FishPrint_workbook

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## -- Attaching packages ---------------------------------------------------------------------------

## v ggplot2 3.3.2     v purrr   0.3.4
## v tibble  3.0.3     v dplyr   1.0.1
## v tidyr   1.1.1     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.5.0

## -- Conflicts ------------------------------------------------------------------------------------
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

Calculate Feed Footprint

The feed footprint estimate inputs are:

- FCR
- Percent soy, other crops, FMFO and animal
- The GHG, water, N, P, and land footprint per unit of feed ingredient

We then calculate the feed-associated footprint (FP_{feed}) as:

$$FP_{feed} = FCR_{dry} \sum_{i=1}^{4} FP_i p_i$$

where FCR_{dry} is the dry weight feed conversion ratio, i indexes the feed ingredient, FP_i represents the footprint of the feed ingredient, and p_i represents the proportion of the feed comprised of component i.

For species without LCA data, we will need to estimate FCR and the percent soy, other crops, FMFO and animal products in feeds.

Calculate on farm footprints

The inputs are:

- N and P content of protein [treated as constants]
- Protein content of each feed ingredient [treated as constants]
- Protein content of fish [treated as constants]
- Country-specific GHGs with electricity use [treated as constants]
- Diesel, petrol, and natural gas GHG values [treated as constants]
- Yield

- Total harvest
- Production system type
- Aerated or not
- Electricity, diesel, petrol, and natural gas use
- Grow-out period

Nitrogen and Phosphorus

Alon - update this section to describe the methods from your calcs (in a narrative style) so we have them for the methods section of the paper

The non-feed (which here we mean as the virtual footprint associated with the feed) nitrogen and phosphorus are calculated as by estimating the difference between the N and P in the feeds and the N and P in the final fish, following:

$$FP_{nonfeedN} = FCR_{dry} N_{Pr} \sum_{i=1}^{4} (Pr_i p_i) - N_{Pr} Pr_{fish}$$

where N_{Pr} represents the average nitrogen content of protein, Pr_i represents the protein content of each feed component, and Pr_{fish} represents the protein content of a unit of fish or shellfish. Similarly,

$$FP_{nonfeedP} = FCR_{dry} P_{Pr} \sum_{i=1}^{4} (P_i p_i) - P_{Pr} Pr_{fish}$$

where P_{Pr} represents the average phosphorus content of protein.

Greenhouse gases

The non-feed associated greenhouse gas emissions are calculated as the electricity use times the country-specific GHG footprint, plus the diesel, petrol, and natural gas use times each of their GHG footprint factors.

Land

The non-feed associated land use refers to the pond area allocated to the growth of a unit of output. This is calculated as:

$$FP_{nonfeedland} = Yeild/Harvest$$

Water

To calculate the on farm water use, we estimate the evaporative losses over the surface area allocated to the unit of production as:

$$FP_{nonfeedwater} = C_{aeratoin} Evap_{rate} FP_{nonfeedland} GrowOut$$

where $C_{aeration}$ is the constant factor for aerated ponds.

[Sorry I got lazy with equation notation – will eventually improve!]

Plots

This is largely fake data, so probably shouldn't think about it too much.

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## Warning: Expected 2 pieces. Additional pieces discarded in 1802 rows [6, 7, 18,
## 19, 30, 31, 42, 43, 54, 55, 66, 67, 78, 79, 90, 91, 102, 103, 114, 115, ...].
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