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An ecosystem perspective on stock recovery in the presence of life-history changes

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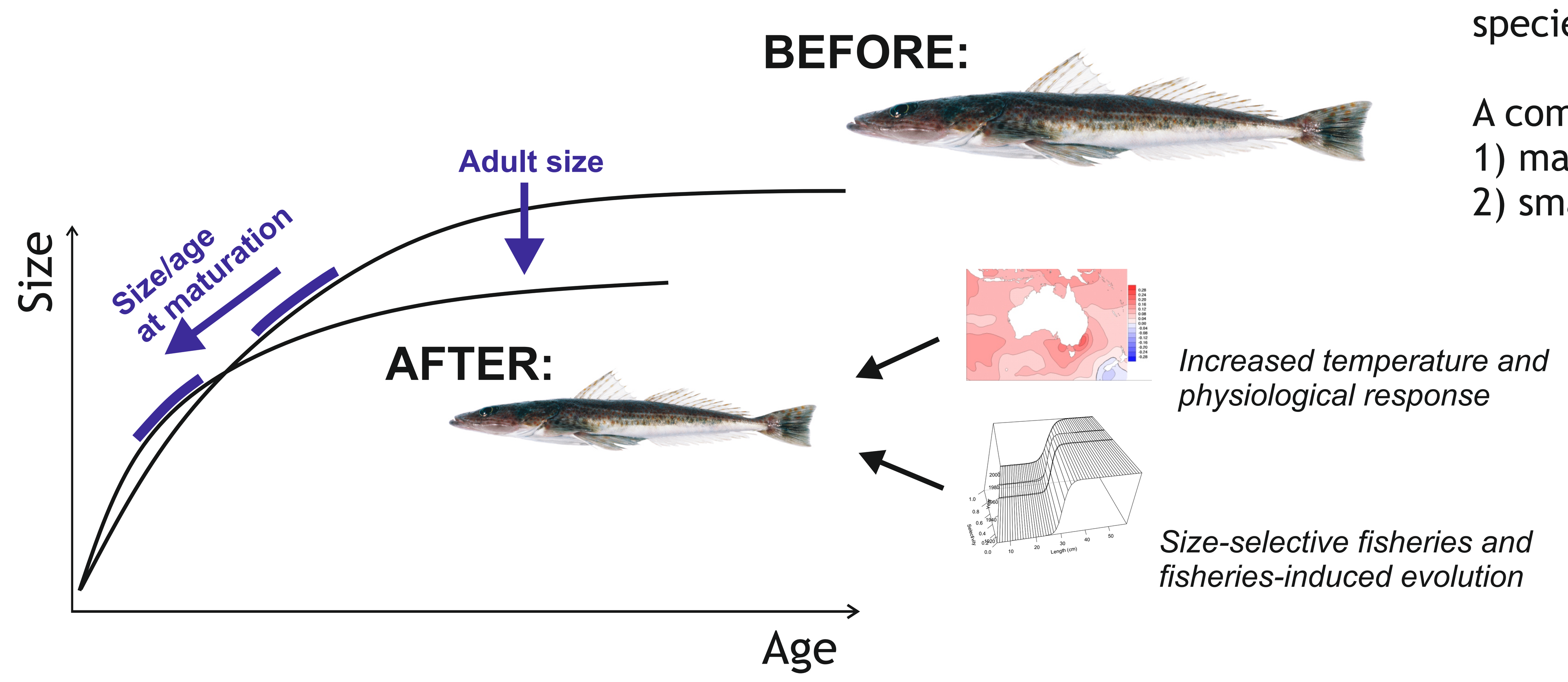
1. Background and main question:

