Coral-Reef Anthozoans - Effects of Irradiance, Ultraviolet-Radiation, and Temperature on the Activities of Protective Enzymens against Active Oxygen. Coral Reefs 8:225-232

76. Anderson RS, Brubacher LL, Calvo LR, Unger MA, Burreson EM (1998) Effects of tributyltin and hypoxia on the progression of *Perkinsus marinus* infections and host defence mechanisms in oyster, *Crassostrea virginica* (Gmelin). J Fish Dis 21:371-379

77. Koch MS, Schopmeyer S, Kyhn-Hansen C, Madden CJ (2007) Synergistic effects of high temperature and sulfide on tropical seagrass. J Exp Mar Biol Ecol 341:91-101

78. Liess M, Champeau O, Riddle M, Schulz R, Duquesne S (2001) Combined effects of ultraviolet-B radiation and food shortage on the sensitivity of the Antarctic amphipod *Paramoera walkeri* to copper. Environ Toxicol Chem 20:2088-2092

79. Sargian P, Mostajir B, Chatila K, Ferreyra GA, Pelletier E, Demers S (2005) Non-synergistic effects of water-soluble crude oil and enhanced ultraviolet-B radiation on a natural plankton assemblage. Mar Ecol Prog Ser 294:63-77

80. Sargian P, Pelletier E, Mostajir B, Ferreyra GA, Demers, S (2005) TBT toxicity on a natural planktonic assemblage exposed to enhanced ultraviolet-B radiation. Aquat Toxicol 73:299-314

81. Duquesne S, Liess M (2003) Increased sensitivity of the macroinvertebrate Paramorea walkeri to heavy-metal contamination in the presence of solar UV radiation in Antarctic shoreline waters. Mar Ecol Prog Ser 255:183-191

82. Peachey RBJ (2005) The synergism between hydrocarbon pollutants and UV radiation: a potential link between coastal pollution and larval mortality. J Exp Mar Biol Ecol 315:103-114

83. Martinez MDG, Romero PR, Banaszak AT (2007) Photoinduced toxicity of the polycyclic aromatic hydrocarbon, fluoranthene, on the coral, *Porites divaricata*. Journal of

Environmental Science and Health Part a-Toxic/Hazardous Substances & Environmental Engineering 42:1495-1502

84. Cleveland L, Little EE, Calfee RD, Barron MG (2000) Photoenhanced toxicity of weathered oil to *Mysidopsis bahia*. Aquat Toxicol 49:63-76

85. Pelletier E, Sargian P, Payet J, Demers S (2006) Ecotoxicological effects of combined UVB and organic contaminants in coastal waters: A review. Photochem Photobiol 82:981-993

86. Little EE, Cleveland L, Calfee R, Barron MG (2000) Assessment of the photoenhanced toxicity of a weathered oil to the tidewater silverside. Environ Toxicol Chem 19:926-932

87. Sargian P, Mas S, Pelletier E, Demers S (2007) Multiple stressors on an Antarctic microplankton assemblage: water soluble crude oil and enhanced UVBR level at Ushuaia (Argentina). Polar Biol 30:829-841

88. Southerland HA, Lewitus AJ (2004) Physiological responses of estuarine phytoplankton to ultraviolet light-induced fluoranthene toxicity. J Exp Mar Biol Ecol 298:303-322

89. Steevens JA, Slattery M, Schlenk D, Aryl A, Benson WH (1999) Effects of ultraviolet-B light and polyaromatic hydrocarbon exposure on sea urchin development and bacterial bioluminescence. Mar Environ Res 48:439-457

90. Miller MW, Hay ME (1996) Coral-seaweed-grazer-nutrient interactions on temperate reefs Ecol Monogr 66, 323-344

91. McClanahan TR, Sala E, Stickels PA, Cokos BA, Baker AC, Starger CJ, Jones SH (2003) Interaction between nutrients and herbivory in controlling algal communities and coral condition on Glover's Reef, Belize Mar Ecol Progr Ser 261, 135-147

92. Thacker RW, Ginsburg DW, Paul VJ (2001) Effects of herbivore exclusion and nutrient enrichment on coral reef macroalgae and cyanobacteria Coral Reefs **19,** 318-329

