**Work Plan For Global Fisheries Database and Potential Yields Projects**

The purpose of this document is to lay out the current methods, future tasks, and key questions related to our two projects, creating an aggregate database of fishery status, and estimating the potential of global fisheries.

**Global Fishery Database**

This project will link together available fishery metrics from RAM (Ricard *et al.* 2012), the “unassessed” fisheries following the methods of (Costello *et al.* 2012), the SOFIA fisheries summarized in (FAO 2011), and the “nei” and invertebrate fisheries in the FAO landings database. The goal is a comprehensive database of fishery status that can be used for future analyses.

1. RAM
   1. Compile the most up-to-date version of RAM available
   2. Query updated RAM database for required data (mostly to inform updated panel regression model (PRM)
2. Unassessed Fisheries
   1. Rerun PRM using coefficients from updated RAM database
   2. Apply updated PRM to newest “unassessed” FAO data to provide updated B/Bmsy estimates
3. SOFIA Fisheries
   1. Compile the most up-to-date version of SOFIA assessments available
   2. Assign SOFIA fisheries B/Bmsy values based on their categorical status
   3. Estiamte B/Bmsy for SOFIA fisheries using updated PRM
4. NEIs
   1. Create synthetic NEI fisheries from RAM and estimate group B/Bmsy using PRM methods. Compare estimated to “known” B/Bmsy values
   2. Create synthetic NEI catch histories from RAM. Estimate B/Bmsy of NEI stock by finding the synthetic NEI catch history with a known aggregate B/Bmsy that best matches the catch history of the NEI stock
   3. If 4.a and 4.b are successful, apply methods to FAO NEI stocks
5. Invertebrates
   1. Design a PRM for invertebrates, likely by adding a fixed effect to the current PRM model
6. Compile
   1. Aggregate RAM, unassessed, and SOFIA databases at the best available resolution

Key Questions

* How should we deal with the competing spatial scales of the databases?

**Potential Yields Project**

This project will build off of the global fishery database to assess the magnitude and timing of potential recovery (i.e. stabilizing the fishery at or near Bmsy) for various fishery metrics (biomass, yields, and profits). This project has three broad components; a biological and current status model, an economic model, and a control rule function.

*Current Status and Biological Model*

The basis of this exercise is a Schaefer model, parameterized as ratios in the form

where *b* signifies B/Bmsy and *f* signifies F/Fmsy, and *r* is the intrinsic growth rate. Values of *b* are obtained from the Global Fishery Database, leaving us with a need to estimate *f* and *r*. MSY is also needed to estimate the magnitude of potential yields.

1. Estimating MSY,*r,* and *f*
   1. Where available, we will use estimates of MSY and *f* from RAM
   2. For all other fisheries, we will use depletion estimates *b* from the Global Fishery Database, along with catch histories, to calculate MSY using the CatchMSY method from (Martell and Froese 2012)
   3. Calculate current *f* from *b*, MSY, and most recent catch using *f =* (Catch/MSY)/*b*
   4. *r* is provided as an output from CatchMSY

This provides us with current *b* and *f*, and all the required parameters of our biological model for future projections.

Key Questions:

* How should we incorporate errors/bias in catch reporting?
* How should we appropriately tally error throughout this process?

*Economic Model*

Our economic model is given by

Where Π is profit, *p* is price per ton, *c* is the cost per unit of fishing effort, and β controls the way in which costs change in proportion to the amount of fishing effort exerted. *MSY, f, b*, and *r* are produced by the biological model, leaving *p*, *c*, and β as unknown.

1. Price
   1. Price is set as a constant, though a demand curve could be designed
   2. Price per ton was calculated using the FAO database of landed value, and is assigned to the level of ISSCAAP species categories
2. β is 1.3, meaning that costs per unit effort increases with effort
3. Cost
   1. As with price, we estimate unique cost parameters for each ISSCAAP species group. We accomplished this by leveraging the principle that profits are zero at open access equilibrium. We estimated distributions of *b* for each ISSCAAP category using the PRM. We then assumed that the lower quartile of the distribution for a given species category represents open-access equilibrium conditions, giving us a *b* at open access (*boa*).
   2. Given that profits at *boa* are 0, and at equilibrium *f* at *boa* is 2- *boa*, we can then calculate *c* as
4. Catch shares
   1. We are also interested in evaluating how the implementation of catch shares affects our results
   2. We accomplish this by considering a catch share scenario in which price is scaled up and costs scaled down by a defined amount

Key Questions:

* Do we need to develop a demand curve for price?
* What is an appropriate method for setting *b*oa? Is there a better approach to estimating cost?
* How should we set the scalars for the catch share effect?

*Control Rules/Policy Functions*

Given our biological and economic models, we can now consider how to project the recovery process. To calculate the raw change in biomass, yields, and profits, resulting from recovery, we can simply compare current values with those at MSY (if we take MSY to be the goal of recovery). However, another key component of this analysis is to calculate the timing to achieving recovery, and the potential loses to yields and profits that might occur along the way.

In order to assess the trajectory of recovery, we need to develop a control rule for the process of recovery.

1. Arbitrary control rules
   1. These include policies such as fish constantly at *f*=1, or fish at *f*=0until *b*=1, and then fish at *f=1*
2. Optimized control rules
   1. For the optimized control rule, for each fishery we specify an *f* for any given *b*, by using a dynamic optimization process to maximize net present value (NPV)
   2. This results in a series of customized control rules (e.g. below)

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*Outputs*

Using our biological, economic, and control rule models, we can now consider the magnitude and timing of recovery for biomass, yields, and profits for each of the fisheries in our compiled database. This will provide the most complete picture to date of the potential outcomes of recovering global fisheries. Primary outputs might include

1. Updated Kobe plot of current *b* and *f* for all fisheries in our compiled Global Fishery Database
2. Magnitude (raw and %) of change in biomass, yields, and profits resulting from recovery
   1. Globally and by region/fishery characteristics (e.g. size)
3. Trajectories to recovery of biomass, yields, and profits under arbitrary and optimized control rules
   1. Globally and by region/fishery characteristics (e.g. size)

Key Questions:

* Do we include regime-driven species (e.g. small pelagics) that might not have a consistently attainable level of MSY?
* Should we only consider currently “overfished” fisheries (*b* < 1), or should we also consider the development of currently “underfished” fisheries (***b > 1*)?**
* How should we deal with the possibility that achieving MSY for all fisheries simultaneously is not possible?
* What about the possibility of shifts in global productivity resulting from climate change?

Works Cited

Costello, C., Ovando, D., Hilborn, R., Gaines, S.D., Deschenes, O. and Lester, S.E. (2012) Status and Solutions for the World’s Unassessed Fisheries. *Science* **338**, 517–520.

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Ricard, D., Minto, C., Jensen, O.P. and Baum, J.K. (2012) Examining the knowledge base and status of commercially exploited marine species with the RAM Legacy Stock Assessment Database. *Fish and Fisheries* **13**, 380–398.