

Using Dynamic Energy Budget Models to Assess the Impact of Disturbance on Life History and Population Dynamics of Medium-Sized Cetaceans

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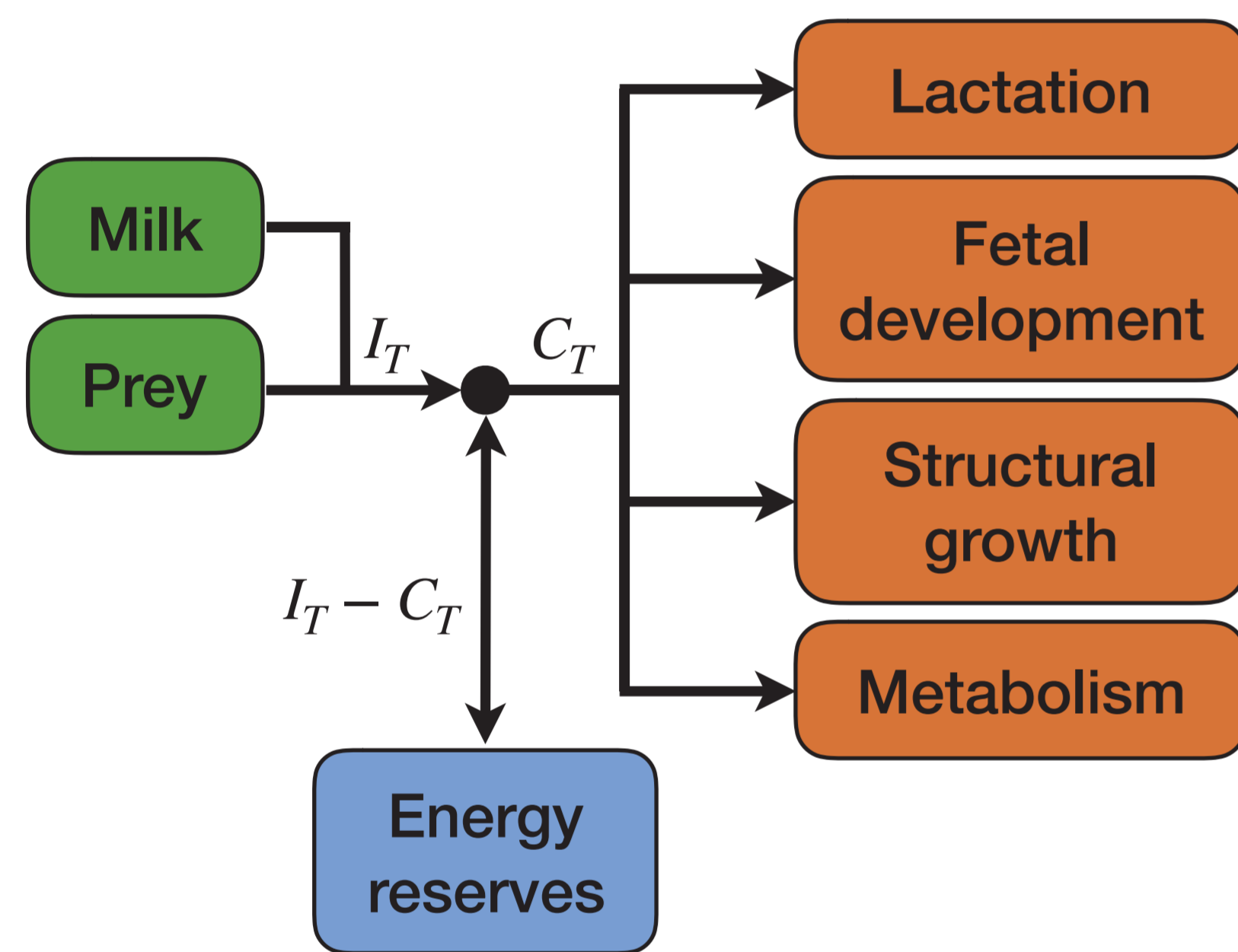
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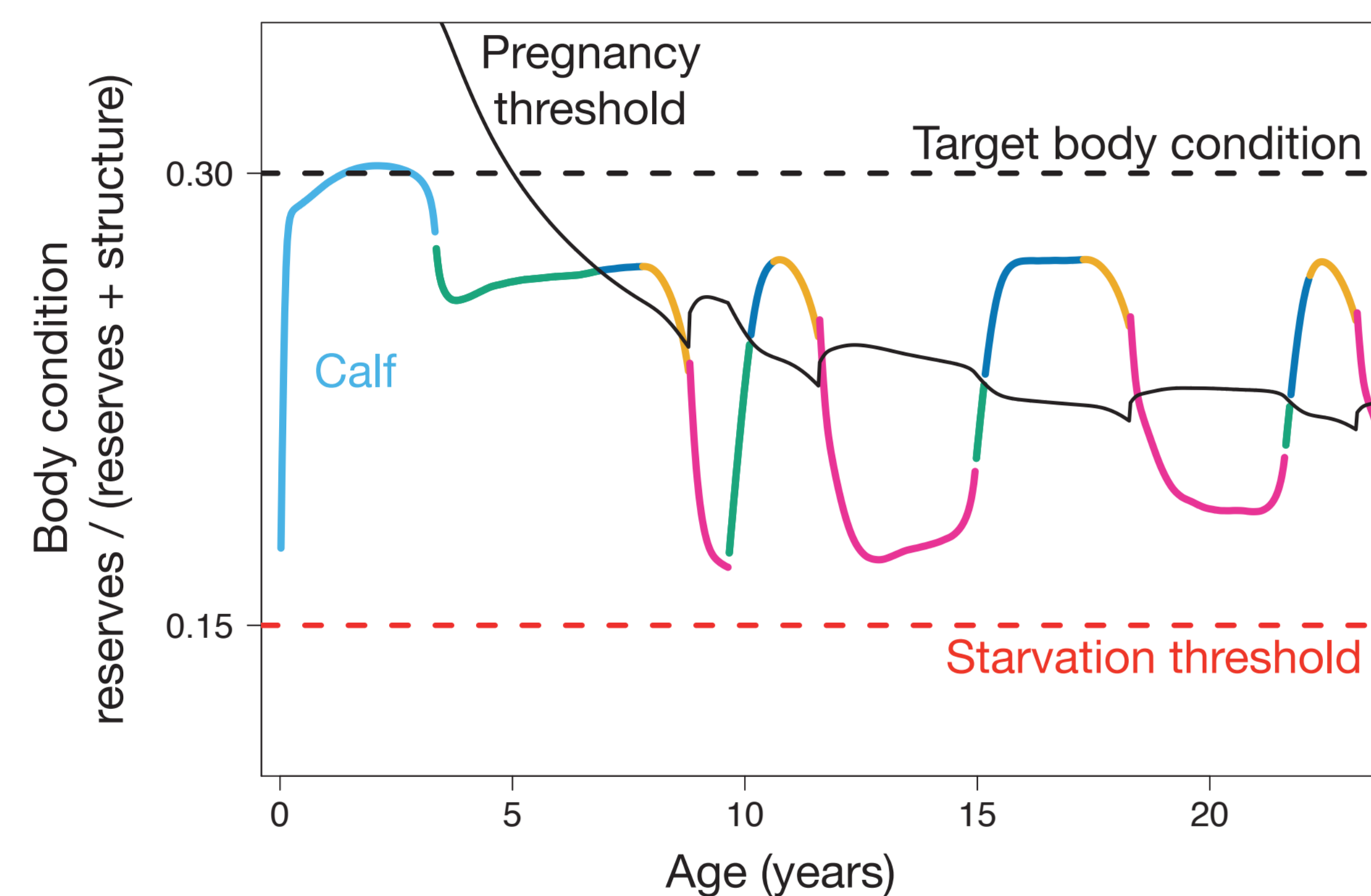
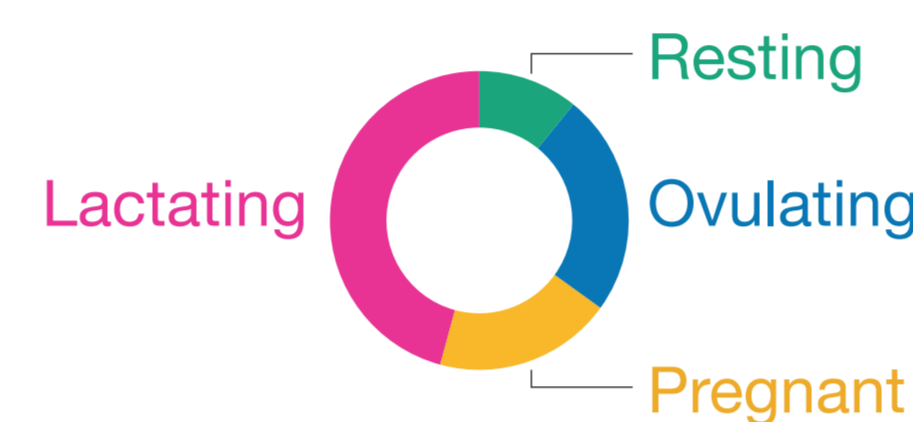