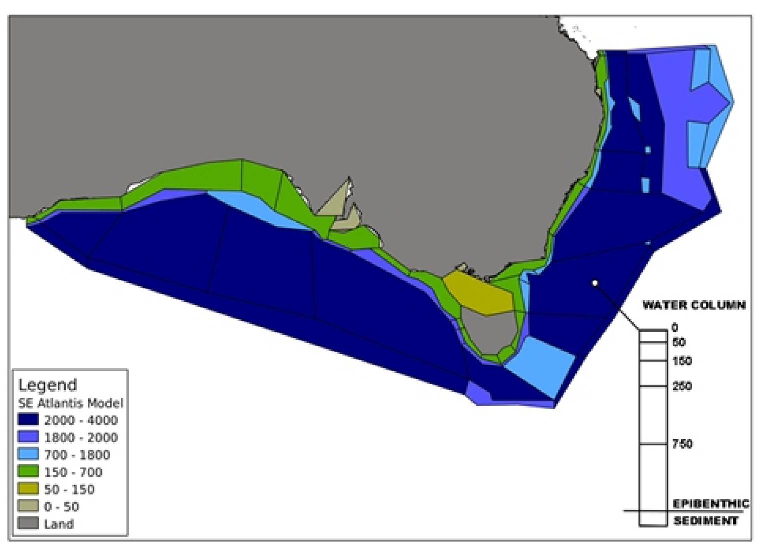


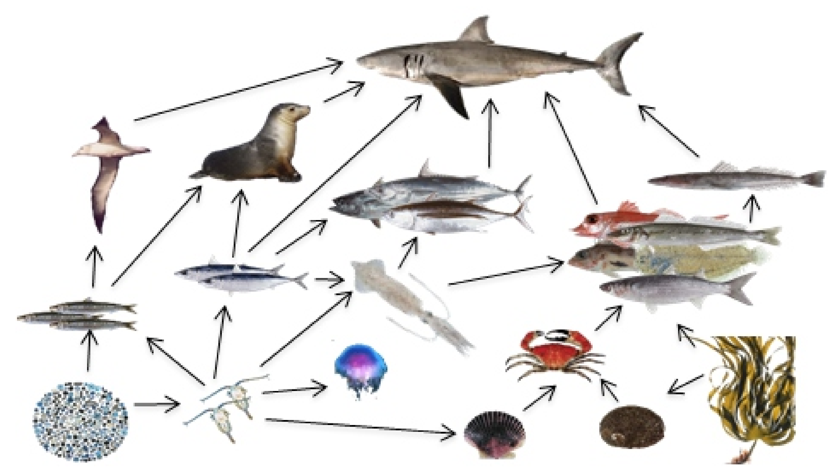
Empirical and theoretical studies show that life-histories of many fish species are strongly affected by fisheries and climate change.

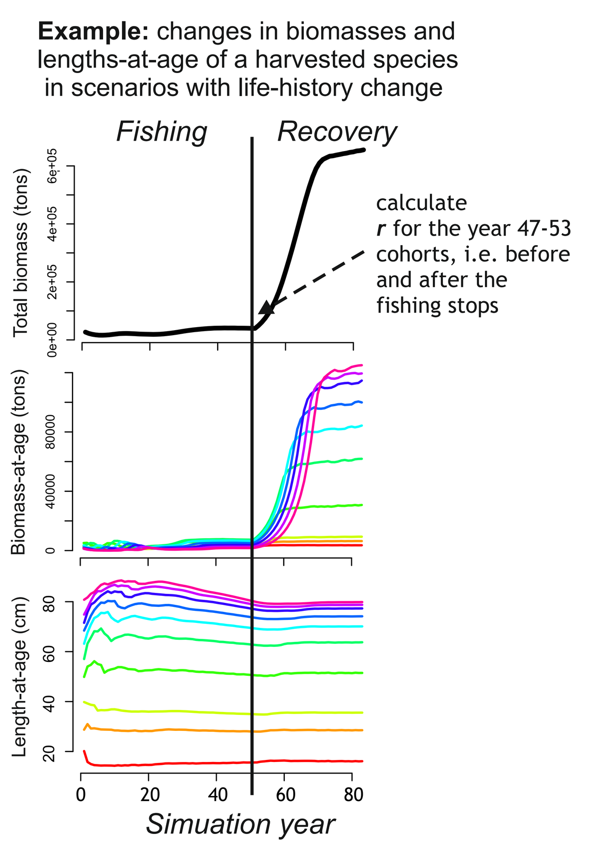
A common trend of life-history change is towards:
1) maturation at earlier age and smaller size
2) smaller adult size-at-age