93. Humphrey C, Webr M, Lott C, Cooper T, Fabricius K (2008) Effects of suspended sediments, dissolved inorganic nutrients and salinity on fertilization and embryo development in the coral *Acropora millepora* (Ehrenberg, 1834). Coral Reefs 27:837-850

,94. Canning-Clode J, Kaufmann M, Molis M, Wahl M, Lenz M (2008) Influence of disturbance and nutrient enrichment on early successional fouling communities in an oligotrophic marine system. Mar Ecol 29:115-124

95. Sundbäck K, Alsterberg C, Larson F (2010) Effects of multiple stressors on marine shallow-water sediments: Response of microalgae and meiofauna to nutrient-toxicant exposure. J Exp Mar Biol Ecol 388:39-50

96. Fukunaga A, Anderson MJ, Webster-Brown JG, Ford RB (2010) Individual and combined effects of heavy metals on estuarine infaunal communities. Mar Ecol Progr Ser 402:123-136

97. Byrne M, Soars NA, Ho MA, Wong E, McElroy D, Selvakumaraswamy P, Dworjanyn SA, Davis AR (2010) Fertilization in a suite of coastal marine invertebrates from SE Australia is robust to near-future ocean warming and acidification. Mar Biol 157:2061-2069

98. Atalah J, Crowe TP (2010) Combined effects of nutrient enrichment, sedimentation and grazer loss on rock pool assemblages. J Exp Mar Biol Ecol 388:51-57

99. Fukunaga A, Anderson MJ, Webster-Brown JG (2011) Assessing the nature of the combined effects of copper and zinc on estuarine and infaunal communities. Environ Pollut 159:116-124

100. Fitch JE, Crowe TP (2012) Combined effects of inorganic nutrients and organic enrichment on intertidal benthic macrofauna: an experimental approach. Mar Ecol Progr Ser 461:59-70

101. Jochum M, Schneider FD, Crowe TP, Brose U, O'Gorman EJ (2012) Climate-induced changes in bottom-up and top-down processes independently alter a marine ecosystem. Phil Trans R Soc B 367:2962-2970

102. Roger F, Godhe A, Gamfeldt L (2012) Genetic diversity and ecosystem functioning in the face of multiple stressors. PLOS One 7:e45007

103. Thiyagarajan V, Ko GWK (2012) Laval growth response of the Portuguese oyster (*Crassostrea angulate*) to multiple climate change stressors. Aquaculture 370-371:90-95

104. Alsterberg C, Sundback K (2013) Experimental qwarming and toxicant exposure can result in antagonistic effects in a shallow-water sediment system. Mar Ecol Pogr Ser 488:89-101

105. Chan VBS, Thiyagarajan V, Lu XW, Zhang T, Shih K (2013) Temperature dependent effects of elevated CO_2 on shell composition and mechanical properties of *Hydroides elegans*: insights from multiple stressor experiments. PLOS One 8:e78945

106. Ekvall MK, Martin JDLC, Faassen EJ, Gustafsson S, Lürling M, Hansson L-A (2013) Synergistic and species-specific effects of climate change and water colour on cyanobacterial toxicity and bloom formation. Freshwater Biol 58:2414-2422

107. Byrne M, Gonzalez-Bernat M, Doo S, Foo S, Soars N, Lamare M (2013) Effects of ocean warming and acidification on embryo and non-calcifying larvae of the invasive sea star *Patiriella regularis*. Mar Ecol Progr Ser 47:235-246

108. Cabrerizo MJ, Carrillo P, Villafane VE, Helbling EW (2014) Current and predicted global change impacts of UVR, temperature and nutrient inputs on photosynthesis and respiration of key marine phytoplankton groups. J Exp Mar Biol Ecol 461:371-380

109. Dangre AJ, Manning S, Brouwer M (2010) Effects of cadmium on hypoxia-induced expression of hemoglobin and erythropeoietin in larval sheepshead minnow, *Cyprinodon variegatus*. Aquatic Tox 99:168-175

110. Davis AR, Coleman D, Broad A, Byrne M, Dworjanyn SA, Przeslawski R (2013) Complex responses of intertidal molluscan embryos to a warming and acidifying ocean in the presence of UV radiation. PLOS One 8:e55939

