Atlantis Course Universidad de Concepción

Day 4 - Biology & Ecology

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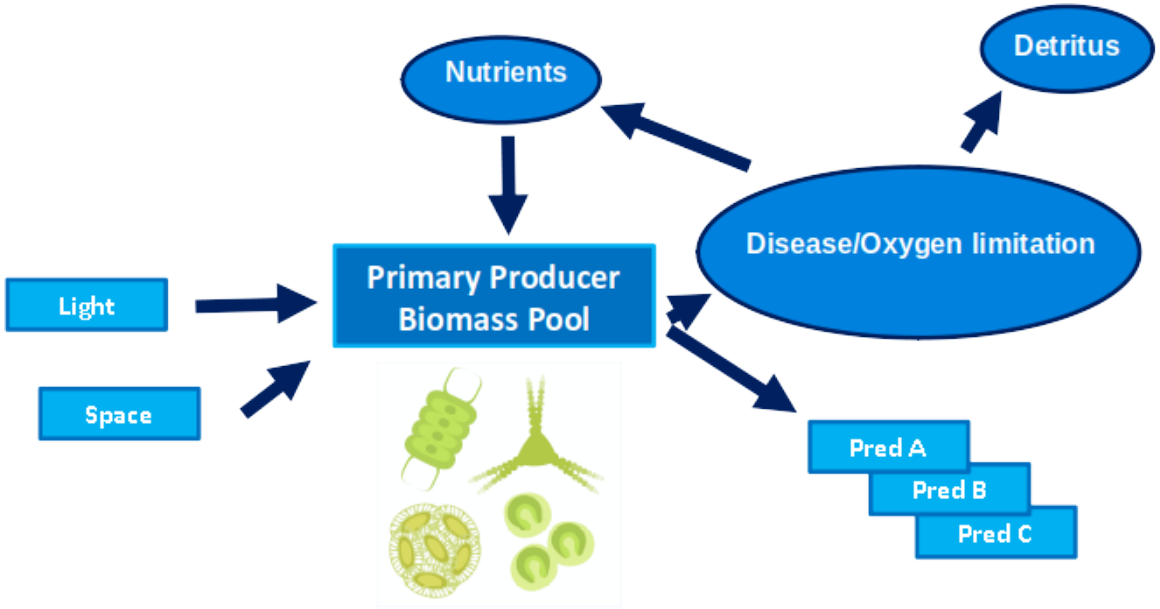
CSIRO Ocean & Atmosphere
www.csiro.au

Primary producers

$$\frac{\delta P_i}{\delta t} = P_i \cdot \alpha_{light} \cdot \alpha_{nutrients} \cdot \alpha_{space} \cdot \mu_p - M_p - M_o - \sum_j M_{j,P_i}$$

