**Appendix 2**

**Ecological Monographs**

**Roethler, M., Fales, R., Donoghue, C., and Padilla-Gamiño, J.**

**Impacts of climate change (ocean warming and acidification) on kelps: a meta-analysis**

Table S2. Response variables in each response category and the corresponding number of data points and number of studies with data for each response variable.

| **Response variable** | **Data points** | **Studies** |
| --- | --- | --- |
| ***Biochemical composition*** |  |  |
| **C:N ratio** | 101 | 20 |
| **Nitrogen** | 131 | 30 |
| Carbon | 106 | 23 |
| **Proteins** | 33 | 7 |
| Mannitol | 27 | 6 |
| Soluble carbohydrates | 17 | 5 |
| δ13 C | 15 | 5 |
| **Lipids** | 14 | 5 |
| **εp** | 10 | 1 |
| **Laminarin** | 6 | 3 |
| DNA | 4 | 2 |
| RNA | 4 | 2 |
| RNA : DNA ratio | 4 | 2 |
| Alanine | 2 | 1 |
| Alginic acid | 2 | 1 |
| Alpha-linolenic acid | 2 | 1 |
| Amino acid | 2 | 1 |
| Amino-nitrogen content | 2 | 1 |
| Arachidonic acid | 2 | 1 |
| Arginine | 2 | 1 |
| Aspartate | 2 | 1 |
| Cellulose | 2 | 1 |
| Cysteine | 2 | 1 |
| δ15 N | 2 | 1 |
| Eicosapentaenoic acid | 2 | 1 |
| Eicosatrienoic acid | 2 | 1 |
| Fucoidan | 2 | 1 |
| Gamma-linolenic acid | 2 | 1 |
| Glutamine | 2 | 1 |
| Glycine | 2 | 1 |
| Histidine | 2 | 1 |
| Isoleucine | 2 | 1 |
| Leucine | 2 | 1 |
| Linoleic acid | 2 | 1 |
| Lysine | 2 | 1 |
| Methionine | 2 | 1 |
| NO3- nitrogen | 2 | 1 |
| Phenylalanine | 2 | 1 |
| Proline | 2 | 1 |
| Serine | 2 | 1 |
| Threonine | 2 | 1 |
| Tyrosine | 2 | 1 |
| Valine | 2 | 1 |
| 2-oxoglutarate | 1 | 1 |
| Citrate | 1 | 1 |
| Free arginine | 1 | 1 |
| Free aspartate | 1 | 1 |
| Free glutamine | 1 | 1 |
| Fumarate | 1 | 1 |
| Malate | 1 | 1 |
| Monounsaturated fatty acids | 1 | 1 |
| Oxaloacetate | 1 | 1 |
| Polyunsaturated fatty acids | 1 | 1 |
| Pyruvate | 1 | 1 |
| Saturated fatty acids | 1 | 1 |
| Succinate | 1 | 1 |
| Total non-structural carbohydrates | 1 | 1 |
| ***Enzyme activity*** |  |  |
| **Nitrate reductase** | 31 | 4 |
| **Total carbonic anhydrase** | 23 | 3 |
| **Peroxidase** | 20 | 3 |
| Glutathione reductase | 14 | 1 |
| **RuBisCO** | 12 | 2 |
| External carbonic anhydrase | 10 | 3 |
| **Glutamine synthetase** | 3 | 2 |
| GADPH | 2 | 1 |
| GAPDH | 2 | 1 |
| L-aspartate | 2 | 1 |
| Malate dehydrogenase | 2 | 1 |
| Mannitol-1-phosphate dehydrogenase | 2 | 1 |
| Phosphoenolpyruvate carboxykinase | 2 | 1 |
| Glutamate synthase | 1 | 1 |
| Glutathione peroxidase | 1 | 1 |
| Internal carbonic anhydrase | 1 | 1 |
| Isocitrate dehydrogenase | 1 | 1 |
| Phenylalanine ammonia-lyase | 1 | 1 |
| Polyphenol oxidase | 1 | 1 |
| Pyruvate kinase | 1 | 1 |
| ***Fluorescence*** |  |  |
| **Fv/Fm** | 574 | 48 |
| **α** | 118 | 18 |
| **Ek** | 85 | 13 |
| rETRmax | 83 | 10 |
| NPQ | 45 | 8 |
| ETRmax | 25 | 9 |
| **YII** | 21 | 5 |
| Ec | 19 | 4 |
| Fv/Fo | 14 | 1 |
| rETR | 11 | 2 |
| Photoinhibition | 6 | 1 |
| **Fv/Fm reduction** | 2 | 1 |
| ***Growth*** |  |  |
| **Surface area** | 269 | 11 |
| **Biomass change** | 225 | 38 |
| **Elongation rate** | 149 | 21 |
| **Change in surface area** | 121 | 8 |
| **Length** | 68 | 9 |
| **Diameter** | 33 | 4 |
| **Number of cells** | 31 | 6 |
| **Weight** | 14 | 2 |
| **Germ tube length** | 9 | 1 |
| **Relative size** | 3 | 1 |
| Change in width | 2 | 2 |
| Perforation area | 1 | 1 |
| ***Net primary productivity*** |  |  |
| **Net photosynthesis** | 188 | 21 |
| **NPmax** | 69 | 12 |