111. Delorme MJ, Sewell MA (2014) Temperature and salinity: two climate change stressors affecting early development of the New Zealand sea urchin *Evechinus chloroticus*. Mar Biol 161:1999-2009

112. Enzor LA, Place SP (2014) Is warmer better? Decreased oxidative damage in notothenioid fish after long-term acclimation to multiple stressors. J Exp Biol 217:3301-3310

113. Ericson JA, Ho MA, Miskelly A, King CK, Virtue P, Tilbrook B, Byrne M (2012) Combined effects of two ocean change stressors, warming and acidification, on fertilization and early development of the Antarctic echinoid *Sterechinus neumayeri* Polar Biol 35:1027-1034

114. Fleming CR, DiGiulio RD (2011) The role of CYP1A inhibition in the embryotoxic interactions between hypoxia and polycyclic aromatic hydrocarbons (PAHs) and PAH mixtures in zebrafish (*Danio rerio*) Ecotoxicology 20:1300-1314

115. Foo SA, Dworjanyn SA, Poore AGB, Byrne M (2012) Adaptive capacity of the habitat modifying sea urchin *Centostephanus rodgersii* to ocean warming and ocean acidification: performance of early embryos. PLOS One 7:e42497

116. Foo SA, Dworjanyn SA, Khatkar MS, Poore AGB, Byrne M (2014) Increased temperature, but not acidification, enhances fertilization and development in a tropical urchin: potential for adaptation to a tropicalized eastern Australia. Evol Appl 7:1226-1237

117. Gaitán-Espitia JD, Hancock JR, Padilla-Gamino JL, Rivest EB, Blanchette CA, Reed DC, Hofmann GE (2014) Interactive effects of elevated temperature and pCO_2 on early-life-history stages of the giant kelp *Macrocystis pyrifera*. J Exp Mar Biol Ecol 457:51-58

118. Godbold JA, Solan M (2013) Long-term effects of warming and ocean acidification are modified by seasonal variation in species responses and environmental conditions. Phil Trans R Soc B 368:20130186

119. Höher N, Regoli F Dissanayake A, Nagel M, Kriews M, Köhler A, Broeg K (2013) Immunomodulating effects of environmentally realistic copper concentrations in *Mytilus edulis* adapted to naturally low slainities. Aqautic Tox 140-141:185-195

120. Holiday DK, Elskus AA, Roosenburg WM (2009) Impacts of multiple stressors on growth and metabolic rate of *Malaclemys terrapin*. Environ Toxicol Chem 28:338-345

121. Ivanina AV, Taylor C, Sokolova IM (2009) Effects of elevated temperature and cadmium exposure on stress protein response in eastern oysters *Crassostrea virginica* (Gmelin) 91:245-254

122. Ivanina AV, Hawkins C, Sokolova IM (2014) Immunomodulation by the interactive effects of cadmium and hypercapnia in marine bivalves *Crassostrea virginica* and *Mercenaria mercenaria*. Fish Shellfish Immun 37:299-312

123. Ko GWK, Dineshram R, Campanati C, Chan VBS, Havenhand J, Thiyagarajan V (2014) Interactive effects of ocean acidification, elevated temperature, and reduced salinity on early-life stages of the Pacific oyster. Environ Sci Technol 48:10079-10088

124. Martinez-Crego B, Olivé I, Santos R (2014) CO_2 and nutrient-driven changes across multiple levels of organization in *Zostera noltii* ecosystems. Biogeosciences 11:7237-7249

125. Matoo OB, Ivanina AV, Ullstad C, Beniash E, Sokolova IM (2013) Interactive effects of elevated temperature and CO_2 levels on metabolism and oxidative stress in two common marine bivalves (*Crassostrea virginica* and *Mercenaria mercenaria*). Comp Biochem Physiol A 164:545-553

126. Miller SH, Zarate S, Smith EH, Gaylord B, Hosfelt JD, Hill TM (2014) Effect of elevated CO_2 on metabolic responses of porcelain crab (*Perolisthes cinctipes*) larvae exposed to subsequent salinity stress. PLOS One 9:e109167

127. Muthukrishnan R, Fong P (2014) Multiple anthropogenic stressors exert complex, interactive effects on a coral reef community. Coral Reefs 33:911-921