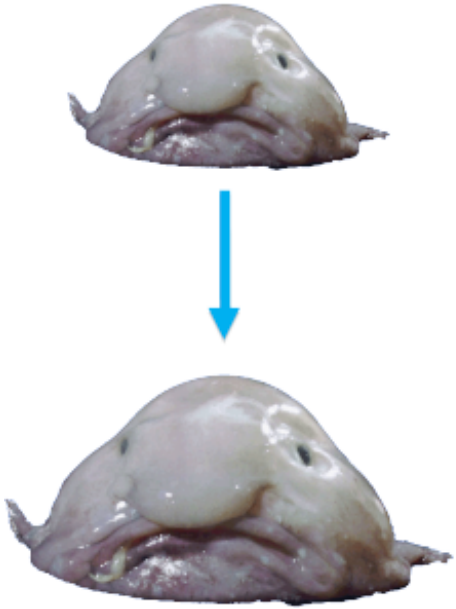


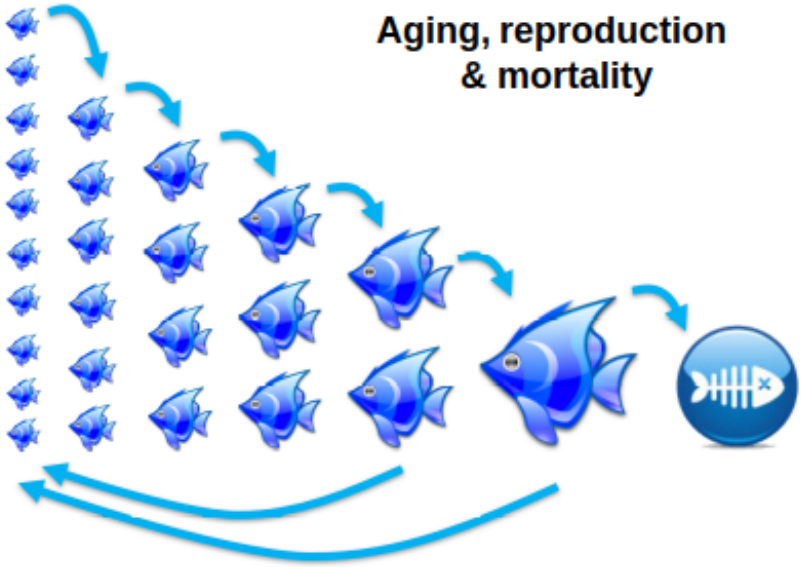
Biogeochemistry+

- Simple versions
- Oxygen
- Explicit N-cycle
  - nitrification, denitrification
- Bacteria (as colonisers)
  - conditions N-cycle
- Ecotox
  - lethal sub-lethal

Ecological representations

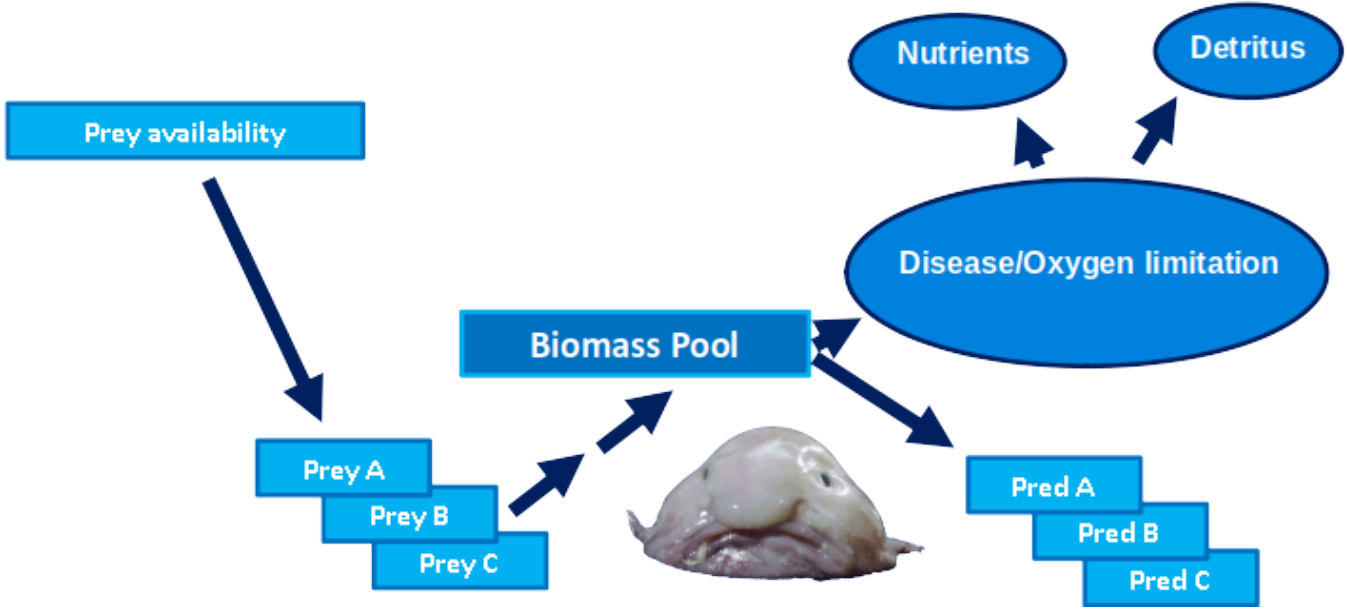
- Functional groups & key species
- Biomass pools & age structured meta-populations





