

FishPrint_workbook

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Agenda for next meeting

1. Report back from Alon on FCR modeling and FCR-feed composition relationship
2. Yield/harvest data updates
 - Patrik going through to update the data in this column Challenges with data as reported:
 - Unclear in a number of studies what the temporal dimension
 - Number of harvests per year can vary though
 - Some specify it in m3 Decision:
 - Set all cages to 0? Amount is very small compared to feeds. Focus is on land occupation, but not freshwater or marine area occupation
3. Define groupings __ Jessica to suggest some incorporating:
 - fed commercial, fed non-commercial and unfed
 - intensive, semi-intensive and extensive
 - – Need to update this classification in the data frame - walk through with group for consensus.
 - taxa groups?
4. Next steps:
 - Standardize units
 - Calculate sd's
 - Think about biodiversity and how to incorporate
 - Think about how to reweight estimates by production/representativeness
 - Add in energy N, P, H2O from refineries
 - Handling of byproducts
 - Weighting of feed ingredients:
 - Just use chicken feather meal for animal products
 - Soy is more complicated
 - Ocean area required to support

To do

1. The biggest gap is harvest and yield, which is needed to get a per unit land FP, as well as a surface area for evaporative losses.
 - Harvest and yield time dimensions will need to be standardized
 - Can use data from the Blue Frontiers report
 - For places that have multiple uses, we will need to apply an allocation method (consistent with the feeds)
2. Fill in feed ingredient FP and protein content values
 - Alon pulled the terrestrial feed data N and P content → currently using a straight mean for these _ Question for Rob: use of P-eq vs PO4-eq in feed FP data → check that P-eq would be P release (same for N-eq) _ Question for Rob: energy category in feed FP data
 - Question for all: how to weight the footprints of the feed ingredients within a category
 - Top 10 most representative crops (excluding soy b/c that is included separately), check for presence in EcoVent and crop N/P, if not present in both, move to 11th most representative [Patrik will take a stab at this]
3. Factors to multiply protein content by to get N and P
 - Patrik can get factors with reference → done, but may need to add reference
4. Whole fish N and P content by species (or use protein content and N and P factors)
 - Alon will talk to Zach about this; also talk to Christina about the modelled values → done
5. Replace placeholder diesel, petrol and natural gas CO2 eq/L values with data in function
 - Rob - diesel already in, others coming
6. What units do we want the FP estimates in?
 - Input from anyone (we just need to pick something at some point to make sure everything is consistent)
 - L, ha, t CO2eq, /kg fish at farm gate
7. Evaporation
 - We have average evaporative loss by country
 - We may want to consider a multiplication factor for losses from aerated ponds [maybe only include in discussion; would also influence methane emissions from ponds]
 - We need to decide how to construct the distribution (currently just the arithmetic mean, but we could add a weighting)
 - Only apply to freshwater ponds [include exploration of evaporative loss from brackish ponds in SI – also discuss the dilution water]
8. Edible portion and per gram protein
 - Present results in terms of LW, but also add in edible portion and per g protein
 - Still need to compile this data
9. Add in fish in-fish out metric
 - We can get to this through the same FMFO data that we are using
 - Return to discussion of broader biodiversity issues [likely just a discussion point – justification: none of our other categories go all the way to impact]

Code improvements

1. Standardize units throughout
2. Update feed associated FP function to handle fed and non-fed species (or just make all feed ingredient proportions zero for non-fed)
3. Incorporate differences based on system type in each function
4. Add categorical variables we need to add/standardize are: system type, fed/unfed, aerated/non-aerated, intensity level

```
## -- 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 ----- t  
## 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:

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

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,

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

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:

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

Water

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

$$FP_{nonfeedwater} = C_{aeration} Evaprate FP_{nonfeedland} GrowOut$$

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.

```
## Warning: Expected 2 pieces. Additional pieces discarded in 386 rows [6, 7, 18,
## 19, 30, 31, 42, 43, 54, 55, 66, 67, 78, 79, 90, 91, 102, 103, 114, 115, ...].
```

