**Releasing aquaculture from the fishmeal ceiling through alternative feeds**

Richard Cottrell, Julia Blanchard, Kirsty Nash, Ben Halpern, Halley Froelich

**Methods**

* Search of Google Scholar, Scopus and Web of Science databases for Life Cycle Analyses (LCA) of a range of insect, algae, bacteria and yeast products used as a replacement for fishmeal in aquaculture feed.
* We compliment this meta-analysis with studies detailing the effects of insect, algae, bacteria, and yeast-based alternative feeds on feed conversion ratios of farmed finfish or crustacean.
* We limit inclusion to LCA studies that address the life cycle of a product from farm-gate and nutritional studies that specifically replace (rather than add to) fishmeal and/or fish oil with an alternative as a protein or lipid source respectively.

*Caveats:*

* Very few studies use 1:1 replacement of fishmeal with alternative feeds as replacement of fishmeal/oil may co-occur with greater inclusion of other products to obtain the correct nutritional standards for the animal. Therefore, the replacement levels detailed in our analysis imply the proportional fishmeal and oil reduction possible with the incorporation of alternative sources such as insects or algae.
* Replacement values account for any increase in fish oil that occurs with a loss of fishmeal and vice versa. As we assume forage fisheries provide both fishmeal and oil, the replacement accounts for total forage fish ingredients used.

*Questions*:

* Do I need to account for the trade-offs in more animal/bone/feather meal as they have essentially no impact – under the assumption that people are not going to stop eating meat.
* What about soy meal – even though we know the land contribution from aquaculture is tiny – would that drastically change with alternative feeds? – Another paper?