Invertebrates

$$\frac{\delta B_i}{\delta t} = \sum_p B_i \cdot \alpha_p \cdot \epsilon_{assim} \cdot \gamma_{O2} \cdot \gamma_{space} - M_l - M_o - \sum_j M_{j,B_i}$$

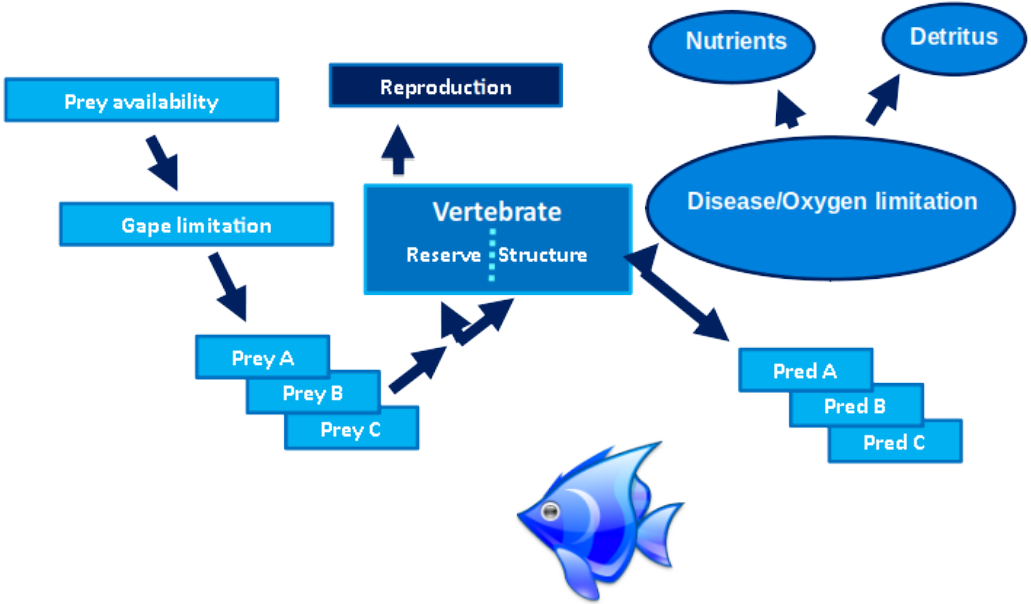


Invertebrates

- Age structure and migration explicit for some groups
- Community structure & resource partitioning
- Definition of groups must be done carefully

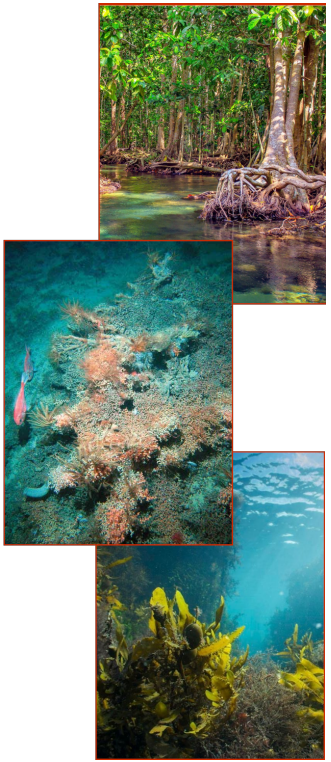
Vertebrates

$$\frac{\delta B_v}{\delta t} = \sum_p B_v \cdot \alpha_p \cdot \epsilon_{assim} \cdot \gamma_{O2} \cdot \gamma_{space} - M_l - M_o - \sum_j M_{j,B_v}$$



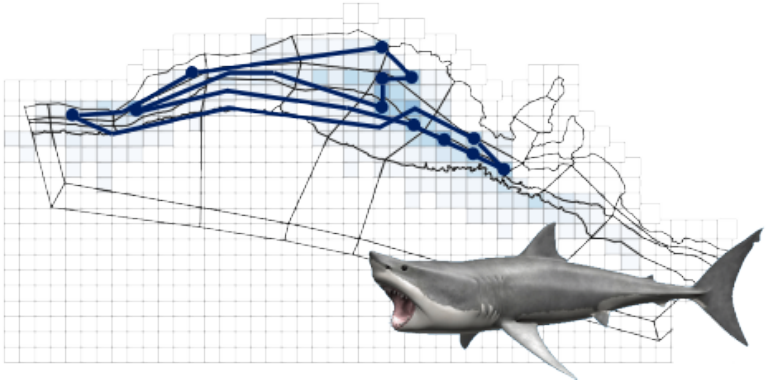
Biogenic habitat

- Spatial limitation
- Biogenic habitat (habitat effects)
  - sessile maximum biomass substrate dependent
  - habitat dependent = availability scaled
  - no age structure (recovery may be too fast)
  - reefs have most detail (rugosity, symbiosis, bleaching)