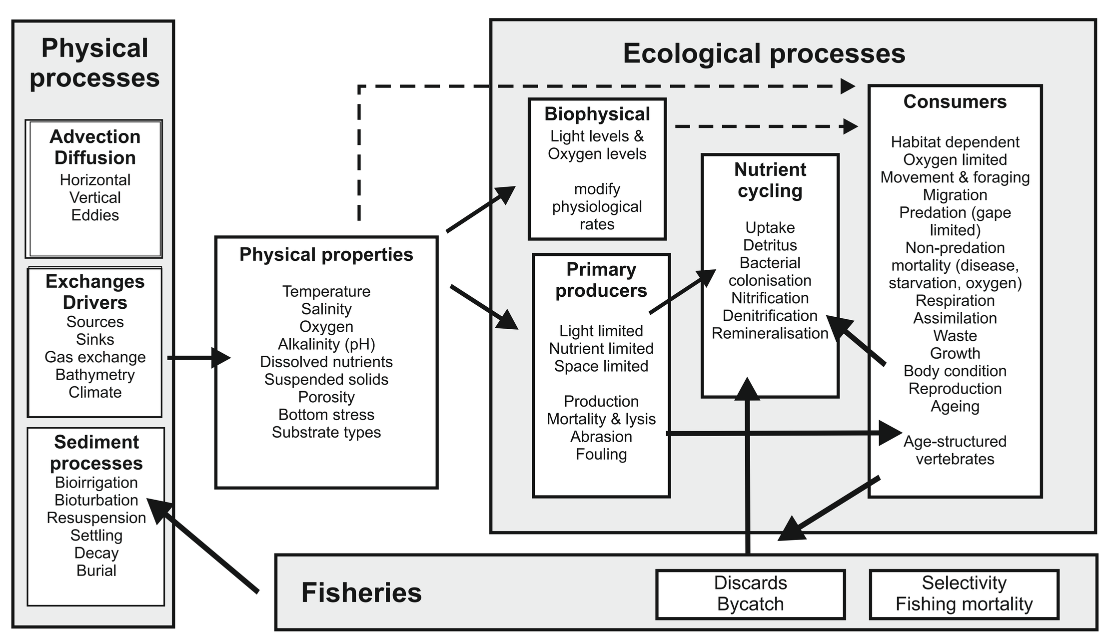
Does this life-history change affect stock recovery rates?

2. Methods:









1. We used South East Australian marine ecosystem model (in Atlantis framework) to assess how population per capita growth rates (*r*) are affected by earlier maturation and decreased adult body size.

2. Simulation design: 50 years of fishing for 10 species of different trophic level and life-history characteristics followed by 33 years of fishing moratorium

3. During the 50 years of fishing adult body size of fished species was forced to decrease by a total of 10-12%, juvenile body size incresed by 2-5% and age of maturation decreased by 1-2 years. Once fishing was stopped life-history traits remained the same as in year 50. Baseline simulations run with same fishing rates but no life-history change

4. Per capita population growth rates (*r*) calculated for different cohorts using life-history tables of stage specific survival and fecundity and compared among scenarios with and without life-history change