Energetics shape whale life history

Whales are composed of structural mass and energy reserves. Difference between incoming and outgoing energy determines amount of reserves. Reserves decrease rate of feeding, increase rate of milk supply, initiate reproduction and prevent starvation mortality. Model is parameterized based on pilot whales, *Globicephala melas*.

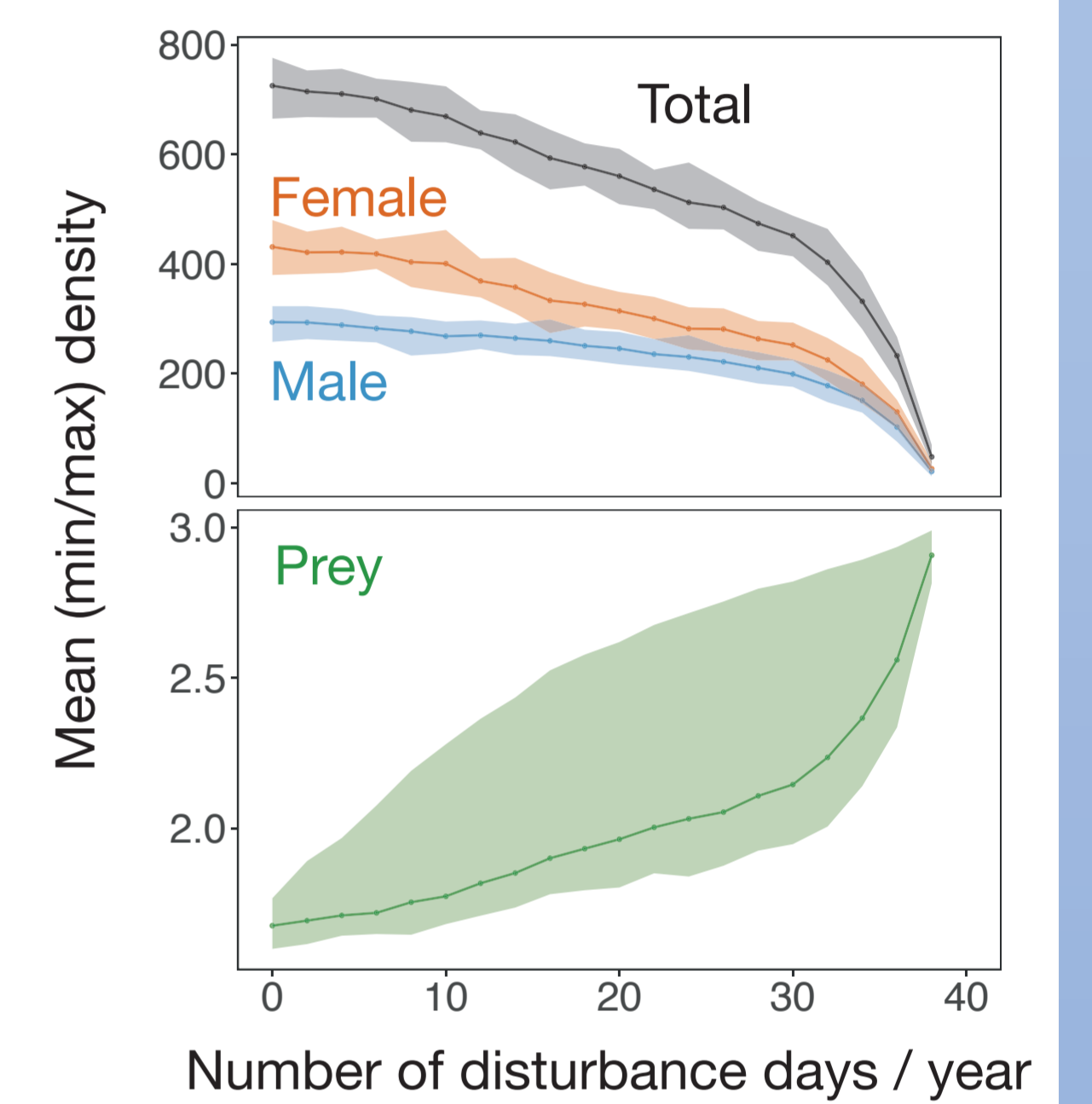


Reproductive cycle



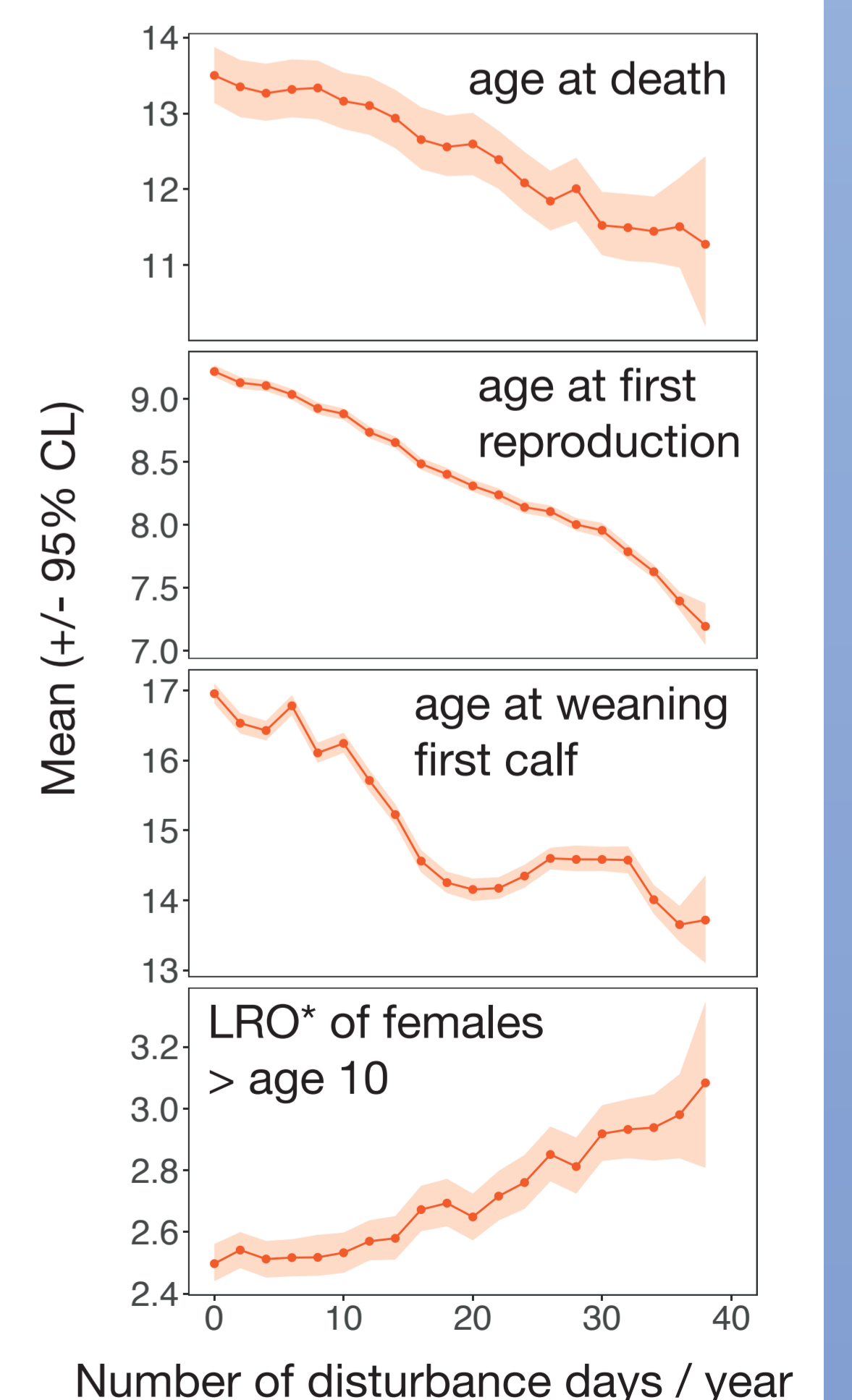
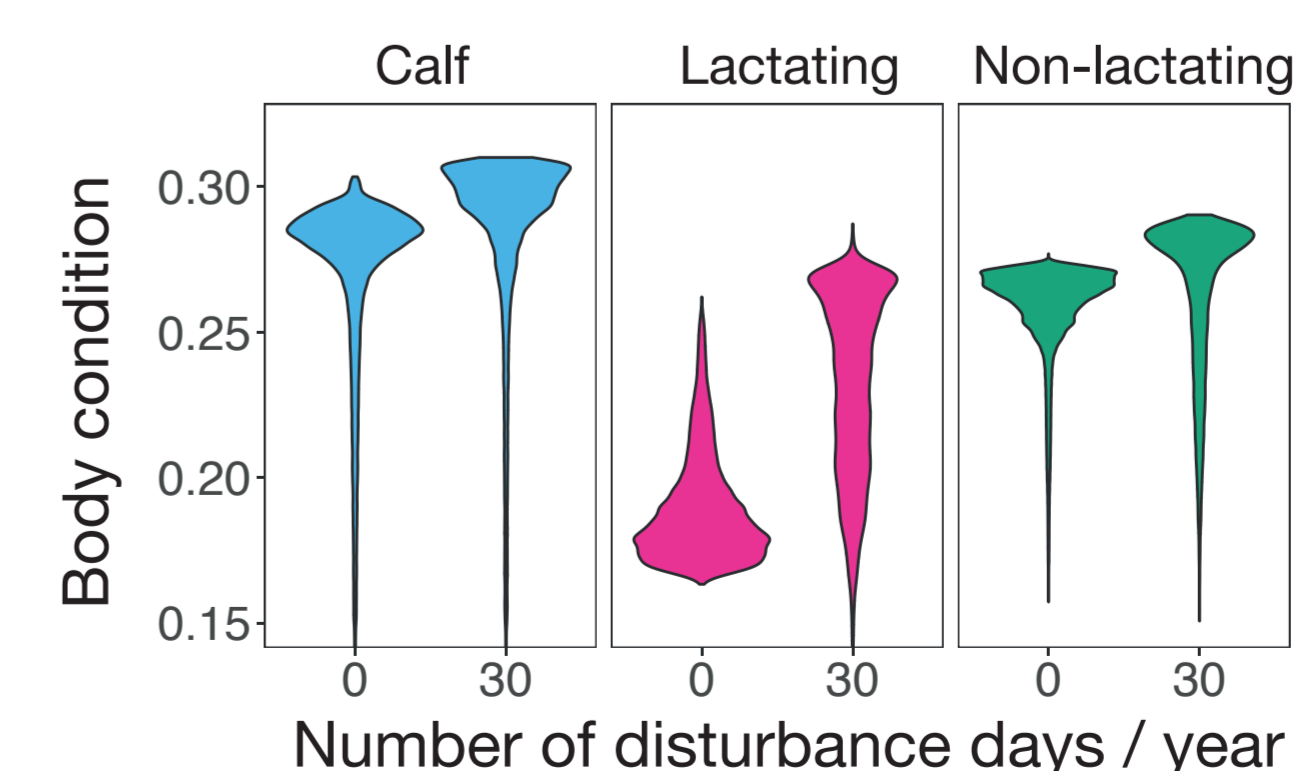
Disturbance decreases whale and increases prey density

Disturbance is modelled as a yearly recurrent, consecutive number of days without feeding on prey. Disturbance decreases whale density in the stationary state ('carrying capacity'). Reduction of top-down prey control increases mean prey availability.