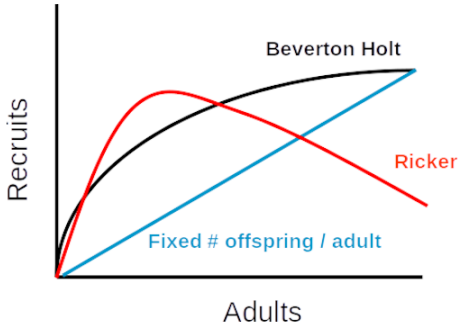
Movement

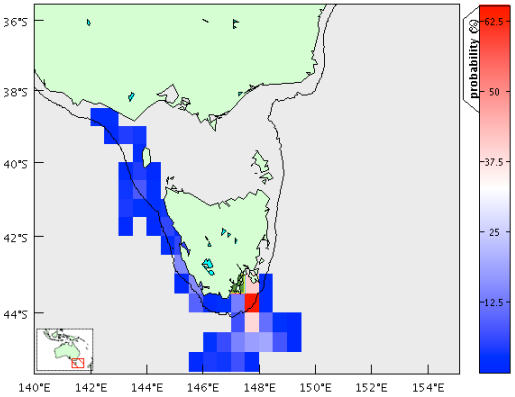
- Quarterly distributions
- Density & food dependent
- Sedentary
- Mixed
- Seasonal migrations
- must intersect with prey or starve
- Interpolate based on cruising speed
- Include if needed to represent ecology of interest
- vertical (access prey, benthopelagic coupling)



Reproduction

- Based on parental condition and environmental characteristics (e.g. temp or salinity)
- ‘Stock-recruitment’ relationships
- Live birth and maternal care
- Young of year recruits
- no explicit larval phase (miss predator-prey switch unless use plankton-based recruitment)
- Adding explicit larvae



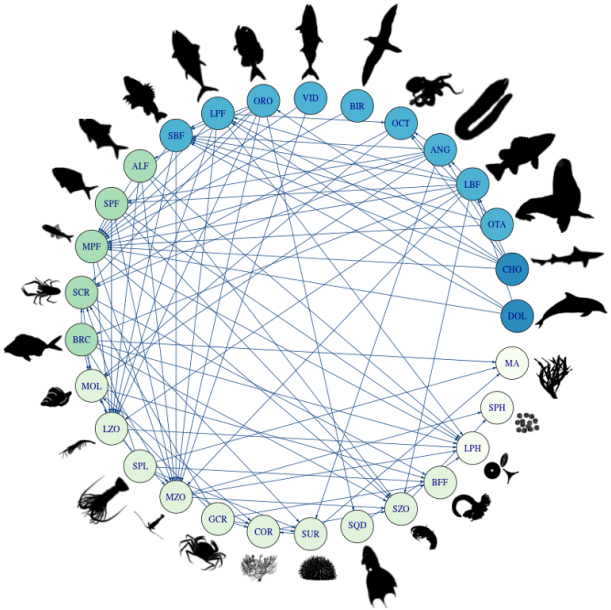


Diets & Consumption

- Maximum potential availability
- realised reduced by actual availability and gape limitation

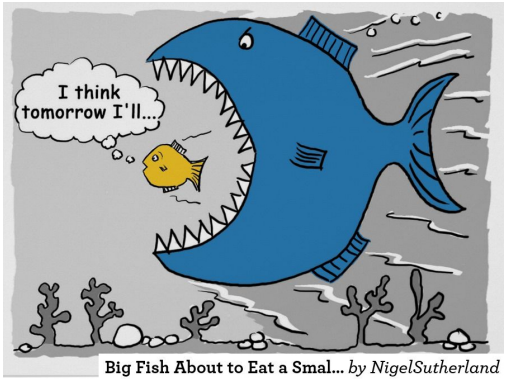
  Careful with Det

- ontogenetic definitions
  - juvenile → juvenile
  - juvenile → adult
  - adult → juvenile
  - adult → adult



