Paper 1: Synthesis, Challenges, Research Priorities

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Paper 1:
Synthesis, Challenges, Research Priorities

Purpose:
To tackle the issue of the carbon flux contribution from upper trophic levels

Goals:
1. Synthesize the existing research on fish carbon flux

2. Recognize challenges in measuring fish carbon flux and discuss approaches to resolve them

3. Develop research priorities to fill the large gaps in understanding fish carbon flux

Background

1. Ocean C cycle, biological pump, flux to ocean interior

2. Importance of C sequestration (climate change)

3. Need to improve understanding bio pump (to improve models):
    - Interannual, seasonal, spatial variation
    - Food web controls of C flux
    - Environmental factors and climate impacts on bio C flux

Research on fish carbon flux - Synthesis

1. Horizontal transfer *– need text on this*

2. Dissolved inorganic products

3. Downward C flux:
    - Passive: feces, carcasses
    - Active: vertical migration

4. Compare current knowledge to science on zooplankton carbon flux *– some POC figures missing here*

Research on fish carbon flux - Synthesis

1. Mesopelagic DVM fishes can contribute ~30-40% of total carbon flux – *need text on this*

2. Fecal pellets – rapid sink rate and low decomposition

3. Gut carbonates may provide up to 15% of total oceanic carbonate production

4. Carcasses – *need text on this*

Challenges – Research Gaps

Fish biomass: orders of magnitude of uncertainty in DVM fish biomass measurements

Location of studies is limited *– need text on this*

Active flux

Research methods to measure active flux, sediment traps don´t measure this.
DVM fish respiration *(-Debbie)* (Relate ETS method with in situ resp. measurements etc.) *(-Santiago)*

Fish community composition: are some groups more important at mediating transport? E.g. coastal epipelagic fish v. open ocean mesopelagic fish

Challenges – Research Gaps

Passive flux:

Fish fecal pellet –

- production rate (N of pellets produced per fish per day)
- sinking rates
- carbon content of fecal material

Carcasses – contribution of deadfall to C flux. What % biomass die, are eaten, sink ? *– need text on this*

PIC component *– need text on this*

Overcoming Challenges

Fish biomass: Use minimum and maximum biomass number to get a range of potential flux; minimum number will constrain biogeochemical models

Active flux: (TBC)
Bioenergetics of DVM fish – *Need text on this (Debbie/Santiago)*

Passive flux: Embrace the knowns & unknowns to target where real data desperately needed:

- Get reasonable maximums and minimums for all the parameters
- Produce a distribution of likely output numbers, using ranges for all parameters
- Identify which parameters are most responsible for uncertainty

Overcoming Challenges

Passive flux cont.:

Feces –

- Combine production and sinking rates measured in lab, extrapolate to fish abundance in situ; or
- Estimate fecal production rates through bioenergetics (noting these rates are dependent on many factors (i.e., temperature, diet, season, etc.)
- Rough estimate of primary production to biomass to fecal pellets – *Need text on this*
- Biomass-specific (not species-specific) fecal pellet production rate
    - Epipelagic and mesopelagic fish (migrating vs. non-migrating)
    - Size range (smaller orgs have higher weight-specific metabolism)

Carcasses – *Need text on this*

Research Priorities *– Need text on this section*

With better measurements/estimations of biomass, active and passive flux, and simultaneous measurements of zooplankton/fish/total flux, could:

~~Calculate relative contribution of active vs. passive flux to total flux~~:

- ~~No studies with both passive and active flux from fish. This is an imperative exercise to take on in order to derive total fish flux values across regions (average, range).~~
- ~~Comparing locations (e.g. shallow coastal vs. deep open ocean) as a proxy for passive and active. Need for more studies.~~

Calculate relative contribution of fish flux to total flux (vs. fluxes mediated by other groups, including zooplankton)