| **GPmax** | 25 | 5 |
| **Gross photosynthesis** | 14 | 4 |
| Carbon fixation rate | 7 | 2 |
| DOC release rate | 7 | 2 |
| Photosynthetic quotient | 7 | 2 |
| **CO2 uptake** | 6 | 2 |
| Carbon acquisition | 5 | 1 |
| **Nitrate uptake** | 3 | 3 |
| Ammonium uptake | 1 | 1 |
| Bicarbonate uptake | 1 | 1 |
| Change in pH | 1 | 1 |
| Oxygen evolution inhibition rate | 1 | 1 |
| Photosynthesis : Respiration ratio | 1 | 1 |
| POC release rate | 1 | 1 |
| Total alkalinity | 1 | 1 |
| Vmax | 1 | 1 |
| ***Pigments*** |  |  |
| **chlorophyll-*a*** | 98 | 24 |
| chlorophyll-*c* | 45 | 11 |
| Fucoxanthin | 38 | 6 |
| De-epoxidation state | 34 | 6 |
| Xanthophyll cycle pigment pool : chlorophyll-*a* ratio | 33 | 4 |
| Fucoxanthin : chlorophyll-*a* ratio | 20 | 3 |
| chlorophyll-*c* : chlorophyll-*a* ratio | 20 | 3 |
| Xanthophyll cycle pigment pool | 17 | 4 |
| Beta-carotene | 15 | 3 |
| Beta-carotene : chlorophyll-*a* ratio | 15 | 2 |
| Carotenoids | 10 | 4 |
| Accessory pigment : chlorophyll-*a* ratio | 10 | 1 |
| Antheraxanthin : chlorophyll-*a* ratio | 10 | 1 |
| D1 protein | 10 | 1 |
| Violaxanthin | 10 | 1 |
| Violaxanthin : chlorophyll-*a* ratio | 10 | 1 |
| Zeaxanthin | 10 | 1 |
| Zeaxanthin : chlorophyll-*a* ratio | 10 | 1 |
| Viola+Zeaxanthin : chlorophyll-*a* ratio | 5 | 1 |
| Accessory pigment pool | 4 | 2 |
| chlorophyll-*a* : chlorophyll-*c* ratio | 2 | 1 |
| ***Reproduction*** |  |  |
| **Germination rate** | 76 | 16 |
| **Sex ratio** | 69 | 12 |
| **Reproductive success** | 28 | 6 |
| **Spore production** | 28 | 4 |
| **Oogonium formation** | 18 | 4 |
| **Fertility** | 18 | 1 |
| **Number of oogonia** | 9 | 3 |
| Frequency of females with vegetative growth | 8 | 1 |
| **Reproductive area allocation** | 5 | 2 |
| **Sorus induction** | 4 | 1 |
| Total fertile area | 4 | 1 |
| Half maximal reaction time | 3 | 1 |
| Ungerminated spores | 3 | 1 |
| **Weight gain during sorus formation** | 1 | 1 |
| ***Respiration*** |  |  |
| **Dark respiration** | 203 | 27 |
| ***Stress response*** |  |  |
| **hsp70 expression** | 120 | 4 |
| **Malondialdehyde** | 22 | 3 |
| **Iodine accumulation** | 22 | 1 |
| SOD activity | 20 | 3 |
| **Phlorotannin content** | 20 | 6 |
| **CAT activity** | 20 | 3 |
| Insoluble phlorotannin content | 7 | 1 |
| Radical scavenging activity | 7 | 1 |
| **Antioxidant pool size** | 6 | 1 |
| Iodine efflux | 6 | 1 |
| **Flavonoid content** | 4 | 1 |
| Phenolic content | 4 | 1 |
| **Antioxidant capacity** | 2 | 2 |
| Lipid peroxidation | 2 | 2 |
| Total phenolic content | 2 | 2 |
| p-38-like protein phosphorylation | 2 | 1 |
| **36 kDa band intensity** | 2 | 1 |
| 42 kDa band intensity | 2 | 1 |
| **DMSP** | 1 | 1 |
| Hydrogen peroxide | 1 | 1 |
| ***Survival*** |  |  |
| **Density** | 303 | 11 |
| **Survival** | 300 | 10 |
| **Mortality** | 6 | 2 |
| **Change in density** | 1 | 1 |
| ***Tissue Health*** |  |  |
| **Tissue loss** | 22 | 2 |
| Maximum strain | 21 | 1 |
| Breaking stress | 21 | 1 |
| **Fresh weight : Dry weight** | 17 | 3 |
| **Number of blisters** | 3 | 1 |
| **Dry weight : Wet weight** | 1 | 1 |

Within each category, variables are listed in prioritization order (most to least data points, except for biochemical composition, where C:N ratio is prioritized despite having less data). Bolded variables indicate that this variable made it into the final analysis because higher-ranked variables were unavailable for that study.