Another Problem Fish Don’t Need: A Probabilistic Exploration of Present and Future Pharmaceutical Mixture Risk to Fish

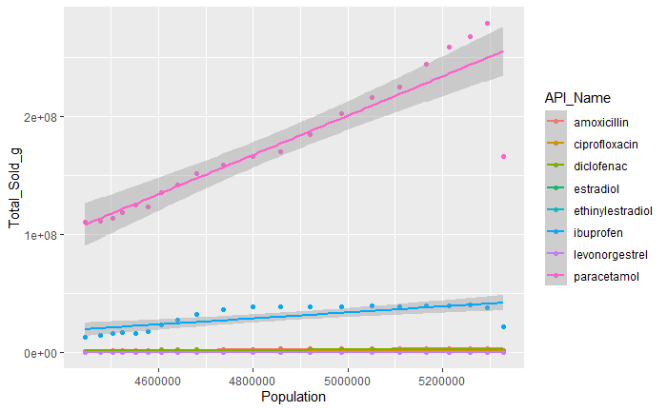
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# Introduction

* Introduction of state of the art
* Pharmaceutical ERA severely hampered by collapsing uncertainty to thresholds
* Big plans for toxic-free environment, but a big question mark over how ERA will change to account for this

# Methods

## Consumption of Pharmaceuticals by Population



* LM relationship between population and consumption of certain APIs modelled from historical data (1999-2019)
* Not a particularly precise technique, but saves *so* much work with non-linear demographics

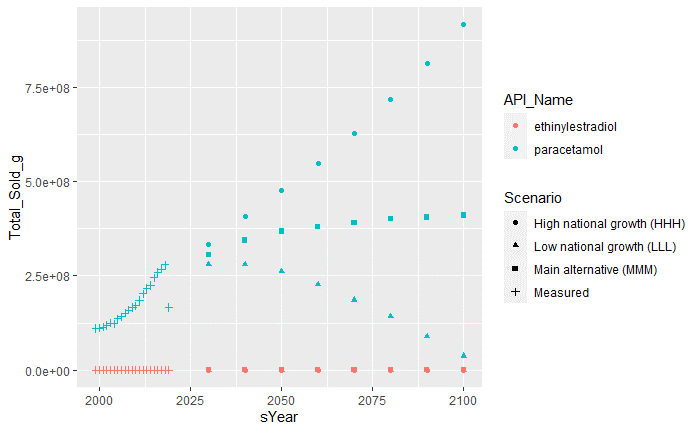
## Population Predictions

* Low, main and high alternatives taken from SSB projections

Chart, line chart

Description automatically generated

* Linear relationships applied to predicted population to predict future consumption



* Exposure prediction of 2-6 well-studied APIs with sales data for Norway~~, Prescription data for the UK~~
  + Big question mark over how historically rich this data may be, if poor we may not be able to predict future risk
  + Avoid messing about with population, demographic scenarios to save time
* Joanke’s WWTP removal rates used to construct upgrade scenarios (percentage of pop with access to infrastructure X removal rate)
* Toxicity data (ideally DRCs) from the literature, probably just for fish (with APIs chosen based on fish toxicity)
* Prediction of Sum RQ, Sum TU, joint probability of exceedance under various scenarios

Diagram, schematic

Description automatically generated

Figure : Will use modified, expanded version of SETAC poster BN

# API Shortlist

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| API Name | Type | Criteria | Toxicity | Notes |
| Estradiol | Estrogen | Well-studied, high risk | Fish feminisation |  |
| Ethinylestradiol | Estrogen | Well-studied, high risk | Fish feminisation |  |
| Levonorgestrel | Androgen/Progestogen | Well-studied, high risk | Fish masculinisation |  |
| Diclofenac | NSAID/Analgesic | Well-studied, moderate risk |  |  |
| Ibuprofen | NSAID/Analgesic | Well-studied, moderate risk |  |  |
| Paracetamol | Analgesic | Well-studied, moderate risk |  |  |
| Ciprofloxacin | Quinolone antibiotic | [Well-studied?](https://www.aces.su.se/aces/wp-content/uploads/2018/11/Ciprofloxacin-EQS-data-overview-2018.pdf), high risk |  |  |
| Amoxicillin | Antibiotic | ??? |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

* Joint probability of exceedance of PNECs is a wash, but would exceedance of EQS be a slightly more relevant metric?
* The more I think about this, the more I think to myself “no more than 2 APIs” is the right way to go about things

# Results

* I don’t really know how to present the results, but I’m sure some ideas will present themselves as I work more intently on this

# Discussion

* Probably at least some scenarios will suggest unacceptably high risk to fish, and recommendations can be made based on the ones that don’t
* Can have some discussion of cost here, but nothing seriously quantitative
* Shockingly, a paper using probabilistic risk assessment will talk about how good it is, and how it permits more nuanced risk management by stakeholders than just a good/bad thresholds
* RQs hard to put in context really, but can tie in to conservation/management goals for NO and UK water bodies
* None of our measures of combined risk are really great, here are some other options proposed in the EU/used in the US

# Conclusions

* BN/PERA is good for predicting nuanced risk
* Fish are in trouble, possibly, under various scenarios
* We could do so much more cool stuff if I had the time
  + Spatially explicit BNs
  + Proper inclusion of population, climate, demographic, etc. scenarios
  + And so on

Hi Sam, I have looked through the two articles from Karina, and I went to the 2012 article by Bachaus and Faust to find more info. They have an example which is quite well described. I have yellowed some of the things that I found useful. The **endpoint** and **trophic level** (possibly also organism) need to be the same. Also, the toxicity data requirements need to be **balanced** - meaning that it will be challenging to combine a data rich API to a less data risk API as I understand it. 