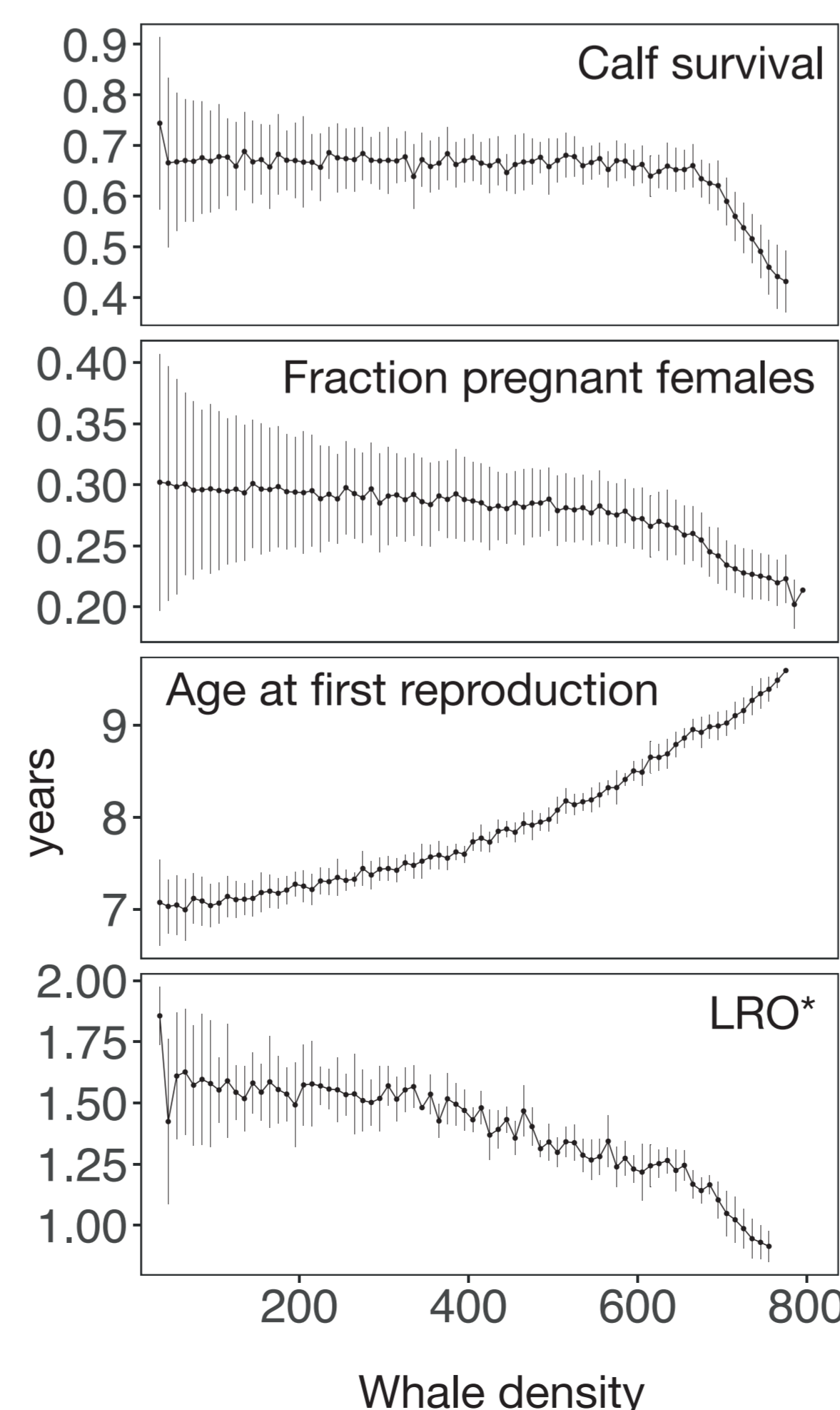
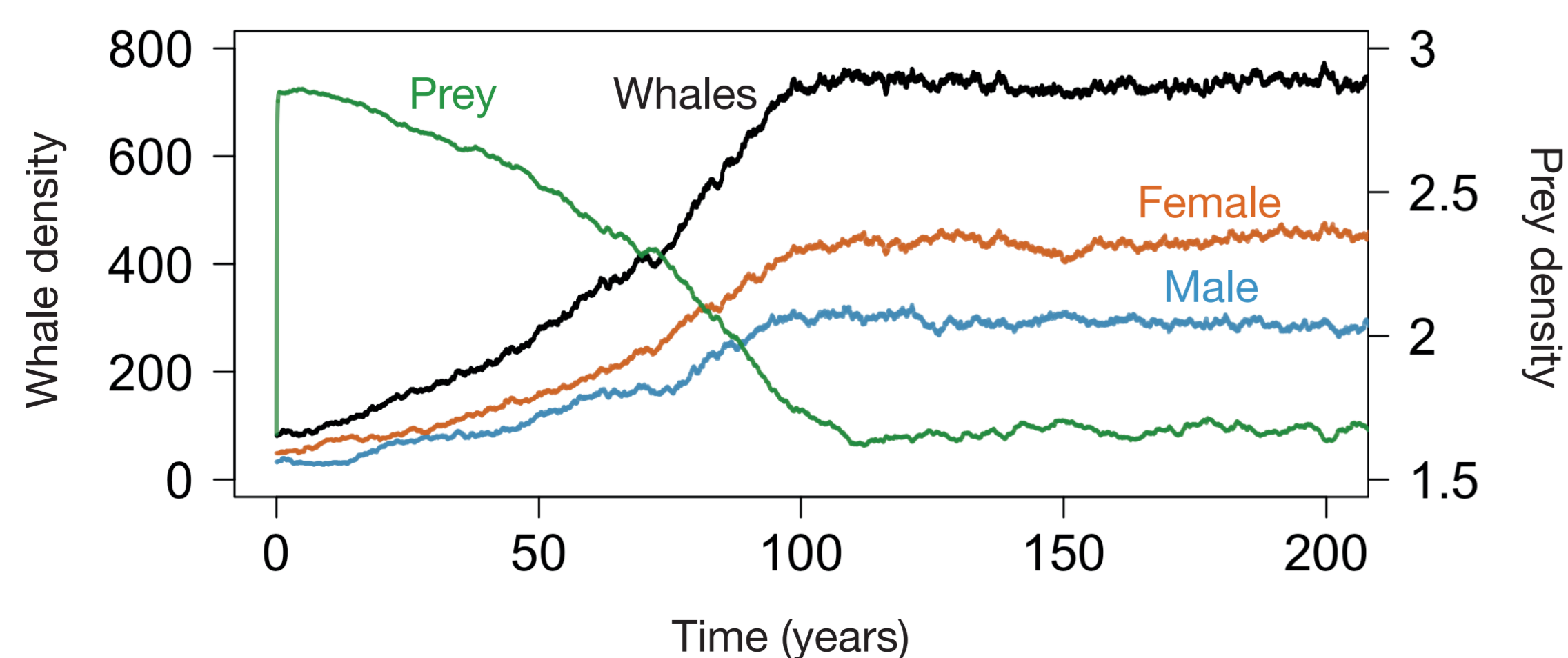
Increased prey density masks negative effects of disturbance on whale life history

Disturbance increases mortality among females during lactation of their first calf, which decreases overall female life expectancy. However, surviving females benefit from increased prey density and have improved body condition (below), earlier birth and weaning of first calf and higher reproductive output beyond age 10 (right).



Density dependence results from prey depletion

We use individual-based modeling to simulate a whale population that feeds on a self-replenishing prey base. Prey depletion by whales limits energy availability and decreases energy reserves. This induces life history changes that stabilize population growth (below). Relationships between demographic rates and whale density (right) are an emergent property of the model.



*Lifetime Reproductive Output = number of female calves born per female

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