Diet Connections

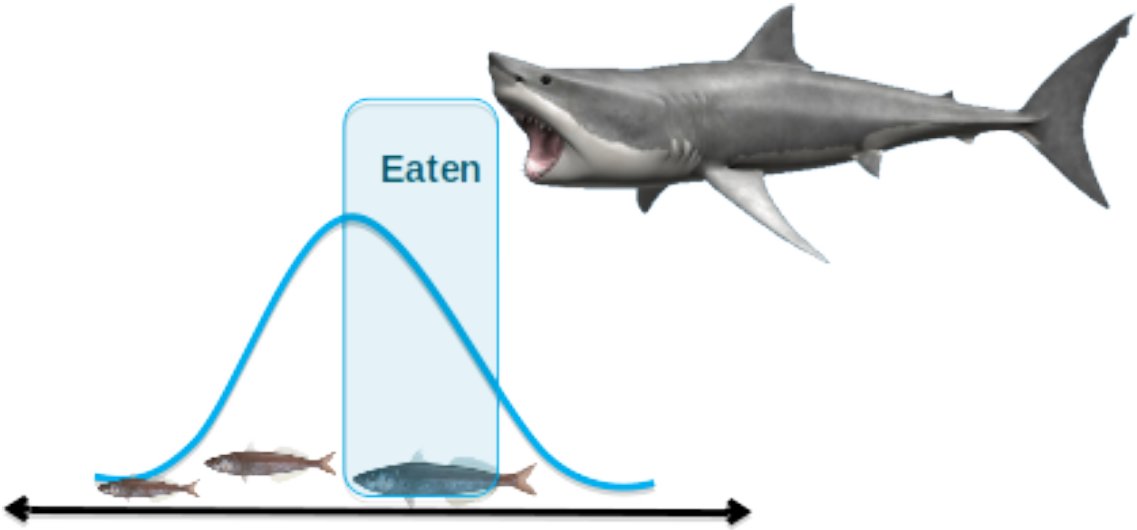
- Non-zero values = commitment
- interaction that seems unimportant may become critical later
- Connections can have non-symmetric impacts
- Use local (cogener) data preferentially
- Size-relationships predator-prey are consistent across systems
- Stomach content problems (soft bodies digest rapidly, patchy data, too few links can impact predictions)



Big Fish About to Eat a Smal... *by NigelSutherland*

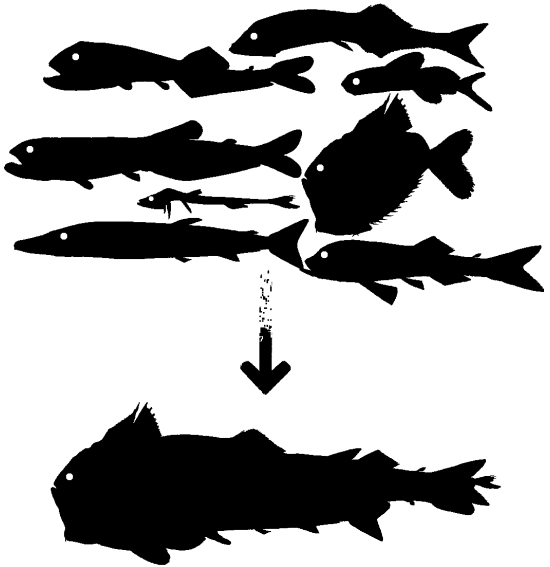
Diet Connections: Gape limitations

- strength = causal mechanism (and emergent diet)
- weakness = makes calibration harder