$$\boxed{r = \ln (R_0) / G}$$

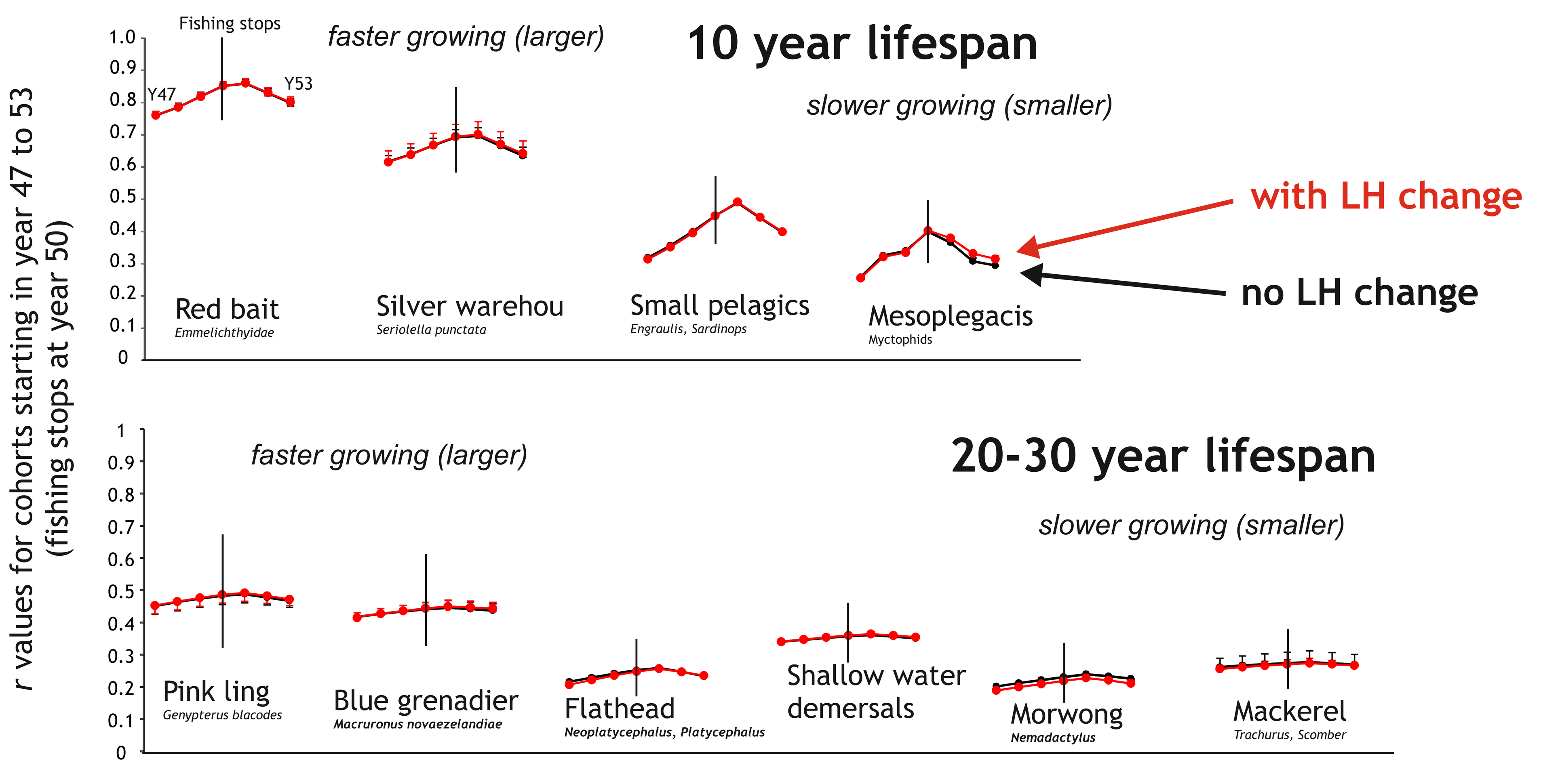
Reproductive value: $R_0 = \sum_{x=\text{age at maturity}}^{x=\text{age at death}} l_x f_x$

Generation time: $G = \dfrac{\sum l_x f_x x}{\sum l_x f_x}$

l_x - survival to age x
f_x - fecundity to age x

The *r* values calculated in the Atlantis framework require some approximations and should not be compared with absolute *r* values from empirical data

3. Results:



error bars show min-max values from alternative simulation designs

1. Increased juvenile growth rate, earlier maturation and smaller adult body size compensate each other and have negligible final effect on ***r***
2. Differences among species are considerably larger than the effects of life-history change
3. Per capita population growth rate mostly depends on the individual growth rate; fast growing and early maturing species have higher ***r***

Life-history changes expected from fisheries-induced evolution or increased temperatures have only minor effect on the short-term rate of stock recovery

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