128. Neale PJ, Sobrino C, Segovia M, Mercado M, Leon P, Cortés MD, Tuite P, Picazo A, Salles S, Cabrerizo MJ, Prasil O, Motecino V, Reul A, Fuentes-Lema A (2014) Effect of CO_2 nutrients and light on coastal plankton. I. Abiotic conditions and biological responses. Aquatic Biol 22:25-41

129. O'Gorman EJ, Fitch JE, Crowe TP (2012) Multiple anthropogenic stressors and the structural properties of food webs. Ecology 93:441-448

130. Paul-Pont I, de Montaudouin X, Gonzalez P, Jude F, Raymond N, Paillard C, Baudrimont M (2010) Interactive effects of metal contamination and pathogenic organisms on the introduced marine bivalve *Ruditapes philippinarum* in European populations. Environ Pollut 158:3401-3410

131. Petersen DG, Sundbäck K, Larson F, Dahllöf I (2009) Pyrene toxicity is affected by the nutrient status of a marine sediment community: implications for risk assessment. Aquatic Toxic 95:37-43

132. Queiros AM, Fernandes JA, Faulwetter S, Nunes J, Rastrick SPS, Mieszkowska N, Artioli Y, Yool A, Calosi P, Arvanitidis C, Findlay HS, Barange M, Cheung WW, Widdicombe S (2015) Scaling up experimental ocean acidification and warming research: from individuals to the ecosystem. Global Change Biol 21:130-143

133. Renick VC, Anderson TW, Morgan SG, Cherr GN (2015) Interactive effects of pesticide exposure and habitat structure on behavior and predation of a marine larval fish. Ecotoxicology 24:391-400

134. Rivest EB, Hofmann GE (2014) Responses of the metabolism of the larvae of *Pocillopora damicornis* to ocean acidification and warming. PLOS One 9:e96172

135. Schneider KR, Van Thiel LE, Helmuth B (2010) Interactive effects of food availability and aerial body temperature on the survival of two intertidal *Mytilus* species. J Thermal Biol 35:161-166

136. Schram JB, Schoenrock KM, McClintock JB, Amsler CD, Angus RA (2014) Multiple stressor effects of near-future elevated seawater temperature and decreased pH on righting and escape behaviors of two common Antarctic gastropods. J Exp Mar Biol Ecol 457:90-96

137. Tait LW (2014) Impacts of natural and manipulated variations in temperature, pH and light on photosynthetic parameters of coralline-kelp assumblages. J Exp Mar Biol Ecol 454:1-8

138. Vaz-Pinto F, Olabarria C, Gestoso I, Cacabelos E, Incera M, Arenas F (2013) Functional diversity and climate change: effects on the invisibility of macroalgal assemblages. Biol Invasions 15:1833-1846

139. Vieira LR, Guilhermino L (2012) Multiple stress effects on marine planktonic organisms: influence of temperature on toxicity of polycyclic aromatic hydrocarbons to *Tetraselmis chuii*. J Sea Res 72:94-98

140. Zervoudaki S, Frangoulis C, Giannoudi L, Krasakopoulou E (2013) Effects of low pH and raised temperature on egg production, hatching and metabolic rates of a Mediterranean copepod species (*Acartia clause*) under oligotrophic conditions. Mediterranean Mar Sci 15:74-83

141. Ferrari MCO, Munday PL, Rummer JL, McCormick MI, Corkill K, Watson S-A, Allan BJM, Meekan MG, Chivers DP (2015) Interactiv effects of ocean acidification and rising temperatures alter predation rate and predator selectivity in reef fish communities. Global Change Biol 21:1848-1855

142. Coelho FJRC, Cleary DFR, Rocha RJM, Calado R, Castanheira JM, Rocha SM, Silva AM, Simões MMQ, Oliveira V, Lillebo AI, Almeida A, Cunha A, Lpes I, Ripeiro R, Moreira-Santos MM, Marques CR, Costa R, Pereira R, Gomes NCM (2015) Unraveling the interactive effects of climate change and oil contamination on laboratory-simulated estuarine benthic communities. Global Change Biol 21:1871-1886

143. Suckling CC, Clark MS, Richard J, Morley SA, Thorne MAS, Harper EM, Peck LS (2015) Adult acclimation to combined temperature and pH stressors significantly enhances reproductive outcomes compared to short-term exposures. J An Ecol 84:773-784