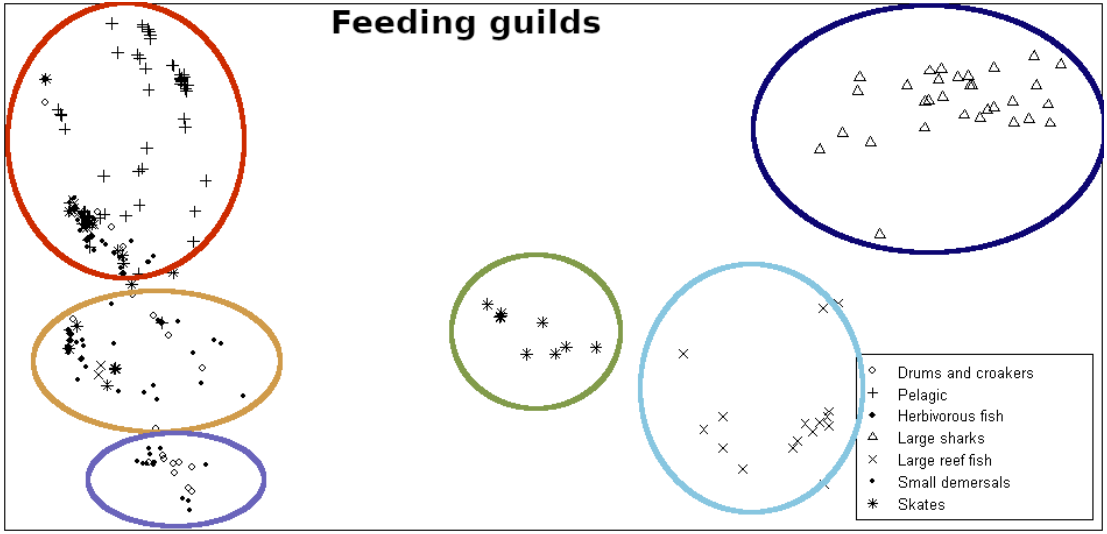
Biological Resolution

- Species vs functional group
- Individuals vs aggregates (pools)
- Pragmatic reasons to aggregate
  - ignorance (little data available to resolve further)
  - computation convenience (model funs faster with less groups)
  - heuristics (lots of groups means teasing out understanding takes longer)



Grouping Methods

- Subjective grouping
- Rule-based (trophic, non-trophic interactions)
- multivariate statistics (clustering, network theory, MDS, factor analysis)



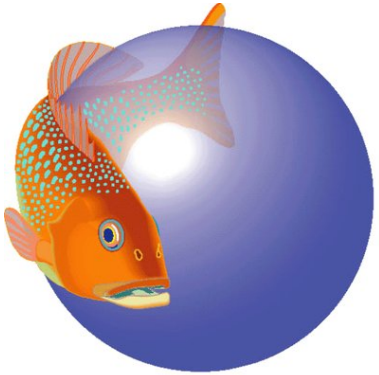
MDS of stomach content data (GoC) - Ainsworth

Biological warnings

- Specialists MAD when you aggregate (don't let that stop you)
- Be alert to implications & try alternatives
  - results can be effected
  - if "centric" have a GOOD reason & be transparent
  - try alternatives

Biological Knowledge Gaps (same as any model)

- carefully consider whether should include/omit (loop analysis helps)
- pedigree data from multiple sources
  - local observations, data from elsewhere, expert opinion
  - becomes part of uncertainty analysis
- identify as critical data need and get data (where feasible)
- When all else fails. . .



https://www.fishbase.de/

Biology starting state

- Biomass distributions set based on:
  - spatial biomass data (e.g., remote sensing, smoothing spline of point data) simple habitat occupancy rules (e.g. depth, habitat affinity etc)
  - spatial segregation of predator and prey
- Adult locations may impact recruitment distributions
- ‘Evolve’ based on group habitat affinities, polygon habitat cover, prey (or nutrient) and predator biomasses, nutrient availability, fishing pressure
- Speed of calibration depends on realism of initial state

Ecology What matters most?

- Recruitment
- Consumption rates
- Diet interactions
- linear and quadratic mortality
- Weight of recruits
- Seasonal distributions
- Growth and mortality while outside the model
- Individual growth rates, length-weight conversions
- Max age, and age-at-maturity
- Habitat preferences
- Migration patterns and timing

Thank You

Ocean & Atmosphere

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